Background Report for the Development of the Reference Document on Best Environmental Management Practice in the

Public Administration Sector

Final Draft

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This document has been prepared by ICLEI European Secretariat with the support of Ambiente Italia and Lake Constance Foundation

EXECUTIVE SUMMARY

Legal background
On 25 November 2009, the Council and the European Parliament adopted the proposed revision of the EcoManagement and Audit Scheme (EMAS) regulation (EC) No 1221/2009, which went into force on 11 January, 2010.

One of the new elements of this revised regulation is Article 46 stating that sectoral reference documents (SRD) on best environmental management practice (Article 46(1)) shall be developed which shall contain best environmental management practices, sector-specific environmental performance indicators and, where appropriate, benchmarks of excellence and rating systems identifying environmental performance levels.

In particular, four pilot documents for best practices were commissioned to the Institute for Prospective Technological Studies (IPTS), part of the European Commission's Joint Research Centre (JRC): tourism, construction, retail trade and public administration.

Objective of this document
In the future, the aforementioned reference documents shall be elaborated for a range of sectors identified as priorities for EMAS regulation based *inter alia* on their environmental impact and/or their suitability for EMAS uptake. In the case of the Public Administration (PA) sector, ICLEI European Secretariat has been contracted for the collection of background and sector information. This SRD for the Public Administration sector will be compiled by JRC-IPTS, on the basis of this background study prepared by ICLEI ES with the support of Ambiente Italia and Lake Constance Foundation.

Information sources
For drafting this document, information was used from various sources including a number of comprehensive reports. Additional information has been collected directly from the Public Administration Sector, e.g. local governments, local companies and operators working with them. A number of site visits proved to be very useful for obtaining technical and performance data and information on economic considerations.

Intention of this document
The use of EMAS is voluntary for all organisations (art.3 EMAS II regulation) that are interested in applying for the scheme. This document is intended to support environmental improvement efforts of all actors in the Public Administration sector. Consequently this document is not only for EMAS registered organisations but for all actors in the sector with or without an environmental management system and for the policy-making of the Commission.

However, EMAS registered organisations, shall take into account the relevant sectoral reference document(s) when assessing their environmental performance. The same applies to the EMAS environmental verifiers when checking the requirements according to Article 18 of the EMAS regulation.

PREFACE

1. Status of this document

This document is a working draft of a sectoral reference document as mentioned under article 46 of the EMAS Regulation (1221/2009), concerning the Public Administration (PA) Sector.

2. Relevant legal background

The Community Eco-Management and Audit Scheme (EMAS) was introduced in 1993 for voluntary participation by organisations, by Council Regulation (EEC) No 1836/93 of 29 June 1993 (EC, 1993). Subsequently, EMAS has undergone two major revisions:

- Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 (EC, 2001);
- Regulation (EC) No 1221/2009 of the European Parliament and Council on 25 November 2009.

The latest EMAS Regulation followed a large-scale evaluation of the EMAS scheme that began in 2005. This evaluation, together with input from the various stakeholders in the scheme, identified strengths and weaknesses and proposed options to improve the effectiveness of EMAS. Consequently, on 16 July 2008, the Commission adopted a proposal for the revision of the EMAS Regulation as part of the Sustainable Consumption and Production Action Plan (EC, 2008a). The objective of the proposal was to strengthen the scheme by increasing its efficiency and its attractiveness for organisations, and was also aimed to generate a wider influence beyond EMAS registered organisations, by encouraging these organisations to take into account environmental considerations, when selecting their suppliers and service providers.

The proposed changes gave special attention to the needs of small organisations (SMEs and small public authorities) and to the promotion of best environmental practices. Regarding the latter, reinforced environmental reporting through the use of mandatory key performance indicators and sectoral guidance on best practice in environmental management, were added to the Regulation. Best environmental management practice and environmental performance indicators should be developed for specific sectors. The aim was to help organisations to better focus on the most important environmental aspects in a given sector.

The revised EMAS came into force on 11 January, 2010. This document is the last of a set of sectoral reference documents as referred to in article 46 of Regulation (EC) No 1221/2009. This document describes best environmental management practice, and includes environmental performance indicators for specific sectors and, where appropriate, benchmarks of excellence and rating systems identifying performance levels. The use of this reference document is voluntary but EMAS organisations are strongly encouraged to use them for setting up their environmental management system and for defining their environmental targets. Reference documents are publicly available without any charge for use by every organisation that wishes to improve its environmental performance, irrespective of whether or not a formal environmental management system is in place.

Box 1-1. Article 46 of Regulation (EC) No 1221/2009, pertaining to sectoral reference documents

Article 46

Development of reference documents and guides

1. The Commission shall, in consultation with Member States and other stakeholders, develop sectoral reference documents that shall include:

(a) best environmental management practice;

(b) environmental performance indicators for specific sectors;

(c) where appropriate, benchmarks of excellence and rating systems identifying environmental performance levels.

The Commission may also develop reference documents for cross-sectoral use.

2.The Commission shall take into account existing reference documents and environmental performance indicators developed in accordance with other environmental policies and instruments in the Community or international standards.

3. The Commission shall establish, by the end of 2010, a working plan setting out an indicative list of sectors, which will be considered priorities for the adoption of sectoral and cross-sectoral reference documents.

The working plan shall be made publicly available and regularly updated.

4. The Commission shall, in cooperation with the Forum of Competent Bodies, develop a guide on registration of organisations outside the Community.

5. The Commission shall publish a user's guide setting out the steps needed to participate in EMAS.

That guide shall be available in all official languages of the institutions of the European Union and online.

6. Documents developed in accordance with paragraphs 1and 4 shall be submitted for adoption. Those measures, designed to amend non-essential elements of this Regulation, by supplementing it, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 49(3).

3. Objective of this document

The aforementioned reference documents are elaborated for a range of sectors identified as priorities for EMAS regulation based on their environmental impact and/or their suitability for EMAS uptake. Specifically, this background document on the Public Administration sector is produced by ICLEI European Secretariat with Ambiente Italia and Lake Constance Foundation and will then be developed in the final reference document by the Institute for Prospective Technological Studies (IPTS), part of the European Commission's Joint Research Centre. In particular, Lake Constance Foundation is responsible for Chapter 2 and Ambiente Italia for the work on indicators and benchmark of excellence within Chapter 3. The final document will have the same structure of the other reference documents. Public Administration and in particular local governments are the main objective for EMAS implementation. Thus, a major task of this work is to produce inside knowledge of the practices, indicators and processes that are necessary for a successful implementation of EMAS within public administrations.

4. Information sources

Concerning environmental management and available measures to increase environmental protection and sustainability within this sector, a lot of information is already publicly available from various sources including a number of comprehensive reports. For drafting this document, such information has been considered along with information collected directly from public

administrations and other stakeholders, including local operators and non-governmental organisations. A number of site visits proved to be very useful for obtaining technical and performance data and information on economic considerations.

5. How to understand and use this document

EMAS is a voluntary scheme. This document is intended as a support tool for all the actors in the PA sector who intend to improve the environmental performance. This means that this document is elaborated not only for those organisations who have implemented EMAS but also for all those who have implemented any other environmental management system or who just want to contribute to increasing environmental protection and sustainability. However, for EMAS registration, the assessment of the environmental performance of the organisation concerned shall take into account the relevant sectoral reference document(s).

6. Environmental indicators and benchmarks of excellence

With respect to the development of reference documents, the EMAS regulation states that they shall include environmental performance indicators for specific sectors. They are defined as follows: "…a parameter or a value derived from parameters, which points to, provides information about, and describes the state of the environmental performance of a technique or measure".
Environmental indicators express useful and relevant information about the environmental performance of an organisation and the efforts done to influence its performance. Annex IV, C of the EMAS regulation states that indicators shall:

a) give an accurate appraisal of the organisations performance;

b) be understandable and unambiguous;

c) allow for a year to year comparison to assess the development of the environmental performance of the organisation;

d) allow for comparison with sector, national or regional benchmarks as appropriate;

e) allow for comparison with regulatory requirements as appropriate.

The indicators can be designed as:

- absolute indicators;
- relative indicators;
- aggregated indicators;
- weighted indicators.

Annex IV, C foresees the use of absolute and relative (or normalised) core indicators for the following key environmental areas:

- energy efficiency;
- material efficiency;
- water;
- waste;
- biodiversity;
- emissions.

In the same Annex it is stipulated in relation to the previous core indicators that “where an organisation concludes that one or more core indicators are not relevant to its significant direct environmental aspects, that organisation may not report on those core indicators”.
Finally, Annex IV, C states that “each organisation shall also report annually on its performance relating to the more specific environmental aspects as identified in its environmental statement and, where available, take account of sectoral reference documents as referred to in Article 46”.

This document reviews the most significant environmental aspects of the Public Administration sector and for each of them describes the most relevant indicators. Selected indicators will be identified as absolute indicators (type A) and relative indicators (type A/B).

An environmental indicator may be appropriate for a certain territory or administration, but may not be for others. If an indicator can be applied to many territories or administrations of a similar type, a benchmark may be derived from it.

The choice of a set of indicators for a Public Administration deals with many different issues, starting from data availability and the capacity of monitoring the most significant environmental aspects. Sometimes there are indicators which have been imposed on Public Administration by higher authorities and Public Administration have less freedom to select indicators suiting their particular needs. Indicators, in general, can be used to compare year on year trends or to compare the performance of one organization with another. Some indicators, like air quality or production of waste, are related to the territory or to the citizens’ habits. Other indicators, like water consumption per employee or kWh consumption per square meter of public buildings’ surface, are directly related to the organization itself.

The different issues which have to be taken into account in the definition of the most suitable set of indicators implemented by a PA could be summarized as follows:

- significance of the environmental aspects (direct and indirect);
- data availability;
- objective monitoring or assessment of the performance;
- evolution over time within the organization;
- benchmarking between similar organisations/activities/processes.

At European level many indicators have been developed for local governments. Reference should be made to these indicators instead of creating new ones, in particular: Green Capital Award, Reference Framework for Sustainable Cities, Covenant of Mayors, Capital for Biodiversity, Green Cities Index.

Benchmarks among Public Administrations can be defined using different approaches. They can vary from the best performance achievable ever or achievable by very few, to current/potential average in the Public Administration sector. Another issue when designing benchmarks relates to the relative success or failure achieved.
A number of regional/national initiatives are already in place to benchmark Public Administrations. In the Netherlands, the average energy use for PA is monitored. In Belgium, targets related to green procurement have been set.
In the following chapters a benchmark of excellence, related to the most significant environmental aspects identified, will be selected considering the capacity to describe the environmental impact and the capacity to evaluate the performance of the Public Administration, informing on what is potentially achievable under certain circumstances using a restricted number of quantitative indicators. Indicators can be attributed with a number. As far as this quantification reflects the best performing organization, it represents the benchmark of excellence. The benchmarks of excellence are reference points against which a Public Administration can compare its environmental performance in order to identify improvement potentials.

SCOPE AND STRUCTURE

The PA sector is made up of over 80,000 organisations throughout Europe, each with their own governance structure. The vast majority of these organisations are concentrated at local level and fall under the competence of local governments (82,893 in total). The sector comprises the general government sector plus (quasi) public corporations (OECD, 2011) and is characterised within Eurostat's classification of economic activities in the European Community primarily according to NACE code O84 (NACE rev. 3): "Public administration and defence; compulsory social security". Other NACE codes are also applicable to the sector, including, but not limited to, A02.0 (forestry, logging, and related service activities), E36 (water collection, treatment and supply), E38 (Sewerage), E39 (Remediation activities), E49.3.1 (urban and suburban passenger land transport), F41.2 (construction of residential and non-residential buildings), etc.

The public sector plays a crucial role in promoting EMAS. First, PAs are the central actor in bringing together the various EMAS stakeholders. Second, these organisations are themselves large and have an environmental impact which can be reduced and documented with EMAS. Third, they can have an impact on environmental focussed procurement through their buying power (Jungwirth, M., 2011).
Public Administrations at all levels have been facing large changes and modernisation phases over the last decades. The necessity to modernise public administration arises from numerous challenges in all EU member states, such as decreasing revenues and increasing public depth; taking on additional tasks without considerable finance; increasing demands on administration; development and implementation of modern ICT systems and structures.

However, Public Administrations have still problems to adopt EMAS, because of education of servants; procedures already implemented; and streamlined structures. Furthermore, many of the issues tackled under EMAS have an effect on other policies. EMAS needs to be integrated into a larger concept of more general management system of the PA.

Unless otherwise stated, this study focuses mainly on public local governments, as the level of implementation and the closest to the citizens.

Following a brief description of the context and scope of this document (current section), Part 1 ('General Information') provides some background information on the Public Administration sector in short chapters:

- Chapter 1.1 regarding the public administration sector in Europe (composition, revenue and expenditures, employment)
- Chapter 1.2 regarding EMAS within the public administration sector
- Chapter 1.3 regarding linking EMAS to European programmes and processes

Part 2 describes the environmental relevance of the sector associated with the activities of PA. In particular the following aspects are analysed: Climate change mitigation and adaptation; Use of land; Mobility; Air quality; Noise; Waste; Water supply and waste water treatment; Green spaces and biodiversity; Energy; Environmental information /education of citizens and companies; Green public procurement.
The direct and indirect environmental aspects form the basis for the following part on possible solutions.

Part 3 represents the main body of document and presents the 'Best environmental management practices (BEMPs)'. It is divided into two main parts, the first dealing with the focus on making public administration services more sustainable - each addressing a particular **services** over which policy-makers have, or could reasonably be expected to have, a significant degree of control and that have important consequences for environmental performance or impact. The second aims at improving the sustainability of public administration internal processes (green public procurement and integrated environmental management).

The structure to describe the techniques is very similar to the one used in the Best Available Techniques Reference Documents (BREFs) according to the Industrial Emissions Directive, which replaced the IPPC (Integrated Pollution Prevention and Control) Directive with effect from January 2014.

In particular:

- Chapter 3.1 deals with the best environmental management practices for mobility
- Chapter 3.2 addresses the best environmental management practices for environmental services (air quality, noise, waste management)
- Chapter 3.3 deals with the best environmental management practices for urban water management
- Chapter 3.4 deals with the best environmental management practices for green spaces and biodiversity
- Chapter 3.5 addresses the best environmental management practices for energy management
- Chapter 3.6 addresses the best environmental management practices for internal processes within the PAs (green public procurement and integrated management)

Part 4 of the document shows the description of several emerging techniques, focused on the performance of Public Administrations in the fields of resource efficiency, ecosystem services, adaptation to climate change, ICT-enabled governance for smart cities.
Another procedure still in the development phase and therefore only briefly described is the standardisation in the field of sustainable development in communities.

Part 5 of the document summarises the main conclusions on Public Administration best practice, relevant indicators, and proposed performance benchmarks.

Background Report for the Development of the Best Available Techniques Reference Document on
Best Environmental Management Practice in the Public Administration Sector

List of figures

List of tables

1 GENERAL INFORMATION ABOUT THE SECTOR

1.1 Composition of the public sector in Europe

The public administration sector is made up of over 80,000 organisations throughout Europe, each with their own structure, laws and governance style. The vast majority of these organisations are concentrated at local level and fall under the competence of local governments (82,893 in total) (Dexia, 2011). The sector comprises the general government sector plus (quasi) public corporations (OECD, 2011) and is characterised within Eurostat's classification of economic activities in the European Community primarily according to NACE code O84 (NACE rev. 3): "Public administration and defence; compulsory social security". However, other NACE codes are applicable to the sector, including, but not limited to, A02.0 (forestry, logging, and related service activities), E36 (water collection, treatment and supply), E38 (Sewerage), E39 (Remediation activities), E49.3.1 (urban and suburban passenger land transport), F41.2 (construction of residential and non-residential buildings), etc.

NACE codes, however, are problematic when attempting to establish the number of employees within the sector. The codes do not distinguish between public and private activities, but present only totals within a given field. Sectors such as E36 (water collection, treatment and supply) and P (education) are often characterised by a mixture between both public and private employment. This statistical shortcoming means that NACE codes are by and large unsuitable for public administration sector statistics and make it difficult to gauge the true extent of EMAS penetration within the public administration sector.

Table 1.1 illustrates total Government expenditure, revenue, debt and expenditure for 2010.

Table 1.1: Total Government expenditure, revenue, and debt.

	Total Government Expenditure			**Total Government Revenue**			**Total Government Debt**	**Total Government Expenditure**
	Million EUR (2010)			Million EUR (2010)			Million EUR (2010)	Percentage of GDP (%)
	Central	State	Local	Central	State	Local		
Austria	78,047.90	27,354.60	23,583.40	67,712.40	25,418.80	22,223.40	205576.1	71.8
Belgium	105,270.40	53,151.20	24,974.20	93,966.00	50,565.60	24,362.60	340738.5	96.2
Bulgaria	10,109.50		2,477.70	9,234.80		2,604.60	5858.9	16.3
Cyprus	6,694.50		362.1	5,339.30		355.6	10652.6	61.5
Czech Republic	44,800.80		17,718.70	38,851.90		17,252.80	56571	37.6
Denmark	98,877.40		88,025.20	92,974.50		87,473.50	102183.1	43.7
Estonia	4,326.20		1,433.50	4,233.30		1,462.60	956.7	6.7
Finland	50,858.00		40,470.00	40,866.00		39,976.00	86975	48.3
France	473,612.00		228,724.00	361,228.00		227,033.00	1591169	82.3
Germany	385,860.00	317,880.00	193,280.00	327,990.00	300,690.00	183,320.00	2061794.7	83.2
Greece	87,991.00		6,242.00	61,476.00		5,677.00	329351	144.9
Hungary	32,216.00		12,070.10	28,781.80		11,189.70	78249.9	81.3
Ireland	91,463.40		10,451.20	42,414.70		10,503.60	144268.7	92.5
Italy	451,467.00		244,849.00	383,919.00		237,280.00	1842826	118.4
Latvia	4,419.70		2,112.50	3,534.60		2,067.90	8027.4	44.7
Lithuania	6,967.00		3,152.40	5,710.30		3,174.90	10459.3	38
Luxembourg	12,361.00		2,106.10	11,027.60		2,099.70	7672.5	19.1

Malta	2,632.50		38.1	2,405.40		38.9	4250.4	69
Netherlands	185,521.00		102,397.00	160,893.00		97,746.00	369894	62.9
Poland	93,393.20		52,976.30	72,389.50		48,952.50	195425.4	54.9
Portugal	66,897.40		11,231.60	50,675.70		10,878.20	161256.5	93.3
Romania	36,240.70		11,724.20	29,259.70		11,746.90	37409.3	31
Slovak Republic	15,844.40		4,865.30	11,249.20		4,278.20	26998.4	41
Slovenia	11,036.60		3,605.40	9,287.70		3,462.00	13736.7	38.8
Spain	200,144.00	178,017.00	74,198.00	147,190.00	142,132.00	67,349.00	641802	61
Sweden	105,411.00		88,562.70	103,477.40		89,175.60	146467	39.7
United Kingdom	791,061.20		241,063.70	619,989.20		237,533.90	1353278	79.9
EU-27	**3,453,523.80**	**576,402.80**	**1,492,694.4**	**2,786,077.0**	**518,806.40**	**1,449,218.1**	**9812653.1**	**80.1**
Source: Eurostat, 2011								

1.1.1 Composition of the public administration sector in Europe

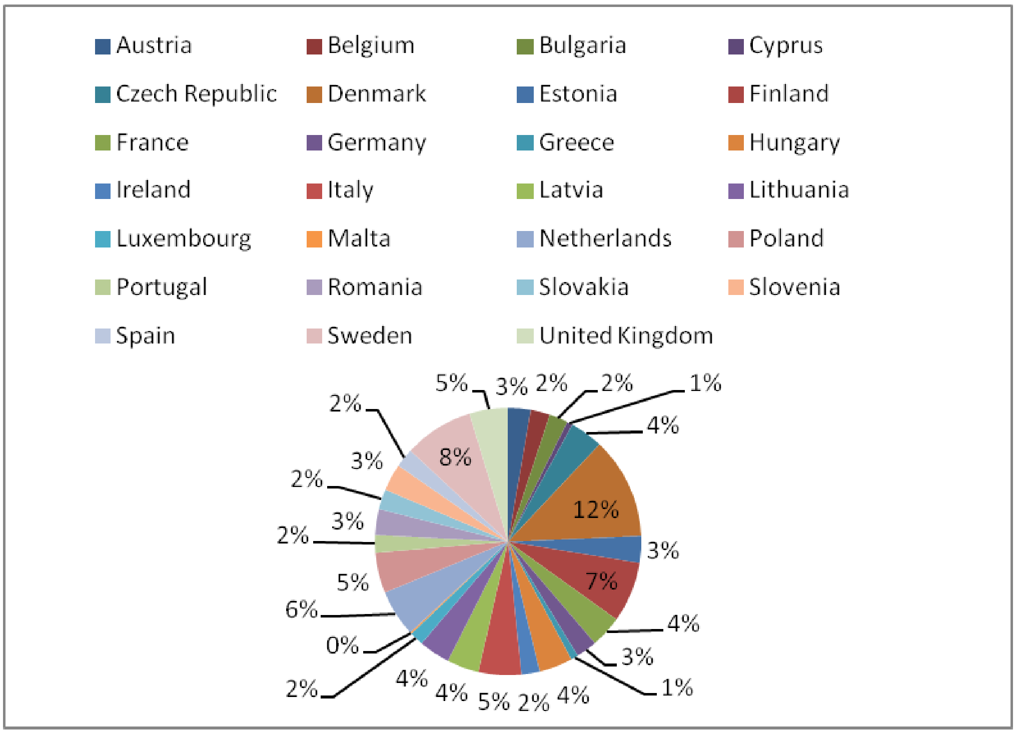

Figure 1.1: Local government expenditure as a percentage of total GDP by country

Local government expenditure as a percentage of total GDP by country is represented in Figure 1.1. Local government expenditure within the EU-27 stood at EUR 1,453,826.3 million or 12.3 percent of GDP in 2009 (this figure saw a slight dip in 2010, falling by 0.2 percentage points). At central government level, expenditure rose to 28.1 percent in 2010, up 0.4 percentage points from 2009. Amongst the EU-27 Denmark has the highest general government expenditure (central, state, or local government + all social security funds at every level of government + all non-market, non-profit institutions that are controlled and mainly financed by government units) in relation to GDP, at just under 60 percent. Expenditure outweighed revenue intake in each government sector, with central government expenditure EUR 667,446.8 million higher than revenue in 2010. Local government revenue stood at EUR 1,449,218.1 million in 2010, up from EUR 993,580.3 million in 2000. Since 2000 local government revenue within the EU-27 has increased by one percentage point, to 11.8 percent of total GDP. Figure 1.3 shows central government expenditure against central government revenue 2010 for the EU-27 as a whole.

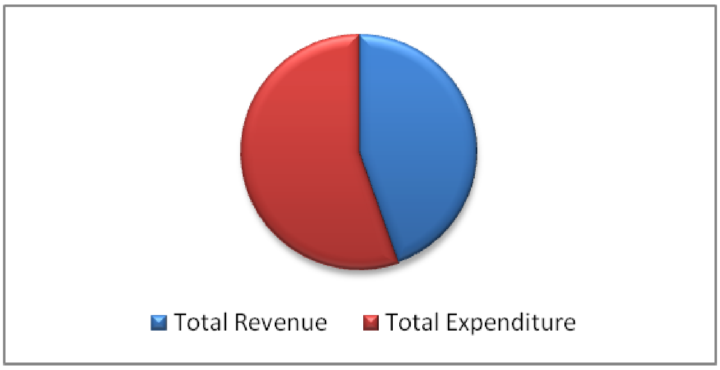

Figure 1.2: Central government expenditure against central government revenue 2010

1.1.3 Public sector employment in Europe

Table 1.2: Public sector employment in EU-27

	Total Public Sector Employees	**NACE Code O84 Employees**	**Total labour force**
	Total Number*	Total Number (2010)	Total Number (2010)
Austria	349,205	287,000	4,096,300
Belgium	1,020,620	409,000	4,488,700
Bulgaria	627,590	236,500	3,052,800
Cyprus	70,452	28,900	385,100
Czech Republic	965,600	327,100	4,885,200
Denmark	763,300	160,400	2,717,600
Estonia	157,700	39,700	570,900
Finland	696,000	116,100	2,447,500
France	5,201,100	2,561,000	25,735,800
Germany	4,600,000	2,789,100	38,737,800
Greece	1,022,100	369,900	4,388,600
Hungary	722,000	315,400	3,781,200
Ireland	405,200	104,300	1,843,700
Italy	3,311,582	1,451,700	22,872,300
Latvia	284,216	62,000	940,900
Lithuania	398,027	81,200	1,343,700
Luxembourg	24,662	22,900	220,800
Malta	40,608	155,000	164,500
Netherlands	1,859,800	541,600	8,370,200
Poland	3,190,700	1,071,600	15,960,500
Portugal	512,355	303,600	4,978,200
Romania	1,723,400	459,300	9,239,400
Slovak Republic	487,765	195,100	2,317,500
Slovenia	233,894	57,900	966,000
Spain	3,217,500.00	1,435,300	18,456,500
Sweden	1,249,580	272,500	4,545,800
United Kingdom	6,162,000	1,851,700	28,941,500
EU-27	**39,296,956**	**15,705,800**	**216,449,000**
Source: Eurostat, 2011			

* Numbers are indicative rather than representative due to varying years being used for data, depending on most up to date statistics available.

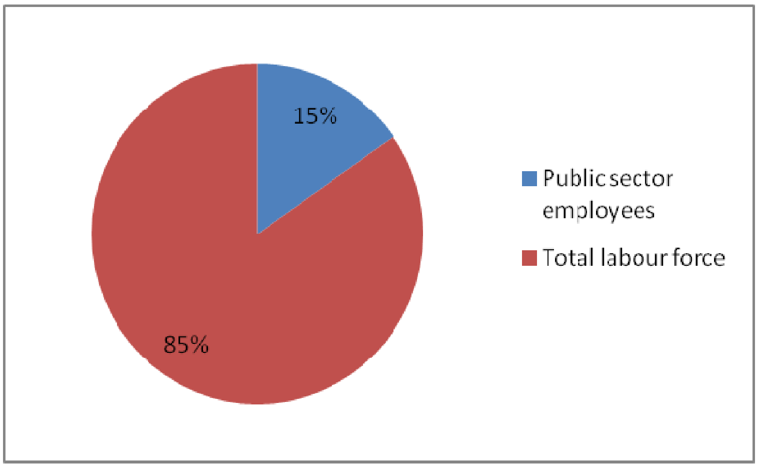

Figure 1.3: Public sector employees against Total labour force in EU-27

As can be seen by the data presented in table 1.2, the public administration sector is a major employer within the EU-27, accounting for over 39 million employees from a total workforce of 216,449,000 (making up around 15 percent of the Total labour force, as graphically represented by Figure 1.3). Among the highest public administration sector employers are Norway and Denmark, with over 30 percent of their workforce within the sector, followed by France on 24 percent. These statistics indicate the potential for EMAS to connect with a great number of people through targeting the sector.

On a purely numeric basis the United Kingdom has the largest public sector employment in Europe, with 6,162,000 state employees (2011). Luxembourg has the smallest with 24,662 state employees (2011). Interestingly both countries employ an almost identical number taken as a percentage of the total labour force, coming in at 18 and 17 percent respectively.

As public sector employment data from national statistic agencies varies in scope and date between EU-27 countries, and data from the International Labour Organization (as obtained via OECD publications) does not go past 2008 - before the financial crisis fully took hold - it is difficult to comprehensively analyse public sector employment trends. National statistic data does in some cases, however, prove illuminating. In several countries data immediately indicates that the level of public sector employment is falling, such as in the UK (Public sector employment decreased by 24,000 in the first quarter of 2011, and is down 143,000 from the same time in 2010), Ireland (a public sector decrease of 3,700, excluding temporary census workers), and Estonia (a fall of 7,800 employees in the public sector between 2009 and 2010). Greece, the country widely-accepted as the most severely affected by the economic crisis, was unable to provide up to date public sector employment statistics. Others bucked the trend, such as Belgium who saw a marginal increase of 7,665 public sector employees between 2009 and 2010 and Cyprus whose public sector employment climbed in 2010, going from 67,300 in 2008 to 70,429, an increase of 3,129. Poland saw a slight increase in NACE code O84 public administration and defence; compulsory social security employment (0.4 percent). The decreases shown reflect the political and economic reality of many EU-27 nations in 2011.

1.2 Multi-level governance in Europe and its implications for the public administration sector

As can be seen by the data in table 1.3, Europe comprises many governance bodies divided across levels of power and authority. Figure 1.4 graphically relates the number of local authorities in EU-27 countries, with France clearly the largest in terms of quantity.

Table 1.3: Tiers of government in EU-27

	Tiers of government		
	State	Provincial	Local
Austria	9		2,357
Belgium	6	10	589
Bulgaria			264
Cyprus			378
Czech Republic	14		6,249
Denmark	5		98
Estonia	15		227
Finland	20	74	416
France	26	100	36,683
Germany	16	323	12,312
Greece	50		1,034
Hungary	19		3,175
Ireland	8		114
Italy	6		252
Latvia			119
Lithuania			60
Luxembourg	3		116
Malta			68
Netherlands	12		443
Poland	16	314	2,478
Portugal	2		308
Romania		41	3,180
Slovak Republic	8		2,928
Slovenia			210
Spain	17	50	8,111
Sweden	20		290
United Kingdom	3	35	434
EU-27	**275**	**947**	**82,893**

Source: *Dexia EU subnational governments key figures 2010 / 2011, OECD Government at a Glance 2011*

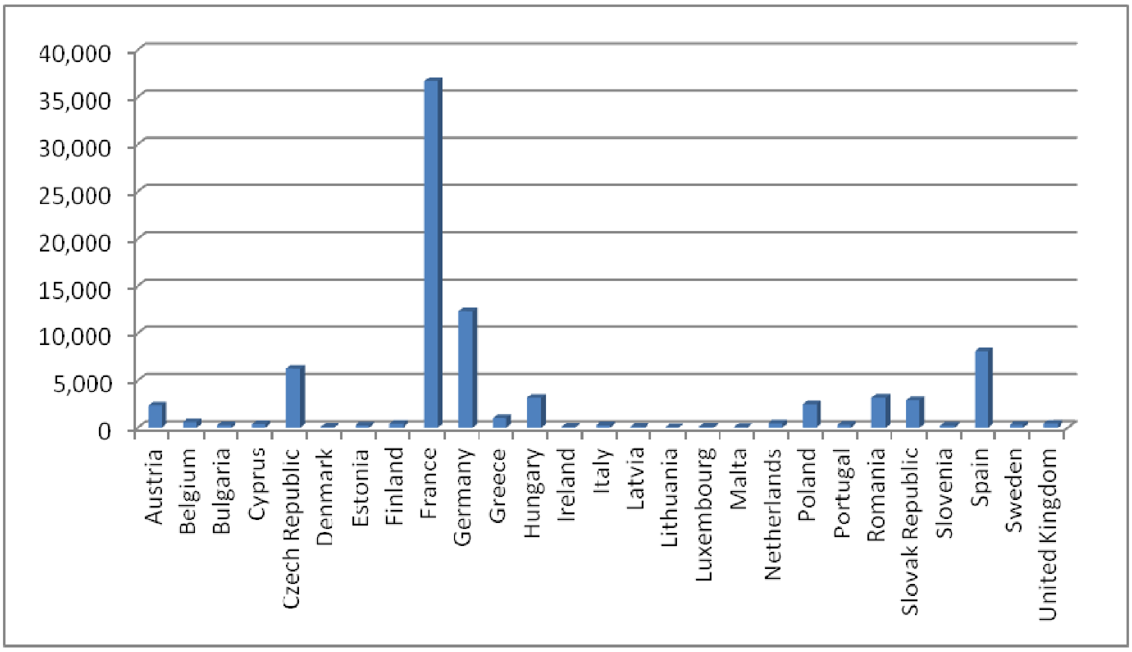

Figure 1.4: EU-27 local government authorities

All EU member states operate either a unitary or federal governance structure. In a unitary structure power is granted to administrative branches from the central government, which has supreme power, whereas in federal states sub national governments share sovereignty with the central government. The sub national governance structure of nations is not standardised in Europe, with each country operating a different governance style.

The relationship between the levels of government is complex, and is one of varying levels of power. Fiscal determination, regulatory policy and decision making ability (in regards to, for example, management of public authorities, choice of public services to provide, etc.) is concentrated at central, state / regional or local level depending on the national governance structure. Local governments have limited rights to levy taxes and are often supplemented by national taxes, such as in Germany, the United Kingdom, Spain, Hungary, Portugal and the Netherlands (Local authority competences in Europe, 2007). In certain countries however, such as Italy, France, Sweden, and Belgium, local authorities retain fiscal power and are financially independent

The level of power and influence varies hugely by country: As a federal republic power at state level in Germany is strong. Each state is a parliamentary republic and therefore has rights of self-determination. In Austria, however, another federal republic, states' power is far more limited, with little legislative capacity. In fact Austrian federalism is considered mainly theoretical.

In Ireland power outside of the central government is weak and local government has progressively lost control over services to national and regional bodies.

In England local authorities are tasked with promoting the "economic, social and environmental well-being" and have the ability to enact local bye-laws on matters such as public order and public health. England has a mix of unitary authorities, county councils, and district councils, all of which are bound by parliamentary decisions (central government).

Due to the large number of different governmental authorities, often numbering in the thousands (see table 1.3 above), several countries have opted for reform in order to make local and regional government more efficient. In this case power is consolidated and the territory over which the government has competence is redrawn and expanded.

All authorities are bound by the laws of their higher authority, with the European Union being the highest level. Due to this structure, state and regional governments are bound to implement both EU and central government policy.

1.3 EMAS within the public administration sector

Figure 1.5: EMAS registered organisations by NACE code O84

1.3.1 EMAS-registered public administration sector organisation

Figure 1.5 geographically represents EMAS registered organisations under "NACE code O84.11" within the current online EMAS database (http://www.emas-register.eu/). The list is not exhaustive however as other organisations within the public administration sector are registered – unfortunately the EMAS register does not explicitly distinguish between public and private organizations and so it is near impossible to get a fully accurate description of the scope of EMAS within the sector. As such this graphic will be expanded in the future, as the EMAS register is currently developing a tool that will allow the extraction of more information. 17 EU countries are registered with EMAS, with by far the biggest number – almost half of all registrations – being Italian organisations, followed by Spain and Germany. These three countries represent 84 percent of all EMAS registrations in the sector.

1.3.2 The potential for expansion of EMAS within the public administration sector

At present public administration sector organisations registered with EMAS constitute less than one percent of the sector, indicating the potential for great expansion. Many public sector organisations already operate an environmental management scheme, and adhere to various environmental policies set out at central government or EU level. EMAS can integrate and streamline these policies, increasing visibility in the sector and attracting new registrations. Securing political will may be a challenge as local politicians move into an increasingly fiscally austere environment. Tightening budgets across the EU-27 are seeing cut backs in local government budgets and public employment in many member states.

1.3.3 Other European programmes and projects linked to sustainable development

Covenant of Mayors

Aims

Launched in 2008, the Covenant of Mayors asks local and regional authorities to make a voluntary commitment to increase energy efficiency and the use of renewable energy sources in their territories. The EU funded process supports the EU's 202020 aims, asking cities to exceed the EU 20 percent CO_2 reduction objective by 2020. Before the process begins, the CoM requires a political commitment from local governments.

The CoM says that it is "the only movement of its kind mobilising local and regional actors around the fulfilment of EU objectives".

Process

Covenant signatories are required to prepare a Baseline Emission Inventory - a measure of the amount of CO_2 emitted due to energy consumption within a given period of time (the recommended base year is 1990) - and submit, within the year following their signature, a Sustainable Energy Action Plan (SEAP) outlining the key actions they plan to undertake.

A SEAP outlines the activities and measures set up to achieve the CoM targets, together with time frames and assigned responsibilities.

Signatories are comprised of cities across Europe, ranging from small villages to major metropolitan areas such as London or Paris. All signatures are voluntary.

The SEAP must be approved by the municipal council before being enacted and is subject to review by the Joint Research Centre.

Once the SEAP is enacted, signatories can submit examples of their measures to an online database. These examples are known as "Benchmarks of Excellence". Other signatories can view these examples with an aim to replicating the actions taken.

Signatories can also browse others SEAPs through the online "Catalogue of Sustainable Energy Action Plans", here: http://www.eumayors.eu/actions/sustainable-energy-action-plans_en.html.

Length

The process can continue indefinitely (though working towards 2020), and monitoring occurs every two years through the submission of an "implementation report".

Initiator

The Local council (Mayor) must approve the SEAP before the CoM process can begin. A list of the Mayors who signed is available on the CoM web page (see below).

Monitoring

Every two years after having submitted the SEAP, signatories are required to report on their SEAP implementation. These implementation reports aim to check the compliance of the interim results with the foreseen objectives in terms of measures implemented and CO_2 emission reductions.

Training

As some signatories do not have the financial and technical resources to fulfil their commitments, the CoM has designated a special status for public administrations and networks that commit to helping signatories design and implement SEAPs. Provinces, regions and national authorities that provide strategic guidance, financial and technical support are called "Covenant Coordinators", while the network of local authorities that engage in promotional activities, liaise with their members and build experience-sharing platforms (basically websites on which material can be uploaded) are called "Covenant Supporters".

Promotional, technical and administrative assistance is provided on a daily basis to Covenant signatories and facilitators by the Covenant of Mayors Office (CoMO), managed by a consortium of networks representing local and regional authorities.

In cooperation with the CoMO, the Joint Research Centre of the European Commission assists signatories with scientific and technical questions, mostly related to emission inventories and action plans.
Alongside the European Commission, the Covenant benefits from full institutional support, including from the Committee of the Regions, which supported the initiative since its inception; the European Parliament, where the two first signing ceremonies were held; and the European Investment Bank, which assists local authorities in unlocking their investment potentials.

Signatories
The Covenant of Mayors (CoM) has 2,849 Signatories, affecting 129,822,245 inhabitants across Europe. There are 85 "Covenant Coordinators" and 58 "Covenant Supporters", who help signatories meet their CoM goals.
For a full list of signatories, click here:
http://www.eumayors.eu/about/signatories_en.html

Aalborg Commitments

Aims
The Aalborg Commitments are a set of shared commitments on sustainable measures to be implemented by local governments across Europe. The Commitments are voluntary and require local governments to willingly put measures in place to increase sustainability.

The Aalborg Commitments document, which outlines what is required under the commitments, is in two parts: the general commitments to be signed, and the annex on suggested targets as inspiration for the target setting process. These commitments aim to ensure local governments play an active role in increasing sustainability.

The Aalborg commitments are separated into ten topics:

1. Governance
2. Local management towards sustainability
3. Natural common goods
4. Responsible consumption and lifestyle choices
5. Planning and design
6. Better mobility, less traffic
7. Local action for health
8. Vibrant and sustainable local economy
9. Social equity and justice
10. Local to global

Commitments to be made are listed in greater detail under each heading.
The full list is available here:
http://www.aalborgplus10.dk/media/pdf2004/finaldraftaalborgcommitments.pdf

Process
The process began in 2003, defining the list of themes deemed to be most important to local governments in the field of local sustainability. The choice of themes was based on the OPUS survey conducted by CEMR and Eurocities within the framework of the Sustainable Cities and Towns Campaign to support the Thematic Strategy on Urban Environment, the European Common Indicators, the Aalborg Charter and other relevant initiatives.

In March 2004 it was decided that the Aalborg Commitments document would not specify targets, but indicate the main fields of work required, leaving the setting of targets to local governments themselves, as local government representatives felt that local circumstances should be considered in depth before determining the exact goals to be pursued.

The Aalborg Commitments document now requires cities and towns to initiate a local, participatory process to identify specific targets and timeframes.

Signatories

For a full list of signatories, click here: http://www.aalborgplus10.dk/default.aspx?m=2&i=308

In order to sign up to the commitments, local or regional governments must:

1. Endorse the Aalborg Charter.
2. Endorse the Aalborg Commitments.
3. Agree to produce an integrated Aalborg Commitments baseline review as a starting point for the target setting process within 12 months following the date of signature. This review must include a policy context, referring to existing political commitments and describing current challenges
4. Agree to enter into a local participatory target setting process that incorporates existing Local Agenda 21 or other local sustainability action planning and takes into consideration the results of the local baseline review.
5. Agree to prioritise the Aalborg Commitment tasks, aiming to address the ten Commitments [stated above].
6. Agree to set individual local targets within 24 months following the date of signature, taking into account the Aalborg Commitments Annex as an inspirational resource, and to set time frames related to the targets that are suitable to demonstrate progress on the Commitments.
7. Agree to make the regular Aalborg Commitments monitoring review of achievements available to citizens.
8. Agree to regularly provide information on targets and progress to the European Sustainable Cities & Towns Campaign and, through this cooperation, to review progress and learn from each other. A first European assessment is scheduled for the year 2010, with subsequent reviews scheduled in five-year cycles.

Length / Monitoring

A first European assessment took place in 2010 and subsequent reviews occur every five-years.

Indicators

Signatories commit themselves to undertaking a baseline review before commencing the target setting process. This review takes into account policy context, refers to existing political commitments and describes current challenges. The signatory then agrees agree to submit to a regular Aalborg Commitments monitoring review of achievements, and to regularly provide information on targets and progress to the European Sustainable Cities & Towns Campaign.

Training

In order to guide local governments through implementing the Aalborg Commitments, ICLEI has developed a web-based tool on sustainable measures. "Local Sustainability" provides a platform from which European local governments can easily access the wealth of resources available to them in developing, implementing, and monitoring policies in support of local sustainable development. This portal is a 'one stop shop' for local governments seeking to find information and guidance on local sustainability issues.

Local Sustainability is designed around the five steps of the Sustainability Cycle, the key mechanism to a cyclical, integrated sustainability management on the local level - and to a successful implementation of the Aalborg Commitments.

Local Sustainability directs users to a selection of specific online tools and guidance, such as the data base **Local Resources 21,** the target setting assistant **Local Targets 21,** the governance process evaluator **Local Evaluation 21,** and the ***Aalborg Commitments Implementation Guide.***

The tool provides the most important links to the Aalborg Commitments, the EU Urban Thematic Strategy, and the European Sustainable Cities & Towns Campaign. Website: http://www.localsustainability.eu/

An implementation guide, as stated above, has been produced to guide cities in putting the Aalborg commitments into place. The guide is a 5-step approach intended to support signatory Local Governments in responding to the requirements of the Aalborg Commitments.
The guide is available here: http://www.aalborgplus10.dk/media/pdf2010/actor-guide_english.pdf

ACR+

Aims
The **Association of Cities and Regions for Recycling and sustainable Resource management** (ACR+) is an international network of **members** who **promote sustainable consumption of resources and management of waste. ACR+ promotes these aims through encouraging prevention at source, reuse and recycling.** ACR+ also works to revise EU policy on waste and resources.

The association helps members to participate in events and discussions held at the European level, notably by representing local and regional authorities in various forums and platforms of discussion with the European Commission.

ACR+ is based on three main principles:

- Sustainable development
- Prevention and recovery of waste
- Partnership between public authorities, private sector and general public

ACR+ activities are open to waste management actors, policy makers / technicians, and members of NGO's or associations.

The association provides studies, bulletins, conferences and seminars. It also facilitates the exchange of practical information and experiences, to find solutions to problems with experts in waste management in Europe and internationally.

The organisation defines its main activities as working to:

- Develop the expertise and skills of public authorities in effective waste-product-resource policies
- Encourage practical action in waste management and sustainable consumption
- Provide support to regional and local authorities to encounter new challenges
- Promote cooperation and partnership to develop eco-efficient solutions

Initiators
The Association was created in Pamplona in May 1994 by a group of cities and regions lead by the Brussels-Capital Region. The association's aims evolved from:

- waste to products and resources, by encouraging prevention, reuse and recycling
- EU-15 to new EU Member States and South-Mediterranean countries
- Public partnerships to multi stakeholders partnerships.

Process
As well as pushing for legislative change at EU level, ACR+ analyses the impact of relevant European legislation at a local level.
ACR+ divides its work into six topics:

1. **Prevention**
2. **Recycling**
3. **North-South co-operation**

4. **Economic instruments**
5. **Legal instruments**
6. **European Policy**

The association creates technical documents, guides, events and represents members at a European level. ACR+ also produces regular news bulletins.

Signatories

ACR+ has almost 100 members world-wide, made up of mainly local and regional authorities as well as national networks of local authorities, representing around 1100 municipalities. For a full list of members, click here: http://www.acrplus.org/default.aspx?page=173

European Energy Award

Aims

The European Energy Award (EEA) can be seen as an instrument to improve energy efficiency within municipalities. The EEA helps municipalities identify strengths, weaknesses and potential for improvement in all energy related activities. The EEA also acts as a certification and quality management system for municipalities, with the standardised assessment permitting a benchmarking between the EEA communities. Member cities are also encouraged to share their experiences and expertise with one another.

Depending on the degree of implementation of possible measures, the community is certified and awarded with the European Energy Award. If 50 percent of the possible measures are implemented and finalised, the community receives the standard European Energy Award, but if 75 percent of the measures are implemented and finalised the community receives the European Energy Award gold. The success of the municipality's efforts is made visible by the EEA through dissemination measures.

The European Energy Award, therefore, consists of two main elements:

- A quality management system for communal energy services and activities
- Certification and award for energy achievements

Signatories

848 communities take part in the European Energy Award throughout Europe (http://goo.gl/uwGy1). The following countries participate in the Award scheme:

- Austria
- Czech Republic
- Cyprus
- France
- Fürstentum Liechtenstein
- Germany
- Greece
- Ireland
- Italy
- Lithuania
- Malta
- Netherlands
- Portugal
- Slovenia
- Spain
- Switzerland

Regional and national organisations which are also founding members are:

Ordinary Members

- ADEME, Département Acteurs Publics, France
- ARE, Liguria - Agenzia Regionale per l'Energia della Liguri, Italy
- B & SU, Beratungs- und Service-Gesellschaft Umwelt mbH, Germany
- BFE, Bundesamt für Energie, Switzerland
- Brandes Energie AG, Switzerland
- Communal Labels GmbH, Switzerland
- e5 Österreich-Programm für energieeffiziente Gemeinden - AEA, Austrian Energy Agency, Austria
- ENCO, Energie-Consulting AG, Switzerland
- EIV, Energieinstitut Vorarlberg, Austria
- Ministerium für Umwelt, Naturschutz und Verkehr Baden-Württemberg, Germany
- Ministerium für Wirtschaft, Mittelstand und Energie Nordrhein-Westfalen, Germany
- Prisma Consult c/o Energieagentur Nordrhein-Westfalen, Germany
- pro:21 GmbH, Germany
- Sächsisches Staatsministerium für Umwelt und Landwirtschaft, Germany
- SIR, Salzburger Institut für Raumordnung und Wohnen, Austria
- SPES Consulting srl, Italy
- Energiestadt Switzerland c/o ENCO, Energie-Consulting AG, Switzerland
- Weisskopf Partner GmbH, Switzerland

Ordinary Members / Municipalities

- Gemeinde Wiernsheim, Germany
- Stadt Luzern, Switzerland
- Stadt Münster, Germany

Sustaining Members

- eza! Energie- und Umweltzentrum Allgäu, Germany
- EIV, Energie Institut Vorarlberg, Austria
- Energie Tirol, Austria

Process

- Energy-related activities are reviewed
- Strengths, weaknesses and potential for improvement is visualised
- Goals for the local energy policy and decision-making criteria are defined
- An energy policy work programme is developed comprising concrete long-term and short-term projects
- The work programme is implemented step-by-step
- A continuous assessment of the results is carried out

The whole process is carried out by the “Energy team”, which is formed by representatives from the community in question’s administration and politicians, and assisted by an external EEA advisor.

European Green Capital Award

Aims

The European Green Capital Award (EGCA) is a European Commission initiative designed to promote and reward local governments for improving their environment and committing to future sustainable progress. The award began in 2010. The award is given to a city that:

- Has a consistent record of achieving high environmental standards
- Is committed to ongoing and ambitious goals for further environmental improvement and sustainable development
- Can act as a role model to inspire other cities and promote best practices to all other European cities

Through competition the award encourages cities to push each other further in their environmental efforts. The winner of the award acts as an inspiration to other cities around Europe. The sharing of Best practice is also encouraged.

At present, the eligibility criteria for cities to enter is as follows:

1. The European Green Capital Award is open to EU Member States, Candidate Countries (Turkey, FYROM, Croatia, Montenegro and Iceland) and European Economic Area countries (Norway and Liechtenstein).
2. All cities from the countries listed above which have more than 200,000 inhabitants can apply for the award (in countries where there is no city with more than 200,000 inhabitants, the largest city will be eligible to apply).
3. In this context, a “city” is understood to be an urban area, excluding metropolitan areas, larger urban zones and conurbations, and is understood as an administrative unit governed by a city council or another form of democratically elected body.
4. Past winners may not apply for a period of ten years after they held the European Green Capital title.

Process:

ECGA can be viewed as a policy tool for local governments and authorities to stimulate environmental activities. The programme is largely about creating role models, and getting cities invested in the idea of environmentalism. As cities involved in the programme differ greatly, in terms of population, topography, political factors, etc., sharing concrete examples of what a European Green Capital can look like is seen as a good way to further progress.

The ECGA is heavily invested in promoting local governments as actors that can drive environmental change.

The ECGA feeds into the European Sustainable Development Strategy. The renewed Sustainable Development Strategy for an enlarged EU aims to identify and develop actions that will enable the EU to continuously improve quality of life. One way in which this will be achieved is through the creation of sustainable communities.

The European Green Capital scheme does not include any pool of funds to support initiatives of participating cities, however other European Commission funding schemes are available.

Initiator

The European Green Capital Award is the result of an initiative taken by 15 European cities (Tallinn, Helsinki, Riga, Vilnius, Berlin, Warsaw, Madrid, Ljubljana, Prague, Vienna, Kiel, Kotka, Dartford, Tartu & Glasgow) and the Association of Estonian cities on 15 May 2006 in Tallinn, Estonia. Their green vision was translated into a joint Memorandum of Understanding establishing an award to reward cities that are leading the way with environmentally friendly urban living.

Monitoring:

There are 12 indicators evaluated:

- Local contribution to global climate change
- Local transport
- Green urban areas incorporating sustainable land use
- Nature and biodiversity
- Quality of local ambient air
- Noise pollution
- Waste production and management
- Water consumption
- Waste water treatment
- Eco innovation and sustainable employment
- Environmental management of the local authority
- Energy performance

The information requested is based on the EMS principles: **plan, do, check and act**.

A panel of internationally acknowledged experts assesses the information supplied by each city. This includes qualitative evaluations and a peer review of each application based on the 12 indicators above. Following these evaluations, 3-4 cities are shortlisted. The shortlisted cities will be invited to present their action plans and communication strategies to the jury. Based on this hearing, the jury selects a winning city. The winners are announced at an award ceremony.

Benchmark and best practices are available here:
http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2011/06/Environmental-Best-Practice-Benchmarking-Report-Award-Cycle-2012-2013.pdf

Signatories
Currently, more than 40 major European cities, including 21 EU capitals support the initiative.

European Public Sector Award

Aims
The European Public Service Award (sponsored by the European Institute of Public Administration) brings together and rewards outstanding examples of public sector efficiency and innovation. The award illustrates best practice examples to showcase and reward those involved and to inspire others to follow in their footsteps.
The award is separated by topical themes. The winner is presented with a trophy and news of their award is disseminated by EPSA. The award is free to enter.
The aims of EPSA are:

- To contribute to the progress and implementation of the Lisbon Strategy and its successor, **EUROPE 2020**: A European strategy for smart, sustainable and inclusive growth
- To create a common European administrative space
- To devise new administrative problem-solving paradigms
- To foster constructive competition amongst public sector organisations and reward excellence
- To create a network of public excellence and, thus, establish the conditions for a European learning platform on public administration solutions.

The 2011 competition is focusing heavily on increasing sustainability and enacting green solutions.

Public sector institutions from all levels across Europe – with special attention given to local and regional approaches, as well as public sector enterprises, agencies or public-private partnerships – are eligible to submit their projects for the award. The lead applicant must be a public sector actor.

EPSA also organises "knowledge-transfer" events, in which public authorities can network and learn from one another.

Process
All entrants must fill out an online application form, outlining the success of specific projects they have undertaken.

Signatories
In 2011 the European Public Sector Award (EPSA) received 274 applications from 32 European countries and European institutions.
Top submitters in the 2011 edition were Spain, Romania, Austria, Italy, Poland and Germany. Out of the 274 applications, 116 came from the local government level, 66 from the regional level, 85 from the national level, and 7 from European institutions.

For a detailed breakdown, click here:
http://www.epsa2011.eu/files/Final%20Results/EPSA%202011%20figures%20-%20GENERAL.pdf

Initiator
Public sector entities must apply for the award online.

Indicators
The following general criterion is used for the selection of the best projects:

1. Innovation: novelty of the solution; degree to which the case shows a leap of creativity in the practice of public administration; something different that goes beyond what currently exists;

2. Public concern: extent to which the case addresses a pressing need or important problem of public concern; the project topic is high on the agenda in European public organisations, a critical mass of public sector bodies are tackling the issue;

3. Sustainability: the project shows or describes elements which are going beyond the period of the project implementation/delivery (after the planned and realised objectives and activities);
4. Impact: the provision and illustration of proven evidence, benefits and visible impact; tangible results demonstration;

5. Learning capacity and transferability: the lessons learnt and the potential value to other entities; the project provides the potential for successful replication by other governments; it stimulates improvement in its application and provides mutual learning perspectives.

Applications submitted under specific themes are then judged under more specific criterion, such as:

1. Link between innovative projects and EU environmental legislation/EU environmental objectives;

2. Convincing balance of environmental measures and cost-effectiveness;

3. Internal and external communication and awareness raising.

Training
At the final event, training workshops are held, as well as study tours and the awards ceremony itself. Knowledge-transfer sessions are organised by the EPSA.

Managing Urban Europe 25 (ended 2008)

Aims
This project ran from 2006 – 2008 and aimed to improve the environmental quality and sustainability performance of local and regional authorities. 25 EU local and regional authorities took part in the project.
As part of Managing Urban Europe-25 (MUE-25), a framework for better implementation of already existing environmental management systems like EMAS, ISO 14001 and *eco*BUDGET was produced.
The project also provided a method for cities and regions to better work with integrated management, and supplied local training, capacity building and applied research to cities.
According to its website, the project was closely linked to the Thematic Strategy on the Urban Environment within the 6th Environmental Action Plan of the EU and the Leipzig Charter.
The main outcome of the project is a framework model of an integrated management system that enables the implementation of integrated management systems for urban areas. Applying the system puts cities in a better position to improve the implementation of environmental legislation, urban management, municipal compliance with existing legislation and voluntary agreements, as well as environmental assessment and reporting and communication with local stakeholders. It also facilitates the combining of different policies into a single coherent strategy.
Authorities tested the framework model and provided feedback on their experiences. The MUE-25 project concluded with a Forum on "Managing a Sustainable Future for Cities and Regions" in Berlin in February 2008, highlighting the experiences of the 25 pilot cities.

Initiator
The project was co-funded by European Commission DG Environment and had a total budget of 2.9 million euro. Local and Regional governments made a commitment to test the environmental management systems prior to the projects start.

Signatories
Local and regional governments from 25 countries took part in the project. For a full list of those involved, click here: http://www.mue25.net/ListFullArtGrpNoLogo.aspx?m=4
Steering group partners include ICLEI, UBC, UWE, UNEP / GRID-Arendal, and Bodensee-Stiftung.
Network partners include ACR, Energie-Cites and ASSURRE.

Reference framework for sustainable cities

Aims
This toolkit aims to aid local authorities and stakeholders in making aligned decisions on their city's strategy, policies and plans. The tools organise the assessment of sustainability and the monitoring of their urban strategy. The toolkit also provides examples of successful policies.
So far only a prototype has been developed. Full operability is planned for the end of 2011, with dissemination and communication of the tool scheduled for the first half of 2012.

Ultimately the tool is a means for cities to translate policy goals into practice and was created as a means to disseminate policy and practical information on sustainability in Europe. It aims to assist practitioners in local authorities, regional and other bodies to improve the design and promotion of strategies and projects to stimulate sustainable urban development. Voluntary or

community-based organisations and businesses can also use it as a resource for engaging in local debates and decisions about sustainability.

Process
The tool shows and explains step-by-step what actions are possible or necessary to organise the process in a city or municipality. Users are guided through a series of questions to explore their city's approach to sustainability and are then provided with tools outlining ways to improve this. The reference framework starts with an assessment of how the city or municipality sees itself in terms of characteristics and features and existing actions to promote sustainability. It provides a range of questions that can help the user and other actors (politicians, city managers, planners, citizens, businesses, etc.) review their approach towards sustainability, reflect on existing priorities and inform the city strategy review and development process. Tools and supporting guidance are given to monitor implementation and to evaluate the results.
The Reference Framework is intended to offer guidance and support to improve decision-making and action on sustainability.

Signatories
Organisations involved in the project are:

- DGALN
- CERTU
- European Union
- URBACT
- Council of European Municipalities and Regions
- EUROCITIES
- EUKN

Countries involved:

- The EU 27
- Turkey
- Macedonia
- Iceland
- Switzerland

Capital of Biodiversity (ending 2011)

Aims
Co-funded by LIFE+ and coordinated by Deutsche Umwelthilfe, the European Capitals of Biodiversity project motivates communities through friendly competition to protect biodiversity and increase sustainability at the local level. Cities and municipalities compete within their respective countries for the title of "Capital of Biodiversity". The winner is the city that is deemed to have acted with the greatest commitment for biodiversity, taking such measures as creating and protecting natural green spaces, recuperating important habitats, considering nature and biodiversity in their planning processes and so on.
The competition encompasses France, Hungary, Slovakia, Spain and Germany. Local authorities are judged in different size classes and thematic categories including municipal green spaces, planning instruments, protection of species and ecosystems, agriculture and forestry, water management, communication and environmental education. The competitions are accompanied by a series of workshops in each country and the release of printed brochures presenting strategies and best-practice examples from the participating municipalities. The competitions in the five countries are implemented by Natureparif (France), Lake Balaton Development Coordination Agency (Hungary), Fundación Biodiversidad (Spain), the Regional Environmental Center (Slovakia) and German Environmental Aid (Germany). IUCN (International Union for Conservation of Nature) and ICLEI–International Training Centre are international partners of the project.

The project is officially set to end in 2011. Organisers are keen to continue the project, though due to funding difficulties this is not likely to occur. An extension of LIFE funding was applied for but was denied. Organisers are instead hoping national governments will play a larger funding role, though in one official's opinion, the current financial difficulties faced by European nations means this is not likely. There is still the possibility that the competition will be run in a reduced capacity, but the set up will vary from the current Capitals of Biodiversity.
Indicators / Monitoring

Biodiversity monitoring systems comprise a set of indicators that are carefully chosen to reflect important characteristics of biodiversity such as diversity of species, coverage of natural vegetation and fragmentation of habitats, but also the efficacy of governance and level of public awareness. Indicators allow us to gauge reality in a simple but meaningful way.

The **advantages** of indicators for assessing municipal biodiversity efforts are manifold. To name a few, they:

- Prove the effectiveness of current measures;
- Mark progress towards a diverse and healthy living environment;
- Improve citizens' and decision-makers' acceptance and support for biodiversity measures by affirming the benefits with solid facts and figures.
- Identify shortcomings that can be addressed with targeted responses;
- Allow for efficient and target-oriented allocation of funds;
- Unmask the ineffective allocation of funds; and
- Allow you to compare your progress with other municipalities.

The Capitals of Biodiversity competition uses a shortened and adapted version of the Singapore Index to better suit the countries and broadened its applicability to encompass rural towns and villages. A questionnaire is used for monitoring purposes. Indicator questions include "What proportion of your municipality is comprised of natural or seminatural areas?", "What proportion of your municipality is officially protected?", "What proportions of your municipality fall into different land-use categories? "and so on. Table 1.4 represents Capitals of Biodiversity participation in numbers.
The indicator questions are available here: http://www.capital-biodiversity.eu/54.html#c142

<u>Signatories</u>

Table 1.4: Capital of Biodiversity, participation in numbers

Municipality participation in numbers of the Capital of Biodiversity						
	# of workshops		# of participants		# of municipalities represented	
	2010	*2011*	*2010*	*2011*	*2010*	*2011*
France	3	5	170	350	80	150
Germany	4	4	148		98	
Hungary	5	4	98	90	68	53
Slovakia	2	2	96	86	15	28
Spain	4	3	194	81	68	37
Totals	**18**	**18**	**706**	**607**	**329**	**268**

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2 ENVIRONMENTAL ASPECTS WITHIN THE PUBLIC ADMINISTRATION SECTOR

2.1 Environmental Aspects Linked To Public Administration Services

Direct and indirect environmental aspects within the public administration sector
In order to define the direct and indirect environmental aspects of public administrations, it is necessary to take into account:
- the different levels of administrations: local, regional, national, European
- the specific thematic focus and competences - specially in the case of regional and national administrations
- the structure and allocation of competences between the national, regional and local level (political framework)

To identify the direct and indirect environmental aspects of all the different political and structural scenarios in the 27 EU Member States would be a study of its own and would burst the scope of this document. The present description is based on a political framework and administrative structure common for most of the EU Member States.
As underlined in the introduction of the document, local authorities are the most important target group for EMAS and other environmental and/or sustainability management systems. Therefore this chapter includes a detailed description of the direct and indirect aspects of local administrations, while regional and national administrations are mentioned because of their interrelation with local authorities.

Direct and indirect environmental aspects
The EMAS Directive differentiates between direct and indirect environmental aspects. Direct environmental aspects are defined as activities, products and services being under direct supervision, for example by the municipality. Indirect environmental aspects are related to those activities of the municipal administration that it does not control completely, but that it can influence to a certain extent. Indirect environmental aspects can result from a municipal administration's interactions with third parties, in particular citizens. The following analysis will show that public administrations have a direct and an indirect influence on most aspects.
Core activities of local and regional public administrations such as land use planning and other related plans, public procurement or capital investment are regarded as "indirect aspects" in EMAS and ISO 14001. This definition bares risk to be misleading. Because of the importance of these activities in the corona of public administrations responsibilities and the direct influence of the administration they should be considered as direct aspects in order to avoid confusion and to underline the importance of those aspects. So far, only few administrations include the "services" land use planning and other planning into their EMS. To include all planning activities of the administration into EMAS or another environmental management scheme would contribute highly to the prevention of environmental impacts and therefore be in accordance with the precautionary principle. Figure 2.1 provides an graphical overview of environmental aspect in a local authority as a spatial positioning of the aspects – illustrating the importance to expand environmental management to the whole urban area - while table 2.1 links environmental aspects to services of public administrations and provides the respective NACE-codes for associated services.

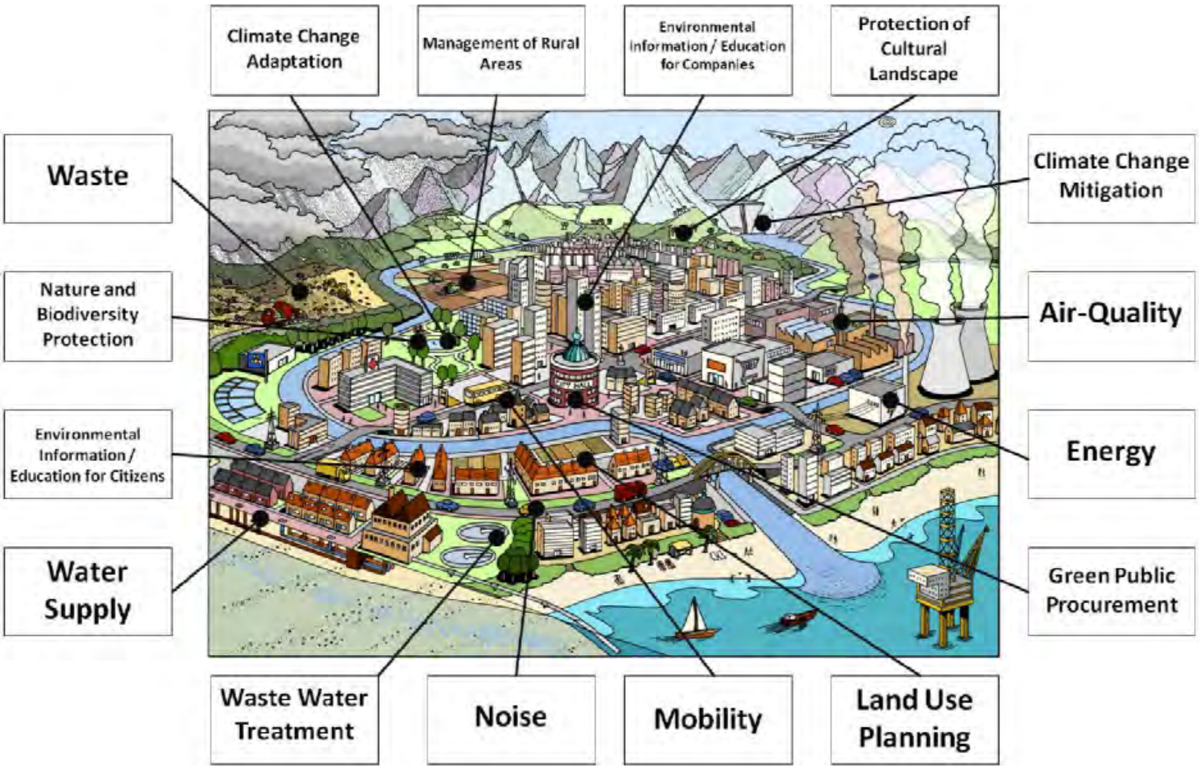

Figure 2.1: Environmental Aspects in Local Authorities

Table 2.1: Main Environmental aspects of services of public administrations with NACE Codes

Environmental Aspect	**Service of Public Administrations**	**Direct / indirect influence**	**NACE Code (*)**
Climate change mitigation and adaptation	Environmental Services Sustainable Health and Social Services Sustainable Economy	Direct + indirect	A 02.0, E 40.1, E 49.3.1, F 41.2
Use of land • Urban sprawl • De sealing, green areas • Transport / mobility • Landscape development / water bodies • Energy / climate	Sustainable Land Use Sustainable Green Spaces Sustainable Housing	Direct + indirect	A 02.0, E 36, E 38, E 49.3.1, E 40.1, F 41.2, L68.2.
Mobility • Municipal operations • Transportation infrastructure • Public transportation • Inter modality • Local economy	Sustainable Mobility Sustainable Health and Social Services	Direct + indirect	E 49.3.1

Environmental Aspect	**Service of Public Administrations**	**Direct / indirect influence**	**NACE Code (*)**
Air quality • Transportation and mobility • Urban climate • Buildings and energy • Enforcement of legislation and monitoring of compliance with legislation	Environmental Services Sustainable Health and Social Services	Direct + indirect	E 40.1, E.49.3.1, F 41.2
Noise Vibration, odour, dust, visual contamination	Sustainable Health and Social Services	Direct + indirect	E 40.1, E.49.3.1, F 41.2, O 92.33
Waste • Waste collection • Waste processing and disposal • Enforcement of legislation and monitoring of compliance with legislation	Environmental Services Sustainable Health and Social Services	Direct + indirect	E 38
Water supply and waste water treatment • Own water consumption • Design and implementation of drinking water supply infrastructure • Design and implementation of waste water collection	Sustainable Water Management Sustainable Health and Social Services	Direct + indirect	E 36
Nature and biodiversity protection and restoration, protection of cultural landscape • Urban land use planning • Planning and maintenance of green areas • Transport / mobility • Biodiversity in water bodies, agriculture and forestry • Communication, cooperation and organisation	Sustainable Green Spaces Sustainable Leisure Activities	Direct + indirect	A 02.0, F 41.2, E 49.3.1, O92.43
Management of public forest and rural areas, urban forest • Management of public forests • Management of rural areas	Sustainable Leisure Activities Sustainable Economy	Direct aspect	A 02.0
Energy: • Energy consumption • Energy production • Energy supply and distribution • Biodiversity	Environmental Services Sustainable Economy	Direct + indirect	E 40.1
Environmental information /education of citizens: • Formal environmental education • Informal environmental education	Sustainable Education	Direct + indirect	E 92.56, P85, R93.1

Environmental Aspect	Service of Public Administrations	Direct / indirect influence	NACE Code (*)
Environmental information /education towards companies (global players, SMEs) and other organizations (legislation, promotion /support)	Sustainable Economy	Direct + indirect	P85
Green public procurement: • Choice and composition of services • Environmental performance and practices of contractors, subcontractors and suppliers	Sustainable Economy	Direct + indirect	

The environmental aspects listed above will be described[1] in the following paragraphs according to:

- Importance for services of public administrations
- Brief introduction
- Relevant NACE Codes
- Environmental impacts
- Related European environmental legislation
- Direct and indirect influence on the aspect
- Examples for own regulations
- Interrelation with other environmental aspects (e.g. energy, traffic and air quality)
- Interrelation with other sustainability aspects (e.g. environmental quality and health)
- Stakeholder Landscape: Stakeholders which should be considered in order to achieve environmental objectives within the local/regional/national functional area

2.2 Environmental aspect: climate change

2.2.1 Relevance for other public services on the local level

- sustainable water management
- sustainable mobility
- sustainable green spaces
- sustainable land use
- sustainable housing
- environmental services
- sustainable education
- leisure activities
- sustainable health and social services

2.2.2 Relevant NACE codes

Relevant for all public services

2.2.3 European Legislation

A more extensive overview over the European legislation regarding climate change can be found on: http://ec.europa.eu/dgs/clima/acquis/index_en.htm#Effort

- Decision No 406/2009/Ec Of The European Parliament And Of The Council Of 23 April 2009 On The Effort Of Member States To Reduce Their Greenhouse Gas

[1] Except for noise and environmental information/education.

Emissions To Meet The Community's Greenhouse Gas Emission Reduction Commitments Up To 2020

- Decision No 280/2004/EC of the European Parliament and of the Council of 11 February 2004 concerning a mechanism for monitoring Community greenhouse gas emissions and for implementing the Kyoto Protocol
- Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community

2.2.4 Public administrations and climate change

Since climate change as a cross cutting issue needs a highly integrated approach, climate change is extensively handled in every environmental aspect. The following is supposed to give a brief introduction. For details, please see the above.

Without any doubt, climate change is one of the central topics public administrations have to deal with now and for the foreseeable future. Especially local authorities have a key-role to play for climate change mitigation as well as climate change adaptation. First, they are in a privileged position to directly or indirectly influence the amount of greenhouse gases emitted within their boundaries. Directly through the design of the services they provide and indirectly through setting the framework conditions for citizens and businesses alike. Second, since local authorities are responsible for a broad range of infrastructure and shape local living conditions to a large degree, climate change will present them with unique challenges and demands to adapt to: infrastructure like sanitation might have to be adapted to heavy rain while overall availability of water might decrease, new health risks might arise and the overall quality of life might suffer e.g. through increased occurrence of heat waves – to mention just a few aspects of adaptation.

In one way or the other, climate change is tied to almost every environmental, economic or social issue. Either through the effects climate change will have on them (thus calling for adaptation) or through the contribution of respective activities to climate change (thus calling for mitigation efforts). For many cases, both are true.

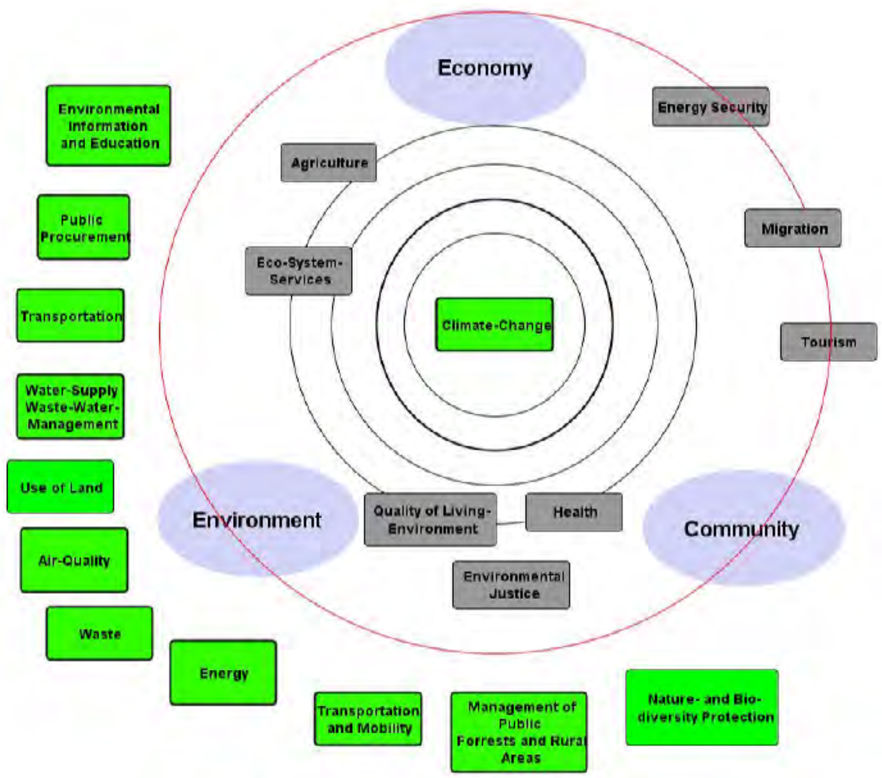

Figure 2.1: Cycle of aspects and sector relevant to climate change

Besides the complex relations of climate change to public services, environmental aspects and economic and social issues in general, the level of uncertainty and the required long term perspective has proven to be challenging. Knowledge about the local and regional extend of climate change is only emerging right now and is only available in some countries and for some regions. But even where data is available – Germany for example has set up a pool of regional studies on climate change, the expected extend of climate change can only be described in terms of probabilities.
On the European level, the member states have agreed upon the 20-20-20 goal to reduce GHG emissions, raising the share of renewable energies in the energy mix and improving energy efficiency compared to 1990 and the member states have started to implement the goals, resulting in national climate strategies in many member countries. Efforts regarding adaptation are not as advanced yet, although the process of developing national adaptation strategies is well on the way[2].
In order to deliver optimal vertical integration, i.e. implementing EU and national strategies on the local and regional level in an efficient, timely and coherent manner, a highly inclusive and integrated approach is necessary. A variety of initiatives and tools has been developed to support local and regional authorities with the development and implementation of integrated climate change strategies. The management model of the "Managing Urban Europe Initiative"[3] has been designed with the compatibility to EMAS in mind and offers an extensive capacity development package on integrated management focused on climate change.

2.3 Environmental aspect: Use of land

Land use planning is relevant for most of the services provided by public administrations and of special importance for the following services:

- Sustainable Land Use
- Sustainable Green Spaces
- Sustainable Housing
- Sustainable Mobility
- Sustainable Leisure Activities

All member states have various levels of planning from overall regional planning to the spatial planning of the regional administrative authorities down to communal building regulations. The responsibilities vary from one Member State to the other, therefore the more general overview given in this chapter should be adapted to the national distribution of responsibilities.

Within the EU LIFE-Project "Ecolup – Environmental management for local land use planning", the legal framework of four EU member States have been analyzed to evaluate, if land use planning could be included into EMAS as a "service" provided by the local authority. The analysis concludes that EMAS may be used in communal urban land use planning under the following conditions:

- Communal urban land use planning must take influence on the given environmental aspects
- The local authority must be able to influence land use planning
- The local authority must be able to involve its citizens and representatives of other interest groups and to establish a monitoring system (Ecolup, n.d.).

The planning process and (to the extent possible) its implementation is a service provided by the public authority. Urban land use planning is made up of the zoning regulations and the development plan. The landscape plan is an ecological specialised plan that regulates the overall form of communal surroundings as a part of the zoning plan. Further programmes and plans, such as the urban development plan, the framework for urban development or specialised plans such as traffic planning or energy planning are related and should be considered.

[2] http://www.eea.europa.eu/themes/climate/national-adaptation-strategies

[3] www.localmanagement.eu

The environmental aspect *urban sprawl* is a topic of central importance for sustainable settlement area development. Regional and local administrations can play a key role in supporting conservative land use in settlement development due to the planning sovereignty they hold. Designating which land is to be used for settlement and construction is one of the most important tasks in communal urban land use planning.
Land use planning on local level is an instrument of settlement development and at the same time an instrument of planning and building laws and regulations and of weighing up the interests of different groups. It is an "umbrella" environmental aspect with impacts on all significant environmental aspects on local level. Land use planning has also a clear relation to social and economic aspects and is therefore a important component of the sustainable development on local and regional level. By including land use planning into the environmental management system, environmental impacts can not only be reduced but also avoided.

2.3.1 Relevant NACE-Codes

A 02.0, E 36, E 38, E 49.3.1, E 40.1, F 41.2, L68.2.

2.3.2 Environmental Impacts

- Urban sprawl
- Surface sealing
- Soil degradation (erosion, organic matter decline, compaction, salinisation, landslides, contamination)
- Transportation /Mobility
- Energy /Climate
- Air quality
- Noise
- Landscape development
- Water bodies
- Biodiversity: Ecosystems, Fauna and Flora

Urban land use planning effects directly the natural environmental balance, alters the way in which land is used, and thus has a great impact on many aspects of the environment.
The area of soil surface covered with an impermeable material represents around 9% of the total area in Member States (EEA, 2010). Between 1990 and 2000, the sealed area in EU15 increased by 6% and the demand for both new construction and transport infrastructures due to increased urban sprawl continues to rise. In comparison to Europe as a whole, Germany's land use growth with 5 m^2 per year and person is average. Austria features the highest figure with 10 m^2 of new construction land per year and person.
Land use that seals surface, thus dividing plants' and animals' natural habitats, is only one example of how transportation harms the environment. In the year 2000, surface area used for transportation purposes amounted to 17,280 km2 or 4.8% of Germany's surface area, increasing by 0.5% (81 km2) by 2002(EEA, 2010). Further impact is caused by energy consumption, noise pollution, toxic emissions and gases harmful to the ozone layer, e.g. CO_2 (EEA, 2011b). The economic losses caused by costs incurred through traffic accidents, subsequent costs, and time-loss due to traffic jams are often not in any way calculated in communal transportation cost figures. Establishing the true costs of transportation would help to alleviate this deficit.
Settlement development has a fundamental effect on the level of energy use and is also of importance for the climate due to its association with $C0_2$ emissions. Energy is used not only in the production of construction materials and construction itself, but also in the demolition and recycling of existing structures and infrastructure, as well as in transportation and the energy structures require when they are in use. The fact that power grids are used for long periods of time ranging from 50 to 100 years requires that we establish high standards for new structures and that the energy use in older ones is adapted to current standards.
Furthermore, settlement development influences the local microclimate through changes in heat radiation balances, prevailing air currents, level of atmospheric humidity, groundwater table, and vegetation, as well as through emission of dust and toxic substances, all of which factors in turn have an effect on the overall climatic system.

2.3.3 European Legislation

- Environmental Impact Assessment – EIA Directive 85/337/EEC
- Environmental Assessment – SEA Directive 2001/42/EC
- EU Fauna-Flora-Habitat Directive (FFH) and the resulting NATURA2000-Network
- EU Water Framework Directive
- EU Directive on environmental liability with regard to the prevention and remedying of environmental damage 2004/35/CE
- Integrated Pollution Prevention and Control (IPPC Directive) 2008/1/EC

2.3.4 Direct and indirect influence on the aspect

Table 2.2: Environmental aspects linked to Urban Sprawl

Environmental aspect: urban sprawl	
Direct influence	**Indirect influence**
Establishing how much land is available for construction	Decreasing further dispersion of settlement
Settlement development that conserves surface area	Avoiding fallow areas within the city
Maintaining settlement borders	Conservative use of surface area in development and choice of construction type
Optimisation of relationship between land dedicated to transportation and to settlement. Optimisation of construction site use	Intensified usage of attractive locations
Retrospective consolidation: Use of empty slots, combined types of usage, raising occupation density, minimization of transportation network, etc.	Quantitative and qualitative compensation for loss of surface
	Mobilization of potential in existing construction sites

Table 2.3: Environmental aspects linked to Green Areas

Environmental aspect: de-sealing /green areas	
Direct influence	**Indirect influence**
Use of water-permeable coverage for public parking lots	Information and sensitisation of private constructors and architects on the importance of de-sealing
Disconnection of rain water pipe system from waste water/sewage pipe system	
Re-exposure of soil on commercial and private properties	
Protection of existing natural habitats	
Creation /extension of biotope corridors	Consider private properties for the connection of biotopes (green grids)
Use of native species Creation of dry-walls, watery areas, roof and siding plantings, etc.	Information and sensitisation of private garden owners regarding native species and creation of habitats by
Carefully linkage of settlement area to surrounding landscape by means of connecting plantings and paths	

Table 2.4: Environmental aspects linked to Transport/Mobility

Environmental aspect: transport /mobility	
Direct influence	**Indirect influence**
Reduction of surface area used through compact settlement structures with short distances between destinations instead of	Increase in level of development measures (measurements? Standards?) within neighbourhoods, reduction of average distance

excessively extensive settlement and suburbanisation	to nearest public transportation access
Combination of different types of land use instead of separation into distinctive use type districts	Designation of transportation routes for motorised and rail traffic, for pedestrians and bicyclists
Conservative and differentiated development of transportation surface area by means of terminal streets, courtyard housing developments, short link roads and residential streets in residential areas instead of all-encompassing transportation development in residential areas	
Reduction and relocation of parking spaces, e.g. Designation of Park+Ride parking spaces	Influencing citizens behaviour by Park+Ride parking spaces
Expansion of existing bicycle paths, sidewalks and other infrastructures, e.g. by roofed-over bicycle parking lots	Influencing citizens behaviour by roofed-over bicycle parking lots

See also Environmental Aspect: Transport /Mobility

Table 2.5: Environmental aspects linked to Landscape Development / Water Bodies

Environmental aspect: landscape development / water bodies	
Direct influence	**Indirect influence**
Preservation and development of existing forest areas and their functional diversity	Preservation and development of man-made landscapes
Designate use of shoreline settlement areas into green areas	
Restoration of flowing waters, preservation, renovation and improvement of flowing waters	

Table 2.6: Environmental aspects linked to Energy and Climate

Environmental aspect: energy /climate	
Direct influence	**Indirect influence**
Increase of energy efficiency by - Density of urban development - Types of structures present - Orientation of structures - Arrangement of buildings - Roof form and orientation	Online roof maps Incentives Information centrs/front office
Planning of energy supply : - Central (local or distant source of energy) or decentralise supply - Source of power supply - Heating technology and regulation - Central or decentral use of renewable sources of energy	

See also environmental aspects Energy and Climate Change

Examples for own regulations:

- Construction ordinances such as construction of obligatory construction of solid surfaces, e.g. terraces and parking spaces with water-permeable coverage
- Parking control systems and vehicle storage concepts
- Traffic calming, designation of 30-kmh zones

- split sewer fees
- obligatory connection to district heating for house owners
- exceeding legal standard of minimum 10%-quota of renewable
- Raw material /waste
- Participation

2.3.5 Interrelation with other environmental aspects

Energy, transport, climate change, nature and biodiversity protection, soil protection, governance

2.3.6 Interrelation with other sustainability aspects

Quality of life, mobility, security, recreation, health, economic development, social deprivation, demographic development

2.3.7 Stakeholder Landscape

Table 2.7: Stakeholder Landscape

Stakeholder	Affected	Can influence	Remarks
Regional administrations		X	Provide the regional frame for local land use planning and related specific plans, specially transport
Citizens	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement (e.g. Agenda 21 /sustainable city development)
Other departments of the local authority	X	X	Contribution to the EMS environmental assessment /performance audit, goals and measures of environmental program, monitoring, stakeholder involvement
Industry / economic sector /tourism	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement (e.g. Agenda 21 /sustainable city development).
Social public and private institutions	X		Information and consultation according to legal requirements; participation above legal requirements, permanent involvement (e.g. Agenda 21 /sustainable city development).
Educational public and private institutions	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement (e.g. Agenda 21 /sustainable city development).
Environmental NGOs	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement (e.g. Agenda 21 /sustainable city development).
Local authorities in neighborhoods	X	X	Planning of joint services, compensations, design of complementary economic offers, commuter problematic

2.4 Environmental Aspect: Mobility

2.4.1 Relevance for other Public Services on the Local Level

- Sustainable Water Management
- Sustainable Green Spaces
- Sustainable Land Use
- Sustainable Housing
- Environmental Services
- Sustainable Education
- Sustainable Health and Social Services
- Sustainable Economy

2.4.2 Introduction

Citizens and local businesses expect local authorities to provide a variety of services related to mobility: infrastructure like streets as well as (public) transportation-services. The more so, the more society and economy differentiate and specialize: people need to get to their workplace and have mobility needs associated with their social relationships; local businesses today often have complex and globalized supply-chains and thus depend heavily on a steady supply of raw-materials or prefabricated parts – which may come from all over the world.

The organization of the transport sector in a given country is complex, since the responsibilities are divided upon many public and private or (semi-)private players. Responsibilities, interests and restrictions on resources of different federal levels and private businesses interact: for some streets, local authorities are responsible, others fall within the competence of the next federal tier or are even organized on the national level. In some countries private investors may operate streets and in some cases the separation of infrastructure and transportation-service is relatively new (eg the railway-system in Germany). The "customers" (citizens and businesses alike) on the other hand expect a unified and efficient service and mobility is perceived as a major contributor to economic success and quality of life.

Local authorities shape the local transportation infrastructure itself as well as the need for transportation: Since transportation connects places and local authorities have a big saying in how and where these places are placed through their authority over land-use-planning, local authorities are responsible for guaranteeing mobility as well as reducing the need for transportation.

At the same time, the environmental (and economic and social) impacts of transportation can be massive and impede quality of life in urban areas considerably.

In order to improve air-quality, the European Union has introduced the Air Quality Directive, which performed a paradigm-shift by introducing immission values. If at any given point, these are not met, the responsible authority has to introduce action plans and air quality strategies which will ensure the adherence to immission boundaries in the future – resulting for example in the introduction of "low emission zones", denying vehicles with poor emission standards access to the inner city.

The boundaries usually consist of a daily average or maximum value which may be exceeded several times during a year and a long term average over a given time. For the pollutants most relevant and closely related to mobility (at least when it comes to immission on-site) boundaries are:

- PM10: 50 $\mu g/m^3$ (daily average) not exceeded more than 35 times per year. Yearly average not exceeding 40$\mu g/m^3$.
- ozone: 120 µg/m3 (highest 8 hour average), may only be exceeded 25 times (averaged over three years)
- NOx: 1 hour average of 200 NO_2 may not be exceeded more than 18 times a year. Yearly average of 40 µg may not be exceeded.

2.4.3 Relevant NACE-Codes

H49.3.1 - Urban and suburban passenger land transport; O84

2.4.4 European Legislation

- Air Quality Directive: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0050:EN:NOT

- Environmental Assessment –SEA-directive: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32001L0042:EN:NOT

2.4.5 Environmental Impacts

Environmental impacts from transportation stem from the operation of vehicles on the one hand and the implementation of infrastructure like roads, rails and airports, on the other hand. The first is usually associated with a variety of emissions – mostly noise and a variety of air-pollutants – the latter is associated with the consumption of land.
Road-traffic and other transportation is among the most important contributors to fine particle matter and NOx emissions(EEA, 2011) emitting roughly 3.200 gigatons of particle-matter and almost 9.400 gigatons of NOx[4]. Although, private households and industrial processes contribute more emission, since air-circulation is limited, the exceedance of immission limits in urban areas are usually strongly associated with road traffic. Besides air-quality issues, noise emissions – especially from road transport – are affecting the environment in urban areas: About half the citizens in the European Union living in agglomerations with more than 250.000 inhabitants are exposed to noise levels above 55db at daytime, about 17% of the inhabitants are exposed to harmful noise-levels, also mostly originating from road transportation, during night time (EEA, 2009). Of course, transportation is also a major contributor to greenhouse-gas-emission: in 2006, up to 19% of GHG-emissions in the European Union originated from transport activities, mostly from road transport (EEA, 2008).
The infrastructure necessary for modern mobility usually consumes land, thereby destroying habitats directly, or disturbing other habitats by being an insurmountable obstacle for the local wildlife.

2.4.6 Direct and Indirect Influence

Table 2.8: Environmental Aspects of municipal operations

Environmental aspect: municipal operations			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Fleet-vehicles	Fuel efficient fleet-vehicles, low-emission technology	Driving behavior of employees	Training for fuel-efficient driving
		Mobility choices of employees	Job-ticket, mobility management

Table 2.9: Environmental Aspects of Transportation Infrastructures

Environmental aspect: transportation infrastructure			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Design and implementation of transport infrastructure	Using noise reducing coating for streets, bicycle- and pedestrian-friendly design of street-area, introduction of dedicated bus-lanes and car-sharing lanes, zones with	Citizens mobility choices (modal split)	Information campaigns, design and implementation of road transport infrastructure, land-use planning, see public transport, parking-space-management, mobility counseling, congestion

[4] http://www.eea.europa.eu/data-and-maps/data/data-viewers/air-emissions-viewer-lrtap / values for 2009, particle matter including PM10 and PM2.5

	30km/h speed limit, pedestrian-friendly design of streets, tram-systems		charges
Compact structure of settlements	Re-usage of brown field-sites, mixed residential-commercial areas, land use planning	Spatial-development in neighboring cities / on regional level	Joint planning initiatives, participation in regional development initiatives

Table 2.10: Environmental Aspects of Public Transportation

Environmental aspect: public transportation			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Design and implementation of infrastructure for public-transportation	Using environment friendly vehicles, using smaller vehicles on less frequently used bus-lines, decision on whether to introduce trams, bus-lanes	Citizens mobility choices (modal split)	Easy to use public transportation services, timely and reliant services, unified services through transport associations; image campaigns for public transportation, modern technology to guide user, pricing-scheme
Design of public-transportation service	Density of transportation network/distance to nearest access point, service frequency, clean and safe buses, well educated personnel,	Employees of public and private businesses	Campaign for mobility management, job-tickets for public transportation, mobility counseling,

Table 2.11: Environmental Aspects of Inter Modality

Environmental aspect: inter modality			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Design and implementation transportation infrastructure and services	Adjustments between local and regional transportation services, parking lots for car-sharing, rent-a-bike offerings, possibility to take bikes with you in public transportation	Citizens mobility choices (modal split)	Information campaigns, grant-schemes for bikes, usage of modern information technology to access time tables and unified information platforms

Table 2.12: Environmental Aspects of Businesses

Environmental aspect: businesses			
		Logistic-choices of businesses	Information campaigns, offering EMAS-convoys
		Mobility choices of employees of public and private businesses	Campaign for mobility management, job-tickets for usage of public transportation

2.4.7 Connections to other environmental aspects

land-use planning, climate change mitigation and adaptation, air-quality, nature- and biodiversity-protection

2.4.8 Connections to non-environmental issues

Inclusion and social justice, traffic-security, health, sustainable economy

2.4.9 Stakeholder-Landscape

Table 2.13: Stakeholder-Landscape

stakeholder	affected	can influence	remarks
citizens	X	X	affected through pollution (air, nose), and breakdown of transportation systems, can influence through mobility choices, customers of public transportation
local businesses	X	X	heavily affected by possible breakdowns of transportation systems, can influence through supply-chain logistics and mobility management
local commerce	X	X	depend on easy access to their shops, can motivate customers to choose bus and train
tourism-sector	X	X	traffic congestion may de-value their products, can motivate tourist to use public transportation, depend on good accessibility
citizens in specific neighborhoods	X	X	maybe affected by transportation / infrastructure needs; can slow-down planning-processes or overturn results, may be able to provide better solutions for infrastructure through high level of knowledge about specific sites
NGOs		X	may possess relevant knowledge, may be able to influence other stakeholders

2.5 Environmental Aspect: Air Quality

2.5.1 Relevance for other public services on the local level

- sustainable mobility
- sustainable green spaces
- sustainable land use
- sustainable housing
- environmental services
- sustainable education
- sustainable health and social services

2.5.2 Public Administrations and Quality of Air

On one hand, clean air is an important prerequisite for good health and quality of life for citizens, making it a high priority for public administrations – especially local authorities. On the other hand, many activities (also contributing to quality of life) connected to modern-life have an impact on air-quality on the local level: all economic sectors as well as citizens mobility choices, to name two examples, are tied to various levels of emission of airborne pollutants.
In order to limit exposure of citizens as well as ecosystems to harmful airborne pollutants, EU-legislation introduced hard immission-limits. Exceedance of the limits carries the obligation of developing and implementing short-term action plans and long-term air-quality-plans. Additionally, the member-states had to introduce systems to monitor the current air-quality and compliance with immission-limits. The monitoring systems are usually maintained on regional or national level and even the short and long term planning may be done on a regional level.

Although – at least in theory – the influence of a local authority on air-quality planning maybe limited, in reality, the planning process will happen in close cooperation with the local authority since the majority of measures has to be implemented on the local level by the local administration

At the same time, local authorities should work together closely with neighboring authorities: on the one hand, because many air pollutants travel far – so a good air quality planning in the surrounding area is of high interest – and on the other hand pollution can be the result of the relation of a city to the region, e.g. because people live and work at different places.

2.5.3 Relevant NACE-Codes

E 40.1, E.49.3.1, F 41.2

2.5.4 European Legislation

- Air Quality Directive: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0050:EN:NOT
- Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste
- Environmental Liability Directive: http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=Directive&an_doc=2004&nu_doc=35
- Environmental Asessment –SEA-directive: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32001L0042:EN:NOT
- Protection of the Environment through Criminal Law / Directive http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0099:EN:NOT

2.5.5 Environmental Impacts

Although, air-quality has improved in the last twenty years, the topic is still relevant. The EEA reported the exeedance of NO2 limits in almost every member state in 2009[5] mostly related to traffic. In the same year, 36% of rural monitoring stations had to report the exceedance of the target value for O3 – a value designed to protect human health[6]. Impacts on the environment include the reduction of life-expectancy of Europeans by 8 months through the exposure to PM2.5 (EC, 2005). Air pollutants are responsible for acid rain, eutrophication and biodiversity-loss, ozone depletion and climate change.

[5] http://acm.eionet.europa.eu/databases/airbase/eoi_reports/eoi2010/index_html

[6] http://acm.eionet.europa.eu/databases/airbase/eoi_reports/eoi2010/status_air_quality2009_O3.pdf

2.5.6 Direct and Indirect Influence

Table 2.14: Environmental Aspects of Transportation and Mobility

Environmental aspect: transportation and mobility			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Design and implementation of transportation infrastructure: streets, public transportation etc.	Using low-emission vehicles for public transportation, providing alternative routes for individual traffic around densely populated districts	Citizens behavior: choice of mode of transportation, usage of low-emission vehicles	Offering strong inter-modal options for transportation, pricing and quality of public transportation, connection of transportation services and planning to neighbouring cities, counties and regions. Information-Campaigns, mobility counseling. Land-use-planning for compact city. Introducing inner city tolls

Table 2.15: Environmental Aspects of Urban Climate

Environmental aspect: urban climate			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Air-circulation in the area	Introducing circulation aisles into land-use-planning		
Air filtering through green spaces	Green spaces to absorb pollutants	Air filtering through green spaces	Motivate citizens to introduce roof gardens and façade greeneries

Table 2.16: Environmental Aspects of Buildings and Energy

Environmental aspect: buildings and energy			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Design and implementation of other infrastructure	Low emission vehicles, modern low-emission heating-technology in public buildings, modernization of public buildings	Citizens behavior: decisions about heating-systems in private buildings, standard of isolation of existing buildings	Information campaigns, energy-counseling, financial incentives, some standards can be set through land-use-planning (which “suggest” application of technologies exceeding the minimum legal requirements)

Table 2.17: Environmental Aspects of Legislative Matters

Environmental aspect: enforcement of legislation and monitoring of compliance with legislation			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Development and implementation of air-quality-planning and measures in case of exceedance of air-quality-limits	Integrated planning, introduction of environmental zones, refitting of public vehicles with filter-systems	Behavior of citizens and industry	Information and education, control intervals, introduction of fines, information on bonfires and proper disposal of green waste
Control of minimum requirements and effectiveness on filtering technology, emission-limits etc of manufacturing- and power-plants,	Density of controls, education of inspectors,	Behavior of citizens and industry	Information and education, control intervals, introduction of fines

2.5.7 Examples of own regulations

Introduction of city toll, voluntary introduction of environmental zone

2.5.8 Interrelations with other environmental aspects

- transportation
- land use planning
- climate change
- protection of nature and biodiversity
- waste
- noise

2.5.9 Interrelations with other sustainability aspects

Health, cultural heritage, social justice (Pye, 2006)

2.5.10 Stakeholder-Landscape

Table 2.18: Stakeholder Landscape

Stakeholder	**Affected**	**Can influence**	**Level**	**Remarks**
Citizens	X	X	Local	clean air as a prerequisite for health, consumer-choices contribute to air-quality (or lack thereof)
Citizens (car-owners and users)	X	X	Local and regional	can influence air-quality by using clean cars, park & ride, affected by measures to improve air quality (city toll, environmental zones etc)
Industry / secondary economic sector		X	Local	contributes to air-quality: can use cleaner production methods and optimized logistics
Health-care-services	X		Local	Have to deal with dangers to health through bad air-quality, can provide knowledge about the health-threat of bad air-quality
Service-providers, tourism	X	X	Local	Bad air may lead to diminishing number of visitors, impact of tourism on air-quality

Stakeholder	Affected	Can influence	Level	Remarks
Citizens in specific neighborhoods	X	X		Some air-pollutants have a limited area of spreading around its origin (eg particulates), some neighborhoods might be more affected than others, citizens of these neighborhoods have to accept measures and can influence the effectiveness of measures
NGOs	X	X		Represent stakeholder groups, might have agendas and knowledge relevant to the topic

2.6 Environmental Aspect: Waste

2.6.1 Relevance for other public services on the local level

- sustainable water management
- environmental services
- sustainable education
- sustainable health and social services
- sustainable economy
- sustainable land use

2.6.2 Introduction

Since most human activities make use of resources, which are bound to end up as “waste” at some point, which in turn can have harmful impacts on the environment and health of citizens, the avoidance, collection and processing of waste is an important topic for every society – especially if they are as highly industrialized as the EU member states are. The EEA states, that a third of resources used in the EU is converted to waste and emissions[7].

Since the introduction of waste into the environment can have great impact on health and environment, waste collection, transport, processing and disposal are highly regulated by a number of EU, national and local regulations – ranging from regulations prohibiting fly-tipping and littering to regulations concerned with the storage of radioactive waste. Responsibilities are divided among different federal levels: the collection, transport and processing of urban waste from private households is often organized on the local level – either as a public service from the administration or by private companies commissioned by the administration. Especially hazardous waste on the other hand is usually the responsibility of a higher level federal tier.

Local and regional administrations usually have the following connections to the environmental aspect “waste”:

- their operations produce waste
- they are providing services like curb-side collection, cleaning of public space, resource recovery etc.
- they are responsible to assure legal compliances of citizens, private businesses and operators of waste collection, waste transportation, waste processing and waste disposal services.

2.6.3 Relevant NACE-Codes

- O84.02.04 (Public Order and Safety Activities), E38. - Waste collection, treatment and disposal activities; materials recovery; E39. - Remediation activities and other waste management services

[7] http://www.eea.europa.eu/de/themes/waste

2.6.4 Environmental Impacts

According to the EEA, every EU citizen produced 520kg municipal waste in 2004 – which is only about 10% of all generated waste in the EU. This is projected to rise up to 680 kg municipal waste per citizen in 2020[8]. Municipal waste and its management are a major contributor to the emission of GHG: Even though the EEA expects GHG emission from municipal waste to drop considerably until 2020, municipal waste will still be responsible for 10 million tons of GHG-emissions in 2020[9].

Further impacts on the environment include smell, noise-emission, emission of particles, used land and - depending on treatment and disposal facilities - the emission of a variety of other toxic substances (e.g. from incineration facilities etc).

The aforementioned impacts may occur during "normal" operations of waste management facilities. Many types of waste are inherently hazardous or become hazardous during treatment and disposal (e.g. landfills) with potentially catastrophic impacts of the environment in the case of natural disasters (e.g. floods) or other crisis (e.g. failure of landfill containment or fire in a waste-plant): According to the EEA the treatment and disposal of municipal and industrial waste is responsible for 24% of all soil contaminations. [10] Other impacts during crisis include contamination of water (or air) through a variety of toxic substances.

2.6.5 European Legislation

- Waste Framework Directive: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0098:EN:NOT
- Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste
  Ancillary legislation relating to landfill of waste
- Commission Decision of 17 November 2000 concerning a questionnaire for Member States reports on the implementation of Directive 1999/31/EC on the landfill of waste
- Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste
- Directive 2000/59/EC of the European Parliament and of the Council of 27 November 2000 on port reception facilities for ship-generated waste and cargo residues - Commission declaration
- Regulation on Waste-Statistics: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002R2150:EN:NOT
- Waste Electrical and Electronic Equipment Directive (WEEE): http://eur-lex.europa.eu/Result.do?arg0=waste+electrical+and+electronic&arg1=&arg2=amend&titre=titre&chlang=en&RechType=RECH_mot&idRoot=15&refinecode=LEG*T1%3DV112%3BT2%3DV1%3BT3%3DV1&Submit=Search
- Air Quality Directive: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0050:EN:NOT
- Environmental Liability Directive: http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=Directive&an_doc=2004&nu_doc=35
- Environmental Assessment –SEA-directive: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32001L0042:EN:NOT
- Protection of the Environment through Criminal Law / Directive http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0099:EN:NOT

[8] http://www.eea.europa.eu/publications/briefing_2008_1/EN_Briefing_01-2008.pdf

[9] http://scp.eionet.europa.eu/publications/wp2008_1

[10] http://www.eea.europa.eu/data-and-maps/figures/overview-of-economic-activities-causing-soil-contamination-in-some-wce-and-see-countries-pct-of-investigated-sites

2.6.6 Direct and Indirect Influence on the aspect

Table 2.19: Environmental Aspects of Waste Collection

Environmental aspect: waste collection			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Infrastructure to collect waste	Trucks with low emissions, functional bins, establishment of collection points for special waste, quantity of collection points /waste separation bins	Citizens behavior: - reduction of waste production Increase of separation of waste	Pricing of services dependent on mass and sorting, design of services (garbage boxes, intervals of curb-collection), information campaigns towards citizens, “recycling competitions”
Design and implementation of service	Green logistics, frequency of waste collection		

Table 2.20: Environmental Aspects of waste processing and disposal

Environmental aspect: waste-processing and disposal			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Design and implementation of infrastructure to process and dispose of waste: recycling-facilities, incinerators, landfills, logistics	Application of modern up-to-date technologies in incinerators, waste-separation and landfills, green logistics.	See above	See above

Table 2.21: Environmental Aspects of Legislation Enforcement

Environmental aspect: enforcement of legislation and monitoring of compliance with legislation			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Control of legal compliance of public and private “waste business”; and other businesses, sanctioning and stopping of non-compliance	Introduction of environmental monitoring-scheme (water analysis, air analysis in order to identify release of substances into the environment), regular visits at service-providing facilities (own and private), fines	Behavior of private (and public) businesses	Information, controls, pricing of services
Control of legal compliance of citizens , sanctioning of non-compliance, stopping non-compliance	“Litter patrol”, hotline to report abandoned vehicles and illegally disposed waste, fining-scheme	Citizens behavior	Information, quick disposal of abandoned vehicles and other litter

2.6.7 Own Regulations

- fine for littering
- service costs dependent on level of waste separation and amount of waste

2.6.8 Interrelations with other environmental aspects

- energy: usage of waste for energy production. Further connection to air-quality issues.
- climate change: waste as a considerable source of GHGs
- land use planning: contamination of land, brown fields etc.
- biodiversity: impacts
- air quality

2.6.9 Interrelations with other sustainability aspects

- social deprivation of parishes / “broken window theory”
- effects of placing processing and disposal facilities on land-prices and nearby citizens’ health and local quality of life (smell, noise)
- health: waste as a source of health-hazards
- local economy: quality of living environment supports local economy, pricing of waste-management services may provide economic advantage or disadvantage

2.6.10 Stakeholder-Landscape

Table 2.22: Stakeholder-Landscape

Stakeholder	Affected	Can influence	Level	Remarks
Citizens	X	X	Local	Produce waste, customers for services, interest in design and appearance of public spaces, can behave (un-)lawful
Businesses	X	X	Local	Produce waste, customers for services, can behave (un-)lawful
Civil-society: NGOs		X	Local	Knowledge, can have related tasks (nature protection, development of area regarding public spaces, economy etc.)
Neighbouring communities	X	X	Regional	Produce waste, may share processing facilities, landfills and services, are affected by decisions about processing and disposal sites
Regional tier of government		x	Regional	Responsible for regional land-use planning
National tier of government		X	National	Implement EU-directives, aggregate waste-statistics

2.7 Environmental Aspect: Water supply and waste water treatment

Water supply and waste water treatment is relevant within others for the services
- Sustainable Water Management
- Sustainable Health and Social Services

About 80 percent of public water use is accounted for by residential and small commercial users. In most of the EU Member States, responsibility for water supply and sanitation provision lies with municipalities, which are regulated by the states.

Responsibility for policy setting in public water supply and sanitation in Germany is shared between the EU, the federal government and state governments (Länder). The EU sets the framework legislation for water quality and water resources management. The organization of public water supply and sanitation, however, remains a prerogative of EU member states. The German states (Länder) play a key role in the sector by setting, among other things, the legal framework for tariff approvals. Municipalities, legally entrusted with service provision, play an

indirect role in influencing policy positions related to water and sanitation through their influential municipal associations. Often, municipalities create inter-municipal utilities or public-private utilities for drinking water supply.
The Drinking Water Directive sets standards for the most common substances (so-called parameters) that can be found in drinking water. In the DWD a total of 48 microbiological and chemical parameters must be monitored and tested regularly. In principle WHO guidelines for drinking water are used as a basis for the standards in the Drinking Water Directive.
WISE (Water Information System for Europe), is the Common Reporting Strategy for water legislation. A series of maps on water quality, updated with the latest information reported by countries, has been published by the European Environment Agency (EEA).

Waste water from households and industry represents a significant pressure on the water environment because of the loads of organic matter and nutrients as well as hazardous substances. Industrial production and household consumption increased at a rapid rate during the last century, producing larger amounts of wastewater. With high levels of the population in European countries living in urban agglomerations, a significant fraction of waste water is collected by sewers connected to public wastewater treatment plants. Average connection rates between 80%-90% are reported for Northern, Southern and Central Europe. Eastern Europe still copes with much lower rates of 40%-65% of the population connected to primary waste water treatment at least. The level of treatment before discharge and the sensitivity of the receiving waters determine the scale of impacts on aquatic ecosystems. The types of treatments and conformity with the directive are seen as proxy indicators for the level of purification and the potential improvement of the water environment.
The central piece of legislation is the Urban Waste Water Treatment Directive (91/271/EEC) (148). It is a key EU water policy, which aims at protecting the environment from the adverse effects of urban wastewater discharges. The directive sets minimum standards for the collection, treatment and disposal of wastewater that depend on the size of the agglomeration, and the type and sensitivity of the receiving waters.

2.7.1 Environmental impacts

Climate Change, demographic developments, urbanization, economic progress, social changes influence the water sector in many ways. The increase of water consumption can have negative impacts on the environment and in countries with increasing water shortage like Spain or Greece, conflicting interests regarding water, dried out groundwater reserves and saline groundwater belong to the increasing problems.
But also decreased water consumption can have negative operational, health and even environmental impacts. On the water-supply side, reduced consumption means reduced water flow through pipes, leading to a longer length of stay of drinking water in pipes, which in turn carries the risk of contamination of water with bacteria or heavy metal (through corroding pipes). The reduction of water consumption also leads to a lower amount of waste water rushing through the sanitation system, resulting in reduced transportation of solid constituents of waste water, which in turn harms the sanitation system and leads to increased odour during summer. These problems are usually associated with oversized water supply or waste water treatment facilities - a problem that will increase in the future because of the ongoing demographic changes in many EU-countries and the increasing need to reduce water consumption .
In regions with enough water supplies, a decrease in water consumption may also lead to rising ground water levels, since less water is abstracted: Berlin for example might (partly because industry changed – but also through modernized technology and water saving efforts which led to significantly lower water consumption per capita) soon reach pre-industrial ground water levels.[11] An increase which demands further efforts to protect buildings but also demands efforts to protect ground water quality.
Especially the new member states located in Eastern Europe are in need of enormous investments in the WSS sector. The more so, since water supply and treatment facilities have sometimes been neglected for decades. The situation varies considerably: While about 60% of

[11] http://www.bwb.de/content/language2/html/4163.php

inhabitants were connected to urban waste water treatment in Poland in 2009, the same was only true for a third of the population in Romania.[12]
The existing and foreseen problems are the lack of investments in the rural and municipal water supply which lead to poor services (e.g. lacking water pipes, insufficient water availability during drought, etc.), the limited availability of water resources and simply a lack of time.
Technologies are actually available but most of them are too expensive or far too time consuming to implement simultaneously with ongoing progress and changes. To illustrate: In 2003, the need for investments into infrastructure for water supply and waste water services in Romania was estimated to be as high as 12 billion Euro (Speck, 2006) - investments, which are hard to come by for a government with around 60 billion total revenues.[13]
Water supply limitation counts as major concern. Another challenge within the water sector in Europe is privatization and lobbyism in the water sector.

