Disclaimer: This work is not fully finalised, accordingly not all content reflects full analysis and stakeholder discussion.

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Green Public Procurement

Windows and external doors

Technical Background Report

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Report for the European Commission – DG-Environment by JRC IPTS, 2012

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EXECUTIVE SUMMARY

This Technical Report presents the background information and proposed revised Green Public Procurement Criteria (GPP) criteria developed for the product group of **Windows and External Doors**. The proposed purchasing criteria also include appropriate explanatory notes to assist their implementation. The revised draft criteria proposals have been develop following research undertaken by the project team and feedback from stakeholders. **Chapter 1** provides the wider policy context and an outline of the methodology followed in this research.

The **definition and scope of windows and external doors** for the purposes of the revised GPP are detailed in **Chapter 2**. The criteria will focus on replacement windows and external doors, using the following definitions based on relevant standards, EN 12519 and EN 14351.

Window: Building component (glazing) for closing an opening in a wall or pitched roof that will admit light and may provide ventilation, including the frame of the window which is defined as the component forming the perimeter of a window, enabling it to be fixed to the structure.

Roof Window: Window intended for installation in a roof or the like which is inclined. Roof windows have the same characteristics as windows installed in walls with regard to function, cleaning, maintenance and durability.

External Doors: Doorset which separates the internal climate from the external climate of a construction for which the main intended use is the passage of pedestrians, including the frame of the door which is defined as the component forming the perimeter of a door, enabling it to be fixed to the structure.

The official statistics for windows and external doors provides some **Market Data** for production and trade figures, however data is not available for all Member States. Where necessary assumptions and modelling have been used to calculate figures, for example stock. This is clearly outlined in **Chapter 3**. The European windows market stabilised in 2010 following a slowdown 2009.

Additional market data sources indicate that overall the production structure of the market for windows is dominated by plastic frames, although this does vary between Member States. For example, in the Nordic countries, wooden framed windows are more dominant. From a supply side, there are many manufacturers and installers of windows, including small and medium enterprises. There is limited information available regarding the market and production structures for external doors.

Chapter 4 outlines the **key environmental impacts** for windows and external doors, informed by a review of relevant literature and analysis undertaken using a life cycle assessment tool, EcoReport. The key environmental impacts of windows and external doors are due to **energy losses**, through the window or external door, during the operational phase of the building, which is influenced by the thermal performance characteristics of the window or external door. The EcoReport analysis highlights that the single most significant impact is related to total energy consumption, with energy lost during the use phase the most important factor. The other significant environmental impact is green house gas emissions, influenced by energy consumption in the use phase.

The influence of location specific factors, such as climate, heating and cooling seasons, building type and orientation, are vital to the performance of windows and external doors. These factors need to be considered to ensure an optimum balance between the U and g values is achieved. As with previous studies, the research has shown that no particular frame material provides an overall environmental advantage over the impact categories assessed.

As part of the analysis, **the improvement potential for windows (Chapter 5)** has been assessed for residential buildings through changes in the specification of the U and g value of the window, which

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affect its thermal performance. The results of this part of the research demonstrates that it is highly important to assess and purchase a window in relation to the building in which it will be installed, taking into account the building's specific parameters, such a types, use, heating/cooling regime, shading devices and climate in order to get the correct balance between the U and g value and therefore maximise the potential energy savings.

Although not included in the quantitative analysis, it is important to highlight that potential energy savings will also arise from changes in lighting use as a result of a number of factors, including the window type, amount of glazing, orientation, shading devices and lighting control. This is especially the case of non-domestic buildings.

Cost considerations are an important part of green public procurement, and in order to fully assess these, a life cycle cost approach should be used. **Chapter 6** outlines an example life cycle cost assessment, using the EcoReport tool. However, due to the large number of location specific factors involved when purchasing a window, the Purchasing Authority will need to consider this for their particular circumstances. Key aspects to consider include:

- The optimal performance of the window required in order to identify the correct products and product prices.
- Installation and maintenance costs – savings may be possible if a large number of windows are replaced at once or maintenance is dealt with as part of existing contracts.
- The actual expected lifetime of the products under consideration.
- Current, location specific rates for gas, electricity and water.
- The efficiency and type of boiler used for the heating.
- The wider building perspective and other energy performance changes that may be implemented at the same time

Chapter 7 provides an overview of public procurement needs, and where data is available, an estimate of the public procurement market. An overview of national green public procurement schemes available for this product group is provided.

The key **European legislation** relating to windows and external doors is presented in **Chapter 8**. This includes legislation relating to construction products, energy efficiency of building and products, packaging, waste management and the use of hazardous substances. In addition a summary of existing national energy labels or ecolabel criteria for windows and doors is provided. These focus primarily on the energy balance or performance of the window or external door.

The **revised draft green public procurement criteria** for windows and external doors are presented in **Chapter 9**. This section presents the existing criteria and the rationale for changes based on the outcome of the research undertaken and stakeholder feedback received to date, followed by the proposed revised criteria. The key changes relate to the energy performance criterion, which has been revised and is now based on the Energy Performance of Buildings Directive Cost Optimal Methodology calculations, following feedback at the first stakeholder meeting. New criteria have been added regarding the selection of contractors for the installation of windows and doors. Other criteria have been subjected to mainly minor changes. Key areas for discussion at the next stakeholder meeting are summarised in **Chapter 10**.

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ACRONYMS

AE	Acidification Emissions
BFRC	British Fenestration Rating Council
BMS	Building management system
BoM	Bill of materials
BPIE	Building Performance Institute Europe
CH_4	Methane
CITIES	Convention on International Trade in Endangered Species of wild fauna and flora
CLP	The Classification, labelling and Packaging of Substances Regulations
CN code	Combined Nomenclature
CPD	Construction Products Directive
CPR	Construction Products Regulation
CWCT	Centre for Window and Cladding Technology
EC	European Commission
EMAS	EU Eco-Management and Audit Scheme
EPD	Environmental product Declaration
EP	Eutrophication Potential
EPBD	Energy Performance of Buildings Directive
EU	European Union
EU27	European Union 27 Member States
FSC	Forest Stewardship Council
FLEGT	Forest Law Enforcement, Governance and Trade
GDP	Gross Domestic Product
GHG	Greenhouse gases
GHS	Globally Harmonized System
GPP	Green public procurement
GWP	Global warming potential
Hw	Hardwood
LCA	Life cycle assessment
LCC	Life cycle cost
MEErP	Methodology for the Ecodesign of Energy-related Products
MS	Member State
NFRC	National Fenestration Rating Council
NOx	Nitrogen oxides
NZE	Nearly zero energy
PAHs	Polycyclic aromatic hydrocarbons
PEFC	Programme for the Endorsement of Forest Certification
PM	Particulate Matter
POPs	Persistent Organic Pollutants
PVC	Polyvinyl chloride
REACH	Registration, evaluation, authorisation and restriction of chemicals
SME	Small and medium enterprises
SOx	Sulphur oxides
Sw	Softwood
TIMs	Transparent insulation materials
UPVC	Unplasticized polyvinyl chloride
VAT	Value added tax
VOC	Volatile organic compound
VPA	Voluntary Partnership Agreement
VTT	Technical Research Centre of Finland
WER	Windows energy rating
WFD	Waste Framework Directive

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1 Introduction

Green Public Procurement (GPP) is a voluntary instrument, with the aims of "having clear, verifiable, justifiable and ambitious environmental criteria for products and services, based on a life-cycle approach and scientific evidence base"[1]. Moreover in general – due to Procurement Rules – the criteria should be proportionate, have a clear objective and provide equal access for bidders.

The European Commission has developed several sets of recommended GPP criteria for a range of different products and services, which are available on the dedicated website:

http://ec.europa.eu/environment/gpp/gpp_criteria_en.htm.

The European Commission's Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS), with support from AEA (and their partners at the Centre for Window and Cladding Technology - CWCT), is conducting a study to develop an evidence base to inform possible sustainable policy tools for Windows and External Doors. In particular the project will review and revise the existing European GPP criteria for this product group. The evidence base is being gathered in line with the Methodology for the Ecodesign of Energy-related Products (MEErP) tool methodology[2] and has been developed around a number of key tasks: 1) Definition and Categorisation of Windows and External Doors, 2) Economic and Market Analysis, 3) Technical Analysis, 4) Improvement Potential and 5) Draft Criteria Proposal.

This Technical Background Report presents the proposed revised GPP criteria developed for the product group of **Windows and External Doors**. The proposed purchasing criteria also include appropriate explanatory notes to assist their implementation. The revised draft criteria proposals have been develop following feedback from stakeholders. This report contains background information on the market and environmental impacts of windows and external doors and describes the most important European legislation and labelling schemes relevant to this product group. Further background information is available in the individual tasks reports, which are available from the project website[3].

For the GPP of Windows and External Doors two sets of criteria are presented:

- **Core criteria**: these are designed to be used by any European contracting authority. They address the most significant environmental impacts, and are designed to be used with minimum additional verification effort or cost increases. This set of criteria can be used as minimum criteria to develop the tender.

- Comprehensive criteria: these are intended for use by authorities who wish to purchase the best environmental products available on the market, and may require additional administrative effort or imply a slight cost increase as compared to the purchase of other products fulfilling the same function. The comprehensive criteria can be used as incentives for the market to gain added value based on life cycle costs.

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[1] http://ec.europa.eu/environment/gpp/index_en.htm
[2] http://www.meerp.eu/
[3] http://susproc.jrc.ec.europa.eu/windoors/

2 Definition and scope[4]

2.1 Definition

The definition for this product group was proposed on the basis of definitions used in existing labelling schemes and relevant EN standards, in particular EN12519[5] and EN 14351[6]. Subsequent, feedback on the product group definition and scope was received from stakeholders. Further background information regarding the definition and scope of the product group is available in the Task 1 & 2 report, which is available from the project website[7]. The agreed definition for windows and external doors is as follows:

Window: Building component (glazing) for closing an opening in a wall or pitched roof that will admit light and may provide ventilation, including the frame of the window which is defined as the component forming the perimeter of a window, enabling it to be fixed to the structure.

Roof Window: Window intended for installation in a roof or the like which is inclined. Roof windows have the same characteristics as windows installed in walls with regard to function, cleaning, maintenance and durability.

External Doors: Doorset which separates the internal climate from the external climate of a construction for which the main intended use is the passage of pedestrians, including the frame of the door which is defined as the component forming the perimeter of a door, enabling it to be fixed to the structure.

2.2 Scope and Background

The proposed scope of the GPP criteria and in particular inclusions and exclusions were presented and discussed at the first stakeholder meeting. Following the discussion[8] it was agreed that windows and external doors to be installed in new buildings and major renovations, where the whole building performance is being considered as part of requirements under the Energy Performance of Buildings Directive (EPBD recast 2010)[9], should be excluded from the scope of the GPP criteria. Stakeholders also commented that curtain walling should be clearly excluded:

It is proposed that the following are included within the scope of the GPP revision:

- Residential and commercial windows and external doors
- Opaque (non-glazed) as well as part and fully glazed external doors
- Different frame materials e.g. wood, steel, aluminium, plastic
- Components required to operate the window e.g. handles, locks, hinges etc
- Criteria will be applicable to the replacement of windows and external doors only

It is proposed that the following are excluded from the scope of the GPP revision:

- Non pedestrian doors e.g. industrial or garage doors
- Doors designed with specific safety features/characteristics e.g. fire doors

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[4] http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html
[5] EN12519:2004, Windows and Pedestrian Doors. Terminology.
[6] EN 14351:2006+A1:2010, Windows and doors. Product standard, performance characteristics. Windows and external pedestrian doorsets without resistance to fire and/or smoke leakage characteristics
[7] http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html
[8] Summary of the 1st meeting available at: http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html
[9] EPBD recast 2010: Directive 2010/31/EU on the energy performance of buildings (recast) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32010L0031:EN:NOT

- Windows designed for escape routes
- Internal windows or doors
- Revolving doors / Swing Doors
- Tubular Daylighting Devices
- Curtain Walls
- Windows and external doors for new buildings and major refurbishments under EPBD

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3 Market Overview[10]

3.1 Market Data

The aim of the Economic and Market Analysis report is to understand the size of the market for windows and external doors, so that the potential impacts of any improvements can be quantified. To that end, it is necessary to determine:

- The stock of windows and external doors in the EU27;
- Annual sales of windows and external doors in the EU; and
- Annual production levels of windows and external doors in the EU.

As far as possible, this information needs to be split across domestic, public and private settings, and data are required into the future.

Within MEErP, the preferred source of this information is official EU statistics. The PRODCOM codes[11] and CN codes[12] shown in have Table 1 been used to identify relevant production and trade data for 2010.

Table 1: Summary of PRODCOM and CN Codes for Windows and External Doors

PRODCOM	PRODCOM Code Description	CN codes	CN Code Description
16.23.11.10	Windows, French windows and their frames of wood	4418 10 10	Windows and French windows and their frames, of okoumé, obeche, **
		4418 10 50	Windows and French windows and their frames, of coniferous wood
		4418 10 90	Windows and French windows and their frames, of wood ***
16.23.11.50	Doors and their frames and thresholds, of wood	4418 20 10	Doors and their frames and thresholds, of okoumé, obeche, **
		4418 20 50	Doors and their frames and thresholds, of coniferous wood
		4418 20 80	Doors and their frames and thresholds, of wood ***
22.23.14.50	Plastic doors, windows and their frames and thresholds for doors	3925 20 00	Doors, windows and their frames and thresholds for doors of plastic
25.12.10.30	Iron or steel doors, thresholds for doors, windows and their frames	7308 30 00	Doors, windows and their frames and thresholds for doors, of iron or steel
25.12.10.50	Aluminium doors, thresholds for doors, windows and their frames	7610 10 00	Doors, windows and their frames and thresholds for door, of aluminium (excl. Door furniture)

** sapelli, sipo, acajou d"afrique, makoré, iroko, tiama, mansonia, ilomba, dibétou, limba, azobé, dark red meranti, light red meranti, meranti bakau, white lauan, white meranti, white seraya, yellow meranti, alan, keruing, ramin, kapur, teak, jongkong, merbau, jelutong, kempas, virola, mahogany "swietenia spp.", imbuia, balsa, palissandre de rio, palissandre de para and palissandre de rose

***(excl. Okoumé, obeche, sapelli, sipo, acajou d"afrique, makoré, iroko, tiama, mansonia, ilomba, dibétou, limba, azobé, dark red meranti, light red meranti, meranti bakau, white lauan, white meranti, white seraya, yellow meranti, alan, keruing, ramin, kapur, teak, jongkong, merbau, jelutong, kempas, virola, mahogany "swietenia spp.", imbuia, balsa, palissandre de rio, palissandre de para and palissandre de rose, and coniferous wood)

As the data under these codes are aggregated with other window and door related products a number of assumptions, informed by stakeholder consultation, were used to model and estimate the stock and

[10] This section is a summary of the information provided in the "" Definition, categorisation and market analysis report" available at: http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html
[11] http://epp.eurostat.ec.europa.eu/portal/page/portal/prodcom/data/database
[12] http://epp.eurostat.ec.europa.eu/portal/page/portal/international_trade/data/database

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sales figures summarised in this section. A summary of the market data analysis is provided below, with full details of the modelling and assumptions provided in the Task 2 report[13].

3.1.1 EU Production

Based on our analysis of the PRODCOM categories as discussed above, data for 2010 was extracted to identify

- The physical volume of production sold during the survey period (number of items, p/st);
- The value of production sold during the survey period (€).

Within PRODCOM data there are missing data that are recorded as estimates or confidential. There are a number of reasons why data might be missing, such as the reporting country does not survey the heading, the reporting country has a reason to doubt the accuracy of the data, or the reporting country used the wrong volume unit or the wrong production type and the data are not comparable. For the PRODCOM categories selected as part of the study, under the number of items sold heading, a number of countries have not released the data due to confidentiality reasons[14]. Additionally, in the national data, estimates are suppressed and marked with 'E'. Eurostat makes estimates for missing data but only for the EU totals when a number of countries have not reported data, where it would not be possible to identify individual country totals from the EU total.

For the purposes of this study, estimates of the missing data were produced based on the EU totals produced by Eurostat and the Gross Domestic Product (GDP) (2010) of the country. The figures provided for each category were summed and subtracted from the totals provided by Eurostat in order to find the difference. This difference was proportioned according to the GDP of the countries where data were withheld.

The figures for value of production and the numbers of items sold are shown in Table 2. Estimates are marked with an asterisk (*), the three top countries are highlighted in red for each relevant code in term of units produced and value of production.

The trends identified for the selected PRODCOM codes are summarised as follows:

- 16.23.11.10: Italy sold the highest number of products, followed by the UK and Poland in terms of units of products. Italy also had the highest value of production, followed by Germany and France. It can be noted that Germany and France have sold noticeably less units of products compared to the UK, yet Germany's value in production is almost twice as much as the UK's.

- 16.23.11.50 Spain sold the highest number of units, followed by Italy and the UK. Looking at the value of the production, Germany has the highest value, followed by Italy and the UK. It can be noted that Spain's value of production was around 25% lower than that of Germany.

- 22.23.14.50 the UK sold the highest number of units, followed by Germany and Poland. It was Germany that had the highest value of production, followed by the UK and France. The value of the Polish production was less than half that of France.

- 25.12.10.30 Poland had by far sold the highest number of products, followed by Ireland and Germany. It was Italy that had the highest production's value, followed by Germany and France. It can be noted that Poland account for 36% of the overall EU number of products, but account for just 4% of the overall production's value.

- 25.12.10.50 France sold the most units of product, followed by Spain and Italy. However it was Italy that had the highest production's value followed by France and Germany. It can be noted that Spain produced more products units than Italy, yet the Spanish production's value was less than half that of Italy's.

[13] Definition, categorisation and market analysis report available at: http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html
[14] Confidentiality is indicated by ":C"

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These points highlight the large variation that can exist between the quantity of products sold and the value of production sold. Overall, some countries sell a lot of items but have a lower value of production, and other countries sell a similar or lower number and have a greater value in production.

These variations in the data may indicate differences in the production of windows in different countries; however it is also likely to be due, at least to some extent, on the quality of the data. As highlighted above a number of estimates have had to be made, and the completeness of the data is unknown, although it may be significant given the high proportion of small and medium sized companies involved in the production of these products, that do not necessarily have to report data.

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Table 2: Estimated Sold Production in Numbers of Items (000s p/st) and in Monetary terms (000s Euros) – 2010

	16.23.11.10		16.23.11.50		22.23.14.50		25.12.10.30		25.12.10.50	
	Windows, French windows and their frames of wood		Doors and their frames and thresholds, of wood		Plastic doors, windows and their frames and thresholds for doors		Iron or steel doors, thresholds for doors, windows and their frames		Aluminium doors, thresholds for doors, windows and their frames	
Units	**000s p/st**	**000s €**	**000s p/st**	**000s €**	**000s p/st**	**000s €**	**000s p/st**	**000s €**	**000s p/st**	**000s €**
Austria	1,110	445,713	1,336	264,262	1,781	440,639	972	189,962	298	222,401
Belgium	200	98,494	1,100	115,573	998	408,653	268	78,319	936	413,040
Bulgaria	16	2,402	74	8,830	434	59,533	29	5,974	664	62,129
Cyprus	-	-	-	-	0	-	-	-	-	-
Czech Republic	229	71,950	1,812	136,214	3,158	419,228	485	52,081	268	56,105
Denmark	2,496	509,435	2,003	157,383	432	123,644	18	18,513	136	88,617
Estonia	377	58,812	3,577	59,409	140	17,990	35	18,916	18	14,191
Finland	1,225	240,263	1,733	166,614	11	5,758	80	61,532	986	97,222
France	2,104	595,396	8,090	670,770	6,360	2,108,388	4,201	831,165	9,423	1,970,575
Germany	2,357	848,327	10,200	978,796	11,399	2,880,001	4,389	1,514,225	3,155	1,610,618
Greece	10	4,863	43	9,931	3,133	32,183	74	12,802	104	29,522
Hungary	862	90,126	447	28,325	1,295	93,831	245	20,047	66	40,849
Ireland	22	6,422	904	60,557	731	90,365	13,036	36,269	1,105	69,137
Italy	5,587	1,944,760	14,439	937,165	1,150	427,943	3,398	1,522,895	7,041	2,788,074
Latvia	41	10,663	944	18,292	148	17,358	13	7,076	23	8,976
Lithuania	94	26,174	437	18,308	329	39,006	49	19,895	10	4,005
Luxembourg	-	-	-	-	0	-	-	-	-	-
Malta	-	-	-	-	0	-	-	-	-	-
Netherlands	1,296 *	312,964	2,124	231,693	1068*	196,273	1,083*	280,419	961*	289,863
Poland	2,856	495,371	7,370	383,362	8,030	961,267	20,677	252,928	598	176,463
Portugal	67	11,628	2,116	114,908	145	24,260	2,768	152,818	2,150	901,949
Romania	136	23,340	604	30,161	2,401	233,597	40	10,408	372	40,807
Slovakia	9	4,463	14	5,060	872	152,833	47	7,625	418	38,263
Slovenia	140	49,139	388	38,050	460	93,391	26	5,940	53	63,378
Spain	632	99,205	19,279	680,668	810	209,845	2,944	602,236	8,910	1,255,692
Sweden	1,668	376,996	1,931*	230,680*	2,024	11,673	635	252,405	563	181,389
UK	3,785	434,125	11,968	842,698	13,313	2,799,235	1,184	538,400	2,757	927,510
Total EU27	**27,319**	**6,761,030**	**92,934**	**6,187,707**	**60,623**	**11,846,896**	**56,695**	**6,492,850**	**41,018**	**11,350,773**

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3.1.2 EU Trade

The import and export data are categorised in terms of CN codes (see Table 1). The CN codes were identified that correspond to the PRODCOM categories selected for analyses. Similar to the PRODCOM data, some of the data from a number of countries were not available. As no information was supplied on the total EU27 import or export value, it was not possible to estimate the missing data. As a result, the missing data were assumed to be near-zero and therefore negligible.

A summary of the key import and export trends for the different CN codes is as follows:

Windows and French windows and their frames of tropical wood" as specified. (CN 4418 10 10)

For this specific CN code around a third of Member States reported no values for 2010.

- Germany was the country that exports the most outside of the EU27.
- Poland was the main exporter within the EU27.
- France and Luxembourger were the main country importing from within the EU27 closely followed by the UK.
- It can be noted that imports from outside the EU27 represented only a small fraction on the overall imports representing just 8% of the imports' value.

Windows and French windows and their frames, of coniferous wood (4418 10 50)

- It can be noted the market between the Member States was buoyant. In terms of intra EU27 exports, Poland dominated the market representing 32% of the value of Intra EU27 Export followed by Denmark which accounted for 22% of the overall value.
- The UK was the main intra EU27 importer, closely followed by Denmark.

Windows and French windows and their frames, of wood (excl. Exotic wood) CN 4418 10 90

- Italy and Germany were the member states exporting the most within the EU27.
- Poland exported the most outside of the EU27, followed by Denmark.
- England was the main importer both from within the EU27 and from the rest of the world.
- From the data presented in table above it can be noted that window with wooden frames made out of coniferous wood represented the highest import value amongst all other wooden window frame.

Doors and their frames and thresholds, of exotic wood (CN 4418 20 10)

- Germany and Italy were the key exporters outside of the EU27, Ireland was dominating intra EU27 exports.
- France and the Netherlands recorded the highest imports from outside the EU27.
- The Netherlands also imported the most from outside the EU27.
- It can be noted that the Netherland had the highest imports overall, which seems to indicate a noticeable preference for this type of product in this country.

Doors and their frames and thresholds, of coniferous wood (CN 44.18.20.50)

- Sweden represented more than 40% of all Exports to outside of the EU27, followed by Finland and Germany
- Estonia and Poland were leading the exports within the EU27; between them they represented almost 40% of the total exports within the EU27.
- The UK represented just over 30% of the imports from outside the EU27, followed by France.
- Denmark represented a quarter of intra EU27 imports, followed by the UK.

Doors and their frames and thresholds, of wood (excl. Exotic wood) (CN 44.18.20.80)

- Italy dominated the exports outside the EU27, followed by Germany.
- Germany dominated the exports within the EU27, followed by Italy.
- The UK represented 57% of all imports from outside the EU27, followed by France
- The UK also dominated imports arising within the EU27, followed by Germany

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Doors, windows and their frames and thresholds for doors, of plastics (CN 39.25.20.00)

- Germany and Italy were the largest exporters to outside the EU27.
- Poland and Germany dominated the exportation with the EU27 (which is also out of all the CN codes the one with the largest value).
- Germany was the main importer from outside the EU27, followed by the UK
- France and Germany both dominated the imports coming from within the EU27.

Doors, windows and their frames and thresholds for doors, of iron or steel (CN73.08.30.00)

- Germany dominated the whole iron and steel type of window and door frames.
- The Netherlands was the second largest exporter within the EU27.
- France was the main importer from within the EU27.

Doors, windows and their frames and thresholds for door, of aluminium (excl. door furniture) (CN 76.10.10.00)

- Germany dominated the exports, both intra and extra EU27,
- Germany was also the country importing the most from outside the EU27, followed by France.
- It was France that imported the most from with the EU27 closely followed by the UK

From the points above it can be noted that Germany is a key player within the window and doors market especially in term of frames made of iron and steel, plastic or aluminium. In terms of wooden frame based products it appears that a few member states have a dynamic market.

Table 3: Value (€) of total EU Intra/Extra Import and Exports for different CN codes ('000s (2010))

CN Code	EU27_Extra Export	EU27_Intra Export	EU27_Extra Import	EU27_Intra Import
44 18 10 10	13,444	36,257	1,849	21,037
44 18 10 50	89,288	574,995	18,426	509,190
44 18 10 90	43,617	109,221	19,502	81,350
44 18 20 10	8,055	24,533	23,427	44,324
44 18 20 50	99,044	280,133	73,255	205,732
44 18 20 80	228,463	373,475	222,694	335,958
39 25 20 00	196,200	1,287,525	85,666	891,791
73 08 30 00	497	766,193	127,120	716,082
76 10 10 00	201,551	578,575	78,311	382,918

A breakdown of the data in Table 3 for different Member States is provided in the Task 2 report.

3.1.3 EU Apparent Consumption

Apparent consumption is calculated in terms of product units. However, trade data are not available in unit terms (volume data are only available in terms of weight) and as a result was extracted from the Eurostat website in monetary terms. These monetary data for each product category need to be converted into a numbers of items with a unit price.

Without more information available, the unit price of traded products was assumed to be the same as the unit price of sold products by the national manufacturers (sold production). The unit price of sold production can be easily derived from PRODCOM data (the relevant fraction of the data) by dividing the relevant sales data (in €) by the relevant volume data (in number of items). Applying these unit prices to trade data, we can obtain the number of units imported and exported per CN code per country for each code.

Apparent consumption was calculated by applying the following formula:

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Apparent consumption in EU27 = **Production sold in EU27** − **Export to countries outside the EU27** + **Imports from countries outside the EU27**

It should be noted that the above equation assumes no change in unsold "stock" in a given country, which is clearly not going to be true, though the assumption is probably acceptable, as an average result. The full results are shown in the Task 2 report. Table 4 provides a summary comparing the apparent consumption for the different material types in terms of product units suggests that wooden products dominate the market at EU27 level. However, the indications from stakeholder feedback is that this is not necessarily the case, with plastic frames dominating for the EU27 overall. This highlights the limitation of the official statistical data, which may be the result of inaccurate reporting, estimations and non-reporting e.g. SME business.

Table 4: % of apparent consumption for different PRODCOM CODES (2010) (in '000s)

	EU27	Share (%)
Windows, French windows and their frames of wood	26888	9.68
Doors and their frames and thresholds of wood	92691	33.37
Plastic doors, windows and their frames and thresholds for doors	60058	21.67
Iron and steel doors, windows and their frames	57801	20.81
Aluminium doors, windows and their frames, and thresholds for doors	40269	14.50
TOTAL	277707	100

3.1.4 Annual EU Sales/real consumption

The Eurostat data[11,12] did not provide a breakdown for all type of windows and door by materials, nor did they present a breakdown of residential versus non-residential. It was therefore decided to build comprehensive spreadsheet models of the market, covering both the domestic and non-domestic sectors. Inputs to the models consisted of EU official statistics, stakeholder responses to the questionnaire, and various other relevant studies, guides and regulations concerning the European building sector.

Stock and sales have been calculated in terms of square metres (m^2). This approach has been used as key parameters relating to the energy balance of windows are expressed on an area basis, and will enable calculations to be undertaken in later tasks with regards to potential improvement and energy savings be calculated more easily than if stock and sales were calculated on a product unit basis.

Using the model, estimated data for sales were calculated by using the stock data divided by the life span for windows and external doors. The assumptions used in the models are summarised below, with full details included in the Economic and market analysis report:

- The report EU Building under the microscope[15] was published in October 2011 by the Building Performance Institute Europe (BPIE) and was used to establish a baseline m^2 of building across the EU27. It states that 75% of all buildings are residential building and that just 25% are non-residential. The data we applied were as follow:

Table 5 Assumptions applied to establish a baseline of m^2 of building for EU27

	Population (million)	% total EU floor area	Average family house floor space/capita (m^2)	Average family flats floor space/capita (m^2)
North & West [16]	281	50%	41	36
Central & East	102	14%	26	20
South	129	36%	50	31

[15] http://www.bpie.eu/country_review.html
[16] North & West AT, BE, CH, DE, DK, FI, FR, IE, LU, NL, NO, SE, UK
Central & East BG, CZ, EE, HU, LT, LV, PL, RO, SI, SK
South CY, GR, ES, IT, MT, PT

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In terms of residential dwelling, a division of 64% houses and 36% flats was applied based on data from the BPIE report. Looking at the division amongst different type of non-residential building the following was applied[15]:

+ 28% Wholesale retail
+ 23% Offices
+ 17% Educational
+ 11% Hotels & restaurants
+ 7% Hospital
+ 4% Sport facilities
+ 11% Other

The current stock calculated for residential and non-residential door area (m^2) has been assumed to be 1% of the overall building area. This assumption was based on input from technical experts/stakeholders. It can be noted that the area is closely linked to the population, thus Italy, Germany, France, Spain and the UK have the largest residential area, and Luxembourg has the smallest.

The current stock calculated for the window area (m^2) assumes that:

- The average window area for residential buildings is assumed to be 15%[17] of the overall residential building area in square meter.
- The average window area for non-residential buildings is assumed to be 10%[18] of the building area to take account of the wide differences in building types and design.