2.7.2 NACE Code:

E 36

2.7.3 Related European environmental legislation

- Drinking Water Directive (DWD), Council Directive 98/83/EC,
- European Water Framework Directive (2000/60/EC)
- Groundwater Directive 2006/118/EC
- Discharge of dangerous substances (Directive 76/464/EEC)
- Priority substances Directive (Directive 2008/105/EC)
- Commission Directive 2009/90/EC on technical specifications for chemical analysis and monitoring of water status
- Urban Waste Water Treatment Directive (91/271/EEC) (148)

2.7.4 Direct and indirect influence on the aspect

Table 2.23: Environmental Aspects of Drinking Water Supply Infrastructure

Environmental aspect: design and implementation drinking water supply infrastructure	
Direct influence	**Indirect influence**
Urban planning	Information campaigns on water savings
Installation of advanced (tertiary) waste water treatment. Combination of secondary treatment and constructed wetlands	

Table 2.24: Environmental Aspects of Waste Water Collection

Environmental aspect: design and implementation of waste water collection	
Direct influence	**Indirect influence**
Urban planning	Information campaigns on water savings
Installation of advanced (tertiary) waste water treatment. Combination of secondary treatment and constructed wetlands	Information campaigns on substances critical for waste water treatment plants (e.g. medicaments, pesticides)

2.7.5 Examples for own regulations

- Price for drinking water
- Price for waste water
- Split sewer fee

[12] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Water_statistics#Wastewater_treatment

[13] https://www.cia.gov/library/publications/the-world-factbook/geos/ro.html

2.7.6 Interrelation with other environmental aspects

Land use planning, nature and biodiversity protection, soil protection, governance

2.7.7 Interrelation with other sustainability aspects

Good drinking water quality is a prerequisite for health; water as important ecosystem service for the production process in the industry, water bodies such as lakes and rivers as hotspots for tourism development and recreational activities.

2.7.8 Stakeholder-Landscape

Table 2.25: Stakeholder-Landscape

Stakeholder	Affected	Can influence	Remarks
Regional administrations		X	Development and offer of joint services
Public /private companies		X	Development and offer of joint services
citizens	X	X	Information /consultation according to legal requirements. Information and sensitization campaigns
Other departments of the local authority	X	X	Contribution the EMS environmental assessment /performance audit, goals and measures, monitoring, stakeholder involvement
industry / economic sector /tourism	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement (e.g. Agenda 21 /management of water resources).
Environmental NGOs	X	X	Information and consultation according to legal requirements; monitoring
Local authorities in neighborhoods	X	X	Planning and offer of joint services, management of common drinking water reserves

2.8 Environmental aspect: Nature and biodiversity protection and restoration and protection of cultural landscape

Nature and biodiversity protection and protection of landscape is relevant within others for the following services of public administrations:

- Sustainable Water Management
- Sustainable Green Spaces
- Sustainable Land Use
- Environmental Services
- Sustainable Education
- Sustainable Leisure Activities
- Sustainable Health and Social Services
- Sustainable Economy (e.g. tourism)

It is estimated in UNEP's Global Biodiversity Assessment (Heywood, 1995) that, on a global level, biodiversity is decreasing at a faster rate now than at any other time in the past. The situation in Europe is also a cause for concern. The rich biodiversity of the European Union has been subject to slow changes over the centuries, due to the impact of human activities. The scale of this impact has accelerated dramatically in the last few decades. The Assessment by UNEP confirms that in some European countries up to 24% of species of certain groups such as butterflies, birds and mammals are now nationally extinct.
The International Convention on Biological Diversity (CBD) confirms the following main drivers for loss of biodiversity:

- Transformation or destruction of habitats
- Overexploitation of natural resources
- Climate change
- Emissions /Pollution
- Invasive species

Cities occupy just 2% of the surface area of the planet, but absorb a staggering 75% of the World's natural resources (EEA, 2009). Europe is one of the most urbanised continents. Approximately 75 % of its population lives in urban areas; by 2020, this will be 80 %. In all EU Member States, land urbanization and the construction of infrastructures are directly connected with local policies. Local governments are at the front line when it comes to managing natural resources. Their day-to-day-planning decisions have direct impacts on the environment. It is therefore imperative that biodiversity considerations are integrated into urban planning, urban development and management of urban natural resources.

Urban biodiversity may refer to plants and animals that occur within the built environment, for example falcons and pigeons that nest on buildings; or it may refer to remaining biodiversity that occurred in the area long before people built their structures, for example patches of vegetation that have so far survived encroaching development. The protection of natural and anthropogenic green areas within urban areas is not only of vital importance for the conservation of biodiversity, but also for the mitigation of negative impacts of climate change in the cities -microclimatic function of green areas.

Administrative areas of communities include also natural and cultural landscape. In some European member States, local authorities have the competence to declare protected areas and many communities are inside or in the direct neighbourhood of a protected area.

Legally requested (management) responsibilities regarding nature protection for local authorities are increasing, but up to now only very few local authorities are in legal compliance or do even more than requested by law. Protection of nature and biodiversity is complex and only few communities do have the knowhow inside the Authority.

Landscape fragmentation caused by transportation infrastructure and built-up areas has a number of ecological effects. It contributes significantly to the decline and loss of wildlife populations and to the increasing endangerment of species in Europe, for example through the dissection and isolation of populations, and affects the water regime and the recreational quality of landscapes. In spite of the planning concept of preserving large unfragmented areas, fragmentation has continued to increase during the last 20 years, and many more new transportation infrastructure projects are planned, in particular in Eastern Europe.

The amount of variation in the level of fragmentation that was explained by the predictor variables was high, ranging from 46 % to 91 % in different parts of Europe) (EEA, 2011b).

Four out of five Europeans live in cities and towns. Man-made and virtual surroundings dominate the senses and lives of urban citizens. So to a large degree they have lost contact with the diverse multitude of life that keeps them alive. This is one of the reasons, why they hardly understand the pressing importance of preserving biodiversity. Local administrations can be leaders in making the population aware of the need to stop the loss of biodiversity.

Studies in the Netherlands demonstrate that children with good access to green open space, fewer high-rise buildings and more outdoor sports facilities are more physically active. Similarly, studies of eight European cities show that people who live in areas with abundant green open space are three times more likely to be physically active and 40 % cent less likely to be overweight or obese (Ellaway *et al.*, 2005). School children who have access to, or even sight of, the natural environment show higher levels of attention than those without these benefits (Velarde *et al.*, 2007).

2.8.1 Related NACE Codes

A 02.0, F 41.2, E 49.3.1, O92.43

2.8.2 Related European environmental legislation:

- Birds Directive (Directive 2009/147/EC)
- Habitats Directive (Directive 92/43/EEC)
- Natura 2000: EU wide network of nature protection areas established under the 1992 Habitats Directive.

2.8.3 See also legislation on:

- Land use planning
- Water supply and waste water treatment
- Management of public forest and rural areas

2.8.4 Direct and indirect influence on the aspect

Local authorities can play an important role in nature and biodiversity protection, because of their variety of possibilities to be active:

- Planning (instruments and processes)
- Creation and management of community green areas
- Creation and management of protected areas
- Protection of species and biotopes
- Conservation and improvement of water bodies
- Planning and management of rural areas (agricultural land, forests)
- Information and education
- Cooperation (with neighbouring municipalities, regional administrations, private stakeholders)
- Green purchasing
- Climate change: adaptation and climate protection

The German environmental NGO Deutsche Umwelthilfe developed together with six other European partners the very successful award „Capital of Biodiversity" for communities of all sizes (http://www.capital-biodiversity.eu/). In order to apply for the competition, municipalities need to fulfil a very complete questionnaire referring to the most important measures local authorities can realize to protect and to restore nature and biodiversity:

Table 2.26: Environmental Aspects of Urban Land Use Planning

Environmental aspect: urban land use planning	
Direct influence	**Indirect influence**
Inventory on ecosystems and species	
Local biodiversity strategy and action plan (LBSAP), or equivalent policy	Participation of stakeholders in development of strategy and action plan
Resolution for 100 per cent compensations of building interventions	Sensitization of planners, architects, private constructors
Planning /Creation of biotope corridors	
Valid municipal statute for tree protection	
Valid municipal statute for protection of biotopes	
Elaboration of a plan for development of water bodies	
Ecological land reallocation /clearance	

Table 2.27: Environmental Aspects of Green Areas

Environmental aspect: planning and maintenance of green areas	
Direct influence	**Indirect influence**
Planting of native trees and bushes from a regional origin	Sensitization measures for citizens, e.g. Information panels, nature experience paths.
barrier- free ways for small animals (for example hedgehog, amphibian)	Demonstration garden for natural gardening Courses for citizens on natural gardening
Promotion of area successions	Courses for citizens on natural gardening
Near-natural mowing of municipal open spaces	Courses for citizens on natural gardening
General cessation of the use of fertilizers	Courses for citizens on natural gardening
General cessation of the use of pesticides	Courses for citizens on natural gardening
General cessation of the use de-icing salt	
Promotion of nutrient deficient habitats not applying humus layers to open landslides, slopes, etc.	
General abandonment of peat	
Near-natural design of outdoor facilities at municipal kindergartens, schools and public playgrounds	
Sowing of flowering meadows instead of green	Courses for citizens on natural gardening Campaigns on “Flowering Landscape”

Table 2.28: Environmental Aspects of Transport / Mobility

Environmental aspect: transport / mobility	
Direct influence	**Indirect influence**
Insect friendly lighting used for municipal road lights, path lights and outdoor lights	
Flowering meadow strips along municipality roads and on roundabouts	
Providing means for animals to cross roads (e.g. corridors for small animals)	

Table 2.29: Environmental Aspects of Biodiversity in water bodies, agriculture and forestry

Environmental aspect: biodiversity in water bodies, agriculture and forestry	
Direct influence	**Indirect influence**
Restoration of streams and rivers	
Creation of retention areas by creation of buffer zones, reallocation of embankments (relocation of dikes etc.	
Restoration of shore lines	
Restoration of piped streams	
Creation of water biotopes	
Rental of public agricultural land for organic farming	
FSC certification for public forest	

Table 2.30: Environmental Aspects of communication, cooperation and organization

Environmental aspect: communication, cooperation and organisation	
Direct influence	**Indirect influence**
Organic food and Fair Trade products in school and kindergarten cantinas	Information campaigns for children and parents
Support of NGO projects	

Monitoring of urban biodiversity plays an important role to identify the best measures for the protection of biodiversity. See chapter on indicators

2.8.5 Interrelation with other environmental aspects

Climate change and mitigation, land use, transport/Mobility, air quality, noise, water supply, management of public forest and rural areas, environmental education.

2.8.6 Interrelation with other sustainability aspects

Health, education, quality of life, economic development

2.8.7 Stakeholder-Landscape

Table 2.31: Stakeholder-Landscape

Stakeholder	Affected	Can influence	Remarks
Regional Administrations		X	Provide the regional frame for local land use planning and related specific plans. Control body for environmental impact assessment. Coordination of compensation measures
Citizens	X	X	Information and consultation according to legal requirements; Citizens as users of natural areas: Permanent involvement (e.g. Agenda 21 /sustainable city development)
Other departments of the local authority	X	X	Contribution to the EMS Environmental Assessment /Performance Audit, goals and measures of Environmental Program, monitoring, stakeholder involvement
Industry / economic sector /tourism	X	X	Information and consultation according to legal requirements; Tourism as user of natural areas (impacts on biodiversity) Impacts on biodiversity by economic sector Economic sector as user of ecosystem services
Social public and private institutions	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement
Educational public and private institutions	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement Educational institutions as user of protected areas
Environmental NGOs	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement (e.g. Member of management body of protected area, management or monitoring of protected area).
Local authorities in neighborhoods	X	X	Planning and implementation of common protected areas, use of protected areas for leisure activities of citizens from neighboring cities

2.9 Environmental aspect: Management of public forest and rural areas

Management of public forest and rural areas is relevant within others for the following services of public administrations:

- Sustainable Water Management
- Sustainable Green Spaces
- Sustainable Land Use
- Environmental Services
- Sustainable Leisure Activities
- Sustainable Health and Social Services
- Sustainable Economy

Forests and other wooded land cover more than 40 % of the EU's surface area. Forests are characterised by a wide variety of climatic, geographic, and ecological conditions. They encompass temperate, boreal, Mediterranean, alpine and lowland forests, among other forest types. Socio-economic conditions also vary greatly among countries and regions.
According to the European Commission (Konijnendijk, 2003) [14], prior to the accession of the twelve new Member States, about 35% of forests and other wooded land in the EU-15 were in public and about 65 % in private ownership. Since accession, the proportion between areas of publicly and privately owned forests has changed to approximately 40 % and 60 % respectively. The average size of EU public forest holdings is more than 1,000 ha, while private forest holdings have an average size of 13 ha.
In most European countries, local authorities own and manage not only urban parks and roadside trees, but also urban woodland. Due to their close links to the local public, they are well-situated to enhance communication with the public, public participation and involvement of stakeholders and forest users. Due to the economic crisis and the negative impacts for public administrations, there is again an increasing pressure towards commercialization of goods from public forest.

2.9.1 The multifunctional role of forests – environmental impacts

Forests provide a livelihood for millions of workers, entrepreneurs and forest owners, and contribute significantly to economic growth, jobs and prosperity, especially in rural areas. They are an important source of raw materials for forest-based industries, providing the wood, pulp, cork and fibres that supply a plethora of sectors: construction, carpentry and furniture-making, veneer and laminate manufacture, production of household and office paper and sanitary items, to name but a few. In some Member States, forest-based industries are major employers within the manufacturing sector. They also provide energy, both directly and indirectly, and a host of non-wood forest products and services, including grazing and forage for domestic and semi-wild animals. In 2005, forest-based industries in the EU employed about 3 million people in 350,000 enterprises, with a turnover of about EUR 380 billion, producing added value of around EUR 116 billion[15].
Forests are one of the key elements of our ecosystems. They fulfil important environmental functions, serving as a habitat for a variety of plant and animal species, protecting water and soil. They also safeguard land, infrastructure and settlements from erosion and help prevent avalanches or landslides in mountainous regions as well as providing catchments and filtering for water supplies. Forests are home to the largest number of species on the continent (the Mediterranean region alone has 30,000 vascular plants), compared with other habitats, and provide important environmental functions(Bowler, 2010). Approximately 12 % of the forest area is designated as protected forest, meaning that ecological or protective functions are given priority over economic and social ones.

[14] http://ec.europa.eu/agriculture/fore/characteristics/index_en.htm
15Eurostat, Statistics in focus 74/2008 http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-SF-08-074

2.9.2 Urban forest

The urban forest is intensively used for a wide range of purposes, with recreational and aesthetic often dominant. Trees have a very obvious and recognised role in urban climate change mitigation.

However, many of the ecosystem services provided by woodland and trees do not generate direct revenues for local authorities. Local authorities have been facing increasing pressure on their budgets, and green space management, which typically comprises only a minor part of the total budget, is often affected. A study of Nordic cities by Randrup & Persson (2009) showed that the large majority of local authorities had seen decreasing budgets for green space management, and expected further cuts in the years to come. Financing of Peri-Urban Forest is often reactive rather than proactive and strategic.

Compared with traditional rural forest governance, urban forest governance involves a much wider range of stakeholders, interacting with state and non-state organisations operating at multiple scales. All levels of government can impact on the urban forest, from national (administrations and policies relating to forestry, environmental protection, natural resources, nature conservation, but also transport or road works), to various scales of local government (land use planning/zoning) (e.g. Schmied & Pillmann, 2003; Van Herzele *et al.*, 2005b). One of the most significant difficulties in many European countries in applying an integrated approach to urban forest policy at a local level is that many of the local authorities' responsibilities for trees and woodlands are split between different departments (Johnston et al., 1999; Saretok, 2006; Britt & Johnston, 2008; Gerhardt, 2010).

Land use planning secures the ground for peri-urban forestry delivery through zoning and regulating urban development. Green structure planning (including urban forests) can be integrated in the urban development plan, or can be a separate planning document. The protection of green spaces in the land use or urban development plan appears to be rather weak, when in competition with new developments. Based on a survey of 23 European cities, Baycan-Levent & Nijkamp (2009) concluded that - in general – cities which integrate green structure planning in the city development planning succeed more in reaching green policy targets, as compared with cities which develop sector specific green structure plans. In Finland and Sweden, the establishment of National Urban Parks has been a governance innovation. The Stockholm National City Park (NCP), which includes woodland and park areas, was the first of its kind.

2.9.3 EU Policy on Forestry

The Forestry Strategy for the European Union (1998) established a framework for forest-related actions in support of sustainable forest management (SFM), based on the co-ordination of the forest policies of the Member States and Community policies and initiatives relevant to forests and forestry. The EU Forest Action Plan (FAP) encourages environmental education, underlines the importance of the protective role of forests and proposes to explore the potential of urban and peri-urban forests.

2.9.4 Relevant NACE Codes:

A 02.0

2.9.5 Related European environmental legislation

Laws about trees and especially forests are usually national. No direct European legislation on forestry.

Further related legislation:

- Nature and biodiversity protection and restoration and protection of cultural landscape
- Land use planning

2.9.6 Direct and Indirect Influence

Table 2.32: Environmental Aspects of Management of Public Forests

Environmental aspect: Management of public forests	
Direct influence	**Indirect influence**
Integrate green structure planning (including forest and urban forest) into city development planning	Include private forest owner in the planning of green structures (e.g. forest biotope corridors)
Creation of National Urban Parks or forest biotope corridors based on partnerships between national, municipal and private owners	
Qualification of forest managers towards sustainable forest management and innovate approaches such as Dauerwald (permanent forrests) and “Nature oriented forestry” including the protection of natural processes	Training courses for private forest owners
Sustainable management of forests including selective single tree cutting, natural regeneration as the main source for renewal, reforestation with native species, diversification of species (structuring), carefully use of machines, exclusion of pesticides and measures favouring the restoration of biodiversity	Training courses for private forest owners
FSC certification for public forest	

2.9.7 Examples for own regulations

Many cities have their own ordinances and regulations, particularly in relation to tree protection. Vienna, for example, has a long history of tree protection activities and issued its first tree protection ordinance in 1974.

2.9.8 Interrelation with other environmental aspects

Climate change mitigation and adaptation, air quality, noise, water supply, nature and biodiversity protection and restoration, protection of cultural landscape, environmental information /education towards citizens.

2.9.9 Relation to other sustainability aspects

Quality of life, health, leisure, education, jobs /economic development not elaborated

2.9.10 Stakeholder-Landscape

Table 2.33: Stakeholder-Landscape

Stakeholder	Affected	Can influence	Remarks
Regional administrations		X	Provide the regional frame for local land use planning and related specific plans. Control body for environmental impact assessment.
Private forest owners	X	X	Information and consultation according to legal requirements; Cooperation’s with private forest owners (e.g. creation of forest biotope corridors)
Other departments of the local authority	X	X	Contribution to the EMS environmental assessment /performance audit, goals and measures of environmental program, monitoring, stakeholder involvement
Industry /	X	X	Information and consultation according to legal

Stakeholder	Affected	Can influence	Remarks
economic sector /tourism			requirements; Tourism as user of forest areas (impacts on biodiversity) Maintenance of forest /trees for climate change mitigation /improvement of air quality
Social public and private institutions	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement
Educational public and private institutions	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement Educational institutions as user of forest areas
Environmental NGOs	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement (e.g. member of management body of protected area, management or monitoring of protected area).
Citizens	X	X	Information and consultation according to legal requirements; citizens as users of forest and urban forest: permanent involvement (e.g. Agenda 21 /sustainable city development, tree committees in UK)
Local authorities in neighborhoods	X	X	Planning and implementation of forest biotope corridors (green infrastructure), use of forest /urban forest for leisure activities of citizens from neighboring cities

2.9.11 Management of rural areas

Rural areas account for more than 80% of European territory and are home to over a quarter of the population. They are facing major challenges from changing demographic patterns, globalisation, pollution and rapid urbanisation which are leading to unclear and unbalanced ‘rurbain’ areas. It is important to emphasise the inter-connectedness between rural and urban areas in creating territories which promote well-being and economic and social health for all. Furthermore, rural areas are not homogenous and they face different problems according to, for example, their remoteness or proximity to towns and cities, their economic and material resources, their geography and climate, and differing levels of climate-change related threats (Chamber of the Regions, 2008).
All levels of public administrations do have competences regarding the management of rural areas, which often lacks comprehensive planning and coordination between urban and rural /countryside planning. Particularly within the context of rural areas, public–public partnerships have emerged as a new organisational method to respond to the challenge of providing services of general interest. It refers to any collaboration between two or more public authorities in the same country. This collaboration may occur between public authorities of the same type and level (usually inter-municipal consortia) or it may occur between different types or levels of public authorities, for example between provincial and local authorities (CoE, n.d.).

2.9.12 Environmental impacts

The environmental importance of rural areas and their ecosystem services cover all environmental aspects described in this Reference Document: *provisioning* ecosystem services such as the production of food and water; *regulating ecosystem services*, such as the control of climate and disease; *supporting ecosystem services*, such as nutrient cycles and crop pollination; *cultural ecosystem services*, such as spiritual and recreational benefits; and *preserving ecosystem services*, which include guarding against uncertainty through the maintenance of diversity. The EU NATURA2000-Network of our most valuable protected ecosystems and

heard of Europe's biodiversity covers a surface of about 27.000 square kilometres – mainly in rural areas.

Rural areas suffer all kinds of environmental impacts as well as conflicting environmental interests. One example of conflicting environmental interest is the development of biofuels from intensified cultivation of crops as renewable sources of energy which poses important questions and challenges in the interface between energy, environment, agriculture, research and economic policy. Increasingly, energy crops for biofuel are competing with food crops thereby driving up prices of essential food items and leading to biodiversity loss and soil erosion.

Facilitating biogas technology, which produces energy from organic waste materials such as urban, agricultural and forestry residues offers a source of renewable energy which helps to reduce carbon dioxide (CO_2) emissions. It can provide a key element of decentralised and renewable energy strategies. The promotion of biogas technology creates new opportunities for development in rural areas. Energy production as well as the traditional food production can play a major role for rural areas in future. The renewable energy produced provides the cities and densely populated regions with the energy needed and thus creates employment and added value in the rural areas.

In rural and sparsely populated regions, the absence of a critical mass generally leads to qualitative or quantitative public service shortcomings in these areas. The additional costs of basic services impact upon the economic development of rural areas. Therefore the connections provided by public services are vital for territorial dynamism of the areas in question. Authorities at all levels should consider public services systems within a framework of socio-geographical solidarity.

Due to the EU Transport and Common Agricultural Policy, some rural areas have become more accessible, which has encouraged urban sprawl and hence an increase in commuting. So far, these indirect impacts have not been assessed.

The Council of Europe European Landscape Convention (2002) promotes the protection, management and planning of all landscapes and emphasises the strong links between landscape, identity and well-being. The general purpose of the Convention is to encourage public authorities to adopt policies and measures at local, regional, national and international level for protecting, managing and planning landscapes throughout Europe so as to maintain and improve landscape quality and bring the public, institutions and local and regional authorities to recognise the value and importance of landscape and to take part in related public decisions (CoE, n.d.).

2.9.13 Relevant NACE Codes:

A 02.0

2.9.14 Related European environmental legislation

No direct European legislation on management of rural areas.

National and regional legislation on land use planning, landscape planning, etc.

Further related legislation see:

- Land use planning
- Energy
- Waste management
- Waste water management
- Transport/Mobility
- Air quality
- Nature and biodiversity protection and restoration and protection of cultural landscape

2.9.15 Direct and indirect Influence

Table 2.34: Management of rural areas

Management of rural areas	
Direct influence	**Indirect influence**
Integrate green structure planning (including forest, urban forest and rural areas) into city development planning	
Integration of an ecologically oriented landscape plan into land use planning: Integration of urban settlements, protection of significant landscape elements (e.g. orchard meadow)	Awareness raising measures for land-owners and farmers
Lease of land according to environmental criteria	
Planning /implementation of compensation measures to create /protect green infrastructures and biotope corridors	Awareness raising measures for land-owners and farmers

National and regional administrations have specific legal, administrative, fiscal or financial instruments in view to protecting, managing and planning rural areas/landscapes, e.g. approved land use plans on regional level, declaration of protected landscape park etc.

2.9.16 Interrelation with other environmental aspects

Climate change mitigation and adaptation, energy, air quality, noise, water supply, nature and biodiversity protection and restoration, protection of cultural landscape, environmental information /education towards citizens

2.9.17 Interrelation with other sustainability aspects

Quality of life, health, leisure, education, jobs /economic development

2.9.18 Stakeholder-Landscape

Table 2.35: Stakeholder-Landscape

Stakeholder	Affected	Can influence	Remarks
Regional Administrations		X	Provide the regional frame for local land use planning and related specific plans. Control body for environmental impact assessment.
Private land owners	X	X	Information and consultation according to legal requirements; Cooperation's with private land owners (e.g. creation of forest biotope corridors)
Other departments of the local authority	X	X	Contribution to the EMS Environmental Assessment /Performance Audit, goals and measures of Environmental Program, monitoring, stakeholder involvement
Industry / economic sector/ tourism/ agriculture	X	X	Information and consultation according to legal requirements; Tourism as user of rural areas and landscape (impacts on biodiversity) Farmers as managers of rural /cultural landscapes
Social public and private institutions	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement
Educational public and	X	X	Information and consultation according to legal requirements; participation above legal requirements,

Stakeholder	Affected	Can influence	Remarks
private institutions			permanent involvement Educational institutions as user of rural areas
Environmental NGOs	X	X	Information and consultation according to legal requirements; participation above legal requirements, permanent involvement (e.g. member of management body of landscape parks, realization of projects for the protection of cultural landscapes)
Citizens	X	X	Information and consultation according to legal requirements; citizens as inhabitants of rural areas, citizens as users of rural areas: Permanent involvement (e.g. Agenda 21 /sustainable city development)
Local authorities in neighborhoods	X	X	Planning and implementation of land use plans and landscape plans (e.g. green infrastructure), joint services such as waste management, mobility /commuting citizens etc.

2.10 Environmental Aspect: Energy

2.10.1 Relevance for other public services on the local level

- sustainable mobility
- sustainable land use
- sustainable housing
- environmental services
- sustainable education
- sustainable leisure activities
- sustainable economy

2.10.2 Introduction

Availability of energy in its different forms is essential for modern society to function. Every public or private service or product- virtually any activity - is depending on a steady supply of energy. Local authorities' relations to energy can be described in four general relationships:

- Consumer: Although statistics about the direct energy-consumption of local authorities are not available, energy consumption of local authorities is obviously considerable: street-lighting, heating of public buildings like city halls, schools or hospitals – to name just a few examples – will make local authorities major consumers of energy on the local level.
- Producer: Local authorities can be producers of energy. The level of activity in this sector varies all over Europe but since renewable energy is on the rise and generally favors de-centralized energy-production structures, becoming an energy producer may be an option for more local authorities. Either to become more self-sufficient or to sell energy on a larger scale.
- Supplier and distributor: Usually, transmission networks are organized nationally by very few businesses. Energy distribution on the other hand is often organized locally by public utilities owned by the local authority. Even, if the distribution network is not owned by the local administration, they play a key-role in the implementation of the distribution network. Energy suppliers often also play an important role as a reseller of energy.
- Besides these direct relations, local administrations also determine a huge part of the framework conditions for energy consumption of the economy and private households through their strategies of economic and urban development or public housing.

This section will not discuss the use of energy for the purpose of transportation and mobility. The section about the environmental aspect transportation and mobility will deal with these issues.

2.10.3 Relevant NACE-Codes

E 40.1

2.10.4 Environmental Impacts

Depending on the source of used energy and the manner of energy production, a broad variety of environmental impacts is associated with the production of energy.
Most prominently, in 2008 (Borgan, 2011) energy production from fossil fuels for the production of electricity and heat was responsible for about 45% of EU wide GHG emissions which lead to climate change. Besides the emission of GHG, energy production is also responsible for the release of particle matter, acidifying substances and NO_x into the atmosphere, which in turn harm ecosystems and endanger human health and threat the living environment (Borgan, 2011). The latter problem may arise from every combustion-plant - including climate-neutral biomass plants.
Another important impact of energy production is land use through the use of land for power plants, wind turbines and overhead power lines, resulting in loss of natural habitats and therefore biodiversity. The intensification of agricultural activities and even stronger reliance on pure cultures – or even genetically engineered crops in the future - due to the switch to biomass as part of a future energy supply, can result in a decrease in biodiversity or the release of invasive plants into the wild. Also, if biomass isn't of local heritage, transportation of biomass can negate the expected advantages of "CO2-neutral" energy supply.

2.10.5 European Legislation

- EU-directive concerning common rules for the internal market in natural gas (2009/73/EC)
- EU-directive concerning common rules for the internal market in electricity (2009/72/EC)
- EU-directive for the establishment of a scheme for greenhouse gas emission allowance trading (2003/87/EC)
- EU-directive coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors (2004/17/EC)
- Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community
- Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste
- Environmental Liability Directive: http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&lg=en&type_doc=Directive&an_doc=2004&nu_doc=35

2.10.6 Direct and indirect influence

Table 2.36: Environmental aspects of Energy Consumption

Environmental aspect: energy consumption			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Facility management / public buildings	Modernization of buildings: efficient heating systems, improved insulation, heat pumps. Alternative cooling methods through façade greeneries and green roofs, use of waste heat where possible	Private housing	Energy counseling for house owners, information about funding opportunities for house owners, own funding programs, introduction of high energy standards in urban land use planning, using public housing projects for politics, introducing a rent-index

Environmental aspect: energy consumption			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Lighting of public spaces	Efficient, energy-saving street lights, LED-lighting, reduced or intelligent lighting periods	Citizens choice of energy source	Information, energy-counseling, information campaign about climate change and its impacts
Manner of energy production for energy used by the public administration	Purchasing energy from providers of “green energy”, using roofs of public buildings for solar power	Citizens behavior	Energy counseling on efficient lighting, efficient ventilation and heating, information campaigns
Amount of energy used by public administrations operations	Use of energy efficient technology	Energy consumption of local economy	Information about energy efficient facility management and production, energy counseling, EMAS-convoys’
Energy efficiency of public housing	Modernization, better insulation, state of the art energy standards for new projects		

Table 2.37: Environmental aspects of Energy Production

Environmental aspect: energy production			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Manner of energy production for energy used by the public administration	Purchasing energy from providers of “green energy”, using roofs of public buildings for solar power	Citizens as energy producer	Introducing a land register for available roofs for solar panels, information about renewable energy production for house owners (heating through wood pellets, using the own roof for solar power)
Manner of energy production for electricity re-sold by public utilities	Only reselling energy from renewable sources		
Energy conversion efficiency	Combined heat and power		

Table 2.38: Environmental aspects of Energy Supply and Distribution

Environmental aspect: energy supply and distribution			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
Manner of energy production for electricity re-sold by public utilities	Only reselling energy from renewable sources	Customers decision on origin of purchased energy	Pricing scheme, information campaign about climate change, motivational campaigns
Transmission loss and leakages	Modernized and optimized distribution network		

Table 2.39: Environmental aspects of Biodiversity

Environmental aspect: biodiversity			
Direct influence	**How (examples)**	**Indirect influence**	**How (examples)**
De-sealing on energy production facilities	Green roofs, façade greeneries, de-sealing		
Changing agricultural land use patterns	Introducing sustainability criteria for purchased biomass for bio energy production facilities, maintaining a sustainable energy mix, limiting the production of bio energy to sustainable limits depending on regional resources, limiting own demand of biomass for bio energy-production to sustainable limits	Changing agricultural land use patterns	Introducing sustainability criteria for purchased biomass for bio energy production facilities, maintaining a sustainable energy mix, limiting the production of bio energy to sustainable limits depending on regional resources, limiting own demand of biomass for bio energy-production to sustainable limits
Habitat destruction through positioning of photovoltaic systems	Preference for roofs, using place under the panels for calcareous grassland	Habitat destruction through positioning of photovoltaic systems	Information campaign, register of roofs available for photovoltaic and solar power, constraints on permits for photovoltaic systems, information about combination of solar-panels and meadows

2.10.7 Connections to other environmental aspects

- waste
- climate change
- land use planning
- mobility and transportation

2.10.8 Connections to other sustainability issues

- health
- competition among businesses
- local economy
- social justice and poverty

2.10.9 Stakeholder-Landscape

Table 2.40: Stakeholder-Landscape

Stakeholder	Affected	Can influence	Level	Remarks
Citizens	X	X	Local	Consume energy, can use energy efficiently, depend on energy
Businesses	X	X	Local	Consume energy, can use energy efficiently, depend on energy
Private house owners	X	X	Local	Determine energy-standard of private buildings through ownership
NGOs		X	Local, regional	Knowledge, can have related tasks (nature protection, development of area regarding public spaces, economy etc.)
Farmers	X	X	Local, regional	Supply biomass, affected by demand for bioenergy
Chimney sweeps		X	Local	Can serve as energy consultants

2.11 Environmental aspect: Environmental information /education towards citizens

Environmental information /education is relevant for all services of public administrations and should be part of all fields of activities.

It is not unproblematic to include the topic environmental information and education towards citizens among the environmental aspects listed in this guidance. There is no sustainable implementation without acceptance, understanding, will, interest, awareness and recognition of benefits and responsibilities among various actors. To achieve this, an effective communication and involvement strategy is needed. The involvement of citizens with the objective to inform and/or to educate should be part of **all** aspects of sustainable development.
The legal basis for communication and involvement can be found in the Aarhus Convention[16] adopted by the European Community in 1998**.**The Aarhus Convention is a new kind of environmental agreement which links environmental rights and human rights. It is based on the premise that greater public awareness of and involvement in environmental matters will

[16] http://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-13&chapter=27&lang=en

improve environmental protection. The Arhus convention establishes a number of rights of the public with regard to the environment. The public is defined as both individuals and their associations. The parties to the convention are required to make the necessary provisions so that public authorities (on the national, regional or local level) will make these rights effective.

1) the right of everyone to receive environmental information held by public authorities ("**access to environmental information**").

2) the right to participate in environmental decision-making. ("**public participation in environmental decision-making**");

3) the right to review procedures to challenge public decisions that have been made without respecting the two aforementioned rights or environmental law in general ("**access to justice**").

The Aarhus Convention came into force in 2001. European legislation was fully adapted by the EU Regulation on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters to Community institutions and bodies (EU 1367/2006) (EC, 2008).
For most of the environmental aspects described in this document, information and participation of the public is required and regulated by law. A public administration can achieve an improved environmental performance by realizing more public participation than required by law.
Participatory processes were the core of the Local Agenda 21 taken at the Rio conference in 1992. After that, many local authorities have had extensive stakeholder involvement in creating their Local Agenda 21 work. However, one of the pitfalls has been that participatory processes have been conducted parallel to – rather than part of – decision-making. This causes double negative impacts, as the public does not receive information and decision-makers do not receive public input in time to influence important components of decision-making. The integrated management system puts the participatory processes in the heart of strategic decision-making and put a strong emphasize on linking them to each management step.

<u>Communication and Involvement Plan</u>
In order to get the knowledge of who, when and why to involve stakeholders, the public administration needs to do a stakeholder analysis matched to the scope and content of the environmental or sustainability management system. However, the management system may also be expanded in scope and content with time. Furthermore, stakeholders are not constant and fixed but can also change. Therefore, the stakeholder analysis is not a one-time exercise: its revision occurs as part of a regular management cycle.
Furthermore, providing opportunities for the participation and education of all interest groups is highly valued by EMAS. Among the requirements made of an environmental management system is for example making the environmental policy accessible to the public. The municipality must demonstrate that it provides information for and encourages contact with the outside world in order to indicate to what extent it has entered into a process of dialogue with the public and further interest groups.

<u>Adapting the messages and the communication format to stakeholder groups</u>
“The citizen” does not exist. Public administrations need to communicate with different target groups of citizens having different interests and levels of information. Communication has to be clear, attractive (i.e., drawing attention) and definitely cannot be too generalized – the message has to be well-adapted to particular stakeholders, set in particular local contexts and demands.
There is a wide range of formats and methodologies to inform and involve citizens and it is not possible to describe them in this Reference Document. Anyway, methodologies are influenced by trends and the most complex and expensive methodology is not always the most successful.
In order to get a valid basis for decision making it is important to monitor communication and involvement activities with qualitative and quantitative indicators.

<u>Environmental education</u>

Sound information is the first step towards environmental education for citizens. Environmental education plays a key role in raising awareness and changing individual's attitudes, values and behaviour towards achieving sustainability. As such, environmental education is a significant tool in environmental management and the pursuit of sustainability, alongside more traditional tools such as policy, regulation and compliance.
The EU Committee of the Regions (CoR, 2008) stresses that education for sustainable development cannot be effectively implemented without the involvement of local and regional authorities given that in many Member States local and regional authorities have a central role to play in educating the public about sustainable development.
As with regard to communication and involvement, environmental education activities need to be tailor made for the target group, e.g. children, youngsters, families, elderly people, immigrants, citizens interested in nature protection, in sports, in social issues, in culture, etc.
Local and regional authorities should liaise with the media to play a central role in promoting the idea of sustainability by explaining its main principles and benefits to as wide an audience as possible, in language that is easy to understand, and by encouraging and reporting on the public debate on this topic.
The EU Committee of the Regions (Cor, 2008) highlights the following best examples: the Agenda 21 network, RES (Network of Regions on Education for Sustainability) — launched by the Umbria Region in Italy, the European Sustainable Energy Week, the British Change LAB project (Changing Lifestyles, Attitudes and Behaviour), compulsory sustainable development education in Bavaria (Germany) and in Finland, the vocational training system in the Netherlands, the activity of the Regional Environmental Education Centres in Poland and the activity of the open universities.

2.11.1 Direct and indirect influence

Table 2.41: Environmental aspects of Formal Environmental Education

Environmental Aspect: formal environmental education (in schools and universities)	
Direct influence	**Indirect influence**
Environmental education programmes in schools	Environmental education programmes for teachers
EMAS for public schools and infrastructures with strong communication	Communication towards citizens regarding environmental management of schools and other public infrastructures

Table 2.42: Environmental aspects of Informal Environmental Education

Environmental aspect: informal environmental education (live-long learning)	
Direct influence	**Indirect influence**
Realisation of participatory community programmes	Environmental awareness raising in the media, internet and other networks
Programme to support environmental education activities undertaken by non-government environmental organisations	Support of environmental education infrastructures and activities of NGOs (e.g. Nature Information Centre, thematic excursions, Helio floating classroom at Lake Constance)
	Environmental friendly organisation of public events (administration as best practise example)

2.12 Environmental aspects: procurement

2.12.1 Relevance for other public services on the local level

Relevant for all public services

2.12.2 Introduction: Public Administrations and Procurement

Each year European public authorities spend the equivalent of 16% of the EU Gross Domestic Product on the purchase of goods, such as office equipment, building components and transport vehicles; services, such as buildings maintenance, transport services, cleaning and catering services and works. It's worth noting that for most public authorities, construction and

renovation works, and running costs of buildings represent a major share of annual expenditure, in some cases over 50 %.

Few facts about the importance of the construction sector within public procurement:

- Accounts for 10% of EU GDP – turnover of €1,590 billion (2008)
- Employs 7% of the EU workforce (only "on-site")
- Over 40% of final EU energy consumption
- 35% of EU GHG emissions
- Over 50% of all extracted materials used in construction
- Construction & demolition waste over 450 mill. tonnes p.a.

("I:\A-sustainable procurement\Projects\SCI-Network\6 - Info & Data\LMI sustainable construction background report.pdf")

Green Public Procurement (GPP) can shape production and consumption trends and a significant demand from public authorities for "greener" goods will create or enlarge markets for environmentally friendly products and services. By doing so, it will also provide incentives for companies to develop environmental technologies.

Green Public Procurement concerns to all level of administrations. Every year billions of Euros are spent under the EU's Cohesion Policy for regional development and economic and social cohesion throughout Europe. For the 2007-13 programming period (with a total budget of €308 billion), sustainable development was reconfirmed as one of the most important principles of the Cohesion Policy. Many other EU funding programmes exist, such as for instance the Seventh Framework Programme (FP7), which bundles research-related EU initiatives. Where these funds are spent directly by public authorities and the latter carry out procurement procedures to implement the funded projects, the Commission considers that GPP could easily be incorporated. National administrations should all have the criteria that GPP should be used for the implementation of EC funded programmes and projects.

In order to increase the level of *Green Public Procurement (GPP)*, the European Commission published in 2008 the "Communication on Green Public Procurement for a better Environment" (Europa, n.d.) which concretises the existing target of the Sustainable Development Strategy by proposing that "by the year 2010, 50 % of all tendering procedures should be green".
The European policy objective for 2010 was to bring the average level of EU green public procurement up to the standard achieved by the best performing Member States in 2006.

By 2010 all EU Member States plus Norway developed an "Action Plan for Green Public Procurement (GPP)". An overview on aspects such as responsible authority, GPP targets and criteria, training offers and monitoring can be found under http://ec.europa.eu/environment/gpp/pdf/national_gpp_strategies_en.pdf

But not only EU Member States, also OECD states and rapidly developing countries launched sustainable procurement policies.

The basic concept of GPP relies on having clear and ambitious environmental criteria for products and services. However, as the use of GPP increases, the criteria used by Member States should be compatible to avoid a distortion of the single market and a reduction of EU-wide competition. The final aim of the European Commission is to have a single set of criteria. This would considerably reduce the administrative burden for economic operators and for public administrations implementing GPP. Common GPP criteria would be of a particular benefit to companies operating in more than one Member State as well as SMEs (whose capacity to master differing procurement procedures is limited).

<u>10 priority sectors identified</u>

The Commission has identified ten "priority" sectors for GPP. These have been selected on the basis of the importance of the relevant sector in terms of the scope for environmental improvement; public expenditure; potential impact on the supply side; example setting for private or corporate consumers; political sensitivity; existence of relevant and easy-to-use criteria; market availability and economic efficiency.

The priority sectors are:

1. Construction (covering raw materials, such as wood, aluminum, steel, concrete, glass as well as construction products, such as windows, wall and floor coverings, heating and cooling equipment, operational and end-of-life aspects of buildings, maintenance services, on-site performance of works contracts)
2. Food and catering services
3. Transport and transport services
4. Energy (including electricity, heating and cooling coming from renewable energy sources)
5. Office machinery and computers
6. Clothing, uniforms and other textiles
7. Paper and printing services
8. Furniture
9. Cleaning products and services
10. Equipment used in the health sector

ICLEI developed the criteria for the priority sectors. The established GPP criteria distinguish between "core" and "comprehensive" criteria. The core criteria are designed to allow easy application of GPP, focusing on the key area(s) of environmental performance of a product and aimed at keeping administrative costs for companies to a minimum. The "comprehensive" GPP criteria take into account more aspects or higher levels of environmental performance, for use by authorities that want to go further in supporting environmental and innovation goals. Since "core" criteria form the basis of the "comprehensive" criteria, this distinction between "core" and "comprehensive" will reflect differences in terms of ambition and availability of green products whilst at the same time pushing markets to evolve in the same direction.

The EU Training Toolkit includes Methodology to develop a GPP Action Plan and raise political support, clear examples on how and where to integrate green criteria into the PP procedure and Criteria for 10 priority product/service groups. The Training Toolkit can be downloaded from: http://ec.europa.eu/environment/gpp/toolkit_en.htm.

The Commission's 2nd edition of the Buying Green Handbook was published in 2011, as a guide for public authorities to apply GPP:
http://ec.europa.eu/environment/gpp/buying_handbook_en.htm.
Additionally to guidance on the implementation of sustainable procurement, the Procura+ Manual, developed by ICLEI, offers a management model for embedding GPP in public authority decision making. www.procuraplus.org

2.12.3 Relevant NACE-Codes

Public Administration 75

2.12.4 European legislation

In order to guaranty transparency, fair competition and prevent corruption, public procurement is highly regulated. It is important to note, that European legislation does not prohibit public administrations from applying green criteria during tenders. For a more extensive overview of legislation concerning public tenders, please see: http://www.oecd.org/document/36/0,3343,en_33638100_34612958_35017124_1_1_1_1,00.html

- EU Directives 2004/17/EC and 2004/18/EC: DIRECTIVE 2004/18/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 31 March 2004 on the

coordination of procedures for the award of public works contracts, public supply contracts and public service contracts

The current GPP policies at EU level are all of voluntary nature. The main voluntary policy tools are:

- A Communication of the Commission on Integrated Product Policy (2003) which "encourages" all Member States to develop National GPP Action Plans by 2006
- The Sustainable Development Strategy (2006) which aims to increase the average level of GPP in the EU to the level of the best performing Member States (at this time) by 2010. It also identifies activities to be carried out by the Commission to promote GPP.
- The Communication on GPP of 2008 which concretises the existing target of the Sustainable Development Strategy by proposing that "by the year 2010, 50 % of all tendering procedures should be green".
- Development of common GPP criteria in the framework of a "GPP Toolkit" that is provided by the Commission. These criteria are developed to serve as a template for public purchasers and to define minimum standards for GPP in order to assess the level of GPP in the EU. At present, the Commission has developed criteria for 10 product groups whilst 10 other product groups are under development.

2.12.5 Environmental Impacts

Public procurement concerns products and services related to all administrational services and impacts therefore on all environmental aspects.

2.12.6 Direct and Indirect Influence

Table 2.43: Direct and Indirect Influence of GPP

Direct influence	Indirect influence
Request for the application of GPP for the implementation of projects /activities funded by public funds (regional, national, European)	Regular up date of information regarding legal standards as well as voluntary standards /labels
Approval of Green Public Procurement criteria according to national GPP Action Plan and cconsequent implementation	Regular request of information from suppliers regarding their environmental performance in environmental aspects not covered by legal standards or voluntary standards /labels
Identification, approval and application of comprehensive criteria for sectors not covered by the Action Plan	Motivation of suppliers to implement EMAS and/or ISO 14001 and/or to achieve voluntary standards or labels for their products and services.
Identification, approval and application of comprehensive social criteria, e.g. Fair Trade labels	Exchange information and experience with private organizations about GPP and motivate them to establish green procurement criteria /rules
Include Green Public Procurement into training of staff	

2.12.7 Connections to other environmental aspects

Connection /Influence on all environmental aspects

2.12.8 Connections to non-environmental issues

Inclusion and social justice, health, sustainable economy

2.12.9 Stakeholder-Landscape

Table 2.44: Stakeholder-Landscape

Stakeholder	Affected	Can influence	Remarks
All departments o f the public administration	X	X	Should provide up dated information regarding state of the art of environmental and social performance. Should apply GPP criteria consequently
Financial department	X	X	Need to understand and to accept that most cheap offer is often not the most sustainable offer and expensive for society
Public companies	X	X	Should apply GPP criteria
Suppliers	X	X	Should understand that environmental and social quality are of high importance for the public administration. Should be motivated to implement EMAS /ISO 14001 and achieve voluntary standards /labels for their products and services
Private companies	X	X	Should be informed and motivated to voluntarily apply GPP criteria
Citizens	x		Should be informed and motivated to buy products /services of environmental and social quality

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3 BEST ENVIRONMENTAL MANAGEMENT PRACTICE IN THE PUBLIC ADMINISTRATION SECTOR

3.1 Best Environmental Management Practice for Mobility

3.1.1 Chapter structure

This chapter provides a practical look at mobility, presenting pragmatic examples of European cities that are taking steps to improve the sustainability of their transport. Each management practice contains replicable measures to guide public authorities in improving their environmental performance. Section 3.1.2 contains an introduction to mobility in Europe, encompassing the legal and policy position of the European Union. This is followed by an in-depth look at three separate management techniques, supplemented with real world case studies.

Section 3.1.4 provides information on enacting a Sustainable Urban Mobility Plan. Section 3.1.5 looks at improving cycling as a means of environmentally friendly transport, whilst section 3.1.6 outlines how to institute e-mobility in a modern urban environment.

3.1.2 Chapter introduction

When it comes to European mobility, politicians, city planners and citizens are of the same mindset - the way we get from A to B matters. The transport choices we make today will have wide-ranging impacts on the future of our societies, our economies, our quality of life and our environment.

The sector generates 10% of EU wealth in terms of GDP and provides more than ten million jobs. It allows people and goods to move quickly, efficiently and cheaply, and in doing so facilitates future prosperity. The challenge for Europe in the coming years is to create efficient, publically and commercially accessible, sustainable mobility solutions that maintain economic growth.

Statistically, the transport sector requires pressing environmental improvement, and is one of the few sectors in which the contribution to CO2 emissions is increasing rather than decreasing.

According to the European Environment Agency, transport greenhouse gas (GHG) emissions went up by around 34% between 1990 and 2008 - in contrast, between the same period energy industries reduced their emissions by about 9% (Europa, 2011).

Part of the reason for the high emission levels is the sector's reliance on fossil fuels (the majority of the world's petroleum reserves are utilised by transport). In the EU, 96% of energy for transport depends on oil and oil products. 84% of oil used in the EU is imported, costing around €210 billion annually. This reliance brings correlative energy security and scarcity issues.

The intensive use of fossil fuels releases harmful vapours such as nitrogen dioxide (NO_2), carbon monoxide (CO), and sulphur dioxide (SO_2), pollutants such as Particulate matter, as well as GHGs including carbon dioxide (CO2), methane (CH_4), and nitrous oxide (N_2O). These emissions can result in serious health consequences, aggravating respiratory problems, increasing the likelihood of heart attack and lowering the body's defences against tumours (BBC, 2011).

Transport is responsible for about a quarter of the EU's greenhouse gas emissions. In 2008 12.8% of overall transport emissions were generated by aviation, 13.5% by maritime transport, 0.7% by rail, 1.8% by inland navigation, with road transport far outweighing the others at 71.3%.

Congestion is a major barrier to efficient transportation and a problem intensifying in severity. In cities such as London, Brussels and Amsterdam, drivers spend over 70 hours on average stuck on roads in traffic. Congestion costs Europe about 1% of GDP per annum, wastes fuel, increases driver stress and makes journey times unreliable. Cities across Europe are starting to address this problem through emphasising other modes of transport over the private vehicle.

Technological, infrastructural and behavioural change

New technologies have an important role to play in the greening of transport. Innovations such as reduced emission engines, electric vehicles, compressed natural gas (CNG) vehicles, biofuel

vehicles and fuel cell technology can go a long way to making our air cleaner, our cities healthier and lessening the impact of climate change. CNG vehicles produce 30% fewer greenhouse gas emissions than traditional gasoline or diesel and costs less thanks to ample supplies (Guardian, 2012). Biofuels have similar benefits, with domestic production widely possible. Electric vehicles are discussed in-depth below.

The draw-back of these forms of transport is that the vehicles themselves are generally more expensive to purchase than their fossil-fuel counterparts, meaning the payback period from fuel savings can be quite long, and is contingent on high fossil-fuel prices. There is also a debate on-going about the true emissions levels of first generation biofuels, with some arguing that when indirect land use change (ILUC) to facilitate the growing of biofuel crops are taken into account, biofuel emissions can actually be higher than that of crude oil (it should be noted that second generation biofuels still comfortably outperform fossil fuels, according to EU data).

Biofuels have also been linked to deforestation and the clearing of wetlands in order to create areas to grow biofuel crops. When these areas are converted to fields, the carbon contained within them are released into the atmosphere. It was also found that studies touting the reduced emissions benefits of biofuels failed to take into account that other carbon-absorbing plants would have grown on the fertile land occupied by biofuels. This means that the carbon extracting properties of biofuels at the growth stage were double-counted in the studies. Some environmental campaigners also claim that biofuel production will cause a land-grab by wealthy countries, as land in developing countries, particularly in Africa and South-East Asia, is bought by Western bio-fuel production companies. There is also the concern that biofuels would replace agricultural produce, particularly in vulnerable developing countries, leading to food scarcity and food prices rising. (EurActiv, 2012)

Smaller / lighter vehicle size can also contribute to reduced emissions through reduced fuel consumption. It was found that a 30% decrease in weight can reduce GHG emissions by about 15% in both petrol and diesel cars. (IMPRO-Car, 2008)
Investing in sustainable mobility technology is not only beneficial from an environmental point of view, but also from an economic point of view. The market for green products is increasing rapidly, and according to the EU’s Joint Research Centre, products and services related to sustainable mobility will represent a global market of €300 billion in 2020 (up from €200 billion today) (Europa, 2011).
These technologies, however, cannot be the only solution. A mixture of technology, intermodal public transport, and intelligent infrastructure coupled with public involvement in the planning process is required for meaningful change to take hold.
Citizen behaviour is a crucial factor. Educating citizens as to the harms and benefits of various transport methods is necessary to ensure that new mobility infrastructure and technologies are properly utilised. The benefits of soft modes of transport, such as cycling and walking, as well as the disadvantages of some traditional forms (decreased air quality, high congestion levels) is important to present.
A recent survey conducted by Eurobarometer indicates that many people are already willing to take steps to create a low emission transport future. The majority of car users (66%) say they would compromise on a car’s size in order to reduce emissions, and 62% say the same about the car’s range. More than half (60%) would be willing to pay more for their car if this helped reduce emissions (Europa, 2011).
As well as lowering traffic levels and decreasing emissions levels, public transport usage can drastically influence the character of the urban area. Private vehicle use leads to urban sprawl. Scarce land resources are lost to motorways to accommodate vehicles. A reduction in traffic leads to pacification of urban areas, lowering noise and air pollution.
Intermodality is a key component in increasing citizen use of public transport. Facilitating commuters to easily and efficiently switch between integrated transport methods improves efficiency and ensures that travellers spend a larger part of their journey using public transport. Integrated travel helps public transport companies to gain a larger market share than previously possible. It also helps to create a change in public perception and a modal shift towards sustainable transport. According to UITP Intermodality can be achieved through (UITP, 2011):

- The integration of land use and urban planning with mobility and transport planning to give everyone access to the transport network;
- The integration of all public transport modes;
- The improvement of public transport infrastructure, services and interchange facilities, expanding capacity and increasing quality levels;
- Traffic rationalisation, smoother traffic flow and the improvement of road safety;
- Traffic management, real-time information, infomobility;
- The improvement of 'soft modes' (cycling and walking) and their integration in public transport planning and city design. Promotion of 'car sharing' and 'bike sharing';
- The development of e-ticketing and fare management systems;
- Better integration of freight transport within integrated transport strategies;
- Demand management policies (e.g parking policies and regulation, mobility management) integrated with pricing strategies and traffic restrictions when required (eg. Congestion charge, pollution charge, low-emission zones);
- Better cross-sector measures that promote social, health, economic and other policy fields.

<u>Legislation</u>
The EU's Roadmap to a Single European transport Area aims to reduce the level of CO2 emissions by 80% by 2050 compared to levels recorded in 1990. This will require a 70% reduction in oil consumption from the amount used today. Ultimately, the EU wants to separate transport from environmental impact.
EU legislation and policy in the area centres on:

Infrastructure charging
Infrastructure charging focuses on the "polluter pays principle". Two sectoral directives authorise the charging of users for their transportation environmental cost.

Directive 1999/62/EC details setting charges for road infrastructure (motorways, etc.) regarding goods transportation.

Road transport
A number of directives, in force since the 1970s, have gradually worked to reduce emissions and particles, as well as contributing to reducing noise pollution generated by vehicles.
Regarding CO2, the objective is to achieve an average emission level from new vehicles of 120 g CO2/km. Europe is taking a three pronged approach to reducing vehicle CO2 emissions.

- Voluntary commitments by the automobile industry under which European (ACEA), Japanese (JAMA) and Korean (KAMA) car makers have undertaken to reduce average emissions from new vehicles by 25% between 1995 and 2008-2009 (from 186 g CO2/km in 1995 to 140g CO2/km in 2008-2009). Compliance with these commitments is the subject of annual reports by the Commission;
- Better information for consumers on fuel consumption and CO2 emissions;
- Introduction of fiscal measures to promote the purchase of less polluting vehicles.

Moreover, the standards relating to transport fuel quality have been significantly improved, in particular as regards their sulphur content.

The EU has enacted new sustainability criteria for biofuels. The Directive on renewable energy states:

With effect from 1 January 2017, the greenhouse gas emission saving from the use of biofuels and bioliquids... shall be at least 50 %. From 1 January 2018 that greenhouse gas emission saving shall be at least 60 % for biofuels and bioliquids produced in installations in which production started on or after 1 January 2017.

Biofuels and bioliquids… shall not be made from raw material obtained from land with high biodiversity value, namely land that had one of the following statuses in or after January 2008, whether or not the land continues to have that status:

(a) primary forest and other wooded land, namely forest and other wooded land of native species, where there is no clearly visible indication of human activity and the ecological processes are not significantly disturbed;

(b) areas designated:

(i) by law or by the relevant competent authority for nature protection purposes; or

(ii) for the protection of rare, threatened or endangered ecosystems or species recognised by international agreements or included in lists drawn up by intergovernmental organisations or the International Union for the Conservation of Nature, subject to their recognition in accordance with the second subparagraph of Article 18(4); unless evidence is provided that the production of that raw material did not interfere with those nature protection purposes;

(c) highly biodiverse grassland that is:

(i) natural, namely grassland that would remain grassland in the absence of human intervention and which maintains the natural species composition and ecological characteristics and processes; or

(ii) non-natural, namely grassland that would cease to be grassland in the absence of human intervention and which is species-rich and not degraded, unless evidence is provided that the harvesting of the raw material is necessary to preserve its grassland status.

4. Biofuels and bioliquids… shall not be made from raw material obtained from land with high carbon stock, namely land that had one of the following statuses in January 2008 and no longer has that status:

(a) wetlands, namely land that is covered with or saturated by water permanently or for a significant part of the year;

(b) continuously forested areas, namely land spanning more than one hectare with trees higher than five metres and a canopy cover of more than 30 %, or trees able to reach those thresholds in situ;

(c) land spanning more than one hectare with trees higher than five metres and a canopy cover of between 10 % and 30 %, or trees able to reach those thresholds in situ, unless evidence is provided that the carbon stock of the area before and after conversion is such that, when the methodology laid down in part C of Annex V is applied, the conditions laid down in paragraph 2 of this Article would be fulfilled.

The provisions of this paragraph shall not apply if, at the time the raw material was obtained, the land had the same status as it had in January 2008.

Biofuels and bioliquids… shall not be made from raw material obtained from land that was peatland in January 2008, unless evidence is provided that the cultivation and harvesting of that raw material does not involve drainage of previously undrained soil.

Non-road land transport (rail)
Polluting emissions from railway transport are regulated by the Directive on non-road mobile machinery.

Maritime and inland waterway transport
The EU has adopted a strategy to reduce the atmospheric emissions of seagoing ships. It has also put in place measures on maritime safety in order to prevent further ecological disasters. These measures concern the prevention of pollution caused by ships, mechanisms for cooperation in the event of marine pollution and the possibility of criminal sanctions against those responsible for marine pollution.

Polluting emissions from inland waterway vessels are regulated by the Directive on non-road mobile machinery.

Air transport
EU policy strives to improve technical environmental standards relating to noise and atmospheric emissions, strengthen economic incentives, help airports in their environmental efforts, and promote research and development in the long term.

The EU has adopted rules on noise management in Community airports. These rules include a ban on access to European airports for the noisiest aircraft and aircraft construction standards.

Transport and noise
Under Directive 2002/49/EC, Member States have to map ambient noise levels from major transport infrastructures and urban transport in agglomerations. They must also draw up ambient noise management plans aimed at reducing harmful exposure and protecting quiet areas.

Context
The European Environment Agency measures, analyses and reports on the environmental impact of transport. The Agency underlines the risks of the EU failing to meet its commitments under the Kyoto protocol to reduce greenhouse gas emissions.

The thematic strategy on atmospheric pollution fixes targets for the reduction of certain pollutants and reinforces the legislative framework to combat atmospheric pollution. This is achieved through improving Community environmental legislation and including air quality considerations in policies.

Other related acts include:

Decision No 1753/2000/EC of the European Parliament and of the Council of 22 June 2000 establishing a scheme to monitor the average specific emissions of CO2 from new passenger cars [Official Journal L 202, 10.8.2000].

Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions, of 31 March 1998, on Transport and CO2: developing a Community approach [COM(98) 204 - Not published in the Official Journal].

3.1.3 Scope of this Chapter

As with Energy, the chapter aims to gather a range of helpful management techniques that can be tailored for implementation within public authorities. The chapter does not attempt to provide an exhaustive list of techniques. Further reading links provide greater detail and references, in which topics can be explored in greater detail.

The case studies selected outline ways in which cities across Europe are implementing innovative environmental transport techniques, whether it is through emphasising the carbon free benefits of cycling, improving public transport infrastructure and efficacy, or facilitating the use of innovative transport technology.
Sustainable Urban Mobility Plans provide an excellent starting point for any public authority looking to create a more environmentally friendly mobility strategy. This should be used as the blueprint for implementing further measures outlined.

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3.1.4 Enacting a Sustainable Urban Mobility Plan

Description

A Sustainable Urban Mobility Plan (SUMP) is a means for cities to create a modern, sustainable transport system. The plan should provide an integrated approach to all modes of transport whilst taking into account planning for the surrounding environment.

A mobility plan is designed to satisfy the needs of people and businesses in cities and their surroundings, whilst simultaneously building a better quality of life. It builds on existing planning practices and takes due consideration of integration, participation, and evaluation principles. A successful transport policy is one that improves safety and security, reduces air and noise pollution, lowers emissions and energy consumption, improves efficiency and cost-effectiveness of transportation and enhances the attractiveness and quality of the urban environment and urban design.

A SUMP builds on the existing regulatory and policy frameworks in a municipality. It requires (Eltis, n.d.):

- A participatory approach - involving citizens and stakeholders from the outset and throughout the process of decision making, implementation and evaluation, building local capacities for handling complex planning issues, and ensuring gender equity;
- A pledge for sustainability - balancing social equity, environmental quality and economic development;
- An integrated approach – of practices and policies between policy sectors (e.g. transport, land-use, environment, economic development, social inclusion, health, safety), between authority levels (e.g. district, municipality, agglomeration, region, national, EU), and between neighbouring authorities (inter-municipal, inter-regional, trans-national, etc.);
- A focus on the achievement of measurable targets, derived from short term objectives, aligned with a vision for transport and embedded in an overall sustainable development strategy;
- A review of transport costs and benefits, taking into account wider societal costs and benefits, also across policy sectors;
- A method comprising the following tasks: 1) status analysis and baseline scenario; 2) definition of a vision, objectives and targets; 3) selection of policies and measures; 4) assignment of responsibilities and resources; 5) monitoring and evaluation arrangements.

The plan should have the positive benefit of fostering a culture amongst planners and decision makers to strive for a truly sustainable development of urban transport.

Achieved environmental benefits

SUMPs are a relatively new concept. The emphasis of a SUMP is in integrating and improving existing plans, creating an integrative approach to the issue. Due to the newness of the process, it is important that the benefits of SUMPs are expressed to relevant stakeholders and decision makers. Benefits of the process include improved safety, reduced noise, environmental benefits such as lower levels of atmospheric pollutants and GHG emissions, more public spaces, greater biodiversity and improved mobility and access for citizens.

Appropriate environmental indicator

Table 3.1: Appropriate environmental indicator - Public transport

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Modal share of journeys	%		Survey about the % of journeys made by car, motorbike, public transport, bicycle and foot The modal share can be referred to: - systematic (work and school) or non systematic journeys; - the inner area of the city or the whole administrative area.
Passengers travelling on	number	n. public transport	Passengers travelling with urban public

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
public transport		passengers within the urban area/ population	transport within the urban area, disaggregated by means of transport: bus; underground, rail, trolleybus and tram
Public transport network's length	km	km public transport network/ km total street network	Length of public transport network disaggregated by means of transport: bus; underground, rail, trolleybus and tram. The length of reserved lanes could be highlighted separately.
Public transport km travelled	vehicle-km	Km travelled by public transport/ population	km travelled by all the public transport means in a year, disaggregated by means of transport: bus; underground, rail, trolleybus and tram
Accessibility of public transport	number	people living within 300 metres from public transport stop/ total population	Number of people living within 300 metres from an urban public transport stop with a minimum frequency of 15-20 minutes.
Registered cars	number	n. registered cars/ population *1,000	Number of registered cars owned by the citizens
Registered motorbikes	number	n. registered motorbikes/ population *1,000	Number of registered motorbikes owned by the citizens
Deaths in road accidents	number	n. deaths in road accidents / population *1,000	Number of people dead in road accidents
Persons seriously injured in road accidents	number	n. people injured in road accidents / population *1,000	Number of people seriously injured in road accidents

Benchmark of excellence

Referring to the 52 European cities participating in the Green Capital Award editions 2010-2011 and 2012-2013, Freiburg and Stockholm have shown the best results in reducing the modal share of car journeys.

Car use in Stockholm is limited to 33%, compared with 43% public transport, 15% walking and 7% bicycle. The modal split shows that between 2004 and 2010, 14% of Stockholm inhabitants moved away from motorised individual transport to public transport and cycling which have increased by 9% and 3% respectively. On average, there are 360 public transport trips per person, per year in Stockholm and about 90% of Stockholm residents live within 300 metres of public transport with an hourly or more frequent service. According to a 2007 survey, 59% of citizens always or usually use public transport to work / school during most of the trip. They were 53% in 2004. People always or usually using private car decreased from 27% (2004) to 21% (2010).

Considering only the inner city (usually not longer than 5 km), 68% of all trips is done walking or by bike and 25% by public transport. During peak hours, 78% of all trips to the inner city are made by public transport. The car use has been limited only at 8%.

In 1969 Freiburg devised its first integrated traffic management plan and cycle path network and in 1973 the entire city centre was converted to a pedestrian zone. The tramway network comprises 30 km and is connected to the 168 km of city bus routes as well as to the regional railway system. 70% of the population lives within 500 meters of a tram stop, and the trains appear every 7.5 minutes during rush hours. Freiburg administration has developed a 400 km cycling network of bike-friendly streets, street side bike paths, and separate bike paths (about 1.8 meter per inhabitant), and about 9,000 bicycle parking spaces.. Another notable aspect of Freiburg's transport policy is traffic calming: for most streets (other than main streets) the speed limit is 30 km/hour and on some streets cars can travel no faster than walking speed, and

children are allowed to play. As a result of all this policies, between 1982 and 1999, the contribution of cycling to the city's volume of traffic increased from 15% to 28% and public transport from 11% to 18%, while the share of journeys travelled by car fell from 38% to 32% of the total. The "traffic development plan 2020" predicts a further reduction of car's share to 29%.

Nantes is one of the European cities showing the best improvements in the public transport network. In Nantes, between 1999 and 2009 the number of people living within 300 metres from an urban public transport stop increased from 80% to 95% . In 2008 public transport amounts for 50% of transport in the metropolitan area, while the average in the 14 French metropolitan areas with populations of more than 300,000 was 11%.
The city's public transport fleet has undergone numerous upgrades to increase their efficiency and sustainability: Nantes has 79 trams, one of France's longest tramways, and 282 buses run on natural gas out of 352 (80% of the total fleet). Figure 3.1 shows the SUMP management cycle separated into 11 elements to be followed:

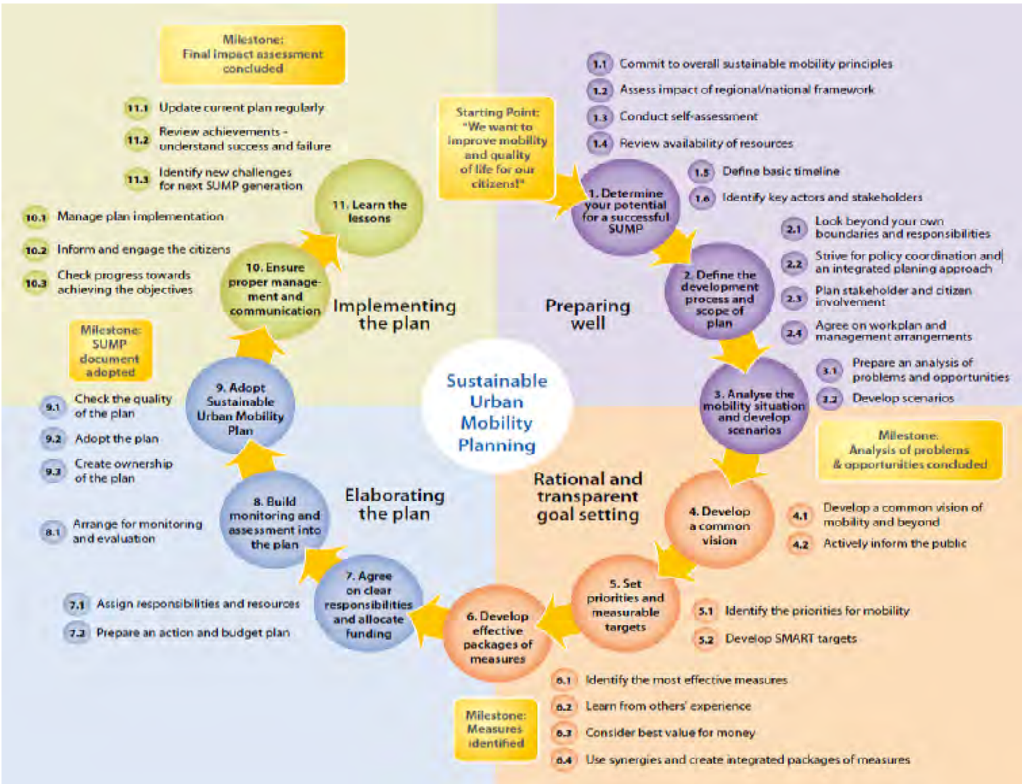


Figure 3.1: The SUMP management cycle Source: Rupprecht Consult, 2011

Operational data

SUMPs aim to accelerate the uptake of Sustainable Urban Mobility Plans in Europe. The project is financed by the European Union under the Intelligent Energy - Europe (IEE) Programme and was stimulated by the Thematic Strategy on the Urban Environment.
The main phases of a SUMP are:

• Planning (process): the core of the transport plan methodology.

• Plan (content of the document): beyond providing a plan outline, this section should focus on actual examples of effective measures.

• Policy (implementation process of the plan and its final appraisal): the final element to facilitate the actual implementation of the plan.

For a SUMP to be effective it is necessary to define SMART targets. These targets should be **S**pecific, **M**easurable, **A**chievable, **R**ealistic, and **T**ime-bound. SMART targets are not solely applicable to SUMPs but are an integral part of any Environmental Management System (EMS).

It is also necessary to have a communication plan in place, to inform the public as to the changes that will take place as part of the SUMP and the reasons for this change. This can take the form of a newsletter, dedicated website, dialogue cafe and so on.

City example: Creating an intermodal SUMP, Nantes, France

The city of Nantes in Southern France is widely praised within Europe for its public transport strategy. In France national legislation requires agglomerations above 100,000 inhabitants to develop a Plans de Déplacements Urbains or PDU (a French SUMP). Nantes' public transport measures have garnered awards for their sustainability - in 2009 the city won "CIVITAS city of the year" for its sustainable urban transport policy and was awarded the title of European Green Capital 2013. Measures that led to the award include the development of a clean bus fleet 80% powered by compressed natural gas, and a quality and performance mark for bus lines. The promotion of bicycles as a means of transport, including fold away bicycles capable of being taken on public transport also contributed, as did the remodelling of city centre roads to favour public transport over private vehicles. The city's excellent tram system was also noted by judges.

Nantes was one of five cities that took part in the CIVITAS Vivaldi project, an EU funded transport initiative. The project sought to implement "an integrated package of innovative transport strategies and measures" that would improve urban vitality, economic success, social inclusion, health and sustainability. VIVALDI led to a substantial reduction in emissions of air pollutants and noise.

As part of the programme Nantes modernised its bus fleet, bringing the bus system up to the same level of public esteem as the tram system. Working with CIVITAS, the city set goals to (Eltis, n.d.):

- provide public transport services with non-polluting vehicles for 70% of the total mileage and 90% of total trips by the end of 2005 (vehicle kilometres)
- renew the bus fleet by purchasing 155 new Compressed Natural Gas (CNG) buses (125 standards, 30 articulated)
- provide the necessary infrastructure for the renewed fleet in the form of a new CNG fuelling station in the south east of the city

This was achieved in 2005. As a result of the measures, fuel costs decreased by 7% and emissions of particulates by 90%. Today 282 buses run on natural gas out of 352 (80% of the total fleet).

The city's public transport fleet has undergone numerous upgrades to increase their efficiency and sustainability. Nantes was the first city in Europe to introduce the electric tram, which was opened in 1985. Today the city has 79 trams and one of France's longest tramways.

Nantes has also reclaimed road space from private vehicles and allocated it to public transport. The highway RN801, previously only suitable for private vehicles, has been dramatically narrowed for cars, and a bus lane has been incorporated in the centre. Space has also been provided for cyclists.

One of Nantes major infrastructure improvements has been the implementation of the innovative "Busway" into its public transport network. The Busway combines the advantages of a tram way with a bus route. Much like a tram, the bus has dedicated lanes, priority at

intersections, modernised stations, a high frequency of leaving times, extended operating hours and four park-and-ride facilities. The route connects the ring road circling the city with the city centre. The Busway has been a resounding success, attracting 28,000 daily passengers by 2010, reducing car traffic by between 40 and 70% (depending on the section of the road), and creating a calmer environment for other road users.

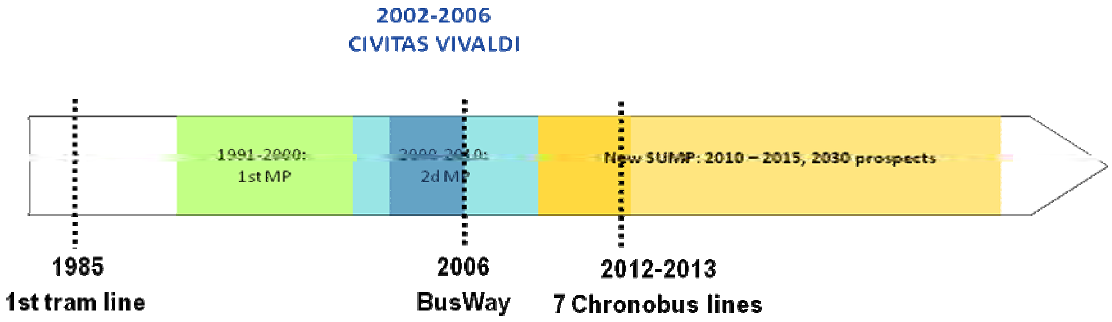
The city has also implemented the Chronobus and Bus Express – high frequency buses with dedicated lanes and roundabouts to improve efficiency.

Car-pooling options have been improved, with specific carpooling areas created and access for companies running corporate travel plans made more feasible.

Nantes is reducing traffic through utilising parking spaces as a way to encourage public transport use. Since 2002 there has been a 64% increase in "Park and Ride" stations constructed, leading to a 10 – 15% rise in use annually.

<u>Planning</u>

Nantes realised that transport is a major contributor to emissions within the city (responsible for 29% in total) and uses its SUMP to ensure it is providing the most efficient transport possibilities for citizens. The City has enacted two SUMPs previously (1991 – 2000, 2000 – 2010), and is currently on its third SUMP (2010 – 2015), as illustrated by figure 3.2 below.



The most recent SUMP is based on four axes: Living centres, Proximity, Networking and Behaviour.

Living centres aims to promote alternative transport methods to private vehicles and to create a city of "short spaces", reducing distances travelled within living centres, ensuring that amenities are nearby and do not require motor vehicles to access.

Proximity concerns allocating space previously reserved for private vehicles to public transport and "soft" means of transport.

Networking relates to connecting living centres through transport networks, including rail, bus and bicycle paths.

Behaviour aims to effect behavioural change through information campaigns, awareness raising and other measures such as the continued adaptation of mobility services.

The cities action plan is broken down into five aspects: 1. Creating the city of short spaces, 2. Building quality public spaces, 3. Organising mobility networks, 4. Encouraging behavioural change, 5. Monitoring and assessing the SUMP (Nantes Métropole, n.d.).

In order to create intelligent mobility solutions, it is important that mobility and urban planning are integrated in so far as possible. Mobility solutions feed into the city's Sustainable Energy Action Plan (SEAP) and territorial climate action plan, aimed at reducing the territory's emissions.

Ultimately the city hopes to achieve a complete panel of alternative mobility solutions: Car sharing, carpooling, rental bicycle, intelligent information, etc.

Nantes public transport measures are reaping tangible benefits. Between 1999 and 2009 the number of people living within 300 metres of urban public transport increased from 80% to 95% and in the last ten years car journeys under five kilometres have fallen by 5%. Cycle paths have also increased, going from 225km in 2001 to 376km in 2009 (a 66% improvement).

Nantes is leading the way nationally - in 2008 public transport amounts for 50% of transport in the metropolitan area, while the average in the 14 French metropolitan areas with populations of more than 300,000 was 11%.

Dedicating public spaces to public transport rather than vehicles has a calming effect on living areas (pacification) and leads to greater public transport efficiency. The proper development of good quality public spaces also increases soft modes of transport. Good quality spaces increase the rate of walking above 30%, whilst poor quality spaces reduce walking rates to between 10-15%.

Sources: Nantes Métropole, (n.d.) European Green Capital Award Nantes 2012 2013, local transport, available from http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2011/05/EGCNantesUKChap2-F.pdf

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City example: Örebro, Sweden

A SUMP requires a new way of thinking for many local authorities. This can cause problems in cities where previous transport plans were centred around the use of cars. This change in thinking was the challenge facing the city of Örebro, Sweden, during the development of their sustainable urban mobility plan, within the BUSTRIP project.
In many public authorities, the personnel and skills required to undertake a SUMP is often spread over many departments that have had no previous experience of working together. The idea may be often unusual for the key stakeholders but it is necessary to achieve a successful high quality sustainable urban mobility plan.

The city of Örebro is the administrative capital of Örebro County in Sweden with approximately 107,000 inhabitants and was one of the cities included in the BUSTRIP project. When the city began the initial steps of the sustainable urban mobility planning process, the understanding of sustainable transport was not strong in Örebro. In order to change the situation, the city used various measures, one of which was a capacity-building assessment which was carried out in a working group as part of the self-assessment, identifying the knowledge gaps among the employees. The outcome was that, whilst the municipality had a good detailed knowledge of transport-related issues, there was no history of this knowledge being integrated to create a sustainable urban mobility plan.

“For many professionals a more holistic way of thinking can be a bit of a revolution,” says Per Elvingson, who started as a process manager for sustainable transport soon after the assessment.

To facilitate the implementation of sustainable urban transport, a special unit – also responsible for raising awareness among employees and politicians – was set up. The unit has, among other things, planned seminars focusing on the reduced need for cars through spatial planning.

In general, a new way of thinking was the key. An important part of capacity building has been getting all key staff to agree on a common analysis of the current situation. In this respect, the SUMP template has been a very good tool.

Meanwhile, it is important to look around at what others are doing beyond municipal borders.

International cooperation has become more important in this process. Over the past few years, Örebro has focused on exchanging experiences. Study visits are an important part of that work. “On a national level, we are trying to build up an informal network for sustainable transport among cities of our own size in the region,” Elvingson says.

For many the SUMP process requires a new way of thinking. Previous transport plans revolved around the car and were road dependent, but with a SUMP, there has been a shift towards using more sustainable terms such as ‘intermodality’, ‘modal shift’ and ‘mobility management’.

This change in thinking can often leave skills gaps within a local authority or, as in the example of Örebro shows us, a lack of integration between them. Thus it is one of the many challenges the Local Authorities need to overcome in the sustainable urban mobility planning process.
This example relates specifically to the Activity 1.4, REVIEW OF AVAILABLE SOURCES, in the Sustainable Urban Mobility Plans Guidelines document.

Source: Elvingston, P. (2012, January). Promoting a new way of thinking, Örebro, Sweden. Retrieved from: http://www.eltis.org/index.php?id=13&study_id=3058

Applicability

The applicability of different aspects of a SUMP will be influenced by the city itself. Contextual factors from city layout to public finances can determine what is feasible to enact in the urban area. Limiting factors include narrow streets, which can act as a barrier to tram lines, ribbon development which can make it difficult to widen roads for bus lanes (and by their nature encourage use of private vehicles), whether public transport companies are publically or privately owned, public resistance to modal change (e.g. banning city centre car access, allocating space and resources to cycle lanes over car transport, lowering city speed limits, etc.) and so on. Banister (2005) identified six main barriers to implementing an effective transport plan (i) resource barriers, (ii) institutional and policy barriers, (iii) social and cultural barriers, (iv) legal barriers, (v) side effects, and (vi) other (physical) barriers (European Parliament, 2010). Approaches to overcome these barriers need to be identified. Cost, of course, is another limiting factor for the scope of public authority measures.

City example: Lille, France

This example gives a brief overview of what is in a SUMP plan, called Plan de Déplacements Urbains from Lille, France.

Monitoring and evaluation of both the planning process and of the implementation of the measures are crucial to the effectiveness of the plan. Monitoring and evaluation mechanisms help to identify and anticipate difficulties in the preparation and implementation of the SUMP, and, if necessary, to "repackage" measures in order to achieve targets more efficiently and within the available budget. It will also provide proof of the effectiveness of the plan and its measures. This allows those responsible for the actions to justify where money was spent.

The reporting should ensure that the results of the evaluation feed back into the public debate, thus enabling all actors to consider and make the necessary corrections (e.g. if targets are achieved or if measures appear to be in conflict with one another). The monitoring and evaluation mechanisms should be defined early and become an integrated part of the plan.

The project PDU of the agglomeration of Lille includes a total of 170 actions defined and structured along the following 6 axes:

1) An "intensive city" and mobility

Within the first axis the agglomeration of Lille promotes sustainable development and urban forms through a better integration of the different elements in policy making and urban design. It also passes through the expansion of a network of heavy public transport as the backbone of urban development. Lille envisages developing so-called micro-PDUs in specific areas, as well as a number of actions, such as the construction of eco-neighbourhoods, to serve as models.

2) A network of public transport

The agglomeration of Lille will invest heavily in the reinforcement of its present public transport infrastructure. This should allow for intermodality and better connections with other jurisdictions, yet also allow for a more complete service to the users. It should also foster intermodality.

3) Sharing the street, alternative modes

The third axis combines a set of activities that should incite a more reasonable use of the private car. This should be done by creating a distribution of road space in favour of the sustainable modes. This translates into an objective to better structure the road network and to optimise existing roads. Walking will be promoted as a mode through an integrated pedestrian network. The metropolitan area has also adopted ambitious plans in relation to cycling. Parking strategies will be in line with the PDU objectives.

4) Freight transport

Actions on freight transport in the metropolitan area of Lille are based on a report produced earlier. Although freight transport is crucial to the economic life of a city, it is also a source of congestion and emissions. The authorities will first search for alternative to freight transport by road. This will be done through the development of a global strategy, reinforcement of intermodality, and clearer integration of the issue of transport in the promotion of economic activities. Specific attention will be paid to urban freight transport. A specific strategy will be developed and a number of experiments will be executed in a coordinated manner.

5) Environment, health and the safety of citizens

To better integrate environmental issues in urban planning documents, an environmental impact assessment became obligatory for all PDUs after the adoption of the European Directive 2001/42/ CE in French law in 2005. Following this assessment, a number of direct objectives and actions were defined that are combined in the 5th axis of Lille's PDU, environment, health and safety of citizens. It intends first to reduce the energy consumption and the atmospheric impacts of mobility and transport on the environment and on health. It will also take a number of actions to reduce road noise pollution, will adopt a cross-cutting environmental strategy in the development of its metropolitan policies, and will create a safe environment for the users of the mobility services.

6) Realisation, monitoring and evaluation

This program of 6 axes is accompanied by a preliminary estimate of the costs.

The connections between the different modes of travels, the citizens that realise them, freight transport, and the space in which transport takes place together require an integrated mobility and transport policy, articulated by the city and its citizens.

The project team needs to ensure that the SUMP document is of a high quality and that the views of key stakeholders have been taken into account in the document. If necessary, bring in external reviewers with experience on sustainable urban mobility planning to check the quality of the document. This process will ensure that the plan and its supporting material actively inform stakeholders and the general public of its main aims and objectives.

This example relates specifically to the Activity 9.1, *Check the quality of the plan*, in the Sustainable Urban Mobility Plans Guidelines document.

Source: Vanegmond, P. (2012, March) PDU from Lille, France. Retrieved from: http://www.eltis.org/index.php?id=13&study_id=3080

City example: Creating a baseline reading, Helsinki, Finland

Helsinki Regional Transport Authority (HSL), in preparation of its SUMP, carried out a status analysis which allowed the authority to examine how the current transport system is operating, how it is affecting the environment and what its main challenges are. This attempt at establishing a baseline, from which local transport can be improved, is vital in the SUMP process.

The Helsinki Region Transport System Plan (HLJ 2011) is a long-term strategic transport plan that considers all transport modes and is also an important part of the land use, housing and transport co-operation of the Helsinki region's 14 municipalities. A key aim of the project is to produce binding decisions and a letter of intent on regional transport system development measures over the next few years. It also aims to ensure implementation and funding of agreed measures in cooperation with all parties. In order to produce such results, it was essential that a thorough analysis of the transportation system should be carried out.

The preparation of HLJ 2011 began with a status analysis. The analysis took a comprehensive look at the operating environment of the Helsinki region transport system (population, jobs etc.), the state of the transport system and people's travel behaviour, as well as at the environmental impacts of traffic.

A large scale traffic survey, conducted in 2007–2008, in close connection with the preparation of HLJ 2011, played an important role in the status analysis. The Helsinki metropolitan commuting area traffic survey included four studies: a travel behaviour survey, an origin-destination survey of passenger cars, an origin-destination survey of public transport, and a park and ride survey. Although the target area of HLJ 2011 covers 14 municipalities, the commuting area is larger and thus the survey area covered as many as 37 municipalities in and around the Helsinki region, and the target population was 1.5 million inhabitants. The survey was also used to provide an extensive database for updating, upgrading and expanding the traffic forecast model system in use.

In addition to the traffic surveys, altogether 15 different sub-studies were done as part of HLJ 2011 in 2008-2010. The sub-studies were used in the preparation process of HLJ 2011 and they also contributed to the status analysis. The studies included a land-use and rail network study, a vehicular traffic network study, a public transport strategy, a study on walking and cycling, a park and ride strategy, a study on mobility management, a freight traffic study, and a congestion charge study (conducted by the Finnish Ministry of Transport and Communications).

Major challenges and threats to the development of the transport system were identified from the status analysis. In order to realise the key goals of developing the transport system, HLJ 2011 had to solve or minimise the problems recognised.

The key goals and thus the major challenges related to six different sectors: economic efficiency, functionality, environmental, social, and land use related problems. Urban sprawl was one of the major causes of several of the challenges and if it were to continue, it would reduce the chances of achieving many of the key goals of HLJ 2011.

The outcome from the HLJ's current status analysis has led to a sustainable urban mobility plan that is comprehensive and thorough in detail. It has helped identify key challenges by which the success of the project is gauged.

This example relates specifically to the Activity 3.1, *Analyse the mobility situation and develop scenarios*, in the Sustainable Urban Mobility Plans Guidelines document.

Source: Granberg, M. & Vilkuna, J. (2012, February) Status Analysis of the Helsinki Region Transport System Plan, Helsinki, Finland. Retrieved from: http://www.eltis.org/index.php?id=13&study_id=3067

Driving force for implementation

Apart from environmental benefits a SUMP can provide improved mobility and accessibility for citizens, can enhance the reputation of the city internationally, and can contribute to a better quality of life in terms of noise reduction, cleaner air and improved road safety. A well executed SUMP also has the possibility to utilise land previously reserved for transport and make it a more social, publically useable space, improving the quality of the urban area.

SUMPs provide an opportunity to engage the public and stakeholders in the planning process, and in doing so gain a level of "public legitimacy" in the measures that are to be carried out. SUMPs allow a direct form of democracy and can foster positivity towards the political decision making process.

The integration potential within a SUMP is a major positive for many cities. SUMPs allow sectors, departments and institutions to work together for a common goal. The policy relevancy of a SUMP expands across sectors, taking in, for example, land use, economic development, social inclusion, etc.

The starting point for any city within Europe that wishes to enact a SUMP should be a desire to improve not only the mobility of citizens, but quality of life overall. Enacting a SUMP takes dedication and a tangible commitment, but the benefits are sizeable.

One issue that hinders many cities is the lack of political support from decision-makers for the SUMP approach. The benefits and added values of a Sustainable Urban Mobility Plan (SUMP) need to be communicated to decision-makers, planners and other urban mobility stakeholders in order to convince them of the advantages of using this approach. The best option is to present the arguments for enacting an integrated mobility plan, emphasising the "quick-win" solutions (benefits that have a long payoff period may not be as immediately attractive to politicians). It should also be communicated that a well thought out transport system engenders high levels of public good-will.

In order to pursue a sustainable transport system, one that meets society's economic, social and environmental needs whilst minimising its undesirable impacts on the economy, society and the environment, it is imperative that sustainability principles are taken into account throughout the whole planning process. It is also advised that current political objectives are revised to see to what extent they are in line with sustainability objectives. It is necessary that legislative and national framework aspects are analysed to identify synergies or potential conflicts.

A properly executed SUMP also carries political benefits. A well designed SUMP can allow planners to engage citizens and stakeholders, gaining their support and adding an extra degree of public interaction. It has the ability to integrate and galvanise different public authorities in striving to achieve a new political vision, bringing together departments for a common goal. A SUMP can even help achieve targets beyond mobility, such as climate change targets, etc.

Economics

The cost of implementing a SUMP varies from city to city and is difficult to put an exact figure on. Possible funding sources include (Rupprecht Consult, 2007):

- Local taxes: a special local transport tax for public transport paid by public or private enterprises, developers;
- Revenue funding: tickets, parking fees, city centre pricing, congestion charging, advertisements;
- Private sector operators, developers, industry; knowledge and skills – SMEs;
- Fundraising activities involving appropriate sponsors;
- Local budgets: from different municipalities and different policy domains;
- State subsidies (regional sources if applicable);
- EU subsidies.

In France, authorities generally spend between €200,000 and €400,000 on the development of a mobility plan. The city of Aachen in Germany has come up with a scheme to jointly finance a part-time mobility manager through its environment department cooperating with its chamber of industry and commerce. This inter-department funding provides the necessary human resource in a tight financial situation.

A SUMP may also allow a city access to certain funding pools that would have previously been unavailable, as well as contributing to fulfilling EU legal obligations. When implementing

measures it is important that they are assessed with an eye to costs and benefits as well as value for money.

As stated in section 3.1.5, the city of Copenhagen has spent 200 million DKK (app. €27 million) on specific bicycle projects between 2006 and 2010. These funds have been used for, among other things, new cycle paths, cycle parking, redesign of intersections and big campaigns to promote cycling.

One such project, the installing of a 200 metre long pedestrian and cyclist bridge, Bryggebroen, across the harbour of Copenhagen from Kalvebod Brygge at Zealand to Islands Brygge on Amager, was deemed to be economically beneficial following a cost benefit analysis. The central estimate is that the bridge has yielded a good economic return with a net present value of 36 million DKK and an internal rate of return at 7.7%. Factors looked at were: Construction costs and maintenance including scrap-value, Effects for cyclists, External effects of cycling, Traffic diverted to cycling from other modes, Taxes, tickets and operating costs for public transportation, Tax distortion loss. The Net present value was calculated at 36, with an Internal rate of return of 7.7%. (Copenhagen, 2009)

The city of London's Electric vehicle plan is estimated to cost around £60 million (€72,111,710) in total. This includes installing the 25,000 charging points across the city and conversion of the public authority vehicle fleet (New York City Global Partners, 2010). The funding for this will be split between the public and private sector, with central government funding forthcoming. This is further set out in section 3.1.6.

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3.1.5 Achieving a city wide Cycling Programme

Description
Vehicle traffic is a major problem for most European cities. Private vehicles result in diminished air quality, increased stress and greater noise pollution. Traffic jams also increase GHG emissions and impact on local businesses and amenities in the area. Cycling removes these negative aspects, providing an excellent solution to modern transport concerns. It is economical, efficient, sustainable and also has compelling social benefits in its favour. The move by cities to increase cycling rates therefore, is done not only in an effort to improve the sustainability of the city in question, but also to enhance citizen health, improve quality of life and reduce economically and environmentally harmful congestion.
According to Copenhagen municipality, the health and life expectancy benefits of cycling are seven times greater than the costs accrued through cycling accidents. Cycling is also much cheaper and often more time effective than most other modes of transport. The municipality estimates that the cost of a bicycle is €0.04 per cycled kilometre when viewed against purchase price and maintenance, while the equivalent cost for a car is €0.30 per driven kilometre. Cycling infrastructure is less intrusive than vehicle infrastructure, and a shift of construction priorities opens up urban space to residents that would otherwise have been reserved for cars. Cycling schemes can also play a major role in helping cities comply with EU air quality legislation, such as Directive 2008/50/EC, which sets (and redefines) standards and target dates for reducing concentrations of fine particles. Under the directive Member States are required to reduce exposure to $PM_{2.5}$ in urban areas by an average of 20% by 2020 based on 2010 levels. It obliges them to bring exposure levels below 20 micrograms/m^3 by 2015 in these areas. Throughout their territory Member States will need to respect the $PM_{2.5}$ limit value set at 25 micrograms/m^3. This value must be achieved by 2015 or, where possible, already by 2010. A full list of Air Quality Standards specified by EU legislation is available at the following link: http://ec.europa.eu/environment/air/quality/standards.htm. Achieving these standards is greatly aided by displacing cars in favour of bicycles. Cycling is the world's most efficient mode of transport in terms of energy used for propulsion gained, and is the cornerstone of sustainable transport policies for the future.

Achieved environmental benefit
Although cycling as a form or transport makes an important contribution to reducing CO2 levels, transport itself is not the field where the largest CO2 reductions can be made. What cycling does drastically improve however is air quality within urban areas. Harmful pollutants are emitted by combustion engine vehicles, and there is a direct correlation between increased traffic and decreased air quality. Cars also tend to stir up dust and particles into the air, increasing the likelihood of citizens inhaling them.
Bicycles are also much quieter when compared to combustion engine vehicles and so have a positive impact on decreasing noise pollution. This is especially pronounced in urban areas.

Appropriate environmental indicator

Table 3.2: Appropriate environmental indicator - Cycling

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Bicycle modal share	%		Survey about the % of journeys made by bicycle by residents. The modal share can be referred to: - systematic (work and school) or non systematic journeys; - the inner area of the city or the whole administrative area.
Cycling network	km	Km cycling network/ population	Length of cycle lanes, paths and routes (reported separately). 30 km/h speed limit streets can be considered

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
		Km cycling network / total (urbanized) area Km cycling network / total (urbanized) area	as a part of the cycling network, but have to be accounted separately. The cycling network length can be compared to the population, to the urbanized area or to the length of the total street network.
Cyclists injured in road accidents	number	n. cyclists injured in road accidents/population * 1,000	Number of cyclists injured in road accidents
Cyclists dead in road accidents	number	n. cyclists injured in road accidents/population * 1,000	Number of cyclists dead in road accidents
Pedestrian network	Ha	Ha pedestrian areas/ population Ha pedestrian areas / Ha total area	The streets in pedestrian areas are generally accessible to cyclists. The surface of pedestrian areas could refer only to pedestrian street surface or to the whole pedestrian area (including buildings)

Benchmark of excellence

Copenhagen has 346 km of cycle paths separated from the road and over 40 km of green cycle routes, about 0.73 meters per inhabitant. Each day in Copenhagen people cycle 1.2 million kilometres, with 37% commuting to work or school using a bicycle. The Copenhagen administration aims to increase the number of commuters using a bicycle from 37% to 50% by 2015 as well as to half the number of serious bicycle accidents compared to 2005 and to ensure that at least 80 % of cyclists feel safe in traffic.

In Amsterdam there are approximately 550,000 bicycles: 75% of all residents aged 12 or older own a bicycle. Half of them use it daily. Amsterdam has more than 400 kilometres of bike paths and 100 bike lanes, about 0.67 meters per inhabitant. Each day, the people of Amsterdam ride more than 2 million kilometres on their bicycles. In Amsterdam, 37% of all trips are done by bicycle, 41% by car and 22% by public transportation. In the city centre, bicycles are responsible for 55% of all trips, and in the nineteenth-century neighbourhoods that percentage is 50%.

Operational data

A camera-based prioritisation scheme can help improve cycling conditions. A camera recognises oncoming bicycles and switches to green, thus enabling the bicycles to cross the junction before the trams or motor vehicles. A network of bicycle routes can be made visible through road markings and infrastructural measures. Cycle and walk ways can be segregated with tactile curbs that take into consideration the needs of the visually impaired. The number of safe and lockable bicycle parking facilities at important public transport stops is a valuable measure to encourage inter-modality. This includes lockable bicycle boxes or manned bicycle stations with additional services for bicycles. A route planner specifically geared towards cyclists is a helpful measure. Unlike conventional route planners, it is important that it be based on the actual pedestrian and cycling network. This can be promulgated online, or as a phone application.

City example: World’s best city for cyclists, Copenhagen, Denmark

Copenhagen is widely regarded as the world’s best city for cyclists, and has been awarded as such - in 2008 the Danish Cyclists’ Federation voted Copenhagen the “Best City for Cycling”, and in both 2009 and 2010 the city was similarly awarded by TreeHugger magazine. Each day people cycle 1.3 million kilometres in the city with 37% commuting to work or school using a bicycle. Over 90,000 tons of CO_2 emissions are saved daily in comparison to car journeys.

This achievement has been born from a change in city planning, which moved from

"Copenhagen – City of Cyclists" programme aims to make cycling the most used mode of transport in the city by 2015, as well as halving the number of serious bicycle accidents compared to 2005 and ensuring that at least 80 % of cyclists feel safe in traffic (as quantified through a phone survey).

As part of the city of cyclists programme cycle tracks and lanes will be extended and made safer, and suggestions to improve the viability and attractiveness of cycling will be incorporated into the city design. The city is not only concentrating on improving cycling conditions, but also on combining cycling and public transport and improving the availability of bicycle parking. The city intends to make infrastructural improvements such as enhancing signal intersections for cyclists, creating more contra-flow lanes and bettering cycle path maintenance. To publicise these improvements Copenhagen is embarking on a renewed cycling information campaign. Part of this campaign aims to encourage those who are new to the city to embrace cycling as a means of transport.

In 2006 the city adopted the Cycle Track Priority Plan 2006 – 2016. The plan dictates the order in which new cycle paths will be built and outlines cycle path policies. Current cycle paths are illustrated in Figure 3.3, in which cycle tracks are in purple, cycling routes in green and cycling opportunities in gold. The success of the Copenhagen's cycling scheme is such that cyclists are now facing bicycle congestion along busy commuter paths. To combat this, city planners are widening existing cycle paths and increasing the number of "bicycle highways".

Figure 3.2 Cycle map of Copenhagen – cycle tracks in purple, cycling routes in green, cycling opportunities in gold

Copenhagen's achievement is widely replicable, and many European and international authorities are already engaged in copying the city's example. Indeed the number of cities pursuing a cycle policy modelled on the Danish capitals has become so common that a term to

describe the process has emerged - "Copenhagenization". One of the most significant factors in Copenhagen's success is its decision to give bicycles priority over motor vehicles, resulting in the development of infrastructure and policy to suit cyclists rather than the traditional facilitation of vehicular traffic. Bicycle bridges, such as the one pictured in figure 3.4 and cycling super highways are built in place of road construction projects and cycling projects are allocated funding more easily than traffic projects.

Figure 3.3: Bicycle bridge in Copenhagen, Denmark. Source: ICLEI

In Copenhagen a sizeable proportion of the mobility budget has been allocated to cycling. Much of this has been spent on infrastructural requirements such as upgrading and expanding cycle paths. In 2009 almost 100 million Kroner (approx. €13.5 million) were granted to improving cycling conditions and in 2010 the figure rose to almost 150 million kroner (approx. €20.2 million). The cost of implementing the previously mentioned Cycle Track Priority Plan 2006 – 2016 is around 400 million Kroner (approx. €53.8 million). According to the Danish Ministry of Transport's methodology for calculating cost benefits investment in bicycle projects is "sound and equivalent or better" when compared to other traffic investments.

In replicating Copenhagen's bicycle success, a city must first understand the reasons behind why citizens choose to cycle, or not cycle. Specific concerns that hamper uptake of cycling must then be comprehensively addressed. Speed and comfort, for example, are major concerns of many cyclists in Copenhagen and the city has taken steps to ensure that these issues are comprehensively addressed.

Source: New York City Global Partners (2011, July 8) Best Practice: City-wide Bicycle Commuting Program. Retrieved from: http://www.nyc.gov/html/unccp/gprb/downloads/pdf/Copenhagen_CityofCyclists.pdf

Applicability

In order to get people to cycle, the feeling of comfort and safety is of the utmost importance. Actual safety can be improved by increasing the number of cyclists on the roads, according to Zofia Jagielska, an engineer with the Copenhagen Centre for Traffic. Doing so creates an awareness amongst drivers of a cycling culture, and can lead to reduced accidents, "In Copenhagen cycling accidents are decreasing all the time. The more that bike in the city, the

more car drivers realise that this is a city with a lot of cyclists, and as soon as they get in a car they pay attention to cyclists from the beginning. If drivers aren't used to cycle traffic, that's when cycle accidents happen."

In order for people to keep cycling however they must have the *feeling* that they are safe. This is different to actual safety, explains Ms. Jagielska, "Sometimes you can feel safe whilst being unsafe and vice-versa. Safety is very important, but we have a philosophy within the cycle programme – do not speak about safety too much as people will think it's dangerous to ride a bike, and it is not dangerous to ride a bike."

"People feel safer in the tracks with the curb separating them from traffic. Prioritising cyclists and giving them space communicates that they are welcome here and that they own the street as much as cars. Symbolic things are important to foster the feeling of safety".

City example: Increasing cycling rates in Zurich, Switzerland

About one third of the citizens of Zurich use their bicycle regularly. To increase these numbers even further the city is focusing on consistent promotion of cycling that encompasses different fields of action.

The promotion of cycling is anchored within the urban mobility strategy and the City of Zurich is aiming to create the best possible environment in order to facilitate cycling within the city to a greater degree. To promote cycling, the city puts an emphasis on an attractive and safe network of bicycle routes, provision of public and private bicycle parking facilities and good public relations work.

The City of Zurich has a cycling network which is dense, well connected, marked with uniform signposting and with minimal gaps. The priority is to close existing gaps even further within this network. This sometimes leads to the implementation of innovative measures like the camera-based prioritisation of the bicycle at the Opera. Additionally, the urban building code states that all new buildings must be equipped with a certain number of bicycle parking spaces.

The city also promotes cycling with targeted public relations work. For instance, the route planner for walking and cycling (part of the internet city map of the City of Zurich since 2011) enables users to find direct or attractive routes between the starting point and destination of their journey. This route planner is also available as an App called "ZüriPlan“ and was downloaded more than 40,000 times in the three months after its launch. Services like the 12 bicycle pump stations, poster campaigns, TV spots, bicycle maps etc., round off the efforts of the city with regard to public relations work.

Source: ELTIS (2012) The City of Zurich promotes the use of bicycles. Zurich, Switzerland. Retrieved from: http://www.eltis.org/index.php?id=13&study_id=3250

Economics

From 2006 to 2010 the city has devoted approximately 200 million DKK (approx. 27 million EUR) to specific bicycle projects.

In Copenhagen a methodology was established to conduct a cost – benefit analysis of cycling. The methodology took into account a number of factors including transport costs, security, comfort, branding/tourism, transport times and health. The city found that the net social gain is DKK 1.22 (€0.16) per cycled kilometre. Comparatively there is a net social loss of DKK 0.69 (€0.09) per kilometre driven by car.

Cycling, the study found, saves society hugely in terms of health costs, including saved treatment expenses and increased tax revenues as a result of less illness (accident costs however do cause some deductions from money saved). In total, including accident reductions, it is estimated that cycling saves DKK 1.7 billion (€228,674,950) in health impact alone.

Cycling infrastructure has also been proven to have a positive socio-economic impact, including increased productivity through shorter commuting distances and increased safety.

In Copenhagen it has been calculated that over €800 million per year is lost on a yearly basis due to congestion, which cycling addresses.

Driving force for implementation

Bicycles improve citizen health in a number of ways. As well as providing physical exercise, bicycles also reduce harmful air pollution which can lead to respiratory problems and heart disease. Traffic congestion is a cause of stress and blood hypertension and large scale cycling works to prevent this. Noise pollution from combustion vehicles can have serious health ramifications, and has been linked to premature death (it is estimated to contribute to the deaths of between 120 to 500 people per annum in Copenhagen). Bicycles produce minimal noise and so positively address this issue of noise pollution.

A study into cycling from Bispebjerg University Hospital, Copenhagen concluded that cycling to and from the workplace on a daily basis reduces mortality rates in adults by 30%. It also contributes to the thirty minutes of exercise per day recommended by health experts. The report further states that those who cycle with intensity live for five years longer on average. Cycling presents an opportunity for senior citizens to become more active, a group typically engaged in a sedentary lifestyle (Schnohr, Marott, Jensen, & Jensen, 2011).

Apart from prioritising bicycle friendly construction projects, it is also of benefit to combine cycling with an integrated, efficient public transport system that centres on reducing private vehicle usage. Cycling should fit into a wider public transport network, including buses, trams and train services. To this end bicycle parking facilities should be provided at train and bus stations, to allow cyclists to combine transport methods within their commute. In Nørreport train station new “sunken bed” bicycle parking facilities are being implemented, while a new 7,000 bicycle parking facility is planned to open in 2013 at the city’s Central Station.

Legislation is also an important component when it comes to a successful cycling programme. “If there are a lot of people with a car and a bike, at some point you need to prioritise cycle traffic over car traffic. Danish politicians haven’t been afraid to take steps such as removing car-park space for a new cycle track. The political will has been great in Copenhagen and politicians have dared to do things that weren’t immediately popular” says Ms. Jagielska. “Now the majority like it a lot. If you build a cycle track, most people will think that it’s a great idea”.

Ms. Jagielska also says that communication is important “it’s not only about infrastructure construction, it is also about communicating and campaigning. The hard means and the soft means need to go hand in hand. You need to remember that people are not environmentalists, they just want their day to function smoothly and to be able to get around quickly.”

Cyclists, in general, do not cycle for environmental reasons. In a 2010 survey into why people in the city cycle Copenhageners gave the following responses:

- 55% said it’s faster.
- 33% said it’s more convenient.
- 32% said it’s healthy.
- 29% said it’s cheap.
- 21% said it’s a good way to start the day.
- 10% said it’s the shortest route to work after changing job or residence.
- Only 9% cited environmental / climate concerns.

Ms. Jagielska also believes that in order to be successful, a cycling strategy must be holistic, “a very important thing is to make the strategy coherent and connected. In many big cities they start building infrastructure and then wonder why people aren’t starting to bike - the reason is that it’s very fragmented and there are big junctions and a lot of traffic, and it’s dangerous. People don’t want to cycle that way. You need to make it coherent. It’s important to remember that if you put obstacles in the way, people won’t choose to cycle. Coherency is the key word!”

Also, when creating a team to manage the implementation of a cycling scheme, the team should be drawn from a variety of backgrounds says Ms. Jagielska, "In Copenhagen we have only one landscape architect and one engineer. Then we have one person working with communications, one who studied philosophy, one who studied society and so on. The people are very mixed and you need these mixed backgrounds. It would be a mistake when creating a cycle programme to just to hire engineers and think that's ok. You need to have a whole team with a lot of different skills, including soft skills."

Cycling is safer in general than motor vehicle use, and wide-spread use curbs traffic accident incidences. Developing a cycle culture takes time and effort, and infrastructure must be adapted to facilitate this.

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3.1.6 Improving the uptake of Electric Vehicles in urban areas

Description

The environmental and health impact of conventional private vehicles coupled with annually increasing maintenance and fuel costs has led many cities to turn away from the internal combustion engine and search for a more environmentally friendly replacement. Electric vehicles (EVs) are the frontrunner sustainable alternative, providing tangible environmental benefits as well as energy security and health benefits.

Instead of an internal combustion engine, which converts refined fossil fuels to mechanical energy, electric cars store energy in a rechargeable battery. These batteries can be charged at any electric outlet plug.

Electric vehicles have improved rapidly over the last number of years, and new-generation electric vehicles offer similar comforts to their fossil fuel counterparts. Thanks to both legislation and increased consumer demand, motor vehicle manufacturers are increasing their efforts within the electric vehicle market. As the number of manufacturers grows and EU and national legislation enforces stricter emissions standards, the availability and choice of electric vehicles is set to increase. This coupled with improvements in battery technology will see the price of the vehicles fall. Already the vehicles are far more cost effective than traditional vehicles when considered in terms of their life cycle.

Under EU legislation, all car manufacturers will need to achieve revised emissions targets. A new car sales fleet will have to average 95g/km of CO2 by 2020, further prompting car manufacturers to invest in the technology.

Achieved environmental benefit

Electric cars hold significant environmental benefits over their fossil-fuel counterparts. The only emissions caused by the vehicles are generated in the production of electricity - the cars themselves emit nothing. As electricity generation from clean sources increases, the carbon footprint of electric cars correlatively drops. As such the vehicles play a role in curbing GHG emissions and combating climate change. It is important to emphasise that the emissions benefits of electric vehicles are only fully applicable if the energy being generated is from renewable sources.

EVs are far more efficient than internal combustion engine vehicles in terms of energy use. 75% of the chemical energy from the batteries in EVs is converted to power the wheels, while internal combustion engines convert only 20% of the energy stored in gasoline (US. Department of Energy, 2012). EVs do not consume any power when stopped in traffic and have the ability to recover energy normally lost during braking (the kinetic energy used in breaking further charges the car’s battery).

As a result of the increased efficiency, EVs are far quieter than internal combustion engine vehicles and contribute significantly to reducing noise pollution, particularly in congested urban areas. This however has been cited as a safety concern for pedestrians, cyclists and the site impaired, and may lead to an increase in collisions. To combat this some manufacturers are adding noise to their electric vehicles (in the United States this is a legal requirement) (Williams, 2011).