As with doors, it can be noted that the area is closely linked to the population, thus Italy, Germany, France, Spain and the UK have the largest residential area, and Luxembourg has the smallest.

Table 6 presents some of the data calculated in this section for window and door areas depending on the type of building. Further details are provided in The Task 1 & 2 report available from the project website.

Table 6: Residential and non-residential window and door areas for the main populated countries

('000 m^2)	Non-residential		Residential	
	Windows	**Doors**	**Windows**	**Doors**
Germany	91.056	9.106	409.753	27.317
France	72.035	7.203	324.157	21.610
Italy	100.654	10.065	452.943	30.196
Spain	76.714	7.671	345.215	23.014
UK	69.023	6.902	310.602	20.707
EU27	**600.000**	**60.000**	**2.700.000**	**180.000**

Finally, it is necessary to calculate how the stock of windows and doors is likely to grow over the years to 2050. Table 7 presents the forecast for window and doors to 2050 based on a 2%[19] overall floor space increase across the EU27 both for residential and non-residential building.

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[17] http://www.byg.dtu.dk/upload/institutter/byg/publications/rapporter/byg-r201.pdf
[18] Based on input from Technical Experts,
[19] http://www.ecodesign-wp2.eu/downloads/2011-07-14_Ecodesign%20Working%20Plan%20Background%20study%20Draft%20task%201-2-3.pdf

Table 7: Forecast for the residential and non-residential window and door areas for EU27

('000 m^2)	Non-residential		Residential	
year	Windows	Doors	Windows	Doors
2010	600000	60000	2700000	180000
2015	662448	66245	2981018	198735
2020	731397	73140	3291285	219419
2025	807521	80752	3633845	242256
2030	891568	89157	4012058	267471
2040	1086817	108682	4890676	362045
2050	**1324824**	**132482**	**5961707**	**397447**

3.1.5 Annual EU Sales

The models developed in the previous section were used to generate estimates on sales of windows and external doors. The estimations were based on the relationships between the total stock of facilities and their anticipated lifetimes. It is estimated there is an additional 2% of floor space added every year across EU27, and that the refurbishment rate for windows and external doors is typically 30 years, which enables a replacement cycle of 5% per year to be established. Thus using the stock data calculated above the estimated sales growth over the coming years as shown in Table 8.

Table 8: Estimated sales for the most populated MS in 2010

('000 m^2)	Non-residential		Residential	
	Windows	Doors	Windows	Doors
Germany	4552810	455281	20487645	1365843
France	3601745	360175	16207853	1080524
Italy	5032699	503270	22647144	1509810
Spain	3835724	383572	17260759	1150717
UK	3451138	345114	15530120	1035341
EU27	30000000	3000000	135000000	9000000

Based on the replacement rate of 5% per year and 2% per year growth rate for floor area across EU27 for all buildings, a forecast of estimated sales to 2050 has been calculated as shows in Table 9.

Table 9: Forecasted sales growth in EU27

('000 m^2)	Non-residential		Residential	
	Windows	Doors	Windows	Doors
2010	30000	3000	135000	9000
2020	36570	3657	164564	10971
2030	44578	4458	200603	13374
2040	54341	5434	244534	16302
2050	66241	6624	298085	19872

The sales for windows and external doors presented in Table 9 were calculated on the basis of the entire market, including both replacement and new construction. The proposed scope of the GPP criteria has changed during the project, and following the first stakeholder meeting, it was agreed that the focus should be on replacement windows and external doors and not those for new construction or major refurbishment. Windows and external doors for new construction and major refurbishment will be addressed through whole building assessments under EPBD. It is therefore necessary to provide an indication of the sales for the replacement market only, excluding new construction sales.

Feedback from stakeholders indicates that the ratio between the replacement and new construction market for windows is typically 60:40% for residential construction and 46.5:53.5% for non-residential construction. This is a general trend and addition research has not identified any additional information to cast doubt on these figures. Therefore the numbers calculated should be used with caution. However it is considered that these are reasonable ratio's on which to make an initial calculation. It is highly likely that the market split between replacement and new construction will vary between MSs, for example as a result of building programmes, the quality of the products installed

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already, the building stock age or incentives to encourage replacement of windows and doors. This will be true for both residential and non-residential buildings.

The feedback provided relates to the split between replacement and new construction markets for windows. In the absence of information regarding the split for doors, it has been assumed that doors and windows are bought and replaced at the same time and the split will therefore be the same.

Applying the ratios for replacement and new construction markets to the total sales forecasted for residential and non-residential sectors provides an indication of the sales for the replacement market for windows and external doors. The calculated figures are presented in Table 10.

Table 10: Calculated sales for replacement only in EU27

('000 m2)	Non-residential		Residential	
	Windows	**Doors**	**Windows**	**Doors**
2010	13950	1395	81000	5400
2020	17005	1701	98738	6583
2030	20729	2073	120362	8024
2040	25269	2527	146720	9781
2050	30802	3080	178851	11923

3.1.6 Summary of Market Data

The market data section concentrated on providing an overview of what the current market for windows and external doors looks like. The section established the stock, the annual sales, the annual production levels and the production and consumption in the recent years of windows and external doors in the EU. The production and consumption across EU in 2010 is summarised in Table 11.

Table 11: Production and consumption across EU27 in 2010

	Units sold (million)	Cumulative value (billion euro)	Highest seller (number units)	Highest seller in value
Windows, French windows and their frames of wood	27.3	6.8	Italy UK Poland	Italy Germany France
Doors and their frames and thresholds of wood	92.9	6.2	Spain UK	Germany UK
Plastic doors, windows and their frames and thresholds for doors	60.6	11.9	UK Germany Poland	Germany UK France
Iron and steel doors, thresholds for doors, windows and their frames	56.7	6.5	Poland Germany	Italy Germany France
Aluminium doors, thresholds for doors, window, sand their frames	41	11.4	France Spain Italy	Italy France Germany

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Looking at the trade across MSs and outside the EU, Germany is a key player within the windows and external doors market especially in terms of frames made of iron and steel, plastic or aluminium. In terms of wooden frame based products, few MSs have a dynamic market. The calculations carried out in this study suggest that wooden frame products dominate the market at EU27 level. However, the indication from stakeholders feedback is that this is not necessarily the case, with plastic frames dominating the EU 27 overall. This highlights the limitations within the official statistical data. For this reasons these figures should be treated with caution. The overall apparent consumption for the EU was estimated at 277.7 million units broken down as shown in Table 12.

Table 12: Breakdown of the European window and external door market depending on the material used

Product Type	Share (%)
Windows, French windows and their frames of wood	9.68
Doors and their frames and thresholds of wood	33.37
Plastic doors, windows and their frames and thresholds for doors	21.62
Iron and steel doors, thresholds for doors, windows and their frames	20.81
Aluminium doors, thresholds for doors, windows and their frames	14.5

3.2 Market & Production Structures

The windows and doors market is primarily driven by the building construction activity on a national, regional and global basis. In turn, the construction market is strongly influenced by basic demographic and economic influences. Residential construction can be affected by a number of variables such as population growth, economic conditions, income levels, interest rates, employment and consumer confidence. Non-residential construction spending is influenced by private and public policies about capital investment, interest rates and occupancy rates. The following section gives an overview of the windows and doors markets.

3.2.1 General Trends in product design and product features

3.2.1.1 Global Trends

Despite the recent downturn in the global economy, worldwide demand for windows and external doors is forecast to rise 6.8 % per year. The demand for windows and external doors in the residential building construction market is expected to outpace demand in the non-residential building construction market as the residential market in developed countries suffered a greater impact due to the recession in 2009 and 2010[20].

Through to 2015, demand for energy efficient windows and external doors is expected to rise faster than the overall market. This has been attributed to increasing consumer awareness and government support e.g. the Energy Star in the US[21] and the Programmes in Canada[22]. China, due to its rapid economic growth and increasing house sizes, is the world's largest national window and external door market, accounting for 27% in 2010 and expected to expand to 30% in 2015. The US market for windows and external doors is expected to recover and grow by 7.7% through to 2015. This is after experiencing a decline of approximately 25% between 2008 and 2010 due the countries major economic recession. Demand in Japan and Western Europe is expected to recover after declines in 2009 and 2010. The developing nations of the Africa/ Middle East region and Latin America are also forecast to experience especially fast growth between 2008 and 2013, despite a deceleration from the pace of the period 2003-2008. Table 13 shows global demand across a number of regions.

Table 13: World Window and Door Demand (Value – Euros converted from US Dollars)

	Year			% annual growth	
Regions	**2005**	**2010**	**2015**	**2005-2010**	**2010-2015**
Windows and door demand	86.8	104.8	145.8	3.8	6.8
North America	27.5	21.3	30.4	-5	7.4
Western Europe	22.9	24.6	29.2	1.4	3.5
Asia/pacific	27.8	46.8	69.5	11	8.2
Other regions	8.7	12.1	16.7	7.1	6.7

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[20] http://www.freedoniagroup.com/brochure/27xx/2790smwe.pdf
[21] http://www.energystar.gov/index.cfm?c=windows_doors.pr_taxcredits
[22] Value converted: 1 GBP = 1.18230 EUR
http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Action/energy-efficiency-policy/Potentialforloans

3.2.2 European Window Market Trends

The European window market stabilised in 2010 after a major slowdown in 2009[23.] Of the 125.8 million window units produced in Europe during 2010, 59.6% were in the EU27, 15.7% in Norway, Switzerland and Turkey, and 24.7% in Russia and the Ukraine. The recovery in those last countries was the driving force to increase the European window market between 2009 and 2010 by 0.4%. After a collapse of 49.4% in 2009, the total market in these countries grew by 21.4% last year. In contrast, the market across the 27 EU states decreased by 6.6% in 2010 following a 10.9% decrease in 2009 [24].

German market increased by 3.3% in 2009 and 4.9% in 2010 largely due to support for installation of energy efficient windows. However, government support will be significantly lower in 2011 and the growth in German window demand is expected to slow. With 12.6 million window units installed last year, Germany was the largest single window market in Europe during 2010 accounting for 16.8% of the EU market and 10% of the wider European market.

Poland has emerged as major market for windows and external doors in recent years. A total of 6.36 million window units were installed in Poland in 2010 compared to 6.23 million in 2009. Spain's window demand fell 35% in 2010 to 5.15 million units sold. This follows an 18.4% decline in 2008 and 34% decline in 2009. In Europe, the market is expected to stabilise and a return to growth, although small, is expected.

3.2.3 European External Door Trends

Accurate figures for external pedestrian door demand across Europe were more difficult to obtain. External pedestrian door market is directly linked to the windows markets as the two products are often purchased at the same time for new builds and renovation purposes, however trends based on data as identified above for windows were not available.

3.2.4 European market trends – materials

There are a number of key global trends with regards materials[20]

- Plastic is predicted to be the fastest growing material through to 2015 by continuing demand for vinyl windows and doors due to their "low cost, durability, minimal maintenance requirements and superior energy efficiency". Plastic windows are expected to account for 37% of global window demand in 2015
- Fibreglass entry doors are expected to take market share from wood and steel entry doors as improvements in manufacturing techniques have enabled manufacturers to make fibreglass that more closely resembles wood.

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[23] These are the results of a study carried out by the Fenster + Fassade trade association (VFF) with the support of Professor Dirk Hass of the KünzelsauerInstitutfür Marketing (KIM), which was presented at BAU 2011 in Munich

[24] http://www.globalwood.org/market/timber_prices_2009/aaw20110201e.htm

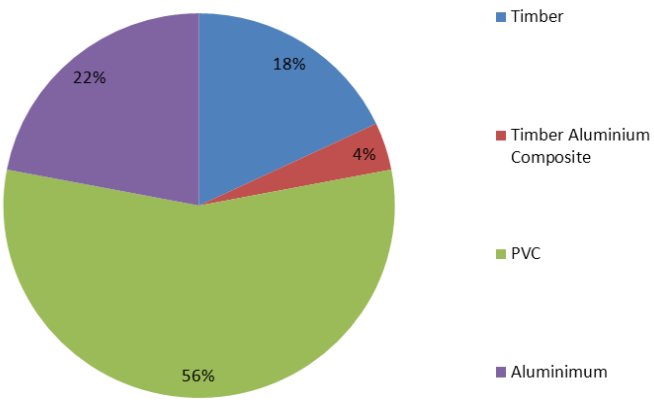

Figure 1: Breakdown of window production depending on the frame material used

The key trends in materials used for windows in 2009 are summarised in Figure 1. PVC holds the dominant position (56% but lower than previous years), timber (18% but decreasing), aluminium (22% maintained its position). The market in Europe for wood windows is greatly influenced by cultural preferences and building styles. For example Norway, Sweden and Finland comprise 70% of the market share of wood windows. In contrast PVC is very dominant across the rest of Europe. For example PVC market share is over 70% in emerging markets including Russia, Poland and Turkey.

These results were confirmed by the feedback from stakeholders. In Northern Europe, wood windows hold the dominant market share and represent as much as 90% of the domestic market while in Southern Europe aluminium windows are most popular. This trend in Southern European countries appears to be shifting as the drive for greater energy efficiency is pulling an increase in demand for PVC windows. In Middle European countries PVC windows are estimated to account for 50% of the demand.

Aluminium is most favoured for non-residential construction. Aluminium has an unusually high market share in Italy (37%), especially in the south of the country, and in Spain (70%). Generally, high rise buildings demand higher requirements of windows such as fire proofing and reinforced glass.

In 2004, wood was the dominant material for external doors (46%), followed by metal (43%), with a small share going to plastics (11%)[25]. By 2009, wood and metal are essentially even, by 2014, metal door demand will pull slightly ahead of wooden ones, with plastics still lagging by a considerable margin. Historically, wood has been favoured particularly in Northern Europe where a strong tradition of wood construction has influenced the demand. However, concerns over deforestation are improving the share of other materials on the market. Metal doors are gaining market share by enhancement in product design, strong demand from commercial users, and special applications. Recent technical advances permit manufactures of plastic doors to offer improved appearance and performance, and unlike competitive wood and metal units, are completely rot-proof and rust-proof.

3.2.5 Technology market trends

The trend towards increased versatility in window design and innovation is most likely to intensify going forward. This trend is being strongly driven by environmental, energy and hence cost saving principles. In recent years, the trend for highly glazed buildings, conservatories and orangeries has grown worldwide in modern architecture. These changes in design, and a focus from consumers on energy efficiency and the demand for better design e.g. thermal performance has put pressure on industry to respond to these requirements.

[25] Ecolabel and GPP Criteria for Windows and Doors Preliminary Report December 2010 (unpublished)

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A further market influence is the shift from new construction to retrofit construction activity. Retrofitting provides an enormous market opportunity for owners and green builders and, recently, energy service provider companies.

Glazing is nearly always the largest constitute part area of the overall window unit in terms of area, and therefore the properties of the glazing, for example the U-value are very important. Multilayer glazing is the most popular commercially available glazing. Today, triple glazed windows are growing in popularity due to the inherently low U-value. As Figure 2 and Figure 3 show, triple-glazing features consist in three pieces of glass sealed together to create an insulated glass unit. The gas fill between the panes is typically argon or krypton, with krypton producing a lower U-value with less cavity or fill thickness, which at the same time helps to reduce the weight of the window. Due to higher thermal insulation requirements demands from the market, three-layer glass with a U-value of 0.6 W/m^2K will be used increasingly, becoming the 'norm' in Scandinavian countries in recent years and growing rapidly in Germany[26].

Figure 2: Example of typical triple glazed window unit (section view)[27]

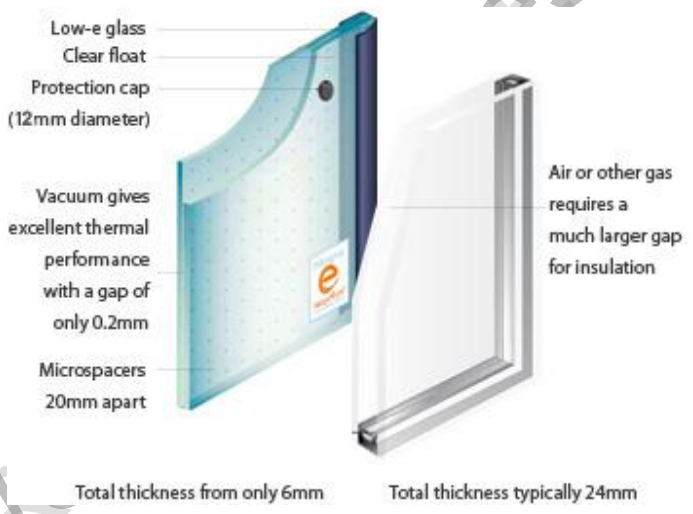

Figure 3 : Example of a vacuum glazing system[28]

Vacuum glazing consists of two sheets of glass separated by a narrow space with an array of support pillars keeping the two glass sheets apart. Intensive research leads to a minimization of the convective heat transfer and the total weight of the window. Due to the thinness of vacuum glazing and its excellent thermal performance, it is highly suited to retrofit in existing buildings having the potential to significantly reduce heating.

Other market shares belong to low-emissivity (low-e) coating, which are an additional feature of multi-layer glazing, which can be applied to individual glass layers in order to improve the energy balance of the window by reducing energy losses from within the building. Solar control glass can also be used to reflect the sun's heat to avoid the build up of heat and therefore reduced the cooling requirements. Smart windows[29] that can adjust the solar factor and transmittance properties to outside and indoor conditions are also available, reducing energy costs relating to heating and cooling.

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[26] http://www.glassforeurope.com/en/issues/faq.php
[27] http://www.conservatoriesscotland.com/Windows_And_Doors.htm
[28] http://www.pilkington.com/europe/uk+and+ireland/english/products/bp/bybenefit/thermalinsulation/spacia/default.htm
[29] Properties, requirements and possibilities of smart windows for dynamic daylight and solar energy control in buildings; A state of the art review. Available online at:
http://www.sciencedirect.com/science?_ob=MiamiImageURL&_cid=271495&_user=525224&_pii=S0927024809002992&_check=y&_coverDate=2010-02-01&view=c&wchp=dGLbVlS-zSkzS&md5=82ea9530c114356a48790da8a5310617/1-s2.0-S0927024809002992-main.pdf

Recent technology developments in solar cell glazing and aerogels[30] have enabled solar energy collection from transparent glass or lower density of windows respectively. This area is seen as having a lot of potential in the building industry and highlights the alternative uses for windows (Figure 4 and Figure 5).

However, the high costs are major down sides at the moment for the new products. These products are more suited to roofing and facades in commercial buildings and sports halls and are not yet in a position to challenge conventional residential windows where transparent (and not translucent) glazing is most often required.

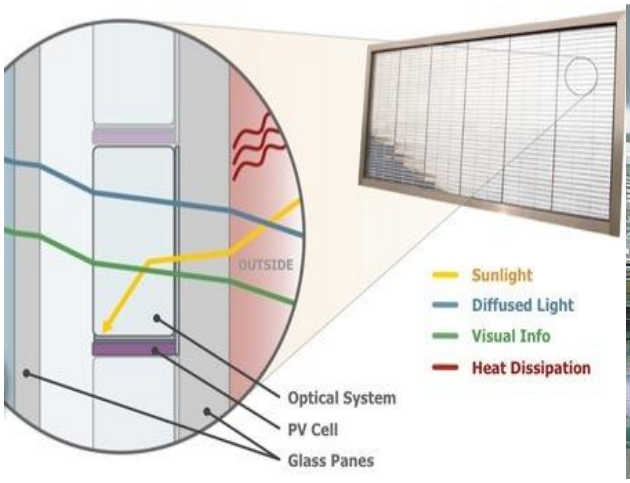

Figure 4: Example Solar Cell Technology

Figure 5: Example of translucent aerogel insulation used for commercial purposes

The frame can have a significant influence on the efficiency. Although it comprises 10- 25% of the window area in commercial buildings, the quality will affect the insulation properties of a double glazing window by up to 30%[31]. Research shows that frames of high-performance are composite materials, such as fiberglass, that offer most of the strength, stiffness and durability of aluminium with the thermal performance of wood. Other composite frames include foam-filled vinyl frames with aluminium exterior claddings, wood frames with polyurethane foam thermal breaks and slender foam-filled fibreglass extrusions with wood interior finish and aluminium outer weathered components[32]. Aluminium-clad softwood core frames have proved a successful composite combination with a longer life. Timber faced with aluminium exterior is common reaching an estimated U-value < 1 W/m^{2}K. The range of low energy windows, which include windows with a U-value of 0.8 -1.0 W/m^{2}K, is continually growing. These types of windows will have the best chance of competing on the market in the future.

Further information regarding best available technology, and best not yet available technology can be found in the Task 4 report, which is accessible on the project website[4].

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3.3 Market Structures

3.3.1 Trends in the market across Europe

The European market is heavily influence by the cost of raw materials, advancements in technology, policy and regulatory considerations. In addition to this, window and external doors have a decorative role in both commercial and domestic markets and as such they are influenced by social and cultural

[30] Aerogel insulation for building applications; A state of the art review. Available online at: http://www.sciencedirect.com/science?_ob=MiamiImageURL&_cid=271089&_user=525224&_pii=S0378778810004329&_check=y&_coverDate=2011-04-01&view=c&wchp=dGLbVlV-zSkWz&md5=33133e1b8d74002d1dd203ca75af973f/1-s2.0-S0378778810004329-main.pdf

[31] http://www.double-glazing-info.com/Choosing-your-windows/Window-frame

[32] http://www.wbdg.org/pdfs/jbed_winter10.pdf

preferences. In terms of market shares, the residential sector takes 66% and the non-residential sector 34% being approximately 60% due to renovation and 40% due to new build[33].

In general the European market for windows and external doors across can be segregated into Northern Europe (Scandinavia), middle Europe (Germany, France etc.) and southern Europe (Italy, Greece etc.) with evident trends in each area. In Northern Europe, windows which are open to the outside are extremely common while in middle Europe tilt and turn windows are popular. In the south, sliding windows are very common in domestic properties. At a national level, casement windows are very popular in France.

Regarding material types, 90% to 95% of the market is wooden windows in northern Europe, in middle Europe the market for PVC is extremely strong (greater than 50%) while in southern Europe aluminium is greater than 50% of the market[34] although PVC is growing due to the requirements for improved insulation.

In relation to glazing types, triple glazing is becoming the standard across middle Europe. This excludes the UK where U-value requirements are higher than middle continental Europe and the drive for triple glazing is slower. Southern Europe has very different glazing requirements and aim to achieve a lower g-value[35]. In general, across Southern Europe, single paned, coated glass is quite common. However, the trend towards double glazing is increasing. Across Europe, aluminium framed windows are commonly found in older commercial buildings.

3.3.2 Structure of the supply side

In general across Europe, the development of the market has been at a national and in some cases local level. Depending on the trend and preferred window types, specialised manufacturers have developed to cater for the local or national market.

For both aluminium and UPVC windows and external doors the structure of the supply side is similar. Companies are involved in the extrusion of the material producing a series of profiles. These profiles are cut and crimpled/welded together, such as the outer frame, sash, transom and beads. Assembling together the profiles one complete system is made up. The quantification of the number of window manufacturers operating across Europe is difficult, as much of the market is composed of small and medium sized enterprises (SME's) and microbusinesses. For example, in Greece up to 95% of the market is composed of SME's[36].

The extruded profiles are usually purchased from the company is by the manufacturer (known as the fabricator). The fabricators range from smaller companies producing a few frames per week to larger companies producing several thousand per week. Manufacturers utilise the profiles to form the finished window or external door. This is achieved by cutting and assembling the profile and adding hardware such as locks, hinges and handles as well as weather seals and gaskets. For example, in Germany, approximately 300 manufacturers make up 60% of the market. The remaining 40% is made up of approximately 5000 small businesses. Many of these companies carry out product installation also. Fabricators can then sell directly to the home owner (retail/domestic market) or they may supply the new-build market (house builders) or the commercial and public sector (local authorities/social housing). There are thousands of window installers across Europe varying in size from large specialised companies to local micro enterprises. Most of these companies do not manufacture, and will buy their products from a fabricator. Local builders will often be involved in installation, for example as part of a refurbishment or extension construction project.

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[33] Figures provided as part of stakeholder feedback.
[34] Figures estimated by stakeholders
[35] This expresses the share of solar energy that is transmitted, through the element, to the inside of a building
[36] Figures provided as part of stakeholder feedback.

4 Key environmental impacts

4.1 Environmental performance of windows and external doors – literature review

This section aims at reviewing the existing literature and providing an initial indication of where the key life cycle impacts are likely to exist for windows and external doors. The life cycle assessment (LCA) is a widely used environmental analysis methodology which provides a systematic scheme to evaluate and compare the environmental burdens of a process or product's life cycle within a defined system boundary. The environmental impacts considered results from the whole life cycle including the materials production stage (raw material supply, transport, manufacturing, etc), use stage (energy loss, maintenance, etc) and finally the end of life (recycling, disposal, etc).

The LCA of windows vary significantly in the assumptions they seek to inform and hence the scope and design of such analyses also vary significantly. Salazar and Sowlati[37] undertook a review of published and unpublished papers on LCA of windows. This review concluded that in general, LCAs are carried out on windows for two reasons: a) to compare window frame materials and compare their relative impacts throughout the life cycle or 2) justifying increased emissions or resource use during manufacturing when compared with energy saved during the use-phase for improved product performance.

In addition, a study commissioned by the European Commission in 2004[38] presented a review of LCA studies examining windows. The study discussed how LCA comparisons should be undertaken at application level rather than at material level. LCAs focused on the application stage establish a more complete and comprehensive view of the environmental impacts over the life cycle of the product. Therefore, correlations can be drawn between the production phase, use phase and end of life treatment and important impacts of these stages should be included.

The study concluded that for windows, in terms of preferable material, there is no windows material that has an overall advantage for the standard environmental impact categories. This conclusion is reached as it shows the most promising ways to lower the environmental impacts is through design optimization, therefore the choice of materials is of a minor importance as long as the material can provide the required system quality of the window.

4.1.1 Environmental performance of wooden windows – literature review

A recent study examining the LCA of wood windows[39] showed the main contribution of such windows to the greenhouse effect was during the use-phase. However, the contribution depends on the emissions of CH_4 because of the combustion for heating the buildings. The impacts of the end of life phase are smaller but not negligible and mostly dependent on the methane (CH_4) emissions due to wood anaerobic decomposition in landfill. During the production phase, double glazing production was the most relevant process to GHG emissions followed by the semi-finished wood tables which are used for window frame production.

Tarantini et al[39] studied a wooden window produced and mounted in the North of Italy. This study fully agrees within the above mentioned results and considers that the contribution of other production

[37] Salazar and Sowlati: A review of life-cycle assessment of windows, Forest Products J., Oct, 2008: 58, 10
[38] LCA of PVC and of principal competing materials available under: http://ec.europa.eu/enterprise/sectors/chemicals/files/sustdev/pvc-final_report_lca_en.pdf
[39] Tarantani et al, A LCA to GPP of building materials and elements: a case study on windows, Energy 36 (2011) 2473-2482

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processes such as wood frame machining, pin insertion, frame gluing and assembling, brushing or even painting do not significantly contribute to the greenhouse effect. The low contribution of in-company processes to greenhouse effect can be explained also because the factory shed is heated by burning wood scraps recovered from the industrial processes. The energy used for drying the tables and for transport them within the production area is the main determinant of the wood table production contribution.

The contribution to the photo-oxidant formation category is mainly due to the window production processes and in the second place to the used and maintenance. Glass production contributes to VOCs emissions due to the production of the electricity used within the process, whereas wood tables production impacts are due to NO_x emissions from truck transport in Northern Europe.

The contribution of the wood window life cycle to the acidification category is mainly due to the window production phase. The combustion of fossil fuels for generating the electricity for operating machine tools and for heating the building in the use phase is the main source of SO_x and NO_x emissions. Transports are a not negligible source of NO_x emissions.

Analysing the primary energy indicator, the contribution of the use phase reaches 85% of the consumption; the manufacturing of the main windows components is modest whereas the contribution of the maintenance and end-of-life stages is irrelevant.

Table 14 shows a summary of the environmental impacts caused by the wood windows. As observed, for each impact category the most critical processes in the window life cycle are identified. Burning fossil fuels for heating the building is the single most important process for all the impacts categories except waste production. Although the environmental impact of production processes cannot be neglected. The contribution can range between 10 to 60%. These results have been conducted considering specific climate conditions (which affect the product weathering and thermal loss and gain) and technologies. Different assumptions on window service life, climatic conditions and domestic heating or cooling systems, electric energy production processes, etc which are crucial parameters in the window life cycle can significantly affect the results.

Table 14: Contribution analysis of LCA study

Key environmental impacts	Responsible processes or life cycle stages
GHG effect	Energy losses in the use phase (heating and cooling) Double glazing production Production of semi-finished wood tables Wood frame production
Acidification	Energy losses in the use phase (heating and cooling) Double glazing production Production of semi-finished wood tables Wood frame production
Photo-oxidant formation	Energy losses in the use phase (heating and cooling) Maintenance (brush painting) Double glazing production Production of semi-finished wood tables Painting process in production phase
Primary energy consumption	Energy losses in the use phase (heating and cooling) Double glazing production Production of semi-finished wood tables Wood frame production
Waste production	Copper and steel production for ironware Window end-of-life

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4.1.2 Environmental performance of PVC and aluminium windows – literature review

According to the previous mentioned studies different materials are appropriate for different situations and environments. For example, wooden frames and the periodic maintenance that they require will

not be appropriate for high or inaccessible locations, while standard PVC frames will not be appropriate for very hot locations.

Tarantini et al reviewed the environmental impacts caused by the PVC and aluminium windows too. In both material cases the dominance of the use phase in determining the greenhouse effect has been confirmed by several LCA studies on windows. In fact, most of the analysed studies deduce that no material has advantages in all impact categories and highest potentials for improvement are expected in the optimization of the frame structure (e.g. lowering the specific heat loss, raising the amount of used secondary material or lowering the amount of material needed for the same function). Recycling offers the potential to save primary energy and resources for all window frames, especially for non renewable materials as it is the case of PVC and aluminium.

According to the study carried out by Salazar and Sowlati, focused on Northern America residential sector, PVC, aluminium clad wood and fibreglass frames are comparable in cradle-to-gate emissions and significant improvements of the windows life cycle can be obtained for a longer service life and lower replacement frequency. Moreover, the study indicated that the life cycle impacts were dominated by generating electricity for operating machinery as in the case of wood windows.

In these aluminium and PVC cases, the dominance of the use phase for greenhouse effect and the importance of the primary energy for the frame windows production over the other impacts categories is confirmed by all the analysed studies. Moreover, the production of aluminium and PVC frames causes the following environmental impacts to a lower extent: acidification, photo-oxidant formation, waster production (Aluminium, PVC) and emission of hazardous chemicals (PVC).