When used in place of conventional vehicles, EV’s have the potential to greatly improve air quality. A wide-scale changeover to electric vehicle use would reduce atmospheric pollutants such as NO_2, CO and SO_2 and Particulate matter, which can be harmful to human health, overtime causing respiratory illness and heart disease (see air quality chapter for more information).

E-mobility, however, retains some of the drawbacks associated with conventional private vehicles. Land use is a “non-achieved” benefit, as e-mobility does not reduce pressure on land-use for transportation infrastructure. Electric cars also facilitate urban sprawl in the same manner as conventional vehicles and do not address congestion and other traffic problems.

When Life Cycle Analysis (LCA) is taken into account, EVs still outperform traditional vehicles. According to Ricardo PLC (Ricardo, 2011), the current metric for comparing the GHG emissions of European passenger cars is based on measuring the tailpipe CO2 emissions over the New European Drive Cycle (a system used to assess vehicle emissions that is supposed to represent the typical usage of a car in Europe). Tailpipe CO2 measures are not fully accurate, and it is estimated that real world tailpipe CO2 could be 15 - 40% higher, depending on fuel type, technology and vehicle usage pattern. The tailpipe CO2 metric is also insufficient for comparing the environmental impact of zero and ultra-low emission vehicles, such as electric and fuel cell vehicles, since it does not consider CO2 emissions resulting from the generation of the fuel, or those embedded within the vehicle production. Life Cycle Analysis (LCA) is said to be more representative of a vehicles true emissions. LCA considers the entire life cycle of a product or service, from cradle-to-grave. LCA considers many types of environmental impact, not just CO2 emissions. A vehicle`s life cycle can be divided into four blocks:

1. Production of the vehicle
2. Production of the fuel
3. “In-use”
4. Disposal

Material selection, energy use, production processes, supply chain logistics and the choice of primary energy source all influence CO2 released. Vehicle hybridisation and electrification can reduce life cycle CO2 emissions, but this increases embedded emissions from production. When comparing Diesel, Petrol, battery electric vehicles using average mix electricity and bioethanol, electric and bioethanol have the largest particulate emissions by far on a life cycle basis. This is due to high levels of particulates emitted during electricity generation and biofuel production respectively. The highest NOx emissions are associated with biofuels and battery electrics using average electricity mix due to power station emissions (as is the case for particulates). However the lowest life cycle CO is associated with electric vehicles (Lane, 2006).

Figures 3.5, 3.6, and 3.7 illustrate the life cycle emissions of pollutants for passenger vehicle types and fuel types by grams emitted per kilometre. The key used on the graphs relates to: petrol (PET), diesel (DSL), bioethanol (BioE), biodiesel (BioD), compressed natural gas (CNG), liquefied petroleum gas (LPG), battery electric using average mix electricity (AvBEV), battery electric using renewable electricity (ReBEV) and petrol-hybrid (HEV) (Lane, 2006).

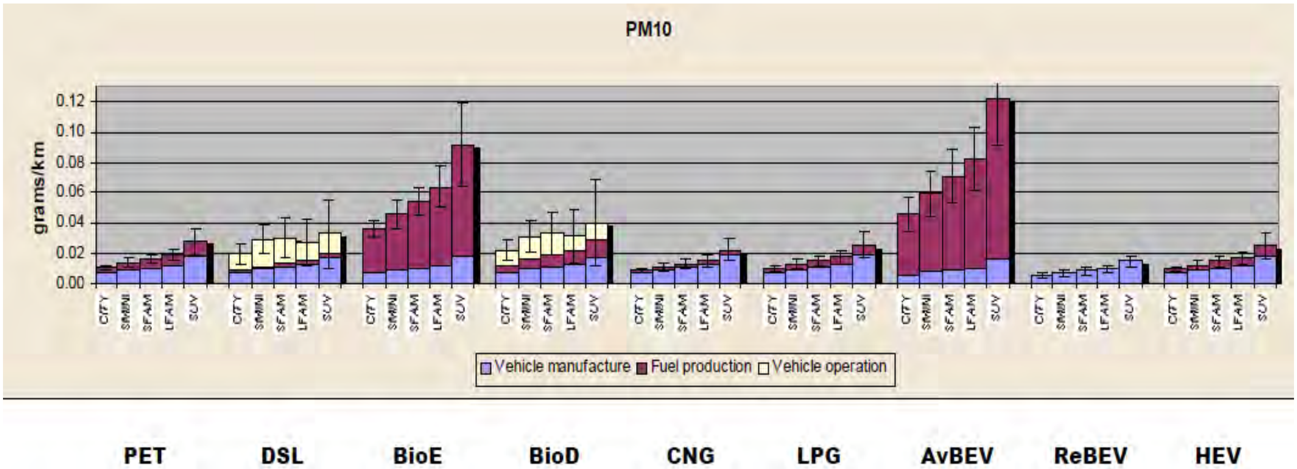

Figure 3.4 Life cycle emissions of PM10 by passenger vehicle types / fuel types by grams emitted per kilometre. Source: Ecolane Transport Consultancy, 2006

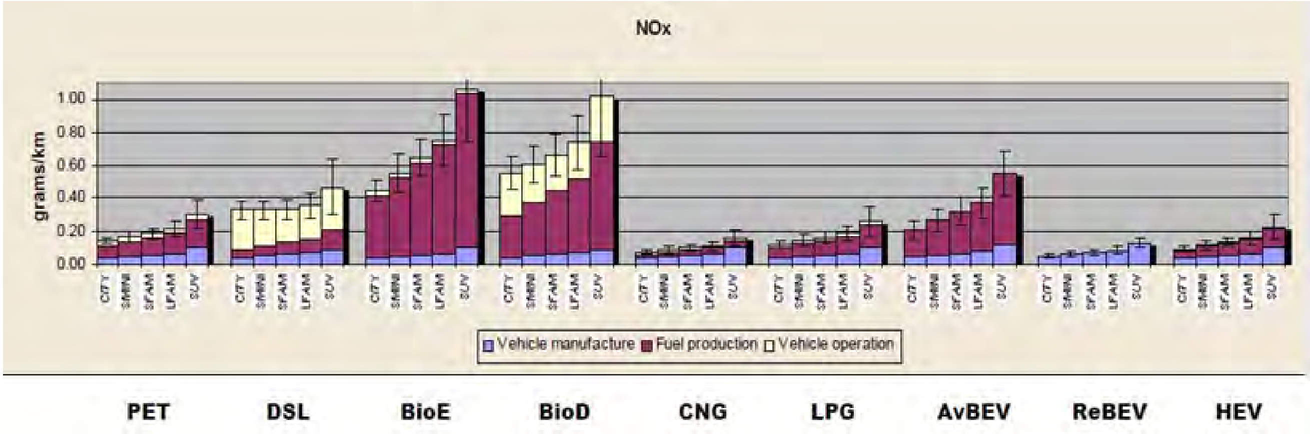

Figure 3.5 Life cycle emissions of NOx by passenger vehicle types / fuel types by grams emitted per kilometre. Source: Ecolane Transport Consultancy, 2006

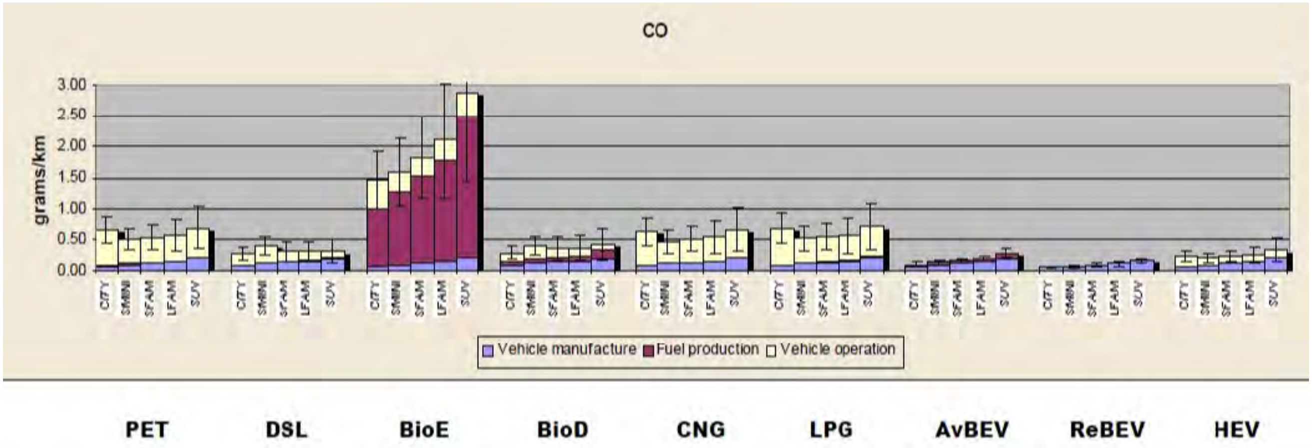

Figure 3.6 Life cycle emissions of CO by passenger vehicle types / fuel types by grams emitted per kilometre. Source: Ecolane Transport Consultancy, 2006

The difference in CO_2 emissions for various vehicle types when LCA is taken into account is summarised in figure 3.8. The key used on the graphs relates to: Plug-in Hybrid Electric Vehicle (PHEV), Extended Range Electric Vehicle (EREV), Electric Vehicle (EV) and Fuel Cell Vehicle (FCV).

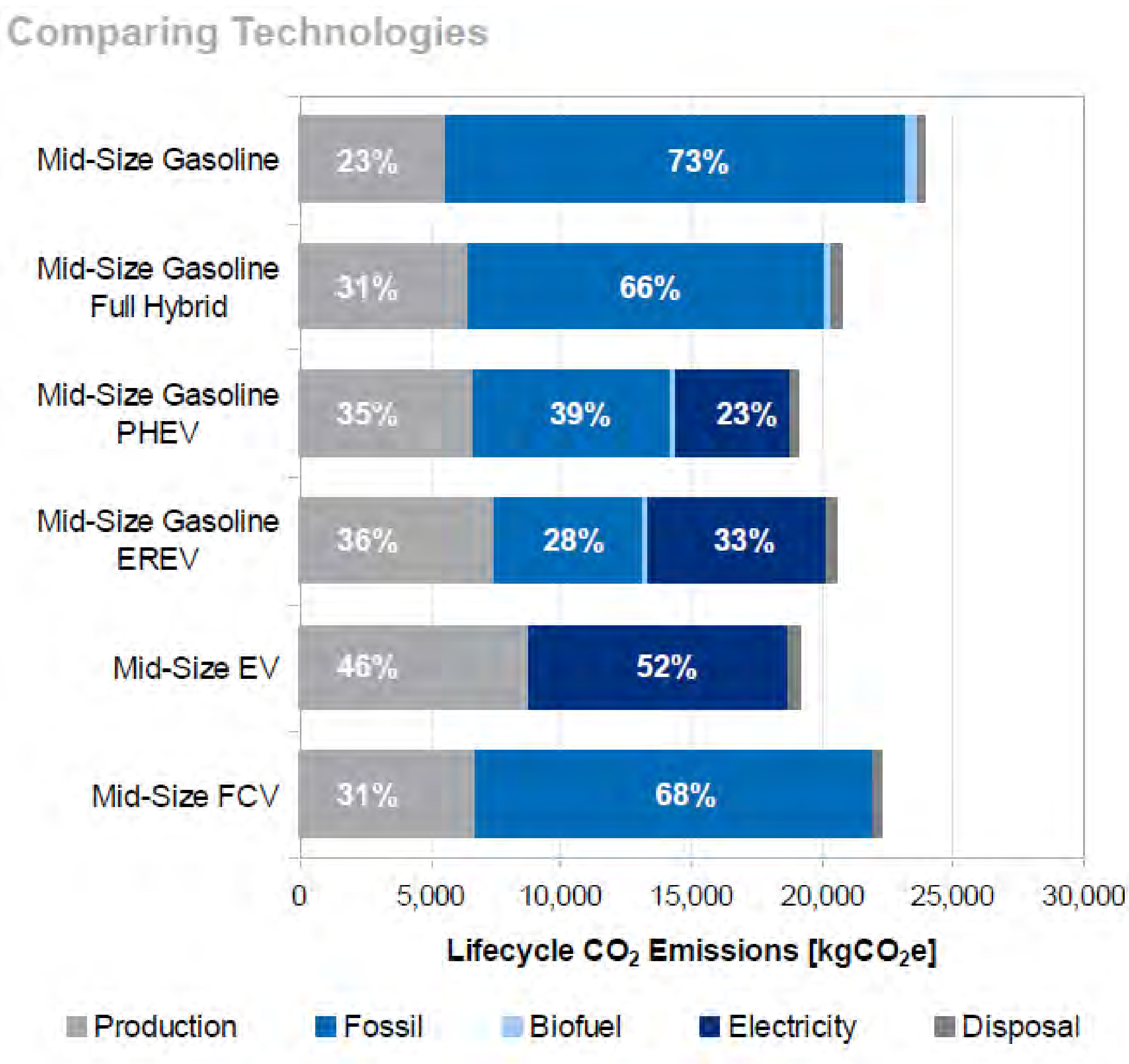

Figure 3.7: Life Cycle CO_2 Emissions for varying vehicle types Source: Ricardo PLC.

Appropriate environmental indicator

Table 3.3: Appropriate Environmental Indicator – Electric Vehicles

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Electric vehicles on the road	number	n. electric vehicles/ total vehicles	Number of electric vehicles (divided into fully electric and Hybrid) circulating on the road. Electric vehicles could be disaggregated into the following categories: cars bikes and scooters commercial vehicles
Electric public fleet	number	n. electric vehicles/ total vehicles of public fleet	Number of electric vehicles (divided into fully electric and Hybrid) which are part of the public fleets owned or managed by the public authority.
Charging points	number	n. charging points/ inhabitants	Number of public charging points available in the city.

Benchmark of excellence

The city of London aims to have 100,000 electric vehicles on the road with 25,000 battery charging points by 2015. 500 charge stations will be on-street, while 2,000 will be off-street in areas such as car parks; 22,500 will be provided in partnership with businesses. The city also aims to convert 1,0 00 Greater London Authority fleet vehicles to electric by the same year. As of May 2011 there were 17,000 hybrid and electric vehicles in use in Greater London, representing the 0.06% of the total number of vehicles registered.

The City of Amsterdam is planning to increase the number of recharging points for electric cars from 200 to almost 1,000 by the end of 2012. The medium term target is to have 5% of all vehicles in the city running on electricity by 2015, which equates to 10,000 vehicles. In 2010, the City of Amsterdam set aside a budget of 3 million euros for a scheme reimbursing businesses in Amsterdam up to 50% of the additional cost of purchasing an electric vehicle. These funds enabled local businesses to purchase 260 new electric vehicles. A new fund of about € 8.6 million will be available until the end of 2015 enabling corporate vehicles in the city (such as couriers and taxis) to run on electricity. On November 2011 the largest electric car sharing project in the world was launched: 300 electric Smarts can be hired without pre-booking or a predestined pick-up or drop-off point, while the cars can be recharged at any of 200 Amsterdam's street charging points.

Operational data

City example: Stimulating e-mobility, London, United Kingdom

The city of London is facilitating the future of environmentally-friendly private vehicle ownership by ensuring the uptake and viability of electric cars. Through enacting its EV plans London is hoping to become the electric car capital of the world.

To achieve this, London has drawn up the Electric Vehicle Delivery Plan. The British capital aims to have 100,000 electric vehicles on the road with 25,000 battery charging points by 2015. The city also aims to convert 1,000 Greater London Authority fleet vehicles to electric by the same year. As of May 2011 there were 17,000 hybrid and electric vehicles in use in Greater London, representing only 0.06% of the total number of vehicles registered.

Tackling the level of emissions caused by private vehicles is a priority for London authorities. It is estimated that poor air quality is responsible for 1,000 premature deaths and 1,000 hospital admissions per year in the city. Transport accounts for 22% of the cities total CO_2 emissions, with motorbikes and cars accounting for 16% of the total CO_2 emissions, 46% of its NOX emissions of and 83% of its PM_{10} emissions. Car transport is also the leading source of CO_2 emissions amongst transport in the city. Figure 3.9 breaks down CO_2 emissions from London's transport by transport mode.

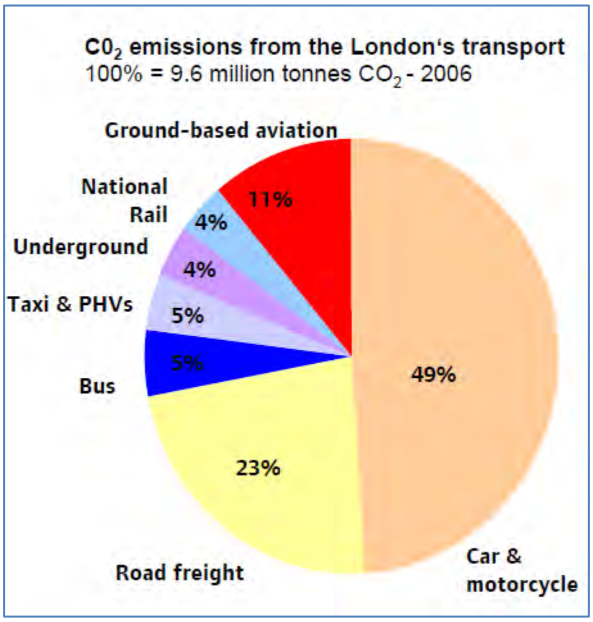

Figure 3.8: CO_2 emissions from London Transport by transport mode. Source: Office of the Mayor of London, 2009

After examining possible candidates for a low-emission alternative to fossil-fuel based car transportation, the city agreed that electric vehicles presented the most effective option. Taking into account the UK's current electricity mix, which includes electricity generated by carbon-heavy energy sources, electric cars are still around 30% to 40% less pollutant than combustion engine vehicles.

The Electric Vehicle Delivery Plan sets out a strategy to stimulate the market for electric vehicles within London. It is separated into three sections.

1. <u>Infrastructure</u>

This aspect focuses on the roll out of charge points across the city. A Source charge point is shown in Figure 3.10. The city will work with the boroughs and other partners to deliver 25,000 charge points by 2015, including a network of fast charge sites. 500 charge stations will be on-street, while 2,000 will be off-street in areas such as car parks. 22,500 will be provided in partnership with businesses. Under city policy, all new developments will be required to provide charging facilities. The city is trialling wireless charge points, in which cars drive over an electric charge pad.

Figure 3.9: Charging point in London. Source: ICLEI

2. <u>Vehicles</u>

The public vehicle fleet will be electrified, with a target of 1,000 electrified vehicles in the Greater London Authority (GLA) Fleet by 2015. The GLA comprises Transport for London, the Metropolitan Police Service, the London Fire Brigade, and the Greater London Authority. After a detailed analysis of the operational requirements of the GLA fleet, a procurement framework was established to purchase 1,000 new electric vehicles, with funding support sought from the national government. Support is also being provided to the boroughs and central government to increase their electric vehicle numbers.

The GLA is working with companies to expand the use of electric vehicles, and has established the “Electric 20” partnership. The city is working with twenty companies that already use electric vehicles on a daily basis, such as Sainsbury's, Tesco's, Marks and Spencer, and Royal Mail, to learn from their experiences and encourage other companies to copy their example.

Manufacturers are striving to create a cost model that ensures purchasing an electric car is more cost effective than purchasing a car run on fossil fuels over a four or five year period. The higher initial cost of purchasing (caused by the expense of the battery) is offset by lower maintenance and fuel costs. Costs saved through owning an EV in London include:

- Exemption from the congestion charge
- Lower fuel costs
- No road tax
- Reduced rate parking

3. Incentives, marketing and communications

Marketing is important to the success of the scheme – for it to work, customer benefits must be adequately communicated to the public.

As mentioned above, in order to incentivise potential customers the city is abolishing the Congestion Charge for electric vehicles, abolishing road tax and is working with the borough to develop parking incentives. Car clubs are also being encouraged to increase their percentage of electric vehicles.

To further make owning an electric vehicle easier, the city has developed a London-wide membership scheme for users, which provides access to the charge point network and the congestion charge discount. The scheme, named Source London, provides this for a fee of £10, which was recently reduced from £100. As the fee was intended to be nominal and not to generate revenue, authorities felt that £10 provided more of an incentive to potential users. Source is consolidating all charging points, originally managed by separate borough authorities. By 2015 the scheme hopes to create a system in which no Londoner is more than one mile from a publicly accessible charging point.

Source: City of London, available from New York City Global Partners Innovative Exchange, http://www.nyc.gov/html/unccp/gprb/downloads/pdf/London_ElectricVehicles.pdf

In Portugal an integrated electric mobility network has been put into place nationally, named Mobi.E. This integrated country-wide approach aims in part to instil greater confidence in the viability and future of electric vehicles, ensuring it is not seen as a “fad” technology, but rather the future of private vehicles (Sgorme, 2010).

According to Heather Watkinson of Transport for London, city run-schemes are limited because they stay within the jurisdiction of the city. “London is looking to see whether there are possibilities to extend the Source London card/scheme so that the card can be used outside of London. The difficulty of linking the scheme with other schemes is that other regions might not be using the same charging points, leading to compatibility issues, and that they would also be using different back offices, which would require adjustments to make the cards usable in other places.”

National schemes can lead to a larger uptake in the short term and increase user confidence, solidifying the concept as a viable alternative to fossil-fuel based cars in the minds of the public. In the Republic of Ireland, electric charge stations are being installed in cities across the country, with the national government hoping to have 6,000 EVs on the road by the end of

2012. The scheme is being coordinated at national government level with backing from the national power company ESB.
In Germany the private sector is taking steps in conjunction with the public sector to ensure the roll out and viability of electric cars, with car makers such as BMW, Audi and VW teaming up with the four large power providers to test run and produce electric vehicles.
Due to the high initial cost of purchasing an electric vehicle in comparison to a conventional vehicle many citizens are reluctant to buy an EV. This is often combined with concerns over the shorter travelling range of EV's and the lack of charging infrastructure. In order to kick start uptake, tax incentives and grants from the local or national government or often necessary, coupled with visible infrastructure adaption. In the Republic of Ireland all vehicles with CO2 emissions of less than 75g CO2 per km are eligible for a purchase subsidy of up to €5,000 and electric vehicles are exempt from Vehicle Registration Tax (Department of Communications, Energy and Natural Resources, 2011). In Portugal tax incentives, such as an exemption from both Vehicle tax and Single Circulation Tax, have been introduced to encourage vehicle uptake, as well as a €5,000 purchase price deduction for EVs, similar to the Irish incentive.
In Norway EVs are provided free parking and the use of bus lanes. Incentives such as these act to greatly increase EV uptake and thus make the system more economically viable.
In London charging points are provided in areas of daily convenience such as parking garages and shopping centres, in order to integrate charging into daily life.

Applicability

EV's are suited to city mobility patterns, as traffic congestion requires frequent stopping and starting. Therefore EV schemes are most successful in cities in which short driving distances are the norm. As EVs can be charged by any source of electricity, an electric vehicle scheme is replicable in almost all European urban settings.
When implementing an electric vehicle scheme, a strong communications strategy is necessary. Dissemination means include a dedicated website, citizen workshops, broadcast advertisements, brochures, etc. Without this citizens may not be aware of the strong benefits that EV's possess. Both Source London and Mobi.E contain dedicated websites aimed at citizens.
Public authorities incorporating electric vehicles into their public fleet is a good way for authorities to boost uptake immediately. As stated above, London aims to have 1,000 EVs in its public fleet by 2015. Adjusting procurement policy to favour electric vehicles is a positive step in realising a functioning EV scheme.

Economics

It is estimated in London that the plan will require £60 million (€72,111,710). This includes installation of the 25,000 charging points and conversion of the GLA fleet. The GLA, central Government and private sector will each contribute equally. The funding breaks down as 50% from the government sector and 50% from the private sector. The payback period for the scheme is hard to estimate, though in London it is envisaged that once fully operational the scheme will be transferred to the private sector, or be run through a public-private partnership. Market forces will then set the price of the scheme for consumers.

In the case of London, the city has been criticised for using public money to fund a means of transport that is not public but rather individual. Heather Watkinson of TfL responds that this is justified as the scheme provides benefits in terms of the wider public good. Ms. Watkinson says that "the scheme provides many benefits that will be directly perceptible by the public, such as air quality improvement, reduced health care costs, reduced burden on the NHS (UK health service) and avoidance of EU fines for air quality breaches. Also Source London and support for EVs is one of many greener transport options that are being implemented throughout London, so it is part of a package of options rather than the main one."

Backing from the private sector is a good way to reduce the financial burden on local authorities. Many private companies see this as a good public relations exercise and so are willing to provide time and funding.

City example: Promoting electric vehicle uptake, Rotterdam, The Netherlands

Within five years, at least one thousand electric vehicles will be on the streets of Rotterdam. This is the aim of Project Power Surge. To accomplish this goal the city will install charging points in the city and provide funding for individuals, organizations and companies. Electric transport will significantly contribute to achieving the objective of reducing CO_2 emissions by 50% by 2025, in comparison to 1990 levels.

The Rotterdam Climate Initiative (RCI) is Rotterdam‘s response to the challenges the Rijnmond region will face in the coming decades, and the economic opportunities this offers. RCI is a public-private partnership and serves as executive climate committee. It is an initiative of the city of Rotterdam, The Port of Rotterdam, Deltalinqs (as representative of the industrial companies in Rotterdam) and DCMR Environmental Protection Agency Rijnmond. The partners join forces with their associates to create a unique movement in which government, companies, knowledge institutes, other organizations, and citizens collaborate. For Project Power Surge, RCI works together with different Dutch organisations and companies such as the postal service TNT, energy company ENECO, financial parties and ministries. Rotterdam has the ambition to become a leading city in electric transport. This will improve air quality and reduce traffic noise, significantly improving the quality of life of Rotterdam‘s citizens. The city aims to ensure that at least one thousand electric vehicles will be on the road within five years. By 2025, this number should rise to as many as 200,000. 15% of all electric vehicles in the Netherlands will then be cruising around the Rotterdam region.

During the last years, there has been a significant increase in the number of electric bikes, scooters, cars, and even delivery vans and refuse collection vehicles in Rotterdam. Project Power Surge will boost these numbers, creating the right conditions to dramatically accelerate the introduction of electric transport. Furthermore, electric transport will significantly contribute to achieving the objective of reducing CO_2 emissions by 50% by 2025, in comparison to 1990 levels.

Ahmed Aboutaleb, Mayor of Rotterdam, states: "Reducing CO_2 emissions by 50% in 2025, making sure that we are prepared for climate change, and boosting economic growth – together we can achieve these goals if we, as market parties, citizens and government authorities, pool resources and join forces."

The RCI participates in the C40 Climate Leadership Group, an alliance of 40 large cities from all over the world which collaborate on climate change issues. The group cooperates closely with the Clinton Climate Initiative, which was founded by former President of the United States, Bill Clinton.

Project Power Surge is part of the city's plan to dedicate resources to the installation of sufficient charging points in the city. In addition, Rotterdam provides funding for the installation of the first 1,000 charging points for the benefit of private individuals, organizations, and companies that will purchase an electric vehicle. In order to make electric driving even more attractive, the city will offer an extra 1,000 free parking permits to store these vehicles for one year.

Project Power Surge boosts further development of electric transport. Initiators of innovative projects are encouraged and supported in many ways, for instance through support for experiments, the set-up of regulation-free zones, and the moral support of knowing that the municipal government itself actively participates in innovations and experiments.

Source: LG Action (n.d.) ROTTERDAM, The Netherlands: Surging ahead with electric vehicles. Retrieved from: http://www.lg-action.eu/fileadmin/template/projects/lg-action/files/it/Country_Profiles/LG_Action_case_Rotterdam.pdf

Driving force for implementation

As electricity can be generated by numerous sources, electric cars bypass concerns associated with fossil-fuels, such as peak oil availability and major price fluctuations.

As well as environmental and consumer cost benefits (over an extended period), the energy required for electric vehicles can be produced domestically, stimulating the domestic economy.

Electric vehicles are also much quieter than internal combustion engine vehicles. A large scale changeover would significantly reduce noise pollution.

Another major driving force is electric vehicles ability to improve the economy. As well as the obvious jobs created in construction by internal infrastructure projects, electric vehicles can also support a low carbon economy and economic growth through stimulating the car manufacturing industry.

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3.2 Best environmental management practices for environmental services

3.2.1 Chapter structure

This chapter is perhaps the most wide-ranging of the Best Environmental Management Practices, exploring three distinct topics under the umbrella of Environmental Services – Sustainable Waste Management contained in section 3.2.4, Strategies to reduce Noise Pollution at section 3.2.5 and Strategies to improve Air Quality found at 3.2.6. Each section contains a general overview of the specific area, followed by applicable guidelines and best practice examples from around Europe. Reference literature is provided to supplement the overview given.

3.2.2 Chapter introduction

Human prosperity, health quality and recreational opportunities are contingent on the amenities and resources provided by our environment. The environment supplies common goods and assets that contribute immensely to our daily lives. Environmental Services act to preserve these benefits, and contributes to the sustainable use of scarce resources.

Environmental goods and services are defined by UNCTAD as "those goods and services which measure, prevent, limit or correct environmental damage to water, air and soil as well as problems related to waste, noise and ecosystems and (may) include clean technologies, processes, products and services which reduce environmental risk and minimise pollution and material use depending on a country's level of economic development" (UNCTAD, n.d.).

Economic growth has put a greater strain on environmental resources than ever before. The increase in manufacturing activities coupled with higher consumption rates has resulted in the rapid exploitation of raw materials. Environmental goods and services can play a role in curbing this through promoting more sustainable development.

Today there is an increasing awareness of the importance of preserving these common environmental goods. This increase in environmental awareness, both at public and political level, has led to a huge growth in the number of services designed to protect the environment. Whereas originally environmental services were dictated by basic market needs, such as waste management, increasingly environmental services are a result of the requirements created by environmental legislation, be they at national or European levels. Waste, water and air pollution have received the greatest attention in terms of policy and regulations, as these are the areas in which pollution is most obviously harmful and causes the most salient environmental degradation.

Environmental issues were not meaningfully discussed in the European Union until the early 1970s, over a full decade after its inception in 1957. Originally the intent of the EU (then European Economic Community) was to deal with fiscal matters, political stability and maintain Europe wide peace. In the late 1960s however environmental concerns became increasingly prevalent in Europe and in 1972, with the creation of what would become Direction general (DG) Environment, environmental protection was incorporated into the European Union.

At first environmental policy was utilised mainly to enhance free trade and common market principles (Jungwirth, 2011) (eg. requiring the levels of lead in petrol to be uniform), but in 1973 the First Environmental Action Programme was approved, changing the focus of environmental policy. 1972 - 1987, was regarded as a test phase for European environmental policies and ambitious policy targets were set. From 1987 – 1992 these policies were better integrated into policy fields through "a more detailed legal integration" (Jungwirth, 2011). Policies went from being idealistic to more pragmatic and applicable.

In the previous phase environmental policy had been ad hoc and uncoordinated, (Jungwirth, 2011) but 1987 saw the creation of a coordinated, goal orientated approach with the landmark Single European Act, fully bringing community competence in the field of environment policy[17]. Policies were no longer based on economic principles but instead on principles designed specifically to protect, preserve and enhance the natural environment.

[17] http://ec.europa.eu/ireland/about_the_eu/competences/index_en.htm

From 1992 onwards there has been an increase in legal regulations, but also a widely perceived fall in the application of these policies within member states.
The first European treaty that specifically set out environmental policy was the Maastricht treaty, which came into force in 1993.
The treaty set out the EU's objectives of:

- preserving, protecting and improving the quality of the environment,
- protecting human health,
- prudent and rational utilization of natural resources,
- promoting measures at international level to deal with regional or worldwide environmental problems.

This treaty has led to environmental policy developing at a rapid pace over the last number of years. The Treaty of Amsterdam (1997) solidified the EU's commitment to sustainable development.
What began as a means to influence member states into treating visible pollution, the result of harmful processes, has become a means to encourage member states to take preventative actions before pollution is generated. This has altered the environmental services industry significantly, moving from clean up services to clean environmental technologies and products (Eurostat, 2009). As a result research, innovation, design and consultancy are set to become more important within the environmental services industry in the future.

3.2.3 Scope of this chapter

This chapter focuses on the most salient and pressing areas in which environmental services have been put into place: Noise pollution, air quality and waste management.

In this section best practices range from the highly innovative, as in the case of soundscaping in Florence, Italy, or more conventional methods as in the intelligent means of reducing air pollution in Helsinki, Finland. Ultimately the content is written with the intention of being replicable as policy within public authorities. These BEMPs can be enacted as stand alone measures, or simultaneously, depending on the capacity of the public authority. Ultimately the measures contribute to a holistic, cross-sectoral approach to improving the environmental performance of cities. The case studies chosen in each area - Sustainable Waste Management, Strategies to reduce Noise Pollution and Strategies to improve Air Quality - represent areas in which public authorities used policy instruments to enact meaningful environmental change in their municipality.

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3.2.4 Integrated Municipal Waste Management

Description

The ultimate aim for the EU is to turn Europe into a recycling society, avoiding waste, and reusing unavoidable waste. Today the EU is changing from viewing waste as an unwanted burden, to a resource to be exploited (European Union, 2010). Modern EU policy sees waste management as a hierarchy, where prevention is the best option. Prevention is followed by re-use, recycling, other forms of recovers, with ecological disposal and landfill as the final option, as shown in figure 3.11.

Figure 3.10: The waste hierarchy. Source: Being wise with waste: the EU's approach to waste management

This chapter will focus primarily on best practices in the management of municipal waste. Municipal waste is defined by the European Environment Agency as, “Household waste as well as other types of waste which, due to their nature and composition, are similar to household waste”, the management of which generally falls under the authority of local governments. Municipal waste may consequently include wastes generated by small businesses and public institutions and collected by the municipality; this part of municipal waste may vary from municipality to municipality and from country to country, depending on the local waste management system.

When considering waste it is important to examine the full life cycle of products. Currently this is thought of as a cycle, presented in figure 3.12, in which natural resources are extracted, converted to raw materials, manufactured into products, consumed and then discarded as waste. In reality however, waste is produced at each stage of the product lifecycle, during extraction, exploitation and production.

Figure 3.11: The Product cycle. Source: Being wise with waste: the EU's approach to waste management

As each product that is consumed generates waste in the manufacturing stage, it can be said that the "real" waste of the item is much greater than its actual weight. This theory is known as the "ecological rucksack" concept. Under it a 20kg PC actually weighs 1,500kg, due to resource use. A 16 gram toothbrush actually weighs 1.5kg. Recycling represents a huge potential to regain an unused stock of raw materials. In theory all waste can be recycled either in the form of materials or energy. Figures from European Environment Agency outline recycling rates in the Europe Union in 2003:

- 84% of aluminium waste, consumption of which is 22kg per inhabitant per year
- 56% of paper and cardboard waste, consumption of which is 205kg per inhabitant per year
- 55% of steel waste, consumption of which is 412kg per inhabitant per year
- 47% of glass waste consumption of which is 38kg per inhabitant per year
- 15% of plastics waste, consumption of which is 95kg per inhabitant per year

An optimal management of waste can only be an integrated one, i.e. one that considers this process as a whole. Therefore this best practice will be structured following the approach of figure 3.11 and will take into account all the aspects of waste management, from production (and prevention) to disposal. Before analysing this process in depth, it can be useful to have an overview of waste production and treatment in Europe. Figure 3.13 shows the trends in municipal waste treatment in Europe from 1995 to 2010 while figure 3.14 shows the differences in treatment among different European countries in 2010.

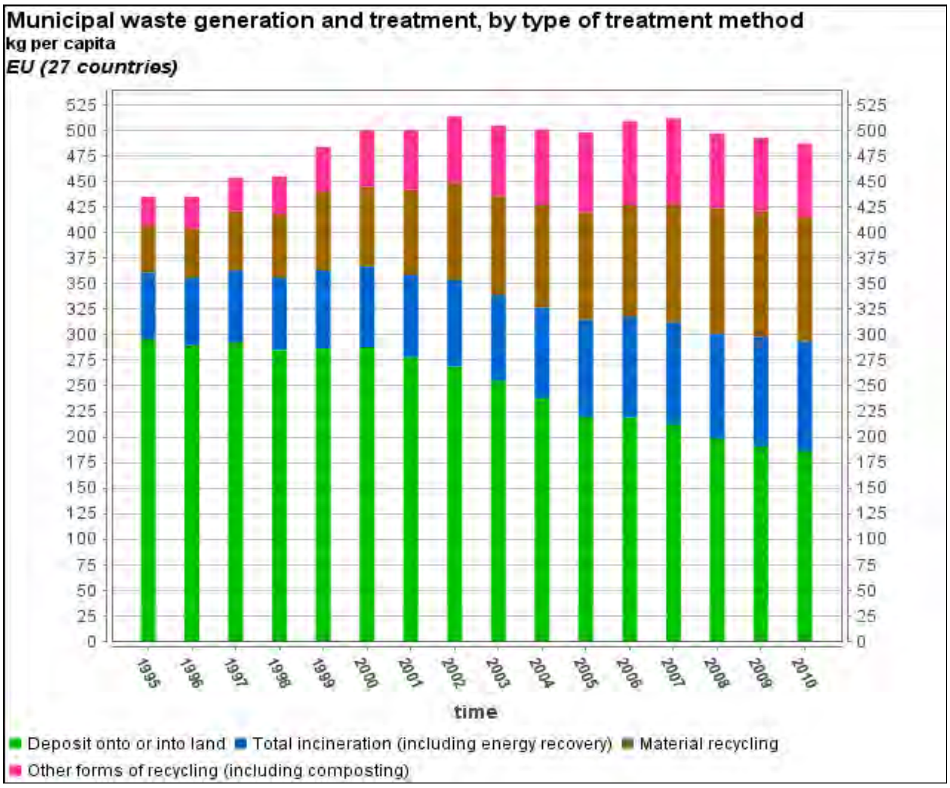


Figure 3.12: Bar chart of EU27 municipal waste generation and treatment, by type of treatment method, from years 1995 – 2010. Source: Eurostat

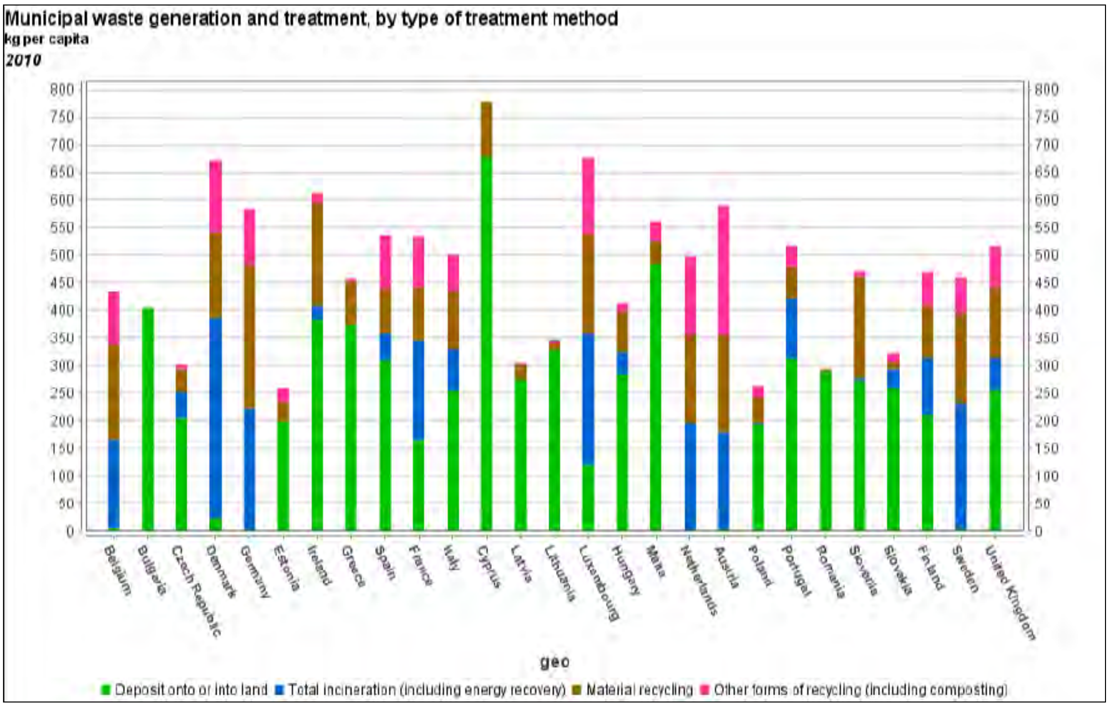


Figure 3.13: Bar chart of EU27 municipal waste generation and treatment, by type of treatment method, by country. Source: Eurostat

Member States and their local governments have enacted the EU waste management strategy, developing consistent municipal waste management plans. This is the case, for example, of the

Devon County in Great Britain, which has drawn up a strategy setting ambitious targets on the reduction of municipal waste (slow down its increase at 1% per year from 2010 on), on the increase in recycling and/or composting (recycle 65% of household waste by 2025/26) and on the diminution of the amount of waste landfilled (35% by 2020 compared to the level of 1995). The structure follows the dictates of the British Waste Strategy, published in 2000 according to the Landfill Directive Scheme (Devon County, n.d.).

Achieved environmental benefits

The proper disposal of waste has been a perennial challenge for humankind. Improperly managed waste quickly becomes an environmental pollutant. Waste destroys soil through leachates, illegal dumping and poorly controlled discharges. Waste can pollute water through groundwater coming into contact with waste and entering aquifers or surface water. Landfill sites produce both methane and carbon dioxide

harming air quality, and can attract vermin to an area. Methane can also build up in landfill, potentially causing explosions (European Union, 2010). An appropriate waste management can have a substantial role in reducing this impact. Furthermore it can contribute to the production of green energy through incineration or anaerobic digestion of bio-waste, whose use is also suitable for the production of fertilisers via a composting process. Waste also leads to a significant loss of materials, a serious problem for the EU, which depends heavily on imported materials. Waste eats into finite resources, a problem that is being exacerbated by a rising world population. Therefore recycling, which allows not only to prevent landfilling, but also to reuse raw materials which would otherwise be lost and that can replace virgin materials in the manufacturing process, presents substantial environmental benefits, turning litter into a resource (Smith et al., 2001). It is estimated that energy consumption reduction associated with recycling is about 15 millions tep for 40 tonnes of waste (Bianchi et al., 2005).

A study conducted by DG Environment in 2001 has shown that overall, source segregation of municipal solid waste (MSW) followed by recycling (for paper, metals, textiles and plastics) and composting /AD (for putrescible wastes) gives the lowest net flux of greenhouse gases, compared with other options for the treatment of bulk MSW. In comparison with landfilling untreated waste, composting / AD of putrescible wastes and recycling of paper produce the overall greatest reduction in net flux of greenhouse gases. The largest contribution to this effect is the avoidance of emissions from landfills as a result of recycling these materials (Smith et al., 2001).

Appropriate environmental indicator

Table 3.4: Appropriate environmental indicator - Waste management

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Municipal waste production	ton	Kg municipal waste produced/ total population Kg municipal waste produced/ effective population (resident + tourist)	Municipal waste produced by households, as well as other waste which, because of its nature or composition, is similar to waste from household. The household component, if possible, have to be disaggregated. The per capita value could be calculated considering also effective inhabitant: residents + tourists + students etc.
Monthly Amount of municipal waste produced	ton	ton municipal waste produced monthly/ ton annual production	Municipal waste production disaggregated on a monthly basis.
Separated collection	ton	ton municipal waste separately collected/ ton municipal waste produced	Municipal waste separately collected disaggregated into: plastic, glass, paper and cardboard, organic waste, tin (aluminium)
Treatment and disposal	ton	ton municipal waste disaggregated by each	Total amount and percentage of municipal waste landfilled; incinerated,

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
		treatment/ ton municipal waste produced	recycled; composted
Waste produced by the local authority	ton	ton waste produced/ n. of employees	Total amount of waste produced by the different activities directly managed by the local authority.
Hazardous waste produced by the local authority	ton		Hazardous waste deriving from activities directly managed or which are under the direct responsibility of the local authority
Citizen complaints about waste management	number		Number of citizen complaints about waste management activities

Cross-media effects
Municipal waste management involves various stakeholders at the local level, i.e. public administrations, experts, industry and commercial organisations, representatives from the waste management sector and consumers associations. Waste management is also closely linked with production of energy at the local level, be it through incineration or anaerobic digestion, and has a direct local impact on air, water and land use.

Benchmark of excellence
Municipal waste production in Freiburg have decreased from 561 kg/inhabitant in 2000 to 445 kg/inhabitant in 2010 (-21%). Thanks to a well functioning integrated waste management system enabling very high performances in the recycling of materials (about 67%), in the same period, residual domestic and bulky waste decreased from 178 kg/inhabitant to 122 kg/inhabitant (-31%). Since brown biowaste containers were introduced in 1997, the amount of biowaste has risen to 99 kg/inhabitants, about 1/3 of the total separated collection of waste. The residual amount of waste which has not been recovered or recycled is incinerated with energy recovery, therefore resulting in zero landfill. The energy generated from waste incineration can be used as electricity and district heating. The amount of electricity currently being fed into the public power grid is sufficient to supply 25,000 households (about 30% of total households).

Operational data

<u>Waste prevention and re-use</u>
Waste prevention is at the top of the hierarchy shown in figure 3.11. Modern waste management focuses on lowering the quantity of initial waste being produced. Member States have difficulties in preventing the generation of municipal waste, mainly because of increased consumption. From the perspective of local and regional reduction campaigns, a reduction strategy begins targeting most significant flows of products, these are:

- Organic waste;
- Paper and cardboard waste;
- Packaging waste;
- Bulky household waste;
- Free newspapers and circulars;
- Bottles for liquid foodstuffs;
- Electrical and electronic waste;
- Household hazardous waste (batteries, cleaning products, etc.);

Certain types of waste or products are also worthwhile targeting due to their symbolic meaning, such as plastic bags from supermarkets, non-reusable nappies (see Venice example in the following paragraph), gadget toys.
<u>Reduction through behavioural changes</u>

There would be a big waste reduction potential just by avoiding unnecessary waste. A study published by the UK Waste and Resources Action Programme (WRAP) shows that roughly one third of the food bought in Britain each year, or 6.7 million tonnes, is thrown away. Of this waste, 4.1 million tonnes are 'avoidable', i.e. it is food that is no longer wanted or it has been allowed to go past its best. It corresponds to 70 kilograms waste per person. The study also finds that about 1 million tonnes of the waste, or around 15 kilograms per person, comprises products unopened or whole when thrown away. Consequently, UK consumers spend EUR 12.6 billion on food that is thrown away each year but could have been used if stored or managed better — corresponding to EUR 530 per household (European Environment Agency, 2009). As stated above, income growth, urbanisation and an expanding service sector can all lead to more municipal solid waste generation. Environmentally responsible behaviour by firms and households, the adoption of waste recovery/reuse innovations and waste prevention policies may be among the drivers that can reverse municipal solid waste growth in the future, thus further decoupling income growth from a grow in waste production (European Environment Agency, 2009). Encouraging consumers to choose greener and reusable products and to repair them when they break instead of buying new ones is also part of a long term waste prevention strategy.

Example: Many Municipalities have started promoting the use of washable nappies instead of disposable ones, such as, for example the Municipality of Venezia, which has launched a campaign in 2001 for promoting reusable diapers and sanitary towels, as shown in figure 3.15 (for more information: http://www.comune.venezia.it/).

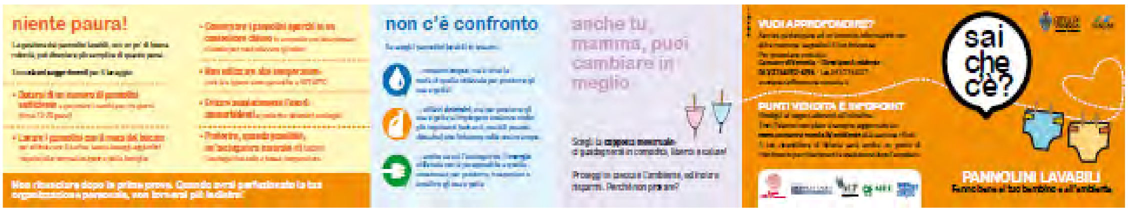


Figure 3.14 The leaflet of the campaign in Venezia. Source: Municipality of Venezia

City Example: Vienna, Austria – Information Campaigns about repairs and reuse and an internet platform for exchanging second-hand products

In Vienna, the promotion of repairs formed part of a tripartite campaign to encourage consumers to repair and reuse second-hand products, and to rent rather than buy. The objective for Vienna is to bring about a change in lifestyles, and in consumers' behaviour and attitudes in order to develop a repairs-oriented society where people would keep products until they really do reach the end of their operating lives.

Two repair guides were published in Vienna in 1997 and 1998. The latter contained 850 addresses for 13 sectors of activity, as well as general repair advice for each sector. 75,000 brochures were distributed at the end of 2002. A new edition, combining the two guides, which were revised and supplemented, was published in 2003.

A Viennese repair network was created by 23 small repair shops fulfilling certain conditions. These were promoted by the municipal waste management service, which offers a toll-free number and forward repair orders to member shops, depending on their specialty.

With this permanent campaign, Vienna wants to raise the awareness of both consumers and businesses on the fact that repairs are an important aspect of waste reduction. They contribute to protecting the environment, whilst at the same time having a positive effect on the regional economy. Maintaining goods can also ensure that jobs in the manufacturing sector pass over to the services sector, which helps decentralise jobs, increase employment for qualified positions, and promote regional economy. The city also opened a Repairs & Service Centre and organises a flea market.

A platform for exchanging second-hand products

The platform for exchanging second-hand goods on the Internet was established in March 1999 by the Viennese Municipal Department for Environmental Protection in collaboration with the Department for Waste.

The exchange system is split into four markets: second-hand goods, compost, toys and information. The information market provides an on-line version of practical guides: the repairs guide, the rental stores guide and the waste disposal manual. Exchanging goods is open to private users and to commercial operators, as well as second-hand stores and landscape gardeners.

Assessment of the Vienna experiment

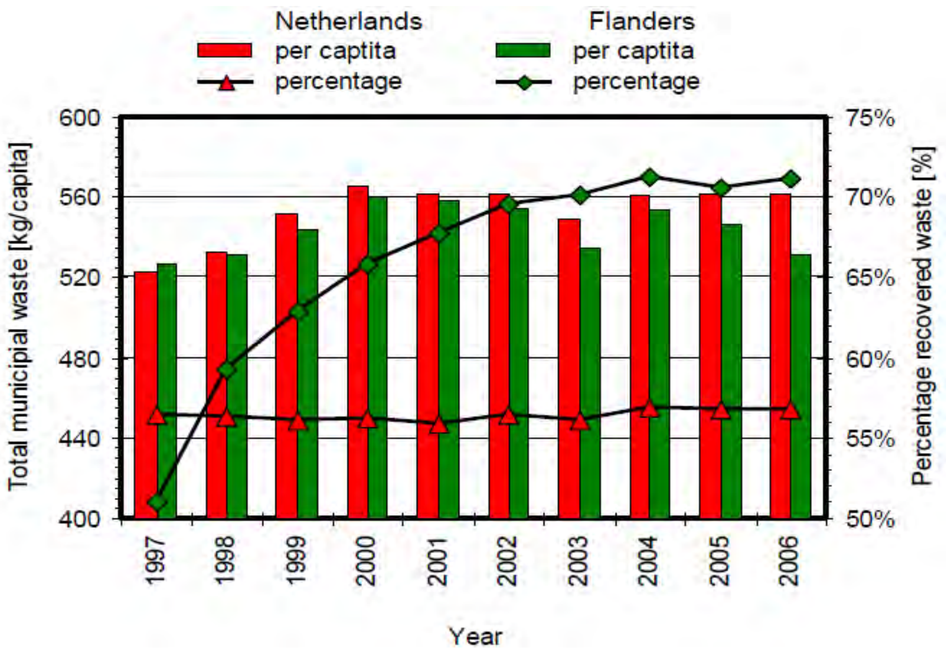
Electrical and electronic equipment constitute a significant share of the repairs and reuse market. The Vienna Repair and Service Centre repairs electrical appliances accounting for a total volume of 400 tonnes of second-hand items every year. The municipal flea market sells approximately 450 tonnes of second-hand items every year. All this contributes significantly to reducing waste.

Source: ACR+, *Municipal Waste in Europe: Towards a European Recycling Society*. Paris, France: Victoires Editions

<u>Pay-as-you-throw schemes</u>

One effective method of pushing consumers to produce less waste is to set up Pay-as-you-throw-schemes (PAYT). These have taken different forms in the various countries where they have been applied. Generally, PAYTs are defined as a volume- or weight-based accounting and unit pricing, whereby local authorities usually have it at their discretion to examine which solution matches best with local conditions and will be the one applied (Reichenbach, 2008). Bin identification is by far the most popular option for municipalities and waste management associations in Europe. For this approach to work, it is vital to have a good system for bin allocation, particularly in densely inhabited, multi-family areas, to ensure accountability for the waste generated. Possible solutions include individually locked bins, locked container boxes and wire cages set up for a known circle of users. Not to be ignored aside from the investment and maintenance costs for these installations, is the issue of the more difficult accessibility, which may increase the time needed for hauling processes under such arrangements. An alternative to a collection system with bin identification is user identification for which the most common

technical solution is delivered in the form of so-called chamber systems. Also known as waste lock or lockhopper installation, these are waste storage devices that require users to pass their waste through a special feeding chamber. Users get registered while accessing this chamber and their amount of waste deposited is recorded. The responsible authority then either bills the user or the system itself deducts a corresponding amount from prepaid credits. These systems are meanwhile operated in environments ranging from large housing blocks through shopping malls to single-family house areas, and allow the principle of PAYT to be applied on a full-scale. The proven benefit and strength of PAYT as compared to any conventional form of charging households for waste services is the incentive that this approach provides for diverting waste material that can be forwarded to recycling away from the collection of mixed residual waste ending up at landfills or incinerators, and the savings that can be obtained through optimised collection. As the most evident and instantly noticeable consequence of PAYT introduction, the reduction of collected residual waste in conjunction with an almost proportional growth of the quantities collected in systems for source-separated materials can be observed. This is particularly the case where charging structures allow recovery of the cost of unlimited recycling and do not make restrictions as to the amount forwarded to recycling. Backed by a sufficient collection infrastructure, this will encourage the diversion of waste material (for which options other than the disposal via residual waste collection exist) into the respective systems for selective collection. For example, in Flanders pay-as-you-throw schemes have been introduced, thus decoupling its amount of collected waste from the rest of the country, as shown in figure 3.16. As in the case of Flanders, evidence in other countries has proven PAYT schemes to increase the amount of source separation dramatically (ISWA, 2011).



3.15: Results achieved by the PAYT scheme in Flanders compared to the Netherlands. Source:Koller, 2011

However, shortage of space and storage capacities for source-separated waste in the households, as well as poorly developed or uncomfortable systems for selective waste collection, were found to have a negative influence on these efforts. (Reichenbach, 2008).

Waste Prevention through law enforcement

A strict regulatory framework is indispensible to kick start the reduction process. To this extent, EU directives have provided a reliable legal and regulatory framework (see section 2.6.5). For example, the application of the substance ban of the Restriction of Hazardous Substances (RoHS) Directive since 2006 has reduced the amount of potentially harmful substances in electronics placed on the EU market by about 110.000 tonnes annually. Hazardous waste (3% of total waste) continues to decrease in the EU-12, notably due to the introduction of cleaner

technology and mine closures, although at EU-27 level an annual increase of 0.5% can still be observed. (European Commission, 2011).
It is important to set quantitative objectives, either general or per-waste-flow specific ones. To set an absolute objective, such as 500 kg per inhabitant of waste per year, represents a clear target which can shape a campaign (on the other hand, per sector objectives could help target more specific polluting products). For example, in 2007 the ACR+ launched a European action campaign for reducing waste to increase the international exchange of information and experiences between local authorities on the theme of waste prevention and help them benchmarking this. The benchmark objective provided is 100kg less municipal waste per inhabitant per year. This is an ambitious target if one considers the average per capita waste production in Europe, which is about 600 kg. Table 3.5 illustrates the main sectors involved and the reduction potential for them (ACR+, 2009).

Table 3.5: Actions on the main waste flows and their reduction potentials. Source: ACR+, 2009

100 kg less municipal waste		
Actions on the main waste flows	**Stock (kg/inhab./year)**	**Waste reduction potential (kg/inhab./year)**
Organic waste	220	40
Promoting composting at source (at home, at neighbourhood level, within green spaces, etc.)	180	30
Campaigning against food wastage	30	8
Promoting reusable nappies	10	2
Paper waste	100	15
Taking action against advertising and/or free newspapers	20	5
Acting to promote dematerialisation (at schools and in offices)	80	10
Packaging	150	25
Favouring products that are deposited for disposal	35	12
Promoting tap water	6	2
Developing reusable bags	2	1
Campaigning against overpacking	107	10
Bulky waste and/or miscellaneous waste	130	20
Promoting the reuse of clothing	8	4
Promoting the reuse of furniture, EEE, toys and miscellaneous bulky waste	110	13
Campaigning against superfluous purchases	12	3
TOTAL	**600**	**100**

Eco-design

Eco-design is an important component of waste reduction, as it is influencing manufacturers to use less wasteful techniques in production. Promoting eco-design is a very important step in an optimal waste management, so as to diminish the life-cycle impact of commonly used products. (ACR+, 2009).

Waste logistics optimisation

Another important point in reducing the environmental impact of waste is represented by logistics optimisation. Once collected, waste has to be transported to treatment and disposal plants and this transportation produces polluting emissions. Optimisation can be reached on the one hand by optimising collection systems through the improvement of route schedules and on the other hand by using more efficient means of transportation. Efficiency in transportation can be achieved by using less polluting vehicles, such as methane vehicles or switching to rail transport, like in the case of Freiburg, where they switched to rail transport for the waste being transported to landfill. In the city, municipal residual waste and bulk waste is transported to

treatment facilities by rail since 2006. Drivers also attend fuel-saving driving courses (ASF GmbH, 2011). Routes can be reduced by studying efficient collection strategies and by optimising location and collection in order to reduce the distances travelled.

The principle of producer responsibility

The principle behind producer responsibility is that the producer bringing products to the market must also be co-responsible for their take-back and recycling.The EU is increasing legal requirements for recycling and disposal of products, with higher standards for materials recycling. The producer responsibility is an important framework for the waste market (Koesegi, n.d.). In the Directive 2008/98/CE, the principle of extended producer responsibility has been enforced. This foresees obligations of various types, such as eco-design obligations (this will be analysed in the next paragraphs), physical or financial return obligations, collection reuse or recovery performance obligations etc. (ACR+, 2009)

An example is represented by the deposit on refillable/reusable packaging, i.e. consumers have to pay a deposit for it when they purchase it. When they bring back the empty packaging to supermarkets or stores, they receive the deposit back. This system works particularly well for glass bottles or PET bottles (they can be refilled 20-50 times). On the basis of producer responsibility, which is set in the law, producers have the obligation to fulfil the legal requirements. This also means they have to carry at least partly the costs needed. Such systems are established particularly for packaging waste. Either the system carries the total cost for collection/sorting/recovery of packaging waste or the municipalities pay part of the cost and the system pays part of the cost (Williams, 2011).

Recycling

The main benefit of recycling is to avoid an environmental damage. Some products, when they become waste, are potentially dangerous and toxic. For example used oil, lead acid batteries, electrical and electronic waste can cause serious environmental damage: to soil and crops, to surface waters and groundwater, to the atmosphere (for example, release of CFC) (Bianchi et al., 2005). Recycling is also a crucial element in the management of packaging waste, since it not only prevents them to be disposed or incinerated, avoiding the production of CO_2, but it also permits the reuse of materials, lightening the impact of resource extraction and exploitation. Recycling relies heavily on citizen participation and acceptance, and requires manufacturers to ensure that their products have the ability to be recycled. The removal of hazardous materials from products is vital to ensure their recyclability. According to the Packaging Directive (Directive 94/62/EC, amended by Directive 2004/12/EC) recycling targets for packaging waste are set. Within 31/12/2008 a recovery objective of minimum 60% is set. Singular targets are also set, these are at least 60% for glass, paper and cardboard, at least 50% for metals, 22.5% for plastic and min. 15% for wood. (ACR+, 2009).

Other recovery and disposal

Landfills are the least desirable waste disposal method as they damage the surrounding environment and emit gases hazardous to human health. Therefore, the EU is now putting pressure to local governments to reduce their biodegradable waste going to landfill and identify alternative treatment methods (See reference legislation). Consequently, a number of local governments in Europe have developed an organic waste collection scheme resulting to a reduction in CO_2 emissions. For example Reggio Emilia has set up a recycling scheme involving organic waste and has published a multilingual flyer (figure 3.17) to inform all its citizens, Italians and immigrants, on how to separate waste.

Figure 3.16: The multilingual leaflet for composting. Source: Municipality of Reggio Emilia

Anaerobic Digestion

Generation of biogas through Anaerobic Digestion is one efficient way of managing collected organic waste. Digestion is defined as the biological decomposition of organic matter of biological origin under anaerobic conditions with an accompanying production primarily of methane (CH_4) and carbon dioxide (CO_2). In biogas the methane content is approximately 65 % by volume (Harvey, 2010). Before using it most of the carbon dioxide must be eliminated. Biogas can be used to produce electricity in a CHP plant, be directly fed into the national gas grid or be used as fuel for vehicles (see Kristianstad city example).

Composting

Alternatively, green waste can be used for composting, i.e. turning them into fertilizers. In order to avoid polluting soils, compost must be made from pure organic materials, such as garden or kitchen wastes (ACR+, 2009). From 1999 to 2008, composting capacity has increased by five times in Finland and Hungary, and tripled in Italy. Nevertheless, if composting is to play a role in diverting waste from landfill then a well-functioning market for compost is needed. This necessitates a good quality product and national quality standards to enforce that. These standards have been set in Finland, the Flemish Region, Germany and Italy, and they have led to good results (European Environment Agency, 2009).

Incineration

Another efficient option public authorities have to embrace waste as an unexploited resource, is to use it in the production of electricity through a modern waste incineration plant. Modern incineration plants can contribute to energy production in numerous forms, such as electricity, heating and steam. Incineration plays a key role for those wastes which cannot be recovered. Due to the dangers linked to this technique, the Waste Incineration Directive (2000/76/EC) raised the technical and environmental standards for incineration and therefore increased costs. The climate-relevant CO_2 emissions from waste incineration are determined by the proportion of waste whose carbon compounds are assumed to be of fossil origin (IPCC, 2001); therefore it is very important to link incineration with high levels of materials recycling. On the other hand, because incinerators can generate power, high energy prices can incentivise the use of this practice. It is to be reminded that the incineration of separately collected biowaste is recognised as renewable energy source and can contribute to the renewable energy targets of the Member States.

Mechanical-biological treatment

An alternative option is represented by mechanical-biological treatment (MBT), which is used to treat mixed municipal waste. This is a pre-treatment method, whereby mixed household waste is mechanically separated into a high caloric refuse-derived fuel product and a residue, which is first digested or composted and then sent for landfilling or to dedicated incinerators. Capacity for mechanical-biological treatment has doubled or tripled in some countries, with Italy having the largest treatment capacity. All the options described above can be used

complementarily and their adoption can vary from case to case (European Environment Agency, 2009).

Promoting composting in Colchester, Nova Scotia, Canada.

The Municipality of Colchester endorses composting as a natural way of recycling organic matter and nutrients back into the soil for use by new and growing plants. Colchester County promotes 2 types of composting: curbside composting and backyard composting. Both types of composting help to extend the life of landfills, decrease greenhouse gas emissions, protect groundwater and streams, and turn waste into a valuable resource. The municipality provides its dwellers with a curbside green cart, which is meant for the disposal of organic material only. All residents with green carts are provided with mini-bins for the collection of kitchen waste. Mini-bins are to be emptied into curbside green carts on a regular basis. Green carts are then collected every second week in conjunction with garbage. Alternatively, Colchester dwellers can set up their backyard composting system using an open pile, constructing a basic wooden bin themselves, or purchasing a backyard composter. The Municipality has backyard "Earth Machines" available for sale at a price of $30.00. These can be purchased at the Public Works Office at the Municipal Building. The municipality is also organising a "2012 Compost Giveaway", taking place from April 28th to May 5th, 2012, which will entitle each household within the County to 100 kg of free compost.

Source: http://www.colchester.ca/composting

City example: Freiburg, Germany

The city of Freiburg, located in Southern Germany, provides citizens with a waste management system that is both ecologically and economically sustainable. The city works with citizens and has achieved a waste strategy that is as much about personal responsibility as authority measures. The system exceeds German legal requirements and offers numerous waste solutions for each form of waste.

Freiburg's main waste management policy is structured on a hierarchical set of principles:

1. Waste prevention - reducing the amount of waste at source
2. Waste recovery
3. Ecological disposal.

These different strands of waste management combine to form an integrated concept. The city fosters waste prevention through involving citizens in the waste management process. A communications campaign targets citizens, encouraging them to engage in responsible waste behaviour. Citizens are encouraged to separate waste and to cut down on the waste they generate. Waste management is actively discussed with citizens, which are regularly informed of new regulations and measures, and receive background information on waste management decisions in the city. This information is distributed via leaflets, waste disposal calendars (with waste collection dates included) and through public participation events. Without broad citizen acceptance, achieving a reduction in waste and an increase in recycling is not possible, as it is up to the individual to ensure these systems are followed.

The City targets young people in its campaign to encourage waste reduction. Children who grow up with a responsible waste attitude are likely to maintain this attitude throughout their life. Projects aimed at children include:

"Kids and Agenda 21" – Launched in 2001 and finishing in 2002, this competition for primary schools encouraged children to think about climate protection and encouraged environmentally

conscious behaviour and social interaction. The project hoped to create a "ripple effect" and reach parents through the children.

"Garbage is not necessarily waste" -This community action, started in 2003, aimed to get people to re-examine what it is they are throwing away, and to sort their waste. As part of the action an educational waste guideline was produced, which all Freiburg schools are required to carry in their library. In 2004 the action expanded and recycling paper and environmentally friendly materials were added to schools. Parents, teachers and pupils were informed of the benefit of recycling through material supplied by city cleaning company ASF GmbH.

The city's change in waste management policy took place in 1991, with the passing of a comprehensive waste directive. The directive introduced a legally-mandated recycling concept (City of Freiburg, 2012). Among its provisions, the directive bans the use of throwing away crockery and beverage packaging. Incentives are given for the use of textile diapers, composting your own green waste and discounts are given for collective waste disposal pooling.

The 1991 directive has been hugely successful and between 1992 and 2007 the quantity of waste to be recycled rose from around 17,000 tonnes to around 60,000 tonnes. Waste for disposal also decreased significantly, dropping from 52,000 tonnes to 28,000 tonnes in the same time frame. On average the waste corresponds to 100kg of residual waste and 63kg of organic waste per citizen, suggesting the campaign of waste separation and recycling was well embraced by Freiburgers.

The city has also set up three dedicated free to use recycling centres, where citizens can get rid of excess waste material.

Ecological recovery of non-avoidable waste is an important component of Freiburg's overall waste management scheme, with the sorting and recovery of waste contributing to overall sustainability aims. Organic waste, glass, paper, packaging, metal and electronic scrap, wood and cork, etc. are collected and sent to be recovered.

Organic waste is collected separately by the municipality and is used to generate electricity within a combined heat and power plant (CHP). The electricity produced is fed into the regional power net. In 2008 8,450 MWh were produced (Wild et al., 2010).

One of the supreme advantages of modern waste facilities is that they make it possible to convert waste into an energy resource. Freiburg uses both waste incineration for energy, and gas from landfill sites.

The process of recovering landfill gas was started under the 1991 directive. In 2005, federal German legislation required all landfill sites for untreated waste to close. One of Freiburg's largest landfills, Landfill Eichelbuck, was closed under the legislation. The site had been active since 1972, receiving thousands of tonnes of waste yearly. Measures were instituted to minimise environmental hazard from the site, focusing on the recultivation and after-treatment of waste. Today the recovery of gas (primarily methane) from the site continues and the extracted gas is funnelled to a co-generation plant. Up to 90% of gas is recovered from the sites. This recovery not only provides a fuel source that would have otherwise been wasted, but also prevents harmful emissions from entering the atmosphere. Further actions will be taken to completely close the site, such as sealing of the surface and greening of the area.

Freiburg's household and industry waste that cannot be recycled is disposed of in a thermal treatment and energy generation plant (City of Freiburg, 2012). TREA Breisgau (Thermische Restabfallbehandlungs- und Energieverwertungsanlage/Thermal facility for disposal treatment and energy generation) was established with surrounding areas to provide ecologically friendly regional waste disposal. The plant employs advanced waste incineration technology and services around 1.3 million people, as well as businesses and industry. Through tender Freiburg has secured 29,000 – 52,000 tonnes for a fixed price until 2030 (Wild et al., 2010). Energy

produced through incineration is used to supplement district heating and the electricity grid. One of the negatives of Incineration plants is the generation of unwanted ash. This ash has been put to good use however, being used to cover regional landfill sites which are being closed.

From mid-2011 heat from the plant will be decoupled in favour of a biomass centre (Breyer et al. 2011). In this centre green waste will be used for incineration in heat and power stations.

The fermentation plant Biogasund Kompostbetrieb Freiburg (BKF) GmbH converts organic waste into compost and biogas, covering 1% of Freiburg's energy needs.

Freiburg's waste disposal services operate through a Public-Private-Partnership. The city created the now semi-privatised waste management and cleaning company Abfallwirtschaft and Stadtreinigung Freiburg GmbH (ASF). The local government took the decision to partly privatise the waste services in 2000. This decision was taken to reduce the financial burden on tax payers, whilst still maintaining political and strategic control. The City of Freiburg retains the full control over the calculation of waste fees and has ultimate responsibility for waste management.

In Freiburg citizens can choose the size of their waste disposal containers and the frequency of waste collection. This alters the fee that they are required to pay. Waste separation can also influence the fee paid. The system is designed to promote an attitude of waste reduction and sorting - those who produce less pay lower fees. Several households can also group together and share fees for containers (known as a "disposal society") (Wild et al., 2010). In Freiburg organic waste containers are emptied once and week and cleaned by the authorities twice a year, ensuring exceptional hygiene and service, which promotes broad acceptance.

In contrast to landfill dumping the cost to consumers has increased, however given the high technological and ecological level of the system, costs are competitive in comparison to other German cities. The annual cost of waste management in Freiburg is around €21 million (Wild et al., 2010).

Freiburg's waste management approach works so well partly because it acknowledges the needs and concerns of citizens. It combines best practice, technological advancement and financial common-sense to create a widely accepted waste management system focused on prevention and material / energy recovery.

Source: Wild & Hoppe (2010).

City Example: Milton Keynes, United Kingdom - Food Waste Collection Campaign and Biogas into National Grid

Figure 3.17: Food collection in Milton Keynes, United Kingdom. Source: Milton Keynes

Milton Keynes, one of the first local authorities in the United Kingdom (UK) to implement a waste recycling collection, has signed a contract with Renewable Power Systems to divert food and green waste from landfill and produce biogas to be fed into the national gas grid. The process of identifying appropriate options and running trials was a solid start to a new approach with multiple energy and environmental benefits.

In the UK in 2008, 6.7 million tonnes of food a year was thrown away. This represents a third of all food bought for consumption at home and is worth a total of £8 billion, or an average £400 for every household. By preventing this scale of food waste about 15 million tonnes of CO_2 emissions a year would be saved, the equivalent of taking one in five cars off the roads.

Milton Keynes, with its 100,000 households, having established an admirable dry recyclable collection system, has now turned its attention to the collection and treatment of food and green waste. Green waste (biodegradable waste i.e. that can decompose naturally and organically, such as grass cuttings, hedge trimmings) collections have been in operation since 2003. The Council decided that it needed to look at the recycling of food waste in order to divert waste from landfill and meet its LATS (Landfill Allowance Trading Scheme) targets.

Before implementing a food waste collection the Council ran a number of trials to learn what type of collection would be the most cost efficient and likely to bring in the biggest yield, best participation rate and also find out what type of collection would suit its residents. The Council ran two trials for several years; one where residents collected food and green waste combined and one where the two different waste streams were collected separately. After assessing the results of the trials and carrying our surveys with the residents it was clear that the preferred method of collection was combined food and green waste. This approach offered the best environmental benefits, it was also cheaper and saw a higher level of waste being diverted from the residual stream.

Andy Hudson, Head of Environment and Waste of the Council stated that ‘*’There are a number of benefits to collecting green and food waste together, one being the simplicity of the system.*’’ In 2009, Milton Keynes introduced food waste collections across the borough in two phases: In July 2009 it delivered kitchen caddies and green bins to around 50,000 homes and in September of the same year 40,000 further houses were provided with bins.

Awareness raising and developing the food waste collection

The Council was very keen for its residents to understand the reasoning behind the food waste scheme and how it works. Prior to implementing the weekly food waste scheme a number of activities were undertaken:

- The Council launched a campaign to educate residents about the new scheme and advise them of what could be collected in the food waste caddies.
- The scheme was not made compulsory because they did not want to make residents feel forced to save food waste in their caddies and green bins.
- Leaflets were printed in the local paper (a week before the start of the scheme) and were also distributed to all households showing what could be recycled and were sent out with the kitchen caddie.
- Waste officers also went door-to-door to explain the recycling system

Milton Keynes asked its residents to either put food straight into the caddy or line the caddy with newspaper, as shown in figure 3.18. It elected not to use or provide corn starch bags because of the confusion with plastic bags which could lead to greater contamination rates.

Results: high amount of food waste diverted from landfill and biogas production

The recycling officers reported a 90% participation rate for the scheme and there have been few problems with contamination. The Council's recycling rate for last financial year (2010) was 52%. This should reach 56 or 57% in 2011. The food and garden waste services make up 38% (of the 52%), so equates to a recycling rate of approximately 20%. Last year Milton Keynes composted 24,000 tonnes organic waste which was diverted from landfill.

Currently the organic waste is treated at the Envar in-vessel composting facility in St. Ives, Cambridgeshire with a very low contamination rate at 0.5%. The council is using the St Ives site as an interim measure as from the beginning of 2012, all organic material will be treated at the Renewable Power Systems, close to Milton Keynes. The Council signed a contract with Renewable Power Systems to develop a dry anaerobic digestion system (AD) with a capacity of approximately 40,000 tonnes to treat the organic matter. As it is a dry anaerobic digestion plant, there is no need to install all the tanks and pumps that you need for wet AD. This makes it more cost effective and quicker to build.

Money saved from diverting organic waste from landfill and avoiding landfill tax and LATS (Landfill Allowance Trading Scheme), will overall save the Council and a significant amount. The AD facility will upgrade the resulting output/product by the production of biogas which will be then fed to the National Gas Grid. The facility will also mean less transportation impacts. Overall, there will be a significant carbon and environmental benefit; injecting the gas is 70% more efficient than using Combined Heat and Power (CHP), which is the norm for AD plants. It will also provide a local outlet for other organic wastes especially those deriving from commercial properties like restaurants.

Following the steps initiated by Milton Keynes for awareness raising about setting up a food waste collection scheme can be straightforward (leaflets, door-to-door, newspaper advert, delivery of kitchen caddies with instructions on how to use the scheme).

It is important to monitor the impact – i.e. how consumers react to the introduction of a new scheme – householders reacted very positively in the appearance of a new organic collection system whereby the approach is linked to the reduction of greenhouse gas (GHG) emissions.

A strategic and transparent partnership between the local government and the respective private company that will receive the organic material can lead to significant environmental and economical benefits.

Source: ACR+ - The case study was developed in the framework of the IEE Project "LG Action" - www.lg-action.eu

Applicability

It is vital to know the volume of waste being produced in the municipality per capita before starting to design a waste management system. This information informs collections strategies, influences the quantity of collection areas and allows for the setting of realistic waste targets.

In order to create a sustainable waste management system based on structured hierarchical principles it is also important to take into account the specific attitudes and requirements of citizens in the municipality. Without citizen participation and acceptance, effective waste management becomes an exponentially more difficult task: reluctance on behalf of citizens to engage in activities such as waste sorting leads to diminished efficiency, hurting the chances of achieving long term goals. The habits of citizens should inform the number of recycling centres to build, and influence the location of these sites. Analysing waste behaviour can also influence decisions on the best methods to prevent illegal dumping activities (altering the size of private waste containers for example) and the best strategies to safeguard dumping sites from incorrect waste usage. An effective public relations unit is necessary to ensure that citizens are informed of the benefits of waste reduction and waste separation. Pilot testing new schemes allows authorities to correct any problems and identify potential barriers to the scheme. Through testing and reviews, waste management techniques can be better streamlined and be effective. In terms of encouraging waste sorting from citizens, instructions must be supplied by local

governments that are easy to understand, whilst the choice of selection containers and collection methods must be suited to the local context (ACR+, 2009). Finally, there should be provisions for the separate collections of organic waste.

The efficacy of treatment processes are linked with the efficacy of collection strategies. Recycling efficiency is highly dependent on the correct sorting of waste. The fraction of selected waste that cannot be recovered through recycling should be recovered in the form of energy through incineration activities. It should be however taken into account that, even in small part, incineration plants produce polluting emissions. In terms of GHG effect, the combustion process releases CO_2 but the energy produced enables savings of fossil fuels. The energy efficiency levels for incinerators are relatively low when they only produce electricity, but they increase when this is accompanied by heat recovery for thermal purposes (ACR+, 2009). It is also important to bear in mind that incineration has always to be linked with high recycling rates in order not to burn reusable or dangerous materials. Moreover, incineration plants need to burn waste at high temperatures under controlled conditions to prevent the release of harmful emissions. Therefore, authorities should consider the benefits and possible drawbacks of incineration before deciding on pursuing the option and, as stated above, use it complementarily with other practices. For example, biogas derived from organic waste offers an excellent source of energy. According to estimates, about one-third of the EU's 2020 target for renewable energy in transport could be met by using bio-gas produced from bio-waste (European Union, 2010).

Local authorities can influence behavioural change on their territory through communications campaigns and support for related measures. Measures such as charging only for the quantity of waste produced can foster a culture of waste prevention. Competent authorities should be given trainings on integrating waste prevention into their activities. Based on budgetary realities, local governments may also institute financial aid for low-waste technologies and products. A certification system for eco-designed products is also desirable. In terms of collection and treatment processes, a public private partnership may be economically beneficial, as in the case of Freiburg.

Recycling

"The selective collection strategy must be adapted to the local context, for example to geographical and urban development, factors like population density, amount of isolated houses, the frequency and size of gardens, the number and types of economic activities. Climate constraints are also to be taken into account, in southern countries it is often necessary to increase the frequency of residual waste collection in order to avoid problems with odours. Seasonal tourist waves also alter the quantity of waste produced. The selection process must be practical and user-friendly, with sorting instructions that are easy to understand and apply. Mixed collection is the result of a dual need for local authorities, to keep the sorting instructions for citizens simple, whilst limiting the number of bags. The trend is to increase door-to-door services and/or the number of local drop-off points. Selective collection must enable low contamination rates to be achieved, and materials collected must be easy to separate at the sorting installation. Thus, many towns have abandoned glass collection in combination with light packaging; due to the difficulty of separating broken glass fractions from the other materials for recycling. The main alternatives consist of investing either in selective collection, or in downstream sorting installations. A reduction in the types of waste collected in the same bag enables recycling costs to be reduced. Therefore, there is an economic balance to be achieved between sorting at source and sorting in plants. The resale value of the materials sorted plays an important role in this balance: thus, separate collection of white and coloured glass is being developed in Europe due to the added value that it provides when reselling the materials" (ACR+, 2009). Within the European Union, selective collections are carried out either door to door, or delivered by householders to neighbourhood drop-off points. The main waste flows are:

- Dry fractions:
    - Glass
    - Paper (a mix of packaging and newspapers, magazines and similar)
    - Light packaging including:

    - Plastics: usually containers of a significant size, such as bottles,
    - Metals: steel and aluminum,
    - Beverage cartons
- Organic fractions, mainly kitchen and garden waste
- Other waste fractions collected mainly via voluntary deposits or on demand, such as construction bulky waste, wood, metals, etc (ACR+, 2009).

Effective collection schemes have to be designed in order to fit the specific local and cultural circumstances. Generally speaking collection schemes based on door-to-door curbside collection are more effective in ensuring higher collection rates than collection schemes based on bring facilities, such as street-containers. Collection through retailers can also be very effective, especially for those waste items that occur irregularly in a normal household, which are too small, or too hazardous to design a separate collection for, such as medicines, batteries, energy-saving lamps and small electrical appliances.
There are several factors to be taken into account when setting up a collection and recovery scheme:

- Reasonable targets for collection and recovery (according to European legislation);
- Existence of recycling plants and capacities;
- Short transport distances (as highlighted in the paragraph: “Wast Logistics Optimisation);
- The establishment of a market for secondary raw materials;
- Participation of consumers, enforced through continuous communication (Koller, 2011).

<u>Communication</u>
An important part of a collection scheme is communication. Not only the technical communication is important, but it is also crucial to give citizens highlights about why it is important to separate waste. Raising awareness and commitment is essential in a successful recycling scheme. Therefore it is also important to have continuous communication with city dwellers about recycling (ISWA, 2011).
An example of that is represented by the Local Authority Prevention Demonstration Programme (LAPD) in Ireland. This programme aims to support sustainable consumption and production in Ireland. It provides funding for local authorities developing waste reduction communication projects aimed at achieving households, SME or the public sector. LAPD initiates and supports local authorities, SMEs and NGOs leading local prevention projects, provides specific funding for comprehensive prevention programmes undertaken by local authorities, which include dedicated staff and involve local stakeholders, offers expert technical assistance and publicises successful results of local prevention programmes (Pre-waste, 2010).
Communication to pupils is also very important, also in order for them to share the message with their parents and teachers and reach in that way different target audiences. In Brussels, Belgium, a project called “Accompanied Waste Prevention Projects in School” was implemented, aiming at changing the behaviour of pupils and the school as a whole to consume less paper and thus reduce paper waste generation. Teachers/Schools who wish to engage a class or the entire school in actions in favour of environmental protection can obtain assistance on paper consumption reduction, drinking container waste reduction, food wastage reduction and general waste prevention. Schools can either chose short-term assistance, encompassing access to free teaching materials (electronic or paper) and free training sessions for teachers (on specific topics or general environmental education) or they can commit over an entire school year. This commitment foresees either the involvement in TURN-KEY projects or in SCHOOL CHALLENGES.The TURN-KEY projects involve 3 to 4 animations by specialised education workers that are given in two classes per school over the course of the school year. These classes act as information relays for the rest of the school. Teaching and communication materials are provided to the teachers to carry out projects with the class throughout the year. In addition the education worker meets once with the school team (management, teachers…) to disseminate information on the project and gain their involvement. The SCHOOL

CHALLENGE combines two approaches: on the one hand, children are involved hands-on in the project (bottom up approach) and the management and staff commit and carry out a paper audit of the school (top down approach). The same animations and tools as in the TURN-KEY projects are used. On top of that, an Ecoteam with representatives from management, staff (secretariat, cleaning, maintenance, local authorities…) and pupils meets several times with the specialised education worker. By participating in this extended form, the overall commitment and time investment by the school is higher. The management can, for instance, adapt the school regulation or the way supplies are purchased and used (Pre-waste, 2010).

Materials recycling techniques

The flows from household waste which can easily pass through a materials recycling process are as follows:

- Paper and cardboard: these are subject to specific collection, either door to door, or delivered by householders to a local collection point. Part of this flow may consist of cardboard from collected packaging. Separating the different paper and cardboard fractions is usually carried out at sorting centres combining mechanized equipment (cardboard separating machine, paper spike, baling press) and manual sorting belts. The bales from sorting centres can be sold directly to paper mills, which pulp the wastepaper, mix it with virgin pulp paper, or use it as part of 100% recycled paper production.
- Glass: glass bottles and jars, collected most of the time from neighbourhood glass recycling bins, sometimes from door-to-door systems. Glass waste is treated in specific facilities which carry out an acceptance procedure for glass that has already been collected separately according to colour (green, brown and white) most of the time. These facilities remove undesired materials (corks, caps, labels, and miscellaneous waste), they perform optical sorting to remove infusible materials (sandstone, ceramics) and glass of other colours, and finally grinding. The fractions that are obtained are then shipped directly to the various glassmarkers who make them into new bottles and jars.
- Plastics: Bottles and smaller containers, which also form part of packaging collection. Household packaging plastics mainly consist of PET (bottles that are green, blue or clear) and HDPE (detergents, shampoo). They are often mixed during collection with metal cans and drink cartons, which must then be separated at the sorting centre. They are often mixed during collection with metal cans and drink cartons, which must then be separated at the sorting centre. The flows of pure plastics are then sorted by a recycler, who will carry out the following operations: grinding, washing, drying and extrusion the purpose of which will to be to melt the plastic and recondition it al granules (HDPE and PET) or fibres (PET). The granules are used as raw materials for manufacturing miscellaneous plastic products, while fibres are used for making pullovers or polar fleece jackets, or as insulation for anoraks and sleeping bags.
- Metals: particularly food cans and drink cans made of steel or aluminium, forming part of packaging collection. The steel and aluminium included in packaging collection can be easily extracted at sorting centres using magnets and eddy current separators. Generally speaking, these metals are then sold to scrap metal merchants. Aluminium does not require any other treatment before being re-melted at plants that produce new aluminium items. On the other side, collected steel cans must undergo a treatment to remove the tin present on the surface of the cans. This operation is carried out in dedicated facilities. The steel can then be used in the steel industry (ACR+, 2009).

Rennes Métropoles, France: Collective composting for apartment buildings

This project, which started in 2006 and is still ongoing, rolled out in 150 location for a total amount of 1700 households, corresponding to 20% of participation concentrated on biowaste, and precisely on food and gardening waste. The action was initiated by Rennes Metropoles and CIELE (an NGO promoting environment and energy saving)
In 2005 Rennes Metropoles launched a program aiming at reducing residual waste production from 240 kg/ing/yr in 2005 to 200 kg/inh/yr in 2011. A first operation on home composting in residential area was set up, yet to extend it to all the population a composting unit for a multi-storey dwelling was set up in January 2006, following the request of an inhabitant. Every voluntary household has been asked to bring its bio-waste to the composting unit thanks to a 'bio-bucket" provided by the local authority. One "composting ambassador" living in the building was chosen and trained so that he could monitor the composting process. Every household or joint ownership interested could contact Rennes Metropoles, which took then care of putting them in touch with the responsible NGO. A feasibility study was then set up and, if validated, the project was presented to a joint ownership. If finally approved, some volunteers were identified to take care of the monitoring. The NGO helps them during the initial 6 months before letting them autonomously.
About 500 € per composting unit were spent, providing participants with one composting unit (600 liter) and 2 maturation units (300 liter)

As a result, Rennes Metropoles has around 100 kg/household/year less waste to be treated, saving about 5000 €/yr on waste treatment. The investment is expected to return in 3 years.

This project will also help social bonding between inhabitants.
The main difficulties encountered in this process were to find space for the composting units, to obtain all the necessary authorizations from all the different actors, to keep participants motivated in the long run and to ensure a good quality compost.
Source: pre-waste, 2010

City Example: Waste gives Energy in Kristianstad, Sweden

Kristianstad is the capital of the Swedish province Skåne and the nucleus of the north east Skåne. About 75,000 people live in the municipal area. The Kristianstad Region has some of the best agricultural land in Europe. Good farming conditions, a high level of mechanisation, a good environment and specialised investment in research and development have made Kristianstad into one of the major food centres of Sweden.
The large agricultural sector generates considerable amounts of manure and the food industry produces lots of organic waste. In Kristianstad digestion of organic matter into biogas has become the most important way to reduce the negative environmental impacts of waste and instead use it as an energy resource. Recycling is also an important part of waste management in Kristianstad and material that neither can be recycled nor digested is to a large extent incinerated with energy extraction. Waste management is closely related to energy and climate issues since waste can both generate greenhouse gas emissions and reduce them when used as a bio fuel.

<u>Biogas</u>
Biogas is produced at three different locations in Kristianstad:
• The Landfill
• The Waste Water Treatment plant
• The Biogas plant in Karpalund

Figure 3.19 shows how much biogas that has been produced in the different places over time.

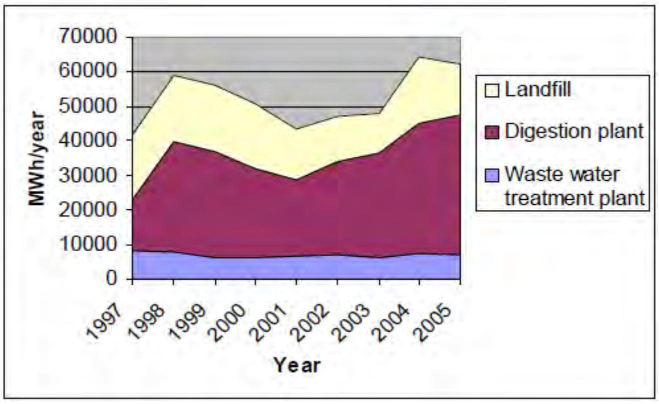


Figure 3.18: Biogas produced in different areas over time.
Source: Municipality of Kristianstad

Landfills are the second greatest methane source in Sweden after agriculture. Collecting the gas and use it for energy production is therefore very important. The gas from the landfill in Kristianstad (about 20,000 MWh) is used for incineration in the district heating plant, together with a part of the biogas from the plant in Karpalund. The collection of biogas from the landfill prevents huge amounts of methane to enter the atmosphere and instead it can be used as a bio fuel and thereby reduce the use of oil by approx. 1,700 m3 per year. The prevention of methane loss is equivalent to 63,800 tonnes of carbon dioxide (in a perspective of 20 years) and the substitution of oil with biogas means that an additional 4,760 tonnes of carbon dioxide are saved.

Methane is also created when waste water is treated. The biogas from the waste water treatment plant is used partly for internal heating production (3,500 MWh) and partly (3,500 MWh) as vehicle fuel. Before 1997 the gas was not used and had to be burnt to avoid methane leakage. Now when the gas is used it replaces approx. 700 m3 of oil or gasoline per year and contributes to a reduction of CO2 emissions of 1890 tonnes.

In 1997 the local Municipal Waste Management Company (Kristanstads Renhållnings AB,KRAB) established the biogas plant in Karpalund, primarily as a treatment plant for waste from the food industry in Kristianstad. The Karpalund plant is the first in Sweden to co-digest municipal solid waste from households (sorted into paper bags) and food industry together with manure for production of useful energy and fertilizer. The project is a result of co-operation between the municipality, farmers, industry and consumers. The production at Karpalund is 40.000 MWh on a yearly basis, which means that approx. 4,000 m3 oil or gasoline can be replaced and 11,000 tonnes of carbon dioxide can be saved. Of the biogas produced in Karpalund and in the waste water treatment plant approximately 11,000 MWh is used as vehicle fuel. The remainder is used as a biofuel in the combined heat and power plant, Allöverket.

Digestion is defined as the biological decomposition of organic matter of biological origin under anaerobic conditions with an accompanying production primarily of methane (CH4) and carbon dioxide (CO2). In biogas the methane content is approximately 65 % to 70 % by volume. Before you can use it as fuel for vehicles you must eliminate most of the carbon dioxide by upgrading. Through absorption with water under pressure (approx. 10 bar), the carbon dioxide will decrease and the methane will increase to a purity of approximately 97 % by volume. The upgrading plant has a capacity of approx. 15,000 MWh/year. In the year 2006 the capacity for upgrading is going to be increased to approx. 50,000 MWh. One of the aims of the biogas project is to increase the use of biogas in the transport sector, since the gas can be replaced by other biofuels in the district heating plant but biofuels are rare in transportations. 75 % of the produced biogas is presently used in the central district heating plant and 25 % is used as fuel for busses and other vehicles. The Public transport Company, Skånetrafiken, has introduced biogas in the city transportation. 22 buses are presently in operation and since 2004 the municipality also has 3 school buses. The municipality has established a car pool with biogas cars and some private companies and households use biogas vehicles. The total number of vehicles running on biogas in Kristianstad is about 220 in May 2006. The municipality is marketing biogas as fuel on the local market. This project aims to increase the number of vehicles fuelled by biogas. This is a joint venture with the private company E.ON as well as

local car dealers.

Recycling

Reuse of material is a crucial part of waste management since both energy and resources are saved. Kristianstad municipality established a large recycling facility in 2001, partly financed by state allowances. In this recycling facility waste is sorted and then redistributed to the most suitable treatment. This procedure has reduced the amount of waste going to landfill by approx. 40,000 tonnes per year. Instead, packaging is being recycled, waste from parks and gardens is being composted and combustible waste goes to incineration etc.

Incineration

Material that is combustible but cannot be treated in the digestion plant or recycled goes to incineration. The process gives energy, but also some carbon dioxide emissions. Since the establishment of the recycling facility in Kristianstad the amount of waste going to incineration has increased by approx. 16,000 tonnes, while material going to landfill has decreased. Kristianstad municipality sends combustible waste to two other municipalities that have heat and power plants for waste and the energy can be used for district heating in those municipalities.

Awards

Kristianstad has been awarded several times during the past years:

• 2001 Campaign for Take Off Award
• 2002 Climate Star
• 2003 Energy Globe Award, 3rd prize
• 2004: Best work for environmental friendly cars (The Swedish association of Green Motorists)
• 2005: Best Climate Work in Swedish Municipalities (The Swedish Association for Nature Conservation)

Source: Municipality of Kristianstad. http://www.kristianstad.se/

Driving force for implementation

A correct waste management is enforced by European Legislation. Furthermore, waste management provides Europe with a whole new resource to exploit. To this end, recycling represents a great economic opportunity. According to EU figures, solid-waste management and recycling industries currently have a turnover of around €137 billion, which is just over 1.1% of the EU's Gross Domestic Product.

The employment potential from waste management – specifically recycling – far surpasses other forms of waste management. If 70% of waste were recycled, it is estimated that an extra 500,000 jobs would be created. Currently waste management amounts to 1.2 to 1.5 million jobs in the EU. Recycling 100,000 tonnes of waste can create up to 250 jobs, as opposed to 10 jobs if disposed of as landfill (ACR+, 2009).

Economics

The main way to pay for an effective waste management system is through taxes and fees. This can be achieved through the general taxation regime, through a specific waste tax, through a variable fee related to waste production or through a set fee. Variable fees can be difficult to implement however, and can have the negative effect of increasing illegal dumping and waste tourism (in which waste is transported to locations in which it is cheaper to dispose of). This can be addressed through transparency of the system, a gradual adaptation of prices and reinforcing checks and implementation of a penalties system. It is important that fees, taxes and charges further legal and political objectives.

It is also estimated that the materials sent to landfill could have an annual commercial value of around €5.25 billion (European Union, 2010).

Engaging in waste prevention activities reduces the amount of waste for collection, resulting in a budget reduction for the effective collection and management of waste. "Pay-as-you-throw" systems (see dedicated paragraph above) are highly effective at getting citizens to reduce waste at source.

The introduction of financial stimuli on a household level usually leads to significant reductions in the amount of residual waste and an increase in the amount of recovered materials.
When conducting a cost-benefit analysis, various factors have to be taken into account, as shown in table 3.6. By considering costs strictly connected to waste management one obtains a waste management net cost analysis, while by including collateral avoided costs and externalities, such as saved costs for the production of primary materials and emissions avoidance, a complete overview of costs and opportunities linked to a correct waste management can be reached.

There are different financing options and approaches of waste management:

- Tax system:
  - For any waste type
  - For special purposes (e.g. landfill tax for contaminated site remediation);
- Fee system
  - In general (e.g. municipality sets certain fee and charges residents for residual waste per household, per square metre living space);
  - For specific purposes (e.g. integrated disposal fee for refrigerators, fluorescent tubes);
- Deposit system
  - For certain waste types (e.g. glass bottles, plastic bottles);
- Full cost system (all services covered)
  - For certain waste types (e.g. Producer responsibility driven systems for packaging, electric/electronic waste);

- Additional Cost system
  - For certain waste types (stakeholders share costs involved for packaging waste) (Source: Koller, 2011).

Table 3.6: **Factors in a Waste Management Cost-Benefit Analysis**

Cost-benefit analysis consists of various factors:
–Costs of separate collection and sorting
–Costs of mechanical recycling and energy recovery
+Revenues from secondary raw materials
+Saved costs for residual waste collection
+Saved net costs for residual waste treatment and landfill
=Result of the waste management net cost analysis
+Saved costs for production of primary materials
+Saved costs for emissions avoidance (CO_2, CH_4) and landfill rehabilitation (external effect)
=Result of cost-benefit analysis (cost-benefit-balance)

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3.2.5 Strategic Noise planning

Description

Excessive noise harms our environment, lowers our quality of life and is injurious to our health. It interferes with business activities as well as leisure time and disrupts sleeping patterns. Prolonged exposure can alter social behaviour, provoking annoyance and irritability.

According to the European Environment Agency, noise (defined as all unwanted sound that is loud, unpleasant or unexpected) above 60 Ldn dB(A)[18] constitutes noise pollution. Around 20% of the population of Western Europe (approximately 80 million people) suffers from noise levels that experts deem unacceptable ("Action against noise: Green Paper", 2006).

In previous years noise was considered merely an unfortunate by-product of technological advance and so was accorded a lower priority than other environmental concerns such as air or water protection. However, as the adverse health effects of excessive noise exposure were better quantified, the European Union began to place greater focus on the area, passing EU-wide measures.

[18] Ldn is an indicator based on an average annual 24 hour period, calculated from the average A-weighted sound pressure levels throughout the day (A –weighting is an adjustment that takes account of the way human ears hear different frequencies). The measurement encompasses three separate periods, day, evening and night, and reflects the differing sensitivity to noise during these periods. 5db is added to evening measurements and 10db is added to night measurements.

The EU Action Against Noise green paper from 1996 was the first time in which noise was specifically dealt with as an environmental issue. The paper called for increased coherency and research into noise exposure and sets out a path for reducing emissions at source. The paper is separated by section. Its core tasks are ("Action against noise: Green Paper", 2006):

Road traffic:

- Reducing noise emission limit values
- Taking action on roads to reduce tyre noise (quieter road surfaces)
- Revising vehicle tax arrangements to take account of noise levels
- Introducing noise testing as part of vehicle roadworthiness tests
- Developing economic instruments such as incentives for purchasing quiet vehicles
- Limiting the use of noisy vehicles (banning HGVs from towns at night or during weekends)

Rail traffic:

- Extending emission limits to cover the whole of the railway network
- Carrying out further research on reducing train noise
- Harmonising methods for assessing and predicting train noise

Aircraft:

- Setting stricter emission limits
- Aid for building and using quieter aircraft
- Protecting the areas around airports
- Introducing a system for classifying aircraft according to their sound emission level

Outdoor machinery:

- The noise from certain types of machine used in public works (in particular compressors, pneumatic drills and tower cranes) is already covered by Community directives, as is the noise from lawn mowers.
- Directive 89/392/EEC, in respect of the health and safety requirement relating to machinery, lays down that machines must be designed and constructed so as to reduce noise as far as possible.

The EU Environmental Noise directive 2002 aims to harmonise noise management in Europe. It aims to "avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise". It requires competent authorities to take three steps in tackling noise (EPA, 2009):

- Undertake strategic noise mapping to determine exposure to environmental noise;
- Ensure information on environmental noise and its effects is made available to the public;
- Adopt action plans, based upon the noise-mapping results, with a view to preventing and reducing environmental noise where necessary and particularly where exposure levels can induce harmful effects on human health and to preserving environmental noise quality where it is good.

The first step for authorities is to draw up "strategic noise maps" for major roads, railways, airports and agglomerations, using harmonised noise indicators to monitor noise pollution. These maps chart in detail noise levels at different locales throughout the urban area, and are used to pinpoint areas in which noise reduction activities are necessary. Noise maps show the noise on an average day in an average year. Environmental Protection UK summarises the purpose of strategic noise maps as ("Reducing Transport Noise", 2012):

- To enable the assessment of the exposure of population to noise – by linking population data to the noise levels on the maps;
- To assist in the identification of areas that have good environmental noise quality ('quiet areas');
- To inform the development of action plans to manage the exposure of populations to noise; including reduction if necessary, and, in urban areas, prevent locations of existing quiet from becoming noisy;
- To raise public awareness and engage everyone affected in the development of noise action plans.

The main indicator used to describe the noise levels on the maps is Lden, expressed in A-weighted decibels - dB(A) (“Assessing Exposure – Strategic Noise Mapping”, 2012).
The directive also requires authorities to inform the public about the effects of noise pollution through an effective communications campaign. This is the second step.
The final step of the directive requires authorities to create noise action plans to reduce local noise levels and maintain environmental noise quality where it is good, based on the results of the noise map. Noise action plans create a blueprint for the management of environmental noise and its effects. Figure 3.20 from the SILENCE project outlines the steps involved in creating an effective noise plan:

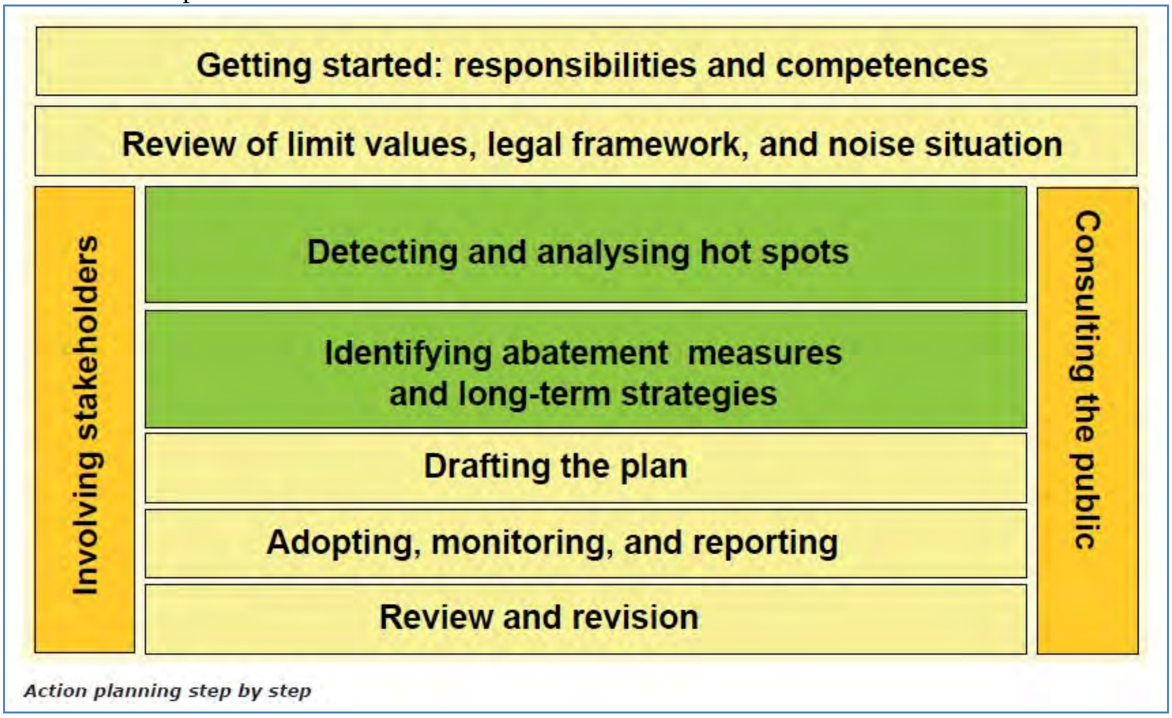

Figure 3.19: Noise planning, step by step. Source: Silence, Practitioner Handbook for Local Noise Action Plans, n.d.

Effective techniques within noise plans include (Kloth et al., n.d.):

- Noise screens and tunnels
- Low road noise surfaces
- Building insulation
- Low-noise trams
- Renewal of public transport fleet
- Low-noise waste collection vehicles
- Redesign of street space
- Reducing traffic volume
- Bans on trucks

Achieved environmental benefits

The World Health Organisation (WHO) has concluded that exposure to noise pollution can be both directly and indirectly harmful to health. Evidence on the relationship between environmental noise and specific health effects suggests that noise pollution can lead to cardiovascular disease, cognitive impairment, sleep disturbance and tinnitus (World Health Organisation [WHO], 2011). The WHO further states that traffic noise alone is harming the health of almost every third person in Europe, and that one in five Europeans is regularly exposed to sound levels at night that could significantly damage health.

A report published in 2011 by the WHO outlines the health problems posed by transportation noise alone:

The evidence from epidemiological studies on the association between exposure to road traffic and aircraft noise and hypertension and ischaemic heart disease has increased during recent years. Road traffic noise has been shown to increase the risk of ischaemic heart disease, including myocardial infarction. Both road traffic noise and aircraft noise increase the risk of high blood pressure (WHO, 2011).

Studies on the effects of chronic exposure to aircraft noise on children conducted by the WHO have found:

- Consistent evidence that noise exposure harms cognitive performance
- Consistent association with impaired well-being and motivation to a slightly more limited extent
- Moderate evidence of effects on blood pressure and catecholamine hormone secretion

Biodiversity is also affected by noise pollution and is altering the way animals communicate, mate and prey on one another. Animals that evolved with hearing sensitive enough for the quietest conditions are now having their usual habitats disrupted by man made noise. Animals such as bats are refusing to hunt in noisy areas, whilst frogs and bird species are unable to communicate for reproductive means due to noise (WHO, 2012).

Appropriate environmental indicator

Table 3.7 Appropriate environmental indicator - Noise

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Complaints about noise pollution	Number		Complaints about noise pollution received by the local administration in a year.
Noise levels exceeding local limit values	Number	n. measurement of noise exceedings/ n. total measurements	Measurement of noise levels exceeding the limit values set by the local acoustic mapping.
People exposed to noise levels exceeding local limit values	Number	people exposed to noise exceedings /total population	People exposed to noise levels exceeding local limit values set by the local acoustic mapping.

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
People exposed to daily noise levels	Number	people exposed to noise during day, evening and night/ total population	Number and percentage of people exposed to noise levels measured outdoors during day, evening and night (Lden). From the broad overview of the limit values in a large number of Countries, and from the scientific evidence, there seems to be a consensus that Lden around 50-55 dB (or the equivalent level in other units) would represent a good noise quality in an urban area. Data can be disaggregated by traffic source: road, rail, industry, air.
People exposed to night noise levels affecting health	Number	people exposed to noise during the night/ total population	Number and percentage of people exposed to noise levels measured outdoors during the night (Lnight): > 40 dB(A) - health-based limit value (set by WHO) which is necessary to protect the most vulnerable groups such as children, the chronically ill and the elderly. > 55 dB (A) - interim target recommended in for exceptional local situations where the achievement of 40 dB (A) is not feasible in the short run. Data can be disaggregated by traffic source: road, rail, industry, air.

Benchmark of excellence

Within the framework of Directive 2002/49/EC (1), exposure data have been provided by agglomerations with more than 250 000 inhabitants, as reported by the Noise Observation and Information Service for Europe (NOISE) of the European Environment Agency (EEA). While not all Member States have reported yet, and some differences between Member States may be attributed to methodological differences rather than differences in exposure, these data provide an indication of the exposure distribution within large urban areas in the EU. According to this database, German Cities show, in general, the best performances. As regards noise levels from roads, most of German urban agglomerations have only 20%-30% of citizens exposed to noise levels, measured during day, evening and night (Lden), higher than 55 dB(A). In particular, less than 20% of the citizens of Augsburg (17%), Berlin (19%) and Stuttgart (18%) are exposed to noise levels from roads (Lden) higher than 55 dB(A). People exposed to noise levels from roads measured during night (Lnight) higher than 50 dB(A) are 11% in Augsburg and Stuttgart and 15% in Berlin. People exposed to noise levels from roads higher than the outdoor night value of 55 dB(A) World Health Organization are 5% in Augsburg and Stuttgart and 10% in Berlin. As regards noise from railways (including tram and underground), on the other hand, Berlin perform better than Augsburg and Stuttgart: only 7% of people are exposed to Lden > 55 dB(A) and 5% are exposed to Lnight > 50 dB(A).

Operational data

The city of Stockholm utilises the noise map created under the European noise directive to identify buildings most affected by noise pollution, and calculate the number of residents affected and the cost of protective actions. This also takes into account the number of windows and maximum noise level for each building. Over 10,000 buildings have been identified as sites for noise reduction measures.

In addition, Stockholm is erecting noise barriers (around 50km have been built), improving building window insulation along road ways, putting restrictions in place on heavy goods traffic on city streets at night, reducing the speed limit from 50km/h to 30km/h, creating environmental zones and placing a ban on vehicles older than eight years from travelling in the city centre.

Noise issues are taken into account when designing and locating houses and in traffic planning. As part of the "Traffic noise and planning" project, the City of Stockholm cooperated with other actors to develop guidelines regarding the design of buildings that achieve a good acoustic environment. The city is also testing and developing quiet road surfaces. The city has set up two permanent noise monitoring stations that measure noise levels 24 hours a day.
The EU-project Quiet City Transport (QCity), of which Stockholm is a member, aims to develop an integrated approach to noise mitigation at both technology/infrastructure levels. QCity provides municipalities with tools to establish the EU mandated noise maps and action plans, and provides them with a broad range of technical solutions for specific problem areas they encounter. Other member cities include Antwerp, Athens, Brussels, Caen, Gothenburg, Augsburg, Ostend and Stuttgart.

In Leeds, United Kingdom, the city has implemented traffic calming measures to combat both noise and air pollution. According to the city:

[The scheme tips] the balance in favour of the residential function of the street and [reduces] the domination of motor vehicles. Speed humps, chicanes, road narrowing, planting and other measures were introduced to both physically and visually reinforce the message that the motorist is only a guest in the area and that the residential function takes priority.

One problem the scheme has faced is that slowing cars require a great deal of deceleration followed by acceleration, which can add to noise levels. The scheme is therefore hoping to incorporate measures that allow for the constant use of 3rd gear. According to the report, where speeds have been reduced from 50km/h to 30km/h, typical reductions in noise levels have been between 4-5 dBA. (Harvey, n.d.) It was also shown that granite roadways result in noise levels between 3-5 dBA higher than smooth asphalt, even if restricted to a small area of carriageway.

City example: Noise reduction in Oslo, Norway

Over the last number of years the city of Oslo has introduced substantive measures to reduce noise pollution, particularly in the field of transportation. The city is committed to noise reduction and has set the goal to reduce the noise impact by 10% by 2020 compared to 1999.

One of the major sources of noise in Oslo is road traffic. Road traffic is an increasing problem for the city, which intensifies during the winter months. About 1.3 million people are exposed to road traffic noise levels exceeding 55 dBA outside their homes in Norway ("Road traffic noise", 2008). Statistics show that the number of noise afflicted persons in Oslo is increasing. In 1999 it was estimated that 68,100 people suffered from excess noise, while in 2007 the number increased to 79,000. Figure 3.21 shows the share of Oslo dwellers who are exposed to noise values above 55dB (A) during the day and above 45 dB (A) during the night.

1. Share of population exposed to noise values of L (day) above 55 dB (A)

Of the 538 411 inhabitants in Oslo:

Lden	Number of people exposed and percentage of total population
55 - 59	136020 = 25.3 %
60 - 64	95780 = 17.8 %
65 - 69	64200 = 11.9 %
70 - 74	44240 = 8.2 %
> 75	3240 = 0.6 %

2. Share of population exposed to noise values of L (night) above 45 dB (A)

Of the 538 411 inhabitants in Oslo:

Ln	Number of people exposed and percentage of total population
50 - 54	109780 = 20.4 %
55 - 59	76690 = 14.2 %
60 - 64	55410 = 10.3 %
65 - 69	11930 = 2.2 %
70 - 74	370 = 0.06 %
> 75	0

Figure 3.20: Share of population exposed to excess noise values in Oslo, Norway, day and night
Source: Oslo Kommune, 2008

To combat this the city has introduced a number of measures aimed at private vehicles. The city has lower speed limits and introduced a charge for studded tyres (studded tyres can cause greater wear and tear on roads, which increases noise emissions). Road surfaces are renewed regularly by the city, as newer road surfaces produce less noise. The "**Project Environmental friendly pavements",** which ran from 2004-2008, conducted research on optimising the environmental properties of road surfaces in order to reduce the environmental impact on surroundings, including noise pollution ("Road traffic noise", 2008). Trial areas for quiet road strips have also been established. In a further effort to reduce transport noise, the city is building tunnels for road traffic, mitigating noise pollution in the surrounding areas. Figure 3.22 depicts a noise map of the city for road and rail traffic.

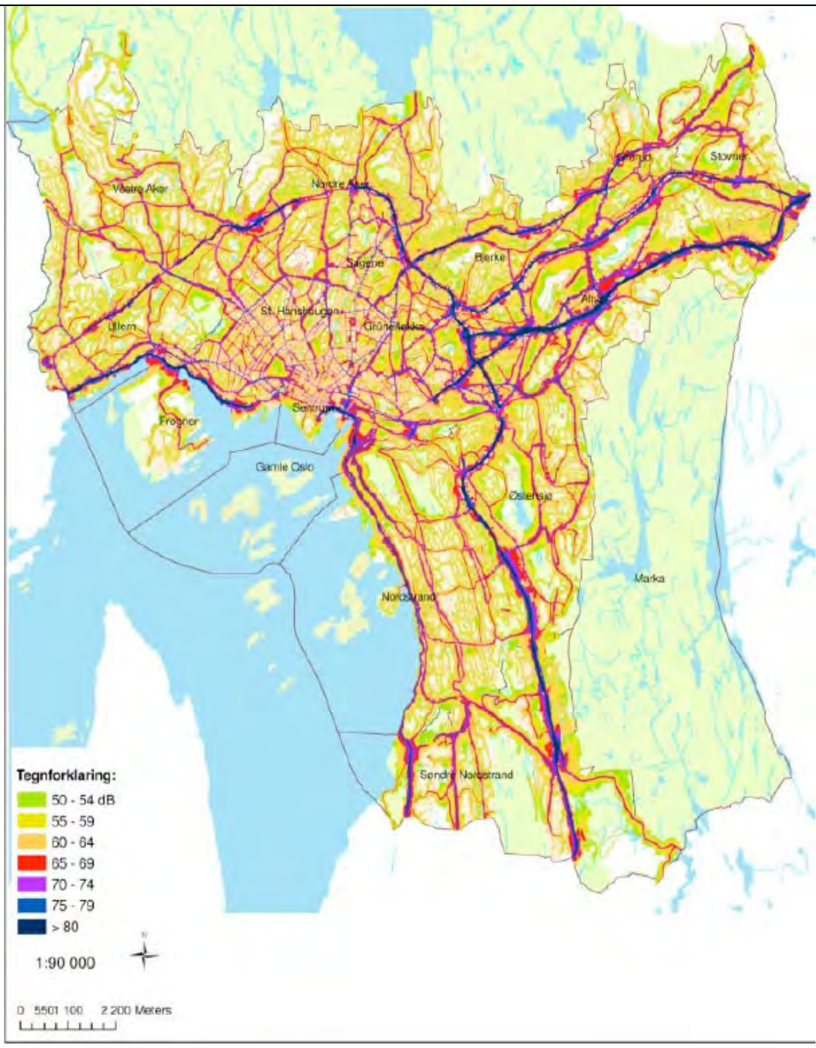

Figure 3.21: Noise map for road and rail traffic in Oslo, 2006. Source: Oslo Kommune

Projects to increase public transport levels have also been undertaken, such as the “Mobility Oslo” project. The project works with public and private sector actors to encourage alternative modes of transport to the car. A particular focus is put on encouraging school children to cycle or walk to school. Similarly, the Sam Fram project aims to improve public transport in the city, enhancing its reliability, user-friendliness and attractiveness. New cycle lanes are being installed throughout the city, and footpaths are being renewed and enhanced in order to encourage people to switch to soft modes of transport. The frequency of tram and bus departures is being improved and the metro system is being extended and upgraded.

As well as improving public transport and encouraging behavioural change, the city is also implementing direct noise reduction measures, such as noise screens along roadways. Subsidies are granted from the city to citizens for the purposes of insulating and soundproofing their property.

Rail and transportation also represents a major source of noise for the city. The city employs a holistic approach to reducing rail traffic noise, focusing on direct measures such as erecting noise screens to limit noise exposure along the tracks, and measures to combat the noise at source, such as increased maintenance of tracks and stations to reduce squealing and rolling noises. Authorities identify problem areas and carry out track grinding and lubrication. The city is also replacing older trains with newer, quieter trains. The tracks themselves are being upgraded, as are foundations in order to reduce vibrations.

By the nature of activities conducted within them, ports generate high noise levels. To address this, the Port of Oslo participates in the Noise Management in European Ports (NoMEPorts)

project. The main objective of NoMEPorts is the reduction of noise, noise-related annoyance and health problems of people living around port industrial areas through a noise mapping and management system (Port of Oslo, n.d.). The handling of goods containers (and the equipment used in handling) can lead to noise emissions far exceeding EU regulation levels. To address this the city has provided engine insulation, and has started a process to procure vehicles with more silent engines. Silent-working cranes have replaced traditional forklifts.

Increased care has been placed on the handling of empty containers, which can generate large amounts of noise when moved. Empty containers have also been stacked in walls close to built up areas and used as sound barriers. To reduce excess vibrations, the port terminal area has been completely asphalted. Vegetation zones and noise screens have also been established in the terminal area.

Additional measures carried out by the port authorities are summarised as (Port of Oslo, n.d):

- Development of a programme simulating noise effects
- Replacement of forklifts and reach-stackers with gantry cranes with rubber tyres
- Substitution of diesel engines with electric power
- Reduction of noise from warning bells
- Insulation of our machinery room
- Installation of rubber bricks on trailer trucks preventing sharp noise
- The terminal ground has been asphalted in order to level the surface.
- Establishment of a noise deflection wall

Although these measures have contributed to noise reduction, port neighbours are still subjected to noise levels above EU limits. The port authorities are committed to improving this situation and are constantly revising and improving their noise reduction measures. One such measure is the increased centralization of port activities, making it easier to contain and reduce noise. Electricity is to be provided for docked ships at Oslo port, in order to prevent emissions and prevent noise pollution from ship engines.

After reviewing the noise-map, the city has identified areas suitable for designation as so-called quiet areas. A quiet area is defined by the city as: “Areas which offer recreation, outdoor experiences and/or cultural activities in surroundings sheltered from or distant from dominant noise sources”. These areas preferably have noise levels below 50dB and are protected through traffic management, noise screening and regulation of industrial activities.

Source: Oslo Kommune (2008, December 5)

One of the newest and most innovative measures to address noise pollution is the practice of “soundscaping”. Soundscaping is a concept in which architecture is constructed not just on aesthetic and functional principles, but also taking into account acoustic qualities. Soundscaping, in short, is the acoustic design of outdoor space.

Soundscaping is not necessarily about achieving silence, it is about achieving sounds that are congruent with the landscape, giving greater preference to the sounds people prefer. Soundscaping allows authorities to reimagine the sounds of a modern city, making sound a considered resource.

The difference between the approach of traditional noise abatement and soundscaping is summarized in figure 3.23:

Table 1. *Comparison of Noise Control and Soundscape Approaches.*

Noise Control Approach	Soundscape Approach
– Sound as waste	– Sound as resource
– Concerns sound of discomfort	– Concerns sounds of preference
– Human response related to level of sound	– Preference often unrelated to level—quiet not the objective
– Measures by integrating across all sound sources	– Requires differentiation between sound sources: wanted sound from unwanted sound
– Manages by reducing level	– Manages by 'wanted sounds' masking 'unwanted sounds'

Figure 3.22: Comparison of noise control and soundscape approaches. Source: City of Stockholm

A soundscape design requires input from a wide range of stakeholders including local authorities, architects, developers, consultants, local inhabitants, and so forth (City of Stockholm, 2011).

Figure 3.24 illustrates the design process of soundscaping:

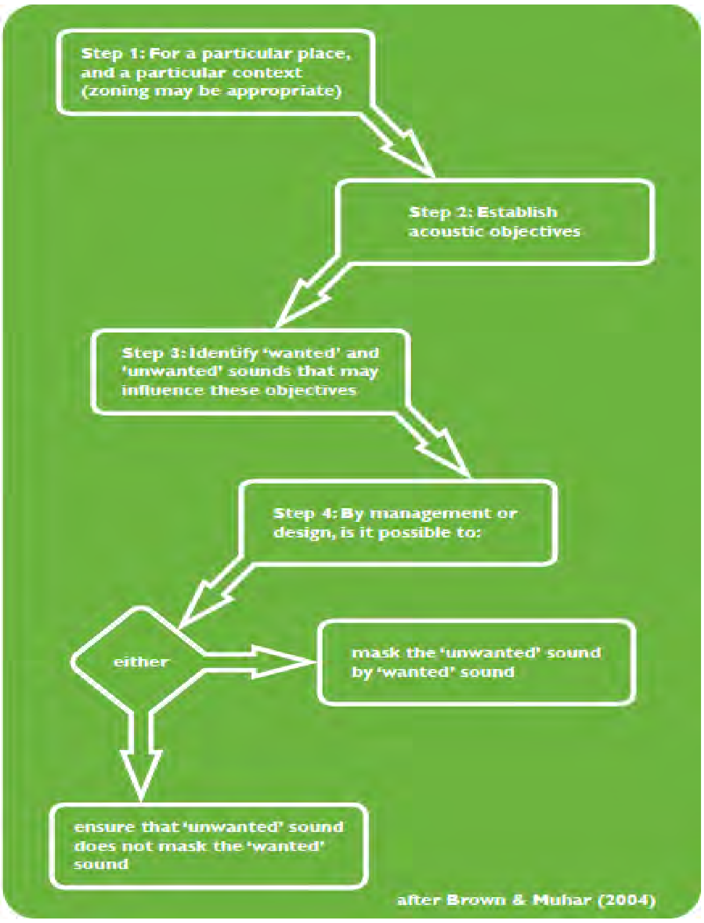

Figure 3.23: Design process of soundscaping. Source: Brown & Muhar, 2004

City example: Adding positive sounds to mask unwanted sound, Florence, Italy

In areas where reduction of noise levels are not viable, a more active approach may be necessary, such as adding positive sounds in order to mask unwanted sound. For this purpose Architettura Sonora in Italy has developed an intelligent and interactive audio system.
In most urban areas, plans and actions aiming at the mere reduction of noise levels are not viable. This is sometimes because of their invasiveness and aesthetic impact, or simply for reasons of economical or technical feasibility. Plans and actions should be aimed more to the perceived quality of sounds than the mere noise reduction to effectively improve a citizen's acoustic comfort.
This approach is usually called 'the soundscape approach'. In this case study we reflect upon our experiences over recent redesign of the soundscapes of noise polluted areas, especially garden and parks, with the aid of an intelligent and interactive audio system that is able to mask background noise. The artificial soundscape generation system comprises innovative sound sources (loudspeakers) able to withstand harsh, outdoor conditions. Those loudspeakers are carefully designed to be aesthetically pleasant and to perfectly complement architectural and natural landscapes. At the heart of the system is a piece of software capable of choosing the proper soundtracks (from a music database of meta-compositions) and to process them in real time to match the features of the noise to be masked.
This step involves the participation of different professionals like urban planners, acousticians, psychologists and sociologists to define the acoustic features of the area under study, relying on data such as the activities which have to be encouraged or discouraged, the user's expectations, and so forth. The action plan will be based on the generation of artificial soundscapes which are able to restore and redevelop the degraded soundscapes. The audio system to generate artificial soundscapes consists of:

• Microphones to capture the environmental noise signal
• Soundcard
• Computer with proprietary software
• Amplifiers
• Proprietary loudspeakers

The loudspeakers are specifically developed and produced to dialogue with and become part of the existing context, from the architectural, landscape and naturalistic point of view. They are responsible to produce a uniform and undistorted soundfield inside the area, without disrupting the aesthetic features of the environment in which they are placed.
This software processes in real time the soundtracks chosen among a meta-compositive database to make them effective for the purpose of noise masking. It should be noted that the software does not work as an active noise control process that reduces the energy of the sound field, instead the software adds a small amount of energy to the existing sound field so that the final sound level is a bit higher than the 'ante operam' value, but the reduction in the perceived annoyance greatly compensates for this level increase. The main principles employed for the masking effect are:

1) Spectral and spatial masking
2) Informational masking

Spectral masking is the well known psychoacoustic phenomenon by which each perceived sound creates a bell shaped inaudibility area in the frequency/ sound level plane, depending on both spectral content and time evolution. However, in a 3D sound-field the spectral masking can only be effective if the angle by which the listener perceives both the noise and the masking sound is below a certain threshold. Informational masking is strongly related to the social and cultural context and to the expectations of the user who is within the area 'hic et nunc'. It is based on the 'informational content' of the soundscape: an interesting signal will cause an attention shift, relegating the noise to the perceptual background.
Nevertheless, an 'out of context' sound, that is, a sound completely unrelated to the 'ante operam' soundscape, will easily result in an alarming, alienating, or unwanted aesthetic content.

The audio soundtracks in the meta-compositive database are extremely site-specific, and are composed and designed around the data available from a previous characterisation of the area under study. They can also be designed to encourage or discourage defined activities (relax, playing, social relations, etc.). All soundtracks are highly involving and immersive, taking advantage of surround sound techniques and multichannel systems of 8/16 channels.
The following is a short list of the principal installations where the approach previously described has been tested:

- Sonic Garden “La Limonaia dell’Imperialino”, Firenze, 2004–2007
- Square G. Caen, Paris, 2006
- Sonic Garden at Parco Sempione, Milano, June 2009
- Sonic Garden at Villa Aldobrandini, Roma, May 2010
- Sonic Garden at Castello di Bisarno, Firenze, June 2010

Different assessment strategies have emerged during the years. Some related to the use of psychoacoustic descriptors or even non acoustic ones, others more related to the sociological and psycho-social aspects of the sound experience.
The outcomes of the measurements and assessment process at the Sonic Garden “La Limonaia dell’Imperialino” are already significant in showing and validating the increased acoustic comfort in those areas where artificial soundscapes were employed. Surveys among the users of the garden have indeed confirmed the improved pleasantness and acoustic comfort obtained. The experience of recent years has shown that there is great potential for the artificial soundscape approach as a tool to restore acoustically degraded locations. The promising ongoing research, aimed at the development of an intelligent artificial soundscape generation system and its objective and systematic assessment, will allow the redevelopment of those areas, otherwise condemned to an uncomfortable annoyance if not even a total lack of human presence.

Source: Gaetano Licitra, ARPAT - Regional Environment Protection Agency of Tuscany, Florence, Italy & Lorenzo Brusci and Mattia Cobianchi, Architettura Sonora, Florence, Italy, available from Designing Soundscapes for Sustainable Urban Development, City of Stockholm, http://www.decorumcommunications.se/pdf/designing-soundscape-for-sustainable-urban-development.pdf

City example: Westminster, United Kingdom

Westminster’s sound environment is complex and noise is a serious issue. In 2008-2009 the council received 19,026 noise service requests. Compared to outer London and the rest of the UK it is relatively noisy in Westminster and the quieter night time period is shorter. Noise levels at the rear of properties tend to be significantly lower than at the front of properties.
Average noise levels in Westminster are 62 decibels (dB) LAeq in the day (07:00 – 19:00 hrs) and 55.7dB LAeq in the night (23:00 – 07:00 hrs). This is significantly higher than in outer London and in common with most urban areas exceeds the World Health Organisation guideline levels for Community Noise, 1999.
Road traffic is the main source of noise in Westminster, and it is the biggest cause for concern amongst residents. Thirty-seven percent (37%) of residents questioned said that road traffic noise had bothered them in the last 12 months. Other major sources of noise include construction work, roadworks, neighbours, commercial premises, air conditioning units and aircraft. Figure 3.25 presents a noise map of Westminster.

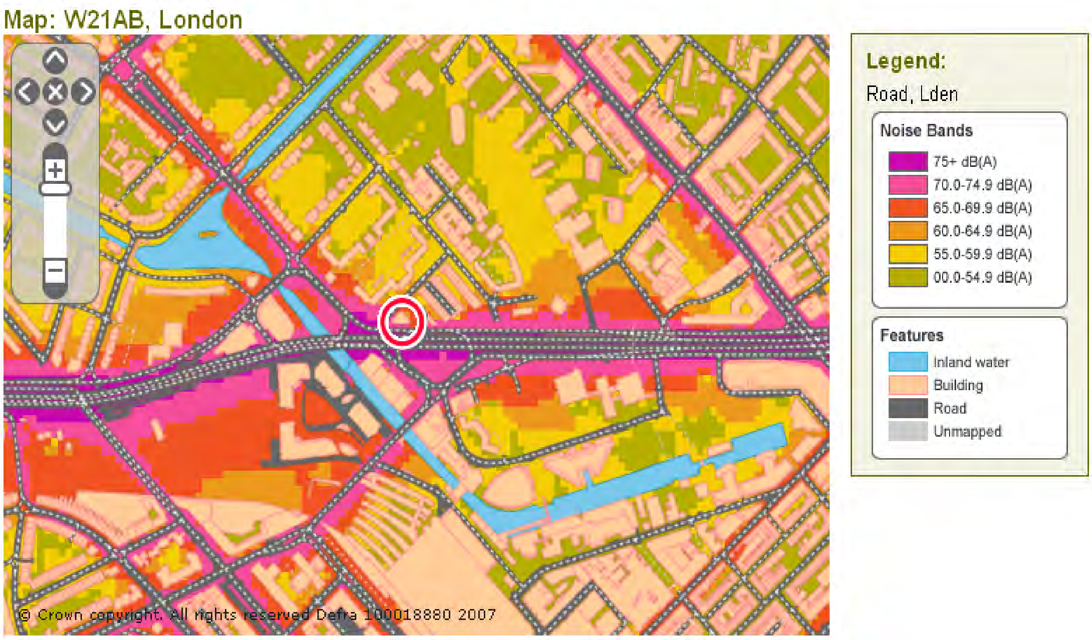

Figure 3.24: Westminster, London noise map. Source: Department for Environment, Food and Rural Affairs.

In response to concerns about noise, Westminster City Partnership (WCP) made a commitment to tackle noise pollution. WCP produced the Westminster City Plan 2006-2016 (Sustainable Community Strategy) which sets out a vision for Westminster's future and highlights this commitment to take action to reduce noise and protect noise sensitive and quieter areas. To enable this, the council decided to produce Westminster's first Noise Strategy, and has:
• Carried out research on the city's sound environment
• Established a panel of noise experts to provide advice on the strategy
• Consulted with the public on the scope and detail of the noise strategy, this included formal consultation on a Noise Issues and Options Report, 2008 and formal consultation on draft of this noise strategy in summer 2009.
The aim of the Westminster Noise Strategy is to contribute to improving the health and wellbeing of Westminster's residents, workers and visitors by reducing noise pollution and enhancing the city's sound environment.
Minimising noise impacts is complicated by the large number of different noise sources, where they are and when they cause a problem. Noise sensitive developments are often in close proximity to noise generating developments. These challenges to developing comprehensive noise strategies are further complicated by the number of different organisations with noise management responsibilities and powers.
Councils have limited powers in relation to many noise sources, but Westminster City Council has taken action to reduce noise pollution and its impacts in many ways. This has included:

• A 24 hour, year round reactive Noise Team service which deals with noisy neighbours, building sites, plant noise, burglar alarms, noisy licensed premises and a host of other environmental problems
• The introduction in 2008 of a proactive noise service which tackles the most longstanding and difficult to resolve problems
• Developing strong noise policies, in consultation with the community, as part of the council's Unitary Development Plan and Statement of Licensing Policy
• Applying a Code of Construction Practice to minimise environmental impact during construction of major projects
• Investing in infrastructure to support quieter transport modes – such as electric car re-charging points
• Working with entertainment venues to assess their noise impact and ensure preventative solutions are implemented
• Acoustic monitoring, data collection and analysis to gain evidence for use in enforcement

related to planning and licensing matters
• Setting noise limits on outdoor concerts and events and monitoring these for compliance
• Taking action to minimise noise from the council's own waste collection services and street cleansing services including:

- glass recycling bank collections are restricted to 07:00 – 22:00 hrs and in parts of Soho with higher numbers of residents 08:00 – 22:00 hrs
- using quieter plastic tipped shovels
- restricting the hours of mechanical sweepers
- implementing an eco driver training system which also has noise reduction benefits.

The strategy has been informed by several research studies on the city's noise environment, a review of relevant policies and legislation and results of consultation on the Noise Issues and Options Report, 2007 and the draft Noise Strategy, 2009. The strategy is shaped by four key objectives:

• Reducing noise levels
• Reducing noise incidents
• Minimising the impact of noise on noise sensitive developments
• Protecting and creating tranquil areas and sounds with positive associations.

There are four noise policies designed to help achieve these:

1. Noise conscious city management, planning and licensing
2. Reducing transport and servicing noise and impacts
3. Integrated noise management and enforcement
4. Tranquil areas and positive sounds.

The strategy also includes a series of short, medium and long-term actions that have been developed to bring about improvements in the council's operations and to facilitate lobbying and engagement with external organisations.

Source: City of Westminster, Westminster Noise Strategy 2010 – 2015, available from http://www.westminster.gov.uk/workspace/assets/publications/Final-Westminster-Noise-Strategy-1269269299.pdf

Applicability

A holistic approach to noise reduction that includes noise mitigation activities as part of achieving wider environmental goals is an excellent way to achieve noise pollution aims. Through creating a dedicated noise pollution action plan that incorporates the measures set out in the EU Environmental Noise directive, cities can gain much greater efficacy than through individual actions lacking in coherency. The plan must be routinely evaluated after action to ensure that reduction targets are being met.

Construction, industrial activities and transportation systems play a large role in noise pollution in Europe. Proper urban planning can mitigate this through ensuring areas of industry and transportation hubs are separated from residential and recreational spaces. Good land use planning, location and design of buildings is important for cities to consider. Industrial noise emissions should be regulated and industry worked with to achieve harmonious results. Published guidelines on acceptable noise emission levels can guide industry in their legal obligations.

In terms of reducing noise produced by private transport, successful measures serve to reduce road traffic, increase public transport use and establish cycle lanes and footpaths. Quiet road surfaces may be substituted and noise screens erected along busy road ways. The designation of quiet areas is a good way to enhance recreational areas and protect biodiversity.

Managing transport noise is a long term process that requires analysis of each specific facet of transportation such as rail, road traffic, air traffic and waterborne traffic. A noise map can help

to identify areas in which noise levels exceed EU limits and can be targeted for mitigation measures. It also provides an overview of locations in which potential quiet areas can be established. After analysis measures to manage noise should be developed for each of the affected areas.
Cities can encourage citizens to be aware of their noise emissions through a comprehensive communication campaign. Driving style, driving speed, car alarms and horns, burglar alarms, and the loud playing of music all contribute to local noise levels, and are within the remit of citizens to control.

Driving force for implementation
As well as health, curbing noise pollution has financial benefits. Economically noise pollution reduces property prices in affected areas and can structurally damage buildings through increased vibrations (OECD, 1997). Health conditions associated with noise pollution also add to infrastructural strain on health services, and increase expenditure on pharmaceutical goods, such as sleeping tablets. European Commission estimates of noise pollution's cost to Europe's GDP range between 0.2% and 2%.

Economics
It has been demonstrated that noise abatement measures perform well in cost-benefit measures. A study carried out by FEHRL using the rate €25 EUR per decibel per household per year found that quieter tyres could produce benefits to the public of between €48 and €123 billion in the period 2010– 2022 (EEA, 20011). The European Commission Working Group Health and Socio-Economic Aspects (WG-HSEA) in the position paper 'Valuation of noise' recommends the use of a benefit of €25 per household per decibel per year above noise levels of Lden = 50–55 dB (EEA, 2010).

Excess noise can lower property prices. According to the EEA "it has been found that properties exposed to higher noise levels will have a lower value on the market than a similar building exposed to a lower noise level. This is valid for residential houses (for which there is extensive literature) but probably also for office buildings. The best estimate is that house prices loose 0.5 % of their value per decibel over 50–55 Lden. (EEA, 2010)

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3.2.6 Structural approach to Air Quality Management

Description

Air quality declined markedly in the developed world in the 19th century, as the industrial revolution saw the spread of emission heavy manufacturing factories and power generation plants. Compounded by the mass uptake of the internal combustion engine vehicle in the 20th century and the emissions caused by domestic heating, the health effects of decreased air quality became widespread in urban areas. As the correlation between air pollution and adverse health consequences has been better understood, national governments and more recently the EU have enacted legislation and policies to ensure minimum levels of air cleanliness are maintained. Policies setting legal limits on the level of emissions permitted by road transport and industrial combustion have resulted in an improvement in air quality and a reduction in pollution-induced health effects.

Air quality in Europe still requires improvement however. Today pollutants in the air contribute to citizens contracting severe health ailments such as lung cancer and cardiovascular disease. Thousands of premature deaths in both the developed and developing world could be avoided through higher air quality.

The major contributors to air pollution are sulphur dioxide (SO_2), nitrogen dioxide (NO_2), suspended particulates (PM_{10}), carbon monoxide (CO), and ozone (O_3). The burning of fossil fuels (particularly coal and oil) for heating, power and motor vehicles contributes directly to the release of SO_2, NO_2 and CO_2 into the atmosphere.

Pollution levels are determined by the rate of emissions versus the rate of dispersion and removal processes. These processes are governed by meteorological conditions and the geographical location of the city. Pollution levels are governed by local emissions as well as pollution brought in from further afield (in the case of Helsinki, Russian wildfires bring in high quantities of PM_{10} to the city). The emissions release height is also important – the higher the release the less likely the pollution is to be transported to respirable level. Power plants and industrial factories have high emission release height, whilst vehicular transport and domestic heating sources have low emission release height.

In the period 1997 to 2008, 13 to 62% of Europe's urban population was potentially exposed to ambient air concentrations of fine and coarse particulate matter (PM_{10}) in excess of the EU limit value set for the protection of human health. However, particulate matter has no threshold concentration, thus adverse health effects can also occur below the limit values. Figure 3.26 shows the amount of days urban dwellers in Europe were exposed to PM_{10} levels exceeding the daily limit value, while figure 3.27 illustrates the annual mean concentrations of PM_{10} in 2009 in Europe.

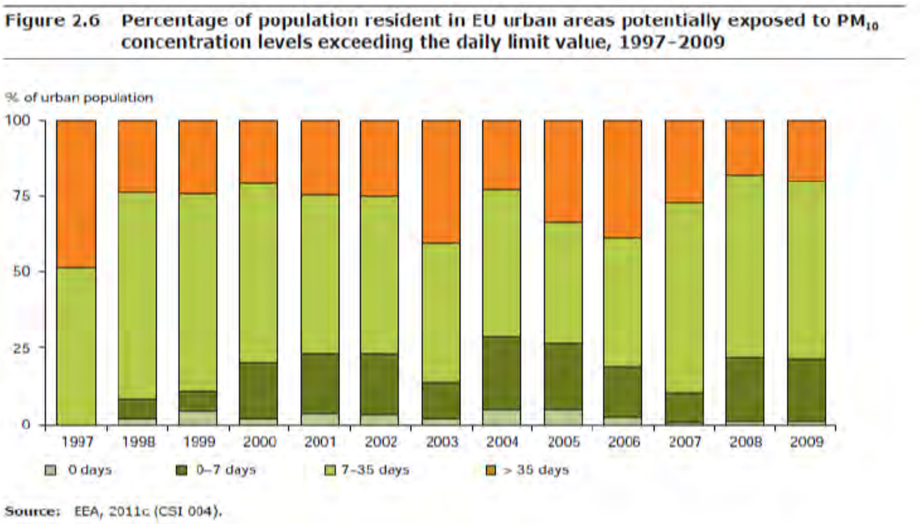
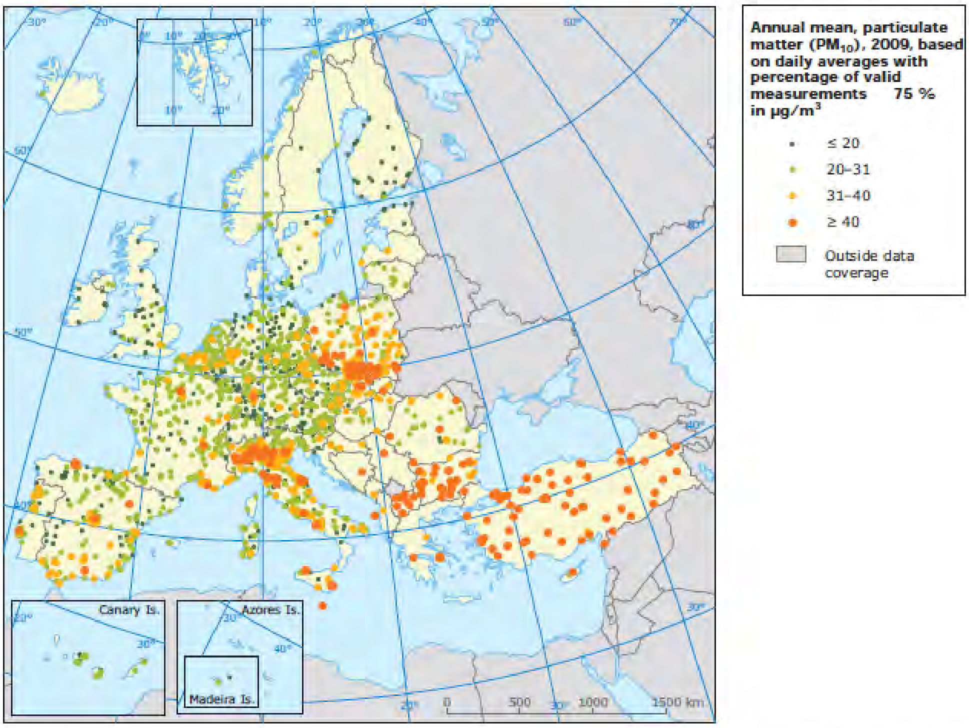


Figure 3.25: Percentage of population resident in EU urban areas potentially exposed to Pm10 concentration levels exceeding the daily limit value, 1997 – 2009. Source: EEA 2011

Map 2.1 Annual mean concentrations of PM_{10} in 2009



Note: The dark orange dots indicate stations reporting exceedances of the 2005 annual limit value (40 µg/m³), as set out in the Air Quality Directive (EU, 2008c).

The light orange dots indicate stations reporting exceedances of a statistically derived level (31 µg/m³) corresponding to the 24-hour limit value.

The pale green dots indicate stations reporting exceedances of the WHO air quality guideline for PM_{10} of less than 20 µg/m³.

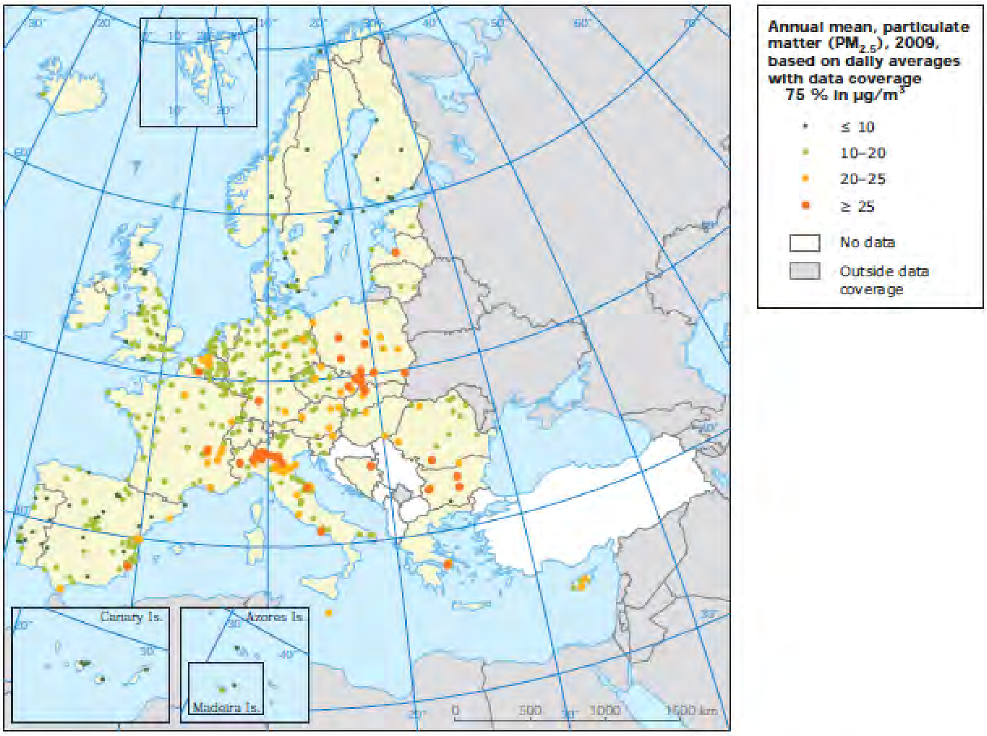
The dark green dots indicate stations reporting concentrations below the WHO air quality guideline for PM_{10}.

Source: Mol et al., 2011.

Figure 3.26: Annual mean concentrations of PM_{10} in 2009. Source: EEA 2011

The fine-particulate fraction ($PM_{2.5}$) represents a particular health concern because these can penetrate the respiratory system deeply and be absorbed into the bloodstream. An assessment of the health impacts of exposure to $PM_{2.5}$ in EEA-32 countries in 2005 indicated that almost 5 million lost life years could be attributed to this pollutant. (EEA, 2010). Figure 3.28 shows the annual mean concentrations of $PM_{2.5}$ in 2009 in Europe.

Map 2.2 Annual mean concentrations of $PM_{2.5}$ in 2009



Note: The dark orange dots indicate stations reporting exceedances of the 2010 annual target value (25 µg/m³), as set out in the Air Quality Directive (EU, 2008c).

The light orange dots indicate stations reporting exceedances of the 2020 indicative annual limit value (20 µg/m³), as set out in the Air Quality Directive (EU, 2008c).

The pale green dots indicate stations reporting exceedances of the WHO air quality guideline for $PM_{2.5}$ of less than 10 µg/m³.

The dark green dots indicate stations reporting concentrations below the WHO air quality guideline for $PM_{2.5}$.

Source: Mol et al., 2011.

Figure 3.27: Annual mean concentrations of PM2.5 in 2009. Source: EEA 2011

Most western countries monitor these pollutants in order to identify areas in which citizens may potentially be at risk, such as in Germany under the authority of the Federal Environment Agency (UBA) and in the United Kingdom under the authority of the Department for Environment, Food and Rural Affairs (DEFRA).

Within the European Union, the Sixth Environment Action Programme called for the development of a thematic strategy on air pollution with the objective of achieving levels of air quality that do not result in unacceptable impacts on, and risks to, human health and the environment. Formulated in 2005, the thematic strategy sets specific long-term objectives for improvements in 2020 relative to the situation in 2000, specifically:

- a 47 % reduction in loss of life expectancy as a result of exposure to particulate matter;
- a 10 % reduction in acute mortalities from exposure to ozone;
- a 74 % reduction in excess acid deposition in forest areas and a 39 % reduction in surface freshwater areas;
- a 43 % reduction in areas or ecosystems exposed to eutrophication.

To achieve these objectives, it was estimated that SO_2 emissions need to decrease by 82 %, NO_X emissions by 60 %, volatile organic compounds (VOC) by 51 %, ammonia by 27 % and primary $PM_{2.5}$ (fine particles emitted directly into the air) by 59 % in the period 2000–2020.
In the 'Roadmap to a Resource Efficient Europe' the European Commission has proposed the following milestone for the policy: 'By 2020, the EU's interim air quality standards will have been met, including in urban hot spots, and those standards will have been updated and additional measures defined to further close the gap to the ultimate goal of achieving levels of air quality that do not cause significant impacts on health and the environment' (EEA, 2011).
From 1993 on, Several EU Directives updated and enhanced emission standards for passenger cars, light trucks and commercial vehicles. The Euro Directives for road vehicle emissions set standards for emissions of NO_X, hydrocarbons (HC), non-methane hydrocarbons (NMHC), CO and PM for most vehicle types. The Euro 4 standards are addressed in Directive 98/70/ EC (EU, 1998a, 1998b) and Directive 2005/55/ EC (EU, 2005). The Euro 5 and 6 standards are covered in Regulation (EC) No 692/2008 (EU, 2008a) and Regulation (EC) No 595/2009 (EU, 2009b). These Standards are commonly known as the Euro 1 to 6 and they set limits for the principal pollutants emitted by cars, thereby contributing to improve air quality in Europe. This quantitative approach is nevertheless not enough to solve the problem. If healthy air quality levels are to be reached and maintained in Europe, a comprehensive structural change in transport habits and in the transport system has to take place (See chapter on mobility).

Achieved environmental benefits
Lowering levels of air pollution has great environmental, biodiversity and health benefits. The quality of air in our cities has a lasting effect on health. Poor air quality can lead to potentially fatal diseases of the lungs and heart[19], with 1.3 million deaths worldwide per year estimated to come from outdoor air pollution[20]. Even relatively low concentrations of air pollutants can cause a range of adverse health effects. Ill people, the elderly, young children and the poor are particularly susceptible to the negative effects of poor air quality. According to the WHO:

- *In Europe, exposure to particulate matter (PM_{10}) decreases the life expectancy of every person by an average of almost one year, mostly due to increased risk of cardiovascular and respiratory diseases, and lung cancer.*
- *Some 40 million people in the 115 largest cities in the EU are exposed to air exceeding WHO air quality guideline values for at least one pollutant. Children living near roads with heavy-duty vehicle traffic have twice the risk of respiratory problems as those living near less congested streets.*
- *Ozone pollution causes breathing difficulties, triggers asthma symptoms, causes lung and heart diseases, and is associated with about 21,000 premature deaths per year in Europe.*[21]

A report from the European Topic Centre on Air and Climate Change estimates that in Finland 1,500–2,500 premature deaths per year are caused by air pollution.
Biodiversity is also affected by air pollution. Air pollution leads to higher nitrogen deposits within soil, which has the capacity to disrupt the biological processes of plants. Nitrogen is absorbed by the roots and transported to the leaves, which results in reduced growth, yellowing of the leaves and in the case of some plant species, death. If substances build up in the tissue of vegetation they can also affect the health of wildlife that consume the vegetation.[22] There is evidence to suggest that nitrogen deposits resulting from air pollution have reduced the diversity of plant species in Europe.[23]

[19] http://www.who.int/topics/air_pollution/en/

[20] http://www.who.int/mediacentre/factsheets/fs313/en/index.html

[21] http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/air-quality/facts-and-figures

[22] http://environment.alberta.ca/02235.html

[23] http://jncc.defra.gov.uk/page-1426

Some of the main polluting substances have been successfully reduced in Europe, such as sulphur dioxide (SO_2), carbon monoxide and NO_X. However other pollutants, such as particulate matter (PM) and ozone (O_3) remain a significant environment-related health concern, linked to a loss of life expectancy, acute and chronic respiratory and cardiovascular effects, impaired lung development in children, and reduced birth weight (EEA, 2010). Figure 3.29 shows the percentage of urban population exposed to higher pollutant concentrations than limit values in the EU-27 plus Iceland, Liechtenstein, Norway, Switzerland and Turkey.

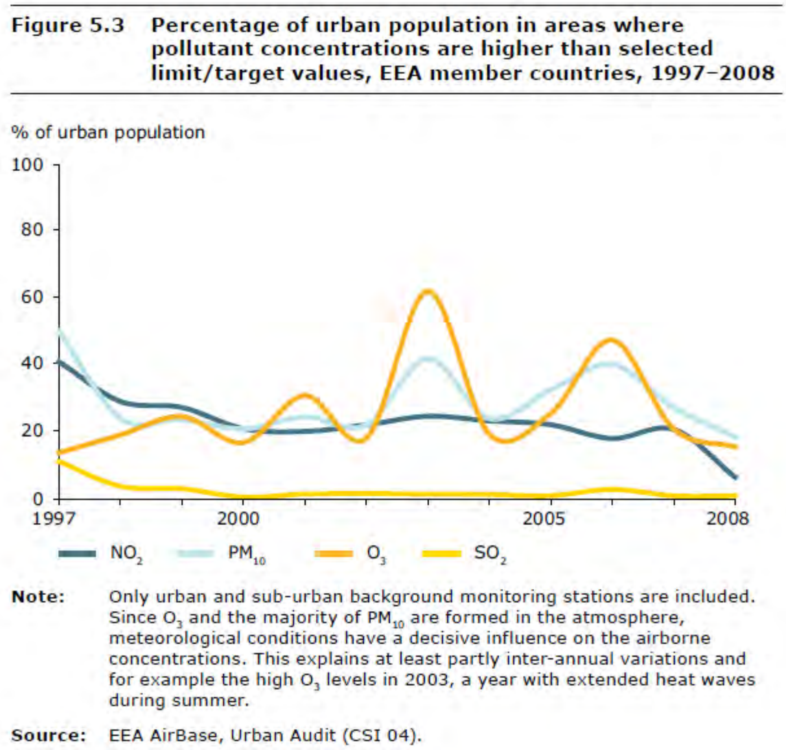


Figure 3.28: Percentage of urban population in areas where pollutant concentrations are higher than selected limit/target values, EEA member countries, 1997-2008. Source: EEA, 2010

Appropriate environmental indicator

Table 3.8: Appropriate environmental indicator - Air quality

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
PM10 daily concentrations	n. days recording a mean value > 50 µg/m^3	n. days recording a mean value > 50 µg/m^3 / 35 days (limit value)	Daily PM_{10} concentrations. In case these concentrations have been registered in more monitoring stations, the value reported could be referred to: - average value of traffic stations; - worst value of traffic stations; - average value of background stations; - worst value of background stations.
PM10 annual concentrations	µg/m^3		Annual average PM_{10} concentrations. In case these concentrations have been registered in more monitoring stations, the value reported could be referred to: - average value of traffic stations; - worst value of traffic stations; - average value of background stations; - worst value of background stations.

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
NO_2 annual concentrations	µg/m^3		Annual average NO_2 concentrations. In case these concentrations have been registered in more monitoring stations, the value reported could be referred to: - average value of traffic stations; - worst value of traffic stations; - average value of background stations; - worst value of background stations.
Ozone concentrations	n. days recording a max 8h mean value > 120 µg/m^3	n. days recording a max 8h mean value > 120 µg/m^3 / 25 days (limit value)	Daily ozone concentrations. In case these concentrations have been registered in more monitoring stations, the value reported could be referred to: - average value of all monitoring stations; - worst value of all monitoring stations.
Air emissions	ton		Annual air emission, including at least emissions of SO_2, NOx and PM.

Benchmark of excellence

In Helsinki emissions from buildings, energy production and industry have progressively decreased and air quality has improved significantly through this. Being a big city with more than 500.000 inhabitants, pressures from road traffic still remain high, as well as long-range transport of particles coming into the area. Nevertheless, Helsinki is one of the big European cities which have reached better improvement in air quality. Efforts to decrease street dust have been effective and the limit values referred to PM_{10} particles was last exceeded in 2005 and 2006. Only the NO_2 annual concentrations, even if decreasing, are still exceeding limit values in some street of the city centre. In 2009 the worst monitoring station registered an annual average of 43 µg/m^3, only 7.5% higher than the current EU limit value of 40 µg/m^3 (Helsinki's integrated approach with reference to air pollution will be analysed more in depth in the paragraph "Operational Data"). Figure 3.31 shows the reduction of NO_2 and PM_{10} in some of Helsinki neighbourhoods.

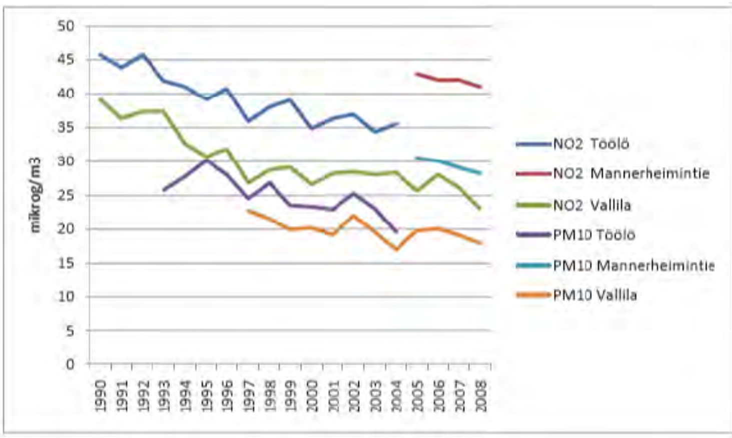


Figure 3.29: Concentration of pollutants in Helsinki neighbourhoods. Source: Helsinki

Operational data

To improve air quality all aspects of urban planning must be taken into account, including land use planning, transport, energy production and energy efficiency, and industry. Citizens must also be educated as to the effects and importance of air quality and be incentivised to use sustainable transportation practices (see chapter on mobility). Having a structured approach to air quality management, with strong managerial oversight and a detailed, applicable plan is necessary to improve air quality. Air quality goals, both short term and long term, must be set in

advance with local authority participation. These goals should be evaluated regularly. Nowadays, transport is the main sector responsible for air pollution in many cities, therefore, a correct transport policy encouraging public transport and green transport solutions is one fundamental step in solving air pollution issues. Along with promoting public transport, incentives to buy hybrid or electric cars could be provided and traffic limitation policies in big cities set up (See chapter on mobility). In order to enable this change of paradigm, air pollution concerns have to be taken into account in land use planning, making public transport more attractive and studying possibilities to establish a low-emissions zone. Street cleaning also plays an important role in air pollution abatement. The reduction of dust and particulate is, in fact, a necessary measure to ameliorate air quality. “Street Dust represents an overlooked urban pollutant. Particles from vehicle emissions are not the only traffic-related factor that causes deterioration of air quality in cities. Suspended road dust, caused by studded tyres, road salt and sand used in winter, may be at least as important in contributing to mortality rates, according to a new study in Stockholm, which suggests that these coarse particles should be controlled separately to fine particles. Many scientific studies have linked particulate air pollution to daily death rates in cities. However, most have focused either on fine particles (less than 2.5 micrometres (μm) diameter), which originate from vehicle exhausts, or on the combined effect of all particles under 10μm diameter, collectively termed PM_{10}. The total amount of PM10 is regulated under EU law, but the effects of coarse particles (2.5-10μm) are less well known, although laboratory studies suggest that short-term exposure may have serious health effects.
In Stockholm, measures to reduce non tail-pipe emissions have included banning the use of private cars with studded tires in some streets to reduce road wear. The road material is also important - as the harder it is, the lower the emissions (but this results in more noise than soft asphalt).
Swedish researchers calculated the concentration of coarse particles at a roof-top monitoring station in central Stockholm, using the difference between measurements of PM_{10} and $PM_{2.5}$. They compared the daily averages of coarse particles for 2000-2008 with the number of daily deaths (excluding deaths due to external causes), using information from the Swedish Cause of Death Register. The increase in daily death rate was higher in late winter and spring (November-May) than in summer and autumn (Jun-Oct): 1.69% compared to 1.31%. This corresponded to higher coarse particle levels during this period; concentrations of over 20μg/m^3 were found on 148 days during November-May compared to just four days at other times of year. Although this study does not examine causes of death, experimental studies have linked exposure to coarse particles with pulmonary inflammation, impairment of the nervous system and development of cardiac arrhythmias. The researchers attribute the higher concentrations of coarse particles during November-May to a greater amount of suspended road sediment caused by the use of studded winter tyres, road salt and traction sand in winter. Previous studies have found that road dust accounts for up to 90% of PM_{10} during winter in Stockholm. These results suggest that, alongside vehicle exhausts, exposure to coarse particles via road traffic is an important public health concern. The researchers recommend that the coarse particle fraction of PM_{10} is controlled separately under EU legislation to prevent exceeding maximum PM_{10} limits, particularly in cities where studded tyres are used. Reducing the use of studded tires by imposing fines in cities has been a successful way to reduce coarse particles in countries such as Norway, but in other countries where the sources are much more diverse and less obvious there is a lack of efficient abatement strategies. Sources of coarse particles that are difficult to control include wear of brake linings, wear of tires and desert dust transported to cities (such as in Spain) from nearby arid (desert) areas” (Meister, 2011).
Emissions from the household sector have also to be reduced through energy efficiency (See chapter on energy). Citizens have to be involved in this process, being actors playing a central role in the improvement of air quality. It is therefore very important to organise awareness-raising activities with regard to this theme. For example, changing driving style can already contribute to lowering emission from private transport; easy measures, such as accelerating gradually, respecting speed limits, maintaining the efficiency of the car by subjecting it to periodic inspections can all reduce tail pipe emissions. The Helsinki case study below offers an organic, operational and useful description of a comprehensive air pollution reduction approach, and will be therefore presented in great detail.

City Example: Air quality improvement in Helsinki, Finland

The city of Helsinki is enacting measures to improve its already impressive air quality standards. The city has drawn up an air protection action plan for 2008–2016, outlining long term measures, goals, and evaluation methods to further lower emissions and pollutants. The plan was approved by the city council in May 2008.

The vision for 2016 is to permanently improve air quality and lessen the negative impacts of pollutants on residents' health, thereby improving living conditions.

Helsinki’s plan contains 43 measures, which focus on land use planning and transport, street dust, fine particles, research and communication. It includes measures designed to reduce levels of nitrogen dioxide (NO_2) and focuses on significantly reducing fine particles (PM_{10}), due to the associated health risks. It also includes a separate communication plan aimed at providing the public with air quality information and recommendations on how to reduce emissions and avoid exposure.

Under national legislation the creation of the action plan was mandatory. The Government Decree on Air Quality states that if the limit value for any emission or pollutant is exceeded (as set by the decree), the local authority must create an air quality action plan to rectify the situation. In Helsinki the limit value for NO_2 is exceeded in the city centre, as a result of traffic exhaust emissions (it is generally exceeded along busy roads and in downtown Helsinki).

The Helsinki Metropolitan Area Council (now HSY Helsinki Region Environmental Services Authority) has simultaneously prepared an air protection action plan for the entire metropolitan area, which contains background data along with measures for which the HSY is responsible. The cities of Espoo, Vantaa and Kauniainen have also prepared their own action plans.

In recent years the city’s air quality has improved greatly and today it is high by international standards. This is thanks partly to the sustainable district heating system, which has resulted in the reduction of smoke stacks, and thanks to falling emissions from buildings, industry and electricity production. Small scale wood burning does however remain the cause of local air quality issues.

Figure 3.31 reports the “Air Quality Index”. The colour coded index is based on health impacts, limit values and guidelines for air quality. When air quality is poor, health impacts are possible on sensitive individuals.[24]

Table: Air quality classes and the connection between health impacts

Class	Health impacts	Other long-term impacts
[illegible]	Adverse effects possible on sensitive subpopulation	Clear impacts on vegetation, material impacts
Poor	Adverse effects possible on sensitive individuals	Clear impacts on vegetation, material impacts
Fair	Unlikely effects	Clear impacts on vegetation, material impacts
Satisfactory	Very unlikely effects	Mild environmental impacts
[illegible]	No health effects	Mild environmental impacts

Figure 3.30 Air quality classes and the connection between health impacts. Source: HSY

In figure 3.32 the quality readings are based on the index value that most harms air quality. Therefore if one of the indices is in the range of poor whilst the rest are in the range of satisfactory, the index will be shown as poor regardless of other values:

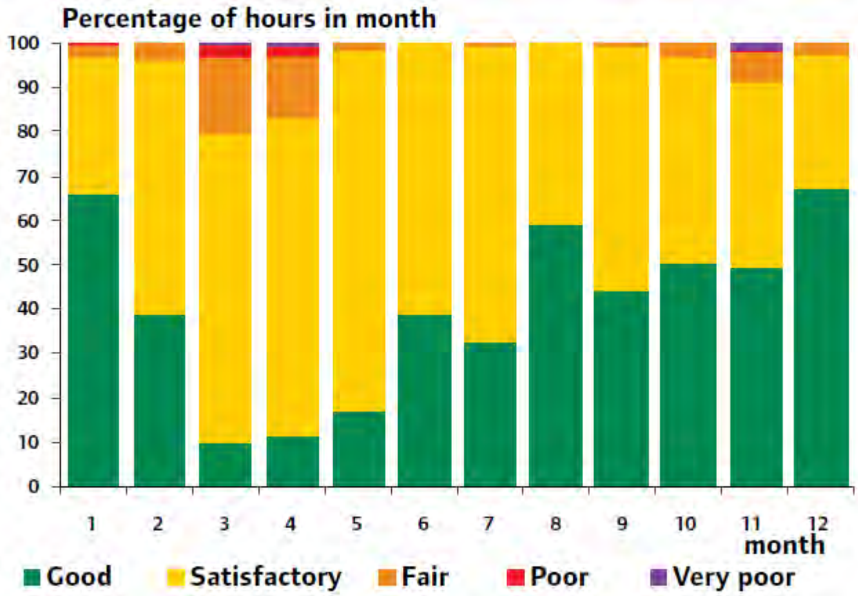


Figure 3.31 Helsinki air quality by month. Source: YTV

Local authorities monitor the quality of ambient air at eleven sites, plus two sites for the Region of Uusimaa, which are considered representative of other similar environments. The results of these stations are updated every hour to the HSY website, available for the public to view (figure 3.33). Seven are in permanent locations, whilst four move yearly. The measurements are used in studying the impacts of traffic and energy production on air quality, and in assessing air quality in residential areas and background areas (YTV, 2007).

The results of these measurements are available through an interactive online map that shows the results in real time. Users can click into the icons for more detailed information, including a graphical representation of the level of each pollutant, and the number of times a pollutant has exceeded the limit value at the monitoring site.

Figure 3.32: Real time air quality situation map for Helsinki, Finland. Source: HSY

Users can also view a Google maps overview of each monitoring device throughout the city. The map, presented in figure 3.34, provides information at each site in which air quality has been measured in the city historically. It shows past annual measurements, how busy the environment is on average and traffic volume.

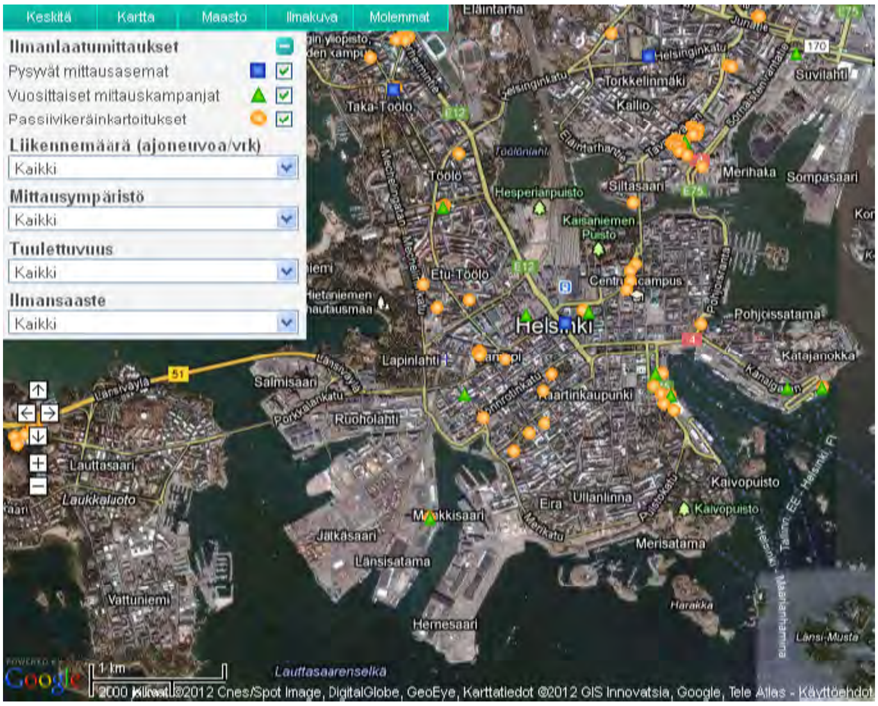


Figure 3.33: Google map of air quality in Helsinki, Finland. Source: Google

To deal with a sudden decrease in air quality the city has created an air quality readiness plan. The plan covers three different types of episodes which would cause quality to suddenly change - an increase of nitrogen dioxide concentrations as a consequence of traffic emissions, a rise in street dust concentrations, or a high amount of smoke coming from a large terrain or building fire.[25]

Long range emissions are a major source of particles for Helsinki. Wildfires in Russia and other parts of Europe can contribute to the level of PM_{10} increasing greatly. As much as over half of the average particle concentrations in the metropolitan area are caused by the long range transport of particles from other countries. During a long range transportation episode visibility may be reduced and smoke may be detected in the air (Helsinki Metropolitan Area Council, 2007).

If it seems likely that air quality will deteriorate to the level that the air quality readiness plan is activated, information is sent automatically to the public from the city's health departments, HYT and the Helsinki Environment Centre. Citizens are warned prior to the air quality deteriorating. This health and safety information is broadcast online and through traditional media.

The air protection action plan is separated into seven sections. For each measure an objective, a respondent and impacts have been specified. In evaluating effectiveness, consideration has been given to air quality and other environmental impacts, costs, timeframes and feasibility. The National Public Health Institute has also evaluated the health impacts of the action plan:

1. General measures - includes international and national measures that Helsinki is helping to promote and implement. Helsinki will serve as a pioneer and exemplar in introducing measures. It is hoped their good example will motivate other countries to follow. The measure will influence taxation and legislation, influence international decision making through lobbying organisations and networks, encourage other countries to reduce particulates that can be dispersed over long distances, serve as an example for other countries and promote the implementation and development of public transport projects.

Measures

1. Influence taxation and legislation
2. Influence international decision-making through lobbying organisations and networks
3. Encourage other countries to reduce particulates that can be dispersed over long distances
4. Serve as an example
5. Promote the implementation and development of public transport projects

2. Land use planning and transport – In Helsinki motor vehicles are the primary threat to air quality, with the number of cars quadrupling in the Helsinki metropolitan area since the middle of the 1960s. Diesel cars were previously promoted in the city, as their CO_2 emissions are significantly lower than petrol vehicles. This resulted in the number of diesel cars on the streets increasing. However, whilst diesel cars are lower in its emissions of CO_2, they are far higher in emissions of pollutants. The introduction of more and more diesel cars had the negative consequence of increasing levels of NO_2 in the atmosphere rapidly.

City planners intend to tackle the air pollution caused by private vehicles through emphasising air quality requirements in city land use planning, particularly people's exposure to pollutants. Public transport use will be increased and cross-city lines developed, as this is where traffic is currently heaviest and thus air pollution most severe. Incentives to purchase low-emission vehicles and congestion charges are also being used (official criteria need to be defined for what constitutes low-emission vehicles however).

An online journey planner was created by the Helsinki municipality, providing users with information on the best public transport options to reach their stated destination. The planner shows the times and cost of different public transport methods available, combining methods within the same journey where necessary. It also provides a map, displaying stops and journey routes, and the overall CO_2 emissions of the journey. Park and ride information is also provided, as well as a price calculator, allowing potential travellers to predict the cost of their public transport use over a period of time. Helsinki was one of the first municipalities in Europe to enact such a planner. The main aims of the planner are to reduce congestion, enhance public health and protect the environment.

To make inter-modal public transport easier and more accessible, Helsinki has introduced an integrated ticket system. HSL's tickets are valid on buses, trams, the Metro, commuter trains and Suomenlinna ferry. It is possible to transfer from one vehicle to another with the same ticket.

The city has also set up so-called "environmental zones", which only low-emission buses and waste trucks may enter. Incentives for the purchase of low-emission vehicles are being introduced, such as reduced parking fees in the city centre.

Pedestrian zones are being developed and cycling and walking encouraged. The city is also looking into offering large companies direct mobility services.

The action plan also contains measures aimed at reducing ship emissions.

Measures
1. Take air quality requirements into consideration in land use planning
2. Make public transport more attractive
3. Develop cross-city lines
4. Promote low emissions
5. Study possibilities to establish a low-emission zone
6. Study and introduce traffic management and pricing mechanisms suitable for Helsinki
7. Develop possibilities to use public transport for leisure travel
8. Offer businesses advice on sustainable transport
9. Prepare transport plans
10. Collect information on emissions from small-scale water traffic and work machines

11. Reduce ship emissions
12. Introduce environmentally-based harbour and fairway charges
13. Develop the evaluation of emissions from harbour activities and their impacts on air quality

3. Street Dust – The city is addressing this by shifting the clearing of snow and the responsibility of street cleaning to a single actor, and improving the efficacy of street dust reducing machinery. The planning and construction of streets will also take into account concerns over street dust.
In Helsinki, the high level of dust that occurs in springtime due to melting snow is problematic for the city – at these times the levels of particulate matter may be elevated for weeks. The dust comes from grit accumulated in snow banks and on road sides during the winter, from the wearing down of tires and asphalt, and from exhaust gas particles (Helsinki Metropolitan Area Council, 2007). The action plan addresses this problem, outlining measures such as sprinkling the streets with saline solution. Done correctly dust binding can be greatly reduce dust at respirable level. In 2006 a 69% reduction in average levels in Helsinki was detected after treatment. Streets without treatment did not decrease in level.
In the city special dust binding equipment has been employed, with the ability to tackle difficult areas such as gutters and in between driving lanes.
Street cleaning is used to remove material from street surfaces that could potentially lower air quality. Larger sized loose material can be efficiently removed by street cleaning, but efficacy drops when attempting to clean smaller pieces of debris (conventional street cleaning equipment is not suited to removing PM_{10} sized dust particles). Attention has shifted to suction sweeping and pressurised washing from brushing, as the former is more effective. Pressurised washing was proven to reduce PM_{10} levels by 15 – 60%, compared to washing. It was also observed that when gritting streets, using salt rather than sand contributes to lowering atmospheric particulates.
If dust levels are forecast to be high for a number of days, the city will advise the Public Works Department and the Uusimaa Road Administration to engage in dust binding. The presence of construction sites within a city can play a sizeable role in influencing dust levels, particularly during summer when dust levels from other sources are low.
In order to combat street dust, Helsinki has come up with a method to bind it, keeping it at road surface level rather than being circulated into the air by vehicles. The process involves adding dust binding agents to water, such as calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$) and calcium magnesium acetate (CMA). These dust binding agents also lower the freezing point of the liquid. Water can be used as a dust binding agent but is ineffective as it soon evaporates.
For dust binding to be effective, treatment must be repeated frequently and cover large areas (after treatment dust levels tend to return after four to five days). Dust binding is not a total solution however as the dust itself is not removed.

Measures
1. Manage street cleaning as a whole
2. Participate in research aimed at reducing street dust
3. Study and introduce means to reduce the use of studs on winter tyres
4. Consider street maintenance requirements in planning
5. Consider dust properties in street construction
6. Reduce dust from building sites and street construction
7. Improve the quality of the machinery used in reducing street dust
8. Improve the quality of sand used to prevent icing
9. Develop the use of salt to prevent icing
10. Develop dust binding in episodes
11. Increase snow removal particularly near roads
12. Speed up street cleaning in the spring and start sooner
13. Develop work quality and quality assurance

4. Energy production – Energy production emissions are strictly regulated, so the action plan does not add to this field. Furthermore emissions from energy production have practically no

impact on the city's air quality thanks to high smokestacks.

5. Particulates - Small-scale wood burning significantly affects local air quality. However, using good, dry wood and the right burning technique considerably reduces emissions. The action plan supports and encourages the adoption of low-emission heating systems. Provisions concerning small-scale wood burning will be added to the city's environmental protection and waste management ordinances.

Measures
1. Encourage the use of low-emission heating systems
2. Add provisions concerning small-scale wood burning to the city's environmental protection and waste management ordinances
3. Participate in research concerning particulates

6. Research – Research will be conducted into efficient measures to reduce air pollutants. Research action plans include:

Land use planning and traffic:
- Study of possibilities to establish a low-emission zone
- Study of traffic management and pricing mechanisms suitable for Helsinki
- Study of possibilities to offer businesses advice on sustainable transport
- Collection of information on emissions from small-scale water traffic and work machines

Street dust:
- Commissioning of research on reducing street dust

Communications and education:
- Planning of a mobility management centre in connection with the proposed ecoefficiency service centre (if established)

7. Communications and education – The plan aims to increase residents' environmental and air quality awareness through theme days, brochures and education. It is hoped that residents themselves will adapt their behaviour to improve air quality in ways such as adopting an economical driving style, using public transport and so on. Schools will also encourage pupils to walk, bike and use public transport.

Measures
1. Increase information on street cleaning for different target groups: residents, properties, real estate companies
2. Plan a mobility management centre in connection with the proposed eco-efficiency service centre (if established)
3. Increase campaigns to promote public transport and include information on air quality in them
4. Provide information on recommendations concerning small-scale wood burning
5. Reduce idling
6. Arrange education on driving economically
7. Develop inter-city cooperation in environmental education
8. Increase residents' air quality awareness and promote sustainable transport options

It is imperative that citizens are informed regarding air quality and are advised on a course of action in the case of a sudden deterioration in quality. In it’s air quality readiness plan, Helsinki states: “Communication is a fundamental element of the actions in all episodic situations. During situations of air pollution, the behaviour of the city residents is guided by means of the information and recommendations, which they are made aware of through the actions of the authorities.”

Applicability

In many cities, the main challenge to clean air is the volume of traffic on the city streets. In this sense mobility management and air quality improvement are symbiotically linked (See chapter on mobility).

A transport policy based on soft modes of transport, such as cycling and walking, and low emission technologies, such as electric cars and public transport can greatly reduce emissions. Private vehicle traffic not only releases emissions such as SO_2, PM_{10}, and NO_2 but also circulates street dust particles into the air.

Many cities have implemented practices reducing accessibility to the city centre for cars, thus reducing congestions and air pollution. In many cases this restrictions are linked with car and bike sharing systems and with car parks served by public transport outside the Limited Traffic Zone in order to improve accessibility.

City example: Bologna, Italy. Building up a "Limited Traffic Zone" and promoting an intelligent transport system to improve air quality

Bologna has, due to its geographical position, traditionally faced air quality problems. In the past, the low capacity of the city centre has often led to heavy congestion that has compromised the quality of life in the historic city centre. The progressive introduction of traffic restrictions that started with the establishment of the historic centre as a Limited Traffic Zone (LTZ) in 1989 has considerably improved the situation. It has led to better air quality and helped to preserve the centre's monumental attractiveness. Besides access restrictions, Intelligent Transport Systems (ITS) have further improved the transport situation in the city centre. For example, several pedestrian areas have been created in the historic city centre through the deployment of movable barriers. These can be lowered from a remote control room to allow deliveries to shops during certain times of the day or the transit of emergency vehicles.

In June 2007, the municipal town council approved the new Master Plan of Urban Traffic (PGTU). The plan is especially concerned with reducing pollution, noise, accidents and congestion, while saving energy. These critical issues affect citizens' lives on a daily basis and have negative impacts on their health, safety and overall quality of life. The interlinked developments under the new PGTU intend to ensure sustainable mobility and accessibility to all parts of the city. This will be achieved through enhanced public transport and cycle lanes, while safeguarding the most valuable environmental and architectural areas.

Bologna projects that a package of cleaner vehicles and fuels together with a drop in private transport by public employees of 20 percent, will lead to a 50 percent reduction of CO_2 emissions and 80 percent reduction of Particulate Matter (PM_{10}) emissions. The city foresees 20 percent less road accidents around schools and a 60 percent reduction of accidents around the newly introduced 30km areas. A new intelligent transport system (ITS) control system is projected to curb the invasion of reserved lanes by private vehicles by 20 percent, restrain illegal street parking by 20 percent, and lower the number of mopeds and freight vehicles crossing through the Limited Access Zone by 20 percent, as well.

Implementing sustainable mobility

In 2006, Bologna was the first city in Italy to implement a road pricing policy based on an intelligent transport system (ITS). The revision of the system will finalise the strategy as part of the city's urban traffic master plan. The system will focus on the "real" external costs of journeys made by private car and make regulations and access control more flexible accordingly.

The main objectives of the measure are to:

- Guarantee flexibility in regulations and access control;
- Improve access policy of the limited traffic zone (LTZ) based on economic incentives or disincentives and the support of electronic instruments;
- Demonstrate the effectiveness of urban mobility management through regulatory

measures;
- Introduce a semi-pedestrian area within the LTZ;
- Promote public transport, cycling and walking; and
- Reduce polluting emissions in the urban area.

Bologna expects that the new road pricing system will significantly lower the circulation of the most polluting vehicles. More specifically, the city expects that the measure will result in:

- A 10 percent reduction in long-term access permission requests;

Intermediate results from 2010 registered:

- A 1.8 percent reduction of car and motorbike access to the LTZ between 7:00 and 20:00; and
- A 2.4 percent reduction of car and motorbike access to the LTZ during an entire day from 0:00 to 24:00.

Source: http://civitas.eu

Driving force for implementation
Cities are by definition interested in enhancing the quality of life of their citizens, and offering them a pleasant environment to live in. Cities also have the highest concentration of air pollution; therefore it is important that local and governmental authorities play an active role in improving air quality standards, as individual citizens are incapable of changing the air quality situation unaided. Better air quality also has benefits in terms of reduced strain on health care infrastructure. The urban area is also made a more attractive place in which to live and work.

Economics
"Air pollution is one of the most serious environmental problems in urban areas around the world. The rapid process of urbanization and extensive energy utilization (mostly due to rapid economic expansion and population growth over the past few decades) has made urban air pollution a growing problem. The air contains varying levels of pollutants originating from motor vehicles, industry, housing, and commercial sources. The effects of air pollution have multifaceted consequences for human welfare. […] Notably, numerous studies have shown that air pollution adversely affects human health. Epidemiological evidence supports an association between exposure to ambient air pollutants and various health effects, such as respiratory symptoms or illness (e.g. asthma), impaired cardiopulmonary function, reduction of lung function, and premature mortality. In particular, the most serious health impacts include a significant reduction in life expectancy, and premature death, both of which are strongly linked to exposure to PM. Although exposure to air pollution damages the health of everyone, numerous studies have shown that certain groups of vulnerable people (e.g. elderly people, children, and those with underlying disease) are at greater risk of being affected by air pollutants" (Retrieved from: Pervin, 2008). This represents a heavy cost for national health systems providing care. It is therefore in the best interest of public administration to reduce diseases created by air pollution. As cities are the centre of economic output, the societal costs of developed countries is estimated to be 2% of the Gross Domestic Product. The ailments caused by poor air quality may also lead to a correlative loss in productivity (Hester, 2009).

Reference Public Administrations
There are numerous publications on air quality in Helsinki published online, providing an in-depth look at the city's commitment to clean air. Documents include:

- Air quality in the Helsinki metropolitan area:
  http://www.hsy.fi/seututieto/Documents/Ilmanlaatu_esitteet/air_we_breathe.pdf

- Environmental Sustainability Issues and Challenges in Helsinki 2010: http://www.hel.fi/wps/wcm/connect/7d593d004298169a9779bf4b956b8a55/Environmental+Sustainability+-esite_nettiin.pdf?MOD=AJPERES&lmod=-918449852&CACHEID=7d593d004298169a9779bf4b956b8a55

- City of Helsinki Air Quality Action plan for the Period 2008-2016 Abridgement: http://www.hel2.fi/ymk/Ilmansuojeluohjelma/summary.pdf

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3.3 Best environmental management practices for urban water management

3.3.1 Chapter structure

This chapter provides guidance on the sustainable management of urban water. It starts by introducing the main elements of water management in European cities then explains the reasons that should push public authorities towards making efforts to improve their water management. Some Best Environmental Management Practices that can help public authorities do so are detailed in Section 3.3.5, and include Integrated Urban Water Management, the integration of externalities into the calculations that govern leakage detection and repair, the use of sewage sludge as a fertiliser for bioenergy crops and finally Water-Sensitive Urban Design.

3.3.2 Chapter Introduction

Traditionally, European cities started on the path of water management by supplying water to their citizens, gradually taking on responsibilities such as sewerage and drainage as cities expanded and urban population grew. More recently, cities have also taken on pollution reduction and the protection of waterways. This introductory section will present some key information about urban water management in Europe.

Consumption patterns – both per capita and among the different economic sectors – vary widely among European countries, as does water availability, though not always in a way that correlates with precipitation levels: perhaps counter-intuitively, countries such as Belgium and the United Kingdom are actually classified as water-stressed[26]. Roughly speaking, around 45% of water is abstracted for agriculture, 40% for industry and energy production and 15% for public water supply, although water abstraction for agricultural use is higher in southern Europe and that for industrial and energy production purposes is higher in northern Europe (EEA, 2003).

The percentage of the population that is connected to wastewater treatment facilities tends to be higher in northern Europe, as does the use of more advanced (tertiary) wastewater treatment systems, as shown in Figure 3.35. As will be explained in more depth in subsequent sections of this chapter, compliance with EU legislation is leading to an increase in both rates of connection to sewers and in the degree of wastewater treatment throughout Europe.

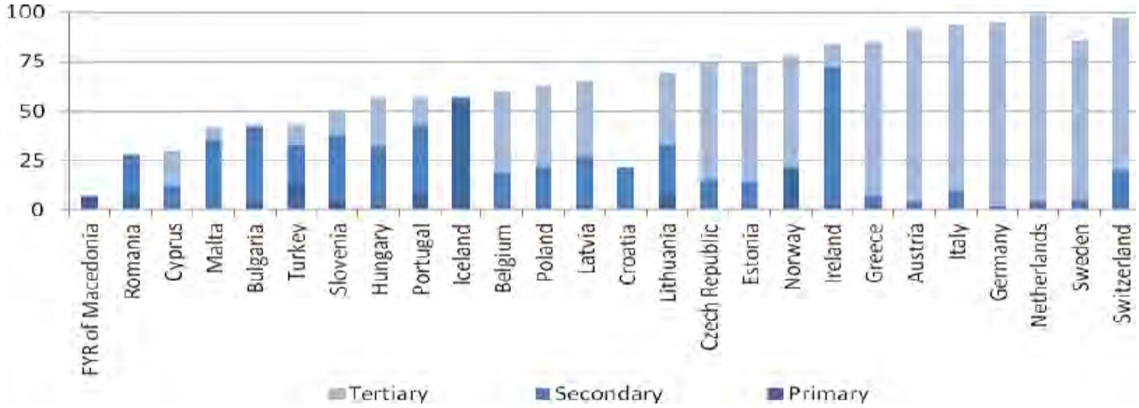

Figure 3.34: Population connected to wastewater treatment (% of total), 2007[1]. Source: Eurostat

A. Main actors

In the EU-27, drinking water operators are 70% publicly-owned, 15% privately-owned and 10% with mixed ownership, with some variation between Member States. Wastewater treatment plant operators break down in a similar way, with the proportions being 79%, 9% and 12% respectively (EUREAU, 2009). Some countries such as The Netherlands mandate the public ownership of drinking water supply companies. For both drinking water and wastewater operation, France, England and Wales are notable for the very high percentage of private operators, as can be seen in Figure 3.36, which shows the clustering of European countries according to a typology of water service operators. The private sector dominates large-scale water service delivery, with a small group of companies from France (Veolia and Suez) and the UK (such as Britain-based Thames Water) leading the pack while also investing in other countries both within and outside of Europe.

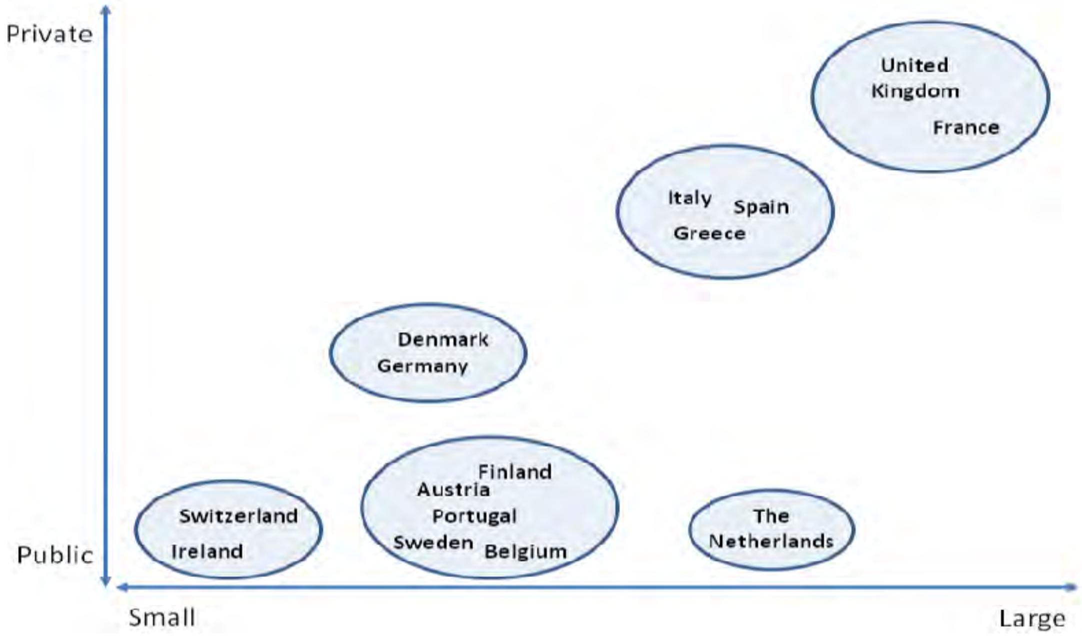

Figure 3.35: Clustering of European countries according to typology[27] of operators (Adapted from: EUROMARKET, 2004)

There are two ways to approach the tasks of urban water managers – the following points will take a sub-sectoral view, examining water supply management, wastewater management and stormwater management in turn. The other way to view these tasks is to look at the end goals,

which are to supply water of an adequate quality and quantity and to limit or eliminate pollution to water bodies. These goals are strongly interlinked, particularly when a more sustainable approach to water management is taken; for example, stormwater is then viewed not as an inconvenience or a source of pollution, but rather as a resource (for water supply).

B. Conventional water supply

The conventional approach to urban water supply is very much demand-driven: investments in resource development, abstraction regimes, treatment techniques and distribution networks are made in response to increases in demand. This approach has been in place for many hundreds of years, and has been a success in the sense that it has allowed for the development of complex urban networks; however, its limitations are increasingly being felt. The unsustainable use of resources has led to their depletion in many parts of Europe, depletion which will only become more severe with population growth and climate change. Conventional systems also tend to be highly energy-reliant, costly and inflexible in the face of changing demand patterns. Unless actual water use is charged, a lot of wastage tends to occur; given that distributed water is treated to potable standard regardless of its end use, the implications are even stronger (Philip, 2011a). Another feature of conventional water distribution networks is that they tend to be highly prone to leakage; active leakage management will be examined as a best practice in Section 3.3.6. The components of water supply management are as follows (Philip, 2011a):

- Resource: Additional water resources are conventionally obtained by damming rivers, abstracting water from lakes, rivers, or aquifers, constructing reservoirs and other means.

- Abstraction: Water withdrawals usually make use of boreholes, pumping equipment and gravity flow channels.

- Treatment: Drinking water is commonly produced through processes such as filtration, sedimentation, aeration, coagulation, disinfection or desalination.

- Distribution: Water is normally conveyed from its source to its point of use through a distribution network composed of water towers, pumping equipment and pipes, and any leaks in the distribution system are detected and repaired based on economic calculations.

- Demand: Water use is customarily controlled through the metered charge of customers' water consumption.

C. Conventional wastewater treatment

In most cities, blackwater (from toilet flushing), greywater (from kitchen sinks, showers, washing machines etc), stormwater and often wastewater from industrial processes are conveyed via a sewer system to wastewater treatment plants which use several methods for treating the water. Typically, the wastewater is first mechanically pre-treated, then goes through a primary (settlement, mainly mechanical) and then a secondary (biological) treatment stage. Some wastewater treatment plants then perform tertiary treatment on the effluent, which typically involves filtration and nutrient removal, though – as will be detailed subsequently in this section – this is only mandated in the EU for agglomerations of a certain size or location.

The outputs of this series of processes are on the one hand liquid, with treated effluent that is discharged to water bodies, and on the other hand solid, with sludge that is typically either sent to landfill or incinerated (having first gone through processes seeking to reduce its moisture content) and is also used to fertilise agricultural crops. The use of sludge as a fertiliser will be examined as a best practice in Section 3.3.7, which will also provide a short overview of landfill disposal and incineration.

D. Conventional stormwater management

The basic principle of urban stormwater management is the rapid conveying of stormwater away from urban areas as fast as possible to avoid localised flooding. Usually, cities use either combined sewers (where stormwater is mixed with domestic and industrial wastewater and sent to wastewater treatment plants) or separated sewers (where stormwater is collected separately, subjected or not to treatment, and then discharged to the environment), or a combination of both. The paths taken by rainwater are shown in Figure 3.37. In this conventional system, stormwater is regarded as a nuisance rather than as a potential resource.

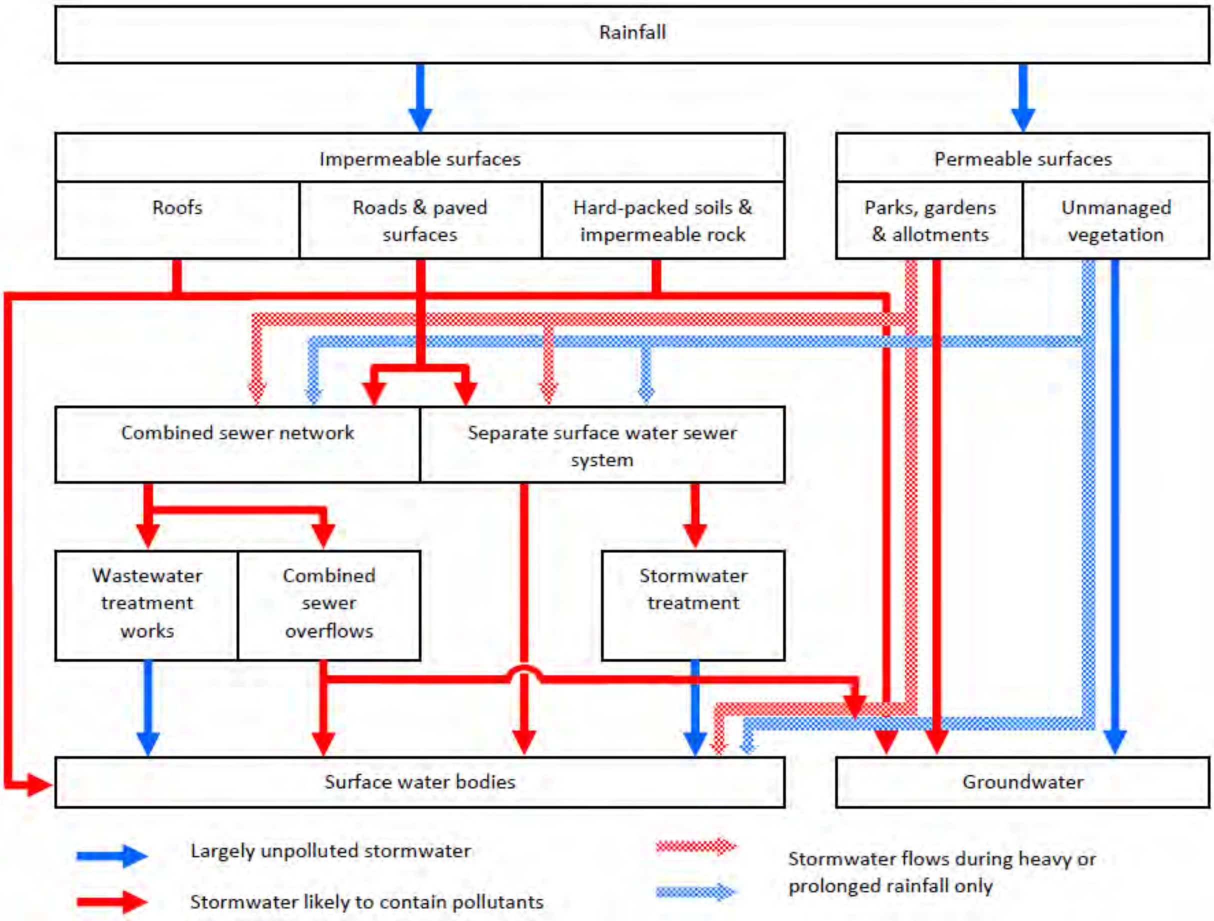

Figure 3.36: Stormwater flows (minus evapotranspiration). Source: Philip, 2011b

The legislative context

As a resource vital to human health, the environment, economic development and many other sectors, water is regulated at the European level. The Water Framework Directive (WFD), adopted in 2000, consolidated a number of existing Directives linked to nitrate pollution, drinking water, bathing water, groundwater, urban wastewater treatment and other target areas, in an effort to harmonise approaches and combat deteriorating water quality. Taking a river basin approach rather than one based on political boundaries, the WFD obliges Member States to establish river basin management plans, and its main target is the achievement of "good" ecological and chemical status in all European waters by 2015. As well as controlling point source pollution, the WFD also seeks to reduce non-point pollution by mandating the application of control measures and best practices (European Commission (DG Environment, 2008).

→ **Cross-sectoral links**

The Water Framework Directive is also linked to other EU legislation, for example that relating to chemicals (the Registration, Evaluation, Authorisation and Restriction of Chemical substances, or REACH Regulation) or to industrial installations (the Integrated Pollution and Prevention Control, or IPPC Directive).

Being a directive rather than a regulation, the WFD must be transposed at the national level, and Member States also have to comply with its component Directives. The one most relevant to urban areas is the Urban Wastewater Treatment Directive, whose requirements vary based on the size of the urban area and on the status of receiving water bodies. Requirements increase in stringency as agglomeration size increases and for those located in more sensitive areas – such as eutrophied bodies of water – but the basic level is secondary treatment of wastewater, for agglomerations of at least 2,000 inhabitants or their equivalent (European Commission (DG Environment), 2008). This Directive has important implications for many agglomerations; one of these is the fact that it will greatly increase the quantity of sewage sludge that will need to be reused or disposed of. This topic is explored in greater depth in section 3.3.7. Relevant component Directives and other associated Directives are described in more detail in the related best practice sections.

3.3.3 Drivers of public authority water management improvement

The conventional approach tends to view urban water management in a fragmented way, often causing unintended impacts, and also tends to rely on technological solutions that are energy-intensive, inflexible and have a short-term horizon. Moreover, developments such as climate change, rising energy costs, deteriorating infrastructure and population growth are posing increasingly graver challenges to it.

A more sustainable approach to urban water management is one that is integrated and emphasises sustainability, flexibility, site-specificity as well as the consideration of all water uses and users (Mitchell, 2004 as cited in Philip, Anton & van der Steen, 2011). The urban water cycle, which is characterised by the strong interconnection of its different elements: freshwater, stormwater and wastewater (Figure 3.38), as well as by its links with other urban management sectors, makes the integrated management of water particularly valuable.

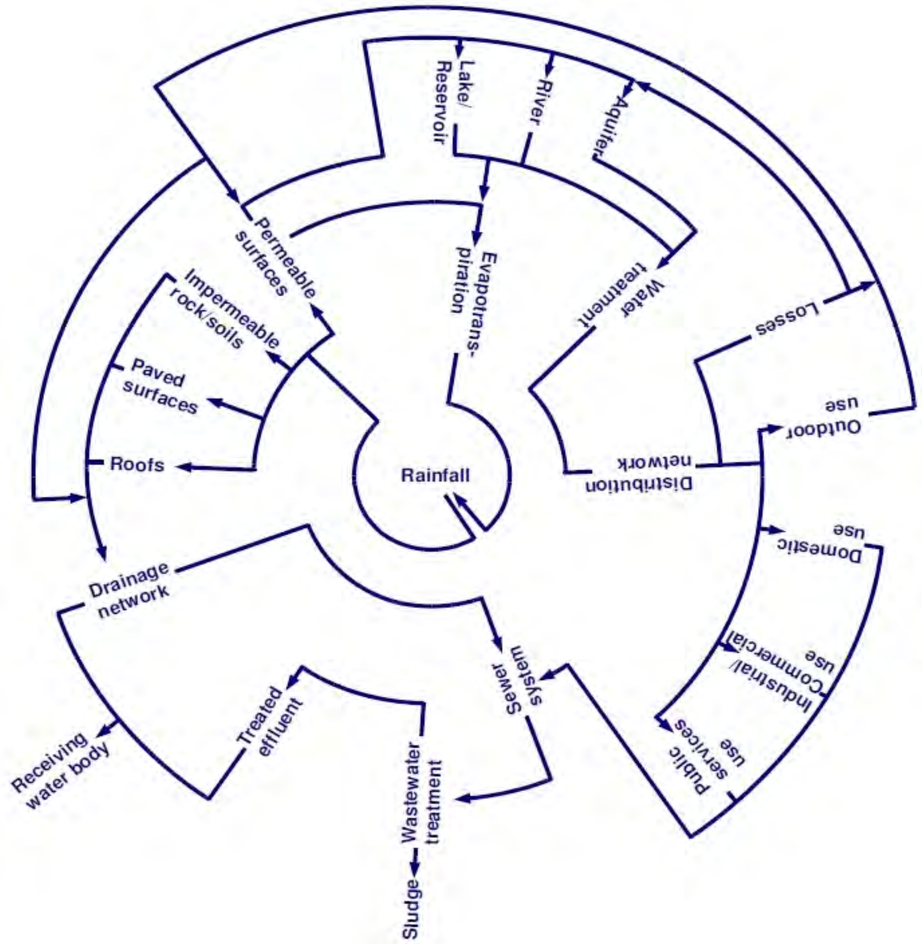

Figure 3.37: The urban water cycle. Source: ICLEI, 2011

The sustainable management of water has positive implications for other urban sectors. For example, sustainable flood control reduces damage caused to transportation and housing infrastructure, and preventing water scarcity removes its negative effects on economic productivity. Moreover, the water-sensitive management of other sectors is also vital to sustainable water management; for example, land use changes can have a profound effect on local hydrology; also, water treatment is traditionally dependent on a stable supply of energy. Finally, the link between water and quality of life is manifested through several aspects such as health, aesthetics and green spaces.

→ **Cross-sectoral links**

The examples provided above are some of many available illustrations of the linkages between different urban sectors.

Links also exist between the different elements of the water cycle and can be both positive and negative. Examples of positive links include using captured stormwater or greywater as an alternative supply of water, while examples of negative links include the contamination of water supply by improperly treated wastewater or reduced groundwater recharge due to the installation of impermeable stormwater management infrastructure.

Integrated management, ideally put in place from the beginning (for example at the planning stage in the case of new housing developments), allows for the rapid identification of synergies and conflicts within the water cycle and between water and other urban sectors, and for putting solutions in place in a timely and cost-effective manner.

3.3.4 Techniques portfolio

In this chapter, Integrated Urban Water Management (IUWM) is presented as a best practice, as is the integration of externalities in leakage management, the use of sewage sludge as a fertiliser for bioenergy crops and Water-Sensitive Urban Design (WSUD) mainly for stormwater management. For the sake of clarity, the latter three BEMPs have been presented independently; in reality, however, these practices are some of the many tools that can and should be applied as part of an IUWM approach. Other IUWM tools and techniques not covered in this chapter have been illustrated in Figure 3.39 below.

While the WFD does promote the adoption of an integrated approach to water management at the river basin scale, for example focusing on the links between water and agriculture as well as industry, it has been criticised for not encouraging integration to a greater extent (Rahaman, Varis & Kajander, 2004; van der Steen, 2006). The water-specific approach to integrated management presented in this chapter, Integrated Urban Water Management, takes a more holistic view of the urban water cycle, seeking to close nutrient and water cycles and to take energy and agriculture into account to a greater extent. IUWM also aims to develop urban water systems that cover all aspects of sustainability: environmental, social and economic (van der Steen, 2006).

The first IUWM tool presented in this chapter is leakage management, and more specifically the integration of externalities such as greenhouse gas emissions into the economic calculations made regarding leakage detection and repair. This cutting edge practice allows for the consideration and quantification of the costs and benefits associated with leakage detection and repair from both an environmental and a social perspective. When these considerations are added to the common practice of evaluating economic costs, they allow for leakage control that has taken a more truly sustainable approach.

The third BEMP covered in this chapter is the use of sewage sludge for the fertilisation of bioenergy crops. Sewage sludge is not a particularly pleasant topic, but it is also not a problem that will go away by itself. Instead, it is a problem that will get worse in Europe as the provisions of the WFD becomes more widely implemented. Sewage sludge contains valuable nutrients and has other properties beneficial to soil; as such, its use as a fertiliser is a sustainable technique that enables the closing of the nutrient loop. However, issues associated with sludge quality mean its use on food crops is controversial; applying it to non-food bioenergy crops that will themselves produce renewable fuel provides a good compromise.

Water-Sensitive Urban Design, subject of the final BEMP, is a concept that integrates the management of urban water (with a particular emphasis on stormwater) with urban design and landscape planning. At the core of WSUD is the idea of making stormwater infrastructure a visible and attractive part of a city rather than seeking to bury it underground. The series of technologies and techniques that can be applied under a WSUD approach also aim to be multi-functional and to provide a series of co-benefits for cities and their citizens, notably health, recreation and ecosystem services. Finally, WSUD options are strongly linked to other aspects of urban water management, often serving water treatment and water supply functions.

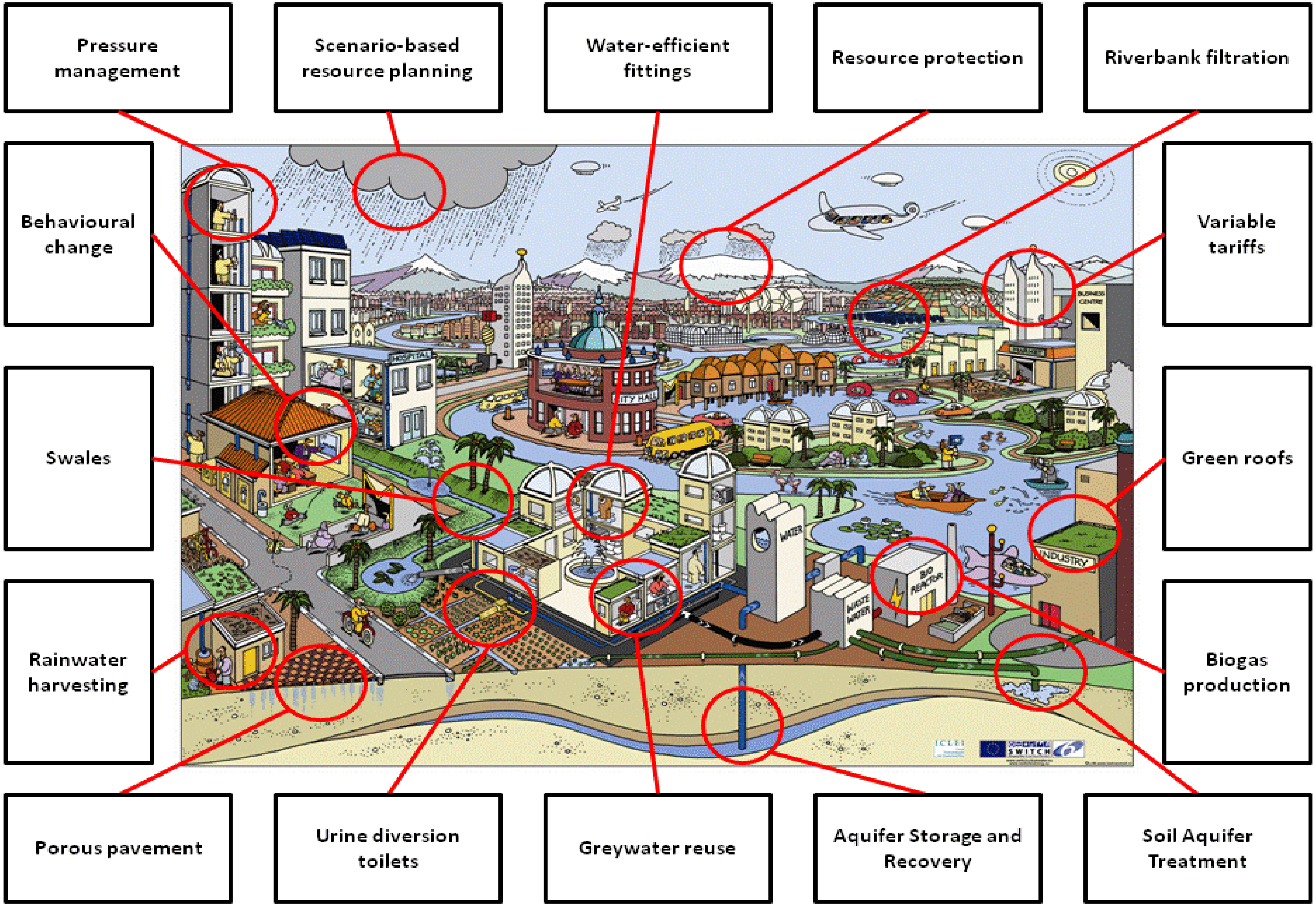

Figure 3.38: Water supply, stormwater and wastewater BEMPs illustrated in the SWITCH Water-Sensitive City of the Future. Source: ICLEI European Secretariat, 2011

3.3.5 Integrated Urban Water Management

Description

The clue is in the name: Integrated Urban Water Management (IUWM) involves the management of the urban water system in an integrated way, i.e. considering all elements of the system. IUWM has several key principles, including (Bahri, 2011 and Mitchell, 2004 as cited in Philip, Anton & van der Steen, 2011):

- Managing the various water management processes (such as storage, distribution and treatment) in a unified way.
- Considering a wide range of water types, including stormwater and wastewater, as resources.
- Balancing the three dimensions of sustainability: environment, social and economic.
- Involving stakeholders in decision-making processes, including water *users*.
- Considering all water *uses*, including ecological water use.
- Matching the water quality of different sources with requirements of different uses of water.
- Emphasizing the protection of water resources at the source.
- Addressing the specificities of the local context.

Achieved environmental benefits

IUWM can bring about environmental benefits simply through the consideration of different parts of the urban water cycle as being linked to one another and to other urban sectors. Bringing together local government staff responsible for different sectors can help identify synergies and conflicts between their areas of responsibility. For example, bringing together personnel from the water department with those from the planning, housing or transport department can lead to an appreciation of the consequences in terms of stormwater flows of any new developments planned by these non-water departments.

Appropriate environmental indicator

Table 3.9: Appropriate environmental indicator - Integrated Urban Water Management

Indicator	Unit of measure (A)	Unit of measure (A/B)	Description
Water drawings	m^3	m^3 water drawings/ population	Annual water drawings can disaggregated by different extraction bodies (underground waters, rivers, lakes…)
Water drawings from stressed water resources	m^3	m^3 water drawings from stressed bodies/ m^3 total water drawings	Annual water drawings from stressed water bodies and stressed groundwater aquifers
Water consumption	m^3	m^3 water consumption/ population	Water consumption can be disaggregated into the following sectors: household, tertiary, industry, agriculture/other use (e.g tourism)

Indicator	Unit of measure (A)	Unit of measure (A/B)	Description
Household water consumption	m^3 litres	m^3 drinking water household's consumption/ population /365 litres drinking water household's consumption/ population/ 365	Household consumption are usually expressed in terms of daily consumption. So the total amount (expressed in m^3 or litres) of drinking water consumed in a year should be divided by 365.
Water consumption of public buildings	m^3	drinking water consumption in public buildings/ total employees working in public buildings	Water consumption of public buildings could be accounted separately. In this case the water consumption should be divided by the total number of employees working in public buildings.
Quality of drinking water	number	n. controls with exceedings/ total controls	The number of exceedings could be influenced by different national legislations.
Orders of no drinking water	number		Orders of no drinking water registered in a year
Inhabitants connected to wastewater treatment	number	n. inhabitants connected to wastewater treatment/ total population	Inhabitants connected to waste water treatment disaggregated considering: primary, secondary and tertiary treatment
Quality of wastewater	number	n° of exceedings per year	The number of exceedings could be influenced by different national legislations.
Water treatment efficiency	%	% BOD_5 reduction; % COD reduction	In case there were many plants, the % of reduction have to be reported for each plants serving more than 2,000 equivalent inhabitants.
Authorization of household waste water into soil	number		
Surface water quality (lakes, rivers, coastal waters)	number	water bodies classified as "high" or "good" ecological status/ total number of water bodies	Number of water bodies into five status classes of ecological status: high, good, moderate, poor and bad. 'High status' is defined as the biological, chemical and morphological conditions associated with no or very low human pressure

Benchmark of excellence

Since 1994, environment protection and sustainable management of natural resources has been a constant feature of the Zaragoza Strategic Plan. As a result of this strategic process, the actions issued from Zaragoza water policies have been included in the Action Plan of the Local Agenda 21 with the basic objective of reducing water consumption.

Zaragoza, with an annual water consumption of 82.6 m^3 per inhabitant in 1994, fixed an objective for 2010 of 65 m^3 , a goal that was reached in 2006.The different campaigns to make people more aware of the necessity of a responsible consumption of water has produced a 23% decrease of domestic consumption, which has reached 104 l/person/day in 2010, a figure clearly under the national average that is around 154 l/person/day.

The campaigns, fully shared with non-government organizations, have been planned both for homes and for school children as well as for professionals, businesses and institutions. The approximate cost of the campaigns from 2002 has been around 2,500,000 Euro and have been implemented establishing two basic lines:

Hammarby Sjöstad is a new urban development in Stockholm where more than 35,000 people will live and work by 2017. Built on a formerly industrial site, it has been designed and built based on holistic environmental principles. One of Hammarby's environmental goals is to halve water consumption. Stockholm residents use 200 litres of water/person/ day. The goal in Hammarby Sjöstad is 100 litres, and thanks to eco-friendly installations, consumption levels are currently at around 150 litres.
Cleaner wastewater is another goal. The quantities of environmentally harmful substances reaching the archipelago via the treated wastewater shall be reduced by 50 % and 95 % of the phosphorus shall be separated out and recycled for use on farms. A test treatment plant for wastewater from the equivalent of 600 people has been built in order to evaluate new technology. The four treatment lines being tested use chemical, physical and biological processes. The wastewater sent to the local treatment plant comes exclusively from the residential units in the area and the levels of contaminant it contains are, therefore, hopefully minimal. The sewage sludge from the treatment plants is biodigested and then used as fertiliser. Biogas extracted from this process is used by buses and approximately 1,000 gas stoves in Hammarby . Storm water, rainwater and melt water are all collected and treated locally.

Cross-media effects

Although most are 'no regret' and indeed often bring many associated benefits for things like quality of life, some individual techniques and technologies associated with IUWM can have side effects for other sectors. However, making technological choices within an IUWM framework allows from precisely the kind of joint management that is needed in order to avoid or plan for these side effects.

Operational data

An iterative management process is essential to the establishment of IUWM in a city, as it takes a holistic and integrated approach to water management, allows for continual improvement and ensures political buy-in for a city's sustainable water management. Its commitment to regular evaluation allows for adaptive management to changing circumstances, and its emphasis on scenario-building encourages the choice of solutions that are most likely to succeed.

→ **For more information…**

…see Section 3.6 of this document, which provides more detailed information on the cyclical sustainability management process.

As has been illustrated previously, IUWM has at its heart the integration not only of the different elements of the water cycle but also a consideration of the links between different urban sectors. As such, it is important to allow for coordinated decision making within a local government, for example through the establishment of a coordination unit with a wider overview of the urban water system and the ability to make links with related urban sectors.
Beyond the local government, the integrated management of urban water also requires the involvement of affected stakeholders in the decision-making process. Stakeholders include not only water users, be they domestic, industrial, municipal or agricultural, but also those who play a role in its management for example in terms of treatment or abstraction. To contribute in a meaningful way to integrated urban water management, stakeholder involvement is a process that needs to be fully integrated into the cyclical management of IUWM, thereby maximising the relevance of decisions but also stakeholder buy-in to these.

Box example: Learning Alliances for stakeholder involvement

Learning Alliances are a type of multi-stakeholder involvement that seek to bridge the gap between experts and stakeholders and are based on the principles of action research. Collaboration in the formulation of the research agenda and in the research itself allows for a joint learning process which is more likely to come up with practically-applicable solutions. As part of the 'SWITCH – Managing Water for the City of the Future' project (2006-2011), Learning Alliances were set up in a number of cities throughout the world (Anton, 2011).

Figure 3.39: Hamburg's Learning Alliance. Source: Niklas Klosterman

City example: Multi-sectoral integration in Hammarby Sjöstad (Stockholm), Sweden

Hammarby Sjöstad is a new urban development in Stockholm; over 35,000 people will live and work in this mixed-use district by the time it is completed in 2017. Built on a formerly industrial site, it has been designed and built based on holistic environmental principles, and has planned its development in an integrated way. District planners have developed the 'Hammarby Model' (figure 3.41), an eco-cycle based on closed-loop thinking, where the various urban systems (such as water, energy and waste) have been designed as an integrated system rather than in isolation. The Model takes advantage of the interrelationships between various areas of urban management. Its integrated planning allows for energetic and financial savings as well as waste reduction, as the outputs from one urban system are planned as a resource for another rather than becoming waste (Loftus, 2011a).

As an example of integrated planning within the urban water system, the uncontaminated rainwater from Hammarby Sjöstad's roofs, courtyards and streets is drained into the adjoining lake rather than conveyed to wastewater treatment plants, thereby avoiding the unnecessary dilution of water to be treated. Integration between the water system and other urban systems is also achieved, as can be seen in the following examples:

- Biogas from the anaerobic digestion of sewage sludge is used as a transportation and cooking fuel
- The wastewater treatment process produces district heating and cooling.
- Sewage sludge and organic waste from households are used as fertiliser for nearby agricultural activities.

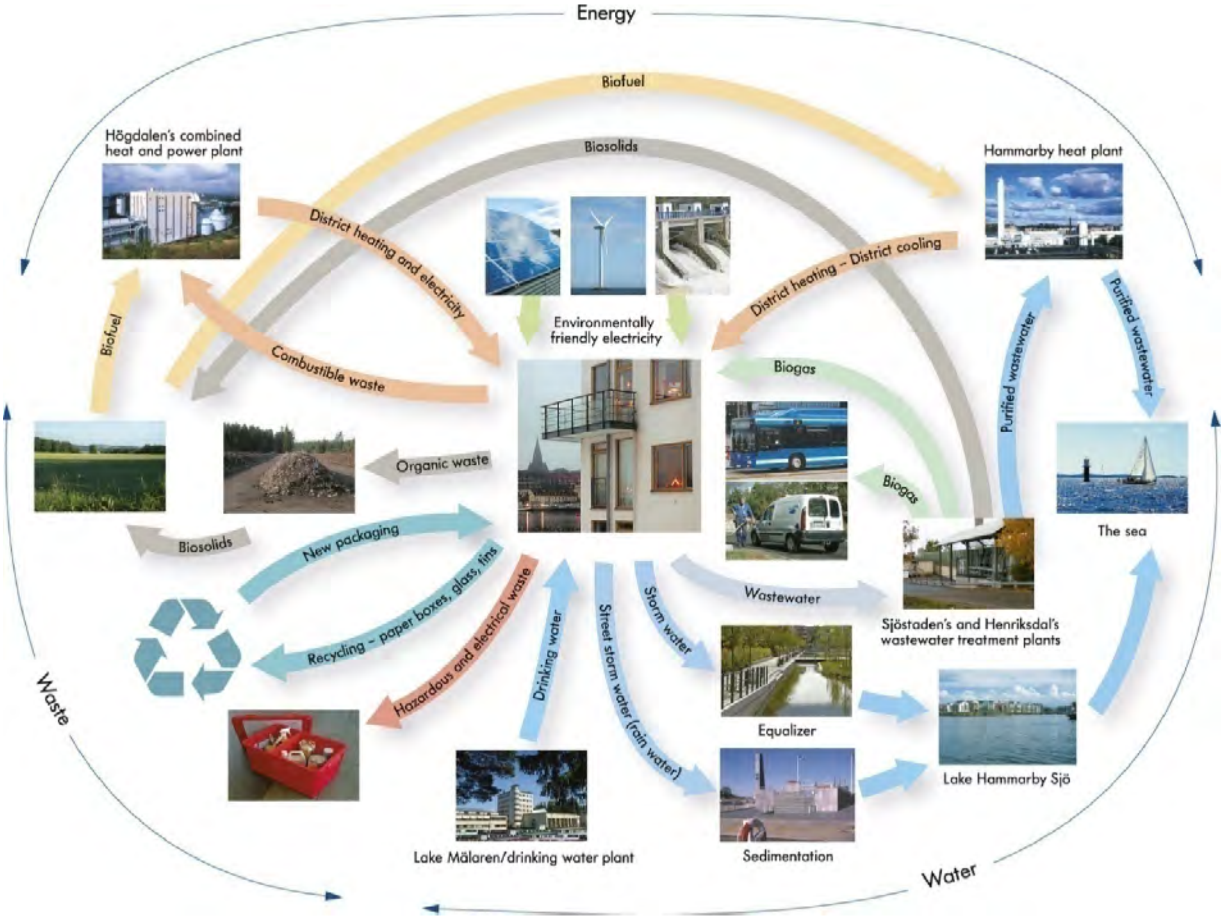

Figure 3.40: The Hammarby Model. Source: www.hammarbysjostad.se

Applicability

IUWM is applicable at the local level in cities of all sizes. Although larger cities tend to have more funds at their disposal for the implementation of pilot projects and the eventual roll-out of sustainable water management measures, as well as for the maintenance of a properly facilitated stakeholder involvement process, this does not mean that cities with fewer funds cannot implement IUWM.