4.1.3 Environmental performance of external doors – literature review

Unfortunately existing life cycle studies for external doors have not been identified. However, it is reasonable to assume similar conclusions with regards energy consumption during the production and use phase given the long life times of the products, although given the reduced areas of doors within the building envelope this is likely to be reduced when compared to windows.

4.1.4 Main conclusions from the windows and doors literature review

The key findings from the previous LCA studies are:

- in terms of preferable materials, there is no window frame material that has an overall advantage for the standard impact categories. The most promising ways to lower the environmental impacts of windows is through design optimization

- for LCAs carried out on windows that considered frame materials, wood had lower embodied energy than the market alternatives, PVC and aluminium. It was found that the embodied energy of the aluminium framework is much higher than those of other materials

- LCAs show that the use phase contributed around 85% to the total primary energy while for the greenhouse effect the use phase represented approximately 80% of the total

- no material has advantages in all impact categories. The highest potential for improvements is expected in optimizing the frame structures

The analysis of existing LCA studies indicates that there is no reason to draw a distinction between frame materials when considering the scope and definition of window for this project, with the use phase energy consumption related to the installation of windows the most significant aspect within the life cycle.

There is a lack of environmental studies on external doors. However, it may be reasonable to assume similar conclusions with regards embodied and use phase energy consumption given the long life

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times of the products, although given the reduced area of doors within the building envelope this is likely to be reduced when compared to windows.

4.2 Technical Analysis – EcoReport

This section provides a summary of the results obtained when the MEErP was applied. An important part of MEErP is EcoReport, a simplified life cycle tool. This tool was used to demonstrate the key environmental life cycle impacts via the identification and application of three base cases of typical products: a window and two external doors made of UPVC and wood. The characteristics of these products are then used as input parameters to EcoReport. Full details of the analysis are available in the Task 3 report[40].

4.2.1 Description of the base cases

Windows and external doors of the domestic and non-domestic sectors come in a variety of designs, using a range of different materials and varying functionality depending on their intended use.

Windows: UPVC double glazed window

According to the stakeholder replies and the studies conducted previously, the UPVC double glazed window is most dominant on the European market as a whole. These windows are designed to be robust, hard wearing and long lived. They require little maintenance and any replacement parts required are likely to be small components, such as handles or hinges. This information is different to that obtained from EU statistics, however due to the uncertainties with the EU statistics, the information in other studies and feedback from stakeholders has been followed in this study. ***External doors: UPVC and solid wooden external doors***

For external doors the market trend appears to be more evenly split between UPVC and wooden external doors. For this reason two base cases have been developed: UPVC and solid wooden. Both are designed to be robust, hard wearing and long lived. They require little maintenance and any replacements parts but small components.

4.2.2 Technical inputs for EcoReport

EcoReport requires a number of technical inputs across the different life cycle phases of production, distribution, use and end-of-life. In addition to the base case analyses, further analyses have been done using EcoReport looking at a range of other window and external doors, including wood and aluminium framed windows, and single and triple glazing, as well as UPVC and wooden doors that will be briefly reported in the coming sections.

4.2.2.1 Production Phase

The information used in this section was provided by the stakeholder consultation and direct contact through telephone conversations and meetings. The materials used are limited and the majority of the windows are of UPVC whilst external doors tend to be a balance between UPVC and wood. This is unlikely to change in the short to medium term. Windows tend to be double glazing although this situation varies between different MS.

4.2.2.2 Distribution Phase

EcoReport considers in this phase the packaging and packaged volume. Whilst stakeholder contribution did not provide detailed Bill of Materials (BoM) data for packaging, stakeholders indicated that windows and external doors are predominantly supplied in plastic film packaging with the fittings usually supplied in plastic packaging and transported on reusable pallets.

[40] Technical analysis, BAT and BNAT available at: http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html

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4.2.2.3 Use Phase

The main factor of this phase is the influence on the building's energy performance. It is important to note that windows and doors are energy related products and not energy using products. The in use energy consumption referred to in the technical analysis relates to the energy balance of the window, and the net energy gain/loss in relation to energy used for heating and cooling. In order to calculate the energy balance of windows and external doors a number of assumptions have been made:

Calculation of energy consumption - Windows

The energy balance of a window and external door is influenced by its construction, the building it is installed in and the local climate. Due to these factors, it is difficult to define the standard window and external door. However, for this project two important values were considered the U-value, which represents the heat losses through the window or external door and the g-value that accounts for the heat gains.

For windows, most of the national labels do not calculate an energy balance figure, instead of that they present standards for the U- and g-value that must be achieved within that country. The British Fenestration Rating Council (BFRC) scheme[41] in the UK is the main exception and has used an energy rating calculation for a number of years. Information provided by stakeholders on the Danish label indicates that the equation is similar to that for the BFRC scheme, with a slight difference in the equation based on a Danish reference house, and would not have a significant impact on the results obtained using the BFRC scheme. Given that EcoReport requires energy input figures in terms of kWh, the BFRC calculation routine has been considered. The analysis in Table 15 shows the BFRC energy ratings calculated for a range of different windows, with various energy performances from the most energy efficient to the worst energy efficient windows. Generally speaking, high performing windows with low U-value and a relatively high g-value performed better as they have a net energy gain, mainly due to minimal heat loss and additional heat gained through solar gains.

Window 1 is a possible best frame and triple glazing window while window 14 is the worst performing with a net energy loss due to considerably higher U-value; this window is constructed of poor quality frame and single glazing. Further information is available in the Technical Analysis document[42].

Table 15: Energy performance of a range of windows

Num	U-value	g-value	BRFC	Num	U-value	g-value	BRFC
1	0.7	0.51	51.70	8	1.95	0.67	-2.44
2	1.0	0.58	44.92	9	1.95	0.46	-43.76
3	1.1	0.60	42.01	10	2.6	0.78	-25.32
4	1.4	0.58	17.52	11	2.6	0.56	-68.61
5	1.4	0.63	27.36	**12**	**2.5**	**0.78**	**-19.16**
6	1.5	0.67	28.38	13	4.7	0.87	-151.47
7	1.5	0.46	-12.93	14	4.7	0.66	-192.78

Units: Overall U-Value (W/m^{2}K), Glass g-value (W/m^{2}K) and BFRC rating (kWh/m^2/y)

Note: A negative BFRC value indicates a net energy loss through the window, with a positive value indicating a net energy gain.

For the base case, the energy performance of window 12 has been used. The energy performance in a UK scenario will be used to calculate the environmental impacts of the window along its life cycle phases and afterwards to provide an indication of the key factors on which to focus the environmental criteria. Further analysis commissioned by Velux and completed by the University of Denmark, aimed to provide an energy balance of the window within different climatic areas of Europe[43]. This research has been used to inform part of the sensitivity analysis undertaken, of which further details can be found in the Technical Analysis document. In addition to the EcoReport results, additional analysis was done on the impacts of different local climatic conditions on the U- and g-values when the heating

[41] http://www.bfrc.org/
[42] Technical analysis document available on : http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html
[43] http:/www.byg.dtu.dk/iupload/insntitutttter

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and cooling seasons change. Further information regarding this is available in the Technical Analysis document.

Table 16 shows the energy balance of a standard double, single and triple glazed window for the size of glazing used for this analysis, based on the energy balance calculations using the BFRC scheme equation. The heat lost or saved is calculated for the window within the context of the reference building and climate data used to establish the BFRC energy balance calculation.

Table 16: EcoReport inputs for energy consumption for windows

Glazing	Glazing (m^2)	U-value (/m^2)	g-value (/m^2)	Heat loss (kWh/a)	Heat saved (kWh/a)
Double	1.82	2.5	0.78	34.88	0
Single	1.82	4.7	0.87	275.68	0
Triple	1.82	1.5	0.67	0	76.46

Calculation of energy consumption – External doors

The BFRC have extended their rating scheme to include external doors, this also provides an energy balance figure for external doors (kWh/m^2/y) which will vary depending on the performance parameters, in this case the U-value.

The BFRC rating scheme for doors uses a standard size of 1.23m wide x 2.18m high. The scheme identifies three types of door design: a solid door, partially glazed door (10-30% glazing), and a fully glazed door (>30% glazing). All three door types cater for all material styles which are mainly UPVC, aluminium and timber.

The calculation methodology dictates that solar gain does not to be taken into account for doors with glazing of less than 60%. Any door with glazing above 60%, where solar gain needs to be considered, e.g. patio, French doors or sliding doors, would be treated as windows. BFRC analysis explains that solar gains (g-value) should not be taken into account when calculating the energy balance of an external door because it covers a much smaller proportion from low U-values of 0.7 to high U-values of 1.8 W/m^2K.

For the purpose of this study, the energy performance of the door base cases has been based on a door matching the UK building regulations requirement with a U-value of 1.4 W/m^2K, air leakage 0 m^3/mh and a rating -96 kWh/m^2/y. A door with these characteristics has been used as we are using the BFRC rating scheme for doors to assess the energy balance. A door with these characteristics would meet UK building regulation requirements, and is therefore considered typical.

Table 17 provides the energy balance of a standard door, based on high energy loss, medium energy loss and low energy loss within the context of the UK building regulations and the BFRC energy rating scheme for doors

Table 17: EcoReport inputs for energy consumption for External doors

Door type	Size (m^2)	U-value (/m^2)	Heat loss (kWh/year)
High energy loss	2.68	1.4	257.28
Medium energy loss	2.68	1.1	201.00
Low energy loss	2.68	0.7	128.64

Calculation of water usage per window and external door

Domestic and non-domestic windows and external doors would be cleaned on a regular basis. However, no indication was given to the quantity of water consumption or the frequency of the cleaning process. Estimations of 0.009m^3/year per standard window and door was taken.

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Other in-use inputs

The use phase of windows and external doors will, in addition to the energy balance and cleaning outlined, require detergent for the cleaning process. Also maintenance and repair during their lifetime should be considered. Considering the latter first, as a first approximation, window repair is infrequent and therefore it is unlikely to be a major contributor to the life cycle. Considering cleaning, an estimation of 15ml detergent used per window and year is considered (density 1kg/l → 0.02kg).

4.2.2.4 End of life phase

Windows are considered to be usually recycled due to the economic value of UPVC, aluminium and wood as well as that of glass. EcoReport fixed assumptions for the reuse, recycling and recovery rates of materials.

Default values, based on a number of sources and assumptions are presented in Table 18. These EcoReport default values for reuse, recycling and recovery rates have been used alongside EcoReport's defaults for incineration and landfill disposal. These values relate to different categories of materials and not specific materials within the different categories.

Table 18: EcoReport default values for fate of materials at end-of-life

Fate	Bulk Plastics	Tecplastics	Ferro	Non-ferro	Extra
EoL mass fraction to reuse, in %	1	1	1	1	1
EoL mass fraction to recycling, in %	29	29	94	94	60
EoL mass fraction to heat recovery, in %	15	15	0	0	0
EoL mass fraction to incineration, in %	22	22	0	0	10
EoL mass fraction to landfill, missing, fugitive, in %	33	33	5	5	29

At the first stakeholder meeting feedback on the above values for end of life materials was sought. Unfortunately no feedback was received and in the absence of any additional information the default values have been retained in the analysis.

4.3 Base Cases - Windows

4.3.1 Windows – Inputs

Bill of Materials (BoM)

Considering the information previously analysed the BoM for a window of UPVC and double glazing is summarized in Table 19. Moreover, a number of materials that are not included in the standard list of EcoReport materials, such as flat glass, double and triple glazing, wood and paint have been considered. The emission data for 1kg of these non-included materials has been extracted from SimaPro[44], after being multiplied by the impact emission factors already established within EcoReport.

Table 19: Bill of materials – UPVC double glazed window

UPVC framed double glazing (1230x1480mm)				
	Material	**Weight Dimensions**	**EcoReport code**	**Comments / Remarks**
Construction phase	UPVC frame	18.030 g	8-PVC	
	Fittings (metal)	1.250 g	33-ZnAl4 cast	
	Fittings (plastic)	1.000 g	8-PVC	
	Fittings (rubber)	1.000 g	56- Bitumen	
	Glazing	41.940 g	102-2 glazing	
Packing	plastic	0.18m3		
Use phase	Water for cleaning	9 l		Lifetime 30 years
	Detergent	15 ml		Heat loss 34.88 kWh/y

[44] SimaPro is a widely used LCA tool, for which a subscription is required: http://www.simapro.co.uk/index.html

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Addition of materials to EcoReport

As commented, glazing is not included in EcoReport. However, developers of EcoReport indicated that group 55 has been used to represent glass in other product groups, such as shelves and lighting equipment. Glazing is obviously a significant component of windows and therefore has an important contribution to several environmental indicators. The data used for double glazing in EcoReport were obtained from SimaPro and summarized in Table 20.

Table 20: Impact assessment for double glazing from SimaPro

Name / material		Units	102 - Double Glazing
Other Resources & Waste	Primary Energy	MJ	9.12
	Electrical Energy	MJ	0.80
	Feedstock	MJ	0.00
	Water (process)	litres	14.58
	Water (cooling)	litres	23.91
	Haz Waste	g	0.00
	Non-Haz Waste	g	70.00
Air Emissions	GWP	kg CO_2 eq.	2.13
	AE	g SO_2 eq.	11.14
	VOC	mg	456.88
	POP	ng i-Teq	0.00
	Heavy Metals	mg Ni eq.	23.59
	PAH	mg Ni eq.	20.70
	PM	g	2.11
Water Emissions	Heavy Metals	mg Hg/20	20.46
	EP	mg PO_4	2,202.82

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4.3.2 Environmental Impact Assessment – Results for Windows

A summary of the data generated by the EcoReport tool, based on the inputs described, is reported in this section. Although a detailed explanation of the results can be found in the Technical Analysis document[45], herewith the main aspects are summarised:

Resources and waste

- **energy usage**: the total energy use contributes from all four life cycle stages, with the use phase being the most significant. The production impact includes the direct energy use to produce the window, as well as non-product related energy use associated with aspects such as the fuel mix and electricity distribution losses which are predefined by EcoReport. Additional information regarding the assumptions behind the environmental impact unit indicators can be found in the EcoReport methodology report[46]. The total energy consumption in the production and manufacturing phases is dominated by the UPVC frame production.

The use phase makes the most significant contribution to the total energy use; further investigation reveals that this is directly linked to the energy loss through the window glazing, as expected. The energy use in the distribution phase relates to the transportation of products to retail outlets. EcoReport assumes that the transport uses a medium-sized truck travelling a distance of 200km. The impact for distribution is calculated based on the size of product being transported.

- **water usage:** the process water consumption is dominated by the production phase. The amount of process water consumed in the use phase reflects the water consumption during the window cleaning stage. There is a credit at the end-of-life for water recovered during the water treatment process (considered in EcoReport by default). The amount of cooling water used throughout the life cycle is

[45] Technical Analysis document available under http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html
[46] http://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Methodology_prep_study/MEErP_study_by_vhk/20110819_MEErP_Methodology_Part_1.pdf

focused in the production phase, and is associated with the energy consumption used for the production process being higher for the production of UPVC and glass. Cooling water will be used as part of the energy production processes, and will for example be taken and returned to nearby rivers once it has been used for cooling. EcoReport reveals that the higher the total weight of raw materials is used, including UPVC and glass that the higher water usage will be.

- **wastes generated:** The production phase dominates the amount of non-hazardous waste production, though the total figures involved are relatively small. The production and manufacturing phase makes the single largest contributions, arising from both the production of raw materials (mainly glass and plastics) and from manufacturing process. Recycling at end-of-life phase leads to a reduction in waste production as a result of the recovery of materials. Hazardous waste generation is mainly from UPVC production phase, and is very low in total.

Air emissions

- GWP100[47]: The impact for GWP is significant in the in use phase, resulting from the energy production for heating and its associated energy loss. The production phase and end-of-life impacts are due to the production impacts of the UPVC and glass materials and the credits earned through the recycling of these materials.

- other emissions: The general profile of the impact assessment for acidification, VOCs, POPs, Heavy Metals and PAHs follow a similar trend with the production phase dominating the impact. The raw material extraction and manufacturing processes involved in the production of mainly glass and to a lesser extent UPVC, steel and rubber which are smaller components of the overall window. In all five of these impact categories a credit is seen for the end-of-life phases, driven by the benefit of recycling these materials.

Although the net result is still an impact, a significant contribution to POP emissions arises from recycling, where credit arises for recycling UPVC, glass and metals. The production phase is mostly impacted by manufacturing and production of materials. The PM emissions for the standard window are related to the distribution phase.

Emissions to water

- **Heavy metal emissions to water** arise mostly from the production and the end of life stages, with the former dominating, associated with the double glazing glass manufacturing.

- Eutrophication impacts for the window are very low across all life cycle phases. The largest contribution is the production processes of the double glazing.

Table 21: Impact Summary for a UPVC Double Glazed Window

Parameter	Unit	Production	Distribution	Use	End of life
Other Resources & Waste					
Total Energy (GER)	MJ	29%	4%	62%	5%
of which, electricity (in primary MJ)	MJ	93%	0%	1%	7%
Water (process)	ltr	46%	0%	21%	32%
Water (cooling)	ltr	75%	0%	1%	25%
Waste, non-haz./ landfill	g	77%	2%	1%	20%
Waste, haz/ incinerated	g	82%	4%	1%	13%
Emissions (Air)					
Greenhouse Gases in GWP100	kg CO_2 eq.	33%	4%	51%	12%

[47] GWP-100: Global Warming Potential, over a 100-year period

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Acidification, emissions	g SO_2 eq.	66%	5%	6%	23%
Volatile Organic Compounds (VOC)	g	62%	0%	1%	38%
Persistent Organic Pollutants (POP)	ng i-Teq	51%	1%	1%	48%
Heavy Metals	mg Ni eq.	62%	1%	1%	37%
PAHs	mg Ni eq.	61%	1%	1%	37%
Particulate Matter (PM, dust)	g	34%	49%	0%	17%
Emissions (Water)					
Heavy Metals	mg Hg/20	63%	0%	1%	37%
Eutrophication	g PO4	68%	0%	1%	31%

The in use phase dominates two impact assessment categories: **total energy consumption** and **GWP** while for the other impact assessments, with the exception of PM related to the distribution phase, it is the production phase that has the largest impact.

4.4. Base Cases – External Doors

4.4.1 External Doors – Inputs

Bill of Materials

Similarly to the window base case, the materials used in the base cases under consideration for the external doors (UPVC and wooden ones) are presented in Table 22.

Table 22: Bill of materials – UPVC and Wooden Door

Solid UPVC door (1230mm x 2180mm)				
	Material	**Weight Dimension**	**EcoReport code**	**Comments / Remarks**
Construction phase	UPVC	30.000 g	8-PVC	
	Fittings (stainless steel)	5.000 g	26- Stainless 18/8 coil	
	Fittings (aluminium)	1.900 g	28-Al diecast	
	Fittings (zinc)	4.200 g	33- Zn Al4 cast	
	Fittings (plastic)	1.000 g	8-PVC	
Packing	plastic	0.27m3		
Use phase	Water consumption			Lifetime 30 years
	Detergent			Heat loss 257.28 kWh/a
Solid Wooden door (1230mm x 2180mm)				
	Hardwood	63,240	105-Hard wood	
	Fittings (Stainless steel)	5,000	26 –Stainless 18/8 coil	
	Fittings (Aluminium)	1,900	28 –Al diecast	
	Fittings (Zinc)	4,200	33 –ZnAl4 cast	
	Fittings (Plastic)	1,000	8 –PVC	
Packing	plastic	0.27m3		
Use phase	Water consumption			Lifetime 30 years
	Detergent			Heat loss 257.28 kWh/a

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Extra Materials for EcoReport

As in the previous case, not all the materials needed are in the database of the EcoReport. For this reason, data from SimaPro was used and summarized in Table 23.

Table 23: Impact assessment for Hardwood from SimaPro

Name / material		**Units**	
Other Resources & Waste	Primary Energy	MJ	0
	Electrical Energy	MJ	0.17
	Feedstock	MJ	0
	Water (process)	litres	2.09
	Water (cooling)	litres	2.83
	Haz Waste	g	0
	Non-Haz Waste	g	0
Air Emissions	GWP	kg CO_2 eq.	0.82
	AE	g SO_2 eq.	1.23
	VOC	mg	650.00
	POP	ng i-Teq	9.25E-05
	Heavy Metals	mg Ni eq.	0.58
	PAH	mg Ni eq.	0.94
	PM	g	0.31
Water Emissions	Heavy Metals	mg Hg/20	2.00
	EP	mg PO_4	320.79

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4.4.2 Environmental Impact Assessment – Results for External Doors

A summary of the data generated by the EcoReport tool, based on the inputs described, is reported in this section. Further information can be found in the Technical Analysis document[48].

Resources and waste

- energy usage: all four life cycle stages contribute to the energy usage, with the use phase the most significant. Total energy in the production and manufacturing phase is dominated by the UPVC frame production. The impact during production phase is much smaller for the wooden door. The use phase makes the most significant contribution to total energy use; because this is directly linked to the energy loss, as expected.

- Water Usage is dominated by the production phase for both UPVC and wooden doors (to a slightly lesser extent).The amount of process water in the use phase reflects the water consumption during the window cleaning stage. There is a credit at end of life for water recovered during the water treatment process, as explained before. The amount of cooling water used is focused in the production phase, mainly by UPVC doors.

- **Wastes generated** of non-hazardous is dominated by the production phase. The production and manufacturing phase makes the single largest contributions, arising from both the production of raw materials and from the manufacturing process, this is true for both UPVC and wooden doors. Recycling at end of life phase leads to a reduction in waste production from the recovery of materials. The credit at end of life is similar for both UPVC and wooden doors. Hazardous waste generation is mainly from production phase especially for UPVC door. For wooden doors the impact is small across all four phases of the product.

Emissions to the air

- **Acidification emission** varies for both UPVC and wooden doors. The larger impact for the production and manufacturing phase for the UPVC door is mainly due to the energy consumed in the

[48] Technical analysis document available on http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html

materials extraction and production phase. The impact during production phase for wood is less due to the reduced energy demand during the production and manufacturing process of wooden materials.

The impact during the in use phase is also relatively high for both types of doors, but especially for a wooden door in relation to the other three phases, where the in use phase contributes the highest impact.

- **VOC impact** is minimal for UPVC doors. In comparison for a wooden door the production phase is influenced by VOCs due to the natural properties of wood, with significantly higher levels of VOCs.

- **POPs, heavy metals and PAHs** follow a similar trend. Production phase dominates the impact, driven by the raw material extraction and manufacturing process of mainly UPVC and wood and to a lesser extent steel and other plastic. For both POPs and heavy metals a credit is seen for the end-of-life phase, driven by the benefit of recycling these materials. PAHs impacts are minimal across all five phases. PM distribution phase is dominated by distributing the materials.

Emissions to water

- **Heavy metal emissions** arise mostly from the production and the end of life stages, with the former dominating, associated with the UPVC and wood manufacturing.

- **Eutrophication impacts** for the external door are relatively low overall with the largest contribution arising from the production processes.

The in use phase dominates two impact assessment categories: **total energy and GWP**. For all other impact category, except PM, it is the production phase that has the largest impact.

Table 24: Impact Assessment for a UPVC and a wooden External Door

Parameters of the UPVC door	Unit	Prod	Dist	Use	EoL
Other Resources & Waste					
Total Energy (GER)	MJ	9%	1%	88%	2%
of which, electricity (in primary MJ)	MJ	92%	0%	0%	7%
Water (process)	ltr	43%	0%	22%	34%
Water (cooling)	ltr	87%	0%	1%	12%
Waste, non-haz./ landfill	g	68%	2%	0%	30%
Waste, hazardous/ incinerated	g	83%	3%	1%	13%
Emissions (Air)					
Greenhouse Gases in GWP100	kg CO2 eq.	8%	1%	88%	2%
Acidification, emissions	g SO2 eq.	51%	4%	27%	18%
Volatile Organic Compounds (VOC)	mg	3%	17%	78%	2%
Persistent Organic Pollutants (POP)	ng i-Teq	52%	0%	1%	47%
Heavy Metals	mg Ni eq.	52%	1%	0%	47%
PAHs	mg Ni eq.	43%	16%	2%	39%
Particulate Matter (PM, dust)	g	16%	78%	1%	5%
Emissions (Water)					
Heavy Metals	mg Hg/20	55%	0%	1%	45%
Eutrophication	mg PO4	68%	0%	1%	32%

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Parameters of the wooden door	Unit	% Prod	% Dist	% Use	% EoL
Other Resources & Waste					
Total Energy (GER)	MJ	2%	1%	94%	2%
of which, electricity (in primary MJ)	MJ	73%	0%	1%	25%
Water (process)	ltr	35%	0%	25%	40%
Water (cooling)	ltr	67%	0%	1%	33%
Waste, non-haz./ landfill	g	53%	2%	1%	44%
Waste, hazardous/ incinerated	g	46%	33%	2%	19%
Emissions (Air)					
Greenhouse Gases in GWP100	kg CO2 eq.	6%	2%	88%	4%
Acidification, emissions	g SO2 eq.	34%	6%	33%	27%
Volatile Organic Compounds (VOC)	g	62%	0%	1%	38%
Persistent Organic Pollutants (POP)	ng i-Teq	52%	0%	1%	47%
Heavy Metals	mg Ni eq.	52%	1%	1%	47%
PAHs	mg Ni eq.	52%	8%	1%	39%
Particulate Matter (PM, dust)	g	8%	86%	1%	6%
Emissions (Water)					
Heavy Metals	mg Hg/20	53%	0%	1%	46%
Eutrophication	g PO4	61%	0%	1%	39%

4.5. Scenario Cases – Sensitivity Analysis

Any number of parameters could be varied in relation to the base case analysis of a standard UPVC double glazed window. The energy consumption in the use phase is the most significant environmental factor, though other factors also merit investigation. In this section, results of a number of sensitivity analyses varying the energy used, the material used and finally the extended product lifetime are presented. Unless otherwise stated, the results are presented over the lifetime of the products i.e. 30 years.

4.5.1 Energy consumption

The energy balance for the standard UPVC double glazed window described above and used for this analysis was a net energy loss of 34.88 kWh/a. However, the energy performance of a window can vary depending on various factors, for example whether the glazing is triple or single glazed. Based on the energy rating, the worst performing window, with the highest net energy loss, was a single glazed window (275.68 kWh/a) with a glazed surface of 1.82m^2. On the other hand, windows constructed using triple glazing result in a net energy gain. This is especially true for high quality triple glazed windows which represent a net energy gain, ranging from 31.88 kWh/a to 94.10 kWh/a depending on the g-value (solar gain) of the window. This analysis focuses specifically on the window (or external door), however it is acknowledged that the energy performance of the window will often be taken into account alongside other parameters of the building e.g. heating, insulation, as part of the consideration of the overall building's energy performance.

Using this information and the same assumptions, the specifications of the glazing were changed. Table 25 shows the weight of materials when changing the weight of the glazing material. The datasets refers to the base-case with a net energy loss of 34.88kWh/year, a single glazed window with a high net energy loss of 275.68kWh/ year (SG), a double glazed window with low net energy gain of 51.65kWh/ year (DG) and a triple glazed window with high net energy gain of 76.46 per year (TG).

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Table 25: BoM for the range of windows with different energy balance

Material (g)	EcoReport code	Base Case	SG	DG	TP
UPVC frame	8-PVC	18,030	18,030	18,030	18,030
Fittings (Metal)	33-ZnAl4 cast	1,250	1,250	1,250	1,250
Fittings (Plastic)	8 -PVC	1,000	1,000	1,000	1,000
Fittings (Rubber)	56 -Bitumen	1,000	1,000	1,000	1,000
Glazing	102 –Double glazing	41,940	0	41,940	0
	103- Triple Glazing	0	0	0	58,574
	101- Single Glazing	0	21,410	0	0

As expected the total energy consumption is higher for a single glazed window where the net energy balance is a significant energy loss. On the other hand, a credit is seen for a triple glazed window where the net energy balance is energy gain. For almost all other categories (except acidification) the impact of a triple glazing window is greater than a high efficiency double glazed window due the production and manufacturing impact of materials such as glass in particular.

4.5.2 Energy balance in different climates

The energy balance of the standard base case window was assessed based on the three different climate areas and the energy performance during the heating season based on research undertaken by DTU and detailed in the Technical Analysis document.[49]. A standard double glazed window in climate zone 1 (Northern Europe) had an energy balance of net energy loss of 180.38kWh/a. The same window in Zone 2 (Central Europe) has a net energy loss of 93.51kWh/a. Finally a window in Zone 3 (Southern Europe) has a net energy gain of 118.18kWh/a. By changing the energy consumption figure in EcoReport, and leaving all other parameters of the base case the same, a comparison between the performances of the same window in different climatic areas was made.

The total energy, GWP and acidification, VOCs, PAHs and PM impacts are less for windows in warmer climates compared to a cold climate in Northern Europe. A credit is seen for windows in warmer climates where there is heat gain through the window. For all other impact categories, there is no change between the different zones, demonstrating that the energy consumption during the in use phase does not have an impact on these.

Similarly the energy balance of the defined window was assessed based on the performance during the cooling season, The standard double glazed window in Zone 1 had an energy balance of net energy gain of 22.71kWh/a, in Zone 2 the net energy gain was 36.15kWh/a and in Zone 3 of 134.90kWh/a. The results show a net energy gain for all three windows in the three different climate zones. As expected the results are similar to the heating season with Total Energy, GWP, AE, VOCs, PAHs and PM showing a smaller impact for windows in warmer climate due to the higher solar gain. Again all other impact categories are not affected due to the in use phase not impacting on these.

The results show that during a cooling season in north and central Europe zones the U-value appears to be the dominant factor. In south Europe, where it is warmer, a very low U-value is not so important. During the heating season, windows with a very low g-value but also a high U-value perform better. Therefore, solar gain is minimised and heat is able to be lost through the window reducing the cooling loads. This shows that the environmental performance of a window very much depends on its location and the balance between the heating and cooling seasons of this location. Further background and analysis with regards the effect of climate on a windows performance can be found in the Technical Analysis document[50].

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[49] Technical analysis document available on http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html
[50] Technical analysis document available on http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html

Table 26: Environmental impacts related to the different zones

Env impact	Z1	Z2	Z3	unit
Air emissions				
GWP 100	1500	800	-750	kgCO2eq
Acidification	1100	900	400	kgSO2eq
VOC	32	24	4	G
POP	5.8	5.8	5.8	ng i-Teq
Heavy metals	420	420	420	mg Ni eq
PAHs	359.6	359.2	358.4	mg Ni eq
PM	845	842	834	G
Total energy	28000	15000	-12000	MJ
Water emissions				
Heavy metals	400	400	400	mg hg/20
Eutrophication	7	7	7	g PO4
Water process	620	620	620	l
Water cooling	1600	1600	1600	l
Waste generation				
Waste non-haz	3950	3950	3950	g
Waste haz	82	82	82	g

4.5.3 Material change

The window frame base-case with standard double glazing made of UPVC was compared with a hardwood, softwood and aluminium frame. In contrast to energy usage, the change of the frame material has an impact on some of the other impact categories. Closer inspection reveals that switching to a wooden frame results in an increased impact for VOCs, Heavy Metals and PAHs due to the manufacturing process of timber frames, especially due to the high energy consumption during the kiln drying process. For the other impact categories there is a reduced impact due to the smaller impacts at the material extraction phase.

For aluminium framed windows, the total energy consumption is slightly less than UPVC, mainly influenced by the energy saved during the manufacturing process due to the high proportion of aluminium recycled. Heavy metals (air and water), PAHs and POPs impact are higher compared to UPVC and wooden frames, mainly due to the material extraction and production phase.

For both non-hazardous and hazardous waste, the impact for UPVC is particularly higher than the other materials. This is mainly due to the fate of the materials at end-of-life. Both softwood and hardwood materials were added in extra materials category assuming that they are 60% recycled. Similarly aluminium has a high recycling rate of 94% while only 29% of plastics are assumed to be recycled. Therefore, the results show a much bigger impact from waste production for UPVC framed windows compared to wood and aluminium frames.

As highlighted earlier, this is based on the default values within EcoReport. Therefore, results can be slightly different depending on the assumptions considered.

Table 27: Environmental impacts related to the different frame materials

Env impact	UPVC	Sw	Hw	Alu
Air emissions				
GWP 100	408	348	342	357
Acidification	780	400	390	480
VOC	17	27	25	21
POP	6	6	6	35
Heavy metals	410	420	420	580
PAHs	360	380	380	510
PM	840	775	770	785
Total energy	7200	5500	5500	5900
Water emissions				
Heavy metals	400	400	400	500
Eutrophication	6.9	0.5	0.5	0.5
Water process	620	500	500	580

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Water cooling	1600	510	510	530
Waste generation				
Waste non-haz	4000	400	400	900
Waste haz	85	10	10	10

4.5.4 Extended product lifetime

The environmental impact of extending a product's lifetime is not a straightforward consideration. A longer product lifetime means more years of use and therefore, inevitably, larger total impacts, especially for the use phase. However, looking at the impacts on a per-year basis, the longer the lifetime, the longer the period over which the production, distribution and end-of-life environmental impacts can be shared, reducing the net impact per year. Meanwhile, the use phase impacts are assumed to be the same year-on-year, so these have no influence on the results.

This conceptual analysis shows how impacts change from the base-case of 30 years to a shorter (20 years) or longer lifetime (40 years). Increasing a windows' life time by 10 years is plausible, and the results suggest that every environmental impact would be reduced if this could be achieved. Stakeholder feedback has made it clear that product lifetime in these categories varies between 20 and 50 years.

Table 28: Environmental impacts related to the different life time

Env impact	**30**	**20**	**40**	**Units**
Air emissions				
GWP 100	400	310	500	kgCO2eq
Acidification	770	745	800	kgSO2eq
VOC	18	16.7	19.2	G
POP	5.79	5.78	5.80	ng i-Teq
Heavy metals	417.521	417.517	417.524	mg Ni eq
PAHs	359.01	358.96	359.06	mg Ni eq
PM	840.1	839.6	840.6	G
Total energy	7000	5800	8500	MJ
Water emissions				
Heavy metals	393.33	393.32	393.34	mg hg/20
Eutrophication	6.85125	6.8511	6.8514	g PO4
Water process	630	590	700	l
Water cooling	1637.43	1637.42	1637.44	l
Waste generation				
Waste non-haz	3864.5	3862	3867	g
Waste haz	86.28	86.23	86.32	g

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4.5.5 Summary

This section reports the results of the EcoReport analysis carried out for the base-cases, mainly a standard UPVC double glazed window and a UPVC door and wooden door. Looking at the environmental impacts of the standard window as modelled in EcoReport, the single most significant impact is related to total energy consumption. Almost 5,000MJ of energy are lost during the use phase of a double glazed window's lifetime. This is twice as much as the volume of energy used during the production phase.

The other significant environmental impact is the GHG emissions, influenced by the energy consumption in use phase. High efficiency performing windows, i.e. ones with a good energy balance, where energy is saved as opposed to loss, see a credit in GHG emissions. Other impact assessment categories are dominated by the production and manufacturing phase, attributable largely to the production of key materials e.g. UPVC, wood, aluminium and glass and to a much smaller extent for stainless steel and rubber fixtures and fittings.

A further environmental impact is PM, which arises from moving the heavy products around in vehicles (distribution phase). However, the way to mitigate this impact is more likely to lie in improving

transport emissions than light weighting the products, though this is also demonstrated to deliver environmental benefits.

The U-value and g-value properties influence the performance of a window when used in different climates. Therefore criteria should take account of local climate to ensure the performance of the window is optimised. Without a common European wide methodology or rating scheme to assess windows across different Member States, it will be necessary to make reference to national legislative requirements as a baseline against which better performing products can be specified.

For external doors, the results are similar. External doors are not expected to have a significant net energy gain due to their much smaller over all proportion of a buildings surface area and the reduced level of glazing. Without this energy gain, the energy loss becomes the key parameter for the energy rating of external doors. With these findings in mind, the natural conclusion is that window and external door manufacturers wishing to improve the environmental performance of their products should look primarily towards designing systems where heat loss is minimised during the use phase. That means that depending on other parameters such as climate, a balance between the U- and g-values is needed. The production phase also has a considerable effect, in particular from impact categories such as water consumption, acidification and VOC emissions and heavy metals.

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5 Improvement Potential

The improvement potential of a product provides an indication of the life cycle environmental improvements that can be achieved through changes in product design. The main focus of environmental improvement for windows and external doors is the energy performance of the product. As noted already, although not energy using products themselves, windows and doors are energy related products and can influence the energy performance of the building in which they are installed.

The improvement potential calculations in this section focus on in use on energy performance. As there are no harmonised methodologies for calculating the energy balance of windows and external doors across Europe[51], the Danish research[52], previously used in the sensitivity analysis has been used. This research is considered appropriate for use in this research as it is the main study identified that has been undertaken to propose a rating scheme for the whole of Europe using energy balance equations for different climate zones, covering both the heating and cooling seasons. The equations for the different zones are based on two residential reference buildings and climate data to define the heating and cooling seasons.

By using this study, an indication of the potential savings as a result of heating and cooling in relation to the windows for different climate zones can be calculated when windows with different parameters are chosen. The savings indicated are illustrative, and exact savings will depend on the window installed and the local characteristics including a building's heating and cooling regime.

This research developed energy balance equations for three climate zones in Europe for residential properties. These equations have been used together with a number of scenarios to demonstrate the potential energy savings that can be made through changes in the U and g values of a window. The improvement potential calculations relate to potential savings a results of energy used for heating and cooling only. Other savings may also be realised, for example reduced energy consumption for lighting, which is discussed in Section 5.4 below.

A number of assumptions have been made (See Section 5.1 below), and there are implications when using the equations to calculate potential savings from heating and cooling in non-residential buildings, which are outlined in the relevant sections below.

5.1 Windows Improvement Potential – Residential Buildings

The Danish research developed energy balance equations for three climate zones across Europe for residential buildings for three different window slope angles, 90, 45 and 30 degrees. For the purposes of the improvement potential calculations we have used the 90 degree (i.e. vertical) equations only, see Table 29, as the majority of windows are at this angle.

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[51] Efforts and research to devise pan-European approaches have been ongoing over the past 10+ years, with no success in developing an energy rating scheme for windows that all Member States can agree on. The underlying issues are the complexities surrounding factors such as climate, different building types and uses, orientation and consideration of the wider building energy performance.
[52] http://www.byg.dtu.dk/upload/institutter/byg/publications/rapporter/byg-r201.pdf

Table 29: Energy balance equations for calculating improvement potential

Zone	Heating Season	Cooling Season
Zone 1 (North)	Eref,heating = 212*gw-89*Uw	Eref,cooling – 20*gw-0*Uw
Zone 2 (Central)	Eref,heating = 251*gw-80*Uw	Eref,cooling – 36*gw-1*Uw
Zone 3 (South)	Eref,heating = 254*gw-36*Uw	Eref,cooling – 120*gw-2*Uw

Notes:
Eref,heating: energy performance of the window in the heating season
Eref,cooling: energy performance of the window in the cooling season
gw: solar energy transmittance of the window
Uw: total heat transfer coefficient of the window

In order to calculate the energy performance and potential savings for windows in the heating and cooling seasons a baseline and different of scenarios have been developed.

5.1.1 Baseline Development

In order to calculate potential energy savings, it is first necessary to calculate a baseline against which improvements can be measured. Normally, using the MEErP methodology, this would be done for the base case established as part of the technical analysis. However, as outlined in the technical analysis, defining a typical window is difficult, and an example using the UK's BRFC scheme[41] was used to highlight environmental hotspots. It not appropriate to use the analysis, undertaken using the BFRC equations to extrapolate across Europe, due to different climate conditions in particular. It has therefore been necessary to establish a separate baseline, using the energy balance equations for the three climate zones, which were developed as part of the Danish research, to provide a better indication of the improvement potential.

In order to use the above equations to establish a baseline energy performance, average U and g values for each of the three climate zone have been calculated using historic data from a TNO research report[53], which was also used by the Danish research.

A weighted average of the U and g values for the three zones was calculated, taking into account the U and g values for different construction periods and the number of buildings within each of these date ranges. Table 30 shows the calculated baseline U and g values for windows used to establish the baseline.

Table 30: U and g values for baseline

Zone	U value	G value
Zone 1 (North)	2.19	0.69
Zone 2 (Central)	2.93	0.75
Zone 3 (South)	3.85	0.80

5.1.2 Scenario Development

To calculate the improvement potential a range of scenarios were developed by the project team's technical experts CWCT. It is however important to note that different configurations of U and g values could result in a similar energy performance, or may differ depending on particular circumstances. These are therefore examples to illustrate the improvement potential.

The scenarios have been developed on the basis of a current typical window and current best performing window. However as the results show, the 'best' product may not provide the greatest saving potential using the Danish equations as a result of the balance between the U and g values.

Zone 1: North

The U value is the key performance parameter in heating dominated climates, and therefore high performance double and triple glazing is common. Research by CWCT suggests overall window U values in the range 1.0-1.4 W/m^{2}K are typical values for new build construction in countries such as

[53] Bakker, L.G. and Visser, H. (2007) Impact of Solar Control Glazing on energy and CO_2 savings in Europe, TNO Report 2007-D-R0576/B

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Denmark, Norway, Sweden and Finland. These values could be achieved in a number of different ways; therefore two current typical performance scenarios have been developed. The Passivhaus[54] requirements set out criteria for high performing windows, and typically represent windows with the best performing U and g values. A window close to these requirements has therefore been used to represent current best performance. Table 31 summarises the scenarios for Zone 1.

Table 31: Summary of Zone 1 Scenarios

Scenario	U value	g value	Description(window)
Scenario 1 (Typical)	1.0	0.46	High performance frame with very good triple glazing (2 hard coats and argon fill)
Scenario 2 (Typical)	1.4	0.46	Average performance frame with very good triple glazing (2 hard coats and argon fill)
Scenario 3 (Best)	0.90	0.34	Triple glazed window[55] close to Passivhaus specification

Zone 2: Central

For Zone 2, values for a BRFC C rated window have been used for typical current performance which is the UK Building Regulation requirement. Although the UK is classified in Zone 1 as part of the Danish research, the BFRC C rated window values are common with those found in countries included in Zone 2 e.g. France, Austria and therefore considered appropriate for use as the basis as Scenario 1 for Zone 2[56]. This demonstrates the difficulties in splitting Europe into a limited number of climate zones.

The same current best performance has been used as Zone 1. Again, this level of performance can be achieved in a number of ways depending on the configuration and how the different properties (U and g value) of the window influence performance. Table 32 summarises the scenarios for Zone 1.

Table 32: Summary of Zone 2 Scenarios

Scenario	U value	g value	Description (window)
Scenario 1 (Typical)	1.65	0.45	BRFC C rated window, for example standard frame, double glazed IGU with low emissivity coating and air or argon fill.
Scenario 2 (Best)	0.90	0.34	Triple glazed window[57] close to Passivhaus specification

Zone 3: South

The southern region is the most difficult to quantify in terms of a typical window performance as the range of common windows ranges significantly and includes both single and double glazed units. For the current typical scenario a basic double glazed, air filled, uncoated window has been used. The frame could be basic aluminium or timber.

In Zone 3, a cooling dominated climate, the g value is the most important factor. This needs to be as low as possible in order to reduce the solar gain in the building and therefore minimise the energy consumption used for cooling purposes. Based on analysis undertaken by CWCT using the Danish rating equation, the best value was achieved using an average performing frame and double glazing with solar control coating. The values for this configuration have therefore been used and are summarised in Table 33.

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[54] http://www.passivhaustagung.de/Passive_House_E/window_U.htm
[55] http://www.trowbridgewindows.co.uk/resourses/pdfs/triple_glazing_data.pdf
[56] Input from technical expert
[57] http://www.trowbridgewindows.co.uk/resourses/pdfs/triple_glazing_data.pdf

Table 33: Summary of Zone 3 Scenarios

Scenario	U value	g value	Description window)
Scenario 1 (Typical)	3.5	0.56	Basic double glazed, air filled, uncoated window
Scenario 2 (Best)	1.95	0.37	Average performing frame and double glazing with solar control coating

5.1.3 Energy Saving Potential (Residential Buildings)

The baseline and scenarios outlined above have been used to establish an estimate and provide an indication of the potential energy savings from heating and cooling as a result of the change in the key window parameters.

In order to do this a number of steps have been undertaken, full details of the calculations are included in Appendix 1. Firstly the energy balance of the baseline and each scenario has been calculated for the heating and cooling seasons using the rating formulas from the Danish research. For the cooling season, the lower the number the better, as this is an indication of the energy consumption required for cooling. For the heating season, a negative figure indicates a net energy loss, and therefore the preference is for positive figure, indicating a net energy gain. The energy balance is calculated as kWh/m^2/year.

This allows the potential saving (kWh/m^2) from heating and cooling for each scenario to be calculated when compared to the baseline. In order to extrapolate the energy savings across each zone and the EU 27, the market data calculated in the Task 2 Market Analysis is used. The data used for these calculations is the stock data for 2010, all of which will have the potential to be replaced in the future, therefore no distinction is made between replacement and new construction markets in these calculations. This earlier research calculated the area of windows (m^2) for residential properties for each Member State, with totals calculated for each of the three zones, based on the split of countries across the different zones. Assuming a 100% change in the 2010 stock from the baseline windows to the different window scenarios outlined above, the total energy saving potential (GWh) for the different scenarios in each of the different zones is calculated, see Table 34.

Table 34: Potential Energy Savings for Scenarios

Zone	Scenario	U value (window)	g value (window)	Total savings (GWh) compared to baseline
Zone 1	Baseline	2.19	0.69	N/A
	Scenario 1 (Typical)	1.0	0.46	71422
	Scenario 2 (Typical)	1.4	0.46	30453
	Scenario 3 (Best)	0.90	0.34	55149
Zone 2	Baseline	2.93	0.75	N/A
	Scenario 1 (Typical)	1.65	0.45	20630
	Scenario 2 (Best)	0.90	0.34	40988
Zone 3	Baseline	3.85	0.80	N/A
	Scenario 1 (Typical)	3.5	0.56	(-10669)
	Scenario 2 (Best)	1.95	0.37	3697

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Although the scenarios have been labelled ‘typical’ and ‘best’, it is clear that the ‘best’ scenario may not provide the greatest saving potential using the Danish equations as a result of the balance between the U and g values. This highlights the importance of understanding the external factors that will influence the energy balance e.g. climate, when choosing a replacement window.

The analysis shows that there are potential energy savings as a result of changes in window design in the majority of cases. A comparison of the total savings for the different scenarios shows that the configuration of the U and g values is highly important. For example in Zone 1, Scenario 1 offers greater savings than Scenario 2, as even though the U value is lower in the second scenario, this offset by the higher solar gain in Scenario 1, resulting in a higher net energy gain in the heating season. For Zone 3, the indication is that no savings are made when comparing scenario 1 to the

baseline. Analysis of the calculations (Appendix 1) shows that this is the result of a reduction in the net energy gain in the heating season as a result of the change in the g value.

This demonstrates that it is highly important to assess and purchase a window in relation to the building, taking into account the building's specific parameters, such a types, use, heating/cooling regime, shading devices and climate in order to get the correct balance between the U and g value and therefore maximise the potential energy savings.

Based on the three scenarios offering the maximum energy savings for each zone[58], the total potential energy savings from heating and cooling for all residential properties based on this analysis for **EU27 would be 116,107GWh per year**. This is of the same order of magnitude of the savings identified by the Danish research which calculated savings of 134,749GWh per year.

To understand the potential savings from **a GPP perspective**, i.e. considering public procurement information was collated on the percentage of properties that account for social housing in different Member States. Where available this percentage was applied to the overall residential window area (m^2) in order to provide an indication of the window area for social housing. Using the same three scenarios as above, the potential energy savings from heating and cooling for the **EU27 would be 13,395GWh**. The detailed calculations are shown in Appendix 2.

These numbers should be treated as estimates and used accordingly. They are based on example scenarios and the information regarding social housing and what is included as social housing differs between Member States[59].

5.2 Improvement Potential – Non Residential Properties

The savings outlined in Section 5.1 relate to windows for residential properties. The energy rating equations developed by the Danish research and used in the above analysis best describe domestic situations, as they were based on residential reference buildings. For domestic buildings, although there are differences in the size and configuration of windows used they are largely similar, therefore a single method of assessment is appropriate (standard size etc) and will give a good indication of the actual performance. The assessment of non-residential (commercial) buildings is more complex. In general there are;

- Wide range of glazed areas (40 – 90% glazed),

- Large range of products, sizes and configurations,

- Large range of floor plate sizes from narrow floor plates which are suitable for natural ventilation and make use of natural light, to very deep floor plates which require additional servicing and lighting,

- Other factors such as shading devices, building use, lighting control, services etc will significantly alter the performance making a windows only approach too simple,

- Would typically have a large number of similar sized windows in a project, making bespoke calculations economically and technically viable.

- Therefore a rating scheme would not be appropriate or necessary.

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[58] Zone 1 – Scenario 1, Zone 2 – Scenario 2 and Zone 3 – Scenario 2
[59] http://www.housingeurope.eu/publication/social-housing-country-profiles

These factors mean that Regulations for new commercial buildings are based on the overall energy use therefore rating individual windows is largely irrelevant. The scope of non-residential refurbishment can lie anywhere between domestic type products/construction to highly glazed facades similar to those on a new building.

The extreme ends of this range are relatively straightforward; the small scale projects could be treated as if they were domestic and the large scale projects as if they were new commercial. The difficulty lies in between these extremes. Non-residential refurbishments on buildings which are essentially domestic in nature could use the rating equations above and buildings which do not meet that requirement would have to be assessed differently. Unfortunately in the absence of an appropriate data source, our research has not been able to identify the proportion of windows in non-residential buildings that is similar to domestic. Therefore a calculation of potential energy savings for this proportion of the total window area for windows in non-residential buildings has not been possible within the scope of this work.

5.3 Consideration of BNAT in Improvement Potential

A simplistic U and g value approach is not appropriate for the development of a best not yet available scenario. The overall performance of, and technologies used in house building has improved dramatically over the past few years (higher levels of insulation, better air tightness, Photo-Voltaic's, solar hot water, heat pumps etc), that a whole building view is needed to establish the most energy efficient configurations.

Where a very high performance/low energy use is required simply considering the performance at a component level is not suitable and a holistic approach is required if the maximum energy savings are to be achieved. The full benefit of a very high performance window will not be achieved if it is installed in a 'low performance' dwelling and therefore all aspects of the dwelling (fabric and servicing) need to be considered in order to optimise the performance. This would involve a cost benefit analysis of the different solutions giving payback periods etc, so that an optimal solution may be obtained.

Improvements in performance will come from;

- Intelligent facades which adjust their shading and ventilation openings to control the internal environment.

- Dynamic products which alter their properties to make best use of the conditions, for example electrochromic glazings under the control of a building management system (BMS). A BMS automatically controls certain elements of a building. These may include the heating, cooling and lighting. Increasingly the BMS is being used to control elements of the façade such as windows and shading devices. The algorithms used allow smarter control of the façade which when combined with other factors can improve the performance/lower the energy use of the building significantly.

Very low U-values are possible; however they may not give the best performance as heat gains become more significant. Whilst improvements in the performance of glazing and frames are likely, the scale of these improvements is likely to be limited. Coated glasses are available that are highly selective (i.e. they let in more visible light than solar energy), however due to the nature of the solar spectrum significant advances here are unlikely. Frames (PVC, timber and aluminium) are available with U-values less than 0.8 W/m^2K – improving on this seems difficult.

Static technologies which may be incorporated into windows in the future to increase performance include;

- Vacuum insulated glazing – this is already available but on a small scale and not at the performance levels quoted by many scientific papers. Theoretically very low U-values are possible however there have been issues with edge sealing, coatings, and durability which are still being addressed.

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- Transparent insulation materials (TIMs) have been used for a number of years however they are translucent rather than transparent. Products with a suitable light transmission have been developed in labs but have not been used in real windows. At the moment TIMs are more likely to be used to replace opaque insulation and this will continue until the visible performance improves.

- Vacuum glazing incorporating TIMs may be possible as both processes improve.

5.4 Other potential savings – lighting

Energy use for lighting can be significant, particularly for non-domestic buildings, however assessing the impact on that energy use via a simplified window energy rating is very difficult.

Factors affecting how much energy is used in lighting include;

- The glazed area,
- The glass type used,
- The orientation of the façade,
- Shading devices used,
- The number, type and position of light fittings,
- Lighting control.

In addition minimum daylight levels/light transmission is not necessarily a regulated value (i.e. no minimum level specified in building regulations) and therefore it would be politically difficult to incorporate it into a rating system. That is not to say that daylight levels are not taken into account – the whole building energy calculation uses the light transmission of the façade when it calculates the lighting energy used and research into daylight in buildings has been undertaken[60].

Due to the nature of the rating equations two windows with the same overall rating can have significantly different light transmissions and therefore the rating doesn't tell the complete story. For example consider the analysis of two example windows using the Danish rating equation for the heating season.

Table 35: Comparison of window energy ratings and light transmittance

	Window 7	**Window 8**
U_{window} [W/m^{2}K]	1.5	1.95
g_{glass}	0.46	0.67
Light Transmittance	0.54	0.75
Zone 1 rating [kWh/m^2]	-55.48	-59.92
Zone 2 rating [kWh/m^2]	-27.63	-21.46

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[60] http://www.ecbcs.org/docs/ECBCS_Annex_29_PSR.pdf

Table 35 shows that although the two windows would have the same rating their light transmissions are very different which would have a significant effect on the internal environment, for example, appearance and artificial lighting use of the building.

In order to give the purchaser as much information as possible when selecting new windows the visible light transmission could be given as an informative value on the ratings label. This approach is adopted by the National Fenestration Rating Council (NFRC) in North America (Figure 6) and allows for a better comparison of different products.

Figure 6 NRFC rating label including visible transmittance

5.5 External Doors

The improvement potential for external doors across the EU27 is difficult to identify. As with windows, there are no pan-European harmonised standards or schemes for calculating the energy balance of doors. Additional research, such as that used in the Windows analysis above has not been undertaken for external doors. This is likely to be due to the reduced energy improvements eternal doors will offer as they have a much smaller area on the facade of a building compared to windows.

As identified in the technical analysis, there is only one known rating scheme for doors, which has been developed by the BFRC in the UK. This takes into account air leakage and U values. For doors with a high proportion of glazing, the windows rating equations are used in the BFRC scheme.

The analysis below uses the BFRC rating and presents the difference between two scenarios for the UK and potential savings. This has not been used to extrapolate across Europe, as it is based on a UK reference building and rating equations for the UK climate.

A current UK Building Regulation compliant door has an overall U-value of 1.8 W/m^2K. Assuming an air leakage of $2m^3/m/h$ (a conservative figure) gives a rating of -130 kWh/m^2. The best performing doors have overall U-values around 1 W/m^2K, which when combined with an air leakage of zero gives a rating of -68 kWh/m^2.

Based on these two scenarios, the savings for the UK, (using the m^2 door area data for residential properties calculated in the Task 2 Market Analysis report) would be 1,283GWh per year. In comparison using the windows scenarios above, the UK saving for windows would be 19,276GWh per year. This clearly demonstrates that the saving potential of windows is far greater than doors for the UK and it would be reasonable to expect a similar result across the EU27 as a whole.

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6 Cost Considerations

6.1 Introduction to Life Cycle Costs (LCC)

There is often the perception that 'green' products cost more than their 'non green' equivalent. Sometimes, but not necessarily always, the purchasing price of a 'green' product may be more than its 'non green' alternative. However if all the costs are analysed over the life time of the product, the 'green' product could prove to be a better economic choice over time[61]. The European Commission's GPP website[62] highlights that LCC should consider the following and factor them in at the contract awarding stage:

- Purchase and all associated costs (delivery, installation, commissioning etc)
- Operating costs, including energy, spares, and maintenance
- End of life costs, such as decommissioning and removal

Using this life cycle approach can bring a number of benefits:

- All costs associated with a good or service is visible, especially operating costs such as maintenance or energy consumption. The latter is particularly important given the ever upward pressure on energy prices;
- It allows an analysis of business function interrelationships. Low purchasing costs may lead to high service costs in the future;
- Expenditure in various stages of the life cycle are highlighted, enabling public authorities to draw up budgetary predication

A LCC approach is important for GPP as it may help to procure products with a better environmental performance, whilst saving the purchasing authority money. The approach to develop GPP criteria requires a number of steps to be taken. This involves the development of a number of analyses outlining the background and evidence required to develop the GPP specifications. More detailed information regarding these steps is available from the European Commission's website[63]. Importantly for the development of GPP specifications there needs to be an 'evaluation of the costs to public procurers and demonstration of ways for calculating the costs on a life-cycle cost basis'[63].

There are a number of tools that can be used to assess LCCs including EcoReport, which has been used throughout this project to assess the life cycle impacts of windows and external doors.

The remainder of this section demonstrates the calculation of LCCs for windows, using EcoReport and scenarios outlined in Section 6 above. Due to the limited information available on external doors the LCC of doors has not been included, however a similar process to that outlined for windows could be followed where the Purchasing Officer has the relevant information available.

6.2 Life Cycle Cost Assessment for Windows

As highlighted above in the Improvement Potential scenarios, the optimal configuration of the window will depend on the climate and heating and cooling demands. This in turn will affect the costs of the different elements over the life cycle and therefore the overall LCCs.

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[61] http://ec.europa.eu/environment/gpp/pdf/toolkit/module1_factsheet_lcc.pdf
[62] http://ec.europa.eu/environment/gpp/gpp_and_life_costing_en.htm
[63] http://ec.europa.eu/environment/gpp/gpp_criteria_procedure.htm

To illustrate the LCCs of windows, EcoReport has been used to demonstrate the cost implications of the different scenarios assessed. The assumptions regarding the input data for the LCC analysis have been: (Figures presented are based on a single product of the standard window size used in the Technical Analysis – 1.2m^2)

1.- **Product cost information** is not easy to obtain, with many companies quoting for all windows that need replacing, rather than on an individual window basis. As part of the first questionnaire €265 was proposed for a standard window. No additional information was received, however analysis of product prices suggests this is appropriate for the baseline. The price has been corrected depending on the location of the windows and based on the cost index information for different window types[64]. For Zones 1 and 2 the following multipliers have been used:

- Scenario 1 (Typical) – 1.1
- Scenario 2 (Typical) – 1.155
- Scenario 2/3 (Best) – 2

For Zone 3 the level of performance isn't as high as those in Zones 1 and 2. Therefore the following multipliers have been used:

- Scenario 1 (Typical) – 0
- Scenario 2 (Best) – 1.15

2.- **Installation and maintenance costs**, are fixed across all scenarios:

- Installation €100
- Maintenance €42

3**.- Water and energy** (Electricity and gas) prices are required in order to calculate the life cycle costs.

3.1- Following similar analysis as part of a study on Toilets and Urinals[65] the 2010 prices calculated as part of that project, based on Eurostat data have been used for Electricity (€0.13/Kwh) and gas (€13.1/Gigajoule).

3.2- The average price for water supply and sewage was €2.53½/m^3 in 2007-08, according to Section 2.4.5 (p58) of the Market Report for Toilets and Urinals. This figure can be brought forward to 2011 using the UK Consumer Price Index for water, available from Eurostat[66]. Figures of 104.7 (2007) and 108.5 (2008) yield an average index of 106.45, versus 119.5 in 2011. Overall, the mark-up is 112.3%, leading to a price of €2.84/m^3.

3.3- Assumed a 30 year lifetime.

The results presented in Table 36 below show the different life cycle costs for the various scenarios. The energy consumption data input into EcoReport relate to the energy balance of the window for the heating and cooling seasons respectively. In the cooling season, the energy consumed relates the cooling and is assumed to be electricity. For the heating season it is the heat balance of the window and therefore assumed to be gas as a result of boiler use.

Using Zone 1 as an example, it is clear from the results in Table 36 that compared to the baseline Scenarios 1 and 2 offer cost savings a result of a reduced energy costs when compared to the baseline, that outweigh the additional product price. However for Scenario 3 the additional cost of the product outweighs the savings resulting from reduced energy consumption for heating and cooling.