The management of water in Europe is governed by a set of Directives which are themselves located under the umbrella of the Water Framework Directive. These Directives must be transposed to the national level by Member States, and while their end targets are binding, Member States are free to choose the methods by which to attain them. For example, the Urban Wastewater Treatment Directive does mandate water treatment for municipalities of a certain size, but the choice of methods for treatment is left open, as long as maximum concentration values for BOD, COD and suspended solids in effluent water are not exceeded. By leaving the choice of methods open and by not setting ceiling values for performance, these European Directives allow for the implementation of IUWM and its advanced components.

Some techniques or technologies that can form part of an IUWM portfolio might not be possible to implement because of national framework conditions. One example is sludge reuse as agricultural fertiliser, which is an IUWM technique that enables cities to close the nutrient loop, but which is effectively banned in a number of countries, such as the Netherlands, due to concerns about health. National legislation can also for example ban the use of greywater in the home, another possible IUWM technique. However, the implementation of IUWM itself does not face legislative barriers at the national level; indeed, it is simply an approach calling for integrated management. However, conditions particular to certain countries may create difficulties for the integrated management of water in urban areas, for example in terms of institutional or cultural barriers.

Contextual considerations

IUWM is applicable in all geographical and all cultural contexts. Cultural specificities might however require particular adaptations of the integrated management style and/or the stakeholder involvement process, though the end result should be the same.

Degree of complexity

The degree of innovation of some techniques and technologies associated with IUWM can be high. As for IUWM itself, the approach is innovative mainly in comparison with the conventional management of urban water, which is generally characterised by its lack of integration. A high level of expertise may be required for the application of some of the techniques and technologies associated with IUWM. The same can be said for the implementation of a stakeholder involvement process, whose success will often require the involvement of one or more dedicated persons with appropriate training in stakeholder process facilitation. On the other hand, the consideration of urban water in an integrated way may often not require more than bringing the relevant people around the same table.

Requirements

As will be detailed below, the financial implications of IUWM implementation can vary enormously depending on the choice of techniques and technologies. Investment in IUWM can be adjusted based on the requirements and resources of communities.

The implementation of basic IUWM principles does not require legislative changes: as detailed above, legislation may restrict the application of certain techniques and technologies associated with IUWM, rather than the implementation of IUWM itself. The establishment of a coordination unit and of a stakeholder involvement process will require administrative adjustments within the local government, which can however be on a small scale.

Political commitment is an essential pre-condition to the implementation of IUWM, and in fact is a step required within the sustainability management cycle. Political commitment allows for the setting in motion of the IUWM process and for the allocation of necessary funds, and lends credibility and legitimacy to the process, for example vis-à-vis stakeholders. Political action may also be required for institutional reforms.

Other considerations
Flexibility is one of the key principles of IUWM. Flexibility is enshrined not only within the available techniques and technologies of IUWM, which are most often modular, decentralised and small-scale, but also within the integrated management process itself which relies on communication, consensus and adaptation to changing circumstances. Given that IUWM can happen at many different depths, the feasibility of implementing it is high.
Social equity should be one of the things looked at within the multi-stakeholder involvement process that is at the heart of IUWM. Indeed, all water uses and users should be considered within this process.
The alternatives to IUWM are 1) the status quo of conventional and non-integrated water management and 2) the isolated application of sustainable water management techniques and technologies without consideration for other affected urban sectors. Although the second alternative does benefit from the introduction of more efficient tools for water management, it suffers – as the first alternative does – from a lack of integration, and hence does not take full advantage of synergies nor considers side effects. For many communities, particularly those facing floods or water scarcity, the importance of managing water in a more sustainable way, and of taking advantage of the positive side effects of IUWM, is high. Moreover, IUWM helps increase the resilience of urban water systems in the face of challenges that cities are facing now and will face increasingly in the future, such as climate change and rising energy costs.

Economics
The costs of IUWM implementation are highly variable and depend on the portfolio of techniques and technologies that are applied. When not taking this portfolio into account, however, the costs linked to the basic application of IUWM can be low, and basically entail the establishment of a coordination unit – which, in the case of small agglomerations, can even consist of one person – as well as of a process enabling integrated management, for example through regular meetings. IUWM implementation also entails the establishment of a stakeholder involvement process which, depending on the number of stakeholders and the level of complexity chosen, can also have variable associated costs. Ideally however, the stakeholder involvement process benefits most from highly-trained facilitation skills, the provision of which entails costs.
The returns associated with IUWM can be important. As detailed previously, IUWM allows for the identification of synergies and conflicts both within different parts of the water sector and between the water sector and other urban sectors, and can also prevent unwanted side effects (and their associated remediation costs). Moreover, many of the techniques and technologies associated with IUWM entail reduced operational costs, by for example requiring less energy to run and also reducing chemical inputs. Moreover, as infringement of the WFD bring about financial penalties, the implementation of techniques and technologies that reduce impacts to the environment also enable savings. Finally, any investment associated with IUWM should also consider the costs that would be associated with more conventional solutions, particularly in the case of new urban developments, where the integration of IUWM considerations at the planning stage can often lead to important savings in terms of construction and energy costs.

Driving force for implementation
IUWM implementation can apply a host of different techniques and technologies; some of these will be explained in following sections, while others have been illustrated. These techniques and technologies bring not only environmental benefits such as reduced water consumption and pollution, but also other benefits linked to other urban sectors, such as reduced energy consumption, and to quality of life. Table 3.10 summarises some of the co-benefits that are associated with IUWM options.

Table 3.10: Co-benefits of sustainable water management options

Options	Urban water management benefits	Selected quality of life benefits and co-benefits to other urban management sectors
Alternative supplies for non-potable demand	• Water supply: Reduces demand • Water supply: Reduces treatment and pumping costs	• Ecosystems: Less water needs to be abstracted from the environment • Urban economic activities: Increased water availability for other purposes • Agriculture and urban green areas: Provides a cheap source of irrigation water
Metering and tariffs	• Water supply: Reduces demand • Water supply: Reduces treatment and pumping costs	• Ecosystems: Less water needs to be abstracted from the environment • Quality of life (social equity): Variable tariffs ensure low-cost fulfilment of basic water needs for low-income groups
Behaviour change	• Water supply: Reduces demand • Water supply: Reduces treatment and pumping costs	• Ecosystems: Less water needs to be abstracted from the environment • Urban economic activities: Increased water availability for other purposes • Energy: Reduced energy consumption through the use of less hot water
Water efficiency measures	• Water supply: Reduces demand • Water supply: Reduces treatment and pumping costs	• Ecosystems: Less water needs to be abstracted from the environment • Energy: Reduced energy consumption through the use of less hot water • Urban economic activities: Increased water availability for other purposes
Leakage management	• Water supply: Reduces demand • Water supply: Reduces treatment and pumping costs	• Ecosystems: Less water needs to be abstracted from the environment • Quality of life (noise and disruption): Future repairs are avoided by pipe replacement • Quality of life (health): Reduces risks of contaminants entering pipes • Urban economic activities: Provides a more reliable supply of water
Aquifer Storage and Recovery	• Water supply: Increases storage capacity • Water supply: Protects water quality • Stormwater management: Runoff reduction • Wastewater treatment: Contaminant removal	• Quality of life (health): ASR provides natural protection from organic pollution and contaminated stormwater runoff • Ecosystems: Subsurface baseflows from ASR can be used to support natural ecosystems • Agriculture and urban green areas: Provides a cheap source of irrigation water
Urine diversion toilets	• Wastewater treatment: Reduces costs	• Agriculture and urban green areas: Provides a cheap fertiliser, and increases urban food security • Ecosystems: Reduction of the nutrient load from wastewater effluent
Soil Aquifer Treatment	• Stormwater management: Peak runoff reduction • Wastewater treatment: Reduces costs	• Agriculture and urban green areas: Provides a cheap source of irrigation water
Constructed wetlands	• Wastewater treatment: Reduces costs • Stormwater management: Reduces runoff • Water supply: Reduces potable water demand	• Quality of life (aesthetic enjoyment and amenity value): Increase in urban green space • Urban development: On-site treatment of greywater and stormwater • Ecosystems: Creation of urban ecosystems
Waste Stabilisation Ponds	• Wastewater treatment: Reduces costs • Water supply: Reduces demand for potable water	• Agriculture and urban green areas: Provides a cheap source of irrigation water • Quality of life (disposable income): Source of local income through harvesting of fish and plants
Biogas production from sludge	• Wastewater treatment: Reduces costs	• Agriculture: Provides a cheap fertiliser • Quality of life (increased disposable income): Reduces cooking and heating bills • Urban economic activities: Provides a cheap and renewable energy source
Sludge reuse	• Wastewater treatment: Reduces costs • Stormwater management: Improves soil moisture retention	• Ecosystems: Source of nutrients • Agriculture and urban green areas: Provides a cheap fertiliser and soil conditioner • Urban economic activities: Provides a cheap and renewable energy or fuel source
Greywater reuse	• Water supply: Reduces demand for potable water • Wastewater treatment: Reduces costs	• Ecosystems: Creation of urban ecosystems • Agriculture and urban green areas: Provides a cheap source of irrigation water • Quality of life (aesthetic enjoyment and amenity value): Increase in urban green space
Site planning	• Stormwater management: Reduced runoff • Wastewater treatment: Pollutants are contained at the source and nonpoint pollution is managed	• Ecosystems: Protection and enhancement of local habitats • Urban development: Development of land can be implemented cost effectively • Quality of life (aesthetic enjoyment): Stormwater-sensitive landscaping emphasises aesthetic features
Porous paving, swales, etc...	• Stormwater management: Reduced runoff • Water supply: Recharge of underlying aquifers • Wastewater treatment: Pollutant removal	• Urban economic activities: Reduced flooding risk • Quality of life (aesthetic enjoyment and amenity value): Swales provide grassy areas
Rainwater harvesting	• Stormwater management: Reduced runoff • Water supply: Reduces demand for potable water	• Ecosystems: Less water needs to be abstracted from the environment • Urban economic activities: Provides a more reliable supply of water • Agriculture and urban green areas: Provides a cheap source of irrigation water • Quality of life (general): Reduces water bills and provides a more secure supply of water
Green roofs	• Stormwater management: Reduced runoff • Water supply: Can reduce demand for potable water • Wastewater treatment: Removal of airborne pollutants from runoff	• Ecosystems: Creation of urban ecosystems • Quality of life (health): Improves air quality and reduces the urban heat island effect • Quality of life (aesthetic enjoyment and amenity value): Increase in urban green space • Energy: Reduced energy consumption through the use of less heating and air conditioning
Detention ponds and basins	• Stormwater management: Reduced runoff • Wastewater treatment: Pollutant removal	• Quality of life (aesthetic enjoyment and amenity value): Increase in urban green space. Use as playgrounds or sports facilities possibly during dry weather • Urban economic activities: Encourages investment in urban areas that would otherwise be prone to flooding

Reference Public Authorities

Hammarby Sjöstad (Stockholm) Sweden:

- Detailed information on the 'Hammarby Model' and the water management goals of Hammarby Sjöstad can be found on the website http://www.hammarbysjostad.se/
- For a general overview of Integrated Urban Water Management in Hammarby Sjöstad see the SWITCH case study 'A vision of Integrated Urban Planning comes to life in Stockholm's Hammarby Sjöstad district - Stockholm, Sweden' (Loftus 2011) which

can be accessed at:
http://www.switchtraining.eu/fileadmin/template/projects/switch_training/files/Case_studies/Case_study_Stockholm_preview.pdf

Dunedin, USA:

- An example of an integrated approach to urban water management is described in the paper 'Integrated Urban Water Management in Dunedin, Florida, USA: Sustainable Practices from a Small Coastal City in the Gulf of Mexico' (Yeh et al, 2011) which can be accessed at: http://www.switchurbanwater.eu/outputs/pdfs/W1-1_1-2_GEN_PAP_Integrated_Urban_Water_Management_in_Dunedin_USA.pdf

Lodz, Poland:

- A description of a Learning Alliance established in the City of Lodz is provided in the paper 'Reflection on the achievements and lessons from the SWITCH urban water management initiative in Lodz, Poland' (Wagner et al, 2011) which can be accessed at: http://www.switchurbanwater.eu/outputs/pdfs/W6-2_CLOD_RPT_SWITCH_City_Paper_-_Lodz.pdf

Reference literature
More information about best practices in IUWM is available from a variety of sources, including the SWITCH Training Kit (ICLEI European Secretariat, 2011). Access it here: www.switchtraining.eu/modules/

3.3.6 Water supply management: Integrating externalities into leakage management

Description
A variety of approaches can contribute to the sustainable supply of water, ranging from the protection of water resources at the catchment level to the reduction of demand through awareness raising campaigns. Active leakage control is another avenue for water demand management, at the utility level. When considering the water cycle as a whole, water leaks are not technically waste, since much of this water eventually finds its way to groundwater. However, when taking into account the enormous investments in the water supply network, covering infrastructure, energy and chemicals, the cost of treating water to a potable standard only to have it lost rather than delivered to its intended users is significant.
Water leakage rates vary across countries, ranging from 7% in Germany to 29% in the UK (Gebhardt, 2008 as cited in Wackerbauer, 2009). In some European cities, leakage rates can be enormous: Non-Revenue Water (NRW) amounts to 60% in Sofia and around 40% in cities like Dublin and Rome (SWAN, 2011). Some cities are hampered by the age of their infrastructure; for example, it is estimated that the average age of mains pipes in London is 100 years, with a third of them being over 150 years old – this is much higher than the European average of 40-50 years (Ratnayaka, Brandt & Johnson, 2009). Statistics provided by cities can vary widely, not least because of varying ways of measuring losses – the water balance developed by International Water Association (IWA) (Figure 3.42) is an effort to standardise these definitions. From the point of view of quantifying leakage, it is more useful if cities are able to evaluate real losses, rather than NRW (water input into the system minus water consumption that is billed and metered).

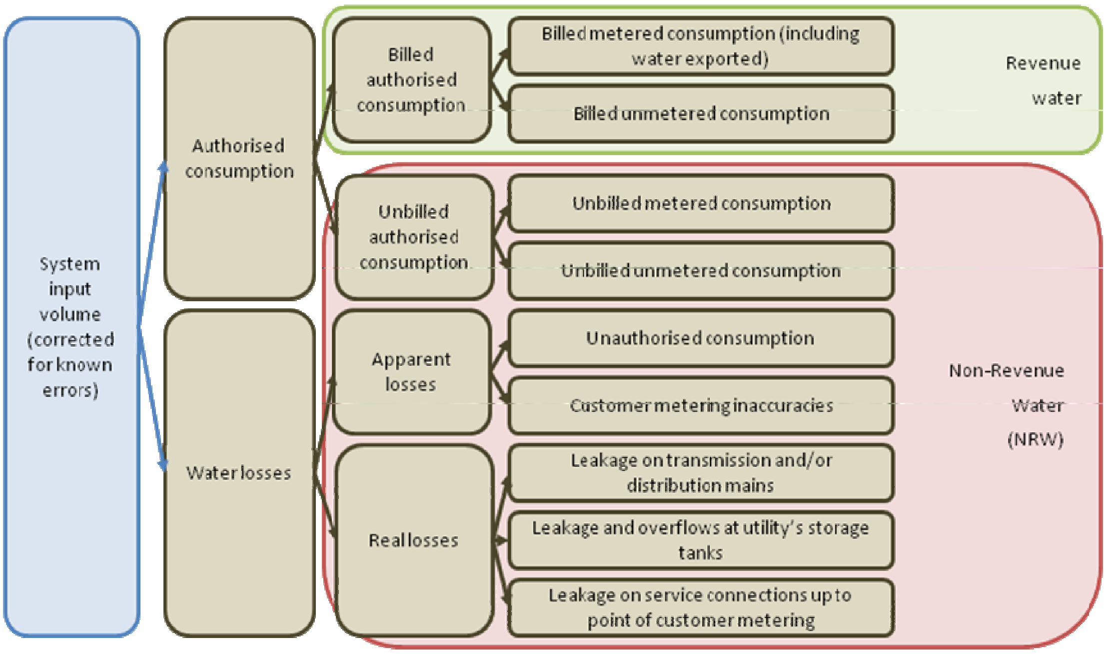

Figure 3.41: IWA standard water balance (Adapted from: Lambert, 2003)

Unlike some of the other BEMPs explored in this chapter, such as the application of sewage sludge to arable land, leakage reduction is not governed by European legislation. In many European countries, leakage is self-regulated by public or private water utilities, often following best practice recommendations set at the national level. For example, the DVGW (German Technical and Scientific Association for Gas and Water) is the German body that sets technical rules for utilities to follow. National standardisation authorities often follow best practice guidelines set by the International Water Association (IWA), as in the case of Germany, Austria and other countries (Lambert, 2003 and Lambert & Taylor, 2010).
The conventional response to leakage tends to be reactive, responding to visible leaks or changes in land surface and pressure drops indicating the presence of leaks: a more sustainable approach is active leakage management, where water managers seek to detect and repair leaks before they become visible or cause damage. Additional tools for advanced leakage management include pressure reduction, quick and efficient repairs and asset management. In the case of Berlin, leaks are actively detected using acoustic means, an effective but labour-intensive method. An alternative or complementary approach is the monitoring of discrete zones to enable targeted repairs. Rough estimates of leakage can be obtained by considering the use of water at the lowest use hours in certain defined metered districts, while making allowance for legitimate night uses of water such as that of hospitals, bars, household storage tanks that fill at night or night-time irrigation (Ratnayaka, Brandt & Johnson, 2009). If the measured night flows form a substantial percentage of average daily flows, this is likely to indicate the presence of leaks. This approach is often complemented by acoustic detection which enables a further narrowing down of the leak's location.

City example: Leakage reduction in Berlin, Germany

Berlin's water management has been strongly shaped by its geography – situated in a glacial valley, its substratum is gravel and sand underlain by clay, enabling extensive groundwater extraction – but mostly by its turbulent history. Following the Second World War, West Berlin was physically and administratively separated from the rest of the city. As a result, West Berlin implemented closed water cycle management by minimising consumption, controlling pollution and extracting water within city boundaries.

One element of this closed water cycle management in West Berlin was the strict control of leakage, not only to reduce costs associated with drinking water provision, but also to prevent groundwater pollution. The imperative to protect groundwater sources was particularly high, given that West Berlin operated a simple aeration, flocculation and filtration system for drinking water treatment since the high quality of groundwater made disinfection unnecessary. Following reunification, the water systems of East and West Berlin were once again joined, and the expertise gained in West Berlin was put to good use. Indeed, while leakage in West Berlin was around 4 or 5%, in the east it was rather in the order of 25%, due in large part to the choice of materials, the manner in which the pipes were lain and the insufficient maintenance of the pipe network. The city succeeded in bringing leakage rates in the east on a par with those in the west, and the Berlin Water Works also implemented a vast water saving campaign modelled on the work it had done in the west, to bridge the gap in water consumption between the two parts of the city.

In the past, the city undertook random searches of the extensive pipe network to find and repair leaks; this was quite a challenge and an expense (Berliner Wasserbetriebe, 2009). Subsequently, a more targeted and cost-effective system for leakage control was implemented in Berlin, relying on a number of techniques and technologies. An extensive database of the pipe network has been established, comprising information about the age, material and condition of pipes as well as information relating to their diameter, depth and flow capacity. The database also records information about leakages to determine both their nature and causes – natural events, traffic or construction or rather linked to shortcomings in their manufacture, installation or maintenance. Using the information gathered in the database, the city is better able to target leakage control activities by starting with the most affected areas (Heinzmann, 2004).

Figure 3.42: Checking for leakage noises in water pipes. Source: flickr /verifex

Water is conveyed through a city's pipe network under pressure. Leaks in a pipe make a distinct noise, which varies depending on the soil, the material and diameter of the pipe, the pressure the water is under and a number of other factors. Monitoring these leakage noises is an effective means to detect and subsequently repair leaks (figure 3.43). In Berlin, a system of microphones and sound locators (positioned in hydrants, valves or household connections) captures these leakage sounds and converts them to electric signals which are transmitted to a central correlation unit that assists ground-based teams in locating the leaks. In addition to these acoustic position-finding techniques, Berlin also uses a number of other techniques such as colour testing, differential pressure measurement, moisture measurement, infrared thermography and small cameras (Heinzmann, 2004).

Achieved environmental benefits

The environmental benefits of leakage detection and repair include water and energy savings. Water savings ease over-abstraction from existing sources and postpone the need to seek new sources of water supply. Reducing the amount of “lost” water reduces the need to treat additional water, leading to energy savings from the operation of pumping and treating equipment; these energy use reductions also lead to fewer greenhouse gas emissions into the atmosphere. The environmental benefits of integrating externalities into the evaluation of leakage repair are obvious, since this allows for the consideration and valuation of environmental variables.

Appropriate environmental indicator

Table 3.11: Appropriate environmental indicator – Drinking water

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Inhabitants served by drinking water network	number	inhabitants served by drinking water network/total population	Number of inhabitants living in dwellings served by the drinking water network
Losses in supply system of drinking water	m^3	m^3 losses)/ m^3 water put in the network m^3 losses / km of total water network per day	Percentage of losses distributed by the local water network, calculated as water put in the network - water consumption, . Water losses can be classified as: - real losses: leakages on transmission and distribution mains, service connections, overflows; - apparent losses: unauthorised consumption, metering inaccuracies. Water losses can be also compared to the network’s length. In this case daily losses have to be divided by the total length of the network.
Length of water pipeline to be renewed	km	km water pipeline to be renewed/ km of total water pipeline	Length of water pipeline which need to be renewed. It could be useful to specify the reason why water pipeline need to be renewed: age, materials, etc..

Benchmark of excellence

In the Netherlands water losses are fairly low when compared to other countries on the continent. In most European countries the average percentage of Non Revenue Water (NRW) is 10% to 20%.

The Rotterdam’s water network halved the percentage of losses between 2006 and 2010. The inefficiency of the use of water resources, defined as the percentage of NRW compared to the total system input, is estimated at 5,1%, coming from 10,2% in 2006. Distribution losses are less than 1,6m^3/km/day. The improvements in system efficiency are due to an active risk-based asset management of the water system with associated structural pro-active grid maintenance. An investment programme to replace PVC pipes with different materials with a longer life expectancy, such as metal is running from 2009 to 2013.

In Amsterdam losses in drinking water pipes have amounted to about 2.5 million cubic metres a year for many years. This is approximately 3% of the total. New investments and managements techniques applied in two neighbourhoods in Amsterdam (Amsterdam Zuid-Oost and Diemen Noord) has managed to reduce losses around 1.6%.

Similar results characterize the Antwerp's water network, which reached a percentage of losses of 2.3% in 2010, a further reduction with respect to the previous year (3,2%). All lead and asbestos pipelines with plastic connections are being replaced. In 2010, a total of 16 km new pipelines were installed and 10 km pipelines were repaired.

Operational data

Urban water distribution networks tend to be highly prone to leakage, detection and repair of which is generally decided by determining the point at which the cost of detection and repair equals the cost of treating and distributing more water – something known as the Economic Level of Leakage (ELL). Below this level, the cost of leakage repair is higher than the benefits gained from doing so. Usually, direct financial costs alone (which can be important, given the size, complexity and underground location of distribution infrastructure) are used to establish the ELL, rather than also considering external environmental and social costs (Philip, 2011a). Considering costs and benefits other than direct financial ones allows for a more sustainable approach which gives a more holistic view of leakage reduction. This integration of externalities into calculations leading to leakage detection and repair is the best environmental management practice explored in this section.

Externalities are positive or negative effects that occur as the result of an action, but that are not perceived by the entity that has perpetrated this action. In the case of leakage, externalities are costs or benefits that are not borne by or do not accrue to the water supplier. These externalities can be environmental, for example the environmental cost of finding additional sources of supply or of creating more greenhouse gas emissions by having to treat and distribute more water, but also social, such as the disruption caused by leakage repair work. The translation of such non-monetary costs and benefits into economic terms is fraught with assumptions and uncertainties, but is useful for informing decision making in societies where monetary considerations take primacy.

There is always a certain background level of leakage that is unavoidable, and the cost of detecting and repairing all leaks makes it prohibitive. Unavoidable annual real losses (UARL) are therefore commonly calculated, and these are a function of the number of service connections, the length of mains pipes, the length of private pipes and the average operating pressure (Lambert, 2003). Beyond these losses however, it is important to determine the point at which leakage reduction benefits outweigh the cost of leakage repair. When externalities are included into these costs, this point is known as the Sustainable Economic Level of Leakage (SELL). Ofwat, the economic regulator of the water and sewerage industry in England and Wales, has commissioned a guidance document on the incorporation of leakage management externalities into the ELL (RPS Water, 2007). Its main report is accompanied by a detailed guidance document which aims to guide water providers through a series of stages, as illustrated in Figure 3.3.11.

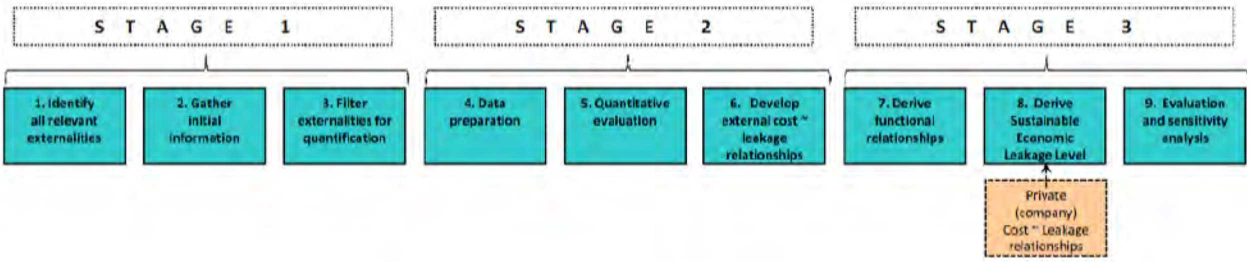

Figure 3.43: SELL calculation process. Source: RPS Water, 2008

The example of Zaragoza given below is one where the carbon dioxide equivalent emissions from leakage management activities have been calculated. Going forward, urban areas should bear in mind the fact that "green-house gas emission evaluation is still subject to a number of crucial discussions relating to the boundaries for evaluation and the methodologies used to avoid double counts" (EUREAU, 2011).

City example: Integrating leakage management externalities in the form of carbon emissions in Zaragoza, Spain

Zaragoza, in the past more reliant on supply-side options such as dam building, has implemented in response to water scarcity and increasing consumption a multi-faceted demand management campaign including awareness raising, tariff reforms and leakage management. Leakage control contributed to decreasing the city's water consumption: system losses were reduced by over 40%, equal to almost 20 million cubic metres of water per year (Philip, 2011c). Zaragoza has also sought to take into account the carbon emission externalities created by its leakage management activities.

Substantial amounts of energy are used by the water sector; although most of this energy is connected to the use phase (the heating of water in particular), the supply of water (pumping, treatment and distribution) still uses around 2 to 3% of worldwide energy consumption. Ideally, the roll-out of the practical application of the IUWM techniques which have been described in this chapter will reduce the energy intensity of the water sector; in practical terms however, energy consumption in the water sector is likely to keep growing for some time as it follows urbanisation trends and increases in quality standards (Muñoz-Trochez, Kayaga & Smout, 2010). The energy consumption linked to leakage detection and repair is not only linked to the energy consumed during the treatment and distribution of water that is then "lost" rather than consumed by end users, but also to the energy consumption of the detection and repair equipment among others. Moreover, energy is consumed as fuel through the transportation of leakage detection and repair teams and through the added fuel consumption caused by the traffic delays inherent with repair activities (Muñoz-Trochez, Kayaga & Smout, 2010).

In Zaragoza, the ELL (1,556 m^3 x 10^3/yr) and the UARL were first calculated. Then emissions from water supply and leakage management activities were estimated using data from the UK, given that figures were not available for Zaragoza, and applied to the type of leakage management undertaken in the city. In order to value emissions, the emissions of the various greenhouse gases were first converted into their CO_2 equivalent, to which a price was assigned in order to obtain a monetary estimate for the emissions. A study done in Zaragoza used 2009 figures of €57 per tonne CO_2 equivalent. The results of the evaluation showed that the value of the externalities (in terms of carbon emissions) for one city leakage repair crew were €20,000 per year – less than 10% of the financial costs (table 3.12). The study found that the bulk of emissions were produced from fuel, energy and materials use at worksites rather than from transport and energy use through labour (Smout, Kayaga & Muñoz-Trochez, 2010).

Table 3.12: Estimated emissions from leakage control activities. Source: Smout, Kayaga & Muñoz-Trochez, 2010

Source of Emissions	Description	Recorded data	Rate	kg $CO_{2}e$	Externality cost (€)
Labour – commuting and welfare	Crew of 4	217 days	32 $kgCO_2$/day	6944	€396
Fuel /energy use - transportation	Car and vans	7227 km	0.210 $kgCO_2$/km	1518	€87
Fuel / energy / materials use – worksites		501 repair events	344 $kgCO_2$/m pipe x 2m	344,265	€19,623
Total					€20,105

Applicability

The Ofwat guidance is intended for the UK water sector which, as has been shown, is characterised by the private operation of water services. However, the principles illustrated in the guidance are applicable for all water providers since these also make financial calculations prior to undertaking leakage management activities.

Geographical and cultural considerations play a role in the calculation of the SELL, since its elements are highly location-specific. For example, the impact of reduced abstraction on flow rates or water levels will vary greatly depending on the hydrological characteristics of a city's water supply, and the monetary valuation of social impacts can also vary greatly among cultures, depending for example on modes of transport and perceptions of the impacts of visual disamenity.
The calculation of SELL is an innovative approach which is beginning to be implemented in some countries. In the UK for example, the SELL approach developed by Ofwat follows on from prior efforts to make water service providers do cost benefit analyses (CBAs) for investments like leakage management, while making allowance for the fact that not all projects are cost-beneficial (RPS Water, 2007).
It is not yet an established methodology, but is likely to become more and more prevalent since it goes in line with the multiple facets of sustainable development: economic, social and environmental. The complexity of this approach is largely derived from the multiplicity of environmental and social variables that need to be taken into account, examples of which are shown in Table 3.13.

Table 3.13: Social and carbon-related externalities from leakage management. Source: RPS Water, 2007

Externality	Potential impacts	
	Carbon	Social
Transportation energy / fuel use	✓	
Road traffic delays / disruption and diversions	✓	✓
Pedestrian diversions		✓
Commercial and domestic disruption / disamenity due to excavation		✓
Noise impact of street works		✓
Transportation energy/fuel use	✓	
Work site energy / fuel use	✓	
Embedded materials	✓	
Road traffic delays / disruption and diversions	✓	✓
Pedestrian diversions		✓
Commercial and domestic disruption / disamenity due to excavation		✓
Noise impact of street works		✓
Transportation energy / fuel use	✓	
Work site energy / fuel use	✓	
Embedded materials	✓	
Avoided costs of discolouration		✓
Road traffic delays / disruptions and diversions	✓	✓
Pedestrian diversions		✓
Commercial and domestic disruption / disamenity due to excavation		✓
Noise impact of street works		✓
Transportation energy / fuel use	✓	
Work site energy/fuel use	✓	
Embedded materials	✓	
Commercial and domestic cost of flooding		✓
Cost of unplanned interruptions to supply / pressure reduction		✓
Transportation energy / fuel use	✓	
Work site energy/fuel use	✓	
Sewer flooding (water only companies)		✓
Road traffic delays / disruptions and diversions		✓
Cost of unplanned interruptions to supply / pressure reduction		✓
Extraordinary fuel use	✓	

Economics

Although the complexity of SELL calculations can add to the financial burden of leakage management, the aim of such a calculation is actually to avoid unnecessary repairs and hence expenditure. Moreover, making allowance for environmental and social externalities will reduce the cost associated with these, even though it may not have to be borne by the entity in charge of managing water.

Driving force for implementation

The advantages of leakage detection and repair are manifold. Leaks cause health risks by contaminating piped water, decrease the quality of service through pressure losses, damage roads, buildings and other infrastructure and increase the chance of further damage to pipes through erosion. Repairing leaks leads to water, energy and financial savings. Reduced energy use also equals lower running costs, which also benefit from reduced chemical input, reduced maintenance requirements and staff costs. Costs also become lower when leakage management postpones the need to invest in order to exploit new water resources – a deferment of capital expenditure. Since the integration of externalities into the evaluation of leakage repair allows for the consideration and valuation of environmental and social variables, its environmental and social benefits make its implementation beneficial for public authorities.

Reference Public Administrations

Berlin, Germany:

- General information on water management, including leakage control, in Berlin can be found at the following website: http://www.bwb.de/content/language2/downloads/info-engl-09.pdf
- More specific information on measures to reduce water losses in Berlin can be found in the paper 'Measures to minimise water consumption and water losses: case study Berlin' (Heinzmann, 2004) which can be downloaded at: http://www.bvsde.paho.org/bvsacd/cd63/measures.pdf
- The case study 'Making urban water management more sustainable: Achievements in Berlin '(Salian, 2011) can be downloaded at: http://www.switchtraining.eu/fileadmin/template/projects/switch_training/files/Resources/Salian_2011_sustainable_urban_water_management_-_Achievements_in_Berlin.pdf

Zaragoza, Spain:

- Information on efforts to reduce water demand in Zaragoza is available in the case study 'Reducing water demand and establishing a water saving culture in the City of Zaragoza' (Philip, 2011) which can be accessed at: http://www.switchtraining.eu/fileadmin/template/projects/switch_training/files/Case_studies/Zaragoza_Case_study_preview.pdf
- More general information on the overall approach to water management in Zaragoza can be found in the paper 'Zaragoza: Taking pride in integrated water management in the city' (Smits, Bueno, Celma, 2011) which is available at: http://www.switchurbanwater.eu/outputs/pdfs/W6-2_CZAR_RPT_SWITCH_City_Paper_-_Zaragoza.pdf

Reference literature

General information about water supply management is available in Module 3 of the SWITCH Training Kit (Philip, 2011a). Access it here: www.switchtraining.eu/modules/module-3/

Information on leakage management is available from national standard-setting organisations. A few examples are:

- For Germany, the DVGW: www.dvgw.de
- For England and Wales, Ofwat (The Water Services Regulation Authority): www.ofwat.gov.uk/

3.3.7 Wastewater management: Sludge reuse for energy crops

Description

As already explained, sludge is one of the outputs of the wastewater treatment process. In Europe, the application of sludge to agricultural lands is controlled by the Sewage Sludge Directive, which seeks to encourage it as a method of disposal. The Directive sets limit values for pathogens and some heavy metals in sludge. Unless it is incorporated within the soil in specific ways, the sludge must undergo a treatment process – be it biological, chemical, thermal, or involving storage – prior to use. The Directive also seeks to reduce the health risk from pathogens by prohibiting the use of sludge on most fruit and vegetable crops, as well as on the cultivation soil of fruit and vegetables (that are eaten raw or are in contact with soil) within ten months of their being harvested. Finally, the use of sludge on crops or grass that animals have access to is also prohibited for at least three weeks prior to grazing or harvesting (European Commission, 1986). The Directive is currently under review, and a study is underway to determine if and how the Directive should be altered, taking into account new knowledge that has been developed since its adoption as well as the implications of the Urban Wastewater Treatment Directive on the quantities of sludge being produced (Milieu Ltd, WRc & Risk & Policy Analysts Ltd, 2009). As a note, farmyard manure is also often applied to agricultural land without undergoing treatment, a practice that will not be considered in this section. The application of both farmyard manure and sludge are also controlled by the Nitrates Directive, which sets nitrate limit values that have to be respected.

The two other common methods of sludge disposal – landfill disposal and incineration – have disadvantages. Landfill disposal of sludge will become increasingly hampered by European legislation on waste which mandates the phasing out of landfill disposal of waste with an organic content of above five percent. Some countries within the EU have implemented even stricter regulation, for example Germany where the limit is set at three percent (European Environment Agency, 2009a). While energy can be recovered from landfills in the form of landfill gas, the incineration of sludge has more energetic advantages than landfilling if certain adapted processes are used. Indeed, while incineration is an energy-intensive process, it is also possible to recover energy from it, using waste-to-energy techniques. Most importantly however, neither method enables nutrient recovery, which is of concern in the framework of the sustainable use of resources but also in light of predicted future shortages of mineral phosphorus (Soil Association, 2010), and is also one of the principles of IUWM.

→ **Cross-sectoral links**

Landfill disposal of sludge relates to the responsibility for waste management of public authorities. Incineration of sludge has implications for energy management, a service examined in more detail in Section 3.2. Although it is not covered in this chapter, another good practice relating to sludge disposal and energy is anaerobic digestion, which generates biogas that can be used as a transport or cooking fuel.

Sludge disposal practices vary widely across EU Member States, as shown in Figure 3.45; some countries rely largely on land application while others almost wholly on incineration or landfilling. Some countries have effectively banned sludge application to land (The Netherlands for example), while others have greatly increased their reliance on it (the United Kingdom for example). Overall, around 36% of sludge is applied to land in the EU. As a percentage of the quantity of fertilisers applied to land in the EU, however, the share of sludge is quite small: over 95% of manure used on land is of animal origin, and sludge is applied to less than 5% of agricultural land (Milieu Ltd, WRc & Risk & Policy Analysts Ltd, 2009).

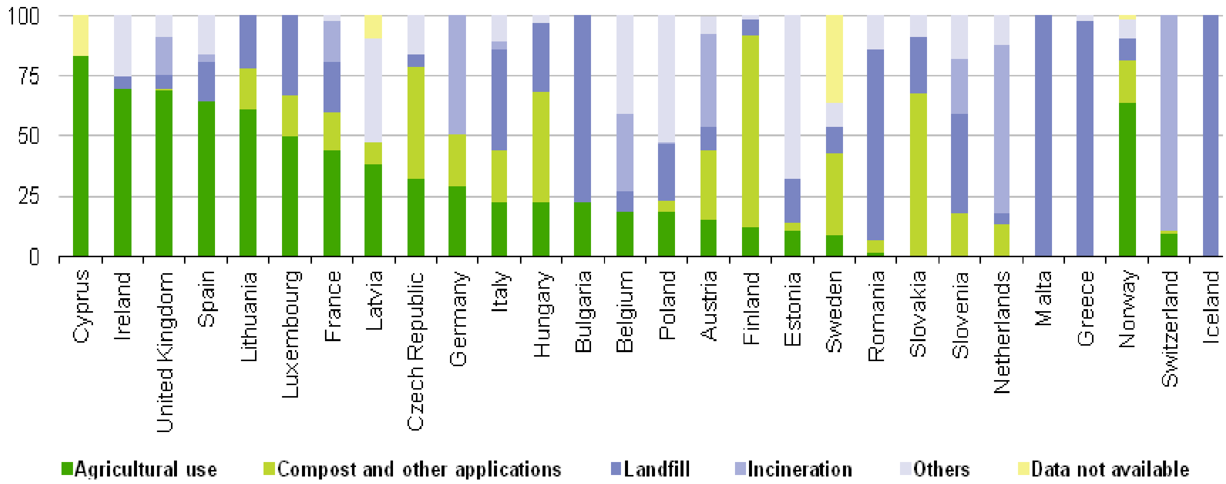

Figure 3.44: Sewage sludge disposal from urban wastewater treatment, by type of treatment, 2007. Source: Eurostat

Although the precise composition of sewage sludge varies depending on the characteristics of the inflowing wastewater as well as on the type of treatment it undergoes, in general sludge contains both pollutants and compounds that make it a valuable fertiliser. The compounds that give it fertilising value are organic matter, nitrogen, phosphorus, potassium, calcium, sulphur and magnesium. Pollutants include heavy metals (which are present largely due to the fact that stormwater and industrial wastewater flows are combined with domestic wastewater), organic pollutants (such as PCBs and PAHs), micropollutants (such as pharmaceutical compounds) and pathogens (bacteria, viruses, fungi, yeast, parasitic worms and protozoa being the main ones) (Aubain et al., 2002). The presence of these pollutants is the main drawback to the use of sludge as an agricultural soil fertiliser, although unpleasant odours and reluctance in some cultures to use human waste also play a role in generating opposition to it.
Despite the requirements contained within the Sewage Sludge Directive, concerns regarding the application of sludge to agricultural land still remain, as evidenced by the adoption of stricter legislation at the national level in several Member States. According to the draft study report commissioned by the EC, adverse effects of sludge application on human health or the environment have not been conclusively proven, although evidence to that effect does exist. The report does emphasise however that it is unclear whether these lack of effects are due to the Directive or to stricter national requirements, and some stakeholders involved in the commenting phase of the report have stressed the need to take a precautionary approach in this matter (Milieu Ltd, WRc & Risk & Policy Analysts Ltd, 2009).

Achieved environmental benefits

The environmental benefits to be gained from the application of sewage sludge as a fertiliser for bioenergy crops are numerous:

- It reduces the need for the use of mined or synthetic fertilisers, hence reducing the environmental burden associated with the mining or production of these (Soil Association, 2010) but also reducing the pressure on finite sources of these, such as mineral phosphorus. The use of sewage sludge as a fertiliser replaces to a great extent the need for commercial fertiliser application, which reduces not only costs but also resource depletion. Moreover, it reduces the cadmium input to soil that derives from phosphate rock utilisation (Milieu Ltd, WRc & Risk & Policy Analysts Ltd, 2009). It should be noted that biosolids (digested or stabilised sludge) have lower nutrient levels than commercial fertilisers, and so will need to be supplemented (Tilley et al. 2008).

- Sludge, apart from containing nutrients, is also beneficial for soil conditioning and moisture retention, and releases nutrients in a more steady way (Tilley et al. 2008).

- If using effluent that has been subjected to secondary treatment for irrigation/fertilisation, such crops help reduce the nutrient input to receiving waters or, in areas where tertiary treatment is mandated, help reduced the energy and construction costs associated with traditional means of treatment.

- If implemented as in Enköping, where the plantation, the wastewater treatment plant and the CHP plant are located in close proximity, the system saves on transportation costs and emissions linked with conventional fuel use and waste handling.

- The application of sludge to energy crops has been identified as a trend for the future, particularly since it links well with EU-level priorities linked to greenhouse gas emissions, landfill disposal reduction and energy security. Although the carbon sequestration potential of sewage sludge application to agricultural crops has not been fully substantiated, it is highlighted by some as a benefit (Milieu Ltd, WRc & Risk & Policy Analysts Ltd, 2009).

Other environmental benefits are linked to the bioenergy crops themselves. They include the phytoremediation of land that occurs in willow plantations, which remove heavy metals and organic pollutants from the soil (Kleinhappl, 2009). Willow plantations (and those of other bioenergy crops such as hemp) also require little in the way of pesticides and herbicides. Also, the use of short-rotation coppice plants such as willow for bioenergy has associated CO_2 emission reductions compared to non-renewable fuels. A willow plantation for example can produce 8 to 12 tonnes of dry matter per hectare, equivalent to 3.5 to 5.5 tonnes of oil per hectare (Lindoff Communications, 2004). Fertilising these plantations with sludge allows for an increased pace of growth, meaning more biofuel is available for incineration.

Appropriate environmental indicator

Table 3.14: Appropriate environmental indicator - Sludge

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Sludge production	ton		Sludge produced by municipal wastewater treatment
Sludge disposal practices	ton	ton sewage sludge divided into different use (agriculture, incineration…)/ total sewage sludge produced	Sewage sludge disposal from urban wastewater treatment, by type of treatment: - agriculture; - compost; - incineration; - landfill.
Bioenergy crops fertilized using sludge	Ha	Ha bioenergy crops using sludge/ Ha total bioenergy crops	Energy production crop areas which have been fertilized using sludge

Cross-media effects

The negative side effects associated with the application of sewage sludge on bioenergy crops are mainly linked to greenhouse gas emissions. For example, more nitrous oxide – a greenhouse gas with a global warming potential 310 times higher than carbon dioxide (Solomon et al., 2007) – is released through this technique than is saved by not applying the equivalent synthetic or mineral fertilisers (Milieu Ltd, WRc & Risk & Policy Analysts Ltd, 2009). Methane is also released as a result of this technique, though appropriate management can limit the emission of these gasses. In some cases, environmental impact associated with the technique can mean other treatment routes are more appropriate. However, overall it is recognised that the application of sewage sludge to land has a lower global warming impact than other routes (Milieu Ltd, WRc & Risk & Policy Analysts Ltd, 2009); its application to bioenergy crops further increases its benefits. In addition to issues related to greenhouse gasses, the spreading of sewage sludge may lead to the accumulation of micropollutants in the soil and the consequent contamination of

groundwater (Tilley et al. 2008). Again, appropriate studies and project set up and monitoring is required to mitigate this risk. Other side effects to consider are linked more to the bioenergy crops themselves than to their fertilisation using sludge: for example, the use of land for the production of energy rather than for growing food crops or for providing ecosystem services is strongly contested. While it is not within the scope of this document to discuss the food versus fuel debate, this is something that communities should take into consideration.

Operational data

Given the existing concerns about the potential impact of sewage sludge application to food and fodder crops, a logical avenue to explore is its application on non-food crops, which still allows for the reuse of nutrients while eliminating health concerns. Even more advantageous is its application on crops that can be harvested to produce bioenergy; this is the Best Environmental Management Practice explored in this section. Bioenergy is the energy derived from biomass, and can be used to produce heat, electricity or liquid biofuels. Sludge bioenergy crop fertilisation can be particularly valuable as a bridging technique, while the human health implications of sludge application on food crops continue to be explored, and while improvements in wastewater composition continue to happen. Indeed, the heavy metal loading in wastewater has been shown to have decreased since the 1980s in response to legislation and improved practices (Milieu Ltd, WRc & Risk & Policy Analysts Ltd, 2009).

As a note, sludge reuse is actually one of the techniques that benefits most from an integrated and holistic approach to water management such as that provided by IUWM. Indeed, many of the negative issues relating to sludge reuse can be reduced or even eliminated by sustainable water management, which for example allows for the reduction of pollutants which are found in wastewater by using separate collection and treatment systems for things like stormwater and industrial wastewater or raising awareness among consumers. As a result, the presence of heavy metals and other pollutants in the wastewater arriving at wastewater treatment plants is reduced.

City example: Sludge reuse in Enköping, Sweden

Sweden has accumulated experience in the cultivation of willow (*Salix* spp.) for bioenergy production since the energy crisis of the 1970s. Large quantities of available sewage sludge – due to Sweden's high sewer connection rate, its high standard of wastewater treatment and strict regulation covering sludge use on food crops – stimulate the use of sewage sludge as a fertiliser for this crop (Lindoff Communications, 2004). Enköping, a city of 20,000 inhabitants located near Stockholm, is an excellent municipal-scale example of the application of this method. The paucity of forestry biomass sources in the area and their price fluctuations led the municipality-owned company that operates the city's CHP plant to consider alternative sources of biomass fuel. This, coupled with the requirement to reduce nutrient pollution in the nearby Baltic Sea, led to the establishment of a willow plantation next to the city's wastewater treatment plant and the CHP plant (Kleinhappl, 2009).

The CHP plant runs almost fully on renewable sources of fuel that are harvested on average within 70 km of the plant, with willow supplying around 20% of the fuel mix, and supplies the majority of the town's heat and electricity. ENA Energy, the plant's operator, now manages over 1000 hectares of willow plantations in the nearby area, renting land from local farmers. The willow plantations are fertilised using sludge from the wastewater treatment process mixed with bottom ash from the CHP plant (the smaller fraction of fly ash is not used as its heavy metal content is regarded as being too high). The willow plantations are also used to purify the decanted water from the sludge dewatering process and the effluent water from the treatment process – this enables irrigation of the crop, nutrient recycling but also tertiary treatment of the effluent while minimising chemical and energetic inputs (Dimitriou, Rosenqvist & Aronsson, 2011). Willow is a convenient choice of biofuel since it is fast-growing and has approximately the same heating value as wood; moreover, since it requires plentiful irrigation and substantial amounts of fertiliser, its combination with sludge and effluent water is ideal (Kleinhappl, 2009).

Some of the key success factors for the project have been identified as follows (Kleinhappl, 2009):

- The enthusiasm of the involved actors and their readiness to finance the project, both at the local level (the wastewater treatment plant, the municipality and the CHP plant) and at the national level – with funding obtained from a local investment programme.
- The close co-location of the wastewater treatment plant, the CHP plant and the agricultural fields allowed for important financial savings.
- The sound planning of logistics and the investigation into appropriate technologies, with support from the University of Uppsala.
- The involvement of farmers in the region and the availability of start-off subsidies for them, and the availability of additional land for the up-scaling of the project.

  The initial reluctance of farmers was overcome by offering a start-off subsidy and by delivering the sludge free of charge, thereby enabling further savings.

Applicability

In addition to EU legislation such as the Water Framework Directive and the Nitrates Directive, whose provisions must be taken into account when designing sludge reuse projects, national legislation can be a barrier to the application of sludge in several Member States. Several countries have enacted legislation that is much stricter than EU legislation, to the point of being an effective ban on the practice. However, this strict legislation tends to relate more to the application of sludge on food crops rather than on bioenergy crops – individual Member States' legislation should be checked (Milieu Ltd, WRc & Risk & Policy Analysts Ltd, 2009).

The potential for the use of this technique in Europe is important. A study found that if only 10% of all the phosphorus entering wastewater treatment plants in the EU-27 was recycled by applying it to short-rotation coppice, this would lead to the production of 600 PJ of energy,

equivalent to approximately 10% of the renewable energy produced in the EU-27 (Dimitriou, Rosenqvist & Aronsson, 2011).

Contextual considerations

The application of sewage sludge needs to take geographic considerations into account, for example in the context of the Water Framework Directive, which places particular requirements for certain sensitive zones. These requirements can encourage the application of sludge and effluent wastewater, since willow plantations can act as a form of tertiary treatment, but can also mean that particular care should be taken in the design of projects to ensure there is no excess runoff of nutrients to water bodies and/or groundwater.

The use of sludge can be a culturally-sensitive topic. Apart from concerns relating to human health, which have not been scientifically verified but are still under debate, and the very real problem of odour, the use of human waste is taboo in many societies. Even though the use of human waste as a fertiliser has a very ancient history, and is prevalent in many societies, it has developed in some places a negative association. This is perhaps one of the reasons behind its renaming as “biosolids”. In this context, the fertilisation of bioenergy crops is a viable alternative, since the disassociation of sludge and food reduces its negative perception. Moreover, co-location in proximity to wastewater treatment plants can avoid any additional odour problems.

Degree of complexity

Sludge reuse is a complex procedure, certainly in the initial setup phase, and requires substantial amounts of expertise. This expertise is linked to the monitoring of sludge composition, of soil characteristics and of plant growth as well as to frequent and thorough monitoring of adjacent water bodies to check for any possible contamination. Although Sweden has had many years of experience with willow plantations, the precise methods used in this country cannot be transplanted wholesale to another setting, since variations in sludge, soil and crops can be important. For example, a demonstration project in the Polish city of Łódź found that addition of sediment to the sewage sludge mix allowed for a reduction of sludge toxicity and hence for optimal biomass growth (University of Łódź & City of Łódź Office, 2011). Appropriate project set up is not only important vis-à-vis compliance with legislation, but also in relation to the intended end use of the bioenergy crops, since the incineration thereof is sensitive to heavy metal uptake in the plants.

Requirements

Political commitment can be an important factor in the implementation of this BEMP. In the case of Enköping, the municipal ownership of both the CHP plant and the wastewater treatment plant facilitated the set-up of the project. However, the city also demonstrated the importance of liaising with other affected parties such as the farmers’ association.

The issue of legislation has already been addressed previously, showing that some Member States have stricter requirements than the Sewage Sludge Directive.

Other considerations

The BEMP described in this section can have a positive effect on local communities, particularly for farmers in the peri-urban area, whose participation in a bioenergy crop scheme can result in financial advantages. The long-term contracts established between Enköping’s farmers and the CHP plant – in the order of 20 to 25 years – make for stable cooperation over the long run. However, it is also possible that these long-term contracts might act as a constraint for the farmers by reducing their ability to respond to market changes as they would be able to when growing annual crops (Kleinhappl, 2009).

The feasibility of this technique is reduced by its technical complexity, and the fact that the use of sludge on bioenergy crops demands both a certain type of energy production plant – able to accommodate biomass but also to deal with the high heavy metal content of the resulting fly ash – and modifications to existing wastewater treatment processes – in the case of Enköping, requiring the construction of storage ponds for the effluent water. However, these constraints are compensated by the financial savings offered as well as by the fact that the technique helps meet multiple environmental goals. The BEMP is relatively inflexible, particularly in the case of

willow plantations which have extended economic lifespans (around 20 years); other lignocellulosic crops can have shorter lifespans.
The main alternatives to the application of sludge on arable land, namely landfilling and incineration, have been covered previously. Sewage sludge can also be used for forestry, bearing in mind considerations of heavy metal uptake in forest products, as well as land reclamation for example of mines or closed landfills; these uses are less widespread (Milieu Ltd, WRc & Risk & Policy Analysts Ltd, 2009). For the application of sludge to bioenergy crops, obvious alternatives to willow are other crops such as hemp or switchgrass.
In the context of increasing connections to sewers and legal obligations under the Water Framework Directive leading to more and more sewage sludge being created, as well as ever-increasing livestock numbers creating mounting quantities of farmyard manure, the question of what to do with human and animal excreta is a vital one. Many countries throughout the world have prohibited the dumping of sludge at sea, its application to food crops is constricted by health and water quality concerns. Although the quality of sludge keeps improving, to the point where the organic movement is considering to allow its application in certain cases (Soil Association, 2010), immediate solutions have to be found. The application of sewage sludge to bioenergy crops such as willow is a solution that meets several purposes; along with the digestion of sludge to produce biogas, these are promising solutions for the management of sludge.

Economics
The use of sewage sludge as a fertiliser for bioenergy crops can benefit from and help meet the requirements of the different European legislation governing bioenergy. The EU Directive on the promotion of the use of energy from renewable sources has led to the establishment of national targets and feed-in tariffs for electricity from biomass, thereby increasing the financial advantages of this technique. The EU Emissions Trading Scheme has in some countries stimulated the production of biomass. Other EU legislation has an impact on the use of sludge as fertiliser for energy crops; for example, this technique reduces the quantity of sludge that has to be disposed of in landfills, thereby helping compliance with the Landfill Directive (Sipilä et al., 2008). The Biofuels Directive, with its voluntary targets for liquid biofuels, has also created added incentives for the use of second generation biofuels which can be produced from lignocellulosic energy crops such as willow. Moreover, the criteria for sustainable biofuels set by the EU explicitly favour these second generation biofuels whose greenhouse gas emissions reduction potential is higher. In some countries, biofuels are exempt from taxation.
Apart from the financial advantages linked to producing a bioenergy crop, this BEMP also benefits from reduced costs linked to the sludge itself. In cases such as that of Enköping, where the municipality owns both the wastewater treatment plant and the CHP plant, the linked financial advantages are important; it is estimated that the city produces heat and electricity at €8/MWh. First of all, spreading sludge on land may be cheaper than disposing of it through other means (Tilley et al., 2008). If the savings from applying effluent water to crops rather than subjecting it to traditional tertiary treatment are passed on to the farmers, profit margins are increased even more (Dimitriou, Rosenqvist & Aronsson, 2011). Secondly, the use of sludge can replace all or most of the synthetic or mineral fertiliser that is added to crops, thereby reducing the cost associated with these. This is particularly important in the context of rising mineral fertiliser costs; for example, in 2010 the price of phosphate rock was more than twice that of 2006 (Soil Association, 2010).
Although it reviewed short-rotation coppice (SRC) crops in general (these include willow) and focused on the case of Sweden, a 2011 study found important cost advantages linked with the application of sewage sludge as well as effluent wastewater (Dimitriou, Rosenqvist & Aronsson, 2011). The study (based on standard yield assumptions and the wood chip prices for 2009) found that the profit margin for basic SRC was zero, but increased to €39/ha with the application of sludge and to €199/ha (€294 in water-limited areas) with the application of effluent wastewater. When considering the opportunity costs for traditional handling of the sludge and wastewater, which in Sweden can be between €77 and €210/ha/yr, it should be possible to provide significant compensation to SRC farmers (Dimitriou, Rosenqvist & Aronsson, 2011).

Driving force for implementation

The application of sewage sludge has a number of associated non-environmental benefits, which include cost and energy savings compared to traditional means of treatment and disposal of sludge, support for local (particularly peri-urban) economies, stability of supply and a reduced dependence on foreign sources of nutrients. In Europe, which has no domestic sources of mineral phosphorus, this latter point is particularly relevant – the 800% price rise of phosphorus rock in 2007/8 provides a good illustration for this point (Soil Association, 2010).

Reference cities

Enköping, Sweden:

- Information on the reuse of sludge in Enköping can be found in chapter 6 of the paper ‘Best practice business models for bio-energy success stories’ (Kleinhappl 2009) which can be downloaded from the following webpage: http://www.encrop.net/default.asp?SivuID=23514

Reference literature

The BEMP explored in this section was the use of sewage sludge to fertilise bioenergy crops. Information about this particular BEMP is largely restricted to illustrations of practical applications, for example in Sweden, but more general information about the application of sewage sludge on land is available here: http://ec.europa.eu/environment/waste/sludge/index.htm

Many other best practices can be implemented for the treatment of wastewater under an IUWM approach, including separate collection systems that reduce the dilution of flows and reuse options that match water use needs with water of an appropriate quality. General information about wastewater management and these other alternatives is available in Module 5 of the SWITCH Training Kit (Philip, Pereira & van Veenhuizen, 2011). Access it here: www.switchtraining.eu/modules/module-5/

3.3.8 Stormwater management: Water-Sensitive Urban Design

Description

Most cities start on the water management path by ensuring water supply and over time incorporate additional concerns such as sewerage, drainage, and more recently pollution abatement and natural resource protection. The ideal end point of the sustainable transition framework (illustrated in Figure 3.46) is the water-sensitive city, a city where water management is adaptive, multi-functional and aligned with the principles of urban design. Technologies associated with Water-Sensitive Urban Design (WSUD), the best practice explored in this section, are some of the main instruments for transitioning to water-sensitive cities. WSUD techniques allow for the incremental improvement of a city's stormwater management, meaning that it can be adapted to local conditions and resources and can take advantage of opportunities that arise for the implementation of small- or large-scale projects.

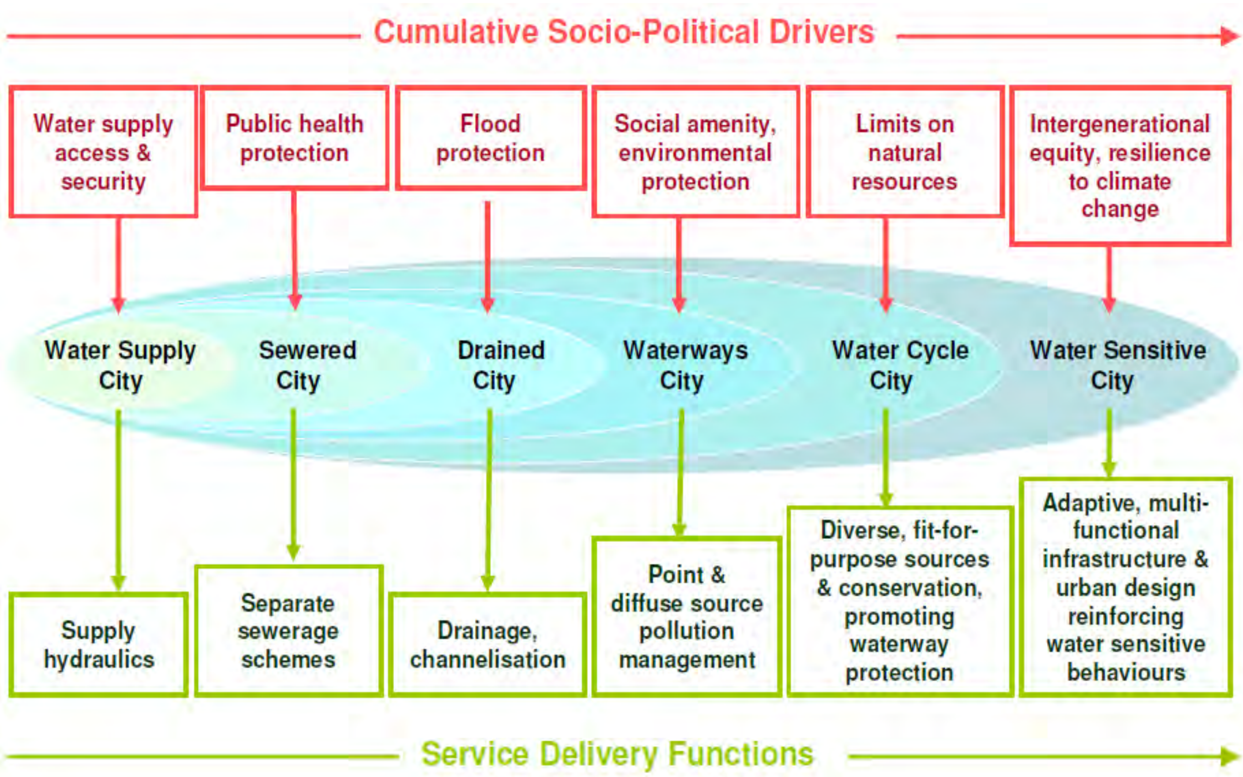

Figure 3.45: Urban water management transitions framework. Source: Brown, Keath & Wong, 2008

Achieved environmental benefits

The WSUD approach and the techniques and technologies that are associated with it deliver a number of environmental benefits. The retention, detention and infiltration of stormwater facilitated by WSUD options reduce peak discharge and prolong the lag time of urban runoff during high precipitation events. This provides flood control and helps to prevent erosion, siltation and high turbidity in streams and rivers as is typically caused by conventional drainage channels due to the high velocity discharge of large volumes of stormwater into receiving water bodies. Many WSUD technologies treat stormwater to various degrees by removing pollutants such as oils, metals and nutrients through natural treatment processes within vegetation, soils and ponds. This improves water quality in receiving water bodies thereby protecting ecosystems and recreational facilities. WSUD also reduces the impact of urbanization on the natural water cycle. The impact of replacing natural surfaces with artificial ones is mitigated through the establishment of impervious landscaping and other systems designed to increase rainfall infiltration to underlying aquifers. Such groundwater recharge also provides an additional source of water supply, reducing the need to abstract (and often treat) water from other sources. Rainwater harvesting, another typical WSUD solution, offers the same benefits.

Other environmental benefits outside of the water cycle also occur as a result of WSUD implementation. Some WSUD options, such as wetlands and green roofs make use of natural systems which encourage urban biodiversity. Many WSUD technologies also reduce the energy footprint of water services. Being largely natural and located on-site, thereby avoiding its conveyance to wastewater treatment plants, sustainable stormwater management methods are much less energy-intensive. They also enable wastewater treatment plants to operate more efficiently since incoming wastewater is less diluted, in the case of combined sewer systems. By taking an integrated approach across multiple urban sectors, WSUD, much like IUWM of which it is a subset, allows for the minimization of unwanted side effects and also for the possibility to take advantage of synergies.

Appropriate environmental indicator

Table 3.15: Appropriate environmental indicator - Rainwater

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Separated rainwater network	km	km rainwater network/ km total network (mixed water + rainwater)	Separated network collecting rainwater only (not mixed with black water).
Infiltration systems	number m^2		Number and extent of areas treated to improve the infiltration rate. These areas can be divided into the following categories: - green roofs - swales - porous pavements - infiltration systems - constructed wetlands
Inhabitants subjected to flood risk	number	n. inhabitants located in a floodplain/ total population	Evaluation of the number of inhabitants located in a floodplain

Benchmark of excellence

Malmö is actively working to disconnect rain water from the combined system, resulting in a smoother flow and a reduction in the risk of overflow. Rain waters are considered also as a resource, helping create spaces for urban biodiversity and aesthetic appreciation. Such a strategy initiated roughly 10 years ago, with various pilot projects in Malmö neighbourhoods. One of the most know projects regards the Augustenborg area, a residential area built in the 1950s which was in need of renewal, suffering from social and environmental challenges, facing seasonal flooding in part because of the lack of permeable surfaces in the area. The City of Malmö, together with the local housing company and Augustenborg’s inhabitants – through a public participation approach – created a new system by incorporating natural principles to manage rainwater flows. A new open storm water system has been created, together with green roofs to manage rainfall flow: nowadays 90% of the storm water from roofs and hard surfaces is collected into the open storm water system made up of 6 kilometres of water channels. The project’s original aim was 70% of all storm water, thus it has surpassed its goal.

Cross-media effects

While most of the side effects of WSUD options are positive, there are some negative considerations to take into account, such as the need for maintenance and the use of substantial amounts of (highly valuable) urban land.

In the case of technologies such as swales, porous paving and green roofs space is not likely to be a problem as the systems can be incorporated into existing urban infrastructure such as road verges, parking lots and buildings. However, as with most urban landscaping, these do need to be maintained to ensure that impervious surfaces and filters do not become blocked and vegetation damaged.

Other technologies such as ponds, wetlands and infiltration basins may indeed require significant space which may be at a premium in dense urban environments. Innovative architecture can overcome such restrictions by incorporating such technologies into building and landscape design. Examples include the creation of infiltration basins in flower beds, detention ponds in fountain features and the construction of playgrounds and sports fields that are also designed to retain stormwater during heavy rainfall.

Operational data

Cities that take a water-sensitive approach think of stormwater as a resource and an opportunity, in contrast with conventional stormwater management, which sees stormwater as a nuisance. At the core of WSUD is the integration of stormwater management into urban design and landscape planning, though WSUD does also integrate considerations linked to the other elements of the water cycle. A water-sensitive approach is increasingly evident in many modern architectural and urban planning schemes, which integrate for example green roofs, ponds or reed beds into their design.

WSUD aims to reduce runoff, improve water quality and take a more decentralised and nature-oriented approach. The main principles of WSUD are not related to specific technologies but are rather applied to any intervention that has an impact on the urban water cycle. These are as follows (Adapted from Hoyer, Dickhaut, Kronawitter & Weber, 2011):

- Water sensitivity: Decentralised methods should be used to manage water in a way that mimics as much as possible the natural water cycle.

- Integration of functionality and aesthetic benefit, and potential for multiple uses: Solutions should be both attractive and useful. Where possible, the integration of recreational and conservation considerations is optimal. This approach is very different to the traditional approach to stormwater management, which most often sought to hide stormwater infrastructure from its users. Using stormwater management technologies as a design feature brings with it many co-benefits.

- Local integration and public involvement: WSUD solutions should fit into the local design and should be adapted to local conditions. The involvement of stakeholders in the planning process is mandatory; this ensures local priorities are taken into consideration but also increases the chances that the local population will gain a better understanding of WSUD technologies and will hence welcome them.

- Cost-efficiency and consideration of maintenance: The chosen methods should be similarly-priced or cheaper than conventional solutions, and appropriate consideration of maintenance requirements – which can be significant – is needed.

- Adaptability: Solutions should be planned so that they retain their functionality in the event of changing and uncertain future conditions.

- Interdisciplinarity: In recognition of the links within the water cycle and between urban water management and other urban sectors, integrated planning is a vital element of WSUD.

City example: WSUD in Melbourne, Australia

Although a fully water-sensitive city has yet to be created (Brown, Keith & Wong, 2008), Melbourne is widely recognised the most advanced example of the application of Water-Sensitive Urban Design (WSUD), a concept originally developed in Australia. The city has outlined its commitment to becoming a water-sensitive city through a 'city as a catchment' approach. This approach involves considering water within the city as a resource which needs to be conserved but also – for stormwater and wastewater – reused (City of Melbourne, 2009).

Melbourne's 'city as a catchment' approach sets targets for 2020 for water saving, stormwater quality, wastewater reduction and the use of alternative water sources. This emphasis on creating a decentralised and varied portfolio of water resources is best understood in the context of the long-term drought situation which Australia faces, which limits the availability of water at the regional catchment scale. In order to meet the targets set, Melbourne has planned a number of projects, including rainwater harvesting, the installation of efficient fittings and a series of WSUD measures (City of Melbourne, 2009).

Melbourne has also established WSUD guidelines for developers, council staff and residents. The guidelines set best practice performance objectives for reductions in suspended solids (80%), nitrogen (45%), phosphorus (45%) and litter (70%). Melbourne follows a water management hierarchy where the reduction of potable water consumption is the first priority, followed by water reuse maximisation, wastewater discharge reduction, stormwater pollution minimisation and groundwater pollution maximisation.

The WSUD guidelines include holistic information on WSUD options as well as an extensive project checklist that prompts the user to enter information about project objectives, funding, baseline data, WSUD principles, risks, design features as well as environmental, economic and climatic impacts. The guidelines also include information about maintenance requirements.

Finally, the guidelines and Melbourne's work on WSUD in general are supported by a website which acts as a repository for case studies, technical information and other useful resources: http://wsud.melbournewater.com.au

Multiple WSUD technologies

WSUD is an approach to urban water management and stormwater management in particular. Although the overall management approach is the BEMP explored in this section, the application of WSUD in the urban context involves the implementation of any number of WSUD technologies. Some of these are briefly illustrated in table 3.16; other examples include bioretention systems, biotopes and geocellular systems.

The technologies highlighted below serve different yet sometimes overlapping purposes: rainwater harvesting is aimed at the reuse of stormwater, constructed wetlands serve primarily to treat stormwater, green roofs help detain stormwater and partially treat it, while swales, infiltration systems and porous paving help with detention, infiltration and treatment. These technologies are also good examples of the hierarchy of stormwater management measures (Shutes & Raggatt, 2010), which aims to manage (prevent, collect and treat) stormwater as close to its source as possible:

Prevention: For example by minimising impermeable surfaces, as in the case of porous paving

- **Source control:** Controlling and treating stormwater as close to the source as possible, as in the case of rainwater harvesting, swales and green roofs.
  - **Site control:** Controlling and treating stormwater from a larger area, as in the case of infiltration systems.
    - **Regional control:** Controlling and treating stormwater from multiple sites, as in the case of constructed wetlands.

Rainwater harvesting

The harvesting of rainwater allows its transformation into a useful resource. Water butts, as illustrated above, are the simplest way to collect runoff from roofs, but more complex systems exist. The rainwater can be used directly for non-potable purposes such as toilet flushing, garden watering or for urban agriculture irrigation.

Constructed wetlands

As well as attenuating stormwater, wetlands naturally remove a wide range of pollutants, meaning that their effluent can be reused. While they require planning and financing to set up, they are inexpensive to maintain. Moreover, wetlands provide amenity value as well as biodiversity-supporting habitat.

Infiltration systems

Infiltration systems collect stormwater and let it infiltrate to groundwater through gravel and rocks. This filtration also allows for the removal of pollutants, though pre-treatment using other technologies such as swales prevents any clogging. These systems are attractive and can even be used for calming traffic.

Green roofs

Green roofs consist of artificial material layers covered with soil and vegetation. They allow for stormwater to be attenuated and released over a longer period of time, thereby reducing peak flows. This, and their many other advantages (reduced energy consumption and increased amenity value, among others), make green roofs a BEMP – see Section 3.4.

Permeable paving

Urbanisation spreads the extent of impermeable surfaces such as roads and parking lots. Permeable or porous paving allows stormwater to drain through, where it can be stored or left to drain to groundwater. Amongst other benefits, pollutants from roads are fully or partly removed and the attenuation of stormwater reduces the risk of flooding.

Swales

Swales are grassy ditches that detain, infiltrate and treat stormwater. Compared to concrete drainage channels, swales offer not only infiltration and treatment, but also amenity value. Appropriate analysis of local conditions – such as soil type, groundwater hydrology and the degree of runoff pollution – is required prior to their construction.

Table 3.16: WSUD options Source: Philip, 2011b. (Images: www.wsud.org)

Applicability

WSUD, as a management approach, is not governed by legislation. However, the application of particular WSUD techniques and technologies can be subject to specific considerations. In general, although WSUD is one of the ideal tools that can help EU countries meet the requirements of the Water Framework Directive, sustainable stormwater management is not

mandated at the European level. However, national legislation can have an impact on the choice of approaches. For example, in Germany, the Water Resources Act mandates the initial consideration and the application – where possible – of decentralised methods of stormwater control. In the United Kingdom, decentralised stormwater measures are also encouraged at the national level, for example in the case of flood risk planning (Hoyer, Dickhaut, Kronawitter & Weber, 2011). Finally, Dublin in Ireland has mandated the installation of sustainable stormwater management techniques in all new developments.

Contextual considerations

Geographical considerations play an important role in the choice of stormwater management practices: conditions vary greatly between cities and must be taken into consideration carefully before implementation. For example, hydrological conditions determine runoff quantities and timing, soil characteristics affect infiltration speed (soils with low infiltration capacity may not be suitable for certain methods such as porous paving), the height of the water table impacts infiltration possibilities (if too high, it can render technologies like swales unusable) and the pollution loads in incoming stormwater influences the treatment effectiveness (some WSUD methods may not be able to treat certain pollutants and highly contaminated runoff). Land use considerations need to be taken into account: for example, busy roads may create debris that would clog a swale located next to it, thereby reducing its usefulness (Hoyer, Dickhaut, Kronawitter & Weber, 2011). Finally, some WSUD options can take up substantial amounts of space – while this may not pose a problem in industrial estates or new developments, multiple-usage options should be privileged in areas where space is at a higher premium.

Unlike the use of human waste as a crop fertiliser, the stormwater management techniques implied under WSUD are not associated with any cultural taboos. However, largely because stormwater infrastructure has for so long been hidden out of sight, some resistance can occur simply because of a lack of awareness about the techniques employed. The involvement of stakeholders at the planning stage of WSUD can help overcome these hesitations and ensure buy-in, not only by providing information about techniques but also by making sure stakeholder needs are integrated within them.

Degree of complexity

Some of the WSUD techniques described in this section are complex: for example, the installation of a large-scale rainwater harvesting system can be quite demanding. However, the WSUD approach in general is much like the IUWM approach described in Section 3.3.5.1, in that it follows a common sense approach that calls for integration across urban sectors, and is therefore in itself not a technically complex process.

Although some of the WSUD options that have been described in this section, such as rainwater harvesting or green roofs, have been implemented in a widespread manner for many decades, WSUD in itself is regarded as an advanced concept. Australian cities such as Melbourne are considered the forerunners in the implementation of WSUD, and many other cities throughout the world have implemented some or many WSUD techniques. However, no city has yet achieved full water-sensitivity.

Requirements

Some WSUD options can require substantial financial investments, but calculations of paypack periods should also take into account positive externalities such as reduced energy consumption, amenity value and the flexibility to adapt to future change. Financial incentives can be put in place to encourage the implementation of WSUD options, as has been done in the city of Portland, USA, where a discount on stormwater management fees is offered to property owners who elect to manage their stormwater onsite (Hoyer, Dickhaut, Kronawitter & Weber, 2011). The provision of subsidies for certain technologies can also be used to establish a market in which non-conventional technologies become more attractive to developers, consultants and property owners.

Although the implementation of WSUD options necessitates careful investigation into local conditions, general guidelines (see for example the case of Melbourne illustrated above) are available and will help public administration bodies narrow down their choices.

At the city level, it is likely that a local authority would want to implement WSUD techniques on its own properties in order to set an example for the private sector and other actors. The adoption of WSUD will require political commitment as well as consultation with affected stakeholders. It will also require a commitment to adequately maintain these installations: many WSUD options require substantial amounts of regular maintenance to retain their functionality.

WSUD is a common sense management practice that is not governed by legislation, though some of the options that can be implemented as part of WSUD are. Some countries encourage the installation of specific WSUD technologies by offering incentives, establishing stricter development requirements and producing minimum standards for their implementation within their engineering guidelines. This is the case in Germany and in the United Kingdom (Hoyer, Dickhaut, Kronawitter & Weber, 2011).

Legislation and regulation can also prove to be a barrier to certain WSUD solutions. Existing standards often relate to conventional drainage systems in which it is assumed that stormwater is either directly disposed to a receiving water body, or, in the case of combined sewer systems, conveyed to a wastewater treatment plant. In such cases there may be requirements in place which, primarily for health and flood control reasons, prevent the reuse of stormwater or even the disconnection of a building's runoff from the centralised drainage infrastructure. Non-conventional stormwater technologies can therefore become subject to legal challenges unless such regulation is updated accordingly.

Other considerations

WSUD options, by bringing water and vegetation into urban areas, can provide an opportunity for less advantaged urban residents to have access to natural spaces and benefit from their ecosystem services. Otherwise, less mobile or less wealthy residents in some cities often have very little, if any, contact with green and blue spaces. Some options can also provide multiple functionalities that benefit the quality of life of urban residents, for example when sporting facilities that also serve a stormwater detention purpose are created.

Creating a water-sensitive city will not happen overnight, but taking advantage of opportunities for the implementation of WSUD options can little by little increase their prevalence in the urban environment. Such opportunities include the construction of new developments, where planning requirements can mandate the cost-efficient installation of WSUD technologies, or the incremental improvements that can be made for example in flood-prone areas (Philip, 2011b).

It is no accident that WSUD is a concept that emerged first in Australia, a continent which is affected by severe periodic droughts and is considered to be highly vulnerable to climate change. In Perth for example, the inflow to the dams that supply the city dropped from an average of 338 GL from 1911-1974 to an average of 75.3 GL[28] in the 2006-2010 period. In Europe, many of the currently water-scarce areas are also predicted to suffer from the effects of climate change, making the imperative to reduce water consumption and make as efficient use as possible of stormwater and wastewater even more urgent.

Economics

WSUD techniques are often more cost-effective to install and maintain than conventional ones; for example, a comparison of a centralised (sewer) versus a decentralised (swale) solution found a cost of €19 versus €17/m^2 (Sieker, 2010). Moreover, reducing the amount of stormwater inflow into wastewater treatment plants (in cities with combined sewer systems) allows these to operate more cost-effectively. Finally, some WSUD techniques such as rainwater harvesting can provide cheap sources of irrigation water for uses such as landscaping and urban agriculture (Philip, 2011b). WSUD options reduce capital costs linked to drains and pipes as well as construction costs, but can potentially increase maintenance and operation costs (CSIRO, 2006).

WSUD measures can positively influence economic development, particularly in water-scarce regions, by ensuring a more secure supply of water. They can also encourage investments in formerly flood-prone areas, which are often of otherwise high economic value. Finally, the often attractive features of WSUD options increase property values in their vicinity, which can itself lead to increased tax revenues. For example, homes located in proximity to New York's Bluebelt – a series of ponds, streams and wetlands designed to store and treat stormwater – have increased in value, leading to higher property tax revenues for the city.[29]

At the individual property level, WSUD options can reduce costs linked to energy (for example, green roofs insulate buildings and reduce heating and cooling needs, but also increase roof lifespans) as well as water (for example, rainwater harvesting provides a source of irrigation water that replaces the need for other sources) for property owners and occupiers.

Driving force for implementation

Apart from benefits linked to water management, WSUD allows for a series of co-benefits. The potential social benefits (in terms of amenity value, air pollution reduction and cost-effectiveness, to name but a few) of WSUD options are given as much weight as the benefits they provide in terms of water management. Since WSUD integrates many different considerations and purposes, it is associated with a number of co-benefits that distinguish it from the conventional approach to managing stormwater in the city. Indeed, draining water away from the city rapidly reduces infiltration and evaporation, enhancing the Urban Heat Island effect and failing to reduce airborne particulates. It also reduces groundwater recharge, thereby affecting drinking water supplies. Finally, though the traditional approach is usually successful in meeting its goal of flood control under design conditions, it sometimes (and increasingly so as climate change modifies hydrological conditions) creates localised flooding though sewer overflows, causing not only damage but also pollution.

The ability to cope with future uncertainty is a key driving force for WSUD technologies. Conventional drainage infrastructure is constructed with limited flexibility and therefore only achieves optimal performance within the narrow range of conditions for which it was designed. In cases where cities have expanded more rapidly than predicted, the system is no longer adequate to cope with the increased runoff leading to localised flooding and combined sewer overflows. Increased rainfall intensity due to climate change can have the same impact on a system designed to cope only with historical rainfall patterns which may since have been regularly exceeded. The design of WSUD solutions typically contain the flexibility to cope with a wide range of urban growth and weather patterns as, unlike pipeline capacities, the performance of natural systems such as wetlands, ponds and infiltration trenches are not necessarily compromised by overly high or low stormwater inflows. In addition, many WSUD solutions can be designed in a way that it is easy and cheap to expand the facilities should this be required under future conditions. In contrast the expansion of a conventional drainage network tends to be complicated, costly and inconvenient for the local population.

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- The case study 'The "city as a catchment" approach - Melbourne, Australia' (Mitrotta 2011) can be accessed at: http://www.switchtraining.eu/fileadmin/template/projects/switch_training/files/Case_studies/Case_study_Melbourne_preview.pdf

Perth, Australia

- A summary of the City of Perth's achievements in adopting WSUD can be found in the document 'Towards a water sensitive city – The urban drainage initiative Phase 2' (2009) which can be accessed at: http://www.water.wa.gov.au/PublicationStore/first/85823.pdf

New York, USA

- The New York City 'Sustainable Stormwater Management Plan' (2008) can be accessed at: http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/nyc_sustainable_stormwater_management_plan_final.pdf

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General information about stormwater management is available in Module 4 of the SWITCH Training Kit (Philip, 2011b). Access it here: www.switchtraining.eu/modules/module-4/

More specific information about Water-Sensitive Urban Design, including the different stormwater management approaches that can be implemented as part of this approach, is available here:

- The SWITCH WSUD manual (Hoyer, Dickhaut, Kronawitter & Weber, 2011), containing examples of WSUD application from around the world. Access it here: www.switchurbanwater.eu/outputs/pdfs/W5-1_GEN_MAN_D5.1.5_Manual_on_WSUD.pdf

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3.4 Best environmental management practices for more sustainable green spaces and biodiversity

3.4.1 Chapter structure

This chapter is intended to guide public authorities in the management of their green spaces. It starts by introducing the concept of green spaces (Section 3.4.3) and then gives reasons that should stimulate public authorities to manage green spaces in a sustainable manner (Section 3.4.4). Some Best Environmental Management Practices that can help public authorities do so include the implementation of Local Biodiversity Strategies and Action Plans (Section 3.4.5), the creation of blue-green networks (Section 3.4.6), the construction of brown roofs (Section 3.4.7) and finally the restriction of urban sprawl into green spaces (Section 3.4.8).

3.4.2 Chapter introduction

The vast majority of Europeans live in cities and towns, and the consumption of land continues apace. For example, in western Germany, the average annual expansion of built-up areas is of 47,000 hectares per year, which, as an illustration, is equivalent over five years to the surface of Greater Copenhagen (EEA, 2006). In terms of green spaces, there are two main consequences of urbanisation: first, urbanisation – particularly if it done in a sprawling way – reduces green spaces outside of the city (countryside and natural areas); secondly, increasing urban populations have traditionally tended to reduce the availability of green spaces within cities themselves. In general, northern European cities tend to have more green space per inhabitant than cities in the south of Europe. Approximately 45 million people in Europe have limited access to green spaces since they live in cities with between 2 and 13 percent of green spaces (Fuller & Gaston, 2009).

Urbanisation can be an opportunity or a threat for green spaces and biodiversity. Seizing the opportunity demands that high quality urban green areas are mixed with dense and compact built up zones Proper urban design can reduce the need for additional urban land-take and fragmentation. It can, at the same time, penetrate the city with greenery and promote biodiversity. Creating and improving green areas, revitalising brownfields, greening roofs and walls, at the same time as maintaining urban density and compactness, maximises the amount of ecosystem services delivered within cities and the ecological footprint. With the right form and organisation, urban areas can provide opportunities, not merely threats, to biodiversity (EEA, 2010).

The Habitats Directive is the key legislative cornerstone for green spaces in Europe. “The Habitats Directive, adopted in 1992, together with the earlier Birds Directive, forms the cornerstone of Europe’s nature conservation policy. It is also a key component of the EU Biodiversity Action Plan, which aims to halt the decline of EU biodiversity by 2010 and beyond. The directive is built upon two pillars: the Natura 2000 network of protected sites (which also includes sites under the Birds Directive) and a strict system of species protection. Its objective is for more than 200 habitats and 1 000 species to reach and be maintained at ‘favourable conservation status’ thus securing their long-term survival. The directive is made up of a series of articles and annexes. The articles outline the aim of conserving biodiversity and the means to achieve it. The annexes are lists of habitats and species of Community interest in need of different forms of protection” (Silva et al., 2010).

3.4.3 Drivers of public authority green space improvement

The links between urbanisation (in terms of noise, air pollution etc) and ill health have been proven, as has the connection between the availability of green spaces and human health. Not only do green spaces allow urban residents to escape from some of the negative aspects of urbanisation, by reducing noise and purifying the air, but they also provide benefits in and of themselves: contact with green spaces has positive psychological implications. Green spaces are therefore one of the key factors in determining quality of life in cities.

Green spaces also provide a range of ecosystem services that are essential to the functioning of human societies. For instance, they help improve urban air quality, attenuate stormwater and hence reduce the risk of flooding, reduce the urban heat island effect and help human societies adapt to climate change. When green spaces are eliminated or altered, they lose the ability to

provide these services and we must then find (costly and energy-intensive) ways to reproduce the services that were once freely available. Green spaces are home to flora and fauna which is not only an inherently important but also provides some of these ecosystem services – pollination by bees and other insects is but one example.

3.4.4 Techniques portfolio

Four best practices associated with green spaces are highlighted in this section; many other examples exist, and cover a variety of topics such as tree canopy increases and green space inventories. The first Best Environmental Management Practice (BEMP) is the implementation of Local Biodiversity Strategies and Action Plans (LBSAPs), through which cities can formalise goals for biodiversity enhancement and ensure the integration of these into wider urban decision-making processes. Blue-Green networks are the second BEMP examined in this section. Although there is no single methodology for their establishment, they are a valuable concept which can bring about a series of environmental benefits but also benefits linked to human health and city economies. The third BEMP is brown roofs, which are a specific type of green roof whose primary goal is to provide habitat for species that live in urban areas – and particularly for those that have developed niche habitats in former brownfield zones – but who also deliver other benefits relating to stormwater management and air quality among others. The fourth and final BEMP is the control of urban sprawl into green areas: densification of urban areas, as practiced in Stockholm, can prevent the incursion of cities into the adjacent countryside, but can also – if properly planned – increase the useful (and therefore beneficial) green space within cities themselves.

The BEMP descriptions also present cases from cities that have demonstrated good practice in that field. The document does not aim to be comprehensive in its coverage of city examples; indeed, as is shown in the table below, many other examples exist.

Table 3.17: Best practices with city examples

Best practice	Examples
Local Biodiversity Strategies and Action Plans implementation	• Waitakere, New Zealand • Joondalup, Australia • Cape Town, South Africa • Edmonton, Canada • eThekwini Metropolitan Municipality, South Africa • Johannesburg, South Africa • Liverpool, Australia
Blue-Green networks	• Oslo, Norway • Lodz, Poland
Green and brown roofs	• Basel, Switzerland • Berlin, Germany • Stuttgart, Germany • London, United Kingdom

	• Birmingham, United Kingdom 8 • Malmö, Sweden • Toronto, Canada
Limiting urban sprawl into green spaces	• Stockholm, Sweden • Copenhagen, Denmark

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3.4.5 Local Biodiversity Strategy and Action Plan implementation

Description

Parties to the 1993 Convention on Biological Diversity (CBD) have to develop National Biodiversity Strategies and Action Plans (NBSAPs) as part of the national-level implementation of the convention. So far, 173 countries have adopted NBSAPs[30]. In their turn, local areas develop Local Biodiversity Strategies and Action Plans (LBSAPs) that detail the strategies and actions that a local government is to implement in order to enhance biodiversity.

LBSAPs include several elements, the first of which is an assessment of the species and habitats, or biodiversity, of the local area. Subsequently, LBSAPs assess the conservation status of these species and set targets for conservation and restoration. Finally, budgets, timelines, responsibilities and partnerships for the implementation of the strategy and action plan are set (Glowka et al., 1994 as cited in ICLEI – Local Governments for Sustainability, 2010). LBSAPs should also include cost estimates, timeplans, task allocations and should also consider the roles and responsibilities of stakeholders. By mainstreaming biodiversity into the regular decision making structure of a local government, LBSAPs maximise the chance of real actions being implemented.

Biodiversity at our service: Including ecosystem services in decision making and policy

Focusing on ecosystem services is beneficial in that it allows cities to make the connection between ecosystems and service delivery (for example the provision of clean water), to anticipate the consequences of decisions or policies and to communicate effectively with stakeholders about the costs and benefits linked to decisions.

The TEEB Manual for Cities: Ecosystem Services in Urban Management (TEEB – The Economics of Ecosystems and Biodiversity, 2010) draws upon work done for the TEEB – The Economics of Ecosystems and Biodiversity for Local and Regional Policy Makers report. The stepwise approach for including ecosystem services in decision making and policy includes the following:

- Step 1: Specify and agree on the problem or policy issue with stakeholders
- Step 2: Identify the most relevant ecosystem services that can help to solve the problem or policy issue
- Step 3: Determine what information is needed and select assessment methods
- Step 4: Assess (future changes in) ecosystem services
- Step 5: Identify and compare management/policy options
- Step 6: Assess the impacts of the policy options on the range of stakeholders

The goal of LBSAPs is the implementation of strategies and actions, which can range from establishing protected areas to education about biodiversity to law enforcement. Protected areas can vary widely in size, but their purpose is the same: to create an area that is managed in a way that achieves conservation objectives. Protected areas are not necessarily closed off, and can be managed so that they provide economic opportunities for local communities.

Achieved environmental benefits

Apart from the inherent importance of preserving and protecting the incredibly diverse flora and fauna that has developed over millennia on planet Earth, the ecosystem services provided by biodiversity provide an impetus for its enhancement. Indeed, without these services, humans would not be able to survive. Urban dwellers depend on ecosystem services both within and

outside of the urban region, since they consume natural resources that sometimes originate far beyond their administrative boundaries. Examples of ecosystem services include clean air, clean water, food supply, climate regulation, pollination, pest control and recreation among many others. Finally, biodiversity is impacted by climate change but is also a key feature in mitigating it and developing adaptive responses to it.

Appropriate environmental indicator

Table 3.18: Appropriate environmental indicator – Green Spaces and Biodiversity

Indicator	Unit of measure (A)	Unit of measure (A/B)	Description
Natural and semi-natural areas	km^2	km^2 natural and seminatural areas/km^2 total area	Natural and semi-natural areas are defined as all areas that are not highly disturbed or man-made landscapes. Some examples of such areas are forests, mangroves, freshwater, swamps, natural grasslands, streams, lakes etc. Parks, golf courses and roadsides are not considered as natural or semi natural. However, natural ecosystems with dominant native species within parks can be included in the computation.
Areas designated for nature protection and biodiversity	km^2	km^2 protected areas/km^2 natural areas	Areas designated for nature protection and biodiversity (EU designations such as Natura2000 as well as national or local ones). Designations can be disaggregated according to 5 different administrative level: municipal, provincial, regional, national, European
Biotope corridors (Green Infrastructure)	number km		Corridors facilitating the movement of species (including restored shore lines of rivers or lakes). For rivers and streams the recommended unit of measure is the km. Regarding land biotope land the linear length could be difficult to measure because there is not a linear corridor but elements (= mosaic) which together forms the corridor.
Native species: vascular plants	number		Native species existing within the boundaries of a local authorities
Native species: birds	number		Native species existing within the boundaries of a local authorities
Native species: butterflies	number		Native species existing within the boundaries of a local authorities

Operational data

The timeframe involved with a LBSAP should be as accurate as possible, and therefore should cover a decade overall with more specific shorter-term objectives being specified. Ideally, LBSAPs should be reviewed every two or three years in order to refine the overall plan.
LBSAPs require political-level approval, which will also increase their legitimacy and chances of success, and should be integrated into the budgetary structure of local governments in order to secure commitment for their implementation. Political leadership and the support of non-governmental stakeholders are vital to the success of biodiversity conservation initiatives. Mainstreaming of biodiversity within local government processes and the creation of long-lasting partnerships can be achieved through participative stakeholder processes. Several steps shape these processes, starting with stakeholder analysis that identifies all affected groups and their interests as well as their importance and influence, and ensuring stakeholder participation in all phases of strategies and plans. Institutional capacity building, at the individual level through education, at the organisational level through integrated planning, and at the system

level, is vital to ensuring a lasting and cross-cutting commitment to biodiversity conservation. Central to the integration of biodiversity considerations across local government functions is the recognition of the role played by biodiversity in various urban services. For example, the water retention and purification functions provided by natural landscapes are often essential for the cost-effective delivery of water in cities. Finally, partnerships at the local level – be they with academia, community groups, or the private sector – and at other levels – for example with neighbouring or distant local governments – can provide useful learning opportunities and strengthen processes linked to the shared mandate of biodiversity (ICLEI – Local Governments for Sustainability, 2010).

Businesses are also being encouraged to strengthen their commitment to biodiversity and ecosystem services through initiatives such as the European Business and Biodiversity Campaign. The Campaign and its website aim to raise awareness, share information and demonstrate useful methodologies and tools, foster partnerships and showcase examples of business commitment. For more information, see their website: http://www.business-biodiversity.eu.

Environmental Impact Assessments (EIA) and Strategic Environmental Assessments (SEA) are two supporting mechanisms for the implementation of LBSAPs. EIAs are at the project level and require a multi-dimensional assessment of the likely impacts of the proposed project, including environmental but also other considerations. Once impacts have been identified, mitigation or compensation actions can be planned into the project or it can be rejected. SEAs are more all-encompassing than EIAs, and cover plans, policies and programmes. Both EIAs and SEAs rely on stakeholder involvement, and are usually mandated for projects of a certain size.

EIA and SEA are governed by two EU Directives. The European Union Directive (85/337/EEC) on Environmental Impact Assessments (or EIA Directive) came into force in 1985 and has been amended several times since, most notably in 2003 where it was more closely aligned with the Aarhus Convention's decisions regarding public participation in decision-making and access to justice in environmental matters. The directive applies to projects, both public and private, with projects listed in Annex I requiring a mandatory EIA because of their significant environmental effects. Examples of Annex I projects are long-distance railway lines, motorways and express roads, airports with a basic runway length ≥ 2100 m, installations for the disposal of hazardous waste, installations for the disposal of non-hazardous waste > 100 tonnes/day, waste water treatment plants > 150.000 p.e.[31]

The second relevant directive is the Strategic Environmental Assessment (SEA) Directive (2001/42/EC), in force since 2001, which has enlarged the scope to enable the assessment of plans and programmes. SEAs are mandatory for plans and programmes that "are prepared for agriculture, forestry, fisheries, energy, industry, transport, waste/ water management, telecommunications, tourism, town & country planning or land use <u>and</u> which set the framework for future development consent of projects listed in the EIA Directive" or which "have been determined to require an assessment under the Habitats Directive."[32] For other plans and programmes, it is up to Member States to screen them to determine their level of environmental effects.

City example: Biodiversity and environmental education in Berlin, Germany

The recreational area of Marienfelde is located on the southern fringes of Berlin, in the borough of Tempelhof-Schöneberg. A former landfill site, it was reclaimed as public property in the 1980s. Due to lasting methane emissions and safety reasons, the area was closed to the public for several years. During this time, nature could flourish undisturbed. In the meanwhile, a facility for the decontamination of the site has started operating, making it accessible again. The borough of Tempelhof-Schöneberg has also been active in providing support to habitat preservation measures and to the organisation of promotional events in the site. On a surface of 40 hectares, visitors can experience an extraordinary diversity of biotopes such as dry grassland, species-rich ponds and shrubbery-rich meadows. The alternation of habitats makes this place significant for the conservation and resettlement of species in the suburban area. Employees of the "Nature Conservation Station" (part of the Naturschutzbund Berlin) are

engaged in planting and maintaining a great variety of ecological valuable biotopes in the whole area of the park. This is the case of the “Green toad pond”, which presents all aspects of a rich-structured biotope: open water spaces, temporally wet meadows, reed and sedge beds, accretion zones. Eurasian Spadefoot Toads, Moor frogs and lizards have found here good living and reproductive conditions. A nature trail connects 11 points of interest, such as piles of fieldstones, artificial sand dunes, hedges of brushwood or wood transformed into an “insect hotel”, where visitors can discover rare species of animals and plants. Information boards give explanations about the ecological needs of these species and illustrate which measures should be adopted to ensure their survival. In this way, dwellers can familiarise with these topics. Guided tours through the site are also offered and volunteer workshops are organised, in order to develop specific plans to preserve these natural habitats. Once a month, pupils between 7 and 11 years-old get together in the nature conservation station and carry out environmental activities, such as mowing the lawns and constructing midget biotopes. Under the patronage of a district councillor and the direction of a nature ranger, they explore the fauna and flora of the park. In summer 2011, a children´s group took care of several colonies of honeybees, giving the numerous guests of the annual event “Long day of nature” (*Langer Tag der Natur*) the opportunity to enjoy self-made honey.

This example shows how a former highly contaminated landfill area can be converted into a nature protection park and become an attractive recreational area for citizens, which are thereby given the opportunity to discover the great biodiversity of their domestic flora and fauna.

Source: Bezirksamt Tempelhof-Schöneberg, Abt. Jugend,Ordnung,Bürgerdienste, Umwelt- und Naturschutzamt

City example: Biodiversity management and long-term planning in Barcelona, Spain

"Barcelona's biodiversity efforts are rooted in the results of a comprehensive Local Agenda 21 process of several years ago which indicated the population's interest in strong biodiversity protection. The City of Barcelona, which is known for innovative environmental policies, has transformed this interest into a series of concrete on-the-ground projects." Barcelona is working on projects relating to a green urban corridor network creation, species and habitats conservation, dissemination of biodiversity information and an international commitment to biodiversity conservation.

The city's urban bird projects "are mostly concerned with the protection of breeding sites (usually in buildings) for birds. Species such as Common Swallows, House Martins and Alpine swifts are very sensitive to the restoration of old buildings and the general public has become sometimes intolerant of breeding colonies. A census involving the public was conducted to locate breeding colonies and to promote acceptance and conservation of the colonies. Through the installation of artificial nests, dialogue with residents and financial aid to committed owners, breeding colonies have been saved or even increased in various neighbourhoods. In relation to this project, work is being done at the same time with other species such as kestrels and jackdaws."

The green corridor network aims to "connect natural spaces throughout the city which are currently isolated. This will be accomplished by means of a network of ecological corridors with a continuous cover of vegetation crossing urban areas and facilitating the movement of wildlife." The City of Barcelona has identified the first and most viable green corridor as the one which would connect Collserola Hill Range with Ciutadella Park. The corridor will be established by making use of existing parks, gardens and street trees. Streets with priority for motorised vehicles will be changed into tree-lined streets with priority for pedestrians and bicycles. The parks will then be linked to these tree-lined streets reaching Collserola.

Barcelona's LBSAP is expected be adopted by the City Council during the course of 2012. The main challenges addressed in the plan are the fitting in of biodiversity in a very dense urban environment, the management of habitat while taking its different uses into account and the protection of species subjected to multiple pressures. Barcelona aims to address these challenges through the following strategic lines:

1. To strengthen municipal leadership
2. To increase knowledge applicable to conservation
3. To integrate criteria fostering biodiversity, from design to maintenance
4. To create new nature spaces
5. To conserve the city's natural heritage
6. To extend the commitment to biodiversity beyond Barcelona
7. To communicate and disseminate knowledge of biodiversity and its values
8. To create opportunities for the interaction with the city's nature
9. To foster citizen involvement in the conservation of biodiversity
10. To extend education on biodiversity at all levels

Main source: ICLEI – Local Governments for Sustainability, 2008

Applicability

For CBD signatory countries, the implementation of National Biodiversity Strategies and Action Plans is mandatory, and implementation at the local level is generally done through LBSAPs. Although these are not mandatory, they are replicable at the local level in cities of all sizes and biodiversity status, since the strategies and actions they imply can be tailored to the needs and resources of the communities in which they are applied. Local governments can commit to protecting biodiversity by signing the voluntary Durban Commitment: Local Governments for Biodiversity, of which one of the declarations relates to the development and implementation of LBSAPs that address the following points (Figure 3.47).

4.3.1	The consideration of biodiversity in all aspects of local planning including, amongst other things: land-use planning, mobility planning, economic development planning, and conservation planning;
4.3.2	The management of natural areas and green spaces, including the restoration and rehabilitation of degraded natural areas and the control of invasive species;
4.3.3	The provision of municipal services, including fresh and waste water treatment, energy generation and housing;
4.3.4	Public procurement strategies, including purchasing of eco-certified goods and services and the ban of hazardous products;
4.3.5	Social development including poverty alleviation and job creation;
4.3.6	Awareness-raising of the value of biodiversity and the need for its protection in all sectors of society;
4.3.7	Stakeholder participation in all relevant aspects of local biodiversity governance; and
4.3.8	The inclusion of biodiversity in city partnerships and cooperation projects with public and private partners.

Figure 3.46: The Durban Commitment – Local Governments for Biodiversity. Source: ICLEI, 2010

A certain degree of expertise, be it legal, environmental or planning-related, is required in order to choose implementation tools that will ensure the successful implementation of the plan. These tools include incentives, be they financial – tax incentives, rebates and grants; non-financial – training, recognition through awards; or market-based – procurement, eco-tourism. Awards include the European Capitals for Biodiversity which is awarded annually to municipalities that demonstrate excellence and commitment to the protection of habitats and species. The award recognises the rich biodiversity that can be found in European cities and towns, and fairness is ensured by dividing municipalities according to their size[33]. Tools also include disincentives or the removal of perverse incentives; innovations in property rights – the establishment of protected areas, stewardship programmes; bylaws; land acquisition and other management options.

City example: Tata, Hungarian Capital of Biodiversity 2010 - Old Lake Rehabilitation

The city of Tata is located in the Komárom-Esztergom County in Hungary. Tata's 220 hectare Old Lake (*Öreg-tó*) is regarded as the oldest (almost 700 year old) artificial fishing lake in Hungary. The Old Lake is considered with its 220 ha water surface one of the most significant lakes of the Central Transdanubian Region and is a focal point for water sports and tourism, international environmental protection and architectural heritage. As one of Central Europe's most important wintering areas for water birds, the area came under protection of the Ramsar Convention in 1989. Up to 25-30,000 wild geese can spend the night around the lake during the autumn migration period. 12% of the European population of the Bean goose (Anser fabalis) stay here. Significant population of the White-fronted goose (Anser albifrons) spends winter on the lake. The Greylag goose (Anser anser), the Pink-footed goose (Anser brachyrhynchus), the Barnacle goose (Branta leucopsis) and the Brent goose (Branta bernicla) can be also found here.

The 11 m high lookout tower built in 1999 on the lake side also helps the observation of migrating birds. The urbanization, industrialization and agricultural development of the catchment area have generated several environmental problems in the last decades (drying karst-wells, air, soil and water pollution), as a result of which Tata and the Old Lake lost their national resort status. The water quality of the Old Lake and the Által-ér water course deteriorated and they became inappropriate for bathing. Sedimentation, eutrophication and basin degeneration led to reduced water conveyer ability (it decreased to a fraction of the original). The reservoir of the lake during floods decreased too. Recognizing the seriousness of the situation, a wide-ranging social cooperation started in the 1980s to save the lake. As a result, a rehabilitation plan of the Old Lake was elaborated, containing the following tasks:

- the reconstruction of the out-flow system of the Által-ér water course;
- the renovation of the Old Lake locks;
- the clearing of the inland water pipeline (sediment removal, bush-cutting);
- the improvement of the upper line of Által-ér;
- the preparation of a filtration system in Tata (20 ha);
- the preparation of a filtration system in Bánhida, a site belonging to the catchment area of Old Lake and Által-ér (11 ha);
- the reconstruction of the Old Lake on 15 ha (habitat reconstruction, the establishment of nature trails and islands);
- the building up of a water quality control system;
- the restoration of the shore line of the Old Lake (forming a green path along 900 m).

This project contributes to both environmental and nature protection, water management and social improvement. Considering that a significant part of the area is vulnerable natural land, includes “Natura 2000” sites and belongs to the protection of Ramsar, the planned habitat reconstruction serves national and international interests.

Source: North-Transdanubian Environment and Water Management Directorate, Local Government of Tat, Lake Balaton Development Coordination Agency.

Economics

The costs of LBSAP development and implementation are highly variable, depending on the types of actions that each plan calls for. Baseline costs are to be anticipated and are linked to the staff time required for mapping, surveying and making threat assessments – if capacity is lacking within the local government, partnerships with local academia or private sector organisations can be particularly valuable – and for the writing of biodiversity reports and plans, but also to the organisational efforts needed to implement a thorough stakeholder involvement process.

Benefits and costs vary depending on several factors. For example, the planting and maintenance of trees in Canberra, Australia, has been estimated to save and generate around US$4 million annually because of the trees’ effect on the local microclimate, on reducing air pollution and on reducing the energy costs associated with air conditioning (Brack, 2002 as cited in TEEB, 2010). The value of ecosystem services can be calculated in terms of avoided expenditure, for example in Vientiane, Lao People’s Democratic Republic, where the value of wetlands at around US$5 million per year is calculated using flood damage costs as a proxy (Gerrard, 2010 as cited in TEEB, 2010). This is also the case in Kampala, Uganda, where a wetland provides free water treatment which would otherwise require an annual expenditure of $2 million if a wastewater treatment plant were installed (Almack, 2010 as cited in TEEB, 2010).

Driving force for implementation

Conserving biodiversity in cities is also important because it puts urban residents in touch with nature; many urban residents might not otherwise have this opportunity, particularly if they come from poor neighbourhoods or those under-served by transport links. As the level of governance closest to communities, local governments are in a good position to engender change. One of the biggest challenges to biodiversity conservation in urban areas is the fact that areas rich in biodiversity are often under pressure as a result of population growth and urbanisation, but also that the geographical distance between urban residents and the ecosystem services they depend on creates a psychological distance as well.

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3.4.6 Blue-Green networks

Description

The creation of Blue-Green networks is one of the most interesting ways in which to recognise the vital role played by water and green spaces in the urban environment in terms of quality of life, health, biodiversity conservation and economic development. The expression "Blue-Green network" generally refers to an urban space development concept defining a network of existing and/or restored rivers and their valleys, and green areas (agricultural areas, parks, old orchards, wastelands, degraded areas and others) as a basis for spatial planning of cities, which will provide sustainable development and adaptation to global climate change. The creation of buffer zones around the green areas and rivers, allowing for more intensive urban functions, can contribute to the protection and maintenance of the continuum of ecological processes within the network. (University of Łódź & City of Łódź Office. 2011). In fact, buffer zones are effective means of minimizing the conflicts between potentially incompatible land uses and do ensure a minimal separation. They may vary considerably leading to significant differences in the physical, cultural socio-economic aspects and in plant cover and soil use. In order to choose the most suitable buffer zone, the local conditions have to be taken into account. Some examples of buffer zones with at times fundamentally different characteristics include industrial/ residential buffers, sensitive habitat buffers, riparian buffer and public facility buffers (Placer County California General Plan, 1994). But also Blue-Green networks can take a variety of shapes and sizes, and can either be set up by regenerating and connecting remaining natural spaces in a city or by implementing protections to ensure natural spaces are preserved. The idea of a network is vital, as it recognises the importance of corridors for the enhancement of biodiversity, and can also be linked to other urban networks such as the transport network, by linking these natural spaces with cycling and walking paths.

→ **Cross-sectoral links**

As well as being important for biodiversity preservation, Blue-Green networks also deliver a range of services that are linked to the urban management services outlined in this document: water management (through stormwater attenuation), health care (by improving air quality

and providing recreational opportunities) and transportation, among others.

Achieved environmental benefits
The creation of Blue-Green networks brings a number of environmental benefits which are closely linked to ecosystem services. For example, the green spaces absorb rainfall and therefore decrease the risk of flooding, absorb CO_2 and therefore mitigate climate change, filter particulates and therefore improve air quality, and provide habitat for flora and fauna, among other advantages.