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[64] http://www.secure-style.co.uk/index.php/products/triple-glaze-vs-double-glazing
[65] http://susproc.jrc.ec.europa.eu/toilets/index.html
[66] http://epp.eurostat.ec.europa.eu/portal/page/portal/hicp/data/database

Table 36: Example LCC analysis for windows across the 30 year life cycle (€)

Scenario	Product	Installation/ maintenance	Electricity	Gas	Water	Total
Zone 1						
Baseline	265	142	65	97	1	570
Scenario 1	292	142	43	-17	1	461
Scenario 2	305	142	43	54	1	545
Scenario 3	530	142	32	16	1	721
Zone 2						
Baseline	265	142	113	87	1	608
Scenario 1	305	142	68	35	1	551
Scenario 2	530	142	53	-29	1	697
Zone 3						
Baseline	265	142	413	-128	1	693
Scenario 1	265	142	282	-32	1	657
Scenario 2	305	142	190	-47	1	590

6.3 Conclusions

Clearly there is a balance to be had between the reduced energy costs as a result of the windows energy performance and the increase in product price that the Purchasing Authority will need to consider when making their purchasing decisions. This example and the assumptions made demonstrate that there will be a number of key parameters (summarised in Table 37) the Purchasing Authority will need to identify for their particular circumstances in order to carry out an accurate LCC assessment.

Table 37: Key parameters to considers for LCC assessment

No.	Parameter
1	The optimal performance of the window required in order to identify the correct products and product prices.
2	Installation and maintenance costs – savings may be possible if a large number of windows are replaced at once or maintenance is dealt with as part of existing contracts.
3	The actual expected lifetime of the products under consideration.
4	Current, location specific rates for gas, electricity and water.
5	The efficiency and type of boiler used for the heating.
6	The wider building perspective and other energy performance changes that may be implemented at the same time

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7 Public Procurement Needs

7.1 Public Purchasing Requirements

Windows and external doors are procured by a range of public sector bodies and installed in a wide range of buildings including leisure centres, hospitals, social housing, schools, colleges, universities and public offices. There are a large range windows and doors available on the market for public sector bodies to choose from, which vary in terms of design, price and performance.

It should be noted that public procurement may include taps in both the non-domestic e.g. for offices, schools, hospitals and the domestic e.g. social housing sectors. As identified throughout this research, the performance of a window or external door will vary depending on a range of factors including climate, building types and purpose, orientation and heating/cooling regimes of the building. It is therefore important that when choosing a window or external door the full range of factors are taken into consideration.

The section below summarise the data calculated for the public procurement market, the existing EU GPP criteria and the position of national GPP scheme.

7.2 Public Procurement Market

In order to determine the possible impacts of GPP on the windows and external doors market, it is necessary to determine the size of the market within public purchasing control. There are four categories that play an important role: commercial buildings, hospitals, educational establishments and prisons.

Little information was found on the percentage of schools, universities, hospitals or prisons under public ownership across EU. In the absence of accurate data, alternative means of estimating the percentages were required: for educational establishments[67,68] and for hospital[69]. Based on this information and the assumptions that 100% of wholesale and retail floor area as well as hotels and restaurants are privately owned, the following tables present the estimated windows and external doors areas in the public sector.

Table 38: Estimated window area in public owned building m²

	Offices	Educational	Hospital	Sport facilities	Other	Publicly owned window area m²
France	4,970,408	9,674,287	4,538,199	864,419	2,377,152	**22,424,465**
Germany	4,188,585	11,919,256	5,417,844	728,450	2,003,236	**24,257,371**
Italy	3,472,562	13,004,493	6,411,658	603,924	1,660,791	**25,153,427**
Poland	1,083,299	3,843,355	2,000,178	188,400	518,099	**7,633,331**
Spain	2,646,650	9,389,853	4,671,912	460,287	1,265,789	**18,434,490**
UK	2,381,285	8,917,740	3,333,799	414,137	1,138,875	**16,185,836**
EU27	20,700,000	77,520,000	37,800,000	3,600,000	9,900,000	**149,520,000**

[67] www.oecd.org/education/database [27.07.2011]
[68] http://stats.oecd.org/Index.aspx?DatasetCode=RFIN1 [27.07.2011]
[69] http://appsso.eurostat.ec.europa.eu /nui/show.do?query=BOOKMARK_DS-055814_QID_148EFB41_UID_-3F171EB0&layout=UNIT,L,X,0;HF_SHA,L,X,1;TIME,C,Y,0;GEO,L,Y,1;INDICATORS,C,Z,0;&zSelection=DS-055814INDICATORS,OBS_FLAG;&rankName1=INDICATORS_1_2_-1_2&rankName2=UNIT_1_2_0_0&rankName3=HF-SHA_1_2_1_0&rankName4=TIME_1_0_0_1&rankName5=GEO_1_2_1_1&sortR=ASC_-1_FIRST&pprRK=FIRST&pprSO=NO&rStp=&cStp=&rDCh=&cDCh=&rDM=true&cDM=true&footnes=false&empty=false&wai=false&time_mode=ROLLING&lang=EN

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Table 39: Estimated door area in publicly owned building m²

Country	Offices	Educational	Hospital	Sport facilities	Other	Publicly owned door area m²
France	49,704	96,743	45,382	8,644	23,772	**224,245**
Germany	41,886	119,193	54,178	7,284	20,032	**242,574**
Italy	34,726	130,045	64,117	6,039	16,608	**251,534**
Poland	10,833	38,434	20,002	1,884	5,181	**76,333**
Spain	26,466	93,899	46,719	4,603	12,658	**184,345**
UK	23,813	89,177	33,338	4,141	11,389	**161,858**
EU27	207,000	775,200	378,000	36,000	99,000	**1,495,200**

The above analysis did not take into account social housing. As part of the Improvement Potential task, data on percentage of social housing for different Member States was obtained and used to calculate the window area for residential dwellings classed as social housing[59]. As noted earlier, what constitutes social housing differs between Member States, with many not having an official definition. However, social housing is typically owned and managed by public authorities or non-profit organisations and made available at affordable levels for those on low incomes. The figure calculated is 230,551,486m^2 or approximately 8.5% of the EU27 total of the residential window area.

7.3 European GPP for windows

The legal framework of the EU GPP scheme is set in Directives 2004/17/EC[70] and 2004/18/EC[71].

Current GPP criteria[72] apply to windows, external glazed doors and skylights that will be used in the building envelope, encompassing residential and commercial properties, and social properties such as schools and hospitals since the product group is defined as an opening in a wall or roof with glass mounted in a fixed frame to admit day-light. They are when possible referred to the national regulations and standards and set thresholds on the following aspects and split in the following kind of criteria:

Table 40: Summary of the current GPP criteria for windows

Technical Specifications provide a clear, accurate and full description of the requirement and standard to which goods, works or services should conform.
1 - Achievement of greater thermal efficiency than required by national regulations by demonstrating that the U-value, g-value, L50 value and daylighting transmittance indicators are improved in x% in comparison to the value defined in the relevant national legislation. The indicators are to be applied to the whole window, glazing and frame combined. The minimum improvement percentage recommended is 20%.
2 - Plastic components weighting > 50g should be marked according to ISO 11469 or equivalent
3 - Filler gases that contribute to the GHG effect, with a GWP >5 over a period of 100 years may not be used in the insulating units
4 - The bidder shall demonstrate that the production of PVC complies with the best practice in accordance with Vinyl 2010 or equivalent
5 – Timber used shall come from legal sources (comprehensive criterion)
Selection Criteria based in the capacity/ability of the bidders to perform the contract
No criteria proposed
Award Criteria* set the basis of which the contracting authority will compare the offers and base its award.
1 - The final product made of wood, wood fibres or wood particles stemming from forest that are verified as being sustainably managed so as to implement the principles and measures aimed at ensuring sustainable forest management, on condition that these criteria characterize and are relevant for the product

[70] Directive 2004/17/EC **coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors.** http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:134:0001:0113:en:PDF

[71] Directive 2004/18/EC **on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32004L0018:en:NOT**

[72] http://ec.europa.eu/environment/gpp/pdf/windows_GPP_%20product_sheet.pdf

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2 - Lead (R23, R25 and H301, H331) and its compounds must not intentionally be added to the plastics and coatings used in windows. The final window product will not release or leach out any substances or preparations that are classified according to Directive 1999/45/EC and 67/548/CEEany substances with the listed R-phrases specified below, under normal usage conditions: carcinogenic (R40, R45, R49) , harmful to the reproductive system (R60, R61, R62, R63), mutagenic, cause heritable genetic damage and possible risks of irreversible effects (R46, R68), toxic (R23, R24, R25, R26, R27, R28, R51), allergenic when inhaled (R42), harmful to the environment (R50, R50/53, R51/53, R52, R52/53, R53), danger of serious damage to health by prolonged exposure (R48), 3 – The proportion to the recycled content of materials used. This excludes process waste. 4 – Chemical products (paint, adhesive, sealants, putty, etc) in the finished window must satisfy one of the following two criteria: a) the product may not be classified as environmentally hazardous according to the EU directive 1999/45/EC or b) the product may contain a maximum of 25 by weight of substances classified as environmentally hazardous according to EC directive 67/548/EC. For wood preservative this rises to 3% as defined by directive 67/548/EC (comprehensive criterion)
Contract Performance Clauses specify the conditions must be met in the contract execution
1- The bidder must ensure maintenance recommendations are provided with the product. It also has to provide documented procedures and instructions for quality and environmental assurance 2- The bidder must demonstrate that the contractor for retro-fitting or refurbishing window installations has in place effective policies and procedures to ensure that post-consumer waste (i.e. the removed windows) is properly dealt with in a sustainable manner, such as recycling or diverting form landfill where possible (comprehensive criterion)

*Award criteria are not pass/fail criteria, meaning that offers of products that don't comply with the criteria may still be considered for the final decision, depending on their score on the other award criteria.

7.4 National GPP Schemes

In addition to the European GPP criteria, three MSs have national GPP criteria for this product group: Belgium, Finland and the UK.

As well as the GPP criteria specifically for windows, a number of MSs have GPP criteria for other construction activities which may influence the type of windows selected as they include requirements in relation to materials and/or building energy efficiency requirements. Table 41[73] summarises the national GPP criteria for 10 Member States.

Table 41: GPP Information on Windows and General Construction for 10 Member States

Member State	Window	General construction	Criteria Document	Environmental and/or social aspects addressed
Austria		X	Construction	Wood from legal sources Overall building efficiency Waste reduction
Belgium	X	X	Sustainable Procurement Guide Windows and Exterior doors Construction Works	Thermal efficiency, solar gain and air tightness requirements Material restrictions for wood and plastic in frames Chemical restrictions Waste requirements Lifetime considerations
Finland	X		Criteria for Windows	Thermal efficiency, solar gain and air tightness requirements Adequate installation and operational instructions Expected life time warranty Chemical restrictions
France		X	GEM Guide – Environmental quality in the construction and rehabilitation of public	Overall building efficiency Waste management

[73] Assessment and Comparison of National Green and Sustainable Public Procurement Criteria and Underlying Schemes

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			buildings	
Netherlands		X	Construction and Renovation of Office Buildings	Overall building efficiency Sustainable timber Waste management requirements
Norway		X	Execution and construction of buildings	Tropical timber is not to be used Overall building efficiency Waste management
Sweden		X	Building Contracts (flats)	Whole building approach Waste management Daylight factor requirements.
United Kingdom	X	X	Glazing Standards	Thermal efficiency, solar gain and air tightness requirements Sustainable supply of timber as a raw material Overall building efficiency
EU	X	X	Windows	Thermal efficiency, solar gain and air tightness requirements Material restrictions for wood and plastic in frames Chemical restrictions Waste requirements Lifetime considerations Overall building efficiency

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8 Existing legislation, environmental labels and other information sources

8.1 Existing European legislation and policies

8.1.1 Construction Products Regulation (CPR) No EC 305/2011

The European Commission has recently adopted a proposal to replace Council Directive 89/106/EEC (Construction Products Directive - CPD) by Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC. The aim of this Regulation is to better define the objectives of Community legislation and make its implementation easier[74]. It now includes a specific essential requirement related to the sustainable use of natural resources, stating that:

"*The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and ensure the following:*

- *Recyclability of the construction works, their materials and parts after demolition;*
- *Durability of the construction works;*
- *Use of environmentally compatible raw and secondary materials in the construction works*".

The regulation published in April 2011 includes a transitional period before the CPD is withdrawn on June 30th 2013 and any products placed on the market in accordance with CPD before 1 July 2013 will still be lawful. However on July 1st 2013 the CPD will be officially repealed and the new Regulation will come into full effect. This regulation sets up the basis for the CE marking and following the introduction of the product standard EN 14351-1[75] the CE marking of window and external door products has been mandatory since 1st February 2010.

8.1.2 The Energy Performance of Buildings Directive 2010/31/EU (EPBD recast 2010)[76]

In May 2010 the EPBD recast the original directive EPBD 2002/91/EC. The recast of the Directive is intended to clarify, strengthen and expand the transposition, by member state, of the original Directive. In doing so, the transposition and implementation of the EPBD recast 2010 is to be facilitated and a significant portion of the remaining cost-efficient potential in the buildings sector will be reaped[74]. The directive promotes the improvement of the energy performance of buildings within the Union, taking into account outdoor climatic and local condition and well as indoor climate requirements and cost-effectiveness. Its provisions cover energy needs for space and hot-water heating, cooling, ventilation and lighting for new and existing residential and non-residential buildings.

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[74] http://ec.europa.eu/enterprise/construction/index_en.htm
[75] EN 14351:2006+A1:2010, Windows and doors. Product standard, performance characteristics. Windows and external pedestrian doorsets without resistance to fire and/or smoke leakage characteristics
[76] http://www.energy.eu/directives/2010-31-EU.pdf

8.1.3 Energy End-use Efficiency and Energy Services Directive 2006/32/EC[77]

The aim of this Directive is to improve energy efficiency, manage demand and reduce energy consumption across Europe. Installing energy efficient fenestration products is one way of doing this and the Directive particularly encourages the public sector in each Member State to set a good example regarding investments, maintenance and other expenditure for energy-using equipment, energy services and other energy efficiency measures[78]. This adoption of this Directive meant that all substantive provisions of Directive 93/76/EEC to limit carbon dioxide emissions by improving energy efficiency (SAVE) are covered by other Community legislation; therefore Directive 93/76/EEC[79] was repealed.

8.1.4 Packaging and Packaging Waste Directive 94/62/EC[80]

The aim of the directive is to harmonize national measures concerning the management of packaging and packaging waste in order to provide a high level of environmental protection to all Member States and to ensure function of the internal market and to avoid obstacles to trade and distortion and restriction of competition within the Community[81]. The Directive seeks to reduce the impact of packaging and packaging waste on the environment by introducing recovery and recycling targets for packaging waste, and by encouraging minimisation and reuse of packaging[82].

8.1.5 The Revised Waste Framework Directive, WFD 2008/98/EC[83]

The WFD provides the overarching legislative framework for the collection, transport, recovery and disposal of waste, and includes a common definition of waste. It encourages the prevention and reduction of harmful waste by requiring that Member States ensure that measures exist to recover or dispose of waste without endangering human health or causing harm to the environment. The WFD introduces a target of 70% recycling and recovery by weight of non-hazardous construction and demolition waste on all Member States by 2020 (article 11, 2b).

8.1.6 Registration, Evaluation, Authorisation and restriction of Chemical substances (REACH) Regulation EC 1907/2006[84]

The REACH Regulation came into force in June 2007 and at improving the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances. Manufactures are required to register the details of the properties of their chemical substances on a central database, which is run by the European Chemicals Agency in Helsinki. The Regulation also requires the most dangerous chemicals to be progressively replaced as suitable alternatives develop.

8.1.7 Directive establishing a framework for the setting of Ecodesign Requirements for Energy-related Products 2009/125/EC[85]

The original Directive (2005/32/EC) on the Ecodesign of energy using products was adopted in July 2005 and focused on energy using products. This Directive has subsequently been repealed by Directive 2009/125/EC, which is a recast and increases the scope from energy using product to energy related products.

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[77] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:114:0064:0064:en:pdf
[78] Technical Specifications for Green Public Procurement Windows Background Report 2008 Report for the European Commission - DG Environment by AEA Technology
[79] http://eur-lex.europa.eu/smartapi/cgi/sga_doc?smartapi!celexplus!prod!DocNumber&type_doc=Directive&an_doc=93&nu_doc=76&lg=en
[80] http://europa.eu/legislation_summaries/environment/waste_management/l21207_en.htm
[81] Packaging and Packaging Waste Directive Article 1 http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31994L0062:en:HTML
[82] http://ec.europa.eu/environment/waste/packaging/index_en.htm
[83] Waste Framework Directive 2008/98/ec, http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:EN:PDF
[84] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=oj:l:2006:396:0001:0849:en:pdf
[85] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:285:0010:0035:EN:PDF

This Directive sets a clear framework for the setting of Ecodesign requirements for energy-related products, aimed at avoiding disparities in regulation amongst individual Member States, ensuring the free movement of such products within the internal market. This Directive provides for the setting of requirements which the energy-related products covered by implementing measures must fulfil in order to be placed on the market and/or put into service. It contributes to sustainable development by increasing energy efficiency and the level of protection of the environment, while at the same time increasing the security of the energy supply

The Ecodesign Directive does not in itself set binding requirements for specific products, however, it does define conditions and criteria for setting, through subsequent implementing measures, minimum requirements regarding environmentally relevant product characteristics and allows them to be improved quickly and efficiently.

8.1.8 The Classification, labelling and Packaging of Substances Regulations (EC) No 1272/2008 (CLP)[86]

The Regulation entered into force on 20 January 2009 and will ultimately replace the current rules on classification, labelling and packaging of substances (Directive 67/548/EEC) and preparations (Directive 1999/45/EC). Substance classification and labelling must all be consistent with the new rules by 1 December 2010 and for mixtures 1 June 2015.

The aim of the regulation is to reduce confusion and potential errors among workers and consumers due to differing forms of labelling and safety data sheets in different countries. The United Nations developed a Globally Harmonized System (GHS) for the classification and labelling of chemicals. As an international agreement GHS is non-legally binding in Europe, therefore the GHS criteria was introduced into Europe via CLP.

The Regulation aims to ensure a high level of protection of human health and the environment, as well as the free movement of chemical substances, mixtures and certain specific articles, whilst enhancing competitiveness and innovation. This should be achieved by ensuring that the same hazards will be described and labelled in the same way all around the world.

8.1.9 EU Due Diligence Regulation[87]

The new EU Timber Regulation (No 995/2010) which entered into force on 2 December 2010 will, as of 3 March 2013, make it illegal to place illegally harvested timber and timber products on the EU market. The regulation aim to prevent the trade in illegally harvested timber and timber products through three key obligations:

- It prohibits the placing on the EU market for the first time of illegally harvested timber and products derived from such timber;
- It requires EU traders who place timber products on the EU market for the first time to exercise 'due diligence; and
- Once on the market, the timber and timber products may be sold on and/or transformed before they reach the final consumer. To facilitate the traceability of timber products economic operators in this part of the supply chain (referred to as traders in the regulation) have an obligation to Keep records of their suppliers and customers.

The Regulation covers a broad range of timber products including solid wood products, flooring, plywood, pulp and paper. Not included are recycled products, as well as printed papers such as books, magazines and newspapers. The Regulation applies to both imported and domestically

[86] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:353:0001:1355:en:PDF
[87] http://ec.europa.eu/environment/forests/timber_regulation.htm

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produced timber and timber products. In July 2012 the European Commission adopted more detailed rules on the due diligence system[88].

8.1.10 European Green Public Procurement Communication[89]

The legal framework of the EU GPP scheme is set in Directives 2004/17/EC[70] and 2004/18/EC[71]. In addition, the European Commission in its Communication on GPP, to achieve a target level of 50% GPP by 2010, has proposed a series of new actions to address current obstacles to the uptake of GPP and to establish a procedure for setting common GPP criteria. Common GPP criteria now consist of two sets of criteria: core criteria (basic GPP requirements for easy applications) and comprehensive criteria (higher GPP requirements for advanced applications). Windows and doors are already included as a product group under European GPP policy.

8.2 Existing European Energy and Ecolabelling Schemes

This section provides an overview of energy and Ecolabelling schemes in use throughout Europe, which are applicable to Windows and External Doors. Full details of labels from countries outside of Europe are detailed in the Task 1 & 2 report.

8.2.1 Nordic Countries - Nordic Swan

The Nordic Ecolabel is a voluntary Ecolabelling scheme that evaluates a product's impact on the environment throughout the whole lifecycle in the Nordic Countries. The goal of the Nordic Swan criteria is to promote the use of energy efficient products that are also manufactured with a minimum of environmental impact. Nordic Swan adopted the criteria for windows and exterior doors in 2008 and are valid until December 2012.

The criteria apply to fixed and opening windows, window doors and exterior doors[90]. In this scheme, the criteria set high requirements on energy efficiency and other relevant product certification requirements. The manufacturers must also have documented procedures and instructions for quality and environmental assurance.

The main aspects of the Nordic Swan related to the energy performance are:

1. Heat transfer (U-value): the U-value must be 1.0W/m^{2}K or lower, for a 1.2 x1.2m window, for the whole window including the frame. An exterior door must have a U-value of 1.0 W/m^{2}K or lower.

2. Solar energy transmittance (g-value): must be 50% or more, measured perpendicular of the glass (so incoming solar energy heats the building).

3. Daylight transmittance: the daylight transmittance must be 63% or higher, i.e. the window must not be considered as daylight shielding.

4. Air permeability: a window must fulfil Class 4 of EN 12207 for air permeability under negative and positive pressure.

Those related to the material restrictions are:

1. 70% of the solid wood in exterior doors must come from certified sustainable forests.

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[88] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32012R0607:EN:NOT
[89] http://ec.europa.eu/environment/gpp/index_en.htm
[90] Nordic Ecolabelling of Windows and Exterior Doors http://www.nordic-ecolabel.org/criteria/product-groups/

2. Halogenated plastics are not permitted; neither are plastics containing additives of lead, cadmium. Chlorinated/brominated paraffin, organic tin compounds, phthalates or polybrominated diphenyl ethers.

3. Exterior doors must not contain chemical products classified as carcinogenic, toxic to reproduction, causing inheritable damage, toxic or sensitizing by inhalation in accordance with regulations in force in any Nordic country and/or EU classification system 1999/45/EC.

4. Plastic casement and frame parts heavier than 50mg must be visible labelled for recycling in accordance with ISO 11469.

5. Filler gases that contribute to the greenhouse effect, with a Global Warming Potential (GWP) greater than 5 over a period of 100 year may not be used in the insulation units. (Inert gases such as argon and krypton have a GWP lower than 5).

8.2.2 Finland - Window Energy Label

A voluntary national energy labelling scheme for windows was introduced in Finland in 2006[91]. A pilot scheme was undertaken involving eight Finnish window manufacturers (sales representing 70% to 80% of the market). The criteria to be applied in the labelling were established in co-operation between Motiva, the Technical Research Centre of Finland (VTT) and the Finnish window manufacturing industry. The rating is based on tests carried out in VTT. The parameters tested are heat transmission, solar radiation transmission and air tightness. The window energy rating label was designed to be close to the European energy label[92], used for other consumer products such as fridges, televisions and washing machines, as consumers were used to its layout[93]. The Finnish label parameters are:

- U-value of the total window (includes pane, frame and the linear transmission),
- g-value of the total window (pane and frame), and
- Air leakage.

8.2.3 Sweden - Window Energy Label

EQ Windows is the Swedish Window Energy Rating Organisation responsible for Window Energy Ratings in Sweden. The Swedish Energy Agency initiated the Window Energy Rating in 2006. Since June 2009 the Window Energy Rating and Labelling is monitored by EQ Windows, a non-profit organization. The ratings scheme for Energy Efficient Windows is a voluntary scheme that uses labels similar to those seen on household appliances. The label tells you how energy efficient the windows are. The rating scale is A - G where A is for windows with U-value 0,9 W/m^{2}K or below and G for 1,5 W/m^{2}K. The calculation of the U-value is done in accordance with ISO standard 10077-2[94] and the determination of a U-value for windows in laboratories that meet ISO standard 12567-1[95]. The energy ratings for Sweden are shown in Table 42.

Table 42: **Swedish window energy ratings**

Energy rate	A	B	C	D	E	F	G
U-value, W/m^{2}K	0.9	1.0	1.1	1.2	1.3	1.4	1.5

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[91] http://www.odyssee-indicators.org/publications/PDF/finland_nr.pdf
[92] http://ec.europa.eu/energy/efficiency/labelling/labelling_en.htm. There is currently no European Energy label for Windows and Doors. Further background information on the Energy Labelling Directive is provided in the "Definition, categorisation and market analysis report" available at: http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html
[93] Window Energy Labelling in Cooling Season: Fenestration and glazed Structures Task 2: Study of Existing labelling systems Aristotle University of Thessaloniki
[94] Thermal performance of windows, doors and shutters -- Calculation of thermal transmittance -- Part 2: Numerical method for frames
[95] Thermal performance of windows and doors -- Determination of thermal transmittance by the hot-box method -- Part 1: Complete windows and doors

8.2.4 Denmark - Window Energy Label

The original voluntary energy labelling agreement for windows between the Danish trade organisations and the Danish Energy Authority ended in 2006. In 2010 a new scheme was launched that commits the window industry to energy rate their windows.

The ratings (A-G) are calculated for the window energy balance for a reference window (1.23m x1.48m) based on a Danish reference house. It is aimed primarily at replacement windows. The new scheme is also linked to the Danish Building Regulations, for example a C rated window will fulfil the present requirements for replaced windows.

As part of the scheme the manufacturers are subject to external inspection, and must when requested be able to provide information regarding the energy balance and parameters used to calculate it for their windows.

8.2.5 UK- British Fenestration Ratings Council

Window Energy Ratings were launched in March 2004 by the BFRC, an independent government-supported body established to develop and administer a system of Window Energy Ratings in the UK.

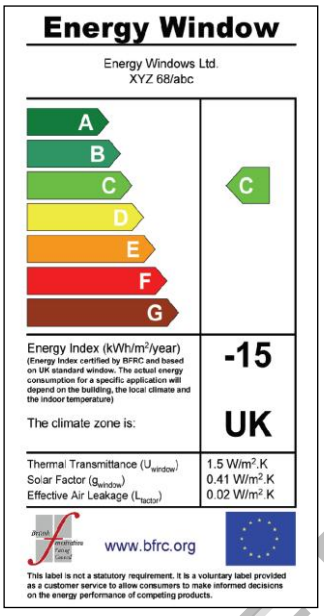

Figure 7: BFRC Rating Scale and Label

The WER's labelling scheme contains an A-G rating system and gives a rating based on the energy performance of the whole window (frame and glass) and therefore allows fair comparison of one window with another (see Figure 7).

The use of WERs as an alternative to U-values as a criterion for compliance gives a more accurate indicator of the energy performance of a window because they take a range of factors into account including the thermal transmittance, useful solar heat gain and air tightness. The measure allows comparison between different products but it does not provide the actual energy efficiency for specific products when installed. The actual energy consumption for a specific product in a specific site will depend on the location, the building parameters such as the insulation and occupancy, the building geometry and orientation, the local climate and the indoor temperature set by the occupants.

The WERs assess the whole window, so covers the frame material, the frame design, the glass type and all the other components that make up the window. The rating is carried out by computer simulation of the product to European Standards and the use of climate data and building models. This generates a single value that can then be used to compare the energy performance of a window simply and quickly.

From October 2010 it will only be legal for window companies to take orders for windows with a WER of band C or above, or a combined U-value of 1.6 W/m^{2}K for installation into existing dwellings. Likewise, all doors ordered on or after 1st October 2010 will have to have a maximum U-value of 1.8 W/m^{2}K[96]. This is as a result of changes in the UK Building Regulations Part L. The Energy Savings Trust's scheme "Energy Efficiency Recommended" endorses the best performing products in a category and has been extended to windows. Those having band B or better may carry the Energy Saving Trust Recommended Logo[97].

[96] http://www.listertf.co.uk/uploads/Approved%20Document%20Part%20L.pdf
[97] http://www.energysavingtrust.org.uk/Home-improvements-and-products/Home-insulation-glazing/Glazing

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8.2.6 European – Natureplus[98]

Natureplus is the label of quality for all building and accommodation products. The label has been widely used around central Europe over the last 10 years. The label's primary aim is to provide consumers as well as architects, tradesmen, building companies and all those involved in construction, with a reliable orientation aid towards sustainable products i.e. environmentally-friendly and not posing any health risks. The Natureplus Quality Label is classified as a Type 1 environmental label as per ISO 14024[99], taking into consideration the EU Ecolabel Regulation[100] and the EU Eco-Management and Audit Scheme[101] (EMAS) regulation on environmental auditing and is valid across the whole of Europe according to uniform criteria[102].

The quality label may be awarded to a range of construction products and components however all products must fulfil the basic criteria[102]. Natureplus specifically refer to timber-framed windows[103] (RL1500) and wooden doors[104] (RL1600). No specific guidance has been issued for timber-framed windows however award guidelines for wooden doors was published in March 2009 specifying criteria for wooden house entrance doors (Award Guideline RL1602)[105].

The component parts of the wooden doors regulated by this guideline are first and foremost, the door leaf and the frame /casement. Where it is necessary that the fittings must fulfil certain requirements, these are explicitly stated[105]. Wooden doors must be classified according to EN 14351 (parts 1 to 3).

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[98] http://www.natureplus.org/index.php
[99] Environmental labels and declarations -- Type I environmental labelling -- Principles and procedures
[100] http://ec.europa.eu/environment/ecolabel/
[101] http://ec.europa.eu/environment/emas/index_en.htm
[102] http://www.natureplus.org/uploads/tx_usernatureplus/RL0000BasicCriteria2011.pdf
[103] http://www.natureplus.org/en/natureplus/issuance-guidelines/?user_natureplus_pi3%5Bcat%5D=15&cHash=9a56e9c7bd
http://www.natureplus.org/uploads/tx_usernatureplus/RL0000BasicCriteria2011.pdf
[104] http://www.natureplus.org/en/natureplus/issuance-guidelines/?user_natureplus_pi3%5Bcat%5D=16&cHash=f25388eb21
[105] http://www.natureplus.org/uploads/tx_usernatureplus/RL1600_Wooden_Doors.pdf

9 New proposal for core and comprehensive criteria

9.1 Introduction

The information summarised in the earlier sections of this report were presented and discussed at the first stakeholder workshop. Based on this information the following were presented as the key areas for the GPP criteria revision to focus on:

- Energy Performance Indicators
- Materials
- End of life phases
- Maintenance

Full details of the presentations and minutes of the discussions from the first stakeholder meeting are available on the project website[106]. It is proposed to revise the GPP criteria for windows and external doors as a result of the research undertaken in this study. A summary of the changes is presented in Table 43.

Table 43: Summary of the proposed GPP criteria revisions for windows and external doors

GPP Criteria Area	Level of Change	Summary of Revision
Energy Performance	Major	Criteria using the EPBD Cost Optimal level calculations proposed and key considerations added as an explanatory note. Where cost optimal calculations have not been completed or made available yet, an alternative criterion is included based on national regulations or national energy rating requirements for windows and doors.
Material selection – Timber	Minor	Taken forthcoming EU Timber Regulation into account
Responsible sourcing of wood and wood-based materials	Minor	Updated to ensure consistency with other product groups
Marking of plastics	Deleted	Limited use in light of other labelling requirements and typical recovery routes.
Global warming potential of filler gases	Minor	Removed reference to particular types of gases
PVC Production	Minor	Updated to refer to VinylPlus, which has superseded Vinyl2010.
Hazardous Substances – Release of substances from products.	Minor	R and H phrases for the release of hazardous substances updated to reflect current Type I label criteria (Nordic Swan) used for the original criteria development.
Exclusion of lead	No change	PVC industry is phasing out lead by 2015, but it is proposed to retain the criterion until then.
Hazardous substances contained in products for finishing windows	Deleted	Covered by existing legislative requirements and some of these products have their own ecolabel/GPP criteria e.g. paint.
Recycled Content – Excluding Glazing	Minor	Clarification that the existing criteria relates to materials other than glazing.
Recycled Content – Glazing	New	Added following feedback.
Maintenance Information	Minor	Additional explanatory note included.
Experience and competency of contractors	New	Added following feedback. Based on submission of references

[106] http://susproc.jrc.ec.europa.eu/windoors/stakeholders.html

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Exclusion of certain contractors	New	Added to ensure consistency with other product groups
Verification	Minor	Where appropriate verification using Type III EPD has been included.

The draft revised criteria will apply to windows and external doors covered by the scope and definition outlined in Section 2. The following sections provide a rationale and explanation of the proposed changes and should be read in conjunction with the draft revised criteria proposals in Section 9.3.

9.2 Discussion of proposed changes

9.2.1 Selection Criteria

Rationale and stakeholder's feedback:

In the case of construction works, selection criteria are usually included. The selection criteria proposed for this product group includes the exclusion of certain constructors/contractors and the selection of those with experience and a good track record of installing these products.

The **exclusion of certain constructors/contractors** criterion proposes that companies that have repeatedly acted against environmental legislation and have been found guilty of grave professional misconduct as outlined in Articles 53 and 54 of Directive 2004/17/EC[107] and Article 45 of Directive 2004/18/EC[108]should be excluded from getting the contract.

In addition, stakeholders highlighted that **the experience and track record of the company installing replacement windows or external doors is of high importance**. In order to maximise the performance of the window or external door it needs to be installed correctly.

At the first stakeholder meeting it was proposed that this could be verified through the number of years of experience and/or EMAS accreditation. As highlighted in the Economic and Market Analysis report, the market for windows and doors includes a high proportion of SMEs. It is unlikely that many of these will have EMAS, and the verification of this criterion limited to the proof by the EMAS scheme would therefore act as a potential barrier for SMEs from bidding for public procurement contracts. Setting a requirement that defines a number of years experience will prevent new companies from entering the public procurement market and does not necessarily indicate a high level competency.

It was also highlighted at the first stakeholder meeting that the installation of windows and external doors can be checked using different tests, for example blower door tests and thermal imaging. These tests can be expensive and in the case of blower door testing, more appropriate to new building rather than the replacement market.

In order to set GPP criteria that is flexible, has minimal cost for installers or Purchasing Authorities and is appropriate for use by all potential bidders, it is proposed to include the following requirement to establish the experience and competence of the contractor: it is proposed that the bidder will need to provide independent references in relation to their performance as a window and/or external door installer.

Revised Criteria:

In the previous GPP set of criteria there were no criteria referring to this aspect, therefore two new criteria have been developed in order to cover these aspects. These criteria are:

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[107] Directive coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors
[108]Directive on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts

1. SELECTION CRITERION (Core)	1. SELECTION CRITERION (Comprehensive)
1. Exclusion of certain contractors Construction companies, which have repeatedly acted against environmental legislation and have been found guilty of grave professional misconduct as outlined in Articles 53 and 54 of Directive 2004/17/EC and Article 45 of Directive 2004/18/EC, will be excluded from the tendering procedure.	**1. Exclusion of certain contractors** Construction companies, which have repeatedly acted against environmental legislation and have been found guilty of grave professional misconduct as outlined in Articles 53 and 54 of Directive 2004/17/EC and Article 45 of Directive 2004/18/EC, will be excluded from the tendering procedure.
2. Experience and competency of contractors The bidder must provide [x] independent references for the installation of window and/or external doors to demonstrate their experience and competency. **Verification:** Provision of [x] independent references to the Purchasing Authority.	**2. Experience and competency of contractors** The bidder must provide [x] independent references for the installation of window and/or external doors to demonstrate their experience and competency. **Verification:** Provision of [x] independent references to the Purchasing Authority.

Explanatory Notes:
The number of references required is at the discretion of the Purchasing Authority, and may be influenced by factors such as contract value and timescales. Typically the number of references required could be 2 to 5 depending on requirements.

9.2.2 Technical Specifications

9.2.2.1 Energy Performance Criterion 3a and 3b

Introduction:

At the first stakeholder meeting it was agreed that the key focus of the criteria should be the impact windows and doors can have with respect to buildings overall energy performance. The findings of the technical assessment undertaken as part of this study and the outcomes from other studies reviewed support the view that the environmental impacts from the energy performance of the windows are important and should be the primary focus of the criteria. At the stakeholder meeting and in subsequent written feedback, a number of points were raised regarding this criterion and other possible approaches:

Regarding the 20% improvement in the U-value, it was highlighted that it may be difficult for some Member States to meet this requirement. For example where they already set stringent U values. Conversely, it may be relatively easy to meet where national requirements at a component level may not be set at a high level, but an assessment of whole building performance is used.

Where possible a net energy balance approach considering their function into the building should be used to assess the energy performance of the windows and doors. In order to ensure it takes into account factors such as climate/building types, which differ between Member States. The consideration of U and g values in isolation will not necessarily result in the best solution and need to be considered within the context of the building and its location in order to get the correct balance. This was highlighted by the outcome of the improvement potential analysis in Section 5, which demonstrated the importance of the balance between the U and g values.

An alignment of criteria with the cost optimal methodology requirement under EPBD recast 2010 is a potential option and also a guidelines / checklist to inform the Purchasing Authority of the types of window/door to purchase would be valuable.

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Existing Criteria:

The current core EU GPP criteria for energy performance state the following:

> *To ensure that all windows fitted into new buildings and as replacement windows in pre-existing buildings achieve greater thermal efficiency than required by National Regulations. To achieve this, the following indicators shall demonstrate [X]% improvement on the value defined in [insert relevant national legislation]:*
>
> *a) U-value,*
> *b) g-value,*
> *c). L50 value and*
> *d) daylight transmittance.*
>
> *The indicators are to be applied to the whole window, glazing and frame combined. The percentage level (ambition level) to insert highly depends on the ambition level defined in national legislation. It is recommended to aim for at least a 20% improvement on existing thermal efficiency national standard demands, while improvements for the other three factors must be defined according to local requirements and present good level of improvement on national requirements*

The comprehensive criteria are similar, but with a 30% recommended improvement.

Rationale and stakeholder's feedback:

It is acknowledged there are limitations with the existing criteria in that they do not consider energy performance within the context of the building or in the form of an energy balance. In addition the way in which different Member States set energy performance requirements differs, which means that some may set a stringent U-value, whereas others may focus on the overall building performance and set a less stringent U-value in order to allow designers flexibility in how to meet an overall building energy performance standard.

There is a practical issue in developing a criterion for windows and doors based on the energy balance as there is not currently a harmonised methodology for calculating the net energy performance of windows or external doors across Europe. A number of countries have developed their own rating schemes e.g. UK, Denmark, which take into account factors specific to the individual countries, such as typical reference buildings and climate. Some countries, for example the UK, specify the energy label rating required to meet particular standards, such as Building Regulations, alongside U- or g-values.

At the stakeholder meeting it was proposed that the EPBD recast 2010 cost optimal methodology may offer a means of revising the criteria. This has been investigated further, and does appear to be a potential option for the development of GPP criteria. This proposal is discussed in more detail below.

EPBD recast 2010 and Cost Optimal Methodology – Background:

The EPBD recast 2010 is primarily focused on new buildings and buildings subject to major renovation. However there are provision in relation to the retrofit and replacement of building elements in existing buildings, such as windows or doors. The relevant part of Article 7 of the EPBD 2010 states that:

> *"Member States shall in addition take the necessary measures to ensure that when a building element that forms part of the building envelope and has a significant impact on the energy performance of the building envelope, is retrofitted or replaced, the energy performance of the building element meets minimum energy performance requirements in so far as this is technically, functionally and economically feasible. Member States shall determine these minimum energy performance requirements in accordance with Article 4".*

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The relevant parts of Article 4 states that:

> *"Member States shall take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to achieving cost-optimal levels. The energy performance shall be calculated in accordance with the methodology referred to in Article 3. Cost-optimal levels shall be calculated in accordance with the comparative methodology framework referred to in Article 5 once the framework is in place.*
>
> *Member States shall take the necessary measures to ensure that minimum energy performance requirements are set for building elements that form part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are replaced or retrofitted, with a view to achieving cost-optimal levels.*
>
> *When setting requirements, Member States may differentiate between new and existing buildings and between different categories of buildings"*

This indicates that the cost optimal methodology should be used to inform the setting of minimum performance requirements for building elements when they are replacement or retrofitted, such as windows (and possibly doors).

The Regulation EU No 244/2012[109] establishes the comparative methodology framework for calculating cost optimal levels of minimum energy performance requirements for buildings and building elements, which includes windows, to supplement the requirements of Article 5 of the EPBD 2010. Further guidelines[110] to facilitate the implementation of the regulation were published in 2012.

The EPBD 2010 requires Member States to establish cost optimal levels of minimum performance requirements. The cost optimal level is not calculated on a case by case basis, but for developing generally applicable regulations at a national level. A robust approach to the development of the reference buildings is therefore required to ensure requirements put in place are appropriate for the majority of buildings. Member States are not required to set their requirements at cost optimal levels, however if their requirements differ then this needs to be reported. If there as significant differences (greater than 15%) then Member States need to justify their existing requirements or explain how the difference will be reduced. At present Member States are in the process of implementing the methodology and undertaking their calculations. The regulation indicates that it is applicable from January 2013 to buildings occupied by public authorities and from July 2013 to other buildings.

There are a number of factors that national authorities should be taken into account, which will influence their cost-optimal calculations on windows and doors, in particular:

1 - **Definition of reference buildings**: requirements for building elements such as windows will be derived from the calculations done at building level. It is thus of high importance that reference buildings reflect the wide variety (type, age, climatic conditions) of existing and new buildings in a country.

Member States have to establish reference buildings for *single-family buildings, apartment's blocks and multi-family buildings as well as for office buildings* in order to make calculations. Even if the studied measure relates only to one single component, e.g. window refurbishment, the energy cost calculations are done on the basis of the entire reference building. For each of these categories, at least one reference building needs to be established for new buildings and *at least two reference buildings for existing buildings subjected to major renovations*. Although the directive stresses the importance of the new buildings when choosing the reference model, in this study attention is paid to the reference buildings for major renovations. In these buildings there are fixed parameters that will limit the selection of the best solution to be applied:

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[109] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:081:0018:0036:EN:PDF
[110] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2012:115:0001:0028:EN:PDF

a) - *building orientation depending on the climates*: maximization or minimization of solar heat gains through glazed facades

b) - *natural daylight into buildings*, particularly for office buildings where artificial lighting is a major source of energy consumption

2 - **Choice of methodology and costs taken into account in the calculation**. The cost optimality framework defines two types of cost calculations: calculation from the macroeconomic level and from a financial viewpoint. Member States are free to determine which of these two calculations they will use to determine cost-optimality and subsequently the minimum energy performance requirements. This choice given to MS is important because costs to be taken into account are not the same for each methodology. To simplify a complex matter:

a) the *financial calculation is a calculation based on the consumer view point*. As a consequence, costs to be taken into account are the prices paid by the customer including VAT and charges. Member States are not required to deduct from the cost the subsidies and grants (e.g. installation of an energy-efficient window) but it is important that they do so, if this financial approach is used.

b) the *macro-economic calculation is a wider vision of the* Member States *economic interest*. VAT and charges (which are beneficial to government finances) are not included in the costs calculation. Subsidies (which are costs for authorities) are not deduced form costs. However, using this method, CO_2 costs throughout the life-cycle must be taken into account. CO_2 costs are extrapolated from the quantity of energy used by the building (after implementation of the energy saving measure), the energy mix that power buildings, the carbon content embedded in energy sources and an artificial CO_2 cost set by the methodology.

By taking into account the CO_2 costs, the most energy efficient solutions are promoted: they provide more energy savings throughout the life cycle therefore their CO_2 costs is always lower, which improves their overall cost ranking.

The cost optimal methodology includes the evaluation of the benefits and costs throughout the life-cycle of the building element. The benefits are expressed in primary energy demand of the building after introduction of the measure*. Therefore, the lower value is, the better the insulation performance*. It should be noted that the energy needed for heating, cooling and lighting must be considered. The costs are expressed in absolute values and shall cover all aspects. These include: material costs, installation costs, and maintenance costs, impacts on building energy costs (approx. energy needed by the building throughout the life cycle depending on the energy saving properties), disposal costs, CO_2 costs and other costs as those of the depreciation.

This analysis will produce a range of cost/benefit ratios and to allow MS to conclude what is most cost-optimal, i.e. the measure/s that have the lowest cost over the life-cycle for the highest energy saving. The directive sets out that the national minimum energy performance requirements should not be more than 15% lower than the outcome of the cost optimal calculation arrived at by the national authority.

3. - **Energy prices**: some prices must be estimated by Member States based on the European Commission (EC) biannual estimated trends for electricity and fuels prices. An estimate of the long-term developments of energy prices beyond 2030 needs to be included in the cost calculation. Member States must use the estimates on fuels and electricity prices development trends provided twice a year by the EC. For price development trends beyond 2030 which are not provided by the EC, Member States have to make some extrapolations.

When the macroeconomic approach is chosen, the cumulated carbon costs must be included in the cost calculation based on the numbers provided by the EC in the methodology. A *sensitivity analysis* has to be carried out by MSs in order to identify the most important parameters of a cost-optimal

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calculation. It may be that the outcome of calculation is mostly impacted by the energy price development scenarios beyond 2030. If the sensitivity analysis shows that this heavily affects cost-optimal levels, further refinement may be agreed with the EU authorities.

4. - **Energy saving calculation and properties of windows**: at a building component level, when analysing what are the cost optimal solutions, calculations of energy savings will be done at the whole building level, based on the reference building. Because cost-optimality calculations need to be done for different windows and doors, it is important to ensure that adequate solutions are tested. This means in practise that it should be ensured that calculations are done for a range of energy-saving solutions: gas filled double glazed units with low-e coating, solar control or triple glazing.

The costs/benefit analysis requires that solutions allowing reaching Nearly Zero Energy (NZE) buildings are tested, hence the importance of ensuring that calculations are done for the best performing units. National authorities may need to be provided advice on the solutions to choose for calculations depending on the use, design, climatic conditions, orientations and glazed surfaces of the reference building considered.

Further information regarding these points is available in the guideline, published by the EC[110] .

Considering these aspects related to the cost optimality, some advantages can be highlighted when being applied from the perspective of revising the GPP criteria:

1.- It provides a common framework for all Member States to use when setting minimum performance requirements for building elements;

2.- It takes cost into account, which is a key consideration for GPP;

3.- Cost optimal levels are considered for a range of reference buildings, thus allowing differentiation between different types of residential and non-residential buildings; and

4.- A number of factors are taken into account when developing the reference buildings, including a number of points that are relevant to windows and doors, such as age, size, climate condition and orientation and shading. This means cost optimal levels and minimum performance requirements are set in relation to specific MS conditions.

As highlighted above, Member States are still developing their calculations in line with the methodology. Therefore there are currently a number of unknown factors that are important to highlight and will need to be discussed further at the second stakeholder meeting:

1.- The EPBD recast 2010 requires minimum performance requirements for building elements that form part of the building envelope and have a significant impact on the energy performance of the building envelope when they are replaced or retrofitted.

Whilst this will include windows, as indicated in the guidance for the methodology, it is less clear as to whether external doors are included. It was highlighted by some stakeholders that the potential improvement from external doors is minimal due to their relative small proportion of the building envelope. While they have been retained within the scope and definition of this product group for the time being, this may need to be reviewed once it is clear if Member States have included external doors in their cost optimal calculations. It is proposed that this is reviewed at the second stakeholder meeting when information on Member States calculations may to be available.

2.- The level of ambition that Member States will set their minimum performance requirements following their cost optimal level calculations is not currently known. It is proposed that this is reviewed at the second stakeholder meeting when information on Member States calculations may to be available to ensure the cost optimal levels seem appropriate in relation to the products available on the market.

3.- Verification of the criterion using the cost optimal methodology should be discussed further with stakeholders, including GPP representatives for the different Member States to understand how this would work in practice once MS calculation information is available. The proposed method is that

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CE declared values[111] for parameters used to calculate the cost optimal performance. This will require information for Purchasing Authority's to be developed on a Member State basis outlining for example the U and g values required to meet the minimum performance requirements, or improvements on them.

4.- Slippages in implementation timescales or delays in Member States carrying out their calculation – see Criterion 3b below.

These points and any other stakeholders highlight should be discussed alongside the draft criteria proposal outlined below at the second stakeholder meeting to ensure the outlined approach is practical. Should there be particular issues preventing the approach developed using the cost optimal methodology from being used, then Criterion 3b, based on slight revisions to the existing criteria is included as an alternative option for the purchasing officer to use.

Revised Draft Criteria – Criterion 3a

Following the discussion outlined above, a draft criterion based on the EPBD 2010 cost optimal level methodology and minimum performance requirements for building elements, in this case windows and external doors is proposed. It is important to highlight that the cost optimal level and minimum energy performance requirements for building elements are not the same and may have different values. The cost optimal level is calculated by the previously explained methodology. This is used a benchmark to assess the appropriateness of current or proposed minimum performance requirements.

The minimum requirements do not need to match the cost optimal level, however any differences should be reported and where minimum requirement are 15% below (i.e. less stringent) the cost optimal level detail of how the gap will be closed must be reported. There is nothing to prevent Member States setting minimum requirements higher (i.e. more stringent) than the cost optimal levels. It is important to be aware of this when considering the percentage improvement in the core and comprehensive criteria, as the percentage improvement will vary depending on how minimum performance levels have been set in relation to the cost optimal levels.

Public Authorities should purchase best performing products to lead by example and promote future innovation. The core criteria have therefore effectively been set to reflect the cost optimal level, as Member States can essentially set minimum performance requirements up to 15% lower than the cost optimal levels. The comprehensive criteria have been set to ensure the cost optimal level is exceeded.

The criteria have been developed with reference to percentage improvements on minimum performance requirements in relation to cost optimal levels to ensure national requirements will always be met or exceeded.

Criterion 3a should be used where possible. However, where Member States have not yet established cost optimal levels using the EPBD methodology, the proposed criterion 3a will not be able to be used. In these cases criterion 3b should be used as an alternative. Public Authorities should only use 3a or 3b and not both.

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[111] CE Marking for windows and doors is covered by harmonised standard EN14531-1:2006+A1:2010. As part of CE marking requirements, manufacturers will be required to make a declaration of products performance against this standard. This will include declared values for parameters such as thermal transmittance, solar radiation, light transmittance etc.

Proposed Core Criteria:

2. TECHNICAL SPECIFICATIONS (core)
3a Minimum energy performance requirements of windows and external doors based on EPBD Cost Optimal methodology: The energy performance of windows/external doors shall be [x]% better than the minimum energy performance requirements set for the relevant building element following consideration of the cost optimal level calculated in accordance with Directive 2010/31/EU and Regulation (EU) No 244/2012. . **Verification:** The bidder shall provide technical information on relevant parameters i.e. those used for calculating the cost optimal level, to demonstrate that the energy performance requirement of the GPP criterion for the building element has been met.

The following explanatory note is applicable for the core criteria, and provides guidance on the percentage level of improvement:

The minimum energy performance requirement chosen should be for the reference building type that most accurately reflects the building in which windows/external doors will be replaced. For example, the correct type of residential or non-residential building.

The percentage improvement stipulated for:

- the ***core criterion*** should be sufficient to ensure that energy performance required by the criterion **meets the cost optimal level**. This should be **a maximum of 15%**. Where the minimum energy performance requirements already go beyond the cost optimal level this should be used for the core criteria. The percentage of improvement will depend on the ambition of the minimum energy performance requirements set following the outcome of the cost optimal methodology calculations.

Proposed Comprehensive Criteria:

2. TECHNICAL SPECIFICATIONS (comprehensive)
3a Minimum energy performance requirements of windows and external doors based on EPBD Cost Optimal methodology: The energy performance of windows/external doors shall be [x]% better than the minimum energy performance requirements set for the relevant building element following consideration of the cost optimal level calculated in accordance with Directive 2010/31/EU and Regulation (EU) No 244/2012. **Verification:** The bidder shall provide technical information on relevant parameters i.e. those used for calculating the cost optimal level, to demonstrate that the energy performance requirement of the GPP criterion for the building element has been met.

The following explanatory note is applicable for the comprehensive criteria, and provides guidance on the level of improvement required:

The minimum energy performance requirement chosen should be for the reference building type that most accurately reflects the building in which windows/external doors will be replaced. For example, the correct type of residential or non-residential building.

The percentage improvement stipulated for:

- the ***comprehensive criterion*** should be sufficient to ensure that energy performance required by the criterion **goes beyond the cost optimal level**. Where the minimum energy performance requirements are already beyond the cost optimal requirements the Purchasing Authority should consider an appropriate percentage improvement based on the performance of the relevant building element available on the market.

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At the stakeholder meeting, it was suggested that a checklist/decision making tool would be useful for stakeholders to assist them generally in choosing the right type of window or external door. Due to the complexities of assessing these products and the range of external factors such as building type, climate, orientation, heating regimes, shading devices, etc. such tools do not exist at a broad or general level. The development of such a tool would potentially be misleading and contradict national requirements. In addition, there are often other practical issues that need to be considered when purchasing a window, which the Purchasing Authority will need to balance alongside the GPP criteria requirements. This includes for example, acoustics, fire protection, burglar resistance, accessibility and the architectural design of the building.

It is therefore proposed to include an explanatory note outlining the key considerations/guidelines to ensure Purchasing Authorities are aware of the types of questions/information that may need to be considered when choosing replacement window or external door.

- Explanatory notes for both core and comprehensive criteria have been included that highlight the key considerations that need to be taken into account when replacing windows and external doors. Full details are included in Section 9.2.6 and Section 9.3.

Revised Draft Criteria – Criterion 3b

As highlighted above, there are some unanswered questions regarding the approach using the EPBD 2010 cost optimal methodology. Criterion 3b has therefore been developed should the cost optimal methodology approach not be suitable at the moment or until a European wide methodology for calculating the energy balance of windows/external doors is developed. This criterion could also be included as part of the GPP criteria specification for Windows and External Doors, together with Criterion 3a, for use by Member States that have not completed their cost optimal calculations in accordance with EPBD 2010 and Regulation (EU) No 244/2012[109]. Note that Public Authorities would only be required to use 3a or 3b, and not both.

Criterion 3b is therefore based largely on the existing energy performance criteria, with some minor changes following feedback from stakeholders and further research that can be addressed when putting the EPBD 2010 cost optimal methodology or lack of European wide energy balance methodology issues to one side.

Window U-value requirements information across different Member States has been collected as part of the BPIE recent research, 'Europe's Buildings under the Microscope'[112]. An assessment of the U values against products available on the market indicates that stakeholder concerns regarding 20% and 30% improvements on national requirements could be an issue for those countries with the most stringent requirements. In order to taken into account the variation in national requirements, it is proposed to amend the criteria for this option. The percentage indication has been removed and replaced with a requirement for the percentage improvement to be based depending on the level of ambition of national requirements compared to the products available on the market. This aspect of the criterion is therefore the same for both the core and comprehensive criteria. In addition it is proposed to include criteria with reference to national energy rating schemes where they exist, to allow greater flexibility in the criteria for those countries that have developed such schemes. The revised criteria are presented below.

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[112] http://www.bpie.eu/

Proposed Core and Comprehensive Criteria

2. TECHNICAL SPECIFICATIONS (core)	2. TECHNICAL SPECIFICATIONS (comprehensive)
3b Minimum energy performance requirements of windows and external doors based on national energy balance label or national legislative requirements The thermal efficiency/energy performance of replacement windows shall be amongst the best performing in [*Name of country or region or location*], in accordance with the following criteria: a) [*If the Member State where the window is to be purchased has developed an energy balance rating scheme i.e. A-G*] The window or external door shall meet the energy performance rating of class [*X*] based on the applicable calculation method. OR: b) [*If no energy balance rating scheme exists*] The window shall demonstrate [*X*]% improvement on the value defined in [*insert relevant national legislation or standards*]: i. U-value ii. g-value iii. L50 value iv. Daylight transmittance The indicators are to be applied to the whole window, glazing and frame combined. **Verification:** a) Copy of the energy rating certificate for the window or external door from the appropriate scheme. b) Evidence of the relevant parameter value, calculated in accordance with the appropriate harmonised standard.	**3b Minimum energy performance requirements of windows and external doors based on national energy balance label or national legislative requirements** The thermal efficiency/energy performance of replacement windows shall be amongst the best performing in [*Name of country or region or location*], in accordance with the following criteria: a) [*If the Member State where the window is to be purchased has developed an energy balance rating scheme i.e. A-G*] The window or external door shall meet the energy performance rating of class [*X*] based on the applicable calculation method. OR: b) [*If no energy balance rating scheme exists*] The window shall demonstrate [X]% improvement on the value defined in [*insert relevant national legislation or standards*]: i. U-value ii. g-value iii. L50 value iv. Daylight transmittance The indicators are to be applied to the whole window, glazing and frame combined. **Verification:** a) Copy of the energy rating certificate for the window or external door from the appropriate scheme. b) Evidence of the relevant parameter value, calculated in accordance with the appropriate harmonised standard.

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The following explanatory note regarding the level of ambition for Criterion 3b is proposed:

Energy performance criterion 3b: To be used instead of criterion 3a when Member States have not completed their cost optimal calculations in accordance with Directive 2010/31/EU and Regulation (EU) No 244/2012) or the calculations do not include the relevant product e.g. external doors. If the Member State where the window is to be purchased has no relevant national regulations or standards available, the procurement professional should look to national regulations from other, appropriate, countries in Europe.

The energy balance rating scheme performance for
- the *core criteria* should specify one of the highest classes
- the *comprehensive criteria* should specify the highest class available

or:

The percentage improvement on national requirements *to insert in the criterion (ambition level) will depend on the ambition level defined in national legislation or standards. It is recommended that the percentage improvement inserted is based on the consideration of the national requirements in relation to the market availability. The level of improvement should be defined according to local requirements and take into account the key considerations identified below.*

9.2.2.2 Criteria related to the selection of materials

The current GPP criteria include a number of requirements relating to materials used in windows and external doors. The EcoReport analysis and previous studies have shown that a particular frame material does not have an overall environmental advantage over other frame materials, with higher and lower impacts identified across the impact categories, depending on the frame material type. It is therefore considered appropriate to include criteria in relation to different material types. It is proposed to revise the following criteria following stakeholder feedback and further research. Full details of the revised criteria are presented in Section 9.3.

Timber –Criterion 4

The use of wood for windows and external doors is an important component when used, for example as the frame material. For this reason, it is proposed to retain the existing criteria relating to timber.

Existing core and comprehensive Criteria:

The current core and comprehensive EU GPP criteria for timber state the following:

Core and comprehensive criterion: Timber

Timber used shall come from legal sources

Verification:

The legal origin of timber can be demonstrated with a chain-of-custody tracing system being in place. These voluntary systems may be 3rd party certified, often as part of ISO 9000 and/or ISO 14000 or EMAS management system.

Certificates of chain of custody for timber certified as FSC, PEFC or any other equivalent means of proof will also be accepted as proof of compliance. If timber stems from a country that has signed a Voluntary Partnership Agreement with the EU, the FLEGT license may serve as proof of legality. Other means of proof that will be accepted includes a relevant and valid CITES certificate or other equivalent and verifiable means such as the application of a "due diligence" system. For the non-certified virgin materials bidders shall indicate the types (species), quantities and origins of the timber, together with a declaration of their legality. As such the timber shall be able to be traced throughout the whole production chain from the forest to the product.

Existing award Criteria:

The current core and comprehensive EU GPP criteria for timber state the following:

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Award criterion: Timber

The final product made of wood, wood fibers or wood particles stemming from forests that are verified as being sustainably managed so as to implement the principles and measures aimed at ensuring sustainable forest management, on condition that these criteria characterize and are relevant for the product

In Europe, these principles and measures shall at least correspond to those of the Pan-European Operational Level Guidelines for Sustainable Forest Management, as endorsed by the Lisbon ministerial Conference on the Protection of Forest in Europe (2-4 june 1998). Outside Europe they shall at least correspond to the UNCED Forest Principles (Rio de Janeiro, June 1992) and, where applicable, to the criteria or guidelines for sustainable forest management as adopted under the respective international and regional inititaitves (ITTO, Montreal Process, Tarapoto Process, UNEP/FAO Dry-Zone Africa Initiative)

Verification:

Acceptable proof of sustainable harvest for timber may be provided for by means of a tracing system being in place. These voluntary systems may be 3rd party certified, often as part of ISO 9000 and/or ISO 14000 or EMAS management system. Certificates of chain of custody for timber certified as FSC, PEFC or any other equivalent means of proof will also be accepted as proof of compliance

Rationale and stakeholder's feedback:

Both of the existing criteria relating to timber, highlighted above, have been considered as part of the criteria review process.

The current core GPP criteria state that timber should come from legal sources. The forthcoming EU Timber Regulation (EU) No 995/2010 will regulate this issue in the future; however it does not come into force until 3rd March 2013. It is therefore proposed to add the following note to the criteria to make this clear as a similar approach has been used in other product groups where legislation is due to come into force shortly after the revision of the GPP criteria.

After 3rd March 2013 this issue will be regulated through Regulation (EU) No 995/2010

Wood and wood-based materials are renewable raw materials, the continued availability of which should be considered from the beginning of the production/extraction process to ensure that future supply is maintained. As highlighted in the previous studies, the use of wood in windows and external doors has little impact on the overall environmental impact, compared to the in use phase, as long as this material is properly chosen for the location and characteristics of the building where it is to be installed. The development of GPP criterion to ensure the responsible source of the wood and wood-based materials used in windows and external doors is therefore considered important.