Appropriate environmental indicator

Table 3.19: Appropriate environmental indicator – Green / blue areas

Indicator	Unit of measure (A)	Unit of measure (A/B)	Description
Green and blue areas	km^2	km^2 green and blue areas/ km^2 total area	Green and blue areas can be disaggregated into the following categories: - anthropogenic greenery and green space: greenery on impermeable surfaces, managed green space (roof gardens, roadside plantings, golf courses, lawns, urban parks, etc.); - natural greenery: protected areas and natural ecosystems (all areas with natural ecosystems, national parks, nature reserves, etc.); - artificial water bodies (reservoirs, artificial lakes, drains, etc.); - natural water bodies (rivers, streams, lakes, etc.).
Recreational green urban areas (RGUA)	Ha	Ha RGUA/ inhabitants Ha RGUA/ Ha municipal surface	Recreational green urban areas can be disaggregated into: - urban parks and gardens; - other recreational and accessible urban areas (not classified as parks and gardens).
Accessibility of recreational green urban areas (RGUA): citizens living within 300m	number	citizens living within 300m of a RGUA/ total population	This indicator has to be calculated using GIS software comparing green areas and population layers.
Roadside trees in the urban area	number	number of trees/ total population	Trees planted along streets and squares (not in parks and gardens)

Benchmark of excellence
The total area of the Municipality of Oslo is 454 km^2 (including land area, lakes, rivers and streams). This consists of 301 km2 of forest (66%) and 153 km2 of built-up area (34%). Within the built-up area, public green areas cover 29.000 Ha (19% of built-up area), about 52 m^2 per inhabitants. The proportion of citizens who live within 300 m of open green spaces, irrespective of the size, is 94%. The corresponding figure for areas over 1 hectare is 89.
The municipality of Vitoria Gasteiz accounts 1,091 Ha of public green areas (33% of the city's urban area). During the period 1974-2010, the urban area used for green spaces has doubled, reaching around 478 hectares, 20 m^2 per inhabitant. If the current extension of the Green Belt (613 Ha) is included, this value increases to close to 46 m^2 per inhabitant. One of the main peculiarities of the Green Belt in Vitoria-Gastiez is its origin. Some of the urban fringe parks were originally degraded areas. The recovery of these spaces, initiated in the mid-90's and at the present time the Green Belt forms a continuous and unified network, formed by several parks that will add 613 hectares altogether. Over the next few years, it is planned that this will be

extended to 787 ha. Nearly 100% of the citizens of Vitoria-Gasteiz live now within 300m of open public zones and green spaces.

Operational data

Different cities and countries have applied the Blue-Green idea in various forms, sometimes focusing on different aspects. In France for example, the government is implementing the Green and Blue Infrastructure, a landscape management tool aiming to enhance biodiversity. The network aims to create or preserve key ‘reservoirs’ for biodiversity and to link these through ecological corridors vital to the free movement of species. Its establishment will first be guided at the national level then followed by regional schemes for ecological coherence which cities and other local bodies will have to take into account when undertaking any planning activities. One example of a simple action to be taken at the urban level to ensure ecological continuity is to create small openings in yard fences that have limited the free movement of fauna such as hedgehogs and toads[34].

Oslo, Norway, is another example of a city that has created a Blue-Green network. The network fulfils several aims: to protect the city’s drinking water sources – these are of high quality and as a result of the protection they receive enable cost effective treatment of the water supply; to create recreational opportunities for the city’s inhabitants, who are never far from water or green spaces; and to preserve Oslo’s impressive biodiversity. Green and blue areas, namely fields, forests, rivers and the sea, make up two thirds of the city’s area. As a result, 95% of Olso’s inhabitants live within 300 metres of a green area. The easy access and clean state of Olso’s green and blue areas, and the leisure and recreation opportunities these afford, are the aspect most appreciated by the city’s inhabitants. Oslo is rich in biodiversity, housing two thirds of Norway’s species, and includes elk and lynx. Oslo has designated a green belt around the city, and manages natural spaces based on ecological principles while taking into account multiple uses and recreational use. The green belt also serves as a protection area for the city’s drinking water intakes from surface sources. Although Olso benefits from its location on a fjord, it has also been impacted by past industrialisation, agricultural activity and urban development. For example, its rivers and coastal waters were not always as clean as they are now, and many of the city’s rivers have been paved over. Olso is working on re-opening these rivers and on creating green corridors connecting the rivers to the surrounding forests. The city has prohibited building within 20 metres of river banks (City of Oslo, 2003).

Another example of Blue-Green Network is represented by the Ashford (UK) Green Corridor, a green space that runs right through the English town. The Green Corridor is made up of parks, recreation grounds and other green spaces alongside the rivers that flow through Ashford. It has been designated as a Local Nature Reserve, and is being looked after by a partnership of organizations. Ashford has been growing steadily since the early 19th century. As the town has expanded, land close to the rivers has not usually been built on due to the risk of flooding and has thus been protected as green space. The Green Corridor is managed to cater for all its different users, to maintain facilities, look after the environment and ensure safety. As well as helping people to use the Corridor, habitats for wildlife will be conserved and improved: for example, some areas of grass currently cut on a regular basis will be allowed to grow to provide habitats for a variety of plants and animals. Because the Green Corridor areas are right next to Ashford's rivers, many of them hold floodwater, thus protecting homes and businesses. Ashford's rivers are surprisingly natural considering their urban surroundings, and are home for many wild plants and animals. Kingfishers, grass snakes, dragonflies and damselflies can all be seen. Ponds like the one at Bowen's Field attract amphibians. Singleton Lake, an artificial lake in the area, is a habitat for wetland birds and Buxford Meadow, a wet grassland in the Area, presents an enormous range of plants, insects and other species.[35]

City example: Blue-green revitalisation in Lodz, Poland

Lodz, formerly a textile production centre, continues to feel the environmental, economic and social impacts of industrialisation and subsequent manufacturing decline. Restoring the city's rivers is seen as a way to address all of these challenges and regenerate the city in a multi-dimensional way. Lodz is implementing a concept whereby water and green spaces are at the heart of urban development and deliver a series of benefits to the environment, human health and the local economy.

The lack of green spaces and open waterways in the city, combined with the health problems created by the low infiltration rates (causing high dust and pollution levels, an urban heat island and low humidity levels), have affected the quality of life of Lodz's inhabitants. That is why Lodz took a broader view in the remediation of these problems instead of just focusing on water management.

Demonstration projects implemented by Lodz have played an important role in creating visibility, interest and cooperation, and as such have been vital in the scaling-up strategy of the project. Their success has inspired the city and other stakeholders to create the Blue-Green network.

The Blue-Green network (figure 3.48) creates recreational areas – contributing to health and quality of life; low-carbon transportation options – such as cycling and walking; sustainable stormwater management infrastructure – decreasing runoff and improving its quality; improved air quality and a more attractive and revitalised city. By improving city aesthetics and quality of life, Lodz is hoping to attract professionals and improve the city's competitiveness. Network creation and maintenance jobs will also create growth. The city, by developing natural stormwater treatment systems, is taking a future-oriented and climate change-conscious approach.

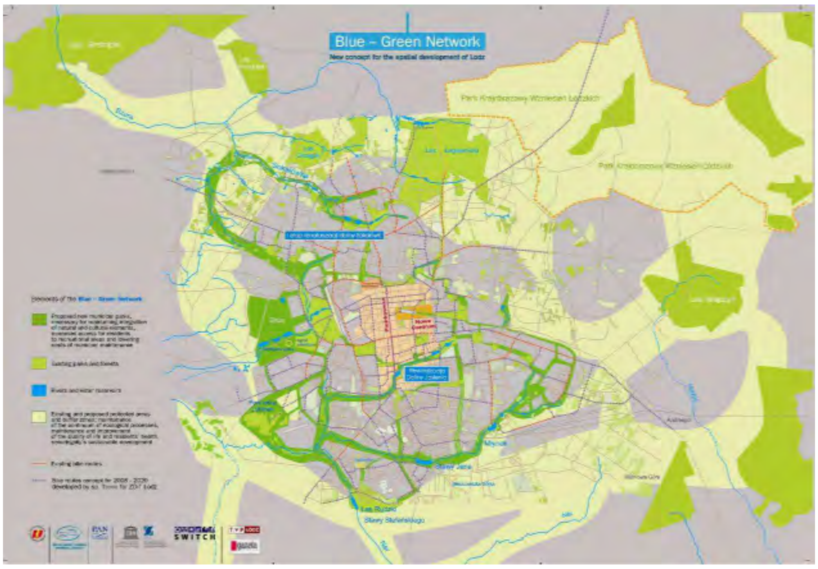

Figure 3.47: Lodz's Blue-Green network. Source: University of Lodz & City of Lodz Office, 2011

Protecting the most biodiverse parts of the city – its river valleys – and being connected to green areas in the periphery of the city, the Blue-Green network will contribute to the conservation of species and habitats in the region.

In sum, the Blue-Green network concept as adopted by Lodz is an ideal way to kick-start sustainable development's social, economic and environmental pillars. (Loftus, 2011b and University of Lodz & City of Lodz Office, 2011).

Applicability

Since Blue-Green networks can range from small-scale endeavours to all-encompassing city plans, they are replicable in most settings. The example of Lodz shows the case of a city starting from a challenging baseline situation; cities with fewer modifications to natural habitats may find it easier to implement.

As shown in the case of Lodz, cities do not exist independently from their surroundings: both green spaces and water bodies are connected with areas that are often beyond the political boundaries of a city. Blue-Green networks will often need to take this into consideration and coordinate with the political entities managing their contiguous territories or the landscapes which they have an interest in preserving. Many cities for example make an effort to protect the catchments that supply their drinking water so in order to improve water quality and reduce the costs associated with treatment. New York City, for example, manages and has purchased extensive areas of land within the Catskills catchment that supplies its drinking water, and the resulting high quality water has meant that it is able to supply drinking water without needing to filter it.

Economics

Costs will vary according to the level of complexity and the chosen elements. Some of the returns associated with the implementation of this BEMP will be perceived by the local authority, for example in terms of reduced stormwater management costs or reduced costs associated with flooding damage to public infrastructure. However, other returns will either accrue to others, for example when citizens benefit from recreational opportunities, or will not be immediately quantifiable, for example in the case of health care expenditure reductions. However, there have been tremendous efforts to place monetary value on green infrastructure, in order to allow for a clear visualisation of costs and benefits. This in turn may help stimulate investment, since it allows decision makers to evaluate economic returns at the regional and community scale. Figure 3.49 offers a highly simplified method of calculating the economic benefit of investments in green or blue infrastructure. The economic benefits to individuals and society, government and business that can be derived from a huge variety of benefits having an economic value are added up. Then in a second step the costs related to the intervention such as development and capital costs as well as management and maintenance costs are subtracted from the economic benefits. By doing so, the net economic benefit or disbenefit can be obtained. Since this calculation remains rather theoretical, a case study from the St. Helens in the UK will visualize how this calculation can be done in practice.

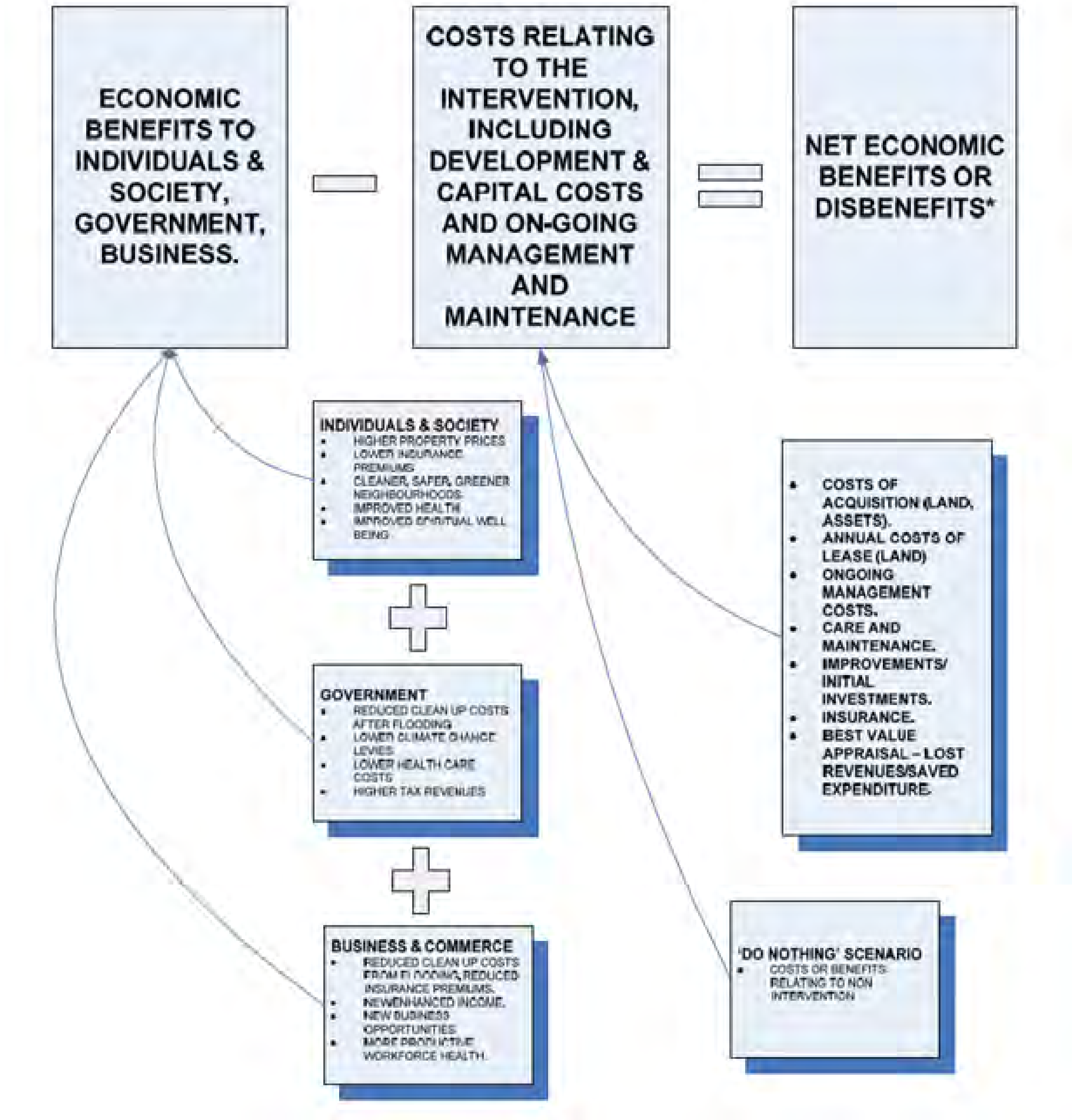

Figure 3.48: Estimating economic value from green infrastructure investment, Source: Urban Open Space Foundation 2003/ECOTEC 2008

The industrial city St. Helens is located between the cities Liverpool and Manchester and has about 100.000 inhabitants. In order to attract more tourism, economy and investments and at the same time increase the quality of life, the St. Helens Urban Fringe Action Plan was completed in 2006, having a special focus on green infrastructure. At the roots of this plan lie two initiatives: One is the Mersey Forest, which for the last ten years has been planting new community woodlands and reclaiming derelict land. The other is the “Countryside In and Around Towns” initiative, which sought to demonstrate how planners can make the most of the open spaces in and around urban areas. Funding of about £80,000 was secured. This investment resulted in economic benefits, some of which can have an immediate monetary value. The land and property values are increasing. At Bold Moss, on the edge of the town, a derelict industrial land has been transformed into a community woodland and nearly 600 new homes had been built. A report by the district valuer found property values in the surrounding area had risen by £15m as a direct result, and new developments worth £75m had been attracted. In addition the Forest Park is expected to attract over 100,000 new visitors a year tp St. Helens and Merseyside. It will create new jobs and business opportunities: developing the park is expected to generate

15 new jobs and 300 training opportunities for people who are out of work. It is predicted that the Forest Park will bring an extra £4m of investment into the area and boost the business involved by 3% in terms of Gross Value Added (GVA) per capita. If these economic benefits are put in a relation to the investment cost (assuming they are complete), it becomes clear, that investments in green infrastructure can indeed provide a local government with immediate economic benefits.
Calculations like this can help convince stakeholders of the importance of investing in green infrastructure and allow policymakers to balance issues of community and economy growth, environmental protection and quality of life.

Driving force for implementation
In addition to environmental benefits, Blue-Green networks also provide a number of non-environmental advantages which include: improving human health by bettering air and water quality as well as providing opportunities to exercise; providing opportunities for low-carbon transportation if they incorporate cycling and walking paths; and creating more aesthetically pleasing cities which attract tourists, new residents and businesses.

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3.4.7 Green and brown roofs

Description

Cities are characterised by the extent of impervious surfaces within them; buildings occupy a large proportion of urban areas, and can lead to a lack of green spaces. Green roofs are one way in which urban areas can add green spaces within their periphery, creating a series of benefits for the environment and human health. Most green roofs are composed of several layers: on top of the normal roof membrane, a root barrier layer protects the roof. Above this is installed a drainage layer which allows water to flow, and this layer is overlain by a filter fabric which prevents clogging; finally, a growing substrate houses the chosen green roof plant species. The substrate is usually composed of organic matter and inorganic material (figure 3.50).

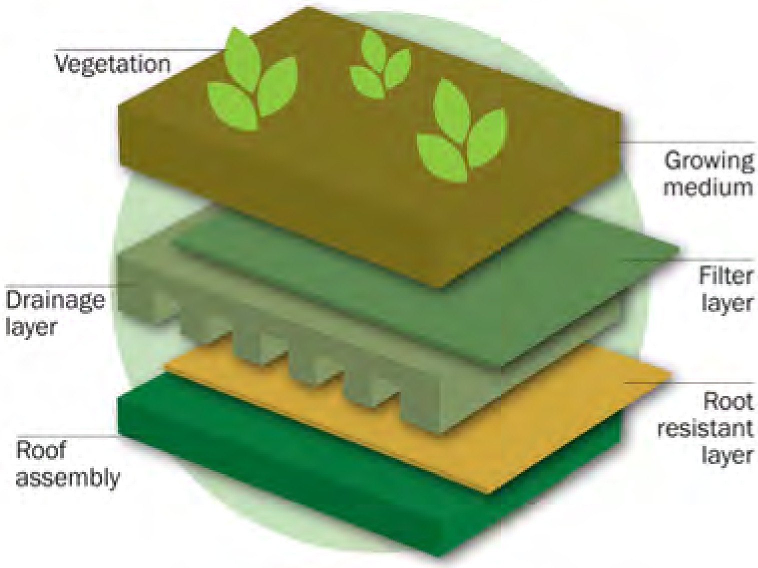

Figure 3.49: Green roof layers. Source: http://www.cc.viu.ca/leed/GreenRoof.htm

There are two main types of green roofs. 'Intensive' green roofs are usually flat and made accessible to the public; they are designed to house plants and shrubs that require maintenance and generally need a thicker layer of substrate on which to grow. Because they require a deeper layer of growing medium and therefore generate significant costs as well as weight that needs to be supported by the building, these intensive green roofs are less common. They also require more maintenance. 'Extensive' green roofs are not made accessible to the public, can be found on flat but also sloped roofs, and are designed to require little or no maintenance. The substrate layer on extensive green roofs is thinner and they therefore house moss, herbs, grass or succulents (Getter & Rowe, 2006). Because they are lighter, they can be installed on large surfaces such as those of industrial buildings or sporting facilities. They are the most common type of green roof, and are the type discussed in this section. Switzerland has been one of the countries most instrumental in green roof research and design, and work undertaken for example in Basel has influenced other cities such as London, the city example explored in this section.

Brown roofs are a type of green roof and are designed for the specific purpose of improving urban biodiversity. As many European cities have become less industrial, the brownfields that have been created in urban areas have become havens for various species, including rare ones. Relatively recently, however, brownfield zones have become desirable to developers because of their central locations and the incentives available for their regeneration. Although this development is a positive one from several sustainable development angles, for example because it allows for in-filling of urban areas rather than spreading into adjacent countryside (see Stockholm's approach to urban sprawl), it can have a detrimental impact on urban flora and fauna that has adapted to these habitats. Brown roofs attempt to reproduce these brownfield habitats on top of buildings Although urban regeneration and an emphasis on in-filling and denser urban development could potentially lead to a loss of green and biodiverse urban spaces, offset schemes whereby green space losses to urban developments are either offset through the

installation of a green roof or through the funding and construction of green space or amenity space nearby can mitigate negative impacts. London for example has such as scheme in place.
As well as being excellent for biodiversity enhancement, brown roofs also provide some of the benefits of traditional green roofs, such as stormwater attenuation and runoff quality improvement – though to a lesser extent than green roofs. Indeed, when green roofs are designed in order to maximise stormwater capture they usually use fertile soils and intensive plant cover, usually Sedum, whose use is not optimal for biodiversity (Bates, Greswell, Mackay, Donovan & Sadler, 2007). Brown roofs will only initially be brown as they will over time become colonised by various plant species and take on a rather green appearance.

Figure 3.50: Green wall in Paris, France. Source: flickr/Lauren Manning

Green walls, also known as vertical gardens, are another way to increase green spaces within a city. Green walls can either be covered in plants that are rooted in the ground, as with ivy-covered buildings, or can be specifically designed so that plants grow from the surface of the wall itself, as in the Quai Branly museum in Paris illustrated in Figure 3.51. Green walls serve many of the same purposes as green roofs, namely building insulation, stormwater attenuation and purification as well as aesthetic value. This type of green surface will not be discussed in detail in this section.

Achieved environmental benefits

Green and brown roofs provide a series of environmental benefits which are listed below. Many of these benefits converge when it comes to climate change adaptation. Indeed, green roofs can help cities adapt to increased rainfall, drought and increased temperatures. Since these are the challenges London is predicted to face in the future, green roofs are part of its adaptation strategy, as highlighted in the case study below.

- Stormwater attenuation. Green roofs help reverse the effects of impermeable surfaces on stormwater management, by reducing runoff and peak flows (volume). Rainwater is captured by the roof and either evaporates, transpirates or is released at much slower rates once the surface becomes saturated, depending on the type of green roof and the intensity of rainfall. Green roofs can reduce runoff by 60 to 100% (Getter & Rowe, 2006).

- Water savings. If stormwater is captured from green roofs, it can be reused for a number of non-potable applications such as toilet flushing or garden watering, thereby reducing the quantity of water that needs to be abstracted and treated to drinking water standard.

- Energy savings. Green roofs provide shading by reducing solar energy gain and also insulate buildings, reducing fuel and electricity use for both cooling and heating. Given the large percentage of urban energy use from buildings, green roofs can have a significant impact on urban energy consumption, with associated greenhouse gas emission reductions as well as cost savings. Green roofs reduce the need for heating in winter but also for cooling in summer, and are therefore suitable for cold and warm climates, as well as for continental climates which are subject to strong seasonal temperature variations. Moreover, green roofs also improve the efficiency of air conditioning systems by reducing the temperature of the intake air.

- Reduced urban heat island effect. Urban surfaces have a low albedo and therefore absorb much solar energy. This, in addition to the lack of evapotranspiration from impermeable urban surfaces, helps create the urban heat island effect, where urban temperatures are higher than those of the surrounding countryside. Green roofs help reduce this effect since they have a higher albedo and also allow evapotranspiration.

- Air pollution reduction and CO_2 absorption. Green roofs help reduce airborne contaminants and particulate matter, improving the health of urban residents, and their plants also absorb carbon dioxide emissions. Air quality is also improved due to the increased humidity and oxygen levels.

- Habitat provision. Green roofs provide habitat for insects, birds and microorganisms.

→ **Cross-sectoral links**
Green roofs are one of the sustainable stormwater management techniques. The benefits mentioned above also mean that green roofs provide benefits linked to energy use (Section 3.5), air quality, noise and waste management (Section 3.2).

Appropriate environmental indicator

Table 3.20: Appropriate environmental indicator – Green and brown roofs

Indicator	Unit of measure (A)	Unit of measure (A/B)	Description
Number of species (biodiversity) living on the rooftop	number		Local wildlife species or specific target species
Recycled products	Number (kg)	n. (kg) of recycled products/total n. (kg) of products	Data have to be disaggregated according to different products, e.g. bricks, timber fenders, rubber membranes, drainage system etc.
Use of local materials	Number (kg)	n. (kg) of recycled materials/total n. (kg) of materials	Data have to be disaggregated according to different materials, e.g. seeds, branches, sand, stones etc.

Benchmark of excellence
Between 1996 and 1997, the City of Basel invested 1 million Swiss Francs (CHF) in a green roof incentive programme. In 2002, following the first incentive programme, and incorporating the outcomes of the research into biodiversity value of green roofs, an amendment to the City of Basel's Building
and Construction Law provided that all new and renovated flat roofs had to be greened according to specific design guidelines A further 1 million CHF funded the green roof incentive programme that ran between 2005 and 2006.
During the first incentive programme (1996–97) 135 people applied for a green roof subsidy, which led to 85,000 m^2 of roofscape being greened. The Building and Construction Law has since provided a major impetus for the development of more green roofs in Basel. In 2006, 1711 extensive green roof projects and 218 intensive green roofs were recorded across the City of Basel in total. Approximately 23% of Basel's flat roof area is green.

Many of the most recent brown roof projects can be found in East London, which has undergone a great deal of regeneration, not least because of the 2012 Olympic Games. For example, in the London borough of Hackney a green roof of 330 m^2 has been created in 2009 with the aim to encourage invertebrates and plant life in an area of regeneration. All materials used to construct the brown roof were sourced with the following criteria: a high level of recyclability; low carbon footprint; sustainable and local supplies. Drainage and water reservoir mat, crushed brick and split logs and branches were 100% recycled.

Cross-media effect

Green roof benefits are sometimes mutually exclusive, and the following trade-offs should be taken into consideration (Philip, 2011b):

- "Green roofs designed with the main objective of reducing stormwater runoff require high vegetation cover supported by a fertile soil. This can lead to nitrate leaching which compromises water quality in the runoff that flows from the roof. In addition the plant species that are good for attenuation (such as Sedum) reduce the potential for biodiversity development.

- Depending on climatic conditions, green roofs may restrict the collection and reuse of rainwater from the roof surface, particularly where the objective is to attenuate stormwater in soils and plants. Designs can however be chosen that optimise reuse opportunities by providing natural treatment of rainwater through soil filtration, although such designs are unlikely to offer the same biodiversity and aesthetic benefits.

- To achieve stormwater attenuation that is sufficient to allow disconnection from a larger drainage system, green roofs need to be integrated with other stormwater BMP options such as infiltration basins and ponds." This has positive impacts on erosion as well as on flooding and its associated property damage. Green roofs also help improve the quality of stormwater runoff through plant uptake of pollutants and filtration, although in some instances the fertilisation of green roofs can increase the nutrient content of runoff and decrease water quality.

Operational data

At the preparatory stage of setting up a green or brown roof, two essential steps require the help of a structural engineer or an architect. This helps avoiding any expensive repercussions in the long-term. The professional can determine the maximum load that the building can support. Certain parts of a roof are stronger because they are supported either by a load-bearing wall or by pillars. In addition, the roof can be checked for water-tightness. It must be in perfect condition because any repairs to the roof will be more costly to carry out once the green roof has been installed.

Besides these two fundamental steps, it is important to consider the following aspects, before actually building y green roof. It is very important to enquire about municipal regulations, and see whether the acquisition of a permit is necessary. Many cities treat green roof installation as a renovation and will require a permit. In case the roof is not flat the pitch must be calculated. As a general rule, the growing medium remains stable on a pitch of up to 25 degrees. But if the slope is greater, one may need to fix metal, wood or plastic battens to the roof membrane to hold everything in place and to avoid any erosion by heavy rain. Special reinforcing mesh is also available for this purpose. Moreover, it is important to ensure roof access. The roof must be accessible both during construction and for periodic maintenance. During installation, plan an access that allows the materials, soil and plants to be safely carried up. Later you will need to be able to access the roof regularly for maintenance. Another important aspect for a green roof is its exposure to sun. This determines the type of plants to be used. Check for nearby mature trees, high buildings, etc. Consider the direction of prevailing winds in order to choose the best position for plants. Tall plants need to be protected from winds if they are not to be uprooted. Depending on where the roof is to be installed, other factors may need to be considered, such as plant hardiness or snow and ice accumulation. Moreover, the planting season for a green roof needs to be taken into account. Spring or autumn are the best times to install a green roof and ensure successful establishment. It is recommended that green roofs are not installed during the summer months.

After considering the aspects mentioned above, the actual installation of the green or brown roof may start. The basic build up of a green roof is three layered: drainage, filter and vegetation layer. Each layer needs to fulfil several functions to decrease the height and the weight of the overall build-up (Source: Greenspec: http://www.greenspec.co.uk/green-roofs-1.php). In addition, it is important to decide, what kind of planting is to be used. In fact, planting is divided into three categories: extensive, semi-extensive and intensive. The difference between them lies in installation costs, depth of the growing media and choice of plants. Depending on the

building structure, one type will be more appropriate than another. Letting plants spontaneously colonize the roof is of course also an option.

Extensive

Besides letting plants spontaneously colonize of the roof this is the least expensive type to install. Extensive green roofs are used in places where access is difficult. Requiring only a minimum of expertise, they are recommended for roofs with a 0 to 40-degree pitch. They make a good choice for large surfaces where building reinforcement would be too costly. The thickness of the medium varies from 5 to 15 cm and, when saturated with water, it weighs between 70 and 170 kg per square meter. The plants chosen must be resistant to drought conditions, quick growing and ideally give good ground cover, since they will only be watered during dry periods. Extensive green roofs do have some drawbacks. The thin substrate layer reduces energy efficiency and water retention, and because they are not suitable for walking on, they cannot be used for recreational purposes. The choice of plants is more limited.

Semi-extensive

Semi-extensive green roofs also have a thinner soil layer, but they differ in that, below the growing medium, there is a drip irrigation system between the geotextile filter course and the geotextile root-repellent. With a drip irrigation system there is no wastage of water because there is practically no evaporation. Also, unlike using a hose, there is no runoff. It allows a wider range of plants, and you can introduce relief by planting small hardwoods, spreading conifers or even vegetables and small fruit plants. To avoid burst pipes, the system must be purged of water before the winter.

Intensive

This is the most expensive type of green roof to install because it does require a specialized firm for a structural analysis of the building and to carry out the installation. Intensive applications are recommended for low pitched or flat roofs. They offer optimum insulation properties and greater water retention. The growing medium on intensive green roofs is deeper, 20 to 60 cm (or more), and consequently weighs between 30 and 950 kg per square metre when saturated with water. To this the weight of the building materials (rockery stones, retaining walls, pavers, stone for pathways etc) has to be added, not forgetting any furniture and decorations. A deeper soil layer means a wider choice of plants, which can include espaliered trees and shrubs, thereby creating a more complex ecosystem. Intensive systems demand more maintenance, particularly regular watering. The installation of a drip watering system is recommended (Source: RONA – Doing it right: http://www.rona.ca/content/installing-green-roof_roof-eave_roof-eave-exterior-siding_renovation).

Maintenance requirements vary depending on the roof type and the plant species, but inspections are recommended once or twice a year for pruning, fertilising, in-filling and clearing debris. Brown roofs require less maintenance, and should be designed so that their habitats are self-sustaining. Brown roofs are particularly low in their maintenance requirements since they do not need to be replaced often. Moreover, because they do not require the application of fertilisers to maintain the plant populations, they provide a better quality of storm water runoff (Source: Greenspec: http://www.greenspec.co.uk/green-roofs-1.php).

City example: Green and brown roofs in London, United Kingdom

London's work on green roofs is strongly linked to its climate change adaptation and mitigation policies and plans; these feature for example in London's Adaptation Strategy (Greater London Authority, 2010). Although the initial push for green roofing in London was mainly centred on their biodiversity benefits, in the last few years the focus has shifted rather to the climate change adaptation benefits they provide, although some boroughs still place a stronger emphasis on biodiversity. In order to reduce the impacts of extreme weather events, the Greater London Authority has committed to increase tree cover by 5% by 2025, to increase greenery in the centre of London by 5% by 2030 and a further 5% by 2050, to create 100,000 m^2 of new green roofs by 2012 and to enhance 280ha of green space by 2012.[36]

Green roofs are a key adaptation feature of the London Plan (which is the capital's spatial development strategy covering the period between 2011 and 2031) and are listed in the second point of the Plan's 'cooling hierarchy', as one of the key ways to reduce the amount of heat entering buildings in summer. All proposed developments have to demonstrate how they reduce overheating and reliance on air conditioning in accordance with this hierarchy. The plan's policies mandate the integration of green infrastructure (including green roofs and walls) from the beginning of the design process of development proposals. London's Living Roofs policy is to be incorporated into the updated supplementary planning guidance on Sustainable Design and Construction of the London Plan (Greater London Authority, 2011).

London will face increasing risks of flooding, drought and high temperatures because of climate change. Several factors have prompted London – in this case Thames Water – to implement stopgap solutions to counter surface flooding. One example is the Thames Tunnel, which collects Combined Sewer Overflows for treatment and thereby prevents pollution in the Thames River. However, there has been a realisation that had extensive green infrastructure projects been implemented several decades ago, the surface flooding situation would currently be much improved. Therefore, in addition to these short-term solutions London is also putting in place longer term green infrastructure solutions.

In terms of green roof installations, the Greater London Authority is not able to be overly prescriptive, since such a role is legislatively and politically better suited to the various London boroughs, such as the Borough of Islington, which has set a prescriptive target for annual increase in total green roof area. The London boroughs set the planning criteria and make the planning decisions for all except the largest of projects, and therefore have an influence on green roof installations. The GLA provides guidance, though it also receives planning referrals for major developments and can hence influence green roofs through these. The GLA hopes to be able to use its website as a central source of accurate information and guidance. It is collecting experiences of green roof installations, including any difficulties encountered and solutions subsequently put in place, in an effort to share lessons learned. For example, in some instances getting the material onto roofs to retrofit green roofs has proved challenging because of the need to use cranes and close roads in a very busy urban environment.

London has been looking to other cities in order to gain useful lessons from their green roof programmes, for instance by reviewing the incentive schemes in place in a number of cities throughout the world (Greater London Authority, 2008a). Not all incentives are probably applicable in London. For example, although grants and subsidies may help incentivise retrofitting green roofs onto existing buildings, they must – especially during challenging economic times – demonstrate clear additionality, something which is hard to determine for green roofs. Also, although Portland, USA's use of reduced drainage charges as a means to incentivise green roof installation is a very positive example, it is not currently replicable in London since the management of water is privatised in the United Kingdom. Such a scheme would have to involve Thames Water, the local water management utility, as well as other key stakeholders. Moreover, at present stormwater management charges are not calculated per square metre in London, making rebate calculations more difficult. Finally, mandating green roof installation as part of building regulations would require accompanying funding opportunities or demonstrably higher benefits compared to costs for investors.

Since the GLA has limited funding currently available to support green roof installations, it is harder for it to mandate these, particularly in the case of retrofit installations (of which London

would have to do most of in order to achieve green cover goals) which require a substantial initial expenditure, unlike new builds where the inclusion of a green roof adds a relatively marginal cost. Perhaps the most cost-effective impact of green roof installation is the lifespan extension they bring to roofs because of the protective effect they have on the roof membrane. London has found that the energy use reductions brought about by green roofs – although in some cases substantial – are variable, meaning that funding for energy efficiency measures is not always applicable to them. Short-term funding has supported retrofit green roof installations in some demonstration sites vulnerable to surface flooding as part of the Drain London project[37]. The GLA is planning to monitor these installations in order to gather data that will be useful for assessing the wider stormwater management provided by green roofs.

The monitoring of green roof installations has proved challenging in London. Manufacturer data was obtained for the 2004-2009 period, which proved useful for showing trends. Remote sensing is a useful tool for mapping data; however, a London remote sensing exercise found it hard to differentiate between living roofs and non-living roofs because of spectral response similarities. Automatic differentiation proved impossible, and manual mapping to resolve this problem would have been too costly. Currently, green roofs are not recorded through the planning system; however, this central means of recording data could be a useful monitoring tool in the future, with the caveat that this data would provide a record of planning consents for green roofs rather than of actual installations, although some boroughs do check installations.

Brown roofs and biodiversity

The design of brown roofs originated in Switzerland and several cities in the United Kingdom have since installed them. London contains a lot of brownfield sites and organisations have made particular efforts to construct brown roofs as a way to preserve habitat for species found in urban areas, including a rare bird, the black redstart. The black redstart is a bird that is on the amber list of Birds of Conservation Concern in the UK and that has made its home in mainly urban areas but which is now under threat because of habitat loss. Brown roofs typically use low nutrient substrates, in order to inhibit plant species dominance, and attempt to maximise microhabitat types. In order to reproduce the habitat typically found in brownfield sites, brown roofs use recycled construction materials. London does not differentiate between green and brown roofs in its planning documents, preferring rather to distinguish roofs based on the depth of substrate involved.

Many biodiverse “brown” roof projects can be found in East London, which has undergone a great deal of regeneration, not least because of the 2012 Olympic Games. Brown roofs are considered an important tool for helping London meet goals set in the Biodiversity Strategy and the Biodiversity Action Plan, particularly in the outer London boroughs. Indeed, several species that thrive in brownfields and therefore on brown roofs have been identified as species of interest in these plans.

In the neighbourhood of Deptford, where brownfield sites provided the only available habitat for black redstarts, biodiversity was taken into consideration in the regeneration of a derelict area formerly composed of wharfs and factories. The Laban dance centre is one of the new buildings built in this area, and it integrates a 460 m^2 brown roof specifically constructed with black redstarts in mind. The substrate is crushed concrete sourced from demolition material from the construction site, which reproduces the original habitat suitable for black redstarts for foraging and nesting. The Laban centre won the 2003 RIBA “Building of the year” award for its innovative design. It provides an ideal showcase for this environmentally-friendly design element (Nelson, 2006). Green roofs can provide an excellent opportunity for involving the local community in biodiversity conservation, though the predominance of installations on buildings owned by the private sector can restrict access and learning opportunities.

Sources: M. Thomas, personal communication, January 16, 2012; Greater London Authority, 2008a

Applicability

The number of green roofs varies a lot across Europe, mainly as a consequence of the presence or lack of incentives and policies to encourage them. Germany is the world leader in green roof construction, with many cities having incentives in place to encourage their installation. These incentives enable the cities to achieve cost savings in comparison with traditional large-scale stormwater management options. “For example, the city of Esslingen in Germany will pay up to 50% of the cost of installing a new green roof, and the city of Darmstadt will pay up to 5000 Euros toward a new green roof” (Getter & Rowe, 2006). Switzerland is another green roof leader, with similar city-level incentives: in Basel for example “homeowners can claim 20% of green roof investment costs for converting unused rooftops to vegetative rooftops. This policy was so successful that in 18 months an area the size of seven football fields was greened. Now, there is a new law in that city that all new flat roofs must be greened” (Brenneisen, 2004 as cited in Getter & Rowe, 2006).

Scandinavia is yet another leading region in the installation of green roofs. For example, the environmentally-friendly Augustenborg neighbourhood of Malmö, Sweden, is home to several green roofs, including one of over 10000 m^2 called the “Augustenborg Botanical Roof Garden”. The green roof attenuates stormwater, insulates the buildings but also encourages local biodiversity. The green roofs of the neighbourhood are part of a wider sustainable stormwater management strategy which aims to attenuate and collect stormwater in order to reduce local flooding. The roof garden is open to the public and is accessible, increasing the learning opportunities that can be derived from it. Augustenborg has made the most of this green roof, promoting it through brochures, and the botanical roof garden building is also home to the Scandinavian Green Roof Association. The Institute disseminates lessons learned and provides training but also undertakes research into simple and cost-effective green roof solutions.

Green roofs have been used in many countries with widely varying climates and therefore have an important replication potential (Bates, Greswell, Mackay, Donovan & Sadler, 2006), but these differing conditions should be taken into account in project design. Plant selection is important: indeed, climatic conditions such as temperature and precipitation can affect the survival of different plant species, as can very localised microclimatic factors such as air vents. Drought tolerance is the most important variable to factor in when choosing plant species; succulents are often chosen.

Green roofs are not suitable for all roofs, as they entail substantial additional weight, particularly for the heavier intensive green roofs. New buildings can be designed to accommodate this weight, but existing buildings need to be checked for compatibility prior to installation. Green roofs can help buildings meet guidelines for green buildings such as BREEAM in the UK or LEED in the USA. Brown roofs in particular can play a role in city Local Biodiversity Action Plans (explored in more detail in Section 3.4.5.1), by helping to create habitat for target species. For example, the black redstart is one of the target species within Birmingham’s LBAP.

Economics

Although the installation of a green roof is more expensive than that of a normal roof, green roofs do generate important direct cost savings in terms of energy consumption and stormwater management and less direct savings for society as a whole (health, amenity, aesthetics etc…). Green roofs, by attenuating stormwater, can help defer or replace expenditure linked to traditional stormwater infrastructure. For example, a study found that converting 6% of Toronto’s roof surfaces to green roofs would be equivalent in terms of stormwater retention to building a storage tunnel worth over 40 million Euros (Peck, 2005 as cited in Getter & Rowe, 2006). The life cycle costs of green roofs can be lower than those of normal roofs, particularly so in countries such as Germany where the widespread uptake of this technology has allowed for economies of scale (Bates, Greswell, Mackay, Donovan & Sadler, 2006). Finally, brown roof designs can reduce the installation costs by being allowed to colonise independently by wind-blown plants. Table 3.21 compares the costs and benefits associated with a conventional gravel roof and an extensive green roof over a 40-year period.

Table 3.21: Cost-benefit analysis for green roof versus gravel roof; costs in Euros (Adapted from Giesel, 2003)

Gravel-covered roof		Extensive green roof	
Costs		Costs	
Gravel cover 5 cm (EUR 5/m²)	5000	Precautionary measures (EUR 10/m²)	10000
		Green roof (EUR 20/m²)	20000
Repair	4000	Repair	0
Partial renewal after 20 years	27500	Partial renewal after 20 years	0
		Regular maintenance (EUR 0.50/m² for 40 years)	20000
Benefits		Benefits	
Reduction of sewage disposal costs	0	Reduction of sewage disposal costs (EUR 0.60/m²/year)	-24000
Improved thermal insulation	0	Improved thermal insulation (EUR 0.06/m²/year)	-2400
Costs minus benefits	**36500**	**Costs minus benefits**	**23600**
Overall savings versus the green roof after 40 years	**0**	**Overall savings versus the green roof after 40 years**	**12900**

A key point to be kept in mind regarding the economics of green roofs is attribution. Indeed, in urban areas which do not provide grant funding for green roof installation, individuals or companies fund green roof installation themselves. However, even though some benefits of green roofs accrue to these individuals or companies (for example when the life span of their roof is extended because of the thermal buffer provided by green roofs), other benefits might accrue to society at large (for example reduced urban heat island effect). In this sense, the value of extrapolated cost saving calculations at whole city levels is limited.

In order to increase green roof coverage, cities around the world have put various incentives in place for their installation. These range from direct financial incentives (grants and subsidies, such as in Chicago, USA) to indirect financial incentives (such as reduced drainage charges like in Portland, USA, or larger development allowances) to ecological compensation (taking a green factor approach, as done in Berlin, Germany, and Seattle, USA) to building regulations (as in Basel, Switzerland) and planning policy. Amsterdam, The Netherlands, has chosen to display all green roof installations on its website[38], using google maps (figure 3.52); this allows the city to showcase green roofs and encourage their installation, but also provides an incentive for the recording of information about installations. Indeed, each green roof marked on the map provides information on its size and date of installation. However, as illustrated in the example provided for London, not all incentives are applicable in all cities.

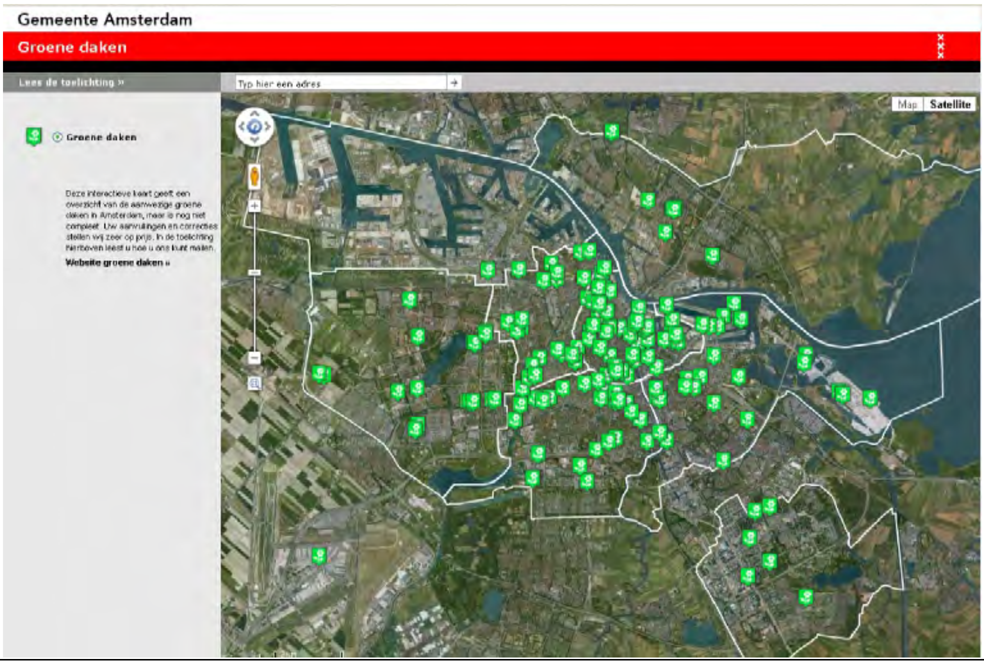

Figure 3.51: Screenshot of green roof mapping in Amsterdam, The Netherlands. Source: http://www.gisdro.nl/GROENDAK/

Driving force for implementation

Green and brown roofs not only provide a series of environmental benefits, but also have other positive impacts:

- Cost savings. By protecting the roofing membranes from damage linked to solar radiation and temperature fluctuations, green roofs help extend the life span of roofs – sometimes doubling it. Moreover, green roofs can increase property values because of their aesthetic value. Finally, the energy savings mentioned previously also help reduce costs.
- Aesthetic value. Green roofs are attractive to look at and provide health benefits linked to contact with green spaces.
- Employment creation. By requiring substrate, plants, installation and maintenance, green roofs can help boost local landscaping businesses.
- Use of waste material. Green roofs, and brown roofs in particular, can reuse waste material as a substrate, for example from construction sites. This reduces the pressure on landfills, the costs of transporting this material, and can lead to financial savings. Best practice within London requires the sourcing of construction material from local and sustainable sources, so that green roofs with the deepest substrate are considered more optimal.

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Several websites provide useful insights into green roofs; however, more specific and local considerations should be discussed with local landscapers that have experience in green roof installation.

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3.4.8 Limiting urban sprawl into green spaces

Description

The world is increasingly becoming more urbanised. Europe's process of urbanisation is already far advanced (with 75% of its population living in urban areas) and is projected to increase in the future: "by 2020, approximately 80 % of Europeans will be living in urban areas, while in seven countries the proportion will be 90 % or more" (European Environment Agency, 2006). As urban populations increase, the tendency is for the land area devoted to urbanisation to increase as well. Although this process has been strongest in the United States, because of the predominance of single-household detached housing and the ubiquity of the automobile, the spread of urban areas into adjacent green spaces has also been a feature in Europe, where cities have become less compact than they used to be (see Figure 3.53).

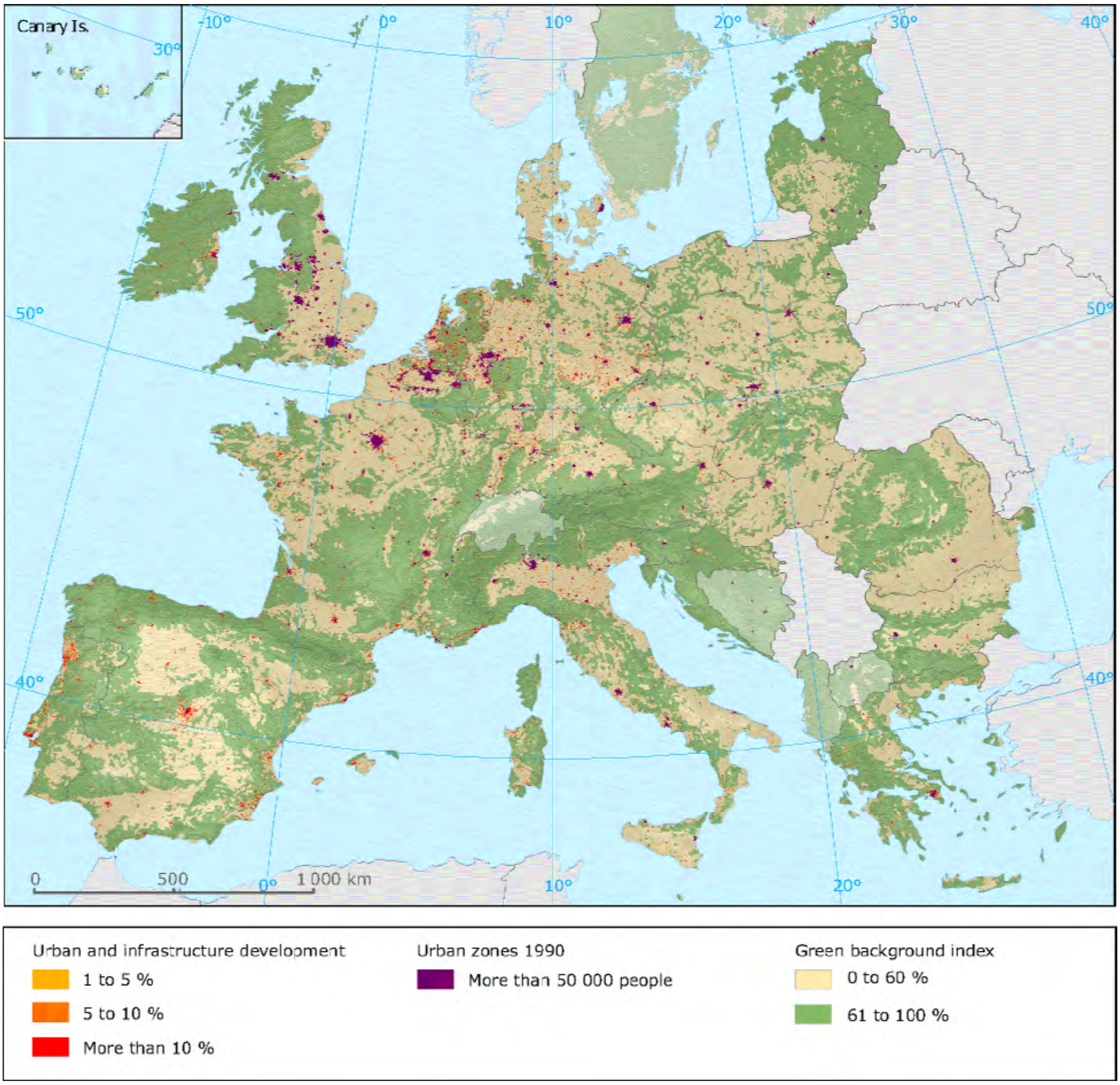

Figure 3.52: Patterns of urban sprawl across Europe. Source: European Environment Agency, 2002

Urban sprawl is defined as "unplanned incremental urban development, characterised by a low density mix of land uses on the urban fringe" (European Environment Agency, 2006) and incorporates elements relating to: environmental changes such as sealing of surfaces, emissions by transport as well as ecosystem fragmentation; changes in the social structure of an area, such as segregation, changes in lifestyle and the neglect of town centres; and economic changes, relating to distributed production, changes in land prices and issues of scale (URBS PANDENS project, as cited in Arnstberg, 2003). As such, urban sprawl has profound implications for all aspects of sustainable development, not just for the environment.

Urban sprawl is an increasing trend, not driven by population growth but rather made possible by changes in transportation systems and in lifestyle aspirations, with other driving forces including "both micro and macro socio-economic trends such as the means of transportation, the price of land, individual housing preferences, demographic trends, cultural traditions and constraints, the attractiveness of existing urban areas, and, not least, the application of land use planning policies at both local and regional scales." Urban sprawl has been in Europe associated with high population density and economic activity, and/or rapid economic growth, and can be seen particularly in areas where EU regional policies have been implemented. "New development patterns can also be observed, around smaller towns or in the countryside, along transportation corridors, and along many parts of the coast usually connected to river valleys" (European Environment Agency, 2006). Urban areas in Europe show different growth patterns, as shown in table 3.22. Overall, Scandinavia is demonstrating a more sustainable pattern of growth, with increasing populations without associated geographical sprawl.

Table 3.22: Types of urban areas in Europe: urban growth vis-à-vis urban sprawl (1991-2001)
Source: Pichler-Milanović, 2007

Growth with containment	**Growth with sprawl**
Copenhagen **Stockholm**	Amsterdam **Athens** Berlin Brussels Dublin Lisbon **Ljubljana** Luxembourg **Vienna** **Warsaw**
	Birmingham Bratislava Budapest **Leipzig** **Liverpool** Prague Rome
Decline with containment	**Decline with sprawl**

As well as the actual paving over of formerly green areas, habitat fragmentation also results from urban sprawl, negatively affecting biodiversity, and is created by urbanised areas as well as the transport infrastructure that services them. Landscape fragmentation has increased in Europe over the past 20 years, but is subject to regional variation, being low in most of Scandinavia but high in western and central Europe, particularly in parts of Belgium, the Netherlands, Denmark, Germany, France, Poland and the Czech Republic. Predicted growth of transport infrastructure in Eastern Europe will increase these trends, and to prevent further negative environmental impacts a new report recommends protecting unfragmented areas, monitoring fragmentation and applying fragmentation analysis in planning (Jaeger, Soukup, Madrinan, Schwick & Kienast, 2011).

Achieved environmental benefits

Reducing urban sprawl has obvious environmental benefits (European Environment Agency, 2006):

- Densification reduces the non-renewable land and soil consumption associated with urban sprawl. It also reduces (but does not eliminate) the consumption of raw materials such as gravel and those needed for example for the production of concrete or asphalt. Reducing urban sprawl allows soil to perform its water and carbon absorption functions, and helps reduce degradation of water quality associated with stormwater runoff from sealed surfaces. Reduced urban sprawl also helps preserve the groundwater recharge capacity of soil, hence reducing water scarcity.

- The changes in lifestyle associated with urban sprawl, which see increases in single-person households, also increase the consumption of resources because multiple-person households consume fewer resources such as water, energy and consumables. Increased energy consumption is also associated with low population density areas whose sprawl reduces the energy efficiency of distribution systems.

- Densification typically allows for increases in public transport usage which counteract the prevalence of cars in sprawling urban areas, and create reductions in fossil fuel consumption and associated greenhouse gas emissions. Fossil fuel use in sprawling areas is not only due to private car transportation but also to fuel consumption linked to the conveyance of goods and waste. Finally, compact cities where people can more easily move around on foot, by bike or using public transport will be more resilient in the face of anticipated fuel cost increases following the peak oil point.

- Reducing urban sprawl allows for the preservation of natural areas, intrinsically important but also vital because of the importance of ecosystem services. Negative impacts of sprawl are particularly evident in ecologically-sensitive areas such as coastal zones, for example in the Mediterranean which is considered to be a biodiversity hotspot.

- Limiting urban sprawl into agricultural land helps not only preserve the soil and biodiversity values of these, but also avoids the transfer of agricultural activities to less productive or more elevated areas – which, respectively, require more fertilisers and irrigation and lead to increased soil erosion.

Appropriate environmental indicator

Table 3.23: Appropriate environmental indicator – Urban sprawl

Indicator	Unit of measure (A)	Unit of measure (A/B)	Description
Artificial surfaces	km^2	Km^2 artificial surface/ km^2 total surface	Any kind of impermeable built-up area: buildings, roads, any part with no vegetation or water, etc. Artificial surfaces can be disaggregated according to their main function: housing, industrial and commercial, infrastructures.
New artificial areas	Ha	Ha new developments/ Ha artificial surface	Areas occupied by new buildings developments, roads etc.
New artificial areas on brownfields	Ha	Ha new artificial areas on brownfields/ Ha total new artificial areas	Brownfields interested by new buildings developments, roads etc.

Benchmark of excellence

About 26% of the Bristol's City Council's administrative area has impermeable surfaces and is soil sealed. The Bristol Local Plan has successfully promoted brownfield development and densification of the city centres, avoiding development on greenfields. During the last decade 2001-2011, 98% of business development, 95% of new homes and 58% of new industries were on brownfield land. Population density has increased from 53 to 60 inhabitants per hectare with particular growth in the city centre. Since 2001 average densities of 230 dwellings per hectare (dph) have been achieved in the city centre with lower densities of 134 dph in inner areas and 55 dph in suburban areas.

In 10 years, Malmö has created several world-leading examples of sustainable construction and regeneration which have actively incorporated innovative greening strategies, including green roofs; green fences (green walls), open storm water management and aquatic-rich ponds as well as tree planting strategies. Western Harbour (WH) is a new city quarter, built on former industrial land, integrating green spaces are in the development to promote biodiversity and ecosystem services. Before developers can buy land in WH, they have to agree to compensate their development by incorporating green points, by which approximately 50% of the area can be considered 'green'.

Cross-media effects

Densification is often understood as making use of abandoned land such as brownfields, which, although they might not count as usable green space for humans, can be (as has been shown in Section 2.3.4.2.3) excellent habitat for some species. Trade-offs: densification by definition will consume open space, leading to a possible conflict between densification and green spaces. However, there are ways to overcome this apparent contradiction, for example by integrating green and blue design elements into the city and thereby making better use of the space available. Indeed, some areas of what is technically open space might not be useful space if it is at the interface of public and private space, as is the case in modernist suburbs (Ståhle & Marcus, 2009). Densification that uses up such non-useful open space yet creates additional useful open spaces or integrates design features such as green roofs or sustainable stormwater management measures can actually increase more green space and a better appreciation of it.

Operational data

One possible approach to reducing urban sprawl is densification, where building types and land use is planned in order to increase population density. Some densification approaches have the potential to increase green spaces within a city while protecting peripheral green areas. For example, many new developments within Stockholm follow a 'new regularism' approach to urban design where both building height and street networks are increased "This approach combined densification with upgrading of public space including not only streets and squares but also parks and green areas" (Ståhle & Marcus, 2009). However, even though strategies such as densification reduce urban sprawl, it should be kept in mind that densification is not the mirror opposite of sprawl since all urbanisation contributes – to a greater or lesser extent – to densification.

Urban sprawl, by its very nature, involves the spreading of cities – sometimes beyond the administrative boundaries of the central hub. As such, since cities are intimately connected to their regional setting, the management of land use needs to be conducted in an integrated and regional way, in order to ensure coordination (European Environment Agency, 2006). The EU can help counteract sprawl by "ensuring that policies are coherent and not sector-specific and that decisions taken at regional and local levels are coherent with a broader set of principles," by being responsive to local conditions and by fostering dialogue and cooperation across different

government levels (European Environment Agency, 2006). However, local action is key to counteracting sprawl. In general, sprawl is discouraged through zoning policies and the creation of green belts, and should also be accompanied by urban revitalisation using pricing and taxation policies for example. Urban sprawl control schemes include (Pichler-Milanović, 2007):

- The "introduction of regional planning agencies which can apply a strategic vision and control.
- The competing development demands of local authorities.
- Urban revitalisation schemes aiming to re-establish the attractivity of the inner urban areas.
- Changes in land taxation laws to achieve environmental goals such as reduced surface sealing.
- More restrictive planning rules such as the "urban growth boundary."
- New legislation on public financing that reduce the dependence of municipalities on their local tax base.
- Road-pricing schemes to make road users aware of the socio-environmental costs of commuting."

City example: Controlling urban sprawl in Stockholm, Sweden

Stockholm’s landscape has been profoundly shaped by its geography: the location of the city on several islands surrounded by water has affected its growth. Rather than uncontrolled sprawl, as has happened in many cities throughout the world, Stockholm between the 1930s and the 1980s is an example of planned sprawl, with the city’s rapid growth being directed in a way that allowed for green ‘wedges’ and other green areas to preserve inhabitants’ access to natural spaces (Arnstberg, 2003).

The green wedge approach was a success, allowing for radial development along main public transportation lines that preserved natural spaces and associated biodiversity but also created a city with a high quality of life. Since the 1980s, however, Stockholm has managed its growth in a different way, emphasising the development of areas within the city’s boundaries rather than allowing growth at the city’s fringe. This new approach has been stimulated by important population growth combined with the realisation that Stockholm’s green and blue spaces needed to be actively preserved from sprawl. This densification “has been called “building the city inwards” or “city healing” where the former has been the paradigm for the City Plan of Stockholm since 1999. Many policies, such as Stockholm’s City Plan (…) proposed to build on semi-central industrial land and save green space due to environmental concerns and Not-In-My-Backyard effects” (Ståhle & Marcus, 2009).

Stockholm is anticipated to keep growing; its population is over 800,000 and anticipated to reach almost a million by 2030. Stockholm is a particular case in the country, in that it has a long history of regional planning. Stockholm’s Regional Plan builds on the idea of sociotopes, which define uses and values of space, and define the ideal distance between inhabitants and different types of open spaces. Stockholm’s land use planning also takes into account climate change and its ambition to be a fossil fuel free city by 2050.

As a result of the city’s densification approach, areas prime for redevelopment have been identified and brownfield sites in the city have been subject to development, as is the case in Hammarby Sjöstad. In addition, Stockholm is seeking to develop a polycentric dense settlement structure linking Stockholm to regional town centres at the periphery of the city. In addition to replicating the densification idea at a smaller scale, and creating self-sufficient urban areas rather than commuter towns, this will also allow the preservation of the green wedges which have become central to the city’s character and appeal (Stockholm City Council, 2010).

Stockholm’s development has not been free of challenges. Indeed, “The Stockholm City Planning Authority has now, in the beginning of the 21st century, reached a point where it can no longer rely on the comfortable strategy of avoiding green space exploitation by building on brownfields and parking lots. The pressure on the inner rather dispersed “green” suburbs is too strong. The demand for new urban design strategies on how to deal with this is expressed in the current discourse among planners” (Ståhle & Marcus, 2009). Moreover, while the city has historically been able to acquire and develop a lot of land, prices are now prohibitively high and the city is starting to play a different role in the redevelopment process, working in cooperation with private developers (Nelson, 2009). Finally, Stockholm must also take social considerations into account, as many of its neighbourhoods have become culturally polarised: a more diverse and inclusive approach is seen to be more in line with the city’s sustainable development aspirations.

Applicability

Increasing public participation in the maintenance of urban green areas increases its success, as has been shown in a comparison of two cities with very different levels of public involvement. "The Hague has an 'open green policy' which means citizens participate in the decision-making processes for urban green spaces. For example, the recent spatial planning policy on ecological connection zones to provide stepping stones between green spaces was put up for public consultation. (…) Green space management in The Hague is described in management plans and citizens can participate in preparing these. With the help of volunteers it is possible to gather data for these plans, such as inventories of wildlife present in the green spaces" (Mabelis & Maksymiuk, 2010).

Economics

"Stockholm has not been afraid of making long-term investments within their city and region. They have laid an extensive metro subway system that has allowed the city to develop in nodes around the rail stations. New investments are being made, such as a light rail system to better connect the inner city with the metro system's hub. These investments mean that only 22% of Stockholmers and 40% of residents in Stockholm County own a car." (Nelson, 2009)

From an economic perspective urban sprawl is at the very least a more costly form of urban development due to (European Environment Agency, 2006):

• increased household spending on commuting from home to work over longer and longer distances;

• the cost to business of the congestion in sprawled urban areas with inefficient transportation systems;

• the additional costs of the extension of urban infrastructures including utilities and related services, across the urban region.

Driving force for implementation

In addition to the environmental benefits linked to reducing urban sprawl, which have been explored previously, there are also a series of socio-economic benefits which can act as driving forces for its implementation (European Environment Agency, 2006):

- Limiting urban sprawl along river valleys and in lowlands can reduce the economic and infrastructural impacts of flooding, which becomes far more costly as floodplains are built over due to the high value of land prices within them. Limiting sprawl in coastal zones will also reduce the impacts of predicted flooding from climate change driven sea-level rise.

- "Urban sprawl generates greater segregation of residential development according to income (…). Consequently, it can exacerbate urban social and economic divisions." "Social polarisation associated with urban sprawl is in some cities so apparent that the concept of the 'divided' or 'dual' city has been applied to describe the divisions between the inner city core and the suburban outskirts."

- Denser urban environments can reduce the costs associated with urban sprawl, which is more expensive because of commuting costs, the business costs due to congestion and the additional cost of extending transport, electricity, waste collection and other infrastructure and services to outlying areas.

- High-density cities which maximise high-quality open spaces while integrating water features offer a higher quality of life since the green spaces are actually used and since they are often associated with sustainable transport options that have positive implications for air quality, noise, etc…

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3.5 Best Environmental Management Practices for the Energy Sector

3.5.1 Chapter structure

This chapter provides a programmatic approach to energy management and describes practical examples of European cities that are taking steps to increase energy performance in their municipality. Each management practice contains replicable measures to guide public authorities in improving their environmental performance. Section 3.5.2 contains an introduction to the current state of energy in Europe, encompassing pertinent EU legislation in the area. This is followed by an in-depth look at three separate management techniques. These techniques are supplemented with real world case studies.

Section 3.5.4 provides information on drawing up and implementing a Sustainable Energy Action Plan. Section 3.5.5 outlines enacting a District Heating System to service built-up urban areas, while increasing the use of renewable energy within urban municipalities is covered in section 3.5.6 Finally the document looks at innovative Smart Grid technology in section 3.5.7.

3.5.2 Chapter introduction

As energy prices rise and Europe is increasingly dependent on imports to meet its energy demands, crucial decisions must be made on the future of energy supply and usage. Sizeable investments will be needed in the next decade to make Europe's installations and infrastructure fit for the future.

Energy is a resource that is inextricably intertwined with almost every aspect of our lives, both commercially and privately. Energy is the vital link that enables us to drive forward social and economic development. Without energy, it is impossible to meet our industrial and social goals, from local to European level.

The current period is a transitionary one for energy. The path decided by authorities now will shape our societies and have wide-ranging impacts on future generations. Traditional energy thinking, with a reliance on centralised fossil-fuel based production, is no longer a viable option when factoring environmental, economic and energy realities. The debate surrounding when "peak oil" will occur continues, with experts predicting varying timeframes. Fredrik Robelius of the Uppsala Hydrocarbon Depletion Study Group, predicted in 2007 that oil will peak by the year 2018 (Association for the Study of Peak Oil & Gas, n.d.), whilst a 2009 report by the UK Energy Research Centre states "we suggest that a peak of conventional oil production before 2030 appears likely and there is a significant risk of a peak before 2020" ("Global Oil Depletion: An assessment of the evidence for a near-term peak in global oil production", n.d.). Similary, in an interview with the Guardian newspaper, International Energy Agency (IEA) chief economist Fatih Birol said in reference to oil production "In terms of the global picture, assuming that Opec will invest in a timely manner, global conventional oil can still continue, but we still expect that it will come around 2020 to a plateau as well … I think time is not on our side here." (Monbiot, 2008). Mr. Birol revised this in 2011, making the shocking statement on Australian television that "We [the IEA] think that the crude oil production has already peaked, in 2006." (quoted in Jervey, 2011). In its 2011 World Energy Outlook, the IEA states that global reserves of coal are waning and would last for only 150 years at current production levels (International Energy Agency, 2011). Within the EU members states are pursuing two alternative energy forms to lower the reliance on fossil fuels: energy through renewable sources, and nuclear energy.

Nuclear energy is facing increasing resistance in parts of Europe due to its perceived danger – according to a 2010 report on attitudes to nuclear power in Europe (EC, 2010a) "A majority still perceive nuclear energy more as a threat than as a neutral source of energy both from a general and personal perspective". This fallout in support has been focused by the Fukushima nuclear disaster of March 2011, which saw the partial meltdown of the Fukushima I Nuclear

Power Plant after it was struck by the Tōhoku earthquake and tsunami. Protests were staged across Europe following the catastrophe. These protests have affected the political goodwill towards the energy source - Germany for example has pledged to close all nuclear power plants by 2022, a marked reverse in its previous policy. Similarly, a referendum in Italy in June 2011 rejected government plans to resume nuclear power generation. In other countries however, such as the United Kingdom, political support remains relatively high. Advocates cite the low-carbon nature of nuclear energy and the large quantities of energy that can be produced.

Renewable means of production and conservation are being pursued as a sustainable alternative. The most recent statistics on renewable energy in Europe (2009) show that 11.7% (Eurostat, 2012) of final energy consumption comes from renewable resources. The EU is aiming to increase this figure to 20% by 2020, with some member states opting to take this even further. Germany, for example, aims to phase out reliance on traditional forms of energy and by 2030 aims to have 100% of electricity supplied by renewable means (cited in Mendonca, Jacobs, Sovacool, 2010).

In order to meaningfully fight climate change more than two thirds of our current carbon emissions must be eradicated (Johansson, Goldemberg, 2002). European statistics however, indicate that carbon emissions are actually growing rather than receding. Fossil fuel based energy production is a major contributor to carbon emissions, as well as other harmful pollutants. These pollutants, including nitrous oxides and particulate or dust, can cause serious health problems such as lung cancer and respiratory disease. In this sense renewable energy is not just important from an environmental and energy perspective, but also from a health perspective.

In the EU the general trend is towards rising electricity prices. In 2005 industrial consumers paid €0.0672 per kWh. By 2010 the figure stood at €0.0919 per kWh. In 2005 household consumers paid €0.1013 per kWh, rising to €0.1213 per kWh in 2010 (2010, however, saw a marginal decrease from 2009). This rise in prices is due to a number of factors, chiefly the sharp increase in the price of oil and coal and inefficiency in EU energy markets (source Eurostat:.
http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&plugin=1&language=en&pcode=ten00114)

Public administrators need to be willing to embrace greater energy efficiency strategies, which save energy both at citizen and business level, use energy more intelligently and look for synergies within energy usage. In order to achieve this, both legislative incentives and implementation initiatives, (eg. the Covenant of Mayors) are available.

Energy powers the European economy, keeps people moving and fuels our societies. Despite its crucial importance, energy supply has developed into a state of crisis – one that will require concerted political, private and local action to overcome. Within this context the benefits of a revised energy programme are manifold. As well as lowering carbon emissions, an energy plan based on environmental principles will increase local energy security, improve air quality and prevent greenhouse gas production. Crucially a more efficient energy policy has tangible financial benefits. According to EU estimates creating a more energy efficient Europe will save €200 billion by 2020, whilst at a micro level renovating a building to make it more energy efficient can generate up to 60 percent in energy savings with no compromise in quality.

Jeremy Rifkin, president of the Foundation On Economic Trends, believes this changing energy landscape is giving rise to a third industrial revolution, one in which energy and communications merge to create an entirely new energy infrastructure. Rifkin argues that the improvements in communications technology allow us to fundamentally change the way we trade and manage energy. We are living, he writes, at the beginning of the "collaborative age", in which people produce their own green energy and share it in an "energy internet". Energy will become democratised when managed by internet technology, much as information has become – Rifkin points to the influence mass sharing and collaboration has had on the music

industry and the information industry. This will "spawn thousands of businesses and millions of sustainable jobs" he continues, adding that it will change society profoundly in almost all aspects, from social to commercial.

As well as environmentally beneficial, investing in energy efficiency and renewable technology is fiscally responsible. Creating new power plants is extremely capital intensive. The financially pragmatic solution to this is simple – use energy more intelligently through better management, utilise more efficient technology and reduce the amount of total energy consumed. The period Europe finds itself in provides an opportunity to move from a system where energy is habitually wasted, costing money and resources in the process, to a system where energy is a contributor to a sustainable economy.

Going green also provides increased positive recognition and opens the possibility of support from the European Union, both in terms of expertise and financing. Local governments have the opportunity to create job opportunities through investing in Renewable Energy Sources, whilst simultaneously limiting environmental degradation. In Germany, the BMU estimates that over 367,000 jobs can be attributed to the field of renewable energies (Federal ministry for the Environment, nature Conservation and nuclear Safety, 2011). In 2009 550,000 people in the EU-27 were employed in the renewable energies industry (European Renewable Energy Council, 2010. http://www.erec.org/statistics/jobs.html .

European policy on energy centres on the Energy 2020 strategy, an offshoot of the Europe 2020 strategy. The Europe 2020 strategy aims for smart, sustainable and inclusive growth. The strategy provides a framework for energy policy, defining the energy priorities for the next ten years and setting out the actions to be taken. EU energy policy focuses on five aspects:

- **20% energy savings by 2020 compared to 1990 levels**
  Savings will mainly be achieved through increased energy efficiency. Energy efficiency is the most cost-effective way to reduce emissions, improve energy security and competiveness and lower energy costs.

- **Free movement of energy**
  Electricity and gas are transported in grids and pipelines that often cross national borders. The energy policy decisions made by one country therefore impact on other countries. The free movement of energy results in more reliable prices, more choice for consumers, greater security of supply, and security for investors in new renewable technologies and infrastructure.

- **Secure, safe and affordable energy**
  A functioning internal market with sufficient transmission and storage infrastructure is the best guarantee for security of supply. However, safety nets are necessary to protect consumers, or at the time of a supply crisis. Affordability is also a central tenet of sustainability. Affordable energy prices are achieved through a competitive internal EU energy market.

- **A technological shift**
  Without a technological shift, the EU will fail on its 2050 aims to decarbonise the electricity and transport sectors. The EU is focusing on second-generation biofuels, smart grids, smart cities and intelligent networks, CO_2 capture and storage, electricity storage and electro-mobility, next-generation nuclear and renewable heating and cooling.

- **Strong international partnership**
  The European energy market is the world's largest regional market (over 500 million consumers) and largest energy importer. Several of the challenges facing the EU – climate change, access to oil and gas, technology development, energy efficiency – are common to most countries and require international collaboration.

Specific directives on energy must be adhered to by member states. The Lisbon Treaty gives energy a new legal basis, which was not the case in previous treaties (Article 194 of the Treaty on the Functioning of the European Union). In recent times the EU has taken steps to reduce its contribution to global warming and to guaranteeing energy supply, and has enacted policies to support these aims. The EU's official website states: "The aims of the EU's energy policy are supported by market-based tools (mainly taxes, subsidies and the CO_2 emissions trading scheme), by developing energy technologies (especially technologies for energy efficiency and renewable or low-carbon energy) and by Community financial instruments."

Under EU legislation member states are expected to meet "indicative" targets for renewable energy production. Although there is significant variation in national targets, 22% of electricity should be generated by renewables by 2010 on average. In its Renewable Energy Roadmap the European Commission has proposed a binding target of increasing renewable energy use from less than seven percent today to 20% by 2020.

Energy Efficiency

Energy Efficiency means obtaining the same energy output using less energy input, thus ameliorating the energy use process. For example, in the case of domestic heating, a system (in this case a building) is efficient when, in order to reach an internal temperature of 20-21 degrees in winter, it consumes the least energy possible (a very good performance for thermal and cooling use can be considered, for example $\leq$ 30 kWh/m^{2}y). Given the strategic importance of this topic, the EU has published in 2002 the first Energy Performance Building Directive, (EPBD, 2002), setting energy performance requirements and a certification system for new buildings and for the retrofitting of old ones. At the end of 2006, the EU pledged to cut its annual consumption of primary energy by 20% by 2020 (http://europa.eu/legislation_summaries/energy/energy_efficiency/index_en.htm) . To achieve this, minimum energy efficiency standards will be set and rules on labelling for products, services and infrastructure introduced. In 2010, the EU adopted a second Directive (.EPBD recast, 2010), setting the objective for new buildings in the Member States to be *nearly zero energy buildings* within 2020. This limit is brought forward by two years for buildings hosting public institutions, which are meant to have a "frontrunners" role in this process. In order to enact this legislation, many member states have enabled incentive systems. Many European Countries adopted a White Certificates Scheme. These are tradable permits which can then be sold on a dedicated stock market to those organisations that are subject to energy saving objectives. Financial incentives (subsidies, fiscal measures) have also been put into place in some countries, such as Italy, guaranteeing a fiscal detraction to those people building or retrofitting buildings according to fixed energy saving parameters (for more information: http://www.aid-ee.org).

In March 2011 a progress report was released outlining that significant improvement is needed amongst Member States if the EU is to meet its energy aims, stating "preliminary assessment shows that cumulative efforts would fall significantly short (reaching less than 10%) of the EU overall target of reducing energy consumption by 20% by 2020." (European Commission, 2011). Energy efficiency is the most important target to achieve in the development of a sustainable energy system. Only if we use energy efficiently will renewable energy be able to provide a significant share of energy to it. The concept, which needs to be widely spread and understood, is that of "sufficiency". Producing energy from sustainable sources is very important, but first of all is fundamental to raise the question of "how much energy do we actually need". In order to reduce the amount of energy consumed, soft and hard measures can be identified. Soft measures comprise behavioural changes, such as switching to a more conscious and clever energy use and not using energy when it is not really needed, while hard measures encompass retrofitting of buildings through walls, roofs and windows insulation, substitution of traditional light bulbs with energy-efficient ones and the installation of an efficient heating system. Some of these practices are indeed still capital intensive at the moment, and need financial incentives to spread at the domestic level. Energy efficiency also means using waste energy, for example, heat produced in the industrial manufacturing process or in energy generation for domestic heating. While reducing CO2 emissions, energy efficiency also

reduces peaks of demand, thus diminishing the need of back-up traditional plants and enabling renewable energy to account for an always increasing part of energy consumption. It has to be said that energy efficiency is strictly linked to energy sufficiency. For instance, once public administrations have achieved good energy efficiency standards, this should also be linked with a conscious and rational use of energy. Setting reasonable indoor temperatures in summer and winter in Public Administrations and Private Businesses will not only decrease the amount of energy consumed, but also increase comfort and the quality of work for civil servants and employees.

Renewable Energy

In order to reach the target of a 20% share of energy from renewable sources in the overall energy mix, the EU plans to focus efforts on the electricity, heating and cooling sectors and on biofuels. In the Energy Roadmap 2050 (EC, 2011) a strong support for RES (Renewable Energy Sources) is envisaged leading, in a *decarbonisation scenario*, to 75% in gross final energy consumption in 2050 and a share of RES in electricity consumption reaching 97%. Figure 3.54 shows the contribution of the diverse RES to total primary energy production in the EU27. As can be seen in the graphic, biomass and energy from renewable waste provide the greater renewable share (See section 3.2.4). This, together with geothermal energy and hydro power, are the so called "programmable" RES, i.e. the ones that can be turned on and off following consumption. On the other hand, wind power and solar energy are intermittent energy sources, whose production cannot be commanded.

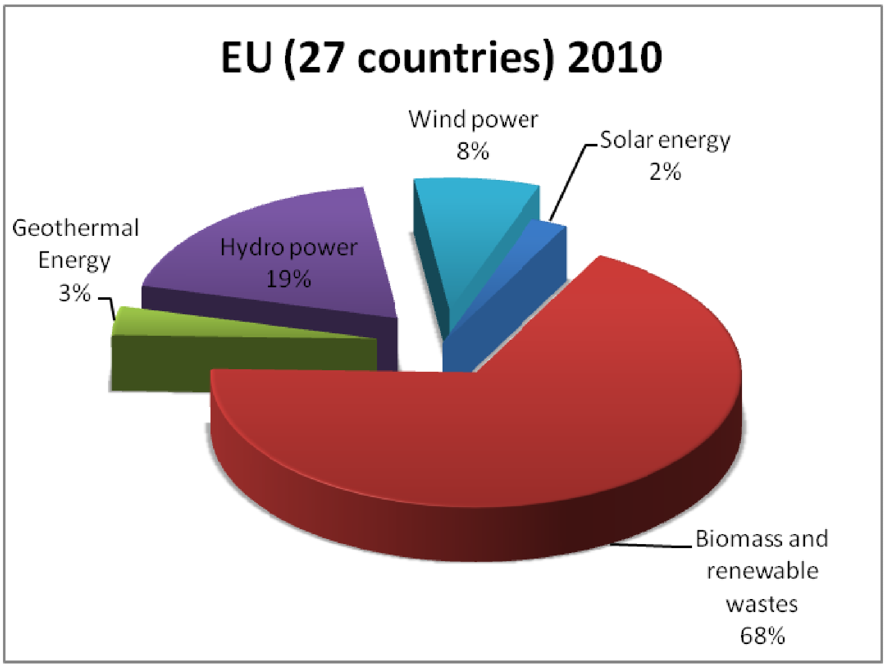

Figure 3.53: Contribution of the diverse RES to total primary energy production in the EU27. Source: Eurostat

At the current stage, RES are being developed through incentive system in many European countries, as shown in figure 3.55.

FEED-IN TARIFFS

In most EU member states electricity utilities now buy electricity generated from renewable sources produced by individuals and companies. Prices paid for 'self-produced' electricity is called a *feed-in tariff*. Prices are in euros per kilowatt-hour (€/kWh)
'0.29-0.46' is a price range from 0.29 €/kWh to 0.46 €/kWh, depending on the amount produced.
Prices valid for April 1st, 2010.

Member state	Windpower "On-shore"	Wind power 'Off-shore'	Solar PV	Bio mass	Hydro
Austria	0.073	0.073	0.29 - 0.46	0.06 -0.16	n/a
Belgium	n/a	n/a	n/a	n/a	n/a
Bulgaria	0.07 - 0.09	0.07 - 0.09	0.34 - 0.38	0.08 - 0.10	0.045
Cyprus	0.166	0.166	0.34	0.135	n/a
Czech Republic	0.108	0.108	0.455	0.077 - 0.103	0.081
Denmark	0.035	n/a	n/a	0.039	n/a
Estonia	0.051	0.051	0.051	0.051	0.051
Finland	n/a	n/a	n/a	n/a	n/a
France	0.082	0.31 - 0.58	n/a	0.125	0.06
Germany	0.05 - 0.09	0.13 - 0.15	0.29 - 0.55	0.08 - 0.12	0.04 - 0.13
Greece	0.07 - 0.09	0.07 - 0.09	0.55	0.07 - 0.08	0.07 - 0.08
Hungary	n/a	n/a	0.097	n/a	0.029 - 0.052
Ireland	0.059	0.059	n/a	0.072	0.072
Italy	0.3	0.3	0.36 - 0.44	0.2 - 0.3	0.22
Latvia	0.11	0.11	n/a	n/a	n/a
Lithuania	0.10	0.10	n/a	0.08	0.07
Luxembourg	0.08 - 0.10	0.08 - 0.10	0.28 - 0.56	0.103 - 0.128	0.079 - 0.103
Malta	n/a	n/a	n/a	n/a	n/a
Netherlands	0.118	0.186	0.459 - 0.583	0.115 - 0.177	0.073 - 0.125
Poland	n/a	n/a	n/a	0.038	n/a
Portugal	0.074	0.074	0.31 - 0.45	0.1 - 0.11	0.075
Romania	n/a	n/a	n/a	n/a	n/a
Slovakia	0.05- 0.09	0.05- 0.09	0.27	0.072 - 0.10	0.066 - 0.10
Slovenia	0.087 - 0.094	0.087 - 0.095	0.267 - 0.414	0.074 - 0.224	0.077 - 0.105
Spain	0.073	0.073	0.32 - 0.34	0.107 - 0.158	0.077
Sweden	n/a	n/a	n/a	n/a	n/a
United Kingdom	0.31	n/a	0.42	0.12	0.23

Figure 3.54: Feed-in tariffs in the EU Countries. Source: http://www.energy.eu

Over the last years, many of these technologies have already reached good scale economies and are becoming competitive on the market. This is, for example, the case of photovoltaic panels, whose prices have sunk in the last years. Figure 3.56 shows the decrease of prices for single- and multi-crystalline silicon cells, while figure 3.57 shows the trend in prices for thin-film cells.

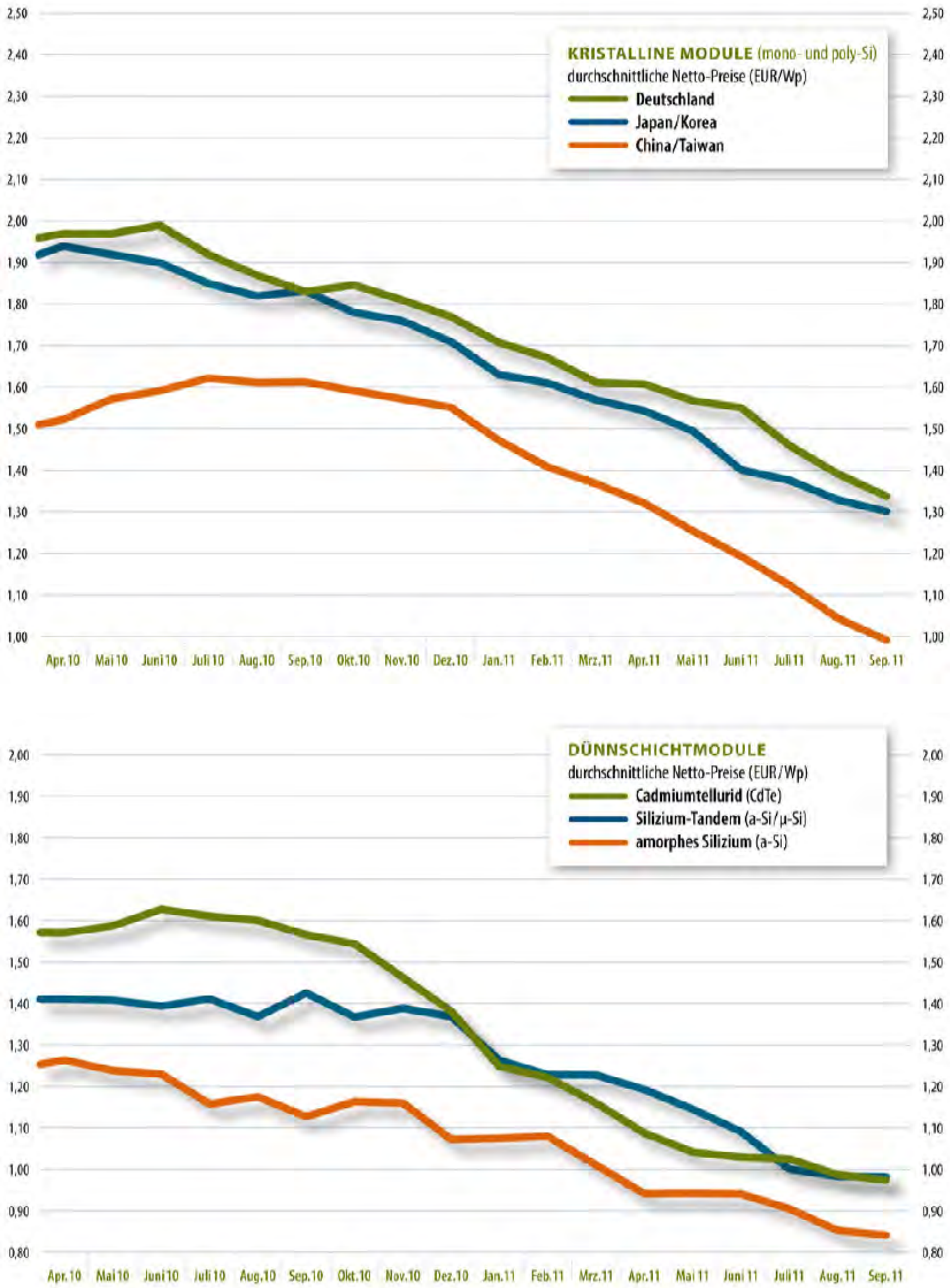

Figure 3.55 and 3.56: Decrease in prices of photovoltaic modules. Source: http://www.pvxchange.com

Due to this decrease in prices, some European States (including, for example, Italy and Germany) are now revising their incentive systems, lowering feed-in tariffs (defined as tariff private consumers receive for feeding renewable energy into the grid). This is due to the increasing costs in the energy bills of private consumers and not to create a “doped market”. According to the EC’s analysis, electricity prices will increase until 2030, due to the replacement of written-off generation capacity and infrastructure and grid investments but then fall (EC, 2011). The renewable energy sources which will be analysed in section 3.5.6 of this chapter are photovoltaic, solar thermal energy, small scale and domestic geothermal plants and biomasses. These are the most relevant energy sources whose adoption can be planned at the municipal level. Wind energy will not be analysed in this section. Small wind turbines’

application is, in fact, still controversial due to technical and economic reasons and big wind farms are large-scale applications and need a complex authorisation process involving many stakeholders (normally an Environmental Impact Assessment is needed).

Nuclear Energy

Nuclear power stations currently produce around a third of the electricity and 15% of the energy consumed in the EU. Nuclear energy in Europe was initiated in 1957 by the European Atomic Energy Community (Euratom). Specific EU measures aim to protect the health of those within the sector and of the public, and to protect the environment from the risks associated with the use of nuclear fuel and waste. Directives require Member States with nuclear facilities to set up a competent regulatory authority, provide information to the public regarding the regulation of nuclear safety, establish national legislation on nuclear safety and commit to periodic self-assessments (Council of the European Union, 2009). As previously stated, several member states, including Germany and Italy, are abandoning future nuclear plans in the wake of the Fukushima nuclear disaster. Nuclear energy is, due to the huge investments, safety requirements and complex management, always competence of the central State. It won't therefore be analysed in greater detail in this chapter. Although the CO2 emissions produced by nuclear plants are very low, the security problems linked to its operation and maintenance, the problems in nuclear waste management and the mere fact that nuclear plants are powered by fossil fuels don't allow nuclear energy to be comprised in the RES.

Security of supply, external dimension and enlargement

The EU has promoted electricity market liberalisation and security of supply through the 2003 Internal Market in Electricity Directive. The Directive 2003/54/EC has been replaced by the Directive 2009/72/EC. Regulation No 994/2010 has been intended to improve security of supply in the natural gas sector (European Parliament, 2010). Switching to RE will secure a greater security of supply in the future, thus relieving the impact of gas and oil imports, which are subject to geopolitical uncertainty and fluctuations. The increasing role of biomass, solar thermal collectors and heat pumps for heating and cooling will contribute to this development. Concerning the enlargement of electrical grids, this is an unavoidable step in reaching the goal of a decentralised energy system. Electricity is meant to play an increasing role according to a scenario developed by the EU (EC, 2011). In a decarbonisation scenario, electricity will double its share in final energy demand to 36-39%, contributing to green transport and heating/cooling, as shown in figure 3.58:

Graph 2: Share of electricity in current trend and decarbonisation scenarios (in % of final energy demand)

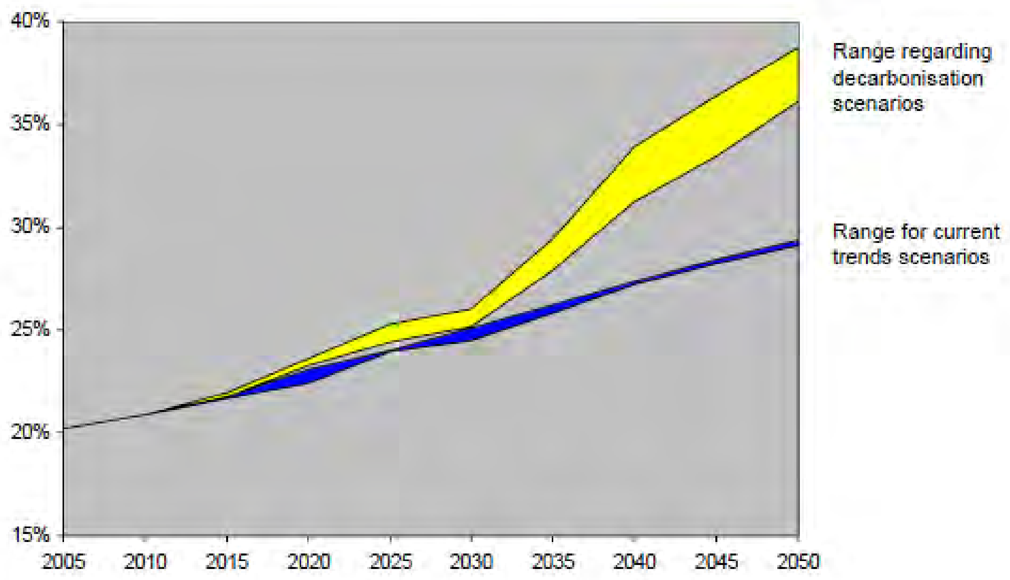

Figure 3.57: Share of electricity in current trend and decarbonisation scenarios. Source: Energy Roadmap 2050

Therefore, huge investments will be needed in order to foster innovation in this sector, on the one hand in the creation of a "super grid" connecting diverse European countries to guarantee energy supply and back up possibilities (this is very important if the unpredictability of some RE is considered. When wind is fading in Italy it may be blowing in Norway). On the other hand grids have to be linked more and more with new information technologies, thus creating "smart grids" (See section 3.5.7) allowing to manage energy demand and supply in an efficient way.

3.5.3 Scope of the Chapter

The chapter is not intended as exhaustive but rather looks at a number of management techniques and presents a range of widely-applicable information on each that can be tailored for the needs of the individual public authority. As such the links to further reading provide more in-depth case specific details and should be used to supplement the overview provided by each description.

As this section will outline, an environmental energy plan with concrete, measurable targets and defined goals is an excellent way to ensure that a sustainable energy system – one based on renewable energy sources that remain affordable to the public - operating to its maximum potential.

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3.5.4 Enacting a Sustainable Energy Action Plan

Description

A Sustainable Energy Action Plan (SEAP) provides a framework for cities to lower their CO_2 levels through sustainable energy measures. SEAPs are entirely voluntary and require a political commitment from local governments, which is solidified through signing up to the Covenant of Mayors (CoM). Figure 3.59 shows the CoM logo. Cities commit to go beyond the 20 % reduction in CO_2 mandated by the Europe2020 policy.

Figure 3.58: CoM logo. Source: Covenant of Mayors

A SEAP outlines the activities and measures to be enacted to achieve the CoM targets, together with time frames and assigned responsibilities. The SEAP must be approved by the municipal council before being enacted and is subject to periodical review by the European Commission's Joint Research Centre.

Once the SEAP is implemented, signatories can submit examples of their measures to an online database. Other signatories can then view these with an aim to replicating the actions taken.

In order for a SEAP to be eligible it must:

- Be approved by the municipal council (or equivalent official body)
- Specify the CO2 emissions reduction target (at least 20% by 2020)
- Include the main results of the Baseline Emission Inventory (BEI) - a measure of the amount of CO_2 emitted due to energy consumption within a given period of time (the recommended base year is 1990), covering at least 3 out of 4 key sectors
- Include a credible set of actions covering at least 2 out of 4 key sectors
- The template must be correctly completed and be consistent with the full action plan.

CoM signatories are required to prepare a BEI and submit, within the year following their signature, a SEAP outlining the key actions they plan to undertake. Energy consumption and emissions are influenced by a number of factors within a municipality, and a BEI can help to identify and target specific areas. The BEI must be prepared prior to the preparation of a SEAP.

A SEAP comprises four steps with sub-sections. These steps may overlap with one another, or may have previously been completed by the local authortiy. In order they are:

1. Initiation
- Political commitment and signing of the covenant
- Adapt city administrative structures
- Build support from stakeholders

2. Planning phase
- Assessment of the current framework: Where are we?
- Establishment of the vision: Where do we want to go?
- Elaboration of the plan: How do we get there?
- Plan approval and submission

3. Implementation phase
- Provide long-term political support to the SEAP process

- Make sure that the energy and climate policy is integrated in the every day life of the local administration
- Show interest in the plan implementation, encourage stakeholders to act, show the example
- Networking with other CoM signatories, exchanging experience and best practices, establishing synergies and encouraging their involvement in the Covenant of Mayors.

4. Monitoring and reporting phase
- Monitoring
- Reporting and submission of the implementation report
- Review

For a SEAP to be successful it requires a long-term vision, specifying the overall CO2 emissions reduction target, a set of short and mid-term actions to be undertaken with time-frames and assigned responsibility, and the implementation of concrete actions, allocating human and financial resources. This should take place in the context of a long-term political commitment that engages local actors throughout the process.

Achieved environmental benefit
As stated above, the target of a SEAP is to reduce emissions at the Municipal level of 20% by 2020. A SEAP, correctly applied, leads to the creation of skilled and stable jobs within a green economy framework, a healthier, cleaner environment, improved quality of life of citizens, enhanced economic competitiveness and greater energy independence and security. For those governments that do not have the expertise to enact a SEAP, Covenant coordinators, comprised of knowledgeable public administrations, offer technical, financial and strategic assistance. Covenant supporters are also available to lend assistance, offering lobbying, communication and networking activities. They are comprised of European, national and regional networks and associations of local authorities.

After joining the CoM, The city of Maranello, Italy has developed its SEAP foreseeing 26 measures to decrease CO2eq emissions within 2020. These include, among others:

- Funding for energy improvement of external lighting of private property
- Energy efficient public lighting
- Energetic refurbishment, global monitoring service and public building energy certification
- Organisation of awareness raising events
- Promotion of best practices (New Maranello library)
- Improvement of public transport
- Creation of municipal and inter-municipal cycle paths
- Installation of solar plants on municipal soil
- Creation of purchasing groups for solar panels
- Installation of geothermal plants in public buildings
- Creating a district heating and cogeneration plant
- Switching to GPP (See Section 3.6.6)
- A webpage dedicated to energy in the Municipality's website

Maranello has presented its BEI, divided per sectors, and elaborated scenarios to take into account demographic growth, future urban development and how these will influence energy demand (for more information: http://helpdesk.eumayors.eu/docs/seap/1162_1322228455.pdf).

The application of the SEAP will allow Maranello to cut its emissions by 22.452 CO2t/y, i.e. 21,5% in comparison to 1995. Figure 3.60 shows avoided CO_2 emissions share per sector and table 3.24 shows reductions in tonnes per year.

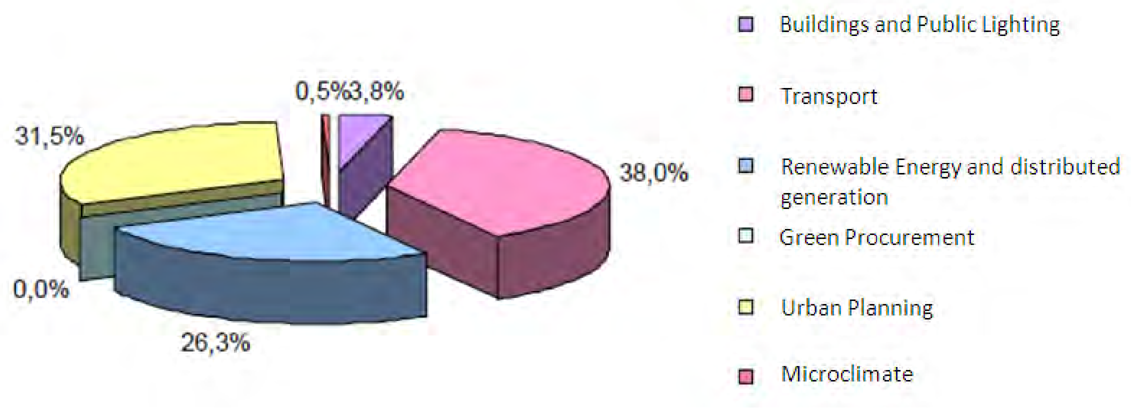


Figure 3.59: Avoided C0$_2$ emissions share per sector Source: SEAP, Maranello Municipality

Table 3.24: CO_2 reduction in tonnes per year. Source: SEAP, Maranello Municipality

Avoided CO_2

	Tonnes/year
Buildings and Public Lighting	1,083
Transport	8,417
Renewable Energy and distributed generation	7,574
Green Procurement	0
Urban Planning	5,239
Microclimate	139
Total	22,452

Appropriate environmental indicators

Table 3.25: Appropriate environmental indicator

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
CO_2 emissions	t	tonnes of CO_2 emissions / population	CO_2 emissions related to the consumption of the whole administrative area, disaggregated by sector: household, services, transport, industry, agriculture. CO_2 equivalent: emission of global warming gas (CH_4, CO_2, SF_6) could be considered instead of CO_2.
Electricity consumption	kWh	kWh electric consumption / population	Electric consumption disaggregated by sector: household, services, industry, other
Natural gas consumption	m^3	m^3 natural gas consumption / population	Natural gas consumption disaggregated by sector: household, services, industry, other
Oil consumption	l	litres oil consumption / population	Oil consumption disaggregated by sector: household, services, industry, other
CO_2 emissions of the local authority	t	tonnes of CO_2 emissions / total number of employees	CO_2 emissions related to the local administration's activities (building, transport etc…). CO_2 equivalent: emission of global warming gas (CH_4, CO_2, SF_6) could be considered instead of CO_2

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Energy consumption of public buildings	kWh	kWh consumed (heating + electricity) / total number of employees kWh consumed (heating + electricity) / total floor surface of public buildings	Electric and heating consumption of public buildings. They could be disaggregated into different types of building (school, sporting structure, etc…)
Energy consumption for public lighting	kWh	kWh consumed / population	
Fuel consumptions of public vehicles	l	litres consumed / total number of employees	Consumption of fuel (gasoline, methane, LPG, petrol) for public vehicle used by employee during the working time

Benchmark of excellence

The Sustainable Energy Action Plan of the city of Växjö (Sweden) - approved in 2008 - foresees a reduction of 65% of CO_2 per capita emissions in 2020 compared to 1993. The strategic vision of the city is to become fossil-fuel-free by 2030.

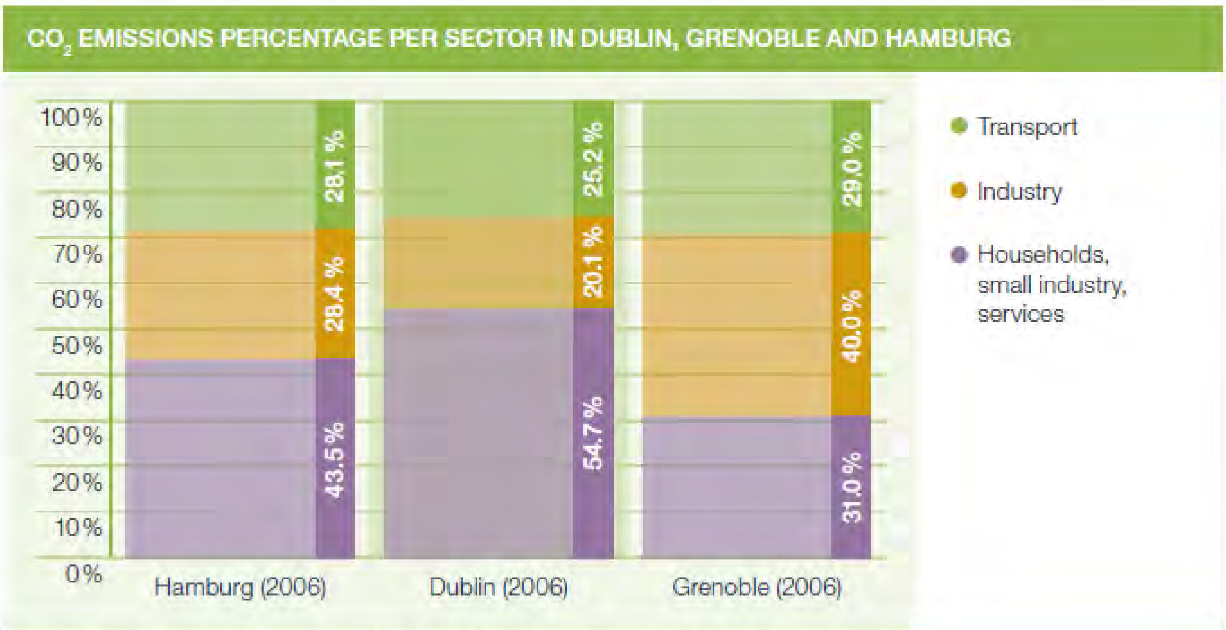
Energy efficiency enhancements have been promoted both in the residential and in the tertiary sector (in shops), also by mean of some soft measures (campaigns), dealing with behavioural aspects and with the general climate issue. CO_2 per capita emissions from the building, equipment/facilities and industry sector are expected to be reduced by 90%.

As regards the transport sector, a reduction of 23% of per capita emissions is expected. The strategic measures identified are: a) a full mobility multi-modal plan either coping with the freight transport to the city centre and further developing cycle paths; b) the construction of a biogas plant that will produce biogas to be used in public transport and private cars.

Operational data

Key target sectors include buildings, equipment and facilities, and transport. Public procurement, land-use planning, and industries should also be targeted.

Collecting and analysing data is essential before beginning a SEAP. Adopting a scenario-based approach to strategy development – considering the impact of a “do-nothing” scenario in which no action is taken and contrasting it with the projected consequences of a specific action plan - is a good way to judge the viability of differing courses of action. Different sectors produce



Source: information extracted from values of the climate Action Plan of Hamburg, Dublin and Grenoble.

different amounts of CO2 emissions. The share of emissions per sector can vary from city to city. Figure 3.61 presents the share of CO_2 emissions per sector in three different cities (CoM, 2010).

Figure 3.60: Share of CO_2 emissions per sector in Hamburg, Dublin and Grenoble. Source: CoM 2010

Identifying external variables that influence energy consumption allows for a more pragmatic action plan. After implementation, performance monitoring indicators should be developed.

Actions to decrease emissions can be as varied as changing public lighting lamps to LED technology, to installing a co-generation power plant. “Soft measures” include energy auditing programmes to provide support to citizens, creating “green kindergartens” that run on renewable technologies and raising energy awareness through smart-metering.

City example: Increasing energy efficiency in buildings, Berlin, Germany

An important aspect of Berlin’s SEAP is to increase energy efficiency in public buildings. Energy efficiency is not only an environmentally responsible path for local governments to adopt, it is also fiscally beneficial. The city of Berlin used energy efficiency as means to lower their budgetary expenditure (through reducing energy costs) and to better their environmental record. Today over 1,400 buildings have been retrofitted in the greater Berlin area.

In the 1990s the city of Berlin made the decision to increase the energy efficiency of its building stock as a means to both create savings and further the city’s environmental aims, resulting in the setting up of the “Energy Saving Partnership” scheme. The primary focus of the scheme is on retrofitting large complexes, such as schools, prisons, universities, recreational facilities and offices and administration buildings. 75% of the buildings retrofitted were public authorities and 20% hospitals. The Berlin Energy Agency (BEA) was put in charge of managing the process. The BEA draws up tenders for the retrofits and establishes Energy Performance Contracts (EPC) between the building owners and Energy Systems Companies (ESCOs). EPCs comprehensively cover planning, implementation, operation and optimisation of building installations and are based on cooperative work. As part of the EPC ESCOs guarantee the level of energy savings (which must be on average 26%), and that they will maintain required comfort levels and provide verification and documentation of the energy savings. The ESCOs also agree to carry out required maintenance on any new hardware installed.

The initial investment required to retrofit the buildings is refinanced through the energy cost savings over a period of time. The BEA assists building owners and ESCOs in determining the terms of repayment. Average payback periods are 8 to 12 years.

The Division for Climate Protection of the Senate Administration of Berlin, who works in partnership with the BEA, offers building owners financial and technical assistance with the tendering procedure. The process runs as follows:

• The BEA manages the process up to contract negotiation.

• Building owners combine several buildings into building pools, which are grouped for tendering. Building pools may contain kindergartens and schools, universities and opera halls, etc.

• The pools must have a minimum energy bill of around €200,000 annually to take part in the scheme.

• To reduce energy consumption in buildings, ESCOs offer sustainable technologies and systems (see below). The proposed EPC did not include window replacement or wall insulation due to the cost of this extending the savings repayment period to unfeasible lengths.

• ESCO finances retrofit investments in advance and depending on the achieved energy savings, building owners repay in annual instalments over an agreed period (usually 8 to 12 years).

• Building owners do not pay for retrofit investments and see energy savings immediately.

Since the scheme was established in 1996, 1400 buildings have been upgraded through the system, resulting in CO_2 emissions savings of 500,000 tonnes in Berlin.

Each building is a minimum of 26% more energy efficient than it was prior to the retrofit, as stipulated in the energy performance contract. Berlin is now looking to increase this figure to 35%. This increase in energy efficiency is achieved through introducing a mixture of sustainable technology, including a revised energy management system, combined heat and power generation (CHP), environmentally friendly lighting systems, automatic control engineering, etc, as shown in figure 3.62.