It is therefore proposed that the current award criterion is moved to the technical specifications to ensure consistency with other product groups. The impending legislative requirement for timber to be from legal sources also means that distinguishing timber products under GPP from the standard requirement is needed and this provides an appropriate means of doing this. The proposed criterion will ensure all wood and wood-based materials used in the construction and renovation of the buildings are coming from responsible sources and compliance with several available certification schemes is included within the criterion.

Revised Criteria:

The current award criteria regarding responsible sourcing of wood will be moved to the technical specifications to ensure consistency with related product groups. It will be included as both core and comprehensive criteria, with the percentage level of responsible sourced wood and wood based materials differentiating between the two.

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2. TECHNICAL SPECIFICATIONS (core)	2. TECHNICAL SPECIFICATIONS (comprehensive)
4. Timber Timber used shall come from legal sources. **Verification:** a) The legal origin of timber can be demonstrated with a chain-of-custody tracing system being in place such as FSC*, PEFC** or any other equivalent means of proof will also be accepted as proof of compliance. b) If timber stems from a country that has signed a Voluntary Partnership Agreement (VPA) with the EU, the FLEGT license may serve as proof of legality. c) Other means of proof that will be accepted includes a relevant and valid CITES certificate or other equivalent and verifiable means such as the application of a "due diligence" system. d) For the non-certified virgin material bidders shall indicate the types (species), quantities and origins of the timber, together with a declaration of their legality. As such the timber shall be able to be traced throughout the whole production chain from the forest to the product. * FSC (Forest Stewardship Council): http://www.fsc.org/en ** PEFC http://www.pefc.org/internet/html *** FLEGThttp://ec.europa.eu/environment/forests/flegt.htm **After 3rd March 2013 it will be regulated through Regulation (EU) No 995/2010.**	**4.Timber** Timber used shall come from legal sources. **Verification:** a) The legal origin of timber can be demonstrated with a chain-of-custody tracing system being in place such as FSC*, PEFC** or any other equivalent means of proof will also be accepted as proof of compliance. b) If timber stems from a country that has signed a Voluntary Partnership Agreement (VPA) with the EU, the FLEGT license may serve as proof of legality. c) Other means of proof that will be accepted includes a relevant and valid CITES certificate or other equivalent and verifiable means such as the application of a "due diligence" system. d) For the non-certified virgin material bidders shall indicate the types (species), quantities and origins of the timber, together with a declaration of their legality. As such the timber shall be able to be traced throughout the whole production chain from the forest to the product. * FSC (Forest Stewardship Council): http://www.fsc.org/en ** PEFC http://www.pefc.org/internet/html *** FLEGThttp://ec.europa.eu/environment/forests/flegt.htm **After 3rd March 2013 it will be regulated through Regulation (EU) No 995/2010.**
5. Responsible sourcing of wood and wood-based materials At least [X]% of the final product made of wood and wood-based materials shall be responsibly sourced. **Verification:** Certification schemes such as FSC, PEFC, or any equivalent means of proof (accepted by the respective competent body).	**5. Responsible sourcing of wood and wood-based materials** At least [X]% of the final product made of wood and wood-based materials shall be responsibly sourced. **Verification:** Certification schemes such as FSC, PEFC, or any equivalent means of proof (accepted by the respective competent body).

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Explanatory notes

The percentage of wood and wood-based materials that should be certified depends on the market conditions of the Member State where the window is to be installed. The percentage of wood and wood-based materials to be certified is usually in the range of:

- *core criteria:* A minimum requirement of 60-70% in weight of the wood and wood-based certified materials can be used
- *comprehensive criteria*: A minimum requirement of 70-80% in weight of the wood and wood-based certified materials can be used

Marking Plastics Components – Criterion 6

Existing Criteria:

The current core and comprehensive EU GPP criteria for plastics state the following:

Criterion: plastic

Plastic components weighting more than 50g should be marked according to ISO 11469 or equivalent

Verification:

Products holding a relevant Type I label fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.

Rationale and stakeholder's feedback:

The marking of plastics in accordance with ISO 11469[113] is intended to help identify plastic products and help inform subsequent decisions regarding handling and waste recovery or disposal. The usefulness of these markings will depend on the products disposal / recovery route at the end of life stage.

The feedback from the stakeholder meeting indicated that those present felt that the current requirement for the marking of plastics according to ISO11469[114] is unnecessary as it was indicated that the products are not broken down manually to recover plastic parts and therefore the labelling not utilised. The representation of stakeholders at the first stakeholder meeting was largely industry based.

In addition, the BoM collected for windows as part of the technical analysis indicates that the main plastic used in windows is UPVC for the frames, with other plastic components limited in terms of their number and weight. Discussion with technical experts confirms that this is a reasonable conclusion. UPVC is easily identifiable through other markings e.g. those required by EN 12608[115] and is generally recovered through recognised routes established by the industry, such as Recovinyl[116] and the recently European wide certification scheme[117] aimed at post consumer plastic recyclers to highlight those that operate to high standards.

Revised Criteria:

From the research and analysis undertaken, together with the feedback from stakeholders, it is proposed to delete this criterion from the GPP specification.

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Filler Gases – Criterion 7

Existing Criteria:

The current core and comprehensive EU GPP criteria for filler gases state the following:

[113] ISO 11469 – Generic Identification and marking of plastic products. This standard specifies a system of uniform marking of products that have been fabricated from plastic materials. It is intended to help identify plastic products for subsequent decisions regarding handling, waste recovery or disposal.

[114] referencesISO 11469 – Generic Identification and marking of plastic products. This standard specifies a system of uniform marking of products that have been fabricated from plastic materials. It is intended to help identify plastic products for subsequent decisions regarding handling, waste recovery or disposal.

[115] EN 12608: Unplasticized polyvinylchloride (PVC-U) profiles for the fabrication of windows and doors. Classification, requirements and test methods

[116] http://www.vinylplus.eu/en_GB/sustainable-development/measuring-our-progress/challenge-1/recovinyl

[117] http://www.eucertplast.eu/en/ and http://www.eucertplast.eu/uploads/downloads/press-release.pdf

Criterion: Filler gases

Filler gases that contribute to the greenhouse effect, with a Global Warming Potential (GWP) > 5 over a period of 100 years, may not be used in the insulating unit.

Verification:

Products holding a relevant Type I label fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.

Rationale and stakeholder's feedback:

The research undertaken as part of this study, has highlighted that filler gas can be of great importance with respect to the energy performance of the window. Therefore the inclusion and retention of a GPP criterion for filler gas is due to the following reasons. Double and triple glazing windows are becoming the most common type of window across Europe. This means that although vacuum glazing windows are already commercially available, filler gases are widely used. In general filler gases have a global warming potential and criteria in other schemes e.g. Nordic Swan, focus on minimising the GWP of the filler gases used in windows and external doors.

It was highlighted at the first stakeholder meeting that some noble gases are scarce and may not necessarily be the most cost effective or best environmental option, for example, the extraction of the noble gases can be an energy intensive process. This will depend on the specific situation/building the product is to be fitted. It is therefore not considered appropriate to develop criteria relating to specific gases or technologies.

The current criterion is focused on the wider impacts related to the global warming potential (GWP) of the filler gas, only where it is used in a window or external door product and does not exclude the use of other technologies that may be appropriate.

Filler gases are commonly used window and door product and this requirement is still included in the environmental label Type I on which the original GPP criteria were based (Nordic Swan) and therefore still considered appropriate. Reference to specific gases i.e. argon and krypton will be removed from the criterion to ensure it is not seen to be promoting particular types of gases.

Even though this requirement is included in some Type I labels, the use of such labels, can only be used where there is a specific requirement that covers the information required to verify the filler gas GPP criterion. Similarly, verification using Type III Environmental Product Declarations (EPD) will only be appropriate where the EPD includes specific information that allows the GPP criteria to be verified. Further information regarding the use of Type I and Type III environmental labels for GPP criteria verification is included in Section 9.2.5.

Revised Criteria:

2. TECHNICAL SPECIFICATIONS (core)	2. TECHNICAL SPECIFICATIONS (comprehensive)
6. Global warming potential of filler gases Filler gases that contribute to the greenhouse effect, with a Global Warming Potential (GWP) > 5 over a period of 100 years, may not be used in the insulating units. **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.	**6. Global warming potential of filler gases** Filler gases that contribute to the greenhouse effect, with a Global Warming Potential (GWP) > 5 over a period of 100 years, may not be used in the insulating units. **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.

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Production of PVC – Criterion 8

Existing Criteria:

The current core and comprehensive EU GPP

Criterion: PVC

The bidder shall demonstrate that the production of PVC complies with best practice in accordance with Vinyl 2010 or equivalent

Verification:

Participation with Vinyl2010 will be acceptable, otherwise the bidder must provide written evidence of Vinyl2010's recommendations or equivalent are complied with.

Rationale and stakeholder's feedback:

The technical analysis undertaken using EcoReport demonstrates that total energy use in the production and manufacturing phase is dominated by PVC frame production for PVC windows. The production of PVC also influences other impact categories, together with glass in the production and manufacturing phase, for example, water use and waste production. Further details are presented in the Task 4 Technical Analysis report, available from the project website. Based on this analysis it is clearly important that the production and manufacturing of PVC is undertaken in line with best practice in order to minimise these impacts. It is therefore recommended that the criterion relating to PVC production is retained.

The current GPP criterion regarding the production of PVC references the Vinyl2010 scheme. This has now been superseded by VinylPlus. The criterion will be updated to reference VinylPlus. This scheme includes a number of commitments and challenges focused on Controlled-Loop Management of PVC, Organochlorine Emissions, Sustainable Use of Additives, Sustainable Energy and Climate Stability and Sustainability Awareness[118].

Revised Criteria:

2. TECHNICAL SPECIFICATIONS (core)	2. TECHNICAL SPECIFICATIONS (comprehensive)
7. PVC Production The bidder shall demonstrate that the production of PVC complies with best practice in accordance with VinylPlus or equivalent. **Verification:** Participation with VinylPlus will be acceptable, otherwise the bidder must provide written evidence that the VinylPlus* recommendations, or equivalent, are complied with. *VinylPlus: http://www.vinylplus.eu/	**7. PVC Production** The bidder shall demonstrate that the production of PVC complies with best practice in accordance with VinylPlus or equivalent. **Verification:** Participation with VinylPlus will be acceptable, otherwise the bidder must provide written evidence that the VinylPlus* recommendations, or equivalent, are complied with. *VinylPlus: http://www.vinylplus.eu/

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[118] http://www.vinylplus.eu/en_GB/about-vinylplus/our-voluntary-commitment

9.2.2.3 Criteria related to the use/avoidance of Hazardous Substances – criterion 9

Existing core and comprehensive award Criteria:

The current award core and comprehensive EU GPP dealing with hazardous substances

Award core and comprehensive criterion: Lead

Lead (R23, R25 and H301, H331) and its compounds must not intentionally be added to the plastics and coatings used in windows.

The final window product will not release or leach out any substances or preparations that are classified according to Directive 199/45/EC and 67/548/CEE any substances with the listed R-phrases specified below, under normal usage conditions:

- carcinogenic (R40, R45, R49)
- harmful to the reproductive system (R60, R61, R62, R63)
- mutagenic, cause of heritable genetic damage and possible risks of irreversible effects (R46, R68)
- Toxic (R23, R24, R25, R27, R28, R51)
- allergenic when inhaled (R42)
- harmful to the environment (R50, R50/53, R51/53, R52, R52/53, R53)
- danger of serious damage to health by prolonged exposure (R48)

Regulation (EC) No 1272/2008, amending and repealing Directives 67/548/EEC and 199/45/EC and amending Regulation (EC) No 1907/2006, gives the following H-phrases which relate to the R-phrases. The final window product will not release or leach out any substances or preparations that are classified with the listed H-phrases, below under normal usage conditions:

- carcinogenic (Carcinogenic 1A, 1B and 2: H350, H350i, H351)
- harmful to the reproductive system (Reproductive 1[a], 1B and 2: h360F, H360D, H361f, h361d, H360FD, H361fd, h360Fd and H360Df)
- mutagenic and cause heritable genetic damage (mutagenic 1B and 2: H340 and H341)
- toxic (accurate toxicity 1, 2 and 3: h330, H331, H311, H310, h300, Aquatic chronic 2: H412)
- Allergenic when inhaled (Respiratory Sensitivity 1 : H334)
- harmful to the environment (aquatic Acute 1 and aquatic chronic 1, 2, 3 and 4: h400, H410, H411, H412, H413)
- danger of serious damage to health by prolonged exposure (Health hazard: H372 and H373)

Verification:

Products holding a relevant Type 1 label fulfilling the listed criteria will be deemed to comply. Other properties means of proof will also be accepted.

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Award comprehensive criterion: Lead

Chemical products (paint, adhesive, sealants, putty, etc) in the finished window must satisfy one of the following two requirements:

a) the product may not be classified as environmentally hazardous according to

b) the product may contain a maximum of 2% by wt of substances classified as environmentally hazardous according to EC directive 67/548/EEC

For wood preservative this rises to 3% as defined by 37/548/EEC

Verification:

Products holding a relevant Type I label fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted. In addition confirmation that either requirement a or b has been fulfilled. Material safety data sheets specifying how the products are classified must be provided. The material safety data sheets must not be more than 3 years old. Written confirmation that he chemical products are approved for their intended purpose by an authority in the window's country of manufacture, and conformation that CCA (chromate copper arsenate), CC (copper citrate), organic tin compounds or creosote oil are present it eh final window product.

Rationale and stakeholder's feedback:

The current GPP criteria for windows and external doors include award criteria regarding hazardous substances. The core award criterion relates to the use of lead and substances with particular properties that should not be released from the window or external door product. The second criterion, which is only included in the comprehensive award criteria relates to chemical products used install/finish the window e.g. paint, putty, sealants and adhesives.

The uses of hazardous substances as part of the manufacturing process are of key importance as they can have an influence throughout the life cycle of the product. This includes for example the generation of hazardous waste during the manufacturing process, as shown by the EcoReport analysis and the recovery or disposal options available in the end of life phase. In addition, the use of hazardous materials has the potential for releases, resulting in possible health and environmental impacts. It is therefore considered important that hazardous substances are not released to protect against this.

The current GPP criterion includes a restriction on the use of lead. The PVC industry itself has identified lead as an issue and the potential health and environmental impacts, by committing to phase out the use of lead stabilisers in the EU27 by 2015. The progress towards the use of calcium organic stabilisers instead of lead stabilisers is shown in Figure 8[119]. To continue promoting this commitment through GPP it is proposed that the current criterion regarding lead is retained.

A number of comments relating to the inclusion of criteria regarding hazardous substances were made at the first stakeholder meeting and in subsequent written feedback. In summary the comments included:

1. Some stakeholders felt that the GPP criteria on hazardous substances had no added value due to the controls provided by REACH. Others suggested limiting the use of hazardous materials was worthwhile, for example to ensure good indoor air quality.

2. Stakeholder supported the approach based on hazardous substances released and not necessarily contained within the product.

3. Perception that current GPP criteria relate to leakage of hazardous substances from window material upon disposal.

[119] http://www.vinylplus.eu/en_GB/sustainable-development/measuring-our-progress/challenge-3

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4. Clarification regarding terminology is required to ensure it is clear. For example the current criteria use the terms products, materials and substances.

Given the range of views from stakeholders, the points summarised above and that criteria relating to hazardous substances are included in current environmental labels for windows e.g. Nordic Swan and the EU ecolabel and GPP criteria for other product groups, it is considered appropriate to include this type of criteria in the GPP requirements for windows to limit any potential environmental and health impacts.

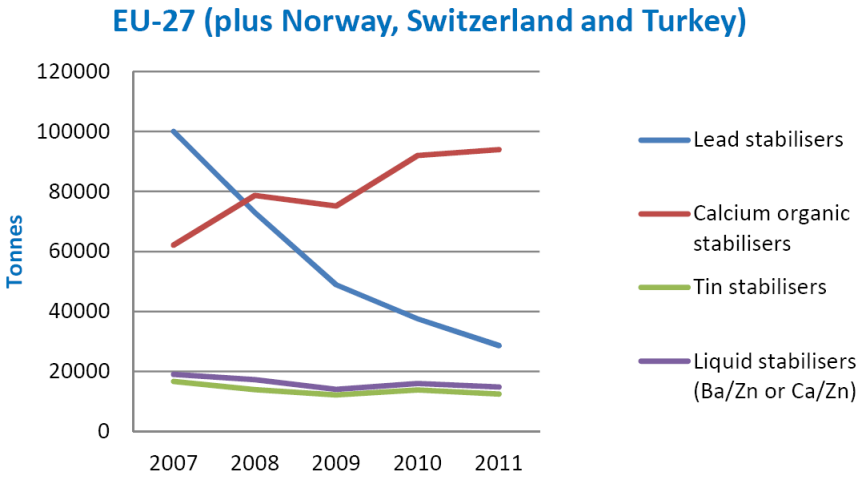

Figure 8: Stabiliser production data[119]

It is proposed to revise the criteria to take into account comments from stakeholders and reflect existing legislation. The criterion regarding hazardous substances from the window or external door will continue to be based on a release, rather than a content based approach as discussed at the stakeholder meeting. The R and H phrases included in the revised criteria reflect those included in the current Nordic Swan label for windows and external doors requirements relating to the classification of chemical products used in the manufacture of windows and external doors, their handling and substances classified as carcinogenic, mutagenic and /or toxic for reproduction. Whilst this criterion relates to substances with these characteristics not being released, any other legislative requirements regarding the use of substances with these characteristics in window and door products i.e. content based must also be adhered to e.g. REACH, CLP or CPR. The updated criteria are presented in Section 9.3.

It is proposed to remove the requirements relating to hazardous substances in other products used for the finishing of windows and external doors, for example paints or putty's. These would not necessarily be supplied with the window, and will be covered appropriately by existing legislation as appropriate, for example REACH and CLP[120]. Should the purchasing authority wish to buy finishing products that meet a high environmental standard, then separate criteria that address these products should be used. For example, the GPP criteria for construction[121] include requirements for paints and there is a separate EU Ecolabel for paints and varnishes, which is currently undergoing revision[122].

The requirements regarding lead have been retained until such time its use has been phased out in the production of PVC.

[120] See Sections 8.1.6 and 8.1.8 of this report for further information on REACH and CLP respectively.
[121] http://ec.europa.eu/environment/gpp/pdf/toolkit/construction_GPP_product_sheet.pdf
[122] http://ec.europa.eu/environment/ecolabel/products-groups-and-criteria.html

Revised Criteria:

2. TECHNICAL SPECIFICATIONS (core)	2. TECHNICAL SPECIFICATIONS (comprehensive)
8. Hazardous Substances The final window or external door product will not release any substances or preparations under normal conditions that are classified according to Directive 1999/45/EC and 67/548/CEE with the R-phrases specified below: • Dangerous for the environment; R50, R50/53, R51/53 • Carcinogenic; R45, R49, R40 • Mutagenic; R46, R68 • Toxic for reproduction; R60, R61, R62, R63 • Very toxic; R26, R27, R28, R29 • Toxic; R23, R24, R35, R39, R48 • Harmful; R22, R48, R68 The final window or external door products will not release any substance or preparations under normal conditions that are classified, in accordance with Regulation (EC) No 1272/2008 as the H-phrases listed below: - Dangerous for the environment; Ecotoxicity Acute Category 1 H400, Ecotoxicity Chronic Category 1 H410, Ecotoxicity Chronic Category 2 H411 - Carcinogenic; Carcinogenicity Category 1A H350, Carcinogenicity Category 1B H350, Carcinogenicity Category 2 H351 - Mutagenic; Germ Cell Mutagenicity Category 1A H340, Germ Cell Mutagenicity Category 1B H340, Germ cell Mutagenicity Category 2 H341 - Toxic for reproduction; Reproductive Toxicity Category 1A H360, Reproductive Toxicity Category 1B H360, Reproductive Toxicity Category 1A H361 - Very toxic; Acute Toxicity Category 1 H330, Acute Toxicity Category 2 H330, Acute Toxicity Category 1 H310, Acute Toxicity Category 2 H310, Acute Toxicity Category 1 H300, Acute Toxicity Category 2 H300, Specific Target Organ Toxicity after Repeated Exposure Category 1 H370 - Toxic; Acute Toxicity Category 3 H331, Acute Toxicity Category 3 H311, Acute Toxicity Category 3 H301, Specific Target Organ Toxicity after Repeated Exposure Category 1 H371, Specific Target Organ Toxicity after Repeated Exposure Category 1 H372 - Harmful; Acute Toxicity Category 4 H302, Specific Target Organ Toxicity after Repeated Exposure Category 2 H373, Specific Target Organ Toxicity after Repeated Exposure Category 3 H335 **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.	**8. Hazardous Substances** The final window or external door product will not release any substances or preparations under normal conditions that are classified according to Directive 1999/45/EC and 67/548/CEE with the R-phrases specified below: • Dangerous for the environment; R50, R50/53, R51/53 • Carcinogenic; R45, R49, R40 • Mutagenic; R46, R68 • Toxic for reproduction; R60, R61, R62, R63 • Very toxic; R26, R27, R28, R29 • Toxic; R23, R24, R35, R39, R48 • Harmful; R22, R48, R68 The final window or external door products will not release any substance or preparations under normal conditions that are classified, in accordance with Regulation (EC) No 1272/2008 as the H-phrases listed below: - Dangerous for the environment; Ecotoxicity Acute Category 1 H400, Ecotoxicity Chronic Category 1 H410, Ecotoxicity Chronic Category 2 H411 - Carcinogenic; Carcinogenicity Category 1A H350, Carcinogenicity Category 1B H350, Carcinogenicity Category 2 H351 - Mutagenic; Germ Cell Mutagenicity Category 1A H340, Germ Cell Mutagenicity Category 1B H340, Germ cell Mutagenicity Category 2 H341 - Toxic for reproduction; Reproductive Toxicity Category 1A H360, Reproductive Toxicity Category 1B H360, Reproductive Toxicity Category 1A H361 - Very toxic; Acute Toxicity Category 1 H330, Acute Toxicity Category 2 H330, Acute Toxicity Category 1 H310, Acute Toxicity Category 2 H310, Acute Toxicity Category 1 H300, Acute Toxicity Category 2 H300, Specific Target Organ Toxicity after Repeated Exposure Category 1 H370 - Toxic; Acute Toxicity Category 3 H331, Acute Toxicity Category 3 H311, Acute Toxicity Category 3 H301, Specific Target Organ Toxicity after Repeated Exposure Category 1 H371, Specific Target Organ Toxicity after Repeated Exposure Category 1 H372 - Harmful; Acute Toxicity Category 4 H302, Specific Target Organ Toxicity after Repeated Exposure Category 2 H373, Specific Target Organ Toxicity after Repeated Exposure Category 3 H335 **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.
Lead (R23, R25 and H301, H331) and its compounds must not intentionally be added to the plastics and coatings used in windows and external doors. **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other	Lead (R23, R25 and H301, H331) and its compounds must not intentionally be added to the plastics and coatings used in windows and external doors. **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other

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appropriate means of proof will also be accepted.	appropriate means of proof will also be accepted.

Explanatory notes:

Regulation (EC) No 1272/2008 amending and repealing Directive 67/548/EEC and 1999/45/EEC, and amending Regulation (EC) No 1907/2066 provides guidelines on the translation between the H- and R- phrases. Legislative requirements restricting the use of substances and/or preparations within window and external doors must continue to be met e.g. REACH, CLP and the Construction Product Regulation (CPR)[123]

9.2.3 Award criteria

Purchase authorities will have to indicate in the contract notice and tender documents how many additional points will be awarded for each award criterion. Environmental award criteria should, altogether, account for at least 10 to 15% of the total points available.

9.2.3.1 Criteria related to the Recycled Content – Criterion 10

Existing award Criteria:

The current comprehensive and award criteria are currently the same, awarding additional points in proportion to the recycled content of materials used.

Award recycled material

Additional points will be awarded in proportion to the recycled content of materials used. This excludes process waste

Verification:

Products holding a relevant Type I label fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted, for example a manufacturer's appropriate certification

Rationale and stakeholder's feedback:

The EcoReport analysis does not allow recycled content to be taken into account; however it would be reasonable to expect reduced environmental impacts as a result of the use of recycled material due to a reduction in raw material extraction and the production e.g. carbon emissions[124], compared to non recycled material using virgin materials, although this may be offset to some extent by any processing of recycled material that is required. The use of recycled material in products will also mean waste has been diverted from landfill, therefore reducing environmental impacts at the end of life stage.

The current criteria were aimed at recycled content in frame materials, although this is not clearly states in the criterion itself. Due to the different manufacturing processes for typical materials, such as aluminium, PVC and timber and the ease at which the criteria would be met for some materials if process waste was included, it was decided to exclude it as part of the requirements. Indeed, inclusion of process waste is best practice for the manufacturing of some materials. It is proposed to revise this criterion to make it clear it relates to frame materials.

The glass industry have provided feedback following the stakeholder meeting indicating support for criteria related to recycled content, however they state that it should not exclude process waste when glazing is considered. The original criterion did not consider recycled content of glazing; it is therefore

[123] See Section 8 for a summary of relevant legislation.
[124] http://www.glassforeurope.com/en/industry/float-process.php

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proposed to divide the criterion into two sections. The first part deals with the recycled content in the frame materials while the second on is focused on the glazing. As this is aimed at glazing only, and not balancing the recycled content of different materials, as in the criterion outlined above, it is proposed to include process waste, and an indication of the level of recycled content that is appropriate for glazing, as indicated by stakeholder feedback. An explanatory note has been included to ensure that recycled content does not adversely affect quality, durability, performance and safety.

Revised Criteria:

3. Award criteria (core)	3. Award criteria (comprehensive)
	9. Recycled Content **Frame Materials:** Additional points will be awarded in proportion to the recycled content of materials used for the window or external door (excluding glazing). This excludes process waste. **Glazing:** Additional points will be awarded in proportion to the recycled content of glazing used for the window or external door **Verification:** Products holding a relevant Type I label or a Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.

Explanatory Notes
- Frame Materials: The use of recycled material should not adversely affect the quality, durability, performance and safety of the product.
- Glazing: The recycled content of the glazing component of the window or external door should not be more than 20% to ensure quality, durability; performance and safety are not adversely affected. For the purposes of these GPP criteria, process waste is material reclaimed within the process it was generated. For example, arising from the production processes of the different materials used in the manufacturing of windows and doors.

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9.2.4 Contract performance clauses

9.2.4.1 Criteria related to the Maintenance information – Criterion 11

Existing contract performance clauses criteria:

The current contract performance clause criteria are state the following

Maintenance

The bidder must ensure maintenance recommendations are provided with the product. It also has to provide documented procedures and instructions for quality and environmental assurance

Verification:

Products holding a relevant Type I Ecolabelled fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.

Rationale and stakeholder's feedback:

Although maintenance is not addressed within the technical analysis undertaken, it is an important aspect that needs to be considered. The analysis has shown that the balance between the U and g values is critical to ensure performance is optimised. Therefore maintenance to ensure the stated U and g values are achieved is important, together with ensuring intended product lifetimes are achieved. The provision of information relating to maintenance was highlighted at the stakeholder meeting as a key aspect. There was general support for the current criterion regarding the provision of maintenance information.

An explanatory note will be added to the criterion to highlight the type of information that could be included as part of the maintenance information. Depending on the window type and frame material, this may include for example details on how often the finish should be checked and re-applied, and which surface treatment is recommended. For materials that do not require finishes to be applied other information may be of use, for example the type of cleaner used e.g. non-abrasive, the removal of grit/dirt, tightening of screws/fixings and lubrication of moving parts as appropriate.

Questions were raised at the stakeholder meeting regarding the verification of the criterion. The maintenance information highlighted above is required by some Type I labels, for example the Nordic Swan, and it therefore considered appropriate to be included in the verification, along with other appropriate means proof, such as extracts of the customer information relating to maintenance.

Revised Criteria:

4. Contract performance clauses (core)	**4. Contract performance clauses (comprehensive)**
10. Maintenance Information The bidder must ensure maintenance recommendations are provided with the product. **Verification:** Products holding a relevant Type I label or a Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.	**10. Maintenance Information** The bidder must ensure maintenance recommendations are provided with the product. **Verification:** Products holding a relevant Type I label or a Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.

Explanatory Notes

Depending on the window type and frame material, maintenance information may include details on how often the finish should be checked and re-applied, and which surface treatment is recommended. For materials that do not require finishes to be applied other information may be of use, for example the type of cleaner used e.g. non-abrasive, the removal of grit/dirt, tightening of screws/fixings and lubrication of moving parts as appropriate.

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9.2.4.2 Waste Management – Post Consumer Waste – Criterion 12

Existing award Criteria:

The current contract performance clause criteria are state the following

Maintenance

The bidder must demonstrate that the contractor for retro-fitting or refurbishing window installations has in place effective policies and procedures to ensure that post-consumer waste (i.e. the removed windows) is properly dealt with in a sustainable manner, such as recycling or diverting from landfill where possible

Verification:

Possible means of proof include EMAS and ISO 14001 certificates or equivalent certificates issued by bodies conforming to Community law or the relevant European or international standards concerning certification based on environmental management standards. Other appropriate means of proof will also be accepted.

Rationale and stakeholder's feedback:

The recovery of construction products, such as windows and external doors is an objective of the Waste Framework Directive[125] due to the environmental benefits that can be gained through recycling and reuse. This could include avoiding raw material extraction, savings in energy consumption and avoiding disposal in landfill and the subsequent management of pollutants required,

The technical analysis using EcoReport demonstrates that for waste there is a net benefit in the end of life phase as a result of recycling. In order to maximise this benefit in the end of life phase it is considered appropriate to retain the criterion promoting effective post consumer waste management.

No issues were raised at the stakeholder meeting regarding the existing criterion on post consumer waste. It is still considered appropriate and therefore it has been left unchanged.

In July 2012 the European Commission launched a European wide certification scheme[126] aimed at post consumer plastic recyclers to highlight those that operate to high standards. Sending post consumer plastic waste to plastic recyclers who have achieved certification under this scheme would be one means of ensuring post consumer plastic waste is dealt with effectively. Similar schemes for other materials do not exist at a European level and appropriate routes for other post consumer waste at a national level would need to be considered

Revised Criteria:

4. Contract performance clauses	4. Contract performance clauses (comprehensive)
	11. Post Consumer Waste Management: The bidder must demonstrate that the contractor for retro-fitting or refurbishing window installations has in place effective policies and procedures to ensure that post-consumer waste (i.e. the removed windows) is properly dealt with in a sustainable manner, such as recycling or diverting from landfill where possible. **Verification:** Possible means of proof include EMAS and ISO 14001 certificates or equivalent certificates issued by bodies conforming to Community law or the relevant European or international standards concerning certification based on environmental management standards. Other appropriate means of proof will also be accepted.