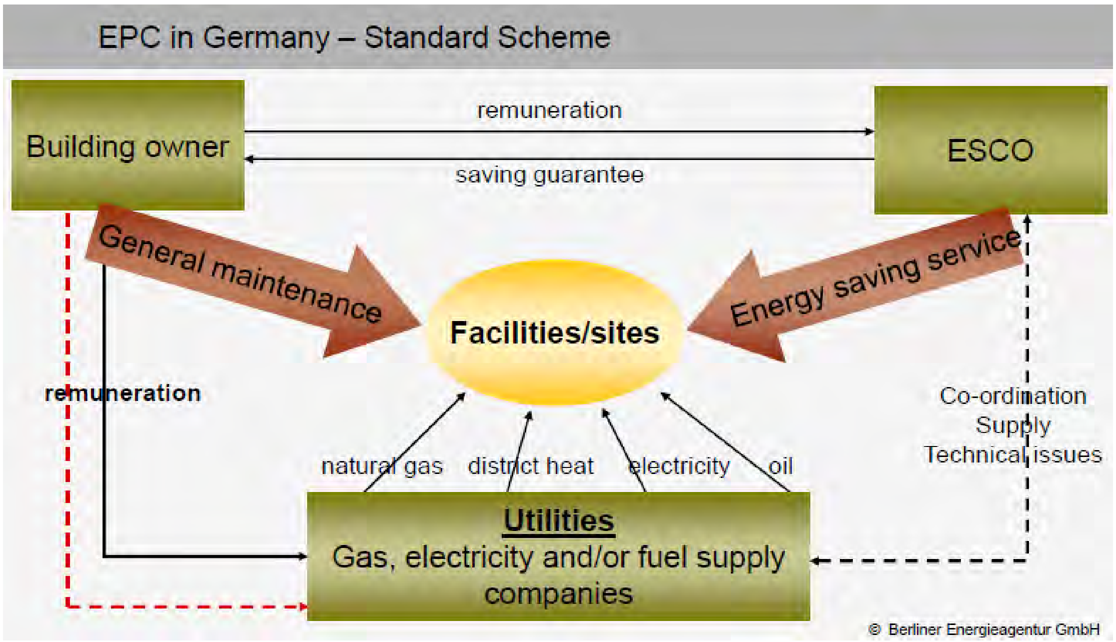


Figure 3.61: Graphical representation of the Energy Performance Contracts. Source: Berliner Energieagentur GmbH

In general changes are made to the central heating, ventilation and cooling devices within the buildings. These changes include:

Heat generation

• Replacement/modernisation of boilers

• Conversion of energy source

• Reduction of heat power

Heat distribution

• Modernisation of pumps, valves, control units

• Hydraulic balancing, thermostatic values

• Heating optimisation (heating curve, heating times)

Hot water generation

• Replacement, reduction of storage volumes, decentralisation

• Optimisation through interval timers, waterborne pathogen control

Ventilation systems

• Replacement ventilation motors/rotors/automatic control

• Operation on demand (CO_2 sensors, frequency converters)

• Heat recovery systems

Lighting

• Electronic ballasts, energy saving lamps, control systems

• Sensor technology, such as presence detectors

Energy management

• Digital energy management systems / building automation

Others

• Individual control equipment for rooms, sealing of windows, water savings measures, operation of CHP, modernisation of cooling

Berlin's Energy Saving Partnership has been replicated successfully with assistance from the BEA's division "International Know-How-Transfer." This division has initiated more than 20 projects in Europe and worldwide. Projects include the Railway depot / train station in Ostrava, Czech Republic, the Municipality of Kranj in Slovenia and the Municipality of Nyköping in Sweden. Program success can be attributed to communication, political will, transparent procedures, support of the Senate Administration of Berlin and enforceable standards.

Berlin has also attributed smooth interaction between stakeholders, strong political will which extended to financial and political support from the Senate Administration of Berlin, clear, enforceable standards and the involvement of independent experts.

The establishment of a coordination unit to implement the scheme may require administrative adjustments within the local government.

The degree of innovation is linked with the capacity of the ESCO implementing the retrofitting. Some technologies require a specialised knowledge and understanding. The availability and introduction of this technology is tied to the contractor and its capacity. In the Berlin scheme, only accredited ESCOs with specific competences are contracted. Currently there are 15 ESCOs and around 100 sub-contractors, each with their own expertise. Berlin has found that as the scheme progresses contractors gain experience and expertise, and effectiveness increases. In Berlin the Division for Climate Protection of the Senate Administration offers building owners both financial and technical assistance with regard to the tendering process.

The scheme can be instituted virtually anywhere with the requisite technical know-how and political will. Political will is essential to the scheme and without it it is highly unlikely energy efficient retrofits will occur. To see the scheme brought to fruition political will must extend to commitment of expertise, time and financing.

There are few geographical restrictions to implementing the scheme. It is however essential that

EPC projects are managed by people with a local knowledge of the current infrastructure and energy system.

The cost of implementation varies in relation to the work required by the building, or building pool, to achieve the stated energy efficiency objectives. The initial investment can be high (around €100,000 for example), but is mitigated by energy cost savings over time. In Berlin the Senate contributes 50 % of project development costs to encourage building owners to adopt the scheme. Already ESCOs have invested nearly €52 million to retrofit almost 1,400 buildings.

Initial investment in energy efficiency is refinanced through energy cost savings over a specific period of time, usually 8 to 10 years.

In Berlin's experience, building owners are unlikely to develop an EPC without financial assistance. 50 % of the initial retrofitting investment in Berlin is covered and without this funding it is likely the scheme would have struggled. Local governments must be prepared to address the initial lack of financing on the part of building owners. Implementing energy efficiency and EPC in an isolated manner is a possibility, but without local government intervention and available financing channels, is unlikely to occur in any serious capacity. Most building owners need local government support / incentives to make retrofitting a reality.

Increased energy efficiency results in lower energy costs. In Berlin savings of €11.7 million (including €2.7 million public budget savings) has been achieved. The scheme also cultivates an effective partnership between the public and private sectors. For building owners the retrofits resulted in increased economic efficiency, and so increased renting attractiveness.

The scheme provides a compensation payment to building owners if the guaranteed level of savings are not achieved.

Lowering energy costs, improving energy security and contributing to a reduction in CO_2 and GHGs are increasingly urgent matters as Europe develops.

Source: Berlin Energy Agency, available from New York City Global Partners Innovative Exchange, www.nyc.gov/globalpartners/innovationexchange

Applicability

For the SEAP to be effective internal administrative structures should be adjusted to reflect the programme. Specific departments with appropriate competencies should be assigned and sufficient financial and human resources dedicated to the implementation of the signed commitments. A sustainable energy policy must be systematically planned and continuously managed. It requires collaboration and coordination between various departments in the local administration, such as environmental protection, land use and spatial planning, economics and social affairs, buildings and infrastructure management, mobility and transport, budget and finance, procurement, etc. It is essential that sustainable energy management is integrated with the other actions and initiatives of the relevant municipality departments, and it must be ensured that it becomes part of the overall planning and management of the local authority.

Human resources are required for the effective running of a SEAP. Guidelines suggest one employee per 100,000 citizens. It is also recommended to set up a new unit within the local administration to manage the implementation. Human resources allocated to building a SEAP can be effective financially through saving on energy bills, increased access to European funding schemes, etc.

Citizens' involvement is key for creating a truly effective SEAP. Signatories commit to mobilise and involve citizens throughout the process. Strategies of information, communication, motivation and co-ordination are a crucial ingredient.

Regular evaluation followed by intelligent adaptation of the action plan allows continuous improvement of the process.

City example: Developing a participatory process, Burgas, Bulgaria

Before sitting down to write its SEAP, the Municipality of Burgas (Bulgaria) sought ways for a wide public involvement, recognising the positive aspects of a participatory process with stakeholders in effectively identifying the energy needs of the region. In addition, greater stakeholder involvement makes policy-making a more transparent and democratic exercise, and enhances the level of knowledge and expertise available. Increased participation in planning also ensures long-term acceptance, viability and support of the strategy and measures.

Burgas aimed for the SEAP to serve not only the purposes of the municipal administration but to benefit society as a whole. To achieve this, citizens and stakeholders were offered the opportunity to take part in the key stages of the SEAP elaboration process, which included building a vision, defining objectives and targets, setting priorities, and so on.

Identifying the main stakeholders was the first step: actors whose interests are affected by the SEAP, whose activities have an effect on it, who possess information, resources and expertise needed for strategy formulation, and those whose participation is needed for successful implementation of the plan.

This included several official bodies, large industrial companies in the region, such as the petrol refinery, the regional heat and energy suppliers, the municipal transport company, the local university, and NGOs, among others. They all declared their interest and support for this development.

Stakeholders' involvement is also the starting point for creating the behavioural changes needed to complement the technical actions embodied in the SEAP. This inclusive approach is the key to a concerted and co-ordinated way to implement a SEAP.

Source: Sustainable NOW: Ways to Successful Sustainable Energy Action Planning in Cities, ICLEI, 2011.

Economics

Creating and enacting a successful SEAP often requires a sizeable financial investment. Financial resources should be indentified prior to implementing the long-term strategy, and accommodated within the municipal budget. For those municipalities with difficulty finding the requisite financing, funding is available at EU level for SEAPs. EU funding instruments include the European Regional Development Fund (ERDF), the European Social Fund (ESF), and the Cohesion Fund (CF). Funding is also encouraged through public-private partnerships. Other funding instruments include Intelligent Energy Europe, ELENA facility and European Energy Efficiency Facility, amongst many others. More information regarding funding options is available here: http://www.eumayors.eu/support/funding-instruments_en.html. A good example of how the measures foreseen in a SEAP can be implemented in an economic advantageous way is represented by the case of Modena, Italy. The Municipality, in collaboration with the Province established an Agency for Energy and Sustainable Development (AESS – Agenzia per l'energia e lo sviluppo sostenibile) with technical and communication tasks. This agency is a non profit organisation, offering consultancy to the public sector and private businesses. The agency is active in favouring the development of renewable energy on the territory of Modena, in promoting energy efficiency and savings and reducing pollution. The agency was co-funded through the SAVE II Programme of the European Union (which financed 30% of it), through public money and by its associates (50 Municipalities, the University, the Chamber of Commerce and 3 NGOs), who are required to pay a membership fee. The role of the agency is

to link the private sector to the public and to identify cost-effective measures to be realised. The aims of the agency are, among others:

- Reduce energy consumption (and energy bills) of local public buildings (-15-20%).
- Installing a renewable energy plant in each school.
- Guide citizens towards more sustainable energy.
- Promotion of energy savings and home security
- Develop and assist in the local sustainability plans development (Local Agenda 21, SEAP, and Local Plan).
- Carry out energy analysis for buildings.
- Feasibility studies, project development and funding possibilities for the development of sustainable energy plants.
- Prepare tenders for energy services.
- Encourage saving and renewable inform the public, communicate with companies.
- Certify the savings obtained by Public Administrations (so to obtain white certificates)
- Promote the role of ESCOs.

The AESS collaborates and brings together:

- The Energy Office of local public administrations
- Employers' associations.
- The local energy distribution companies
- The SMEs of renewable and heat sectors

- ESCOs
- Consumer groups and environmental associations.

In order to be self-sufficient, the AESS offers services on a contractual basis. It
In order to promote Public Private Partnerships, AESS provided assistance to the province of Modena in preparing a tender to substitute thermal power plants without any additional costs for the public administration. As a result, 11 new plants were installed, guaranteeing 8% savings per year. The investment was funded by the ESCO and a 7 years “sharing savings” contract was signed, foreseeing that a part of the savings would pay back the ESCO and the other part would allow the public administration to save money. Although provinces are not CoM signatories, AESS has played a crucial role in preparing the SEAP for the Municipalities in the Province of Modena, also presenting the application for, and obtaining the ELENA Facility (1,4 millions Euro). The project ELENA-Modena foresees three main investment sectors:

- Energy efficiency in municipal buildings
- Photovoltaic roofs on municipality owned buildings
- Public lighting

Technical assistance in preparing tenders is free of charge for the Municipality, which are then directly responsible for managing and carrying out the tender. The SEAP of Maranello presented above was also prepared in this framework. (Antinucci, 2011).

Driving force for implementation
The CoM cites the following benefits amongst the main reasons local governments join:

- Make a public statement of extra commitment to CO_2 reduction
- Create or reinforce the dynamic on CO_2 reduction in their territory
- Benefit from the encouragement and example of other pioneers
- Share the expertise developed in their own territory with others
- Make their territory known as a pioneer
- Benefit from EU endorsement and support
- Qualify for funding available to Covenant signatories
- Publicise their achievements on the Covenant website

SEAPs also lead to new jobs created at local level, lower energy bills for citizens, comfortable living conditions and public money used more efficiently.

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- Each of the cities explored in the following sections - Berlin, Copenhagen and Barcelona - are signatories to the Covenant of Mayors and have implemented SEAPs. The specific actions outlined feed into a comprehensive sustainable energy action plan within each region. Example SEAPs are available to view from the Covenant of Mayor's website. Berlin's SEAP can be viewed here: http://www.berlin.de/imperia/md/content/sen-wirtschaft/energie/energiekonzept.pdf?start&ts=1302593601&file=energiekonzept.pdf

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3.5.5 Enacting a District Heating System to service built-up urban areas

Description

District Heating (DH) Systems use a simple concept to make a large difference in consumer's lives. Rather than channelling the heat produced during the generation of electricity into the sea, DH redirects it into houses and businesses, replacing conventional oil or gas heating. Heat is captured from refuse incineration plants and combined heat and power plants (CHPs) and pumped through a piping network. Figure 3.63 shows a basic configuration of a DH system. A CHP plant produces hot water, which is then delivered to private users using a heat exchanger. After having run through the net and lost some of the heat in the exchange process, water returns to the CHP plant, to be then heated again and recirculated.

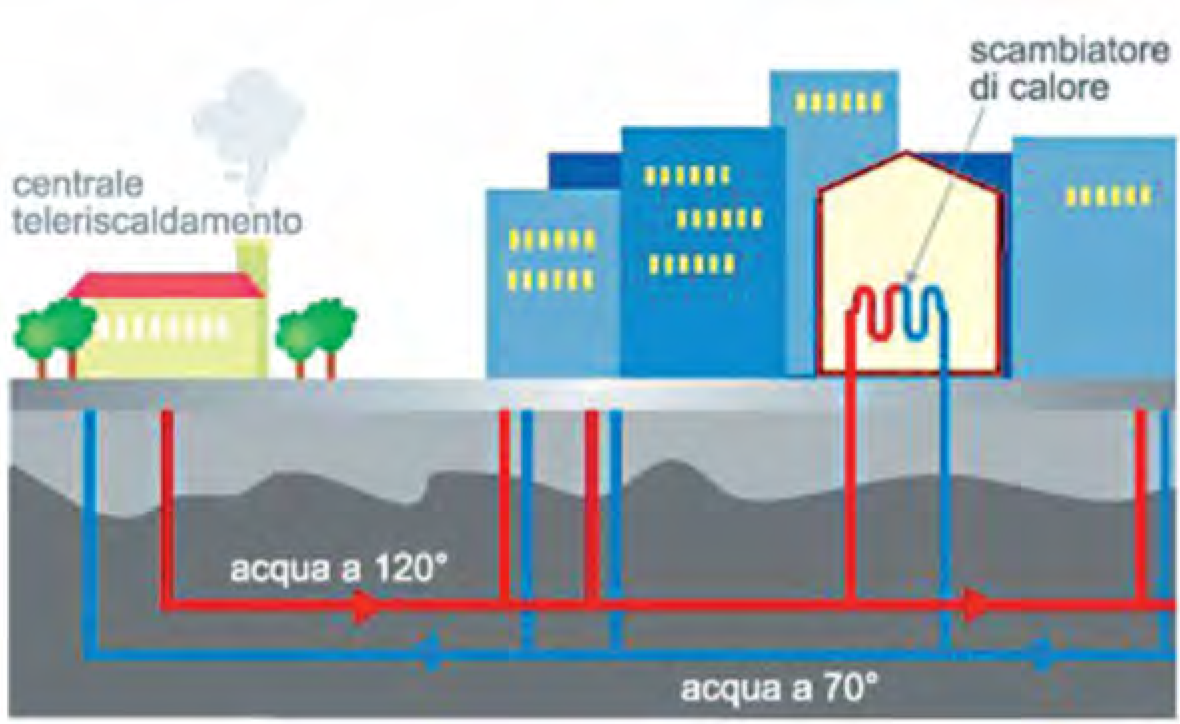

Figure 3.62: Basic configuration of a DH system. Source: a2a

"District energy pipes in modern systems are pre-insulated and installed in trenches, as shown in figure 3.64.

Figure 3.63: DH tubes in a trench. Source: a2a

[…] In modern systems using hot water, heat can be transported several tens of kilometres with only a few per cent loss efficiency. Losses will be reduced if heat is distributed at the lowest possible temperature(for example 70-80°C instead of 110-120°C), which implies buildings designed to have minimal heating and cooling loads. To enable this, the buildings envelop has to be upgraded in order to need smaller peak heating rates. A larger or more effective heat exchanger between the district heat water and building heating water would also help by reducing the temperature drop between the two. Other options are to increase the flow rate (necessitating larger pumps and, in rebuilt systems, larger-diameter pipes or to install larger radiators (for new building underfloor heating represents a very good solution) or to add a peaking plant to boost the temperature during the coldest conditions (Harvey, 2010a). Heat sources are typically cogeneration or incineration plants, many small and medium-sized communities, especially in Sweden and Austria, use biomass as the energy source for district heating. The easiest heat source to capture for district heating is the waste heat from electricity generation through cogeneration. However, if the electricity is already supplied by green sources, cogeneration powered by fossil fuels to produce electricity while providing heating would increase CO_2 emissions. Alternatively, biomass-powered cogeneration would be close to carbon neutral and would represent an efficient overall use of biomass as long as the majority of the waste heat can be put to use. […] The most convenient solution for district heating is to collect heat from sources that would otherwise be discarded. Examples include sewage treatment plants, bakeries, some manufacturing facilities and electrical transformer stations" (Harvey, 2010a). Figure 3.65 shows how losses in energy transformation could provide the heat demanded for end use.

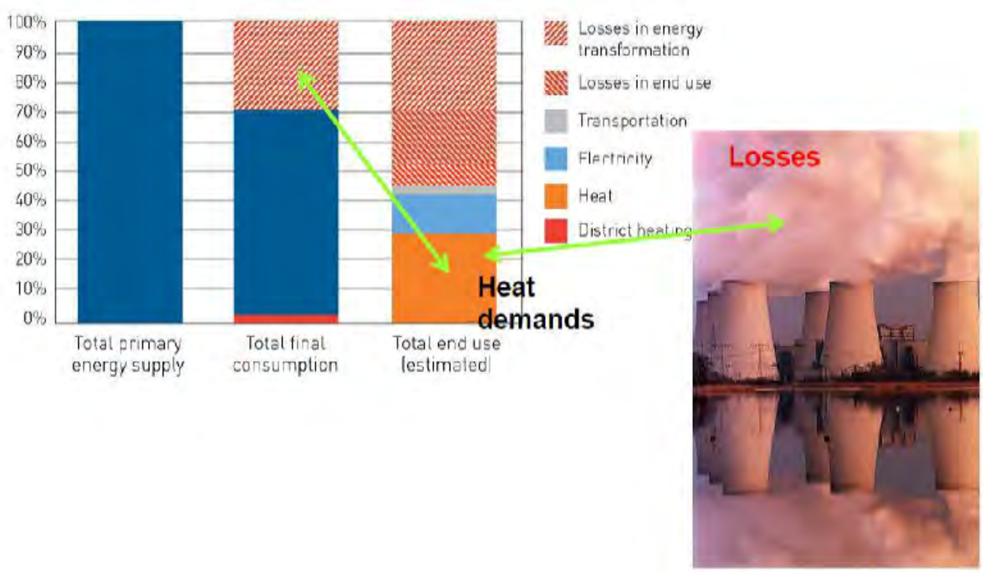

Figure 3.64: Losses in energy transformation and heat for end-use. Source: Euroheat and Power and A2A

In Countries facing cold winters and hot summers, DH can be also used to provide cooling through an absorption refrigerator capable of turning waste heat into cooling. This technique is commonly referred to as trigeneration (electricity, heat, cooling). In addition to using waste heat, this technique also reduces the high electricity peaks caused by an intense use of traditional chillers in summer.

An example of that is represented by the district heating plant of Linate, near Milan (Italy). The plant provides heating, cooling and electricity at the airport of Milan Linate and it is planned to

provide district heating to a large urban area in the eastern part of the City. The plant consists of four cogeneration units[39].

District heating driven by CHP plants and other renewable sources is a feasible way to secure heat energy efficiency in densely populated cities. Due to geographic considerations, being densely populated has a large advantage in instituting the system, as it limits the size of the piping network and its associated installation and maintenance costs (this represents one additional good reason for limiting urban sprawl in city planning. For more information about urban sprawl see section 3.4.8). Within a CHP framework district heating is also an effective means to increase the share of renewable energy used in the production of heat and energy.

Achieved environmental benefit
A District Heating system can have a huge impact in reducing the level of carbon emissions. Hanne Christensen, an engineer working with Københavns Kommune, says that the system is "very important [in reaching the goal of carbon neutrality by 2025]" as the city can "simply change the fuel in a central CHP plant and then reap the benefit of a CO_2 reduction in all of Copenhagen. When we change to biomass it will result in a great CO_2 reduction for the city."
CHP plants use 30% less fuel to create the same amount of heat and power compared to separate heat and electricity plants. As a third of all fuel for the DH system (rising to 45% for the water-based DH system) is supplied by waste incineration and biomass, carbon production is reduced significantly – in the region of 40 to 50% - compared to individual oil and natural gas based boilers.

As vice-director of CTR Jan Elleriis explains, "In principle, heating is a very low value energy source compared to electricity or natural gas, which are a very high value energy sources. Therefore using electricity or gas for heat is a bad solution. There are a lot of value losses in using these sources."
Fuel efficiencies are up to 94% when simultaneously generating heat and power, whilst in conventional plants fuel efficiencies are as low as 30 – 40 %.[40]
Given the poor economic situation many local authorities across Europe find themselves in, authorities may be reluctant to invest in such an expensive project. Jan Elleriis believes that the benefits far outweigh the costs, stating: "For those European countries who want to achieve lower CO2 emissions, there is no other possibility - they have to go in this direction. It's a non-question really to say if this system is economically feasible or not, because what is the alternative if you don't do it?"

City Example: District Heating, Copenhagen, Denmark

Building on a DH framework instituted as early as the 1901, two networks were established, covering the whole of the greater metropolitan area constituting the city centre and 15 suburban municipalities. The district heating system uses four CHP plants, three waste incineration plants and 50 peak load boiler points to generate the required heat, with total heat production of around 33,000 terajoules per year.

Within the Copenhagen district the heating system is owned and operated by Copenhagen Energy. The system is part of the larger metropolitan district heating system, which is operated

by other heating companies in the region, including the Metropolitan Copenhagen Heating Transmission (CTR) and VEKS. Table 3.26 outlines each of Copenhagen's CHP plants and their fuel source and capacity.

Table 3.26: Table of CHP Plants, their Fuel type, and Capacity heat + capacity electricty produced in Copenhagen, Denmark. Source: City of Copenhagen

CHP Plant		Fuel	Capacity heat M'^r^s	Capacity electricity *NW*
Amagervaerket	Unit 1	Biomass. coal, fuel Oil	250	80
	Unit 3	Coal, fuel oil	331	263
Avedorevaerket	Unit 1	Coal. fuel oil	330	250
	Unit 2	Gas. biomass, fuel Oil	570	570
H.C. Oersted Vaerket		Gas	815	185
Svanemoellevaerket		Gas, fuel oil	355	81
Waste Incineration Plant				
Amagerforbraendingen. AMF		Waste	120	25
Vestforbraendingen, VF		Waste	204	31
KARA		Waste	69	12

The DH system originally developed as steam based, catering to industrial needs (such as sterilising in hospitals, etc.). In the 1960s a water based system was introduced. For efficiency reasons what remains of the steam based system is currently being converted to water, as steam has the disadvantages of low efficiency in distribution, lower electricity efficiency in production and higher CO_2 emissions. The conversion project is due to be completed in 2025.

Having a facilitative legal framework has been instrumental to the success of the process. In 1979 the "heat supply act" was passed, making it mandatory for real estate owners to connect to district heating in designated areas. As a result consumers had to pay their share of the DH whether they used it or not. This strategy made DH by far the most sensible financial choice for consumers and as a result almost all use the system to heat their homes in the municipality of Copenhagen.

The heat supply act further mandated that heating companies are to be non-profit and that the price of heat will be determined only by the cost of the production and distribution. Danish energy supply companies have a duty to provide adequate heating at the lowest possible price, without including profit or dividend to the owner of the DH company.

In the 1990s environmental concerns became as significant a concern as energy security in Denmark, and in 1993 the Danish Government decided that the electricity sector should produce electricity from biomass, specifically 1.4 million tonnes of straw and woodchips. Two of the plants in greater Copenhagen agreed to participate. The use of biomass fuels in CHP plants is promoted through subsidies and energy taxes. Subsidies are given to electricity production based on the fuel, whilst conversely heat production based on fossil fuels is heavily taxed. "Saved" CO_2 quotas (the European CO_2-quota trading system) also improves the competitiveness of biomass-fired CHP. Figure 3.66 shows the Copenhagen DH system:

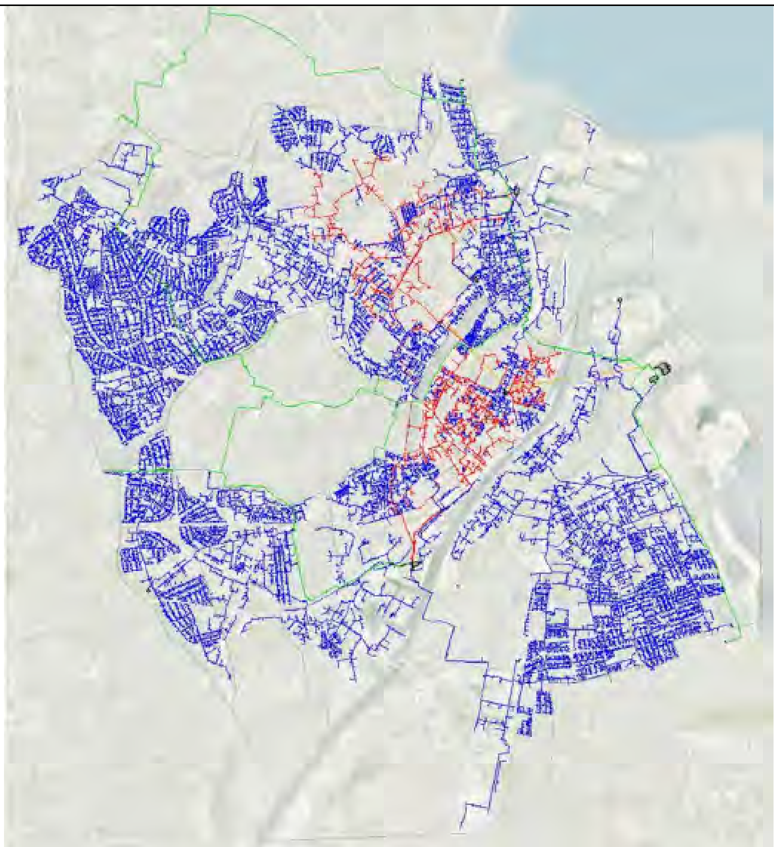

Figure 3.65: The Copenhagen District Heating System. The blue lines are water based distribution pipes, the red lines are steam based distribution pipes and the green lines are transmission pipes. Source: City of Copenhagen.

Switching to biomass is an important element in creating a more sustainable DH system. According to Jan Elleriis, Copenhagen uses its political clout to encourage the use of biomass among privately owned CHP companies: "the society wants biomass to be used in the DH and power sectors, and the municipality wants CO_2 to be reduced as much as possible, therefore when a power company has a plan and wants it to be approved by the government, the authorities can use grants or subsidies to achieve its aims. It is also possible to refuse it on environmental grounds outright.

"Acts have been approved by the government stating that they will give grants to companies using biomass for the production of power. A company using straw for example, gets a grant for every kilowatt hour they produce from the biomass. Biomass compared to coal is much more expensive, therefore there must be these grant from the government in place in order to make it possible to use biomass."

In a further effort to increase energy efficiency and reduce energy consumption Copenhagen Energy has provided energy saving services for customers, such as installing building insulation, lighting controls, electricity pumps, etc. The company is obliged to do this to comply with a governmental demand that applies to all energy services in Denmark. The legislation is designed to drive down demand side energy consumption.

Political will and investment is an important component of creating a wide-ranging and accessible heating grid. This has been one of the most crucial aspects of the systems success in Denmark. This legislative support has created a culture in which DH is regarded as a "public service". As Mr. Elleriis explains, "In Copenhagen we regard DH as a public service in line with sewage, water or electricity and so on. It's not something for an individual to look after. If that did happen it would be more expensive, would not be an optimised solution and there would be greater environmental impact. The municipality and the society believe this is a public service and is the best solution to supply buildings with heat."

He also states that having legislative support allows private companies to invest with greater confidence: “Today there are a lot of private companies involved – all the power companies are private companies. They are involved in this business as they know that there’s a very high level of stability. It’s possible for them to invest in something that will be paid back in 20 years.

“It’s possible for DH companies to go on the national and international market for a loan as their credit rating is very high. Because all of the municipalities are behind the DH company they can borrow money at a very low interest rate compared to other private projects. Therefore it’s possible for them to make these long term investments.”

The DH system has proved so successful that several neighbouring municipalities are considering implementing district heating to replace individual gas-fired furnaces.

In Copenhagen, the public perception of DH has changed from scepticism to one that is overwhelmingly positive. As Hanne Christensen says “Nowadays [the perception] is positive. In the 1990s we had to fight to use DH instead of oil. Some didn’t like it because they had to make an investment to use DH, to changeover from their oil heating system, but really only a minority were unhappy. In general today the public perception of DH is favourable.

Given the poor economic situation many local authorities across Europe find themselves in, authorities may be reluctant to invest in such an expensive project. Jan Elleriis believes that the benefits far outweigh the costs, stating: “For those European countries who want to achieve lower CO2 emissions, there is no other possibility - they have to go in this direction. It’s a non-question really to say if this system is economically feasible or not, because what is the alternative if you don’t do it?”
Source: City of Copenhagen, Copenhagen Energy and CTR, 2011, available from New York City Global Partners Innovative Exchange, http://www.nyc.gov/html/unccp/gprb/downloads/pdf/Copenhagen_districtheating.pdf

Appropriate environmental indicator

Table 3.27: Appropriate environmental indicator - District heating

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Inhabitants connected to the district heating system	number	n. inhabitants connected/total population	
Volumes served by the district heating system	m^3	m^3 volumes served/ total population	Data could be disaggregated considering household; services and industry sectors
District heating heat production	kWh	kWh heat produced/ total population	
District heating electricity production	kWh	kWh electricity produced/ total population	
Energy vectors used by district heating	MJ	MJ consumed related to each single energy vector/ total MJ consumed	The different energy vectors which can be considered are: - coal - oil - natural gas - waste - biomass - geothermal

Benchmark of excellence

The city of Helsingborg is located in the Öresund region (Sweden). Already in 1964 the concept of district heating was implemented as the city's main energy system, a pioneer in Sweden. Household heating and warm water of 78% of the residents in Helsingborg (of a total of 129 177) is provided by a district heating network of 560 km. The district heating also includes generation of electricity (about 40% of the heat produced yearly). The district heating system is integrating all available heat's excesses in the city, combined with a bio fuelled main production plant. The system comprises: available waste heat from local industry; local landfill gas fuelled boiler; heat pumps in sewage purification tank; cogeneration power plant 100% bio fuelled (wooden pellets); peak load unit (CHP gas turbine). This district heating system is based on 98% bio fuel and only 2% fossil fuel. This is the largest district heating system in Sweden with extreme low dependency on fossil fuel.

The biggest European district heating system powered by solar energy is being developed in Marstal, a small Danish town (2,300 inhabitants). Marstal district heating, being one of the "EU flag project", has received EU grants for the expansion of the current solar installations in order to demonstrate the feasibility of a large scale innovative, cost-effective and technically 100 % sustainable renewable energy system. Marstal District Heating's 1,500 members are going to receive 55% of their energy from the solar production and 45% of their energy from locally produced biomass (energy willow). The project also includes a heat pump which is "moving" energy to the energy storage and a turbine, a so called ORC (Organic Rankine Cycle) which is an electricity-producing device that can use the energy from the flue gas produced in the biomass boiler. The EU expansion of the existing 18,365 m2 solar plant will include: 15,000 m2 of solar collectors, a 4 MW biomass boiler with a built-in ORC power producing unit, a 1.5 MW heat pump and a 75,000 m3 pit heat storage.

Applicability

Jan Elleriis argues that due to the size of the investment, it is important that there is a built in market with long-term prospects: "Because it's a long term investment, you need some kind of security that the environment will be the same for many years, and people won't say after a short period "now we want something else". You need to establish a concrete environment.

"That's why it is difficult to get private companies to start such a scheme – they are worried the municipalities will decide to try something else. It's important to have local and governmental backing for these systems to have DH on a big scale. If you don't do it you will only get DH in the most feasible part of the cities - in the rest, where it's feasible but not the highest profit area, you won't. Private companies will make small schemes only, to make the best profit. That's the difference the municipality can make – taking in the societal aspect."

Political will and investment is an important component of creating a wide-ranging and accessible heating grid. This has been one of the most crucial aspects of the systems success in Denmark. This legislative support has created a culture in which DH is regarded as a "public service". As Mr. Elleriis explains, "In Copenhagen we regard DH as a public service in line with sewage, water or electricity and so on. It's not something for an individual to look after. If that did happen it would be more expensive, would not be an optimised solution and there would be greater environmental impact. The municipality and the society believe this is a public service and is the best solution to supply buildings with heat."

He also states that having legislative support allows private companies to invest with greater confidence: "Today there are a lot of private companies involved – all the power companies are private companies. They are involved in this business as they know that there's a very high level of stability. It's easy for them to invest in something that will be paid back in 20 years.

"It's possible for these companies to go on the international market for a loan as their credit rating is very high. Because all of the municipalities are behind the company they have an AAA+++ credit rating and so can borrow money at a very low interest rate compared to other private projects. Therefore it's possible for them to make these long term investments."

In Denmark legislation dictates that biomass must be used in the production of DH, allowing the city to legislatively take control of factors that influence its goal to reduce carbon emissions.

City Example: District Energy, Southampton United Kingdom

The Southampton District Energy Scheme (SDES) is the most advanced in the United Kingdom, producing around 40,000 MWh of heat and 26,000 MWh of electricity per annum. The SDES saves around 10,000 tonnes of CO_2 yearly and has won the Queens Award for Sustainable Development in both 2001 and 2008, and the National Energy Efficiency Award in 2006. The scheme uses CHP plants, which provide over 70% of the annual heat requirement for the scheme, supplemented by geothermal energy and conventional boilers. The heating and cooling is distributed through a network of insulated distribution pipes 14 kilometres in length. Around 45 energy users in both the public and private sector are connected to the scheme, including private and social housing, hotels, offices, council administration buildings, a hospital, retail developments and a leisure complex.

The scheme was launched in 1986 following an investigation by the Department of Energy into alternative energy sources (prompted by the drastic rise in oil prices experienced in the 1970s). A Geothermal well was drilled in the Southampton area but was deemed too small to be effective by national authorities. In response the city council took ownership, partnering with the French private sector company Cofely (then called Utilicom) who specialised in energy management. The scheme was developed under the name of Southampton Geothermal Heating Company Ltd. (SGHC). Cofely provided all of the financial requirements for the scheme and so have ownership of SGHC. As the council was exposed to no financial risk, it was easier to gain support across the board. Initially consumers were served heating purely from the geothermal well, but this was expanded to CHP plants and boilers. In 2009 an agreement was made with Associated British Port Southampton to consume all of the electricity produced (23.5 million kWe) by the scheme's 5.7MWe and 1MWe CHP plants. Previously energy had been fed into the national grid. A mile long cable running underneath the city was installed to facilitate the project. The CHP plants will provide the Port with 55% of its annual electricity needs.

The success of the scheme has been attributed to the close joint cooperation between the City Council and private company Cofely, both of whom share a similar vision of sustainable, cost-effective heating and cooling. Both actively market the scheme, identifying potential new customers and targeting them with information on the benefits and price savings made possible by the scheme. Often there is some reluctance to utilise what is perceived as unusual technology. In these instances the city council itself will approach the customer, explaining how the system fits into the council's vision and the social and environmental benefits inherent in the scheme. The council can also use its power to insist that developers working on council owned land connect to SDES.

Fuel poverty, cases where citizens cannot pay for the resources to adequately heat their homes, has been lessened by the DH system. Fuel flexibility and security has also been enhanced for the local community by the system. Most consumers save 5% – 10% on their overall energy bills as a result of the high efficiency of district power (there is a temperature loss of just one degree Celsius per kilometre of pipe). Hot water flow temperature is around 80 degrees Celsius, with return temperature around 50 degrees Celsius. Each dwelling has an individual heat metre, used to calculate costs. For developers, using district power reduces capital costs by around 20%.

Source: International Energy Agency (IEA) District Heating and Cooling programme, available from www.iea-dhc.org

Economics

The price for district heating is highly competitive to other forms of energy. CTR's heating price is identical for all five municipalities, and has basically been kept at the same level throughout the project's lifetime. "From the perspective of the owner or operator of a building there are savings in the upfront capital costs since boilers and chillers don't need to be purchased as part of the building. There are also savings in maintenance costs and insurance by virtue of having no onsite heating or cooling equipment, less total backup capacity is needed (in buildings that are individually heated or cooled, it is not uncommon to have two identical boilers, one of

which is backup, whereas in a central facility with, say, ten boilers, one backup would be sufficient, unit costs of electrical generators, heat exchanges boilers and chillers all tend to fall with increasing capacity (Harvey, 2010a).

The payback period for a DH system is difficult to predict. In Copenhagen the modern system was established in 1980s and it was set that the system should be paid back in full by 2003. This target was met. The system, however, has a monopoly on heating, which influences the payback period. This is an usual situation for DH: users who are connected to the grid don't have their own boilers and are therefore obliged to use the system. As a trade-off, prices tend to be set slightly below the market price for heating and cooling. According to Jan Elleriis, "the consumers have to pay, so we are not in a situation where suddenly we won't get our money. For us it's more about whether we can keep the price as low as we promised, it's not an issue of whether it will be paid back or not – it will always be paid back. The real mission is to keep prices low and we have sold district heating for an end user price that is 10 – 15% lower than individual heating."
Hanne Christensen adds that for private companies involved in the production of heat via CHP plants the payback period is much shorter thanks to diminished fuel and running costs: "it is maybe 5 – 8 years. The initial investment is covered quite quickly by how inexpensive the plants are to run."

DH benefits from economies of scale in the mass production of heating. Individual heating costs are higher in comparison with DH and thermal efficiency lower (Energy Charter Secretariat, 2005).

Driving force for implementation
District heating systems boast economic, social and energy security benefits. The CHP plants from which the heat is produced can use a mixture of bio-fuels, wood pellets, straw and fuel oils. Thanks to this the energy supply is less vulnerable to fluctuations in world market prices. The reduction in imported oil and fossil fuels results in greater fuel independence– an increasingly valuable position as fossil fuel supplies diminish.

Jan Elleriis believes the extra costs involved in establishing DH are fully justified as a result of the security and supply benefits: "DH is of course more expensive to establish than natural gas. The construction of DH is much more expensive. But then you have the feasibility of DH – that is, you can put every type of fuel into DH. With natural gas you only have gas.
"With DH you can have several different kinds of production units, surplus energy from industries and in principle you can swap between different fuels. When we started DH was based on coal and waste heat and now we can convert into biomass and geothermal heating and so on. The security of supply and flexibility is much better than gas or electrical heating."
CHP is extremely efficient compared with individual electricity and heat plants, with lower overall costs. In 2011, the cost of DH was approximately half the cost of using oil to heat a 130 square metre home with an annual consumption of 18 MWh/year, including energy taxes. Similarly, the cost of district heating is approximately 60% of the cost of natural gas heating for the same home.

Providing low-cost, wide-spread heating also has positive social side-effects, making proper heating accessible regardless of income level. Jan Ellerris adds that due to the high investment and low operational cost DH is also better for local employment. DH generates more jobs and more tax income for the municipalities.

DH costs are comparatively higher than other forms of heating in terms of piping materials, which require thermal insulation and are larger than that required for natural gas heaters (Energy Charter Secretariat, 2005).

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3.5.6 Increasing the use of renewable energy sources within urban municipalities

Description

Photovoltaic

The sun represents an unilimited source of energy, one that, when harnessed correctly, causes no environmental degradation and presents no harmful side effects such as pollutants or emissions. At present however, only limited amounts of energy can be harnassed. Solar photovoltaics, aslso known as solar panels, use energy from the sun to generate electricity (Directgov, 2012). Photovoltaics are comprised of two layers of semi-conducting material (usually silicon), one positively charged, the other negatively charged. This upper layer absorbs photons from sunlight, causing electrons to "jump" from one layer to another, thus generating electrical charge (Boxwell, 2011). Solar cells contain thin strips of metal, which transport the electrical current. The greater the amount of direct sunlight that the solar cell is exposed to, the higher the amount of photons that it absorbs, and therefore the greater the electrical current generated. Photovoltaics are the fastest growing energy technology with an estimated turnover of around EUR 10 billion in 2007, according to EU figures (http://ec.europa.eu/research/energy/eu/research/photovoltaics/background/index_en.htm).

There are various PV-technologies, the most common are:

- Single- and multi-crystalline silicon (figure 3.67): these two are the most energy-efficient photovoltaic technologies (with single-crystalline being more efficient), capable of capturing 10-20% of solar radiation and thus being the most efficient PV technology. On the other side, it takes a lot of time and energy to produce them and they have to bi sliced into thin wafers. These limitations are overcome by thin-film cells, described next (Harvey, 2010a).

Figure 3.66: a single-crystalline cell. Source: Wikipedia

- Thin-film amorphous silicon cells (figure 3.68): although being less efficient than crystalline cells, theyhave an efficiency of approximately 8% but in a LCA perspective they have a reduced impact.

Figure 3.67 A thin-film photovoltaic module. Source: *www.ecorete.it*

Solar thermal

Solar thermal collectors allow to produce heat using solar energy to replace fossil fuels. This has the effect of reducing energy bills and deliver significant environmental benefits, avoiding the emission of greenhouse gases and pollutants.

Solar heating is a mature technology that has been used around the world since the 70s and therefore represents a low risk investment with a payback time normally well below the useful life-span (normally more than 20 years). Solar thermal collectors, like photovoltaic panels, can be integrated with building structure, for example positioned on the roof, a generally unused surface that in this way becomes a system for energy production, also having a very limited or absolutely no visual impact. There are three main types of solar thermal collectors, these are:

- Unglazed collectors: are made of plastic pipes through which water flows (figure 3.69), overlain by an absorbing plate and give a temperature rise of 0-10K (Harvey, 2010a). These collectors are normally much less efficient than glazed collectors; also the average life-span is usually half than other glass collectors. They are nonetheless less expensive (approximately 20% of glazed ones) and suitable for seasonal applications which requires low temperature heat (holiday houses, swimming pools).

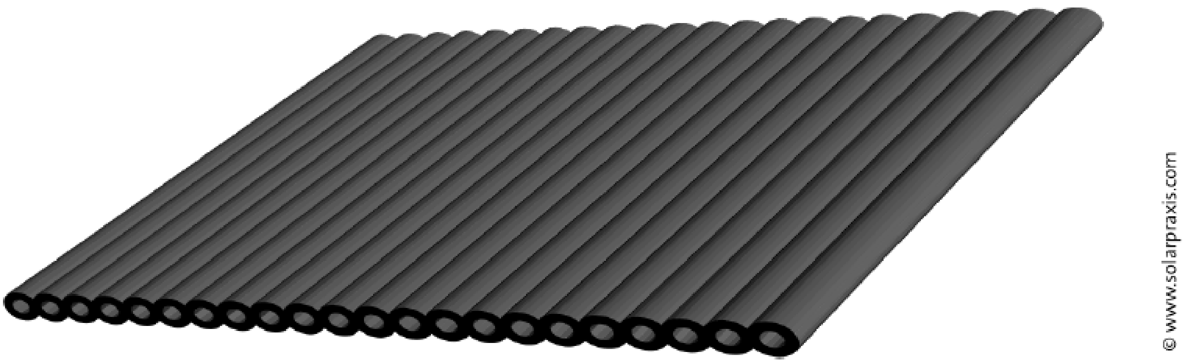


Figure 3.68: Unglazed solar thermal collector. Source: www.solarpraxis.com

- Flat-plate collectors (figure 3.70): transparent flat-plate collectors, with one or two layers of glass, give a temperature rise of 0-50K and can be used to heat water or air. The absorbing plate has a very high absorptivity (greater than normal balck paint, which still reflects 10% of the incident radition. It should have a high heat conductivity to effectively transfer heat to the water and a low infrared emissivity to minimise radiant energy losses (Harvey, 2010a).

Figure 3.69: Flat-plate collector. Source: http://www.solaritalia.com

- Evacuated-tube collectors (figure 3.71): consist of a series of tubes with a vacuum inside in order to eliminate convective heat losses. There are several kinds of evacuated-tube collector, but the only two with demonstrated long life under fluctuating outdoor conditions are the *heat pipe collector*. The heat-pipe collector has a black absorber plate inside each vacuum tube, and within each absorber plate, a pipe that carries a liquid at a pressure such that it will boil where it absorbs solar heat and condense onto a pipe carrying the water that is to be heated. A temperature rise of up to 150K can be achieved, but the tubes must be inclined at a slope of at least 25°. A disadvantage of evacuated-tube collectors is that they cannot be integrated into the roof of a building (Harvey, 2010a).

Figure 3.70: Evacuated-tube collector. Source: www.solarpraxis.com

Biomass

"Biomasses are referred to as plant materials that were produced recently enough through the process of photosynthesis, using energy from the sun, that they are still present in unaltered form" (Harvey, 2010a). I

There are different biomasses, which can be listed as follows:

- agricultural residues
- forest residues
- manure

- vegetable oils
- Residues from food industry
- Residues of the timber industry
- Dedicated crops (2nd generation biomasses are non edible crops)
- Organic Fraction Municipal Solid Waste

Biomasses can be used directly for electricity production or/and heat production (like in the case of timber, which can be used in specific boilers in the form of wood chips or pellet with high efficiency levels), can be used to produce gas through anaerobic digestion or to produce biofuels (See section 3.2.4) (www.itabia.it).

Small scale geothermal plants

Small scale geothermal plants, also defined as low enthalpy geothermal plants, can represent a low-carbon heating/cooling option for public administrations, households and businesses on their territory. These systems exploit the stability of the temperature of the soil, which tends to be constant throughout the course of the year and corresponds approximately to the annual average temperature of the outside air. In the deeper layers of the soil, the temperature increases, reflecting the geothermal gradient. Heat is transferred through a heat pump.

Achieved environmental benefit

Solar power is free, renewable and readily available. It also eliminates many energy security and energy price issues for local governments. It represents an entirely clean form of energy that does no damage to the environment, biodiversity or human beings. Using solar thermal collectors to produce hot water avoids combution of fossil fuels and therefore release of CO2 in the atmosphere, also increasing local air quality. In 2005 solar heating in the EU was equivalent to more than 686,000 tons of oil. The only environmental impact photovoltaic panels can have is the one linked to estraction of the silicon in a LCA perspective (this is particularly true for single- and multi-crystalline silicon cells). Nevertheless, the amount of green energy produced during the normal life-span of the plants (about 20 years) fully repays this imbalance.

For biomasses from energy crops to be sustainable, it is important to create a local supply chain to avoid long distance transportation, which has an environmental impact as well as a social one. It is also important not to replace food crops with intensive cultivation of biomass; this has been done in the past years especially in developing countries, diminishing biodiversity and space for food crops. It is fundamental for wood biomasses to be burnt in high-efficiency boilers, minimizing the release of air pollutants. In fact, while having a positive effect on the aggregated balance of the reduction of emissions, these are at risk of having a negative impact locally.

Low enthalpy geothermics also provides heating and cooling to households without the release of pollutants, but the heat pump needs electricity to exchange heat with the soil (or groundwater). Therefore it could be good to combine this technology with a photovoltaic system. Closed geothermal heat pump systems have a low environmental risk, but you must take a non-toxic and biodegradable antifreeze additives (such as propylene glycol, salts) and avoid the interconnection between groundwater and surface deep aquifers during drilling and operation. In order to guarantee the sustainability and long term functioning of geothermal plants it is important to guarantee regeneration of the soil where the exchange occurs. This can be done by using the plant for heating and cooling (the heat withdrawn in winter will be given back in summer) (Angelotti 2011).

Appropriate environmental indicator

Table 3.28: Appropriate environmental indicator

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Renewable energy plants	kW	kW renewable sources installed/ total kW installed	Power plants installed in the whole administrative area, disaggregated by renewable source: solar, wind, biomass, geothermal, hydroelectric. A further suggested disaggregation is between public and private plants.
Average size of renewable energy plants	kW	kW renewable sources installed/ number of plants	Average size of power plants related to each different renewable source: solar, wind, biomass, geothermal, hydroelectric.
Renewable energy production	kWh	kWh renewable sources produced / total kWh consumed	Energy produced by power plants installed in the whole administrative area, disaggregated by renewable source: solar, wind, biomass, geothermal, hydroelectric. A further suggested disaggregation is between electricity and heat produced.
Renewable energy production of the local authority	kWh	kWh renewable sources produced / total kWh consumed	Energy produced by power plants owned or managed by the local authority, disaggregated by renewable source: solar, wind, biomass, geothermal, hydroelectric
Renewable energy purchased by the local authority	kWh	kWh renewable sources purchased/ total kWh consumed	Renewable energy purchased by the local authority, including certified green electricity and heat produced from renewable sources purchased from private plants (e. g. biomass powered district heating networks).
Solar heating panels installed in private buildings	m^2	m^2 solar thermal panels installed in private buildings/ total population	Data could be disaggregated between big plants (> 50 m^2) and small plants (<50 m^2)
Solar heating panels installed in public buildings	m^2	m^2 solar thermal panels installed in public buildings/total number of employee	Data could be disaggregated between big plants (> 50 m^2) and small plants (<50 m^2)
Solar photovoltaic installed in private buildings	kW	kW photovoltaic panels installed in private buildings/total population	Data could be disaggregated between big plants (> 20 kW) and small plants (<20 kW)
Solar photovoltaic panels installed in public buildings	kW	kW photovoltaic installed in public buildings/ total number of employee	Data could be disaggregated between big plants (> 20 kW) and small plants (<20 kW)

Benchmark of excellence

The City of Ulm (110,000 inhabitants) boasts the second largest solar power production in Germany. The City Council has made it mandatory to plant solar panels on every public suitable rooftop and since April 2008 a strict energy standard (German KFW40 standard) is mandatory for all new buildings. The total photovoltaic power installed in the city is about 26 MW, of which 7.6 coming from large PV installations. This means 0,23 kW per inhabitant. The solar panel covered area is more than 15,000 m^2 - 0.13 m^2 per inhabitant - and 12,951 kW power all together. So far, solar panels have been planted on 30 public buildings, but in the future 100% of the energy demand of public and industrial buildings is planned to be supplied by renewable energies (the Ulm Minster is powered fully by renewables since January 2008). In February 2010 the "100% Renewable Energy Alliance" was founded with the aim to switch the entire region of Ulm and Neu-Ulm to 100% renewable energy by 2030.

Operational data

Photovoltaic

The solar irradiance is maximised if the panel is inclined equatorward at an angle equal to the local latitude. The irradiance can be increased further if the panel can tilt east-west as well as north-south, so as to track the sun in its course through the sky (Harvey, 2010a). A clinometric analysis is necessary to evaluate the field of shading generated by obstacles nearby (buildings, chimneys, trees, towers, parapets, etc.). For installations on flat roofs special attention must be paid to sheds between panel rows, as shown in figure 3.72 (Source, Leva 2011). For the correct functioning of the photovoltaic panels is also important that the temperature of the cell doesn't increase too much. When the cell's temperature becomes more than 25°C the system loses efficiency.

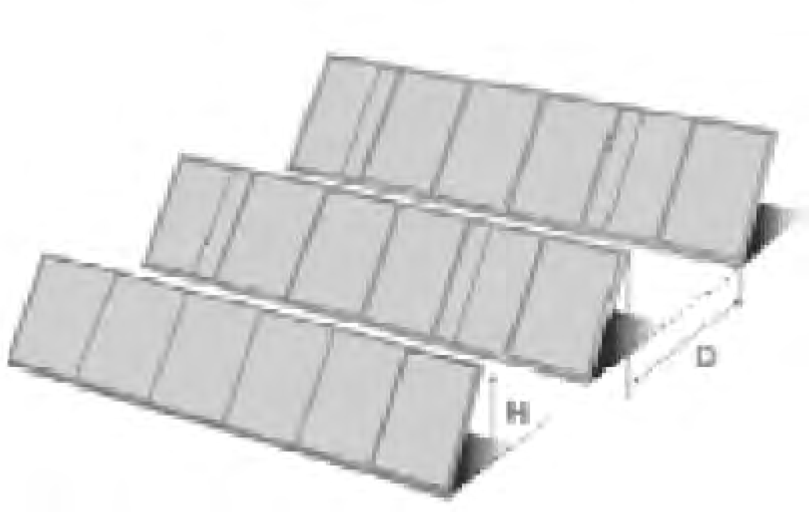
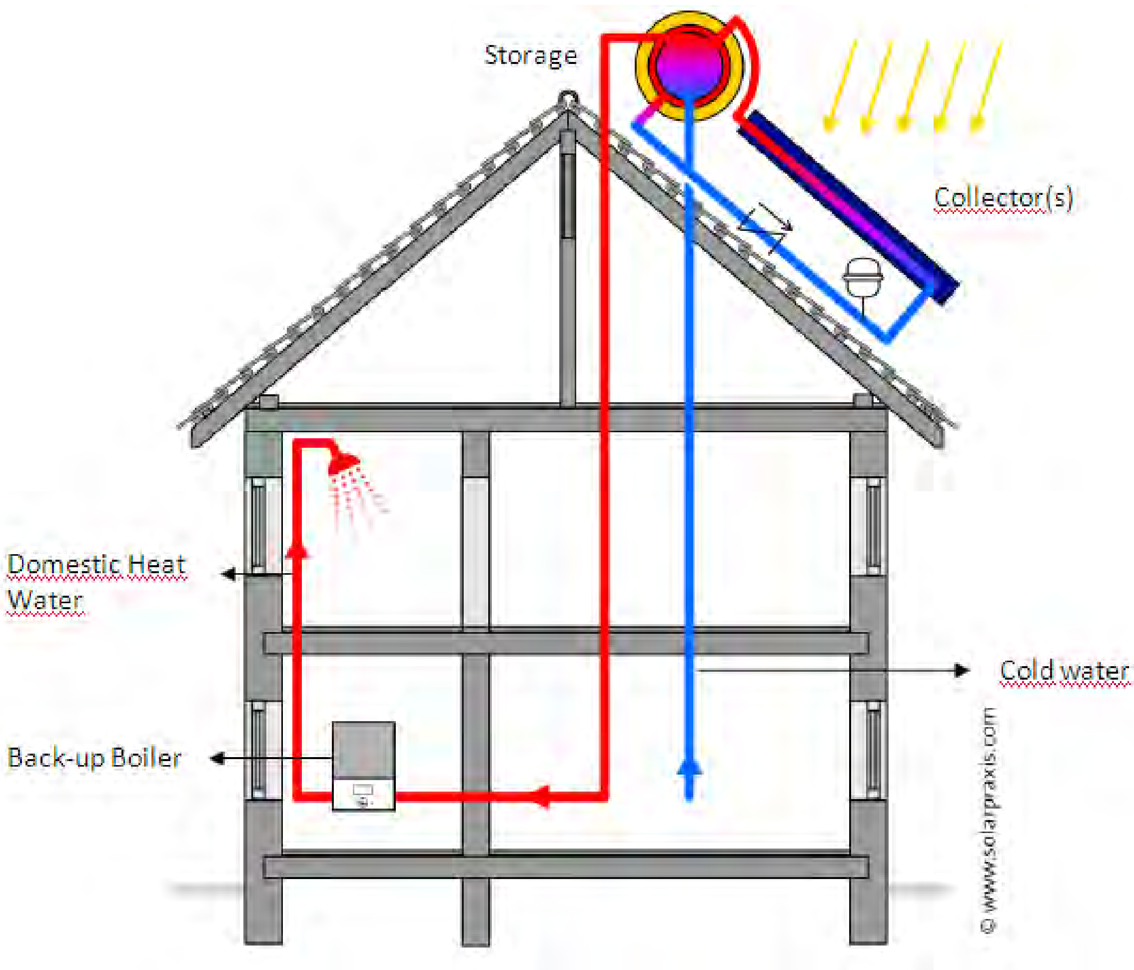


Figure 3.71 Optimal relationship between inclination and shading Source: Leva, 2011

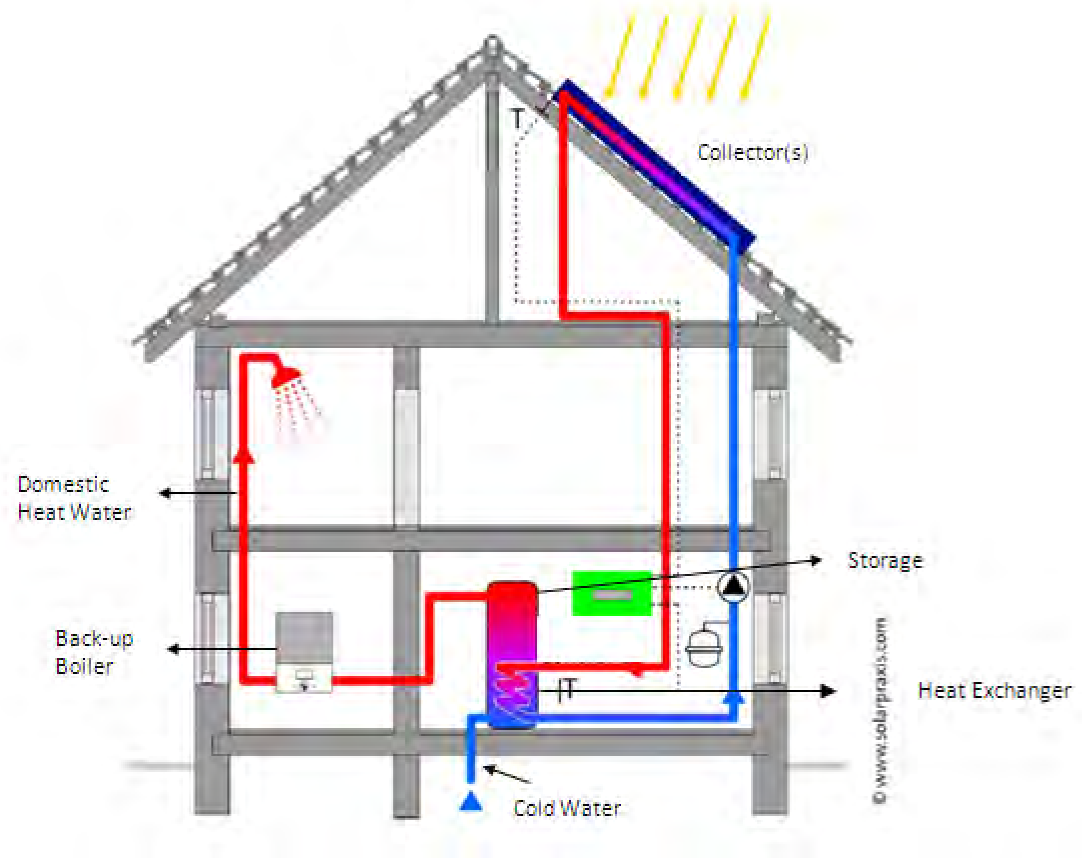
Solar thermal

Solar thermal collectors present some problems; first of all, they are unable to run a full system in the absence of the sun. The system produces hot water anyway, even with a cloudy sky. In fact, diffuse-beam radiation is way less concentrated but much more extended, and it is available the entire time during daytime hours (except during a thunderstorm or with the sky much covered). Solar panels can be installed in all homes, from detached houses to multi-family buildings. In workplaces, where the hot water consumption is limited, a solar system often is enough to meet the hot water requirements. It should be always made sure that in every month of the year and throughout the day, there are no shadows. The most advantageous position is that south-oriented. But also to the extent where the slopes are geared to southeast or south-west the panel can be efficiently installed. It is important that the pitch of the roof (or the panel on a plain roof) is inclined at least 35 ° to the horizontal plane. The tank for collecting hot water can be positioned higher than the solar panel, so as to allow a natural circulation system, as shown in figure 3.73.



3.72: Natural Circulation Solar Thermal System. Source: Motta and Solarpraxis

In case a bigger storage is needed, the tank can be placed in the house, as shown in figure 3.74. In order to avoid the risk of Legionella bacteria, usually a heat exchanger is installed in the storage tank. The circulation system is in this case not natural but driven by a pump.



3.73 Forced-Circulation Solar Thermal System. Source: Motta and Solarpraxis

Biomass

For all the diverse biomasses is very important to create a supply chain with resources that are locally available, reliable and not too expensive.

Wood boilers are one of the biomass sources which are commonly used at the local level. When installing a wood boiler, some aspects have to be taken into consideration. “Owing to the lower energy density of wood fuel compared with oil, wood boilers require relatively large fuel storage areas for the chips or pellets, usually at ground or below ground level. Operational measures to reduce operating emissions from wood boilers are described below. Combustion efficiency in wood boilers is optimised through air staging (splitting the combustion air into a primary air flow directly to the flame and a secondary air flow in direction of the combustion gases) to avoid excess oxygen in the combustion zone and ensure sufficient oxygen above the combustion zone. Secondary air injection increases the low-temperature outer-flame volume to ensure full oxidisation of hydrocarbons, black carbon and carbon monoxide following combustion. Boilers connected to small hot water storage tanks operate under variable load conditions throughout the day, thereby producing relatively large quantities of partially oxidized compounds. Air and fuel feeding systems can ensure optimised combustion performance at loads of between 50-100 %. The installation of large hot water storage tanks can enable wood boilers to operate for longer periods at peak or close to peak load, and reduce the number of start-ups and shut-downs during the day, thereby reducing emissions.70 %. After-burning catalysts are available to reduce carbon monoxide and volatile hydrocarbon emissions” (Source: JRC, 2012).

Low enthalpy geothermal systems

Water / ground heat exchangers can be used to preheat the indoor air in winter and pre-cool it in summer. The heat exchangers referred to as water-soil (i.e., using water as heat transfer fluid for the exchange of temperature) can be placed in horizontal or vertical (see figure 3.75). While the horizontal tubes have lower excavation costs, they need a large surface (such as a garden) in order to be installed and the exchangers, being on the surface, suffer from the seasonal weather changes. Vertical heat exchangers have higher excavation costs. They reach depths from 20 to 300 meters and not affected by changes in external climate (Angelotti, 2011).

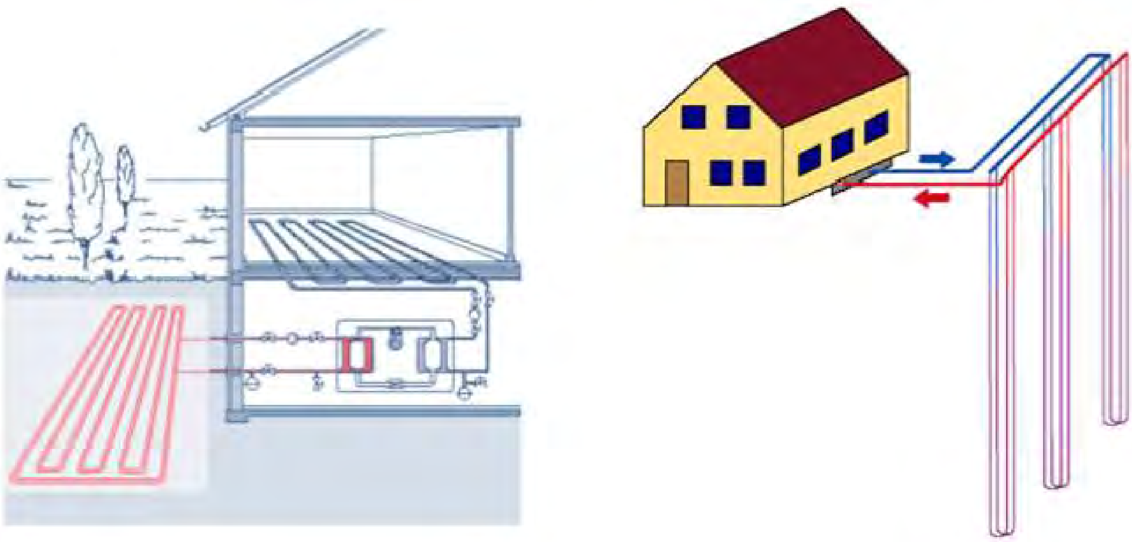


Figure 3.74: horizontal and vertical heat exchangers. Source: Angelotti, 2011

City example: Increasing solar thermal use, Barcelona, Spain

Barcelona has taken legislative steps to ensure the 2,800 hours of sunlight the city receives yearly makes a major contribution to the energy supply. In 1999 the city enacted regulations unprecedented in Europe, mandating the installation and use of solar panels in new buildings, renovated buildings and buildings changing their use. The Solar Thermal Ordinance (STO) made it compulsory for 60% of running hot water to be supplied through solar energy in both private and public buildings. The legislation has resulted in a significant year on year increase in the utilisation of solar energy generation and today it is calculated that the total solar energy received by the city is 28 times more than the energy consumed.

The STO had led to measurable energy efficiency benefits, such as:

- Saving over 70,000 MWh per year. Producing enough energy to satisfy the demand for domestic hot water for 171,000 people, or the needs of around 50 health care centres with 1,400 beds.
- Barcelona has increased the surface of solar thermal square meters in the city 50 fold, from 1.1m2 per 1,000 inhabitants in 2000 to 59m2 per 1,000 inhabitants in December 2010.
- Licenses requested for the installation of solar panels increased from 1,650m2 in 2000 to 87,600m2 in 2010.
- 46 % of the total solar thermal capacity area approved for buildings has been installed.

After the STO was put into place the city moved to strengthen their environmental position and began enacting further initiatives with measurable outcomes. The city passed the Barcelona Energy Improvement plan (PTMB), which ran from 2000 – 2010. The plan comprised 55 local action measures, ranging from financing to education, and aimed at lowering emissions and increasing energy efficiency. The 10 year PTMB influenced the city's energy framework.

In 2002 the city again demonstrated its commitment to increasing energy efficiency through establishing the "Barcelona Energy Agency". This body was tasked with "implementing, managing and monitoring Barcelona's Energy Improvement Plan".

Barcelona also took the innovative step of building solar energy plants in public spaces. A large Pergola (a solar panel structure) was installed in the municipality "Forum" area. Standing at 50 metres tall and with a surface area of 10,500 metres squared, this structures is capable of producing up to 500,000 kilowatt hours of electricity per year. The system is titled at a 35 degree angle for maximum exposure to the sun.

In 2006, Barcelona upgraded the STO through expanding the scope of buildings it applies to. The minimum solar energy demand requirements were eliminated in order to incorporate as many buildings as possible into the ordinance. The STO applies to buildings that are intended for residential, health, sports, commercial, industrial, and any other use that entails the presence of dining rooms, kitchens or collective laundries.

In 2011 the city revised their existing legislation and approved the Barcelona Environmental Ordinance. The legislation made photovoltaic systems mandatory in new buildings.

Later that year the City Council approved the Barcelona Energy, Climate Change and Air Quality Plan. The energy plan will run between 2011 – 2020 and contains 108 projects, focusing on improving technology and raising awareness. The document encompasses a range of environmental topics, with a particular emphasis on energy demand management.

By the end of 2011, 47 municipal installations had been carried out across all city districts, including in 13 primary and secondary schools, 7 public libraries and 12 social and cultural centres.

Financing of the municipal photovoltaic / thermal installations has been assumed by the Barcelona City Council. In some cases other public administrations have acted as co-financers. Local governments must be willing to invest in order to apply the scheme successfully. Funding mechanisms are available for those implementing SEAPs (see above for more information).

The use of renewable energy has created new jobs within Barcelona City, has lowered CO_2 emissions, bolstered energy independence and enhanced the international reputation of the city. Today Barcelona is seen as a leader in the field of photovoltaic use.

Source: Barcelona City Council, 2011, available from New York City Global Partners Innovative Exchange,
http://www.nyc.gov/html/unccp/gprb/downloads/pdf/Barcelona_SolarEnergy.pdf

Applicability
In order to successfully increase the uptake of solar energy (thermal and photovoltaic) it is important that there is political will, coupled with citizen support. Local governments can take the initiative to promote more stringent regulations than are imposed at the federal level, and in doing so provide new market opportunities.

In order to ensure the successful application of the measures set out in the legislation, the city ran educational and information campaigns. One of the difficulties in pursuing the solar objectives has been a lack of public knowledge towards the upkeep and maintenance of solar panels. Solar panels require regular and repeated maintenance to ensure their continued

efficiency and cannot be simply installed and left to run without frequent attention. To address this the Environment Department of the City Council has and environmental information which also gives advice on solar use and maintenance, open six days a week, and it also runs created targeted awareness campaigns via various media.

Often times there will be the need to educate staff (especially those in charge of Technical positions) on the benefits and proper usage of solar energy. Architects may be indifferent to the use of solar panels and municipal districts may be not fully convinced of the benefits. In Barcelona a positive campaign and several meetings that outlined the benefits of the energy source managed to generate sufficient enthusiasm and overcome this problem. This example also illustrates that a potential first negative attitude amongst officials and other stakeholders is not necessarily a barrier to success, if the proper steps are taken to address the situation. It is very important for public administrations to correctly set parameters and requirements for public tenders for energy installations. These normally are Energy Performance Contracts, according to which at least part of the cost of installation, operation and maintenance is refunded to the service provider through energy savings and energy incentives. For mature technologies such as photovoltaic, which nowadays have low installation costs and also benefits of high incentives, banks are also keen to offer leasing contracts for installing plants on public buildings.

Political and legislative will are imperative. Public administrations must be willing to cover the initial financing costs of setting up the scheme (this has numerous positive returns for the administration, such as boosting the local economy). The administration must be willing to work with citizens to help them secure maximum benefit from the plan. They must engage in promoting the scheme and ensure that citizens are supportive and can see the derived benefit both for themselves and their wider community (local / global context).

For other municipalities, the benefit derived from photovoltaic/thermal panels obviously has an implicit sunshine correlative - the more sunshine per year, the more benefit derived obviously has an implicit sunshine correlative - the more sunshine per year, the more benefit derived.

City example: Carugate, Italy

The small town of Carugate in the province of Milan has adopted legislation to promote solar thermal energy after being inspired by the example set by Barcelona. The town enacted its Solar Thermal Ordinance in an effort to foster sustainable building construction and improve energy efficiency in general. Under the policy it is mandatory that all new buildings use solar energy to supply 50% of hot water. The new measures were embedded in the local general Building Code. The city embarked on an extensive communications campaign, both prior to and during construction, with end users and schools. A wide variety of actors from across the community were involved from the outset. Communication was a vital factor in the scheme’s success, and it was promoted in local fairs and schools. A pilot plant was set up in the Municipality buildings and trainings were held for designers and building companies. This regulation has been advanced thanks to EU directives on energy efficiency in buildings, the example of the "Solar Ordinance" of Barcelona, and an increase in the interest of the regions (and, more generally, local authorities) in the promotion of sustainable construction.

The regulation itself has an inclusive approach to energy, taking into account a host of possible measures that could work to increase the energy efficiency of buildings. Renovations were included in the purposes of the Act and the quality requirements for solar thermal were also set out.

The involvement of local banks, offering loans at a much reduced rate for the project, greatly helped implementation. By 2006 the regulation led to a total solar thermal covering (installed or approved) of about 485 square meters. That is an average per capita covering of 1 square meter for every 28 inhabitants, vastly more than the Italian average of 1 square metre for every 1,400 inhabitants.

Licenses requested for the installation of solar thermal panels due to the solar ordinance have reached 87,600m2 in 2010. From 2010 onward over 70,000 MWh per year will be saved, resulting in a reduction of 4,300 tons of CO_2 emissions per year. Since the solar legislation was

enacted the fitting of solar thermal installations has increased by 5212.2% and the solar energy power produced equal to the domestic hot water demand of 171,000 people.

The region has been helped in its desire to replicate Barcelona's example by "Rete Punti Energia" (association of energy agencies of Region Lombardia), which has given the Municipality the necessary technical support. The construction industry (architects, builders, etc.) have been involved from the beginning. The Province of Milan has also been instrumental in bringing the scheme to fruition and the province is trying to extend this type of building regulations to other municipalities.
Costs of the scheme are supported by the user. For solar thermal, the extra cost for each square meter of building is 0.5%. The payback time is 6 years in total. The Municipality of Carugate, together with "Rete Punti Energia", is monitoring the outcome of the regulation.

Source: Intelligent Energy Europe, available from, http://www.solarordinances.eu/Portals/4/STO%20template_Carugate_it.pdf

Regional Management of Bioenergy and Communication Strategy in the Lake Constance Region, Germany.

The expansion of bioenergy usage is part of the energy-strategy of Germany's federal government. In 2008, a nation-wide competition to found "Bioenergy-Regions" was held. The "Bioenergy-Region Lake Constance" presented one of the winning concepts and especially addressed the risk of increasing energy intensive cultivations which can lead to a loss of biodiversity.
At the core of the competition held by the German Agricultural Ministry BMELV (Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz) was the idea to develop a concept on how to establish a network of bioenergy experts and regional actors in the field of bioenergy. The concept also contained a communication strategy to promote sustainable bioenergy projects in order to boost the economy and create new activity sectors in rural areas. The main goal was, of course, to increase the market share of bioenergy. Solarcomplex – the region's leading company in bioenergy - and the Lake Constance Foundation – an environmental NGO – jointly applied for the competition and jointly implemented the regional management for the "Lake Constance Bioenergy Region", after the competition was won.

<u>Bioenergy-Region: The Starting Point</u>
The Bioenergy Region Lake Constance covers the districts of "Konstanz und Bodenseekreis". This is a dynamic business location and residential area as well as a renowned tourism destination with a sensible natural and cultural landscape. In 2008, less than 10% of the overall energy demand was covered by renewable energies. The first step was to analyse in detail existing bioenergy structures and the potential for bioenergy within the region.

<u>Key-findings included:</u>
The region doesn't lend itself to an intensive usage of bioenergy: Being densely populated, with about 240 inhabitants per square kilometer, at least in the district "Bodenseekreis", fruit-growing and other "special cultures" cover about 20% of the agricultural land.
Installed biogas facilities within the region were already bordering on unsustainable overcapacity (in terms of sustainable attainable biomass within the region). Further expansion would have encouraged unsustainable land-use and import of raw materials from other regions.
After the initial assessment, the challenge was to define a path of development, to increase the market share of bioenergy and simultaneously limit bioenergy production to a sustainable limit with value added chains within the region and sustainable produced raw material from the region.

<u>A concept for Sustainable Develoment of Bioenergy</u>
As a consequence of the initial assessment, a simple expansion of bioenergy facilities was out of

the question. Nonetheless, the regional development concept defines a market share of 8% of the regional energy market for bioenergy as a target for the year 2030 – which meant more than doubling the market share of bioenergy.
In order to achieve this growth in a sustainable way, the development concept puts a strong emphasis on increasing efficiency of existing facilities, i.e. using waste heat generated while producing electricity for households, the public sector or the drying of the biomass to then be used. This energy concept is tailored on the different local realities of the regions. Long term goals include:

- fulfilling 8% of regional energy demand with bioenergy;
- increasing efficiency of biogas plants from 40% to 80% by recovering waste heat;
- sustainable production: all raw materials from local sources, paying attention not to cause a biodiversity loss.

<u>Implementation and Results</u>
Right from the start, a variety of partners was involved: engineering offices, private companies realizing bioenergy projects in the region and a public utility. Since the competition made no funds available for investments, the Bioenergy Region Lake Constance had to rely heavily on communication and networking efforts, covering the broad public as well as single target groups like house owners and local/regional politicians.
Communication-measures include:

- Guided bioenergy tours for local authorities, media and civil society;
- Conferences, workshops, public debates etc. on bioenergy villages, district heating, waste heat concepts, sustainable biomass use, regional added value, funding opportunities, new technologies and best practices;
- Educational projects in schools;
- Information of the public with a travelling exhibition;
- Establishment of specialised working groups.

The established bioenergy network consists of already more than 300 members - businesses, communities, farmers, NGOs and interested individuals. Six partners (4 SMEs, a public utility company and an environmental NGO) form the core of the network and perform most of the communication activities.

As a result, the importance of sustainable use of bioenergy gained a prominent position in the regional agenda: there is yet a long way to go, but overall, the region has a more realistic perspective on what can be achieved with bioenergy – and where limitations should be applied.
This intense communication and coordinated knowledge exchange resulted in the realisation of a variety of projects and initiated a number of trends within the region:

- Sustainable alternatives of biomass production: The Bioenergy Region Lake Constance played a key role in initiating field tests with wild-flowers in the region, which might be suitable for energy production and deliver a high ecologic performance. Furthermore, through the Bioenergy Region the field testing of short rotation forestry for energy production, which included ecological assessment, was initiated.
- Sustainable use of bioenergy: 7 existing bioenergy plants realised concepts to use waste heat thereby increasing efficiency considerably (without increasing biomass input). Two more are planning to introduce waste-heat schemes. More importantly, the topic is on the agenda and a discussion is ongoing. During citizen-talks, conflicts and possible solutions were discussed and this dialog represents a good basis for further projects. Furthermore, by increasing efficiency in biomass use, 8 more villages were supplied with biomass with the creation of just one additional plant.

The work of the Bioenergy Region Lake Constance and the development concept were awarded with the "German Energy-Concept Award e-coco" in 2009.
The Bioenergy Region Lake Constance was supported by the German Agricultural Ministry with 400.000€ over three years. The increased regional energy production resulted in a regional added value of about 10.000.000€ during the three years.41
The Ministry considers the first funding period as a successful project and as a result funds another 3 year period with 330.000€ to strengthen the newly established structures. The aim is

to have a permanent regional management without further national funding.

Source: Regional development plan for the Bioenergy Region Lake Constance, available from the Lake Constance Foundation, www.bodensee-stiftung.org/projekte/bioenergieregion-bodensee

Economics

Photovoltaic

The cost of construction of a photovoltaic system is mainly determined by the cost of modules, which are related to the efficiency of conversion of solar radiation: more efficient modules are more expensive to install but allow a greater power per unit of available surface. The choice of the solar module is an essential factor in the cost of a solar photovoltaic system. There is difference between thin-film modules, poly-crystalline and single-crystalline cells. For small installations, such as a photovoltaic system for a house that needs generate approximately 4,000 kilowatt hours of electricity costs around 1600-2600 €. Excluded are costs for the inverter and the mounting. An inverter cost about € 2000. Other costs related to the assembling, installation and connection to the network have to be taken into account. In total, the average cost of photovoltaic is of about 6000-10000 € (Source: http://www.solaranlage.de). For bigger plants economies of scale reduce the aggregate cost. As previously stated, the cost of solar panels has been decreasing significantly in the last two years, thus lowering the aggregate cost. Photovoltaic has dedicated feed-in tariffs in most of European Countries (as shown in figure 3.55), which contributes to shorten significantly its payback time.
Solar power is also a major job creating industry. Over 40,000 jobs in Germany alone have been created by photovoltaics.

Solar thermal

In normal conditions, costs of solar thermal plants are already competitive with non-renewable heating technologies. Depending on the type of construction of the modules, to an improvement in thermal insulation and of the optical properties of the receiving surface of the manifold correspond, in general, an increase in cost and an improvement in overall performance. Therefore, for temperature differences between the external environment and the high heat transfer fluid, the collectors more efficient minimize heat losses. Switching to solar thermal energy presents indubitable advantages in term of having thermal energy for free. Installation costs can vary due to the situation (it is less expensive to install solar thermal collectors in new building than in already existing ones). Normally, the cost of a $5m^2$ plant for a family (3-5-people) for the production of hot water is of about 3,500-4,000€. For a natural circulation plant, this is a bit less, i.e. 2,000-3,000€ (due to the fact that no heat pump for water circulation has to be installed). The greater cost is the one of the collectors. Maintenance costs are normally low, about 2.5% of the total cost of the plant over a 20 years life-span. Solar systems cannot normally provide 100% of heating requirements and are therefore usually installed together with a back-up boiler (Graniglia, 2011).

Low enthalpy geothermal systems

The initial cost of low enthalpy geothermal systems is variable and depending on the type of terrain. There is a fixed cost for machinery, a cost for the hole and a cost per meter of excavation. For vertical systems, costs for the machinery and the hole are approximately of 1000-2500 euro and excavation costs are 50-70 € / m. This technology is significantly more expensive than other technologies for heating, but allows good savings for heating and cooling. These systems are well suited to environments with low population density.

Biomasses

If produced locally, biomass can generates employment and development in rural and suburban areas, thereby contributing to foster the attractiveness of these areas and to counteract the demographic shift to the cities. Unlike other renewable energy sources, biomass requires labour and to the creation of a supply chain, therefore, direct economic participation of the population is easily achievable (Lake Constance Foundation, 2011).

Driving force for implementation

Solar power allows users to generate their own green electricity. If there is a surplus of electricity this can be sold back into the power grid. The power produced is extremely versatile and can be used for anything from electric vehicles to heating the home. Solar power can be used in areas in which it is difficult or impossible to connect to the main power grid. They can be installed quickly and efficiently. In Barcelona the transport authority introduced solar powered bus stops. These bus stops have an electronic panel which updates the bus schedules every 30 seconds, a panel with extra information and an option to light up the display at night. As these stops are entirely self-sufficient they can be installed with much greater ease and speed than if they had to be connected to the local electricity grid. The stops are also remarkably energy efficient (consuming only 72 watts a day) and can run for up to five days without solar radiation. 2000 bus stops were introduced in 18 cities throughout the Barcelona metropolitan area and have been praised for their sleek and modern design. All the RES described before have feed-in tariff system in most of the European countries, and are economically advantageous. There are also many European and local financing possibilities for local administrations which can be used to plan the development of RES on the local level. Local administrations are meant to act as frontrunners in the development and deployment of RES, thus creating a spill-over effect which will spread on their territory. Setting up a local information point for citizens on costs and opportunity of RES is also an efficient solution for contributing to their acceptance and adoption by citizens.

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3.5.7 Smart Grid technology

Description

Smart grids fundamentally change the architecture of the conventional electricity grid, shifting mass production and centralised control to smaller sources and decentralised information (Fox-Penner, 2010). James Momoh defines smart grids as “a self-healing network equipped with dynamic optimisation techniques that use real-time measurements to minimise network losses, maintain voltage levels, increase reliability, and improve asset management” (Momoh, 2012). Smart Grids allow consumers to intelligently manage their own energy usage, providing them with greater control over generation and consumption. The revolution in communications technology coupled with the improvements in the viability of renewable energy sources has facilitated the creation of modern smart grids.

Figure 3.75: Graphical depiction of the MeRegio home. Source: MeRegio

Within homes equipped with smart grid technology, energy information is displayed graphically for consumers, who can view and analyse their household energy usage information in real

time. This allows them to keep track of their personal consumption throughout the day, and to identify any high-energy consuming appliances. The changing cost of electricity is likewise displayed in real time, allowing consumers to choose the most cost effective times to run appliances. Generally the price is tied to the availability, or non-availability, of renewable means - for example when the sun shines and energy from photovoltaic panels is available electricity prices drop. Figure 3.76 presents a graphical depiction of the MeRegio.

Achieved environmental benefit

Smart Grids work to lower CO_2 emissions and increase energy efficiency and as such have the ability to play a major role in helping cities meet their Europe2020 requirements. As the grids communicate intelligently with interconnecting centralised and decentralised energy production plants, energy is only produced, directed and used as required. Through the Smart Grid, power stations and decentralised production plants will operate at optimum capacity, lowering the need for expensive “control energy” used to compensate for peak periods.

Smart grids also have the potential to intelligently links household appliances to the energy system. Users can set the appliances to come on only when tariffs are at their cheapest – saving both money and energy. As the project expands more and more appliances will be integrated into the Smart Grid. Increased energy efficiency will greatly reduce fuel usage and harmful emissions.

Operational data

Example: MeRegio project, Baden-Württemberg, Germany

The Minimum Emissions Regions Project, or MeRegio, runs from November 2009 to the first quarter of 2012. The project takes place in test regions around the Karlsruhe / Stuttgart area of Germany and allows real-time communication between energy consumers, energy resources and smart storage devices. Over 1000 private and commercial participants are taking part in the project.

MeRegio is based on the construction and application of three energy concepts in the pilot regions:

- An E-Energy marketplace for both producers and consumers
- A sophisticated and innovative energy infrastructure
- An information and communication infrastructure that reacts to the evolving market situation

MeRegio is based around the Intelligente Stromzähler (smart electricity meter). Data is sent through an internet connection directly connected to a server of the energy provider. The project is predicated on the idea that the tools for analysing and controlling electricity consumption will be convenient and accessible to consumers. Figure 3.77 shows a representation of this system.

MeRegio sees the implementation of both a regional energy market and a "Minimum Emission Certificate" program. This certificate will be awarded to regions where concrete specifications and standards are developed, based on the MeRegio experience. It is hoped the certificate will incentivise other regions to cut their emissions and encourage regions already engaged in reducing their carbon footprint to further their activities.

As the project is in the trial phase, consumer behaviour within the new system will be studied. Researchers want to see whether consumers react inline with predictions regarding energy usage habits (eg. will consumers use the washing machine when it is windy and therefore electricity is cheaper, or will this factor in their decision?). The data received will influence the development of renewable energy sources by MeRegion, such as photovoltaic, biogas, wind and water power. Currently not all test consumers operate each initiative, but rather households have a mixture of concepts applied. It is hoped that by the end of the project all measures will be incorporated into a new Smart grid district.

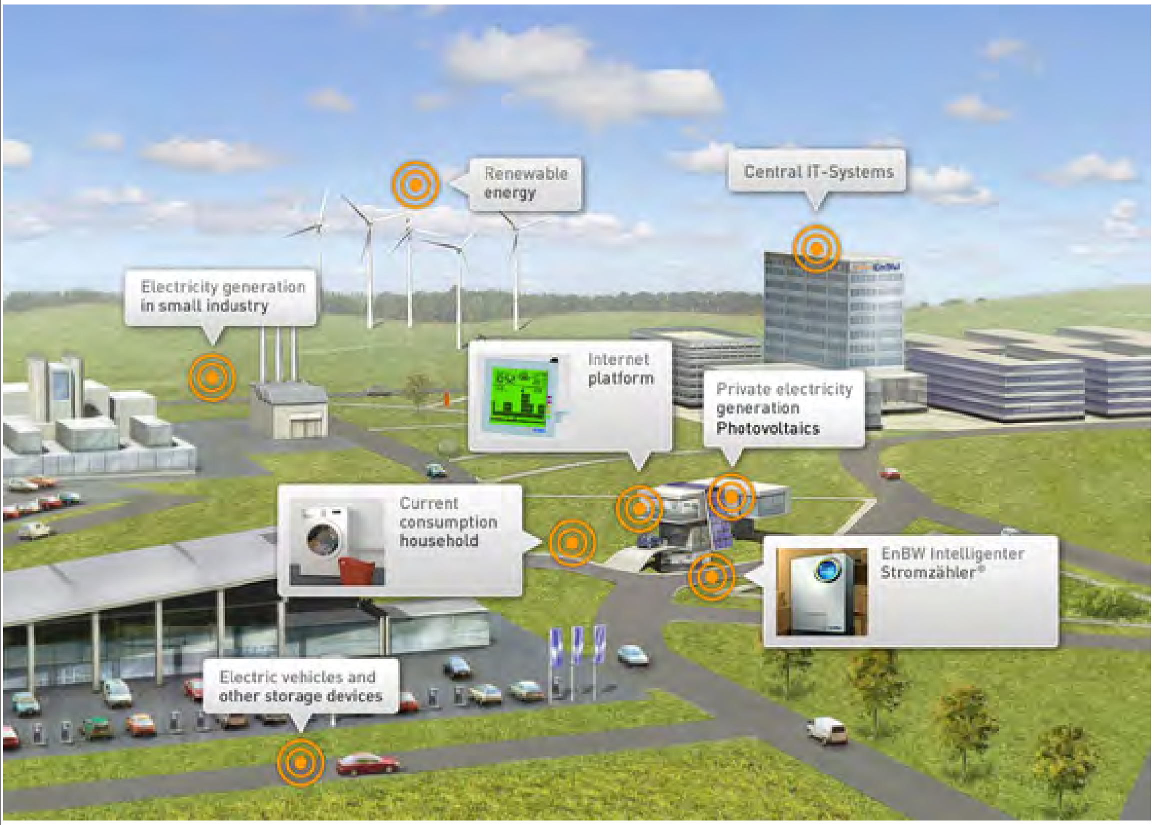

Figure 3.76: Graphical representation of the MeRegio project. Source: MeRegio

The creation of regional energy independence, achieved through decentralised energy production plants (run on biofuels) and through personal energy production via solar energy and household-based mini CHP-plants, is one of the more radical aims of the project, one that Hellmuth Frey, coordinator of the project, concedes will be “difficult to achieve”. Although increased energy efficiency, intelligent energy usage and renewable generation means that the energy requirements of those taking part in the project will be largely covered, households will remain connected to the national grid – allowing them to channel excess energy into it.

The project is coordinated by EnBW Energie Baden-Württemberg. Other partners include ABB AG, IBM Deutschland GmbH, SAP AG, Systemplan GmbH and KIT. The project is largely funded by the German Federal Ministry of Economics and Technology and is part of a larger federal framework to find innovative Information and Communication Technology (ICT) solutions to achieve a higher level of economic viability for renewable energy, security of energy supply and climate and environmental responsibility in power supply.

As the project expands an increasing number of appliances will be integrated into the Smart Grid. Currently an e-management system is being created in which selected appliances will be controlled by a so-called “smart plug”. This plug manages appliances to ensure their energy optimisation (turning on the dishwasher when most economical to do so for example) taking the effort and time required from the consumer out of the picture. MeRegio homes will be installed with a stationary battery, which is capable of storing excess energy produced by the house. The

battery can also store energy produced when at its cheapest, which can be used during other periods. This storage battery has the potential to lower energy costs and improve energy efficiency.

The MeRegio project is one of six E-Energy research projects within this framework, and has been allocated around €10 million from the German federal government's E-Energy budget. Instituting a technologically innovative project such as MeRegio requires a substantial capital outlay, as well as support from private and public institutions.

MeRegio is an innovative project that is still in its testing phase. EnBW will analyse the findings provided by the project to in terms of the practicalities of dynamic energy tariffs and the feasibility of electricity storage batteries and these results will influence the way in which energy is provided to customers. The project shows that with funding and support, actors can be brought together to achieve a degree of innovation and forward thinking that can influence the direction of national energy policy, as well as provide an example to regions globally.

Source: EnBW Energie Baden-Württemberg, available from
http://www.enbw.com/content/de/privatkunden/innovative_tech/meregio/erwartungen/index.jsp

Driving force for implementation

Smart Grids have the potential to save consumers money, whilst generating revenue for suppliers. The system offers advantages for industrial and commercial users, as well as local authorities, in increasing energy-efficiency and thus lowering costs. Smart grids provide businesses with structured information regarding their energy consumption in each area of the organisation, and provides energy advice with a view to identifying further savings potential.

Energy consumption varies greatly depending on the time of day, and the day of the week. It can vary proportionally more if a special occasion occurs, eg. It may increase if the consumer throws a party, and it may decrease if the consumer goes away on holiday. As energy providers cannot predict these special occasions, they are unable to know when energy usage may fluctuate on a user basis. To combat this, an online application allows Smart Grid users to notify the supplier of upcoming events that will influence consumption. This application furthers Smart Grid's ultimate aim of allowing consumers and suppliers to cooperate more closely.

As tariffs are flexible, and consumers receive information in real time, consumers can regulate their usage to cheaper periods. Consumers can also choose to take energy from biogas, photovoltaic panels and CHP plants. If the consumer is not using energy, they can either sell the generated energy in the marketplace or feed it back into the general network for others to use.

City Example: Smart City, Mannheim, Germany

The City of Mannheim has received funding from the federal German government under the E-Energy technology incentive programme to become a fully realized "Smart City". The homes in the area use broadband technology to display pricing and power availability information in real time, ensuring that renewable sources are used to their full extent. Part of the project is the creation of a "virtual energy marketplace" open to all stakeholders.

3,000 homes will take part in the project, which aims to effectively manage power generation, distribution and consumption. This intelligent management will be achieved through an "energy butler", which allows customers to participate more actively in the energy market and make informed choices about their usage.

Smart City Mannheim (moma) is a three phase project that sees nine consortium partners testing the intelligent grid in Mannheim and Dresden. The key objectives of the project are to

demonstrate how renewable energy can be optimally integrated into the grid as well as how the city can function as an energy store.

The project, to date, has been highly successful with Power Plus Communication's Broadband Powerline (BPL) solution providing the communications infrastructure. Using BPL, the power grid is turned into an IP-based, real-time communications platform which connects all households, decentralised generators and measuring devices. A total of **3,000 households** will

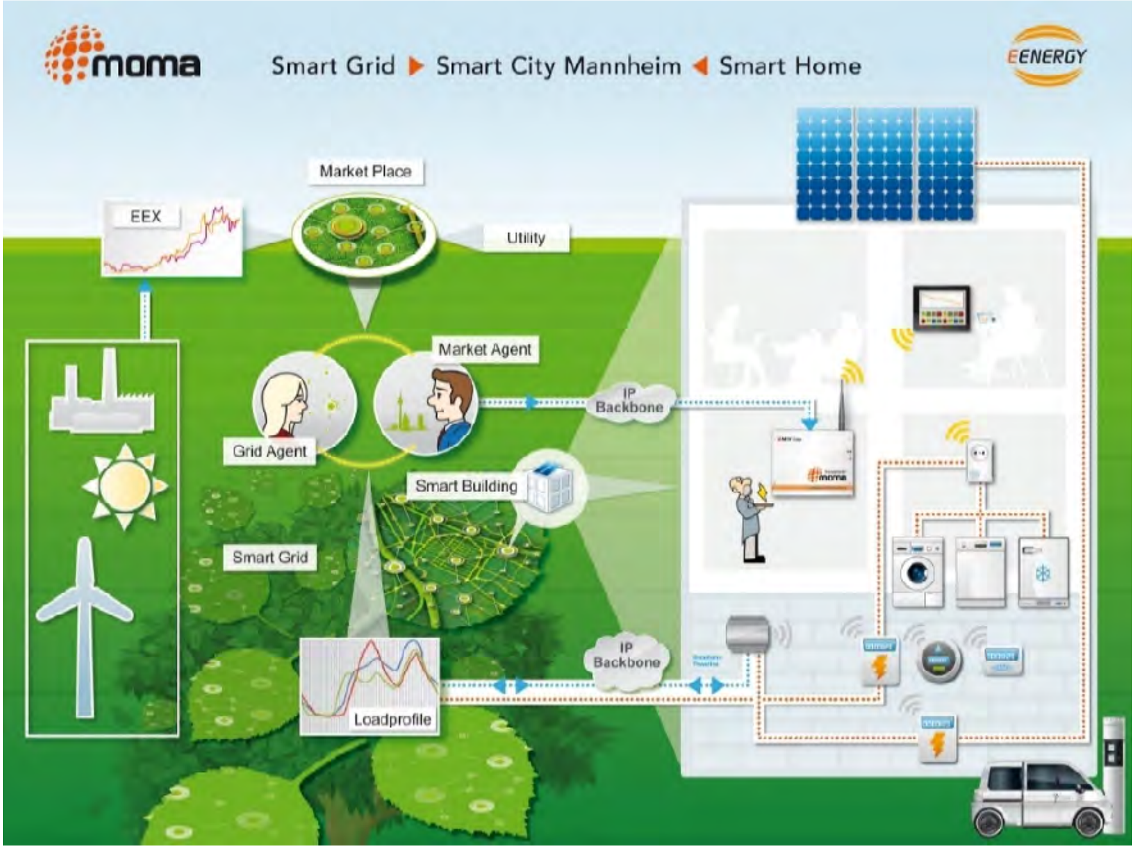

Figure 3.77: Smart Grid visualised. Source: MOMA / EEnergy

be equipped with devices which will intelligently control household appliances and connect them to the smart grid, as shown in figure 3.78. The encrypted data will be transported to the customer's password protected web portal as well as to the utility MVV Energie. The information is available to the customer at all times and at the same time the utility is able to produce invoices more regularly (e.g. monthly). The MoMA project received a 50% grant towards its total cost of €20 million.

Source: Power Plus Communications, available from http://www.ppc-ag.de/117-1-MVV+Energie+AG.html

Economics

In Germany, the German Federal Ministry of Economics and Technology (BMWi) has, in collaboration with the German Federal Environment Ministry (BMU), initiated the "E-Energy: ICT (information and communication technologies) based Energy System of the Future" programme, which runs for a four year term and has received an overall budget of around €140 million. The program aims to utilise information technology to optimise energy efficiency, reduce GHGs and increase the use of renewable energies.

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3.6 Improving the sustainability of public administration management

3.6.1 Chapter structure

This chapter is intended to guide public authorities in the management of their internal processes and resources. It starts by briefly introducing the internal processes that are relevant to this chapter (Section 3.6.2) and then gives reasons that should stimulate public authorities to manage them in an integrated, environmentally-friendly and more sustainable way (Section 3.6.3). Some Best Environmental Management Practices that can help public authorities do so are detailed in Section 3.6.5 and include the implementation of Integrated Management Systems (Section 3.6.5.1) as well as Green Public Procurement (GPP) (Section 3.6.5.2).

3.6.2 Chapter introduction

The internal processes of public administrations are as numerous and varied as public administrations activities, as outlined in Part 1. Some of the main activities in which public administrations are engaged are policy making, revenue collection and budgeting, human resource management, and the delivery of municipal services – whether procured or managed internally – such as social housing, transport, education, libraries, leisure, waste collection, emergency services, etc. Not all public authorities undertake all of these activities; indeed, responsibilities for different services are often split between local, regional and national levels and differ due to national legislation and administrative culture, eg. centralized or decentralized public administration.

Legislation

The section presents an overview of EU environmental legislation and policies - fundamental for the development of management-oriented policy instruments. In particular, the description concentrates on the development of Integrated Management starting from the EMAS regulation and the legal framework for green public procurement.

The Eco-Management and Audit Scheme was first set up in 1993 through Regulation 1836/93/EEC (the so-called EMAS I regulation) as a voluntary scheme for organisations to improve their environmental management. Originally, the regulation was aimed at companies in the industrial sector, but it has subsequently been amended to be open to all organisations. This regulation became the first time an EMS was laid down in law; it called for eco-management and auditing, and is open to EMS other than EMAS: for example, national EMS can still be used, as can ISO 14001. By definition mandated to environment, the framework laid out in the regulation can principally extend to managing sustainability, as well. The regulation has been revised twice since it was first implemented, and the most current version is Regulation (EC) No 1221/2009 of the European Parliament and of the Council of 25 November 2009 (referred to as EMAS III) which entered into force in 2010 (Jungwirth, 2011). In parallel to EMAS, further non-standardised environmental management systems were being developed with particular focus on public administration, amongst them *eco*BUDGET for local governments and Eco-Lighthouse for small public organisations (refer to section 'Description').

In 2006, the EU Thematic Strategy on the Urban Environment (European Commission, 2006) and corresponding guidance on Integrated Environmental Management (European Commission, 2007)[42] suggested an advancement to Integrated Environmental Management Systems (IEMS) to ensure the delivery of policy services and provide public scrutiny on progress not just for internal affairs but, territorially, for the whole functional urban area. The Strategy, calling for IEMS, recommended local authorities to take the necessary steps to achieve greater use of integrated management at the local level and encouraged national and regional authorities to support this process,.

This approach has been taken up and extended by the Territorial Agenda of the European Union – Towards a more competitive and Sustainable Europe of Diverse Regions and the Leipzig Charter on Sustainable European Cities (European Union, 2007) that declare "*an integrated urban development policy is a key pre-requisite for implementing the European Sustainable Development Strategy*". Having recognised and admitted that for the sake of sustainable development of the urban Europe, the economic, social and environmental aspects have to be

considered simultaneously and equally, the document recommends *that "greater use be made of integrated urban development policy as an instrument and, in order to be able to do so, the appropriate framework for this (should) be established on a national and European level."* Further it recommends "*that the European cites consider developing an integrated urban development concept for the city as a whole in every case where this may seem appropriate*".
Following the Leipzig Charter, the integrated approach is a fundamental element of the Toledo declaration (European Union, 2010) as one of the main tools in order to advance in the direction set out in the Europe 2020 strategy.
The tools and methods used by local authorities have "gaps" and deficiencies. These include lack of sound environmental data, lack of formal protocols/partnerships to manage shared environmental issues, lack of agreement on minimum standards for environmental quality and inability of the environmental management systems to manage environmental inequalities. To this end, the Reference Framework for Sustainable Cities, adopted under the French EU Presidency 2008 provides a 'Toolkit for the Integrated Approach', expected to be launched in the course of 2012[43]. IMS is seen as an efficient way of managing the above mentioned failures and improving local policy processes and monitoring of developments in respect of the state of the environment. With EMAS and ISO 14001 as a basis, IMS is promoted as a tool to improve the consistency and coherence between different policies, from an environmental perspective, and a means to maximize the effectiveness of those policies within available budgets. Cities using IMS share the vision that the environmental aspects have to be considered simultaneously and equally, in order to manage the urban environment and provide more reliable assessments of vulnerability and adaptive capacities on the local and regional levels.
"The legal framework for public procurement is defined by the provisions of the Treaty on the Functioning of the European Union (hereafter the Treaty) and by the EU Procurement Directives [Directives 2004/17/EC and 2004/18/EC] as interpreted by the European Court of Justice. From an international perspective the EU is bound by the conditions of the General Procurement Agreement (GPA) of the World Trade Organisation (WTO). The above-mentioned framework establishes a number of rules and principles which must be observed in the award of public contracts. Within this framework, environmental objectives can be implemented in a variety of ways." Sector-specific legislation is also relevant in the sphere of public procurement, for example that covering the energy-efficiency requirements of IT equipment, as is national legislation (European Union, 2011).

3.6.3 Drivers of public authority internal process improvement

Rendering their internal processes more environmentally-friendly and integrated can not only bring about significant positive environmental change – due to the size and scope of activities of public authorities – but can also lead to a series of other benefits, most importantly a more efficient, effective and sustainable service delivery for citizens' quality of life. Above all, these include the possibility to efficiently and targeted use, and partly significantly save, financial resources, to raise the profile of a public authority by actively demonstrating a commitment to environmental protection and to improve working conditions within public authorities as well as companies providing goods, works and services to them. Moreover, other benefits include the improvement of internal operations to become more efficient and effective, better communication with citizens and – in the case of GPP – the possibility to drive environmental innovation within the private sector.
With the current shift to mainstreaming sustainability issues including climate change mitigation and adaptation, resource efficiency, and green economy, as a matter of fact, various EU policies and policy processes require Integrated Management Processes, e.g. the EU Territorial Agenda and Cohesion Policy, the EU Covenant of Mayors and others. Also, more funding programmes and financing institutions require process documentation and performance reports that suggest the application of an Integrated Approach. Finally, European and international recognition is given to local governments and public authorities applying IMS instruments, such as the EU Green Capital, the European Public Sector Award, the European Energy Award and alike.
In addition, many European Member States implement the Aarhus Convention and open their information. Most adequately, IMS offers a structured framework to involve stakeholders by

mutually sharing information in favour of better informed decision making for sustainable development.

3.6.4 Techniques portfolio

The management of public authorities' internal affairs in a way that is more environmentally-friendly and integrated can be achieved in many ways. The main avenues are explored in this chapter, and are the implementation of Environmental Management Systems (EMS), Integrated Sustainability Management Systems (IMS) and Green Public Procurement (GPP).

EMS allow for the incorporation of environmental considerations into existing management structures and can be applied in organisations of all sizes and functions. By providing a framework for action and including a commitment to continuous improvement, EMSs can be applied no matter what environmental challenges face an organisation and no matter what its starting point is. For many local authorities, an EMS serves as point of departure for establishing an IMS, extending from environmental to sustainability issues and services, from internal processes to covering the whole functional urban area.

One of the ways through which public authorities can exert the most influence on the private sector is through public procurement, which is the purchasing of goods, works and services on behalf of a public authority. When this public procurement is made green, by choosing goods, works and services that have a lower environmental impact over their life cycle, public authorities are able not only to save money and improve their environmental performance, but also to positively influence the behaviour of goods, works and service providers as well as to set a positive example throughout the wider community.

In most European public authorities procurement is a relatively decentralised process involving many individuals in different departments. Even where central purchasing units exist, some procurement responsibility will still rest with staff in other units. In such situation ensuring the implementation of green procurement requires effective communication between and within departments, and also the setting of clear priorities. As public procurement is an activity with substantial consequences in terms of environmental impact, reaching out to all municipal services and activities. The most efficient way to use the potential of GPP is clearly to promote the integration of green procurement actions into such management systems that are increasingly used in European local authorities to provide a useful framework for coordinating environmental and sustainability activities[44].

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3.6.5 Best Environmental Management Practices

3.6.5.1 EMAS, ISO 14001 and other EMS

Description

Environmental Management Systems (EMS) are designed to assist organisations in identifying and addressing the environmental impacts of their activities. There are many examples of EMS. However, as mentioned before, EMAS represents the framework system that is open to other EMS. In this section we will refer to ISO 14001, the EU Eco-Management and Audit Scheme

(EMAS), *eco*BUDGET and Eco-Lighthouse. While all of these EMS are voluntary, ISO 14001 and EMAS are promoted by standard setting organisations at national, European and international level. ISO 14001 helps organisations identify and control the environmental impact of their activities, products or services, continually improve their environmental performance, and implement a systematic approach for setting and reaching environmental objectives and targets. It is applicable to organisations in any country, while this in principle is true for EMAS as well, it is mostly being applied by organisations within EU Member States, countries of the European Economic Area (EEA)and increasingly in countries that are candidates for EU accession. EMAS is a management tool for the evaluation, reporting and improvement of organisations' environmental performance; EMAS incorporates the requirements of ISO 14001. Because of its requirements for environmental performance improvement and compliance with environmental legislation, EMAS is considered as a standard of environmental excellence (Bracke & Albrecht, 2007 as cited in Jungwirth, 2011),

Parallel to developing EMAS and ISO 14001, some non-standardised environmental management instruments have been developed to better reflect the needs of public authority organisations. *eco*BUDGET is an EMS designed for local governments that mimics the procedures of local financial budgeting, helping to plan, monitor, and report the consumption of natural resources and their environmental quality within the municipal territory. Developed in Norway, Eco-Lighthouse is a certification scheme for smaller public organisations that cannot afford the capacity to run a full environmental management system according to EMAS or ISO.. More information about each of these EMS will be provided in the section on 'operational data'. Although the EMS vary in their specific characteristics and in the types of organisations they target, as will be shown under the heading "operational data," they do follow some basic general principles:

- **The incorporation of environmental considerations into existing management structures.** Integrating environmental management within traditional management structures is vital not only because this increases the chances that environmental issues will be given due consideration in planning processes, but also because this helps make environmental management more familiar and therefore more usable. For example, the *eco*BUDGET tool uses much of the terminology, processes and approaches that are already familiar to city administrations since they use these in their financial budgeting and their management processes. Also, the Country of Norway encourages the integration of new EMS with existing health, environment and safety activities or existing quality management systems.

- **A commitment to continuous improvement.** Environmental Management Systems are based on continuous improvement processes that rely on monitoring and reporting in order to evaluate successes and failures. All follow variations of a Plan-Do-Check-Act cycle, where planning entails obtaining baseline data and setting targets, doing refers to the implementation of planned actions, checking to the monitoring and evaluation of implemented actions and acting to any corrective action that has to be taken based on the results of the check.

- **Size does not matter.** Organisations of all types and sizes can find an EMS that will suit them: some, such as ISO 14001, are applicable in all organisations; others, such as *eco*BUDGET, have been specifically designed to meet the needs of certain types of organisations, in this case local governments.

- **Problems vary, as do solutions.** As management systems, EMS usually provide a framework for action rather than prescriptive means through which to achieve results. This allows implementing organisations to choose ways forward that are better adapted to local conditions and are better targeted to solve the problems they have identified. Some of these actions are the BEMPs that are described in Section 3.6.5 of this document.

Towards Integrated Sustainability Management (IMS)

Various EU policies and strategies (e.g. the EU Regional and Cohesion Policy, the EU Territorial Agenda, the Leipzig Charter on Sustainable Cities and the EU Thematic Strategy on the Urban Environment) refer to an integrated approach as a key response where traditional planning approaches appear insufficient to tackle the challenge of local sustainable development.

So far, there are only a few local and sub-regional authorities that have sufficiently integrated management structures in place. Their common experiences shows that re-organising and integrating existing practices, plans and strategies in one integrated management system helps to systemize the work, boost the efficiency and provide a multitude of direct and secondary benefits. Available resources are geared towards defined goals, requirements of access to information and transparency of decision-making are met.

The European Union and its Member States underline the flexible character of the EMAS management scheme and the applicability of EMAS to manage aspects beyond environmental performance:
„Today, climate change, demographic development and globalisation determine the framework for (economical) development. Sustainable development is more necessary than ever. The structure and instruments of EMAS can help to understand better the responsibilities of companies and public bodies and to manage social and corporately aspects on all levels and in a systematic way. Environmental management and CSR are both horizontal tasks and therefore it is useful to take the EMAS management system as a basis for CSR management or sustainability management." (UGA, 2009)

The Integrated Sustainability Management (IMS) has been developed on the basis of EMAS III and ISO 14001 respectively the requirements of these management systems. The IMS consists of five major steps repeated in annual cycles. Although the system follows an annual cycle, full revision will be required only every 3-5 years unless evaluation of achievements and results at the end of an annual cycle suggest reconsideration.
The cycle begins with a Baseline Review, in which the current state of sustainability in the city is mapped out. As the next step, targets are set for the priorities identified as a result of the Baseline Review and included in a draft Strategic Programme. Political Commitment is needed throughout the cycle, but becomes most crucial when the Strategic Programme, is being politically approved by the (City) Council.
Completing the preparatory steps carefully will notably diminish the risk of hardships during the implementation. After the three preparatory steps of the cycle, the implementation of the priority actions decided earlier takes place. The actions taken are to be monitored during their implementation in order to gather information on the functionality of the system. During the last step of the system, evaluation and reporting, the collected information is evaluated and used for reporting the successes and possible draw-backs of the process. It provides the basis for a (city) council decision on how to continue in the next annual cycle.
Two cross-cutting elements need to be kept in mind throughout the steps of the cycle: involvement and communication as well as organisational set-up. From the very beginning of the cycle, it is important to carefully plan who are involved in the process and what they can contribute. Getting as many relevant actors activated as possible will make the effort a common interest and is thereby more likely to succeed. A well-functioning organisational setup of the management system will exert decisive impact on the success of the undertaking. Strong organisational management is needed to keep the extensive entity of a city and the great number of stakeholders together and in a common course towards a more sustainable urban area (See: Overview on the Integrated Management System: http://www.localmanagement.eu/index.php/mue25:downloads

Key issues for Integrated Sustainability Management (IMS)

The scope in IMS will be gradually extended geographically and content-wise. Geographically, it extends from a 'one site' approach towards the whole functional urban area. Content-wise, it

moves from focusing on relevant environmental aspects to all sustainability aspects, eg. following the Aalborg Charter (European Sustainable Cities & Towns Campaign, 1994) and the Aalborg Commitments (European Sustainable Cities & Towns Campaign , 2004) or the Reference Framework on Sustainable Cities.

Table 3.29 provides an overview of elements used in the IMS. It presents required documents and reference tools for each of the five steps and two cross-cutting elements.

Table 3.29: Overview of IMS steps and elements

Steps of the management cycle	**Documents / reference tools**
(Update of) Baseline Review	- Baseline Review
Target Setting	- Strategic Programme - Action Plan(s)
Political Commitment	- Council Resolution
Implementation and Monitoring	- Monitoring Programme
Evaluation and Reporting	- Internal Audit (system review and performance) - Monitoring Report - Sustainability Report
Cross-cutting elements	**Documents / reference tools**
Involvement and Communication	- Plan for communication and involvement of stakeholders - Plan for internal communication - SPOT one point for the access to the IMS documents
Organisational set-up	- Organizational structure (with clear definition of roles and responsibilities) - Capacity building programme for employees

Following the EMAS approach, the IMS includes a number of minimum requirements with regard to performance of the organisation:[45]

- Use of set of key indicators plus individual indicators for all relevant sustainability aspects and in all management elements (Baseline Review, Strategic Programme, Monitoring, Reporting)
- Time-related SMART[46] targets in Strategic Programme and Action Plan(s)
- Assessment of evaluation outcomes by Council, administration and stakeholders
- Political commitment (Strategic Programme approved, Internal Audit and Evaluation Report recognized by City Council)
- Gradual extension of scope: From one site approach to the whole urban area and from focus on environmental aspects to all dimensions of sustainability
- Information on performance in Sustainability Report

The main goal of the IMS is to foster sustainability and to plug the gaps of traditional EMS systems. This is achieved through targeting the whole urban area with its indirect aspects, enhancing political commitment and handling all sustainability dimensions simultaneously. As the IMS by definition goes beyond environmental issues and focuses on strategic aspects, it is recommended to establish the coordination function centrally (and not in a technical department). The involvement of the key political body (i.e. the Council) in target-setting and the evaluation process, in line with the annual budget cycles ensures political commitment, legitimization and maximized impacts. While coordination is based within the local administration, strategic objectives and targets are to be implemented via a broader range of actors including administrative departments, private companies and relevant stakeholders. (Robrecht, Hammerl, 2011).

Achieved environmental benefits

EMSs are an efficient and cost-effective way for public authorities to achieve compliance with environmental legislation. EMSs can cover the following things and more: improving water quality, waste management, local governance, land use and planning, outdoor air quality and urban transport; increasing energy efficiency and use of renewable energy, biodiversity and green space; reducing environmental risks and greenhouse gas emissions; preventing and reducing noise as well as protecting quiet areas (European Commission, 2007).

The further development of an EMS towards Integrated Sustainability Management (IMS) can link and help achieve wider environmental and sustainability objectives. For example, the IMS can link to Local Agenda 21 or other projects and initiatives and make its action plans more concrete and more easily implemented by referencing them to time and resources, and by setting clear goals and monitoring progress against these. In addition to delivering concrete environmental benefits, sustainable management systems also help increase access to information, by mandating the disclosure and easy availability of documentation as a part of certification. In a related point, the sustainability awareness raised as part of IMS with citizens, public authority staff and stakeholders is in itself a step towards improved environmental performance.

By widening the scope of the EMS, EMAS or ISO 14001 towards the whole urban area and all dimensions of sustainability, the importance of environmental aspects for other relevant responsibilities of local authorities such as health, job creation, integration of socially more fragile citizens, climate proofed infrastructures etc. will become evident. This integrated approach will not only contribute to more efficient management but also strengthen the role of environmental quality and sustainability performance as well as the role of environmental and sustainability management. As an example, the City of Växjö in Sweden, which started to use EMS and IMS in 2002, has managed to decouple economic growth from environmental consumption. In the period 1993 – 2008, Växjö has increased it Gross Regional Product by 30 % while managed to decrease their CO2-emission at the same time by 50 %.

Generally, public authorities applying EMS or IMS report that they have achieved the implementation of a systematic method of addressing environmental issues and monitoring the impact of its environmental initiatives.

As well, the implementation has given environmental and sustainability issues and initiatives a higher status and resulted in greater awareness among municipal councillors. Because councillors are updated on progress towards meeting environmental and sustainability targets more frequently, they are more aware of the effectiveness of different initiatives.

Another benefit is that regularly involved departments become more closely integrated through their work EMS or IMS. Staff in those departments know each other better and are more aware of each other's work, thereby greatly enhancing co-operation between the departments. As a result, the public authority is able to generate and implement innovative projects.

Appropriate environmental indicator

Table 3.30: Appropriate environmental indicator - Environmental management systems

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Municipal departments certified ISO 14001	number	n. departments certified ISO 14001/ n. total departments n. employees of departments certified ISO 14001/ n. total employees n. planning services included in the certification	Number of departments which have been certified ISO 14001 and number of employees working in these departments.

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Municipal departments certified EMAS	number	n. departments certified EMAS/ n. total departments n. employees of departments certified EMAS/ total employees n. planning services included in the certification	Number of departments which have been certified EMAS and number of employees working in these departments.
Municipal departments included in the Integrated Sustainability Management System	number	n. departments certified EMAS/ n. total departments n. departments and of external stakeholders involved in the Strategic Plan n. external stakeholders involved in the Strategic Plan n. employees of departments certified EMAS/ n. total employees	Number of departments which have been actively involved in the development and drafting of the Strategic Programme resp, applying an environmental management scheme (EMS) – which has not been certified according to ISO 14001 or EMAS scheme - and number of employees working in these departments. Number of stakeholders, who have been actively involved in the development and drafting of the Strategic Programme
Public companies certified ISO 14001	number	n. public companies certified ISO 14001/ n. total public companies	Number of companies completely or partially owned by the local authority which have been certified ISO 14001 (e. g. utilities in charge of managing public services like waste collection, water and energy supply, etc).
Public companies certified EMAS	number	n. public companies certified EMAS/ n. total public companies	Number of companies completely or partially owned by the local authority which have been certified EMAS (e. g. utilities in charge og managing public services like waste collection, water and energy supply, etc).

Cross-media effects

The implementation of an EMS or an IMS itself by definition aims at generating co-benefits and positive cross-media effects. As an umbrella instrument, it coordinates sectors and aspects respectively management instruments used therein. In doing so, the EMS or IMS ensures for all sectors working into a holistic strategy and an overall ambition of a given public authority to continually improve their environmental or sustainability performance. Ideally, sectoral management systems such as a Sustainable Energy Action Plan (SEAP) or a Sustainable Urban Mobility Plan (SUMP) refer to targets set out and approved in the Strategic Programme. Based on these, sectorally required actions are planned, implemented, monitored and evaluated with results being fed-back into the IMS reporting to evaluation the overall sustainability performance of the given organisation. However, this approach is currently only gradually developing.

Operational data

ISO 14001:2004

ISO 14001 is a standard that provides the requirements for an EMS. ISO 14001 is developed and published by the International Organization for Standardization (ISO), an NGO based in Switzerland which, in cooperation with the national institutes which form its membership, sets standards for a variety of sectors "ISO 14001:2004 does not specify levels of environmental performance. […] ISO has many other standards dealing with specific environmental issues. The intention of ISO 14001:2004 is to provide a framework for a holistic, strategic approach to

the organization's environmental policy, plans and actions. ISO 14001:2004 gives the generic requirements for an environmental management system. The underlying philosophy is that whatever the organization's activity, the requirements of an effective EMS are the same. This has the effect of establishing a common reference for communicating about environmental management issues between organizations and their customers, regulators, the public and other stakeholders. Because ISO 14001:2004 does not lay down levels of environmental performance, the standard can be implemented by a wide variety of organizations, whatever their current level of environmental maturity. However, a commitment to compliance with applicable environmental legislation and regulations is required, along with a commitment to continual improvement – for which the EMS provides the framework" (International Organization for Standardization, n.d.).

ISO 14001, like EMAS, is a voluntary standard; the number of organisations with ISO 14001 certification is however much higher. It is applicable internationally, and was set up by the ISO standardisation organisation rather than by the EC.

Other related ISO standards

The ISO 14000 family contains several other important environmental management standards, such as ISO 14004:2004, which complements ISO 14001 by providing additional guidance and explanations. ISO 14031:1999 provides guidance on how an organisation can evaluate its environmental performance, presenting a selection of suitable performance indicators. The ISO 14020:2000 series of standards addresses a range of different approaches to environmental labels and declarations, including eco-labels. The ISO 14040:2006 standards give guidelines on the principles and conduct of Life-cycle assessment (LCA) studies providing an organisation with information on how to reduce the overall environmental impact of its products and services. ISO 14064-1-2-3:2006 represent a greenhouse gas (GHG) accounting and verification standard, which provides clear and verifiable requirements to support organisations in developing GHG emission reduction projects. This directive is complemented by ISO 14065:2007, which specifies requirements to accredit or recognise organisational bodies that undertake GHG validation or verification according to ISO standards. ISO 14063:2006 on environmental communication guidelines and examples helps administrations to make the important link to external stakeholders. The ISO 14051:2011 standard provides guidelines for general principles and framework of material flow cost accounting (MFCA). Finally, ISO 19011 provides general guidance on auditing processes, which is of course a fundamental part of environmental processes (International Organization for Standardization, 2009).

EMAS

The Eco-Management and Audit Scheme (EMAS) is a voluntary scheme that helps organisations improve their environmental management. EMAS is an "environmental management system standard with internal and external validation which requires organisations to publish an environmental statement and provides a verification system with independent verifiers and an official registration." EMAS is open to all organisations and can be applied to organisations as a whole or to units within one, for example the environmental department of a municipality. Rather than setting targets to be achieved, EMAS requires the implementation of a management framework, thereby making it applicable across a wide variety of organisations and working areas (Jungwirth, 2011).

EMAS implementation involves several steps, starting with an internal environmental review of an organisation's direct and indirect environmental aspects. Following this review, a management cycle based on continuous improvement is implemented, involving the adoption of an environmental policy, a programme of environmental activities, environmental audits and corrective action based on audit results. Organisations implementing EMAS must make publicly available an environmental statement describing its activities and environmental management. Independent accredited verifiers verify all of these elements, after which point an organisation can become officially EMAS-registered (Jungwirth, 2011).

Because of EMAS' requirements for environmental performance improvement at for compliance with environmental legislation, it is considered as a standard of environmental excellence (Bracke & Albrecht, 2007 as cited in Jungwirth, 2011),

City example: EMAS in Vienna, Austria

Having decided to become a model city in terms of environmental protection in the 1980s, Vienna undertook to set an example through the environmental management of its own activities, starting in the 1990s a number of environmental management projects. After having first implemented EMAS in one district office, the city decided in 2005 to certify under EMAS the entire city. The EMAS Logo is represented in figure 3.79

Figure.3.78: The EMAS Certification Logo

All of Vienna's 70 municipal departments participate in Vienna's EMAS programme, which is led by a core team that assists other team in implementing environmental management for their activities but also leads the implementation of environmental actions that cover the city as a whole. The creation of a dedicated intranet site has contributed to spreading relevant information across city departments. The participation of the entire city administration in the EMAS work has been a key success factor for Vienna. Vienna's EMAS work has succeeded in raising awareness about the environment and has led to the implementation of many measures. The Austrian capital Vienna was awarded a Best Practice Certificate at the European Public Sector Award (EPSA) in 2011.

Vienna focuses in particular on the areas of buildings, energy, waste, procurement and mobility. By replacing heat circulation pumps in one department, CO_2 emissions per year were reduced by around 11,000 kg; providing eco-driving training for 500 drivers reduced average fuel consumption by 14% and travel times by 6%; switching to energy-saving lighting has reduced energy consumption from lighting by 80% and deactivating the front lighting of vending machines saves around 20,000 kg of CO_2 per year. Other measures have included switching to double-sided printing, behaviour change campaigns to modify heating behaviour, equipping some staff with electric bicycles and fitting power strips with switches at workstations.

The city has placed particular emphasis on awareness-raising as one of the most cost-effective ways to achieve change. Indeed, many chosen measures require no implementation cost (bar those related to communication and initial training) and rely on behaviour change to achieve lasting progress. Awareness-raising, realised through internet and intranet sites, the use of video clips, events, and public relations, has been identified as one of the major success factors of the programme

Source: Wiener Umweltanwaltschaft, 2011a

Eco-Lighthouse

Eco-Lighthouse is an example of a national certification scheme and has been developed in Norway with the support of the Ministry of the Environment for use mainly in small- and medium-sized businesses and public bodies – it covers whole enterprises rather than specific units within them. Unlike ISO 14001, Eco-Lighthouse has industry-specific requirements that must be met by organisations prior to certification. The requirements cover the work environment, procurement, energy, transport, waste, discharges to water, aesthetics and system requirements. One example of an energy requirement is "owners of buildings that have heating systems based on fossil fuel, are more than 15 years old and that heat a useful floor area of more than 400 m^2 must install a less environmentally harmful heating system" (Eco-Lighthouse Foundation, 2011).

In order to receive Eco-Lighthouse certification, an approved consultant, who can either be hired or trained internally, must be used. As part of the management process, annual environmental reports have to be sent to the Eco-Lighthouse office, and recertification occurs every three years. To support the Eco-Lighthouse certification process, networks for organisations seeking Eco-Lighthouse certification have been formed in order to facilitate the sharing of experiences between participants.

The costs related to Eco-Lighthouse certification relate to the hiring or training of the consultant, the certification expense and the annual service charge, and vary based on the size of

the organisation, the complexity of its work, the point from which it starts and on the expertise available within it (City of Oslo, 2005). Political commitment to the process at the municipal level is important in order to ensure the nomination of an Eco-Lighthouse officer, the creation of certifier positions and the payment of the licensing fee; neighbouring municipalities can also cooperate with one another (Eco-Lighthouse Foundation, 2011).

City example: Eco-Lighthouse in Oslo, Norway

The City of Oslo has mandated as part of its Strategy for Sustainable Development the introduction of Eco-Lighthouse certification for small- and medium-sized services and activities that fall within the municipality's remit, including day care facilities, schools, nursing homes and others (City of Oslo, 2003). Oslo has also encouraged organisations that supply services to the city to receive certification – an example of green public procurement (Section 3.6.5.2). The Eco-Lighthouse Logo is represented in figure 3.80

Figure 3.79: The Eco-Lighthouse Logo

Olso's Lutvann School was Eco-Lighthouse certified in 2002, and the efforts made by students and staff since then have helped halve residual waste (saving around €800 per year) and reduce energy use by 15,000 kWh per year. The school engages in strict waste separation and does its own composting of organic waste, endeavours to reduce its consumption of paper and reduces energy use by lowering the heat at night and shutting down the ventilation system while the building is vacant. Students are involved in the process, for example by helping to read electricity meters, thereby increasing their awareness of environmental issues.

The Eco-Lighthouse certification process itself can help reveal cost-cutting opportunities, as happened for Olso's Fire Department, which has reduced annual costs by over €5,000 by reducing waste prior to certification. Waste reduction was achieved largely through procurement practices and agreements with suppliers, who take back non-degradable material and also for example used toner containers. In addition, the Fire Department reduced the number and emptying frequency of waste bins and arranged to gather special waste such as oil or electronic equipment and deliver it to specialised waste collection facilities.

Source: City of Oslo, 2005

*eco*BUDGET

This Environmental Management System was designed by ICLEI – Local Governments for Sustainability particularly for and with local governments, and entails the planning, monitoring, and reporting of the consumption of natural resources within a "political organization" and for a municipal territory. The main focus of *eco*BUDGET is natural resources, which, when they are scarce, can affect many aspects of a municipality's functioning by harming health or constraining economic development among others. The *eco*BUDGET tool "allows for a systematic approach to the application of other instruments and thus for an increased efficiency of local environmental policy [,] promotes sustainable resources management and environmental quality through the setting of locally defined key targets [and] serves as a basis for informed policy making towards local sustainability and a framework to Local Agenda 21 initiatives" (ICLEI – Local Governments for Sustainability, 2007).

Performance is measured against physical indicators – which are set to match the situation in the implementing municipality – instead of financial ones, thereby avoiding having to assign monetary values to natural resources. By presenting information in a visually-attractive way, *eco*BUDGET also allows for the easy presentation of the local government's sustainability achievements.

*eco*BUDGET follows the cyclical approach of local financial budgeting, familiar to local decision makers. The traditional budgeting accounting system is complemented by an environmental budget, in which ecosystem services or natural resources are measured in physical units instead of monetary value. The aim is to keep environmental spending within the limits of an environmental "Master Budget". The Master Budget identifies environmental targets oriented to the sustainable management of natural capital. Once approved by the

Council, the targets become politically binding. At year-end a Budget Balance indicates the city's achievements against the targets.
Being a political instrument, a key feature in the *eco*BUDGET cycle is systematic involvement of political decision makers and urban managers, allowing political steering in the use of environmental resources.

City example: Presenting *eco*BUDGET to the public in Bologna, Italy

"The City of Bologna has adopted *eco*BUDGET as the core environmental management system for its institutional activities. It explores successful practices, factors, and conditions to support good governance for sustainable development. The first goal was to use *eco*BUDGET as a management and communication instrument within the city's Local Agenda 21 plan. However, Bologna found that there are multiple benefits to using the *eco*BUDGET process. The *eco*BUDGET Logo is represented in figure 3.82.

Figure 3.80: The *eco*BUDGET Logo

All major decisions regarding resource and territory management are assessed for their suitability against Master Budget targets. A key element of Bologna's implementation of *eco*BUDGET is spatial and urban planning and using it for the execution of strategic environmental assessment. Building *eco*BUDGET indicators and targets into planning processes and systems allows for early action that is generally more cost-effective than responding to changes as they occur. This also includes the ability to clearly communicate the impact of different planning scenarios. *eco*BUDGET is supporting the dissemination of the environmental impact of various scenarios defined by a structural plan as required by Italian legislation. In this way, *eco*BUDGET has involved the municipality as a whole.
Unique to Bologna is the application of so-called 'mayoral targets' valid for one legislative term. In this way the city government aims to bind its political programme to a transparent and voluntary set of quantifiable targets" (ICLEI – Local Governments for Sustainability, 2007). Figure 3.82 represents a screenshot of Indicators and Targets for the *eco*BUDGET.

	Indicators	Reference year value	Value 2001	Value 2003	Short term target (2003)	Long-term target (2005- 2010)	Short-term target evaluation	Comments
QUIET ENVIRONMENT	Night noise levels in urban area (San Felice monitoring station) dB(A)	67,5 (1996)	66,8	67,4	66,3	55		The increase is caused by a general increase in street traffic. Actions to reach the target have been pursued partially.
	Distance to short target	0%	6%	1%	10%	100%		

Figure 3.81: Indicators and Targets for the *eco*BUDGET

Integrated Management System (IMS)

The challenges facing urban environments in Europe vary, but commonalities can also be detected: they range from air pollution to water pollution and from greenhouse gas emissions to noise pollution. These challenges have environmental impacts, but also negatively affect human health and economic performance, and are complex and related to one another. In seeking to face these challenges, knock-on effects must be kept in mind. Moreover, the sheer complexity of the challenges faced by urban areas in Europe means that integrated management, which takes into account multiple factors as well as solutions, is particularly well-suited to meeting them. The integrated management of urban environments implies "tackling related issues together such as urban management and governance, integrated spatial planning, economic wellbeing and competitiveness, social inclusion, and environmental stewardship. For example, the implementation of Community law on urban air quality not only has implications for pollution control and traffic management, but also requires combined efforts to address city and

town centre management, spatial planning and urban design, health impacts and social justice" (European Commission, 2007).

Integration is a way to address the gaps existing in Europe between sectoral policies (as explained previously), between planning and implementation (for which responsibility is often split between different departments and stakeholders), between resources available and needed, and between administrations and functional urban regions (where competition between municipalities often trumps collaboration) (European Environment Agency, 2009b). Integration also entails linking different administrative levels, departments and sectors together in order to ensure problems are approached in a holistic way and solutions chosen do not negatively affect others. Integrated management is a way to "improve the consistency and coherence between different policies, from an environmental perspective, and a means to maximise the effectiveness of those policies within available budgets. It can also offer greater transparency in policy development and encourage a greater public involvement and acceptance" (European Commission, 2007).

The cyclical Integrated Management System (IMS) developed under the Managing Urban Europe Initiative [47]includes the following five steps, as shown in figure 3.83 (Union of the Baltic Cities Commission on Environment et.al., 2008):

Figure 3.82: Cyclical Integrated Management System

- Baseline review: "The first important step of the IMS is to analyse the present sustainability condition of the city. The purpose is to create a framework of information that will later serve as a basis for setting priorities, targets and the monitoring of progress. […] The baseline review should map legal requirements, data regarding all significant aspects, emerging issues and trends, political priorities, departments and external organisations involved, existing instruments and systems."

- Target setting: "The next step is to prepare the strategic programme and action plan. They are based on the baseline review and its analysis of priorities to be focused on during the following management cycle period. A common vision for the future development of the city should be established in a participatory process. […] The strategic programme is the document that sets long-term targets and measures for the agreed priorities. The priorities should be described using indicators as the main tool of communication within the IMS. Based on indicators, measurable and time-related targets are formulated, and they balance and integrate the environmental, social and financial resources. […] The action plan is broken down from the strategic programme with a perspective of 1-3 years. It should display short-term targets derived from long-term targets and set out measures to fulfil both."

- Political commitment: "During the third step, the strategic programme should be put forward to the council for the purpose of its approval and legitimization. […] Political commitment should be seen as a driving force that stimulates the management cycle. Therefore, it should be sought from the very beginning of the process, when the idea of the implementation of the integrated management system is in its infancy."

- Implementation and monitoring: "With the implementation of the strategic programme and the action plan, the management cycle reaches its very core: all the preceding

assessment and planning has the overall objective of improving the way the city functions in terms of sustainable development. The implementation is where it shows. […] In parallel, and for the purpose of being able to measure and report the results, the implementation of the strategic programme and its action plan should be monitored in an appropriate way and fed back to the politicians. It allows for being able to see if actions are implemented with good results. If not, it allows for taking corrective measures while implementation is in progress."

- Evaluation and reporting: "The data collected through monitoring are used for evaluating both the results obtained through implementation and the way the management cycle is working. […] Evaluation and reporting is the last step of the cycle, but provides the basis for starting a new year with a new cycle. It analyses what has happened during the year in order to understand why things happened or failed to succeed. It provides the politicians with a basis for taking further decisions on the targets and actions for the next year. It provides the stakeholders, including the public, with a report on what the city has done during the year and how they have succeeded in fulfilling their targets."

Integrated management in European cities remains limited despite the availability of examples in more than 50 cities (CHAMP 2012) and its recognised benefits. Several barriers explain this, and include among others fragmented decision making and budgeting, a local resistance to involvement from higher levels of governance and antiquated planning systems (European Environment Agency, 2009b).
Further step public administrations can take in refining their management structure is integrating management issues in their whole administrative scheme. The IMS allows organisations to incorporate all the dimensions of their management in just one system. Managing tasks individually and by sector is, in fact, often inefficient and leading to increased workload and suboptimal results. Re-organising and integrating existing practices, plans and strategies under one steering wheel will systemize work, boost efficiency and provide a multitude of positive outcomes. It will direct all available resources towards the goals defined and secure transparency and democracy in the decision-making process.

City example: The integrated approach applied in Lahti, Finland
Lahti was one of the forerunners of local agenda activities in Finland, which started right after the Rio sustainability summit in 1993. Ever since, Lahti has worked towards sustainable development, e.g. by setting the first environmental policy in 1996. In 2009, within EcoRegion, Lahti complied with the Aalborg commitments baseline review to take stock of the sustainability work realised so far and to think of next steps. A crucial component of this process was co-operation between city sectors and units. From 2010, teams from each city sector met regularly to discuss sustainability in their everyday work. They asked themselves "What does social sustainability mean in a Nordic welfare society? What strengths and weaknesses do we have? Where should we focus our time and energy in the future to enhance sustainability?"
These discussions led to a common vision for sustainability actions: "The Sustainability Programme of Lahti 2011", which has five focus areas:

1. Government towards sustainability
2. Participation and promotion of communality
3. Responsible consumption and sustainable procurement
4. Promotion of resident's well-being
5. Our living environment

Sectors formulated goals and activities especially around the areas of "Government towards sustainability" and "Responsible consumption and sustainable procurement".
In the future, the city of Lahti will focus on developing its monitoring system and indicators related to sustainable development. The city will also look at the municipal decision-making and develop a system for evaluating the impacts of city council decisions in relation to environmental policy targets.
Source: EcoRegion Findings – Results from the Baltic 21-EcoRegion project.

Applicability

Most EMS are not prescriptive and do not mandate the adoption of any specific measures, but instead offer a framework for organisations to identify and deal with issues of specific concern to them. Therefore, their geographical applicability is universal: EMS can be applied in public administrations of any size or spatial location. For example, *eco*BUDGET uses existing means of financial reporting and communication, and can hence be used in local governments of any size: the 11 pilot *eco*BUDGET cities ranged from 14 to 1,674 km^2 in size and from 10,000 to 478,000 inhabitants (Robrecht et al., 2004).

Although the EMS examples developed above have been outlined separately, they are not necessarily mutually exclusive, and can actually complement one another. For example, the joint application of EMAS and *eco*BUDGET can ensure a public administration covers both internal procedures (with EMAS) and its entire realm of influence (with *eco*BUDGET), with *eco*BUDGET providing the political direction for what needs to be achieved and EMAS a more detailed plan for how to achieve it (Robrecht et al., 2004).

Another example of the complementarily of EMS is the fact that EMAS's environmental management system requirements reproduce those given by the ISO 14001:2004 standard.

The implementation of IMS is not without its challenges. These include the need to secure high-level political support as well as sufficient resources, the importance of bridging any gaps between the national government and the local government and the initially potential overwhelming impression of the task at hand. To this end, it is recommended to start the system on a small scale and concentrate on establishing the annual management cycle first using existing processes and tools. Exchanging experiences with other public authorities through networks and case studies will be instrumental (European Commission, 2007). The IMS five-step cycle is in accordance with EMS such as EMAS or ISO 14001. Similarities and complementarities exist between the processes: for example, doing an environmental review under EMAS can help with carrying out a baseline review for an IMS.

The experiences of cities that have implemented EMS or IMS have shown that these systems can be readily applied to a range of local governments. The instrument is applicable in various regions, in large cities and small towns, and developed and developing countries, regardless of political persuasion. EMS and IMS support local governments in meeting their ambitious environmental and sustainability targets as well as fulfilling their legal obligations and voluntary commitments.

Economics

The cost of EMS implementation varies widely based on the measures that a public administration chooses to implement as part of its EMS; the next part of this document will cover some examples of measures that can be implemented as part of an EMS. EMS certification does have some costs associated with it. For example, EMAS certification for public authorities in the UK costs £714.90 for registration and £357.45 for annual renewal.[48]

City example: City of Växjö, Sweden.

Växjö financed its *eco*BUDGET development work through a three-year European Union (EU)-supported pilot project called European *eco*BUDGET. Then for another three years the work has been financed through other development projects such as the EU-funded *eco*BUDGET -Asia pilot project, the Managing Urban Europe 25 project, Integration and Development of Environmental Management Systems (IDEMS), and Success for Sustainable Energy Systems in Advanced Cities (SESAC), among others. In 2007 Växjö councillors gave the city's Planning Department funds corresponding to 50% of a full-time position. All *eco*BUDGET work in other municipal departments and companies is unfinanced because, since the inception of *eco*BUDGET in Växjö, the administration has stated that environmental work in general and *eco*BUDGET work in particular should be performed within the given financial constraints.

City example: City of Bologna, Italy
The Municipality of Bologna has used funding from the European Union's LIFE program to implement *eco*BUDGET in its administration. Now that *eco*BUDGET is completely integrated into the environmental department and the city council, no extra funds are required to run the system.

Sources: ICLEI, 2007 a & b

Driving force for implementation
In addition to the direct environmental and sustainability benefits delivered by environmental management systems or an integrated sustainability management system, they also help:

- Legal compliance: EMS and IMS help to detect gaps regarding the fulfilment of legislation and force the local authority to include appropriate measures in the Strategic Programme /Action Plan for achieving legal compliance.

- Implement the pollution prevention principle: By including planning responsibilities in the scope of EMS and IMS, the management system significantly contributes to the prevention of negative environmental impacts.

- Efficient and effective governance and management: the EMS/IMS provides a sound basis for well-informed decision-making and planning, coordination of instruments, programmes and sectors, efficiency gains through avoiding double work, legal compliance, effective performance monitoring based on targeted indicators.

- Raise an organisation's profile: Public authorities can also increase their competitive advantage by becoming more attractive bidders in tenders and "greening" their reputation, as happened in Aalborg, Denmark, after the creation of the Aalborg Commitments (European Commission, 2007). Pioneers also receive respect and recognition in their country and on European level, e.g. through awards.

- Integrated-management increases the chance to obtain external resources: The public authority provides a guarantee to funding organizations at regional, national and European level that financial resources will be used in a transparent and target oriented manner.

- Integrated management leads to more attractive cities for citizens and investors: Important sign for investors, stakeholders and citizens that the municipality's development is not based on short-lived concepts but on sound and long term planning and professional management.

- Communicate with citizens: Integrated management involving stakeholders and citizens helps create open communication between the public authority and citizens and leads to a participatory management process. Municipalities can only expect cooperation from stakeholders and citizens if they lead by example.

- Save money: Sound management of resources can help save money by reducing consumption. For instance "operation of the Cohesion Policy has shown that integrating environmental considerations into economic decisions can produce significant savings and improve profit and productivity. In particular, this has been the case in the areas of improving waste management and resource efficiency including water conservation via metering and reducing energy used for space heating" (European Commission, 2007).

- Improve health and safety: For example "the level of sick leave at companies certified by the Eco-Lighthouse Programme is lower than the national average [of Norway]. This suggests that the programme's emphasis on working environment provides positive results for the companies that meet these standards" (City of Oslo, 2005)

Reference Public Authorities

Table 3.31: Authorities applying Environmental Management Systems

Authorities applying Environmental Management Systems			
***eco*BUDGET**	**Eco-Lighthouse**	**IMS**	**EMAS**
Växjö, Sweden Bologna, Italy Nordhausen, Germany	Oslo, Norway	Ancona, Italy Lahti, Finland Ludwigsburg, Germany Turku, Finland Donaueschingen, Germany	Ravenna, Italy Vienna, Austria Lewes, UK Kirklees, UK

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The following websites are official sources of information about the management systems described above:

- ISO 14001: http://www.iso.org/iso/iso_14000_essentials
- EMAS: http://ec.europa.eu/environment/emas/index_en.htm
- *eco*BUDGET: http://www.ecobudget.org
- Eco-Lighthouse: http://www.miljofyrtarn.no/index.php/information-in-english
- Integrated management system: http://www.localmanagement.eu/

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3.6.6 Green Public procurement

Description

The sheer purchasing power of public administrations within the EU makes the imperative for GPP all the greater; indeed, public authorities in Europe spend around €2 trillion per year, which is equivalent to 19 % of the EU's GDP. GPP decisions made by public administrations have a direct positive environmental impact, but also provide indirect environmental benefits because of their influence on manufacturing, works and service provision processes as a whole.

In addition, the implementation of GPP makes public administrations more apt to meet local, regional, national and supra-national targets in the areas of greenhouse gas emissions, energy efficiency and other environmental areas. Moreover, the adoption of GPP will help public administrations be more efficient and hence more resilient in the face of evolving environmental challenges (European Union, 2011).

Green Public Procurement is a voluntary instrument, meaning that its implementation is not mandated but rather up to the discretion of public authorities and individual Member States. It is defined as "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" in the Communication (COM (2008) 400) *Public procurement for a better environment*. While many public administrations apply Sustainable Public Procurement, which also covers social and economic aspects of procurement, GPP only covers the environmental aspects of public procurement, and is complemented by EC guidance on the social considerations of procurement. This chapter will explain and give examples of GPP.

Sources of GPP criteria, covering selection and award criteria as well as specifications and clauses within contracts, are a key part of GPP implementation. EU GPP criteria are available for a number of product and service groups, such as furniture, mobile phones or road construction, and can be directly inserted in tender documentation. The EU GPP criteria include two levels, the core criteria, addressing the key environmental impacts and the comprehensive criteria, for those whishing to buy the best environmental product on the market. There are some principles of GPP such as the value for money principle: "Contracting authorities have an obligation to get the best value for taxpayers' money for everything they procure. Best value for money does not necessarily mean going only for the cheapest offer. It means finding a solution which meets the requirements you have identified – including environmental ones – in the most cost-effective way." In addition, to the GPP criteria some other sets of criteria have been developed covering a wide range of product and service groups. Eco-labels for example, set out the environmental requirements, which must be met by products or services in order to carry the label. They involve certification of the product by a third party (i.e. not by the producers or service providers themselves). (European Union, 2011) Ecolabels are a simple and reliable way to guarantee compliance with environmental requirements. Multi-sector, multi-criteria labels are the most commonly used in GPP, they are based on scientific information about the environmental impact of a product or service throughout its life-cycle (from the extraction of the raw-materials, through production and distribution, the use phase and final disposal). Three of the most famous are the EU Ecolabel (flower), the Nordic Swan and the Blue Angel (European Commission, 2008b).

When choosing a label, it is pivotal to carefully consider the underlying requirements and verification procedures. Different logos might provide different standards in terms of environmental performance. A comparison between two international forest certification frameworks, the Forest Stewardship Council (FSC) and the Program for Endorsement of Forest Certification (PEFC) shows that even though both aim at sustainable forest management they use different verification mechanisms and have different requirements.

The governance of the two schemes is fundamentally different. FSC is centrally organized and involves an international centre, regional offices and national FSC working groups, mainly responsible for standard development. The power in FSC is equally distributed among three chambers (environmental, economic and social) with equal voting rights. PEFC provides a worldwide framework for the mutual recognition of forest certification schemes and consists of National Governing Bodies. The control remains at the national

level with the National Governing Bodies appointing voting delegates. Single majority voting is applied, thereby allowing that a single stakeholder group may be overruled.

The FSC is based on one set of principles and criteria, specified by national working groups or certification bodies, where no standard is available. The PEFC, however, supports the development of national standards, which can derive from different reference documents. As a results the standards vary quite substantially (e.g. one of the standards allows the use of genetically modified organisms (GMO), which is strictly prohibited in the FSC scheme).

In terms of transparency, the FSC's standard exceeds the PEFC's standard, since it makes standards and report summaries with all Corrective Action Requests (CARs) for each forest assessment and audit public. The PEFC made the CARs only in exceptional cases public. The same is true for the accreditation of certification bodies.

While the FSC has a separate unit that carries out accreditation and annual inspections of certification body's office and field work, the PEFC does not inspect certification bodies and accepts national accreditation. Both schemes have a different approach towards the chain of custody. The FSC pursues a physical separation for pure products or strictly controls all non-FSC sources for mixed products. Here the threshold is at 10%. The PEFC follows a physical separation, a batch definition or a volume calculation. The PEFC does not have a threshold.

Both schemes offer labels. For the FSC there exists the FSC pure (100%) or the FSC mixed sources. They are in compliance with the ISO guides and have no claim of sustainability. The PEFC offers for 100% PEFC: "from sustainably managed forests" and for less than 100%:"promoting sustainable forestry". The PEFC is not in line with the ISO guides in that it has a claim to sustainability.

Finally, the FSC scheme indicates measurable impact through case studies and reviews of CARs, while the PEFC could not yet document significant impact. All of these aspects lead to a strong and often exclusive support of Environmental NGOs for the FSC, while the PEFC is mainly supported by forest industry and forest owner's support.

This comparison of the two biggest forest certification schemes shows, that one has to be careful when choosing a label, since each label has different obligations, reputations and requirements that might affect the local government's procurement aims. (Sprang, 2006)

In this regard it has to be highlighted, that public authorities cannot require certain eco-labels but they can demand that the product or service meets the standards/ criteria underlying the label. A supplier can then use the eco-label to prove to the procurer that their product meets these standards - however, other forms of proof (including self-verification) must also be accepted by the procurer. (European Union, 2011)

Achieved environmental benefits

The City of Bremen, for example, published a public tender at the EU level to cover the electricity requirements for a number of local public entities, including Bremerhaven Municipality, from renewable energy sources. The initial contracting period was for two years – from January 2009 to December 2010, extended under the terms of the tender to the end of 2012. The contract is for the supply of 79 million kilowatt hours annually, with a total approximate cost of 7.5 million euro per annum. Bids were required to deliver a minimum of 30 percent reduction in the amount of CO_2 emissions associated with the supply of the required electricity, as compared with the average national electricity mix. Considering that the CO_2 savings associated with Bremen's purchase are estimated to be at 75% compared to a supply from non-green sources, the huge environmental impact connected to this procurement activity is indubitable.

(Source: http://www.sustainable-procurement.org).

Certain Procurement areas can be considered high priority for targeted measures to reduce CO_2eq emissions, as identified by the European Commission (Smart SPP Consortium, 2011):

- **Windows and insulation, heating cooling and ventilation systems and energy management system for buildings**

Ex. The headquarters of the District Authority of Weiz (Austria) is located in an office building constructed in 1964. Due to new requirements concerning function, fire protection and energy demand, a comprehensive renovation has been carried out. Renovation measures include a new innovative façade system, mechanical night cooling with the existing air condition system and a circulating heat exchanger based on air. Following renovation the building is planned to achieve a very high energy standard (which is A+ in the Austrian energy certificate) – the reduction of the energy demand for heating and annual CO_2eq emissions per m^2 is about 80%. After the renovation (end of June 2011) detailed energy monitoring will be carried out to evaluate planned renovation measures.

- **Indoor and outdoor lighting system**

Ex. The City of Budapest (Hungary) replaced the lighting system of the "Liberty Bridge", one of the key crossing points over the Danube, and an iconic site within central Budapest. More than 800 light fittings were installed to provide Liberty Bridge's ornamental lighting, 584 of which are LED lights. This amounts to installed power of 40.7 kilowatts, of which the LEDs account for 13.1 kilowatts. The project was carried out in 2009 at a cost of €1.66 million. The estimated life expectancy of the ornamental lighting installed is 15 years and 30 years for the street lighting. This longer lifespan means lower replacement rates, bringing considerable direct and indirect economic benefits and reduced waste. Replacing the lamps is difficult and costly due to their mounting on the bridge and the disruption to traffic, and these costs have been avoided. The savings on electricity compared with the original concept (which used halogen lighting) are estimated at €40,000 per annum, with total savings of €100.000 per annum.

- **Transportation of goods and people**

Ex. Frankfurt am Main (Germany) placed environmentally enhanced services in public transport. 20% (3.3 million km/a) of the public bus transport was tendered. Within a pilot-tendering throughout the EU, incentives for offers considering enhanced environmental busses were set. The contract was awarded to ALPINA, a tenderer from Bad Homburg (Germany). The new busses went into service in December 2006. 32 standard-size-buses, 17 midsized-buses and 2 Minibuses came into operation. Except for the Minibuses, all these EEV-standard (EEV = Enhanced Environmental Friendly Vehicle) vehicles are diesel powered. Therefore in Frankfurt/Main operates the largest diesel powered EEV- standard bus fleet. By using EEV busses, the tendered transport performances will result in a significant reduction of air- and noise pollution. Compared to today's emission limits, particulate matter emissions will decrease to around 20% and those of nitrogen oxides to around 50%. Even compared to the EURO V standard nitrogen oxides are reduced clearly. Noise is reduced by 3dB(A) for both categories of busses. These drastic reductions of noise- and air pollution results in additional costs of less than 0,07 €/km.

- **Energy consuming office equipment, paper and printing services**

Ex. The Central Project Management Agency (CPMA) acts as the central purchasing body in Lithuania. CPMA has implemented GPP criteria in its frameworks for office IT equipment (including desktops, laptops, displays and imaging equipment), stationery and office supplies (including toner cartridges, light bulbs, paper products and writing implements) and printing and copying paper. In total, there are over 60 different product specifications offered in an online catalogue for purchasing organisations to choose from. Buyers are able to easily find green products as they are specially marked in the catalogue. Thanks to the simplified procedures and intense competition, one of the main concerns regarding the price of environmentally friendly products was solved. Major discounts for all product groups have resulted in reasonable prices for green products too. An impressive share of contracts in which green products were purchased can be observed: 61% for IT equipment, 76% for office paper

and 49% for stationery products. The most popular green products are desktop computers and notebooks.

- **Food and catering services**

Ex. Rome (Italy) supports organic agriculture and organic food chains, food safety and nutritional balance, and encourages good environmental performance of current and potential suppliers through its school meal service. Since 2001, Rome has employed an incremental approach to designing its food and catering tenders and its food service, to gradually make these more sustainable and innovative. As a result, organic food accounts for 69% of all food served in Roman schools, except meat, fish and cold cuts. The switch to organic has raised the average cost of a meal by 8% (that is €0.40). Rome's approach has improved the market in terms of sustainability and quality. Companies are now aware that they face a public administration which calls for strict compliance with all the requirements specified in tenders – they therefore take the bidding process very seriously and are encouraged to improve their own performance.

- **Furniture**

Ex. In 2005, the city of Cognac (France) decided to replace its obsolete street furniture with wooden furniture. Analysis of the product revealed that the furniture was made from Moabi – a rare and endangered wood species, often smuggled from the Congo and Cameroon. Since then, the City of Cognac requires compliance with certain eco-label criteria when purchasing products that are derived or contain wood. During 2010 and 2011, wood for construction, wall panels and door units have been purchased, which are certified with the PEFC label, as a minimum. The successful tenderer was a local wood provider. Sustainability criteria have not had a negative economic impact for Cognac. On the contrary, the city actually saved 5% in purchasing costs compared to the same purchase carried out in the previous year, which did not include the sustainability requirements.

- **Cleaning products and services**

Ex. The Municipality of Reykjavik (Iceland) conducted an analysis on the cleaning habits in its facilities. This study showed that the cleaning frequency in the City Council's buildings could be considerably reduced, generating positive results for the environment and the City's budget. Furthermore, by cleaning the offices during office hours, staff reacted more positively about the quality of the cleaning service provided, despite the lower frequency. The City Council also engaged in purchasing non-allergenic, readily biodegradable and free of high concentrations of volatile organic compounds cleaning products, certified by the Nordic Swan Eco-label, thus lowering its environmental impacts.
(All the case studies summarized above are available in an extended version from: http://www.sustainable-procurement.org).

Appropriate environmental indicator

Table 3.32: Appropriate environmental indicator - Green public procurement

Name	Unit of measure (type A)	Unit of measure (type A/B)	Description
Green public procurement procedures	number	n. tenders referring to "environmental criteria"/ total n. tenders	Number of tenders - published in a year - referring to "environmental criteria". The tenders should be disaggregated by products categories: buildings, furniture, electronic appliances, cleaning products, food, paper products, etc.
"Green paper" used in the municipal offices	number	n. "green paper" reams /total n. paper reams expenditure for "green paper" reams /total expenditure for paper reams	The definition of "green paper" refers to paper having a reduced environmental impact. In this case "green paper" could refer to different categories of paper: FSC or PEFC paper, recycled paper, paper with ecolabel.
Organic food served by municipal canteens	number	n. meals with organic food/ total meals served	Organic meals served by municipal canteens should be disaggregated into: partially organic meals and organic meals.
Local authority's green fleet	number	n. "low emission" vehicles/ total n. vehicles	The category of low emission vehicles refers to: LPG + hybrid and electric+ natural gas powered.

Benchmark of excellence

The City of Kolding (Denmark) incorporates the European Ecolabel together with other ecolabels into all its procurement actions where the product group is covered by the label. In 1998 Kolding began the implementation of GPP with the adoption of a GPP policy, being one of the first cities in Europe. Almost 100% of Kolding's procurement activities can be considered green. Environmental aspects are assessed with the same weighting as price, quality and level of service. The EU Ecolabel is used directly by the City of Kolding, whenever they are tendering for goods or services covered by the Ecolabel. The same approach is taken with the Nordic Swan, Bra Miljöval and other relevant labels. Whenever a call for tender for a product group where Ecolabelled products exist the criteria relating the product are simply copied as either technical specifications and/or as award criteria. A copy of the Ecolabel license is considered as full verification, but also alternative documentation can also be accepted. Environmental questionnaires are integrated into all calls for tenders. The questionnaires contain different kinds of questions regarding the supplier's business, the product and the packaging. For every product group there are minimum requirements that must be met. All other questions provide the basis for comparing the environmental standards of the offered products during evaluation. In the last three years, the EU Ecolabel has been included in tenders for cleaning agents, copy paper, work clothes, laundry services (for the detergent used), printing services (for the paper used) tissue paper, and fleet management (for the lubricants used).

Cross-media effects

The principles governing GPP – described in previous paragraphs – are designed to ensure non-discrimination, equal treatment, transparency and proportionality. In addition, GPP can lead to substantial positive effects for producers as well as service and works providers, for example if production methods are specified within procurement tender, thereby leading to changes within entire production lines. This is particularly the case when tenders are put out by large contractors, such as large groupings of public authorities, big cities or the European Commission.

Operational data

For a GPP policy to be successfully implemented, it is very important to define what the main objectives of the policy are (which sectors are to be addressed and why) and to seek for a link with possible complementary policies (e.g. a policy fostering innovation). A GPP policy should be composed on the one hand of a strategy and a clear policy statement and, on the other, of an operational implementation plan. A high level policy statement provides the commitment framework for GPP implementation, outlining the key goals and targets which the authority aims to meet, and against which progress can be judged. The operational plan, instead, should provide an in-depth description of how the goals of the policy will be met in practice (European Commission, 2008b). In order to carry out a successful GPP it is important for a public administration to have an overview of the product groups relevant for their work. At this point follows a brief summary of the most important product groups to consider when aiming at targeted innovation to reduce CO_2 emissions: Windows and insulation, heating cooling and ventilation systems, indoor and outdoor lighting systems, transportation of goods and people, energy consuming office equipment, energy management systems for buildings. All of these products should meet high energy efficiency standards (European Union, 2011). When aiming at an improved health of employees and a support for developing countries and small scale producers the following product group can be considered: food and catering services. Here the procurer can give preference to fair trade labels and catering businesses using organic products. Also cleaning products and services have a tremendous impact on the environment and the employee's health. Here the procurer should require the cleaning contractor to be EMAS certified or to have high environmental standards for their cleaning material used (United Nations Environment Programme, 2010). In case the procurer's aim is to ensure a sustainable management of the global forest cover, it is important to consider where furniture and wood for construction are coming from. This can be done, by checking, whether they are certified with the PEFC label, as a minimum (European Union, 2011). The city of Kolding provides a good example for the use of labels in Green Public Procurement (see Benchmark of excellence).
In order to carry out a successful GPP strategy, public administrations should establish a dedicated working group involving representatives from different departments and ensure that they have the necessary cross-cutting competences to draft a strategy, including (European Union, 2011):

- ✓ Project management skills: to manage the staff, work flow and budget;
- ✓ Technical skills: in order to effectively assess new technologies, precisely identify needs and interact with the market (a simple market research to be informed about upcoming products is a start);
- ✓ Legal skills: to ensure market engagement activities and tendering procedures are legally compliant.

If these competencies are not to be found in-house, Public Administration could consider seeking for external assistance, for example by (Smart SPP Consortium, 2011):

- Government Agencies: Certain Agencies may exist to provide support relating to innovation or energy efficiency. E.g. In Portugal, ADENE's (National Energy Agency) mission is to promote and perform activities of public interest in the energy sector, namely in the field of energy efficiency.
- Sectoral technological centres, professional associations and other public administration organisations.
- Research institutes and consultancy services.
- National/international networks which can provide expertise. For example, the Spanish Federation of Municipalities and Provinces (FEMP).

- Procurement agencies: it can be an option to contract out the whole, or part of the action to a procurement agency operating on behalf of the public administration.

A well structured GPP policy should contain the following operational elements:

- Include clear targets, priorities and timeframes: The introduction of a GPP policy can begin with pilot projects focusing on certain departments, products or service groups. This can help verify internal capacity and testing providing companies.

- The choice of priority intervention areas should chiefly be made based on potential environmental impact, budgetary considerations and market influence potential. Targets are set with the aim of assessing progress and of communicating both within and outside of the organisation. Targets can cover overall procurement (for example the percentage of tenders or tender values that include GPP criteria), be specific to products or services or be operational (for example providing GPP training and/or information). For inexperienced authorities it is recommended to begin with products or services which are easy to understand and whose environmental impact is easy to assess.

- Indicate the scope of the purchasing activities covered.

- Indicate overall responsibilities for implementing the policy.

- Include a mechanism for appropriately monitoring performance against targets, which should ideally include information on the environmental impact of procurement decisions.

- Acting fairly, i.e. applying internal market principles:

  - “Non-discrimination – contracting authorities must ensure equal access to the contract by operators from all EU countries and from countries with equivalent rights

  - Equal treatment – comparable situations must not be treated differently and different situations must not be treated in the same way, unless such treatment is objectively justified. For example, the same deadlines must be applied to all tenderers and the same information provided to each, but tenders with different prices should receive different marks in the cost evaluation.

  - Transparency – tender opportunities must be advertised widely enough to ensure competition. The procurement decision making process must also be transparent, to preclude any risk of favouritism or arbitrariness on the part of the contracting authority. Contracting authorities have the obligation to inform unsuccessful tenderers of the reasons for rejecting their tenders.

  - Proportionality - implies that measures adopted in a procurement process should be appropriate to the objectives pursued and should not go beyond what is necessary to achieve them.”

City example: Organic food procurement in Vienna, Austria

Vienna's "ÖkoKauf Wien" (EcoBuy Vienna) programme is widely recognised as an excellent example of green public procurement. Indeed, it won top honours at the 2011 European Public Sector Awards under the theme 'Going Green: Concrete Solutions from the Public Sector.' "ÖkoKauf Wien" is a key element of the Vienna Climate Protection Programme (KliP) and was launched in 1998.

A very large programme with a yearly budget of €300,000, it has developed around 100 product catalogues for the services regularly procured by the city, and conducts market research prior to the introduction of new standards in order to evaluate market readiness. Since its introduction, the programme has enabled Vienna to save €17 million – out of a total procurement volume of €5 billion – and has avoided 30,000 tonnes of CO_2 emissions per year. The response from the private sector has been positive, and it has adjusted its production processes, products and services to the ecological requirements set by "ÖkoKauf Wien"; indeed, "in many fields, products and services which do not meet the requirements of "ÖkoKauf Wien" have virtually disappeared from the market." Some key factors of the programme's success have been identified as the education of suppliers, the strong political backing for the programme, the involvement of multiple staff members across city departments and the lack of a top-down approach, since procurement practitioners from the administration are heavily involved in the programme's working groups as well as product category and product group development (Wiener Umweltanwaltschaft, 2011b).

Vienna's GPP programme comprises 26 thematic working groups. One of these relates to food, setting requirements for the procurement of food which include provisions for the prioritisation of seasonal fruit and vegetables, for at least 30% of the food procured for Vienna's city facilities to be of organic origin, for the purchase of GMO-free food as well as of free-range eggs. One of the initiatives of the food working group is "Natürlich gut Tellers" ('naturally good dishes'), where dishes that meet certain environmental criteria are awarded the initiative's logo. Currently in place in several restaurants and publicly-owned catering facilities, the city hopes to roll-out the initiative more widely in the future (Patak, 2011).

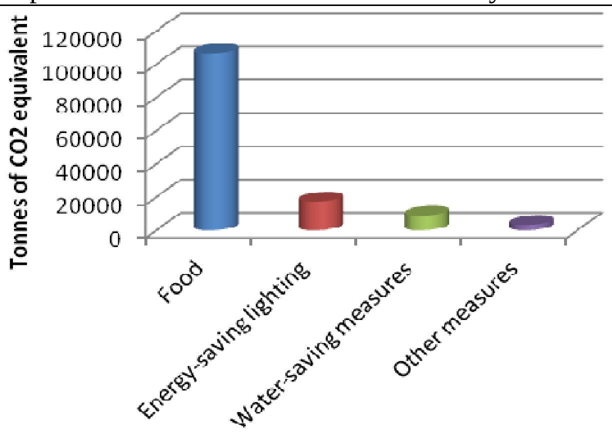

Figure 3.83: Greenhouse gas emissions saved 2004-2008 (Adapted from Patak, 2011)

While the "ÖkoKauf Wien" programme as a whole has helped dispel the myth that using environmentally-friendly products leads to important cost increases, the use of organic food for catering in schools, nursing homes and other public institutions has actually led to quantifiable cost increases. However, the positive environmental impact of organic food purchasing has been demonstrated, helping Vienna avoid approximately 20,000 tonnes of CO_2 equivalent per year. The greenhouse gas emissions avoidance of the food-related initiatives of "ÖkoKauf Wien" has proven to be far superior to that of other initiatives, as shown in Figure 3.110.

"ÖkoKauf Wien" homepage: http://www.wien.gv.at/english/environment/protection/oekokauf/

After having shaped an operational plan, a procurement contract has to be set up. This involves a number of steps (European Union, 2011):

- **Defining the subject matter of the contract**, most often to obtain a description of the product, service or work. Although substantial freedom exists within this definition process, legislative safeguards have been put in place in order to preserve a level playing-field, meaning that contract definitions must preserve free competition and not restrict access to the tender. Carrying out a needs assessment is also crucial to the definition process, sometimes enabling purchase avoidance. After having identified the environmental impacts that the contract will consider, an appropriate and descriptive title should be chosen for the tender.

- **Setting up measurable technical specifications** within the contract both helps describe the contract and hence determine whether companies decide they want to participate in the tender or not, and helps in obtaining offers that truly meet the compliance requirements of the tendering party. Technical specifications can refer to existing criteria (for example those of eco-labels) and can be formulated in terms of environmental performance levels of a material, product, supply or service. Specifications can also refer to existing standards such as full European standards (ENs), but can also be based on performance or functional requirements. These detail the expected outputs and results but do not specify the inputs or a method by which results should be achieved, thereby encouraging innovation. In order to foster innovation, the market should be involved at an early stage, for example by organising Prior Information Notice (PIN) meetings, inviting providers to them and pointing out the public administration's needs. This should be done far enough in advance of actual tendering (at least six months to one year), in order for the market to be able to respond (see the "city example" of Cascais) (Smart SPP Consortium, 2011).

- **Specifying materials and production methods** within a tender is possible as long as this fits into the legal framework surrounding procurement. For example, a tender can specify a type of material to be used, or a certain percentage of recycled material, or the exclusion of certain hazardous substances. In order to comply with the non-discrimination principles, it is in this case important to refer to existing legislation (for example the RoHS Directive for hazardous substances) or eco-labels and GPP criteria. Tenders can also specify production methods while again bearing free competition rules in mind.

- **Using variants** allows tenderers to submit alternative proposals that meet the same minimum requirements that have been set in the tender. The evaluation of the tender bids is done against the same criteria for all submitted bids.

- **Using eco-labels and GPP criteria**. GPP criteria produced by the EU can be inserted directly into tender documentation. Eco-labels can help draw up technical specifications, but can also help verify compliance with specification, for example if a label is accepted as a proof of compliance. Use of eco-labels is subject to certain rules, for example that only the specifications of the eco-label which relate to the subject matter of the contract are considered when awarding the tender, or that eco-label registration cannot be mandated since alternative means of compliance must be accepted.

- **Verifying compliance**: the evidence that will be required to determine compliance should be laid out in the tender documentation. Compliance verification can often be complex and require technical expertise, but there are other ways to do so without it, for example by obtaining evidence of compliance with mandatory EU legislation (such as the RoHS Directive), by relying on eco-labelling as evidence, or by checking environmental product declarations to check compliance with specifications.

In selecting suppliers and service providers, certification under an EMS such as EMAS or ISO 14001 can legally be used by tendering parties to demonstrate their technical capacity to apply environmental management measures, although such certification may not be mandated since compliance should be allowed to be proven using other means.

City example: Procuring lighting solutions in Kolding, Denmark

Kolding has ambitious aims in the field of climate and energy, aspiring to reduce per capita CO_2 emissions by 75% by 2021 compared to a 1990 baseline, and is using public procurement as one of the tools to meet these aims. One of its procurement initiatives entails cooperation with manufacturers in the pre-procurement phase, a good example of smart public procurement. Kolding is a Procura+[49] campaign participant.

The focus of the initiative was on energy-efficient light-emitting diodes (LED) light sources as a replacement for incandescent and halogen lighting sources. The initiative followed following steps:

A. Identifying product groups: The choice of energy-efficient lighting made sense given the high proportion of lighting within the city's energy consumption.

B. Setting up a project team: The municipality formed a team assisted by the Danish Lighting Centre which held the relevant LED lighting expertise.

C. Defining your needs: The project team chose a tried-and-tested LED technology and defined some functional requirements as well as technical specifications.

D. Informing the market: An information meeting was organised with relevant stakeholders.

E. Engaging the market: During the meeting, stakeholders highlighted the need to make the technical specifications more stringent in order to drive innovation, something which the city then did.

F. Tendering and contracting: Kolding invited other municipalities to join the tender in order to increase the purchase volume and therefore make it more attractive for manufacturers. An open invitation to tender was put out, and its division into three product categories encouraged SMEs to participate.

Kolding learned several lessons from its experience in tendering for LED lighting sources:

- "The result from the tool showed that the tender with the lowest lifetime expense was not the economically most advantageous tender when taking into consideration the other allocation criteria, energy efficiency and light quality."
- "Kolding's experiences demonstrate that when working with new technologies, you are dealing typically with a market that is not used to submitting tenders for public invitations to tender. The market is typically smaller businesses." Tender material, evaluation criteria and points allocation procedures should be made clearer.
- "For new technologies, there are neither ISO nor EN standards that can be referred to in the requirements specification or for the evaluation criteria. It is therefore important for the invitation to tender material to clearly show how the desired values will be stated," and a dialogue with the market can assist in this process.
- Kolding used a CO_2 evaluation tool, but failed to learn enough about it prior to the tendering process. "A more thorough examination of the tool would have given the opportunity to set up the evaluation criteria in a way that used the tool in a more goal-orientated way."

Source: Estevan et al., 2011

City example: Responsible procurement in London, United Kingdom

London's Responsible Procurement initiative is considered a leading example of sustainable public procurement. The initiative places particular emphasis on the social side of sustainability, largely because the city contains pockets of economic and social deprivation that are geographically and ethnically concentrated. This city example will however centre more closely on another key aspect of the initiative – environmental protection – which mainly focuses on reducing greenhouse gas emissions, air pollution and waste.

The Mayor's Responsible Procurement Policy is implemented by the GLA Group, which is made up of the Greater London Authority, Transport for London, the London Development Agency, the London Fire and Emergency Planning Authority and the Metropolitan Police Authority and Police Service. The procurement programme is large, involving an annual expenditure of over three billion pounds. Being set by the Mayor, the procurement policy changes in response to particular political priorities. For example, the main priorities at present are the environment, providing skills and employment as well as ensuring contracted workers receive the London Living Wage (as well as encouraging London's private sector employers more generally to pay this wage). These priorities are particularly relevant given the current economic downturn.

Four main themes guide London's green procurement: the reduction of greenhouse gas emissions, the decrease of air pollution, treating waste as a resource and creating a green economy. Indeed, without intervention London's CO_2 emissions will increase by 15 percent by 2025, and its waste production will increase to 23.6 million tonnes by 2020 (Greater London Authority, 2008b). Some of the main environmental projects implemented through procurement in London have been linked to transport (through cycling and hybrid or electric vehicles for example), lighting (such as the installation of LED lighting in GLA Group offices, the London Underground, etc), waste recycling (for example making accessories and furniture out of redundant fire hoses) and energy efficiency. The London Energy Efficiency fund provides funding for energy efficiency retrofits on public sector buildings. Through the RE:FIT programme[50], many GLA Group buildings are becoming more energy efficient in a cost-effective way. The programme uses Energy Performance Contracting, whereby the public sector organisation appoints an energy service company (ESCo) to install energy efficiency measures. Since the ESCo then guarantees a set level of annual energy and cost savings over an agreed payback period, long-term savings are achieved.

Networks of cities play an important role, by providing London with ways to promote and share the work it does on green procurement. London is part of the SCI network[51], is a Procura$^+$ campaign participant and chairs a number of national procurement groups. One of the main ways through which London shares its GPP work is through the Responsible Procurement website[52], which showcases a number of case studies, tools and publications, and the Mayor of London's Green Procurement Code website, containing resources, guidance and a directory of green products. The code is a free service that helps London organisations reach environmental targets. London's frontrunner role has meant that it has often implemented programmes and actions that are more ambitious than EU or UK legislative requirements. The city on the other hand can influence policy making by providing input to consultations.London has taken advantage of the window of opportunity provided by the 2012 London Olympic games. The Olympics have provided an opportunity for local businesses to obtain a share of the large amount of available funds, something which its procurement policy has encouraged. Indeed, requiring all contracts – including small subcontracts – to be published online in the CompeteFor tool has allowed smaller businesses to gain access to Olympics contracts. The tool has also helped less traditional, smaller and more diverse businesses become more involved in procurement, and has helped reduce costs by increasing the competition for contracts. For instance, since June 2011 when the Metropolitan Police Service mandated the use of CompeteFor for all expenditures below £50,000, 88% of contracts have been awarded to SMEs, 15% to organisations led by women and 14% to black and ethnic minority led organisations.Sustainable food procurement is one of London's areas of activity, and is another example of the stimulating role of the Olympics, since the GLA Group is following the high standards set for food procurement during the games.

The standards include provisions that help the environment – through organic or integrated production certification, sustainable fish harvesting, the promotion of seasonal produce and by encouraging better energy and waste management; but also social equity – through fair trade; the economy – by prioritising UK producers; animal welfare and nutrition. The standards are as follows:

- "All food should be produced to UK or equivalent production standards where this does not increase overall costs;
- More food must be produced to higher environmental standards;
- At least 50 per cent of tea and coffee must be fairly traded;
- Fresh produce should be seasonal;
- Food waste must be minimised."[53]

Several examples of sustainable food initiatives that meet or exceed these criteria exist. Chefs and catering managers are being trained to use food in a more sustainable way, for example by purchasing sustainably-harvested fish or by using different cuts of meat that enable a larger proportion of the animal to be made use of. Also, Transport for London composts all food waste and collects and recycles used cooking oil for use as a vehicle fuel. Finally, over 1.7 million free-range eggs are procured by the GLA Group per year in London as a way to support higher animal welfare agriculture.

Sources: M. Galvin, personal communication, January 16, 2012 & Greater London Authority, 2008b

Applicability

All public administrations carrying out procurement activities of one sort or another, be they of products, services or works. As a result, GPP is applicable for all types and sizes of public administrations. The size of a public administration body does however play a role in the extent and type of GPP that it can carry out. Indeed, some of the activities that GPP entails are more easily undertaken by a large public administration body which has sufficient financial and staff resources to allocate to them. One such activity is life cycle costing – described in the next section – which, in particular when seeking to integrate environmental externalities, can be a complex process.

However, guidance for GPP is becoming more and more established, making the process easier and less time- and resource-consuming for public administrations to follow. For example, the EC regularly updates the list of GPP product and service criteria that can be inserted as is into tender documentation and provides a substantial amount of guidance information on its GPP website[54]. In addition, for smaller public administration organisations joint procurement – described in the next section – is a viable solution that allows for the pooling of knowledge, costs and purchase quantities.

Economics

Often, the perception is that applying higher environmental standards will lead to important cost increases. Time and again, this assumption has been proven wrong, as in the case of Vienna explored previously. Research has found little difference in the life-cycle costs of green versus non-green products (Rüdenauer et al., 2007). Several procurement tools contribute to financial efficiency and help build a business case for the introduction of GPP (European Union, 2011):

- Life-cycle costing (LCC): LCC enables the integration of operation and disposal costs into the price of a product or service, and allows for the integration of the environment in a decision-making process which is often still guided by financial considerations. It is different from life-cycle analysis which undertakes a full cradle-to-grave analysis of the environmental impacts of a product or service, including those of raw material extraction and manufacturing. LCC often leads to the choice of greener products which

are also cheaper overall. Indeed, they allow for water and energy savings and are often designed in a way that minimises maintenance and replacement costs. Some LCC calculations also take into consideration environmental externalities.

- Joint procurement: This entails the combining by a group of public authorities of procurement activities, leading to cost savings through bulk purchasing, reduced administrative costs and the pooling of knowledge about markets, technologies and the environment. Joint procurement can be organised by participants or through regional or national purchasing bodies who carry out procurement on behalf of public authorities.

- Energy performance contracting is a contractual arrangement between a building owner or occupier and an energy service company (ESCO) whose purpose is to improve a building's or a group of buildings' energy efficiency. The energy efficiency work is financed by the ESCO or a bank, who receive a fee linked to the energy savings achieved; once the contract is over, the owner or occupier reaps the benefits of the energy efficiency measures.

Driving force for implementation

In addition to the environmental benefits listed previously, the following points are also drivers for the implementation of GPP within public administrations (European Union, 2011):

- GPP as a driver of innovation: Procurement programmes, particularly large ones set by big cities or groupings of smaller ones, can push for sustainable innovation in service delivery or product manufacturing by setting high standards, "providing industry with real incentives for developing green products and services – particularly in sectors where public purchasers represent a large share of the market (e.g. construction, health services, or public transport)." For example, public bodies such as Transport for London or the London Metropolitan police have invested in electric vehicles for their own use as a way to stimulate the uptake of electric vehicles throughout the capital.

- GPP as a cost-reduction tool: "GPP may also provide financial savings for public authorities – especially if you consider the full life-cycle costs of a contract and not just the purchase price. Purchasing low-energy or water saving products for example, can help to significantly reduce utility bills. Reducing hazardous substances in products can cut disposal costs."

- GPP as a way to boost confidence in public administrations: Having a green procurement policy can create a positive, environmentally-friendly and open reputation for an organisation, and lead to improved relations with businesses, civil society and citizens.

- GPP as a means for improving working conditions: Many of the criteria and requirements of GPP contain provisions that directly or indirectly improve the health and working conditions of public sector employees.

City example: Cascais, Portugal - GPP to drive innovation in the framework of the SMART SPP Project

Cascais Municipality is located in the district of Lisbon, on the eastern estuary of the river Tagus. It consists of six parishes (Cascais, Estoril, Parede, Carcavelos, São Domingos de Rana and Alcabideche), with around 190,000 inhabitants. Since 2007, the authority has had a municipal energy agency – *Cascais Energia* – and has signed the Covenant of Mayors. Within this framework, various initiatives and projects are taking place with the aim of boosting energy efficiency and the use of renewable energy, while reducing CO_2 emissions within the municipality.

The Municipal Council of Cascais, the Cascais Energy Agency and the National Laboratory for Energy and Geology (LNEG) have purchased energy-efficient public lighting and focused on

techniques to involve the market prior to the call for tenders (in the pre-procurement phase). This approach allowed market-tailored technical specifications to be developed, which avoided complicated tendering procedures and therefore saved time and resources.

Identifying appropriate product groups

Meetings were held with technicians from departments of the Cascais Municipal Council and Cascais Energy Agency, in order to identify the innovative products of greatest interest, taking into account that they would be the subject of a public procurement contract during the three year Project. Energy efficient outdoor public lighting emerged as a priority product as the Municipality planned to replace around 40 lamps with high-pressure sodium vapour (HPS) technology in the area around the Pedra do Sal Environmental Centre. This space, which raises awareness on the subject of energy efficiency and renewable energy concepts, already had a pilot LED technology system in place.

Setting up a project team

With the aim of ensuring the availability of the various technical skills needed to develop the procurement process, a multidisciplinary team was set up comprising the Cascais Energy Agency, Cascais Urban Services Company, the Electricity and Public Lighting Division, Procurement Division, Transport and Mechanics Division and the Coastal Management Division, as well as the LNEG.

The role of the LNEG was to guide and provide technical assistance to Cascais Municipality in applying the methodology developed in the SMART SPP project to promote innovation and energy efficiency through purchasing, particularly in phases involving the market and those developing the purchasing criteria. This team held regular meetings from October 2009 to July 2011, enabling knowledge to be actively exchanged, thus enriching the final outcome of the project.

Defining the needs that the purchase must fulfil, performance requirements and possible solutions

Once the decision was made to purchase energy-efficient outdoor public lighting to replace around 40 lamps at the Pedra do Sal Environmental Centre, a market study was performed with the aim of:

1. Identifying existing technologies on the market and other technologies which were about to be introduced onto the market, their main features, advantages and disadvantages;
2. Identifying suppliers of these technologies. LED technology appeared to be a promising, albeit emerging solution on the (outdoor) public lighting market.

Important issues to include in the purchasing process were also defined:

• It was decided to replace the HPS lamps, keeping the existing columns;
• A light control system was included in the call for tenders, so as to allow flux to be regulated and thus boost energy savings;
• Suppliers were asked to carry out a photometric study, taking into account existing conditions (the columns would not be replaced and therefore the distances between the lamps would already be defined) so as to present the best solution, both in terms of photometric performance and in terms of energy performance.

An initial version of the technical and energy efficiency criteria to be included in the tender procedure was established in this phase.

Informing the market

In order to bring together suppliers and buyers, an energy efficient lighting seminar was organised, focusing on LED technology for public lighting. In this seminar, the SMART SPP approach was presented and the aim was:

• To convey to potential suppliers information on purchasing intentions and the generic initial requirements;
• To increase buyer knowledge on energy-efficient lighting and LED public lighting through the various suppliers presenting their products, followed by a moderated debate.

Consulting the market

The Cascais Energy Agency invited eleven LED lamp suppliers to take part in informal and individual meetings with the aim of:

• Learning about the features of the products available on the market;

• Informing suppliers about the features of the lamps to be purchased, reflected in the technical and energy-efficiency criteria defined;

• Receiving comments from suppliers on the technical and energy-efficiency criteria;

• Gathering technical and energy-efficiency data, and data on product life-cycle costs.

All suppliers identified in the market investigation process, in previous contracts with the Cascais Energy Agency and Cascais Municipal Council and on their own initiative were invited to take part, having access to the same information. The informal involvement process was carried out in a phase prior to the tender process. Questionnaires were sent out to potential suppliers in order to prepare for the meetings. The aim of the questionnaire was to gather technical and energy efficiency data, and data on product life-cycle costs, as well as to validate these criteria for the market.

During the meetings the suppliers raised questions on the criteria used as well as the proposed performance values, which allowed for a better understanding of the most important questions related to this type of technology. These debates undoubtedly helped establish criteria to be included in the specifications, and allowed the public authority to confirm that the market is able to offer suitable solutions.

Tendering and contracting

The market involvement phase allowed the abovementioned technical specifications to be improved. Research was also carried out into the criteria used in similar procurement processes around the world. The criteria developed included energy-efficiency (luminous efficiency) issues, equipment durability (useful lifespan, mechanical resistance and corrosion), as well as issues relating to the photometric performance of the overall solution (colour temperature, light distribution, etc.), using the standard DIN EN 13201 – Road Lighting as a reference. Other issues to be considered in the assessment were the guarantee conditions and integrating the lamps into the site. For future activities, the decision was made to extend the procurement process to other streets and sites of tourist interest within the municipality. Given the high purchase cost involved and the fact that this is emerging technology, a restricted call for expressions of interest is to be used. The award criterion will be that of the most economically advantageous bids, and the costs throughout the product life-cycle will be taken into consideration in assessing the bids.

Lessons learnt

• Involving the market allowed the development of more rigorous criteria due to the suppliers' comments, as well as saving resources by avoiding more complex tender processes;

• This experience will allow the development of performance specifications applicable to lighting technology in general;

• Having a multidisciplinary team was fundamental in involving the market and in developing procurement criteria, leading to a deeper knowledge of the issues studied;

• Suppliers were made aware of the opportunities for innovation in the public procurement processes and of the need to communicate the performance of their products by means of environmental labelling;

• LED public lighting is still not used a great deal on the site, meaning there has not yet been enough experience to gather data in relation to life-cycle costs;

• This methodology for innovation in public procurements could be replicated in other procurement processes;

• The pilot installation demonstrated that energy saving of around 30% could be achieved by simply replacing conventional lighting with LED.

Source: The SMART SPP Project - www.smart-spp.eu

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4 EMERGING TECHNIQUES/APPROACHES

Generally, the term 'emerging techniques' is understood according to the draft Industrial Emissions Directive (IED, 2010). There, the definition of emerging technique is 'a novel technique for an industrial activity that, if commercially developed, could provide either a higher general level of protection of the environment or at least the same level of protection of the environment and higher cost savings than existing best available techniques'.
As soon as a technically feasible and economically viable technique has been implemented on a major scale, it can be considered as best management practice. If the conditions for the implementation are representative of the whole or a major part of the sector, even a few applications of a technique could be sufficient to draw the 'best management practice' conclusion.

In the case of PA, the environmental performance is not just a matter of targets. It also concerns the way that systems work in local governments, in sites, or in the interactions between them.

In this chapter attention is turned to emerging techniques and approaches in a broader sense. Challenges that PAs need to face, such as global climate and life-support system are not only technical challenges; but also political, economic, social, cultural and ethical.

Over the past years, the following cross-cutting themes/responses have been discussed in European environmental policies and will specifically characterise local governments' policies in the next decades.

Resource efficiency
Due to recent developments in commodity markets, especially a major surge in global raw demand, the issues of resource scarcity and resource efficiency have moved to the forefront of the European political agenda (ESDN Conference, 2011).
In the framework of Europe 2020 Strategy, the European Commission has launched the flagship initiative on "A Resource Efficient Europe" which sets EU PAs on the path to transformation. The flagship called for a roadmap to define medium and long term objectives and means needed for achieving them. The roadmap builds upon and complements other initiatives under the flagship, in particular the policy achievements towards a low carbon economy. Increasing resource-efficiency is one key factor for securing living-standards and jobs in Europe. It will bring major economic opportunities, improve productivity, decrease costs and boost competitiveness. The initiative for a resource-efficient Europe provides a long-term framework for actions in many broad and cross-cutting policy areas such as supporting policy agendas for climate change and climate protection, sustainable energy production and consumption, sustainable transport, cleaner production in industry, using renewable materials, sustainable agriculture and nutrition, urban development and ecosystems.

Ecosystem services approach
The scope of planning for PA's is closely linked to the emerging approaches on ecosystem services. Ecosystem services describe the interactions between the physical environment and human societies (Millennium Ecosystem Assessment, 2005).
Ecosystem services are classified as 'provisioning, socio-cultural, regulating and supporting' types of services.
Typically, local policy makers have to provide multiple services simultaneously. These include: public infrastructure, water and waste management; promoting local economic development; education and health care. Their challenge is to maintain and improve the quality of life for citizens when financial resources and capacities are often severely limited (TEEB for local and regional policy-makers, 2010).
By making use of this concept, local policy makers can fully utilise nature's assets for local development. They can make good use of available instruments and procedures (Environmental or strategic Impact Assessments; Cost-Benefit Analysis for public infrastructure; local and regional tax incentives); develop new instruments to improve biodiversity related decision-making (Payment for Ecosystem Services (PES), Reducing Emissions from Deforestation and

Forest Degradation (REDD) pilot scheme and Clean Development Mechanism projects); advocate environmental concerns at higher policy levels. Ecosystems become therefore building blocks for PA's planning. Integrating the Ecosystem services approach into planning can also lead to a sustainable response to climate change.

Adaptation to climate change

In April 2009, the European Commission released a White Paper outlining a proposed framework for action to reduce vulnerability and adapt to climate change (European Commission, 2009). The White Paper refers to the importance of a climate adaptation strategy that integrates all areas of municipal development, such as building, transport, energy, water management, ecosystems and biodiversity. PAs face a specific set of challenges and in many ways will be profoundly affected by climate variability and change. This is for two main reasons (Ecologic Institute, ICLEI, REC and AEA, 2011):

- Cities are focus points of vulnerability
- Cities rely on complex infrastructure in order to function. This infrastructure is at risk of climate change.

From a policy perspective, the current debate on climate change can provide interesting opportunities. In many PAs strategies to adapt to climate change are currently being developed or refined, and this can create opportunities for policy change and dialogue between different agencies and actors.

The emerging approaches to adaptation to climate change in cities recommend a portfolio approach. Measures taken to adapt to climate change are not always identified as such; they need to be included and integrated in a portfolio of complementary measures and synergies.

A lot of projects concerned with adaptation to climate change have started in the past few years and are still running. Some of these connect adaptation to climate protection research; others focus on the impacts of specific threats such as floods, water scarcity, sea level rise or heat. Impacts in specific European regions are addressed. Only few projects are really focussing on adaptation options for cities and urban regions (ETC, AAC, 2011).

ICT-enabled governance for smart cities

Effective governance of the PAs of Europe today is fundamentally undermined by urban complexity, whereby the high degree of interconnectedness and multiple interactions between socio-economic and environmental factors in a territorial context create major barriers to the effective implementation of sustainable urban development. The proactive governance of cities and the delivery of more sustainable compact cities offer substantial opportunity for the application of enhanced intelligence in urban management, to produce an effective basis for assessment of urban complexity, and decision-making support (Urban API project).

ICT-enabled governance is particularly emerging to "1. Simplify and improve the internal administrative operations of government and their relations with other bodies involved in public management and service delivery; 2. Facilitate public service interaction between government, citizens and other stakeholders, thus enabling better citizen participation and overall monitoring and evaluation of decision-making processes and their implementation and 3. Ensure inclusiveness and equal opportunity for all" (JRC-IPTS, 2011). ICTs bring a significant change in PA's governance, particularly in terms of improved communication and information services, as well as offering the potential to provide urban planners with the tools and intelligence needed to actively manage the urban environment.

ISO TC 268 Sustainable Development in Communities

Another procedure still in the development phase is the standardization in the field of Sustainable Development in Communities. Such International standard will include requirements, guidance and supporting techniques and tools to help all kind of communities, their related subdivisions and interested and concerned parties become more resilient and sustainable and demonstrate achievements in that regard. The proposed series of International Standards will thus encourage the development and implementation of holistic, cross-sector and area-based approaches to sustainable development in communities. It will include Management

System Requirement, Guidance and related standards (refer to http://www.iso.org/iso/). The secretariat of this standard development is the French AFNOR, an association governed by the law of 1901, consisting of nearly 2500 member companies. Its aim is to lead and coordinate the standards development process and to promote their application.

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5 CONCLUDING REMARKS

5.1 General aspects

This document is the reference document for the PA sector and has been developed according to Article 46 of the EMAS Regulation 1221/2009/EC. The most important environmental aspects, direct or indirect, relevant to the PAs have been identified. The document summarises the best environmental management practices dealing with these identified aspects, including sector specific environmental indicators and derived benchmarks of excellence for the environmental performance of PAs and processes/techniques carried out by these PAs respectively.

The kick-off meeting for the elaboration of the pilot reference document on best environmental management practice for the PAs sector was held in September 2011. The overall structure of the document, with particular reference to the techniques, was agreed. The next working period was dedicated to collecting information and data, carrying out relevant site visits and developing the draft document. Communication with the entire research team was ensured at regular intervals.

This document was developed based on information exchange with local governments, consultation with experts, literature review and site visits. The document may be helpful both to all those organisations who have implemented EMAS or want to implement it, and also to all those who have implemented any other environmental management system or intend to improve their environmental performance and move towards greater sustainability.

In the EMAS registration process, with respect to preparing the environmental statement and to assessing their environmental performance, organisations shall take the reference documents into account. Consequently, the environmental performance should be reported using the specific indicators as described in the preface of the document. Best practice techniques and benchmarks of excellence provide reference points against which a local government can compare its environmental performance in order to identify improvement potentials.

The reference document was structured according to the bullet points of Article 46(1). First, identified best environmental management practices (BEMP) are listed. Then, the common specific indicators of the PA sector are described. Finally, derived benchmarks of excellence for each aspect, where appropriate, are shown, with the links to indicators and best practices.

5.2 Best environmental management practices

A best environmental management practice (BEMP) is defined in the EMAS regulation as 'the most effective way to implement the environmental management system by organisations in a relevant sector and that can result in best environmental performance under given economic and technical conditions'. In this document, identified best practices in the PA sector are described in Chapter 3. Their environmental performance has been evaluated in technical detail along with economic considerations. The described practices address the most important environmental aspects of the PA sector, both direct and indirect. Following the preamble of the EMAS regulation, the aim of the reference document is to help organisations to better focus on the most important environmental aspects of the sector. For this purpose, detailed technical information and data were collected and collated, based in many situations on case studies. The structure of the technical descriptions of the different practices is similar to the Best Available Techniques Reference Documents (BREFs) according to Article 13 of the Industrial Emissions Directive (formerly the IPPC Directive): description, achieved environmental benefits, appropriate environmental indicator, cross-media effects, operational data, applicability, economics, driving force for implementation, reference PAs and reference literature.

Best practices for the different environmental aspects were described in Chapter 3. The most important environmental aspects that have been identified for the PA sector are:

- Climate change mitigation and adaptation
- Use of land
- Mobility
- Air quality
- Noise
- Waste
- Water supply and waste water treatment
- Green spaces and biodiversity
- Energy
- Environmental information /education of citizens and companies
- Green public procurement

For most of the above aspects, the following practices have been described:

- Mobility
  - Enacting a Sustainable Urban Mobility Plan
  - Achieving a city wide Cycling Programme
  - Improving the uptake of Electric Vehicles in urban areas
- Air quality
  - Structural approach to air quality management
- Noise
  - Strategic Noise planning
- Waste
  - Integrated municipal waste management
- Water management
  - Integrated urban water management
  - Water supply management: Integrating externalities into leakage management
  - Wastewater management: Sludge reuse for energy crops
  - Stormwater management: Water-Sensitive Urban Design
- Green spaces and biodiversity
  - Local Biodiversity Strategy and Action Plan implementation
  - Blue-green networks
  - Green and brown roofs
  - Limiting urban sprawl into green spaces
- Energy
  - Sustainable Energy Action Plan
  - District Heating System
  - Increasing the use of Solar Power
  - Smart grids
- Management of Public Administration
  - Integrated Environmental management systems
  - Green public procurement

Finally, the document has described the most relevant indicators. Selected indicators have been identified as absolute indicators (type A) and relative indicators (type A/B).
The different issues which have been taken into account in the definition of the most suitable set of indicators implemented by a PA could be summarized as follows:

- significance of the environmental aspects (direct and indirect);
- data availability;
- objective monitoring or assessment of the performance;
- evolution over time within the organization;
- benchmarking between similar organisations/activities/processes.

With reference to the last point, benchmarks among Public Administrations were defined using different approaches. They varied from the best performance achievable ever or achievable by very few, to current/potential average in the Public Administration sector. Another issue that was taken into account was the relative success or failure achieved. The selected benchmarks inform on what is potentially achievable under certain circumstances using a restricted number of quantitative indicators.

6 GLOSSARY

List of terms and abbreviations	
µg/m^3	microgram per cubic metre
€/ton	Euro per tonne
ACR+	Association of Cities and Regions for Recycling and sustainable Resource management
AD	Anaerobic Digestion system
AESS	Agenzia per l'energia e lo sviluppo sostenibile
BEA	Berlin Energy Agency
BEI	Baseline Emission Inventory
BEMP	Best Environmental Management Practice
BMU	German Federal Environment Ministry
BMWi	German Federal Ministry of Economics and Technology
BOD	Biochemical oxygen demand
BPL	Broadband Powerline
BREF	Best Available Techniques Reference Documents
$CaCl_2$	calcium chloride
cars/1000 inh	number of registered cars per 1.000 population
CBA	Cost Benefit Analysis
CBD	Convention on Biological Diversity
CEMR	Council of European Municipalities and Regions
CF	Cohesion Fund
CH_4	methane
Change LAB	Changing Lifestyles, Attitudes and Behaviour
CHF	Swiss Franc
CHP	Combined Heat and Power
CMA	calcium magnesium acetate
CNG	Compressed Natural Gas
CO	carbon monoxide
CO_2	carbon dioxide
COD	chemical oxygen demand
CoE	Council of Europe
CoM	Covenant of Mayors
CoMO	Covenant of Mayors Office
CoR	Committee of the Regions
CPMA	Central Project Management Agency
cross-media effects	the calculation of the environmental impacts of water/air/soil emissions, energy use, consumption of raw materials, noise and water extraction
CSR	Corporate Social Responsibility
CTR	Copenhagen Heating Transmission
dB	deciBel
deaths/1.000 inh	Number of deaths in road accidents per 1.000 population
DEFRA	Department for Environment, Food and Rural Affairs
DG	Direction General
DH	District Heating

DKK	Danish krone
dph	dwellings per hectare
DVGW	German Technical and Scientific Association for Gas and Water
DWD	Drinking Water Directive
EBBC	European Business and Biodiversity Campaign
EC	European Commission
EC	European Community
*eco*BUDGET	A framework tool for environmental management
Eco-Lighthouse	A Norwegian Environmental Certification
EEA	European Environment Agency
EEA	European Economic Area
EEA	European Energy Award
EEC	European Economic Community
EGCA	European Green Capital Award
EIA	Environmental Impact Assessment
ELL	Economic Level of Leakage
EMAS	Eco-Management and Audit Scheme
EMS	Environmental Management System
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Contract
EPSA	European Public Sector Award
EPSA	European Public Service Award
ERDF	European Regional Development Fund
ESCO	Energy Service Company
ESF	European Social Fund
EU	European Union
EU SDS	EU Sustainable Development Strategy
EU-15	Member States of the European Union before 1 May 2004
EU-25	Member States of the European Union from 1 May 2004 until 31 December 2006
EU-27	Member States of the European Union from 1 January 2007
EUR	Euro – European currency
Eurostat	The statistical office of the European Union
EV	Electric Vehicle
FAP	Forest Action Plan
FP7	Seventh Framework Programme (funding programme created by the European Union in order to support and encourage research)
FSC	Forest Stewardship Council
FYROM	Former Yugoslav Republic of Macedonia
g	gram
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GL	Gigaliter
GLA	Greater London Authority
GMO	Genetically Modified Organisms

GPA	General Procurement Agreement
GPP	Green Public Procurement
GVA	Gross Value Added
ha	Hectar
HGV	Heavy Goods Vehicle
HSL	Helsinki Region Transport Authority
HSP	High-pressure sodium vapour
HSY	Helsinki Region Environmental Services Authority
ICT	Information and Communication Technology
IDEMS	Integration and Development of Environmental Management Systems
IEA	International Energy Agency
IED	Industrial Emissions Directive
IEE	Intelligent Energy - Europe
IEMS	Integrated Environmental Management System
ILUC	indirect land use change
IMS	Integrated Management System
inh/km^2	inhabitant per square kilometre
injured/ 1.000 inh	number of persons seriously injured in road accidents per 1.000 population
IPCC	Intergovernmental Panel on Climate Change
IPPC	Integrated Pollution Prevention and Control
IPTS	Institute for Prospective Technological Studie
ISO	International Organisation for Standardisation
IT	Information Technology
IUCN	International Union for the Conservation of Nature
IUWM	Integrated Urban Water Management
IWA	International Water Association
kg	kilogram (1 kg = 1000 g)
kg/effective inhabitant	kilogram per effective inhabitant (resident + tourist)
kg/inh	kilogram per inhabitant
km	kilometre (1 km = 1000 m)
km/h	kilometre per hour
km/km^2	kilometre per square kilometre (eg. cycle lanes, paths and routes/ total area)
kW	kilowatt
kW/employee	kilowatt per employee
kWh	kilowatt hour (1kW= 1000 W)
kWh/employee	kilowatt hour per employee
kWh/inh	kilowatt hour per inhabitant
kWh/lighting point	kilowatt hour per lighting point
kWh/m^2	kilowatt hour / square metre
l	litre
l/inh	litre per inhabitant
l/m^2	litre / squre metre
LAPD	Local Authority Prevention Demonstration Programme
LATS	Landfill Allowance Trading Scheme

LBSAP	Local Biodiversity Strategy and Action Plan
LCA	Life-cycle Assessment
LCC	Life-cycle costing
LED	Light-emitting Diode
LTZ	Limited Traffic Zone
m	meter
m/inh	metre per inhabitant
m^2	square metre
m^2/employee	square metre per employee
m^2/inh	square metre per inhabitant
m^3	cubic metre
m^3/employee	cubic metre per employee
m^3/inh	cubic metre per inhabitant
m^3/m^2	cubic metre / square metre
m^3/resident	cubic metre per resident
MBT	Mechanical-biological treatment
MFCA	Material Flow Cost Accounting
mg/m^3	milligram per cubic metre
MgCl2	magnesium chloride
motorbikes/ 1000 inh	number of registered motorbikes per 1.000 population
MSW	Municipal Solid Waste
MUE-25	Managing Urban Europe-25 Project
MW	Megawatt
MWh	Megawatt hour
N_2O	nitrous oxide
NACE	Nomenclature statistique des activités économiques dans la Communauté européenne / Statistical Classification of Economic Activities in the European Community
NBSAP	National Biodiversity Strategy and Action Plan
NCP	Stockholm National City Park
NGO	Non-Governmental Organization
NO_2	nitrogen dioxide
NOISE	Noise Observation and Information Service for Europe
NO_x	mono-nitrogen oxides
NRW	Non-Revenue Water
O3	Ozone
OECD	Organisation for Economic Co-operation and Development
ORC	Organic Rankine Cycle
PA	Public Administration
PAHs	Polycyclic aromatic hydrocarbons
pass/inh	passenger per inhabitant (urban public transport passengers within the urban area/ population)
PAYT	Pay-as-you-throw-schemes
PCBs	Polychlorinated biphenyls
PCTs	Polychlorinated terphenyls
PDCA	Plan, Do, Check, Act (approach to energy/environmental

	management)
PDU	Plan de Déplacements Urbains (Urban Transport Plan)
PDU	Plan de Déplacements Urbains (Urban Transport Plan)
PEFC	Program for Endorsement of Forest Certification
PES	Payment for Ecosystem Services
PIN	Prior Information Notice
PJ	Petajoule
PM_{10}	Particulate matter less than 10 microns in diameter
$PM_{2.5}$	particles smaller than 2.5 micrometers
PTMB	Barcelona Energy Improvement Plan
RCI	Rotterdam Climate Initiative
REDD	Reducing Emissions from Deforestation and Forest Degradation
refill/ employee	number of ink jet and laser jet refill used/ total number of employees
RES	Network of Regions on Education for Sustainability
RES	Renewable Energy Sources
RGUA	Recreational green urban areas
RoHS	Restriction of Hazardous Substances
SDES	Southampton District Energy Scheme
SEAP	Sustainable Energy Action Plan
SELL	Sustainable Economic Level of Leakage
SFM	sustainable forest management
SGHC	Southampton Geothermal Heating Company Ltd
SMEs	Small and Medium Enterprices
SO2	sulphur dioxide
SRC	Short-rotation Coppice
STO	Solar Thermal Ordinance
SUMP	Sustainable Urban Mobility Plan
t	tonne (1 tonne=1000 kg)
t/employee	tonne per employee
t/inh	Tonnes per inhabitant
TEEB	The Economics of Ecosystems and Biodiversity
Toner /employee	number of toner used/ total number of employees
trees/inh	trees per inhabitant
UARL	Unavoidable annual real losses
UBA	Umweltbundesamt (Federal Environment Agency)
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environment Programme
Urban Heat Island	a metropolitan area which is significantly warmer than its surrounding rural areas
USA	United States of America
vehicle-km	km travelled by all the public transport means in a year
vehicle-km/inh	km travelled by all the public transport means in a year/ population
VOC	Volatile Organic Compounds
WCP	Westminster City Partnership

WFD	Water Framework Directive
WH	Western Harbour
WHO	World Health Organisation
WISE	Water Information System for Europe
WRAP	Waste and Resources Action Programme
WSUD	Water-Sensitive Urban Design
WTO	World Trade Organisation

7 ANNEXES

7.1 Annex I

Transcript of the interview with Jan Elleriis, Vice-director, CTR – Metropolitan Copenhagen Heating

1. What is CTR's background? What is its role within the district heating system? (DH)

CTR is about 25 years old... It's a joint municipal company. There are five municipalities which are the owners of the company. They joined forces in order to establish this technical system because the system runs throughout the five municipalities. It supplies the five municipal district heating companies responsible for the local distribution of district heating in each of the municipalities. We are connected to another system in the western part of the Copenhagen region... [shows on map] We are connected to another transmission company in the western part of Copenhagen where about 11 municipalities have established the same kind of system. Technically they are connected to one another and operate, as it is, as one system, but separated into two companies due to the number of municipalities involved – there were too many municipalities back in 1982, 1983, when the negations were made about establishing the system, there were simply too many to establish one company. Both companies have exactly the same structure.

In Denmark district heating is by law a monopoly business. The municipality finds out which kind of areas are suitable for DH, where DH should be the supply system, and where natural gas should be the supply system, and then they have to stick to these areas. The natural gas company is not allowed to go into the DH company area and vice versa. Our only competition, you could say, is against individual heating. Our competition is oil fired individual heating in houses.

In the city of Copenhagen market share is 98%. We have 2 municipalities where it is very close to 100% and then we have 3 where it is partly DH and partly natural gas. The share is smaller (I don't know exactly what it is). The average level for the country is about 60% of households that are heated by DH in Denmark.

DH has been around for many years in CPH. The type of buildings in Copenhagen makes it very feasible for DH.

2. What are the barriers to expansion?

DH is of course more expensive to establish than natural gas. A natural gas pipe is cheaper for example. The construction of DH is much more expensive. But then you have the feasibility of DH – that is, you can put every type of fuel into DH. With natural gas you only have gas. With DH you can have several different kinds of production units, surplus energy from industries and in principle you can swap between different fuels. When we started it was based on coal and waste heat and now we can convert into biomass and natural gas, and geothermal heating and so on. We have much more flexibility. The security of supply and flexibility is much better than gas or electrical heating.

In principle, heating is a very low value energy source, the demand is low value energy compared to electricity or natural gas which are a very high value energy sources. Therefore using electricity or gas for heat is a bad solution. There are a lot of value losses in using these sources.

3. What's the payback period?

Difficult to say. Depends on the city's situation. In Denmark we have a lot of taxes on energy. The CHP and waste incineration plants use less energy to produce heat than if they were individual systems. There are a lot of energy savings in DH system and therefore you could say, the price of energy and the taxation of energy very much affects the payback time. When we established the system in 1986, the plan was that the system should be paid back in full in 2003, and this target was met.

It's important to remember though, that this is a monopoly business. The consumers had to pay, so we are not in a situation where suddenly we won't get our money. So for us it's more or less can we keep the price as low as we promised, it's not an issue of whether it will be paid back or not – it will always be paid back. The real mission is to keep prices low and we have sold district heating for an end user price that is 10 – 15 % lower than individual heating.

4. To what degree is legislation a necessary driving force in the systems success?

One of the big advantages in Denmark, and the reason why we have so much DH, is that politicians took responsibility in the 70s and 80s. In Copenhagen we regard DH as a public service, in line with sewage, water or electricity and so on. It's not something for an individual to look after. If that did happen it would be more expensive, would not be an optimised solution and there would be greater environmental impact. The municipality and the society believe this is a public service and is the best solution to supply buildings with heat. Today there are a lot of private companies involved – all the power companies are private companies – they are involved in this business but they know that there's a very high level of stability. It's easy for them to invest in something that will be paid back in 20 years. It's possible for them to make a contract, to go on the international market for a loan, and their rating is very high because all of the municipalities are behind the company, so they have an AAA+++ rating, and so can borrow money at a very low interest rate compared to other private projects. Therefore it's possible to make these long term investments and have security for the project, so it's not a problem for private enterprises.

5. <u>How has the liberalisation of the energy market affected the DH monopoly and legislation requiring that a profit not be made on DH?</u>

District heating was excluded. All the grid systems are monopoly business and the whole DH system. We had a conflict, because the heat is produced in a liberalised plant, so the power companies are operating in two markets, on the liberalised electricity market and the monopoly DH market. So there are some rules regarding how the prices should be constructed when dealing with DH – they can only send bills based on real costs. They make an investment and we negotiate, how should this investment be distributed between DH and power, and in the use of fuel, what are the actual costs to purchase this fuel and so on, what are the other costs to have this running and that is what can be included in the bill.

So although it is liberalised, the DH part is not. That's one of the problems CTR has to operate within daily, the negotiations with the power companies, how do we share the real costs between electricity and power, where they can gain profit and not.

6. <u>Legislation requires a certain percentage of biomass to be used. How has this gone in practice?</u>

The society wants biomass to be used in the DH and power sectors, and the municipality wants co2 to be reduced as much as possible, therefore when a power company has a plan and wants it to be approved by the government, the authorities can make some demands regarding biomass use. The biggest power plant here, when it was constructed they were told that they couldn't build it as a coal fire power (they wanted it as a coal fire power plant because that is the cheapest solution), so they had to build it as a natural gas power plant, which was very expensive. After that they negotiated a solution with the authorities, where they said ok, if you use a certain percentage of the fuel as biomass, you can get money from the state to compensate for this. So some acts have been approved by the government that they should give grants to companies using biomass for production of power. A company using straw for example, gets a grant for every kilowatt hour they produce from the biomass. Biomass compared to coal is much more expensive. But due to taxes on energy coal used for heating is more expensive than biomass, which has no taxes. The problem is in order to have competition on the international markets, you cannot have taxes on the fuels for power, because it will not be possible to compete. There's no tax on fuel for electricity production, so therefore from the electricity side, biomass is a very expensive fuel. Therefore they need some kind of grant from the system in order to make it possible to use biomass.

When we have a power plants using biomass a lot of the discussion is about how to share the costs on that, because there is not tax on the energy, but the fuel is very expensive.

7. <u>As well as environmental benefits, there are energy security benefits, which will increase in the future...</u>

Only a small part of the biomass that is used in Denmark comes from Denmark. It is from the Baltic countries, Canada, and Africa. Most commonly used is from the Baltic countries. Biomass produced in Denmark is used in smaller district heating plants around the Copenhagen area.

8. Where does CTR draw its heat from?

We have 3 power plants producing DH. We have 3 big waste to heat plants (incineration) producing both power and district heating. We have a geothermal plant also, which we use in the system. A small one.

9. Is that something you're looking into more in the future? What are the benefits?

We have plans to establish plants about six to ten times as big as the one in operation...
This will take a number of years.
Geothermal is expensive to establish (construction costs). The pumping costs to take up the hot water are high. The heat energy however, the cost is of course zero for that. It's always there. The operation costs of a geothermal then are small compared to a power plant. There's also a risk that you invest several million into a plant that you then find out it doesn't function. Compared to building a power plant you have a huge risk – you have to add that onto the price.
You can say this about geothermal, and it also applies to district heating – it may be expensive to establish but the money you spent is money used for society. It is good for construction and so on, instead of using it on energy that you import. It's a good solution. You cannot just compare the cost, it makes a big difference for society whether you use the cost in the society, or you use it for something you import from abroad. This is especially important given the global financial situation.
To reduce CO2 currently we are converting coal-fire plants to wood pellets. It is actually quite easy to convert a coal fire plant to wood pellet, because you can use the same burners and so on. The whole storage facilities have to change (wood pellets have to be kept in closed storage, compared to coal). That's our plan in the short term, to convert all the coal-fire plants in Copenhagen.

10. What are the maintenance requirements?

All of our maintenance needs are outsourced, we only have 30 employees at the plant. It is outsourced to another company.
The whole system is automatic, so operating the system is done via the control room. They can control and see everything from the control room.
Only 1% of heating comes from peak load boilers, which are run on oil.
This has a big impact on air quality, which in turn has health benefits. One of the advantages is that it prevents local air problems caused by private furnaces.
DH saves about 1 tonne of CO2 compared to individual heating per year. (VERIFY)
One of the problems with incinerators is that we have plastic in the waste. If we want zero emissions, we have to find a method to remove the plastic from the waste.
Boilers that can use biomass, 1 or 2 geothermal plants, plastic being taken out of waste – all of this contributes to Copenhagen's plan to be carbon neutral by 2025.

11. Do you feel confident about achieving 2025 carbon neutrality?

As long as the municipality and the society also want to go in that direction. We are not the owners of the CHP plants. We only produce 2 – 5 % of the heat ourself. We have to reply on others to do what we want them to do, through negotiations. The municipality is very much for going in that direction, and society is very much for going in that direction and therefore the power plants say they want to go in that direction, but of course they are liberalised and so have to look at the monetary aspect. They basically say that if society makes this is an economical solution, then this will happen, because we can't do it ourselves.

12. What is the public reaction?

Compared to the number of people who have DH, the public knowledge of DH is very low. Most people don't know what kind of heating installation they have. Many people think it's to do with coal, and is pollutant heavy, and very few people know that DH is by far the biggest actor in Denmark to reduce the CO2 emissions.

13. My understanding is that through legislation you pay for it whether you use the system or not. What is the public's reaction to this?

Because most of the costs are a depreciation of investment costs and maintenance costs, there some running costs even if you don't use it. Somehow it has to be distributed to the ones connected to the system. Therefore you have to pay for the system when connected, even if not used. As long as it's cheaper than the alternative the public do not have an issue with it. If you have DH it is extremely expensive to convert back to oil for example.

14. Do you have to comply with the legislation requiring Copenhagen Energy to reduce power use from the demand side?

No. Copenhagen Energy has a requirement to reduce it by 2% per annum. Some companies buy low energy electrical bulbs and give them to consumers for example, and have consulting services, in order to meet this target.

As a transmission company we have no end users. If we were involved it would be the same savings twice.

15. What advice would you give to others wanting to start their own DH scheme?

Because it's a long term investment, you need some kind of security that the environment will be the same for many years, and people won't say after a short period "now we want something else". You need to establish a concrete environment. That's why it is the municipalities who owns us. That's why it is difficult to get private companies to start such a scheme – they are worried the municipalities will decide to try something else. It's important to have local and governmental backing for these systems to have DH on a big scale. If you don't do it you will only get DH in the most feasible part of the cities. In the rest, where it's feasible but not the highest profit area, you won't get it. Private companies will make small schemes only, to make the best profit. That's the difference the municipality can make – taking in the societal aspect.

16. How can people economically justify taking on a project of this size in the current climate?

You can turn it around and say to the European countries who want to go for lower CO2 emissions and so on, there is no other possibility, they have to go in this direction. Then you can ask, well what will happen if they don't do it? It's hard to say what is economically feasible, because what is the alternative if you don't do it?

7.2 Annex II

Transcript of the interview with Hanne Christensen and Rune Nielsen, Københavns Kommune

Q1. Regarding the DH system in Copenhagen, it is obviously a complex system that involves many actors, some public some private. What part does the city play in facilitating this system, and what has their role been to date?

The city does the heat planning in the municipality. We decide where we should put district heating. For example in North Harbour there is a city development area, where there will be 40,000 new households and work places... So we do the heat planning, together with our companies, Copenhagen energy who sells to the end users and the transmission company CTR.

Q.2 Is Copenhagen Energy fully municipal owned?

Yes it is.

Q. 3 Is there any difficulty negotiating with private companies within this system?

We've had a process in place the last couple of years. We have our climate plan and we have a 20 % reduction target by 2015 and a target to be carbon neutral by 2025. We want the private companies to use biomass instead of coal and that's part of the negotiation. We buy heat from them and due to that we can negotiate on the kind of fuel they are using. That's been on going for the last couple of years.

Q.4 You subsidise the buying of biomass and tax fossil fuels, does the city make a loss on this?

No, it actually gives us cheaper heat. Because it's subsidised by the national government.

Q.4 How have the companies reacted to the increased biomass?

It's actually also part of their plans and targets to be carbon neutral, but with the negotiations of course it's about who's going to pay the money for converting the plant. They do think it is ok, but they're not keen on paying... (laughs)

Q.5 In CPH legislation plays a large part, how important is legislation to the DH system? Would others trying to copy CPH's example need to enact legislation in your opinion?

Legislation that began in the 1980s and 1990s made it possible for the city to have the DH system like the one we have today, and the DH system in Denmark overall actually. That's a very important part of the DH systems history in Denmark. And now that we are going to use biomass to generate carbon neutral heat it is also very important for us, in terms of taxes and subsidies.

Q. 6. I understand it's a monopoly and the companies have a duty not to make a profit. When power was liberalised by the European Union was there any conflict there?

It's a difficult thing when you're producing power to determine how much the heat costs. The legislation says heat must not cost more than it costs to produce. You can't make a profit from producing heat in Denmark. The price of the heat is only what it costs, but how much does it cost when you're producing electricity as well, which is sold on the market? That of course is a difficult thing to determine. Also when you have a system like we have in Copenhagen, where you have CTR (the transmission system) and Copenhagen energy, they buy the heat, but where do they buy it from? We do have a small unit with transmission owners, CTR and Copenhagen Energy and another in the West, and from day today they plan where they buy the heat from and where the price is best.

Q.7. How large a role does Copenhagen's culture play in the success of the system (Openness to collectivisation, etc.) Other countries may have a problem enacting monopoly legislation from an ideological point of view...

Well perhaps that could be a barrier for others. We do have collective systems, not only in heat also in other areas (garbage, for example). It's tradition in Denmark and especially in Copenhagen. It could be unfamiliar for those who are not used to this kind of thinking.

Q.8 What was the payback period of expanding the DH system? How long before there was a return on the investment.

That depends. For the private companies, only maybe 5 – 8 years, something like that. It's actually very cheap to run in the long run. The initial investment is covered quite quickly by how cheap it is to run. (adding to the viability of the scheme for others in Europe).

Q.9 Are there any geographic factors needed for a DH system to work?

We have small (DH) systems where there are only 3,000 people living, but it is not profitable, it is very expensive for the users to have DH. You have to have a certain amount of people gathered (for it to be worth instituting). It doesn't have to be the size of Copenhagen, but at least 10,000 people.
Q.10 What is the public perception of DH?
Nowadays it is positive. In the 1990s we had to fight to use DH instead of oil. Some didn't like it, but really only a minority. They didn't like it because they had to make an investment to use DH, to changeover from their oil heating system. It cost them and they had to use DH instead. Nowadays we are building more and more low energy buildings and they use not so much energy, so there will be a tipping point where it is not profitable anymore to connect DH to new areas, because the buildings don't use any heat. Maybe in 10 or 20 years... These houses will have a heating source for making hot water, which will likely be electric. In general though the public perception of DH is favourable.
Q. 11 How important is DH to your overall environmental aims?
It's very important. You can just change the fuel in a central CHP plant and then reap the benefit of a CO2 reduction in all of Copenhagen. So that's very important to us. When we change to biomass it will be a great CO2 reduction for us.
Q.12 Was the decision to change from coal to biomass based on energy security or environmental reasons?
No, it was environmental and economical because it is subsidised (at national level), so it works out cheaper to use biomass instead of coal. The biomass is from Sweden and from the Baltic area.
Q.13 What are the barriers to increasing the amount of carbon-neutral fuel in the mix?
We are negotiating with the plant owners to do the investments so that they can use biomass instead of coal. That's one of the barriers. And they have to have legislation because they're not allowed to earn money from the heat production. Today it impossible to use biomass and today only the heat side will gain that money. We need to make new legislation so that the owners can have a share of the money we get from biomass instead of coal.
Q.14 Why are the negotiations with private companies difficult?
Private companies do want to use biomass, but not as fast as we do. They have a target for 2020, but we want it to happen tomorrow! They want to see if it's profitable in the long term, that's what slows it down.
Q.15 Tell me about what it is that is that you do here...
We're making climate plans at the moment, as we have to plan how to become carbon neutral by 2025. What kind of heat system do we want to be carbon neutral by 2025... and that's biomass and CHP. We do have CO2 emissions from waste incineration because of the plastic that is in the waste. We have a project on looking at how to get the plastic out of the waste. We are trialling it in an area in Copenhagen. There are a number of techniques being trialled at the moment.
Q.16 What's the future of the system?
The fuel has to be changed from coal to biomass. After 2025 or, perhaps, 2035, the CHPs will be too old and we will have to decide if we want to make new CHP plants or if we want to do something else. I actually think that we want to do something else, as we have a lot of wind energy in Denmark and we could utilize heat pumps more. But we still need a DH system, we'll just change from CHPs to using heat pumps and thermal energy. We are expecting that geothermal energy will be a part of our 2025 plan, with one or maybe two plants. A large plant that is 5 or 6 larger than the one we have today.
Q.17 Geothermal requires a large investment…
In the long run it is cheap. The investment is about 1 billion DKK, about €125 million. We would need to utilize the pump to make heat most of the year, because the investment is so heavy we need to make money all year round. If we can make it run 6,000 hours a year, the payback period will be about 15 years, maybe more.
Q.18 What are the barriers to setting up the scheme?
Well it's quite a big investment so they have to have the customers ready to pay for it! That's the main problem. I think the system could work without the legislation making it mandatory.
Rune: "There is only one case a week of people not wanting to connect to the grid."

Q.19. Is it difficult to sell the public on these large investments for green technology given the current economic climate?

Hanne: I think in Copenhagen it's not a problem. If the heat gets a lot more expensive that would be a problem, but as long as it does not get very much more expensive I don't think that's a problem. Even with the cost of the investments I don't envisage the heat price going up. It will be a little bit more expensive, but not much.

Q.20 What advice would you give to cities looking to enact a similar scheme?

Hanne: You have to have politicians who want this. The political will is essential.