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[125] This Directive proposes to reach 70% of preparation for reuse, recycling and other forms of material recovery.
[126] http://www.eucertplast.eu/en/ and http://www.eucertplast.eu/uploads/downloads/press-release.pdf

9.2.5 Verification

The verification of GPP criteria is an important consideration. The verification requirements should be designed to minimise the burden on companies, for example, by using information from existing sources, such as test standard results. From the perspective of the Purchasing Authority the verification should be easy to assess.

The verification for a number of the existing criteria includes reference to Type I labels, where they fulfil the listed criteria. At the stakeholder meeting it was noted that window manufacturers are starting to develop and use Type III Environmental Product Declarations (EPD) in accordance with ISO14025, which established the principles and specifies the procedures to develop this tool. Specifically for construction products, EN 15804 details core product category rules for all construction products and services. The structure outlined in the standard is designed to ensure EPDs of construction products are derived, verified and presented in a harmonised way. Where EPD, developed in line with the above standards, provides information in relation to the requirements of the GPP criteria, it should be permitted to be used for the purposes of verification. The verification of relevant criteria has therefore been revised to include reference to this additional verification option.

9.2.6 Explanatory notes related to thermal performance

Explanatory notes are used to provide additional information and guidance on specific criteria. These have been included in the preceding sections where appropriate.

In addition, an explanatory note has been included, which aims to provide guidelines to the public authority on the key parameters will affect thermal performance and should be considered when purchasing windows and external doors e.g. location, orientation, maintenance etc. This has been included in response to feedback at the first stakeholder meeting, which indicated guidelines on the most important issues to consider would be valuable, in what is a complex field.

Existing explanatory notes:

In the current set of GPP criteria some clues about the main factors that influence the thermal performance of the windows are highlighted. They are summarized in the following table:

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Explanatory notes:

The purchasing authority shall have regard to local circumstances:

- *local climate*: which way a window may face, shading of an area, etc

Passive solar building design involves the orientation of windows, walls, place awnings, porches and trees such that the windows and roofs are shaded in the summer while allowing maximum solar gain in the winter. Effective window placement provides more natural light and lessens the needs for electric lighting during the day – thus window placement should be considered by the purchasing authority where practical and effective.

- *regional climate*: the prevailing weather conditions and whether the predominant climate control inside the building will be heating or cooling

Whether heating and cooling is predominantly used in the building will affect the use of tints in the glass, as these can be used to reduce the glare and solar gain in hot climates. It will also affect the choice of coatings, especially low-E ones as different arrangements and coatings are used or reduce heat loss from inside to outside a building, or to prevent heat from outside transferring to the interior of a building.

- *level of sophistication of the window*: whether the environmental payback will be achieved in the lifetime of the window

Triple glazing window requires more materials and may not deliver environmental benefits over and above those consumed during its production, when installed in a temperature climate such as southern England or France for example. However, installation of triple glazing in Scandinavia would be appropriate, and is mandatory in some cases, as the environmental benefits it would deliver would make the extra material investment worthwhile. The potential CO2 savings of using different types of glass optimally have been quantified by a TNO study.

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Rationale and stakeholder's feedback:

The research has highlighted that there is no clear best performing window design (neither frame material nor glazing) but that it depends on the location specific conditions and building where the window is installed. Similarly, the use of double or triple glazing, filler gases as well as that of low-e coatings need to be assessed within the context of the building and the location specific factors, such a climate, orientation etc.

As observed, some information is already included in the existing GPP criteria under the section called "Explanatory notes". In the revised set of criteria, this section has been expanded and includes guidelines on the most important issues to be evaluated or considered.

For example, the proposed guidelines consider the influence of the climate and how U-values and g-values should be matched depending on the relative importance of the heating and cooling needs for the specific location. The influence of solar gain is also highlighted. The orientation of the building and in particular of the window in the building should also be considered. North facing windows or those with shading will not receive significant solar gains. Other factors also highlighted for consideration are the overall energy performance of the building, the size of the window, the gas fill and the number of windows, the need for light transmittance and other practical issues such as acoustics, accessibility, etc.

Revised explanatory notes:

Key Considerations / checklist of the most important issues to be regarded:

There are a number of key considerations that should be taken into account when choosing a replacement window/external door, which will be specific to the building and its location. These are summarised below for reference:

a) The *importance of the climate* i.e. heating and cooling seasons should be considered. This will affect the ideal configuration of the window. In heating dominated climates (i.e. colder climates), *a better U-value is important to minimise the energy losses* through the window. In cooling dominated climates (i.e. hotter climates) *a better g value is important to minimise the energy gains through the window*, and therefore increase the cooling energy demands. In reality the ideal window/door configuration will be a balance between the two, highlighting the advantage of an energy balance or whole building approach.

b) The level of *solar gain will also be affected by the orientation of the window/door to be replaced*, for example north or south facing. Any shading devices (solar shading) installed in the building should also be taken into consideration, as these will also affect the potential level of solar gain and therefore the window specification required.

c) The *overall energy performance of the building should be considered where possible*, to ensure that the window/door installed will offer optimised performance. This may be *affected by the type, age, use and heating/cooling regime of the building*. For example installing windows with a high energy performance may not result in maximum potential savings if other elements of the building are poor in relation to overall energy performance.

d) The *energy performance of the window may differ depending on its size*. It is therefore important to ensure the U and g values considered are in relation to the size of the window required as part of the refurbishment.

e) In windows with a gas fill e.g. double or triple glazed windows the cost of different fill gases should be considered in relation to the level of improvement provided for the building in which it will be installed.

f) The light transmittance of the window should be considered, to ensure this is not reduced beyond acceptable levels, and the window can still fulfil one of its primary functions, of allowing day light into the building.

g) In addition, there are *often other practical issues that need to be considered when purchasing a window*, which the Purchasing Authority will need to balance alongside the GPP criteria requirements. This includes for example, acoustics, fire protection, burglar resistance, accessibility and the architectural design of the building.

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9.2.7 Cost considerations

When purchasing replacement windows and external doors, cost considerations will be an important aspect for Public Authorities. As highlighted in Section 6, it is important to consider all life cycle costs and not just the product purchase price when making purchasing decisions. This includes purchase and all associated costs (for example, delivery, installation, commissioning), operating costs (including energy, spare/replacement parts and maintenance) and end of life costs (for example, removal and disposal). A LCC approach is important for GPP as it may help to procure products with a better environmental performance, whilst saving the purchasing authority money.

Using a life cycle cost approach can provide a number of benefits to public authorities including; visibility of all costs, analysis of costs relevant to different business functions and the ability use expenditure in different life cycle phases to draw up budgetary predictions.

Generally speaking, a more technically advanced window will have a greater purchasing cost, however the cost savings throughout its lifetime compared to an alternative product may be greater, and the balance between the two established in order to optimise payback.

A key parameter in assessing life cycle costs will be product lifetime. The product lifetime for windows and external doors will depend on a number of factors, for example local climate condition and proper maintenance. Consequently there are a range of estimated lifetimes for windows and external doors.

Clearly there is a balance to be had between the reduced energy costs as a result of the windows energy performance and the increase in product price, together with other costs such as maintenance that the Purchasing Authority will need to consider when making their purchasing decisions.

In order to obtain accurate outcomes from a LCC analysis, the inputs will need to be based on location and product specific information. The key parameters to consider are:

- The optimal performance of the window required in order to identify the correct products and product prices.
- Installation and maintenance costs – savings may be possible if a large number of windows are replaced at once or maintenance is dealt with as part of existing contracts.
- The actual expected lifetime of the products under consideration, taking into account factors that will affect lifetime estimates, such as climate, provision for proper maintenance,
- Current, location specific rates for gas, electricity and water.
- The efficiency and type of boiler used for the heating.
- The wider building perspective and other energy performance changes that may be implemented at the same time

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9.3 Revised Draft EU GPP Criteria for windows and external doors

The revised GPP criteria proposals for windows and external doors are presented below:

EU GPP criteria for windows and external doors	
Core criteria	**Comprehensive criteria**
SUBJECT MATTER	**SUBJECT MATTER**
Purchase of high thermal efficient and environmentally sound windows and external doors	
1. SELECTION CRITERION	**1. SELECTION CRITERION**
1. Exclusion of certain contractors Construction companies, which have repeatedly acted against environmental legislation and have been found guilty of grave professional misconduct as outlined in Articles 53 and 54 of Directive 2004/17/EC and Article 45 of Directive 2004/18/EC, will be excluded from the tendering procedure.	**1. Exclusion of certain contractors** Construction companies, which have repeatedly acted against environmental legislation and have been found guilty of grave professional misconduct as outlined in Articles 53 and 54 of Directive 2004/17/EC and Article 45 of Directive 2004/18/EC, will be excluded from the tendering procedure.
2. Experience and competency of contractors The bidder must provide [x] independent references for the installation of window and/or external doors to demonstrate their experience and competency. **Verification:** Provision of [x] independent references to the Purchasing Authority.	**2. Experience and competency of contractors** The bidder must provide [x] independent references for the installation of window and/or external doors to demonstrate their experience and competency. **Verification:** Provision of [x] independent references to the Purchasing Authority.
2. TECHNICAL SPECIFICATIONS	**2. TECHNICAL SPECIFICATIONS**
3a Minimum energy performance requirements of windows and external doors based on EPBD Cost Optimal methodology: The energy performance of windows/external doors shall be [x]% better than the minimum energy performance requirements set for the relevant building element following consideration of the cost optimal level calculated in accordance with Directive 2010/31/EU and Regulation (EU) No 244/2012. . **Verification:** The bidder shall provide technical information on relevant parameters i.e. those used for calculating the cost optimal level, to demonstrate that the energy performance requirement of the GPP criterion for the building element has been met.	**3a Minimum energy performance requirements of windows and external doors based on EPBD Cost Optimal methodology:** The energy performance of windows/external doors shall be [x]% better than the minimum energy performance requirements set for the relevant building element following consideration of the cost optimal level calculated in accordance with Directive 2010/31/EU and Regulation (EU) No 244/2012. **Verification:** The bidder shall provide technical information on relevant parameters i.e. those used for calculating the cost optimal level, to demonstrate that the energy performance requirement of the GPP criterion for the building element has been met.

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3b Minimum energy performance requirements of windows and external doors based on national energy balance label or national legislative requirements The thermal efficiency/energy performance of replacement windows shall be amongst the best performing in [*Name of country or region or location*], in accordance with the following criteria: a) [*If the Member State where the window is to be purchased has developed an energy balance rating scheme i.e. A-G*] The window or external door shall meet the energy performance rating of class [*X*] based on the applicable calculation method. OR: b) [*If no energy balance rating scheme exists*] The window shall demonstrate [*X*]% improvement on the value defined in [*insert relevant national legislation or standards*]: v. U-value vi. g-value vii. L50 value viii. Daylight transmittance The indicators are to be applied to the whole window, glazing and frame combined. **Verification:** a) Copy of the energy rating certificate for the window or external door from the appropriate scheme. b) Evidence of the relevant parameter value, calculated in accordance with the appropriate harmonised standard.	**3b Minimum energy performance requirements of windows and external doors based on national energy balance label or national legislative requirements** The thermal efficiency/energy performance of replacement windows shall be amongst the best performing in [*Name of country or region or location*], in accordance with the following criteria: a) [*If the Member State where the window is to be purchased has developed an energy balance rating scheme i.e. A-G*] The window or external door shall meet the energy performance rating of class [*X*] based on the applicable calculation method. OR: b) [*If no energy balance rating scheme exists*] The window shall demonstrate [*X*]% improvement on the value defined in [*insert relevant national legislation or standards*]: i. U-value ii. g-value iii. L50 value iv. Daylight transmittance The indicators are to be applied to the whole window, glazing and frame combined. **Verification:** a) Copy of the energy rating certificate for the window or external door from the appropriate scheme. b) Evidence of the relevant parameter value, calculated in accordance with the appropriate harmonised standard.
4. Timber Timber used shall come from legal sources. **Verification:** a) The legal origin of timber can be demonstrated with a chain-of-custody tracing system being in place such as FSC*, PEFC** or any other equivalent means of proof will also be accepted as proof of compliance. b) If timber stems from a country that has signed a Voluntary Partnership Agreement (VPA) with the EU, the FLEGT license may serve as proof of legality. c) Other means of proof that will be accepted includes a relevant and valid CITES certificate or other equivalent and verifiable means such as the application of a "due diligence" system. d) For the non-certified virgin material bidders shall indicate the types (species), quantities and origins of the timber, together with a declaration of their legality. As such the timber shall be able to be traced throughout the whole production chain from the forest to the product.	**4.Timber** Timber used shall come from legal sources. **Verification:** a) The legal origin of timber can be demonstrated with a chain-of-custody tracing system being in place such as FSC*, PEFC** or any other equivalent means of proof will also be accepted as proof of compliance. b) If timber stems from a country that has signed a Voluntary Partnership Agreement (VPA) with the EU, the FLEGT license may serve as proof of legality. c) Other means of proof that will be accepted includes a relevant and valid CITES certificate or other equivalent and verifiable means such as the application of a "due diligence" system. d) For the non-certified virgin material bidders shall indicate the types (species), quantities and origins of the timber, together with a declaration of their legality. As such the timber shall be able to be traced throughout the whole production chain from the forest to the product.

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* FSC (Forest Stewardship Council): http://www.fsc.org/en ** PEFC http://www.pefc.org/internet/html *** FLEGThttp://ec.europa.eu/environment/forests/flegt.htm **After 3rd March 2013 it will be regulated through Regulation (EU) No 995/2010.**	* FSC (Forest Stewardship Council): http://www.fsc.org/en ** PEFC http://www.pefc.org/internet/html *** FLEGThttp://ec.europa.eu/environment/forests/flegt.htm **After 3rd March 2013 it will be regulated through Regulation (EU) No 995/2010.**
5. Responsible sourcing of wood and wood-based materials At least [X]% of the final product made of wood and wood-based materials shall be responsibly sourced. **Verification:** Certification schemes such as FSC, PEFC, or any equivalent means of proof (accepted by the respective competent body).	**5. Responsible sourcing of wood and wood-based materials** At least [X]% of the final product made of wood and wood-based materials shall be responsibly sourced. **Verification:** Certification schemes such as FSC, PEFC, or any equivalent means of proof (accepted by the respective competent body).
6. Global warming potential of filler gases Filler gases that contribute to the greenhouse effect, with a Global Warming Potential (GWP) > 5 over a period of 100 years, may not be used in the insulating units. **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.	**6. Global warming potential of filler gases** Filler gases that contribute to the greenhouse effect, with a Global Warming Potential (GWP) > 5 over a period of 100 years, may not be used in the insulating units. **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.
7. PVC Production The bidder shall demonstrate that the production of PVC complies with best practice in accordance with VinylPlus or equivalent. **Verification:** Participation with VinylPlus will be acceptable, otherwise the bidder must provide written evidence that the VinylPlus* recommendations, or equivalent, are complied with. *VinylPlus: http://www.vinylplus.eu/	**7. PVC Production** The bidder shall demonstrate that the production of PVC complies with best practice in accordance with VinylPlus or equivalent. **Verification:** Participation with VinylPlus will be acceptable, otherwise the bidder must provide written evidence that the VinylPlus* recommendations, or equivalent, are complied with. *VinylPlus: http://www.vinylplus.eu/
8. Hazardous Substances The final window or external door product will not release any substances or preparations under normal conditions that are classified according to Directive 1999/45/EC and 67/548/CEE with the R-phrases specified below: • Dangerous for the environment; R50, R50/53, R51/53 • Carcinogenic; R45, R49, R40 • Mutagenic; R46, R68 • Toxic for reproduction; R60, R61, R62, R63	**8. Hazardous Substances** The final window or external door product will not release any substances or preparations under normal conditions that are classified according to Directive 1999/45/EC and 67/548/CEE with the R-phrases specified below: • Dangerous for the environment; R50, R50/53, R51/53 • Carcinogenic; R45, R49, R40 • Mutagenic; R46, R68 • Toxic for reproduction; R60, R61, R62, R63

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• Very toxic; R26, R27, R28, R29 • Toxic; R23, R24, R35, R39, R48 • Harmful; R22, R48, R68 The final window or external door products will not release any substance or preparations under normal conditions that are classified, in accordance with Regulation (EC) No 1272/2008 as the H-phrases listed below: - Dangerous for the environment; Ecotoxicity Acute Category 1 H400, Ecotoxicity Chronic Category 1 H410, Ecotoxicity Chronic Category 2 H411 - Carcinogenic; Carcinogenicity Category 1A H350, Carcinogenicity Category 1B H350, Carcinogenicity Category 2 H351 - Mutagenic; Germ Cell Mutagenicity Category 1A H340, Germ Cell Mutagenicity Category 1B H340, Germ cell Mutagenicity Category 2 H341 - Toxic for reproduction; Reproductive Toxicity Category 1A H360, Reproductive Toxicity Category 1B H360, Reproductive Toxicity Category 1A H361 - Very toxic; Acute Toxicity Category 1 H330, Acute Toxicity Category 2 H330, Acute Toxicity Category 1 H310, Acute Toxicity Category 2 H310, Acute Toxicity Category 1 H300, Acute Toxicity Category 2 H300, Specific Target Organ Toxicity after Repeated Exposure Category 1 H370 - Toxic; Acute Toxicity Category 3 H331, Acute Toxicity Category 3 H311, Acute Toxicity Category 3 H301, Specific Target Organ Toxicity after Repeated Exposure Category 1 H371, Specific Target Organ Toxicity after Repeated Exposure Category 1 H372 - Harmful; Acute Toxicity Category 4 H302, Specific Target Organ Toxicity after Repeated Exposure Category 2 H373, Specific Target Organ Toxicity after Repeated Exposure Category 3 H335 **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.	• Very toxic; R26, R27, R28, R29 • Toxic; R23, R24, R35, R39, R48 • Harmful; R22, R48, R68 The final window or external door products will not release any substance or preparations under normal conditions that are classified, in accordance with Regulation (EC) No 1272/2008 as the H-phrases listed below: - Dangerous for the environment; Ecotoxicity Acute Category 1 H400, Ecotoxicity Chronic Category 1 H410, Ecotoxicity Chronic Category 2 H411 - Carcinogenic; Carcinogenicity Category 1A H350, Carcinogenicity Category 1B H350, Carcinogenicity Category 2 H351 - Mutagenic; Germ Cell Mutagenicity Category 1A H340, Germ Cell Mutagenicity Category 1B H340, Germ cell Mutagenicity Category 2 H341 - Toxic for reproduction; Reproductive Toxicity Category 1A H360, Reproductive Toxicity Category 1B H360, Reproductive Toxicity Category 1A H361 - Very toxic; Acute Toxicity Category 1 H330, Acute Toxicity Category 2 H330, Acute Toxicity Category 1 H310, Acute Toxicity Category 2 H310, Acute Toxicity Category 1 H300, Acute Toxicity Category 2 H300, Specific Target Organ Toxicity after Repeated Exposure Category 1 H370 - Toxic; Acute Toxicity Category 3 H331, Acute Toxicity Category 3 H311, Acute Toxicity Category 3 H301, Specific Target Organ Toxicity after Repeated Exposure Category 1 H371, Specific Target Organ Toxicity after Repeated Exposure Category 1 H372 - Harmful; Acute Toxicity Category 4 H302, Specific Target Organ Toxicity after Repeated Exposure Category 2 H373, Specific Target Organ Toxicity after Repeated Exposure Category 3 H335 **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.
Lead (R23, R25 and H301, H331) and its compounds must not intentionally be added to the plastics and coatings used in windows and external doors. **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.	Lead (R23, R25 and H301, H331) and its compounds must not intentionally be added to the plastics and coatings used in windows and external doors. **Verification:** Products holding a relevant Type I label or Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.

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3. Award criteria	
	9. Recycled Content **9a. Frame Materials:** Additional points will be awarded in proportion to the recycled content of materials used for the window or external door (excluding glazing). This excludes process waste. **9b. Glazing:** Additional points will be awarded in proportion to the recycled content of glazing used for the window or external door **Verification:** Products holding a relevant Type I label or a Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.
4. Contract performance clauses	
10. Maintenance Information The bidder must ensure maintenance recommendations are provided with the product. **Verification:** Products holding a relevant Type I label or a Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.	**10. Maintenance Information** The bidder must ensure maintenance recommendations are provided with the product. **Verification:** Products holding a relevant Type I label or a Type III EPD (in accordance with EN 15804) fulfilling the listed criteria will be deemed to comply. Other appropriate means of proof will also be accepted.
	11. Post Consumer Waste Management: The bidder must demonstrate that the contractor for retro-fitting or refurbishing window installations has in place effective policies and procedures to ensure that post-consumer waste (i.e. the removed windows) is properly dealt with in a sustainable manner, such as recycling or diverting from landfill where possible. **Verification:** Possible means of proof include EMAS and ISO 14001 certificates or equivalent certificates issued by bodies conforming to Community law or the relevant European or international standards concerning certification based on environmental management standards. Other appropriate means of proof will also be accepted.

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Explanatory Notes for the selection criteria:

1. Experience of the installers

The number of references required is at the discretion of the Purchasing Authority, and may be influenced by factors such as contract value and timescales.. Typically the number of references required could be 2 to 5 depending on requirements.

Explanatory Notes for the technical specifications:

3a. Energy performance criterion

The minimum energy performance requirement chosen should be for the reference building type that most accurately reflects the building in which windows/external doors will be replaced. For example, the correct type of residential or non-residential building.

The percentage improvement stipulated for:

- the core criterion should be sufficient to ensure that energy performance required by the criterion **meets the cost optimal level**. This should be **a maximum of 15%**. Where the minimum energy performance requirements already go beyond the cost optimal level this should be used for the core criteria. The percentage of improvement will depend on the ambition of the minimum energy performance requirements set following the outcome of the cost optimal methodology calculations.

- the comprehensive criterion should be sufficient to ensure that energy performance required by the criterion **goes beyond the cost optimal level**. Where the minimum energy performance requirements are already beyond the cost optimal requirements the Purchasing Authority should consider an appropriate percentage improvement based on the performance of the relevant building element available on the market.

3b. Energy performance criterion: To be used instead of criterion 3a when Member States have not completed their cost optimal calculations in accordance with Directive 2010/31/EU and Regulation (EU) No 244/2012) or the calculations do not include the relevant product e.g. external doors.

If the Member State where the window is to be purchased has no relevant national regulations or standards available, the procurement professional should look to national regulations from other, appropriate, countries in Europe.

The energy balance rating scheme performance for

- the *core criteria* should specify one of the highest classes
- the *comprehensive criteria* should specify the highest class available

or:

The percentage improvement on national requirements *to insert in the criterion (ambition level) will depend on the ambition level defined in national legislation or standards. It is recommended that the percentage improvement inserted is based on the consideration of the national requirements in relation to the market availability. The level of improvement should be defined according to local requirements and take into account the key considerations identified below.*

Key Considerations / checklist of the most important issues to be regarded:

There are a number of key considerations that should be taken into account when choosing a replacement window/external door, which will be specific to the building and its location. These are summarised below for reference:

a) The *importance of the climate* i.e. heating and cooling seasons should be considered. This will affect the ideal configuration of the window. In heating dominated climates (i.e. colder climates), *a better U-value is important to minimise the energy losses* through the window. In cooling dominated climates (i.e. hotter climates) *a better g value is important to minimise the energy gains through the window*, and therefore increase the cooling energy

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demands. In reality the ideal window/door configuration will be a balance between the two, highlighting the advantage of an energy balance or whole building approach.

b) The level of *solar gain will also be affected by the orientation of the window/door to be replaced*, for example north or south facing. Any shading devices (solar shading) installed in the building should also be taken into consideration, as these will also affect the potential level of solar gain and therefore the window specification required.

c) The *overall energy performance of the building should be considered where possible*, to ensure that the window/door installed will offer optimised performance. This may be *affected by the type, age, use and heating/cooling regime of the building*. For example installing windows with a high energy performance may not result in maximum potential savings if other elements of the building are poor in relation to overall energy performance.

d) The *energy performance of the window may differ depending on its size*. It is therefore important to ensure the U and g values considered are in relation to the size of the window required as part of the refurbishment.

e) In windows with a gas fill e.g. double or triple glazed windows the cost of different fill gases should be considered in relation to the level of improvement provided for the building in which it will be installed.

f) The light transmittance of the window should be considered, to ensure this is not reduced beyond acceptable levels, and the window can still fulfil one of its primary functions, of allowing day light into the building.

g) In addition, there are *often other practical issues that need to be considered when purchasing a window*, which the Purchasing Authority will need to balance alongside the GPP criteria requirements. This includes for example, acoustics, fire protection, burglar resistance, accessibility and the architectural design of the building.

4. Timber

The FLEGT (Forest Law Enforcement Governance and Trade) action plan was adopted by the EU in 2003. The Action Plan outlines a series of measures to address illegal logging in developing countries. The Plan defines a timber licensing system to guarantee the legality of imported wood products. In order to obtain the license, Voluntary Partnership Agreements (VPAs) have to be signed between timber-producing countries and the EU. Timber products, which have been legally produced in VPA partner countries, will be licensed for the legality of production; more information at: http://ec.europa.eu/environment/forests/flegt.htm

5. Responsible sourcing of wood and wood-based materials

The percentage of wood and wood-based materials that should be certified depends on the market conditions of the Member State where the window is to be installed. The percentage of wood and wood-based materials to be certified is usually in the range of:

- *core criteria:* A minimum requirement of 60-70% in weight of the wood and wood-based certified materials can be used
- *comprehensive criteria:* A minimum requirement of 70-80% in weight of the wood and wood-based certified materials can be used

9. Hazardous Substances

Regulation (EC) No 1272/2008 amending and repealing Directive 67/548/EEC and 1999/45/EEC, and amending Regulation (EC) No 1907/2066 provides guidelines on the translation between the H- and R- phrases.

Legislative requirements restricting the use of substances and/or preparations within window and external doors must continue to be met e.g. REACH, CLP and the Construction Product Regulation (CPR)[127]

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[127] See Section 8 for a summary of relevant legislation.

Explanatory Notes for the award criteria:

9 Recycled Content

9a - Frame Materials: The use of recycled material should not adversely affect the quality, durability, performance and safety of the product.

9b - Glazing: The recycled content of the glazing component of the window or external door should not be more than 20% to ensure quality, durability; performance and safety are not adversely affected.

For the purposes of these GPP criteria, process waste is material reclaimed within the process it was generated. For example, arising from the production processes of the different materials used in the manufacturing of windows and doors.

Explanatory Notes for the Contract performance clauses:

12. Maintenance Information

Depending on the window type and frame material, maintenance information may include details on how often the finish should be checked and re-applied, and which surface treatment is recommended. For materials that do not require finishes to be applied other information may be of use, for example the type of cleaner used e.g. non-abrasive, the removal of grit/dirt, tightening of screws/fixings and lubrication of moving parts as appropriate.

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10 Conclusions and Next Steps

The existing scope and criteria for the EU GPP specifications for windows and doors have been reviewed in light of the technical analysis undertaken as part of this study, the feedback received at the first stakeholder meeting and additional written feedback submitted by stakeholders.

In terms of the **scope**, the **key change is the focus on the replacement window and external door market, with the exclusion of new buildings/major renovations**. The main change in the draft revised criteria relates to the **energy performance criterion**, **with the proposed change being very different from the existing criterion to bring GPP in line with other policy**.

The draft revised GPP criteria for windows and external doors should be discussed further with stakeholders at the second stakeholder meeting planned for autumn 2012. In particular the key points for future discussion are:

- **Proposed EPBD cost optimal approach**:
    - Feedback on the practicalities of the approach;
    - Have Member States published/submitted their calculations?
    - Feedback on the proposed verification, are there other options?
    - Have doors been included in Member States cost optimal calculations. If not, should doors remain within scope?
- **Feedback on the other changes proposed**.
    - Are the proposed changes appropriate?
    - Should other changes be made, or other types of criteria included?

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Appendix 1 – Improvement Potential Calculations: Windows

				Energy Balance - kWh/m2		Savings per m2 (kWh/m2)			Energy Saving Potential (kwh/m2)			
Zone	Scenario	U value	g value	Cooling Season	Heating Season	Cooling Season	Heating Season	Window Area (m2)	Cooling	Heating	Total	Gwh
Zone 1 (Northern Europe)	Baseline	2.19	0.69	13.78	-48.96			1,150,799,923.28			-	
	Scenario 1 (Typical)	1.00	0.46	9.20	8.52	4.58	57.48	1,150,799,923.28	5,270,663,648.62	66,150,898,045.26	71,421,561,693.88	71,421.56
	Scenario 2 (Typical)	1.40	0.46	9.20	-27.08	4.58	21.88	1,150,799,923.28	5,270,663,648.62	25,182,420,776.50	30,453,084,425.12	30,453.08
	Scenario 3 (Best)	0.90	0.34	6.80	-8.02	6.98	40.94	1,150,799,923.28	8,032,583,464.49	47,116,667,314.21	55,149,250,778.71	55,149.25
Zone 2 (Central)	Baseline	2.93	0.75	24.11	-43.88			577,200,076.72			-	-
	Scenario 1 (Typical)	1.65	0.45	14.55	-17.70	9.56	26.18	577,200,076.72	5,518,032,733.45	15,112,286,300.10	20,630,319,033.55	20,630.32
	Scenario 2 (Best)	0.90	0.34	11.34	14.36	12.77	58.24	577,200,076.72	7,370,844,979.72	33,617,320,759.75	40,988,165,739.47	40,988.17
Zone 3 (Southern Europe)	Baseline	3.85	0.80	88.30	64.57			527,380,867.06			-	-
	Scenario 1 (Typical)	3.5	0.56	60.20	16.24	28.10	-48.33	527,380,867.06	14,819,402,364.52	- 25,488,676,601.52	- 10,669,274,237.00	- 10,669.27
	Scenario 2 (Best)	1.95	0.37	40.50	23.78	47.80	-40.79	527,380,867.06	25,208,805,445.69	- 21,512,224,863.85	3,696,580,581.84	3,696.58

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Appendix 2 – Improvement Potential Calculations: Social Housing Windows

				Energy Balance - kWh/m2		Savings per m2 (kWh/m2)			Energy Saving Potential (kwh/m2)			Gwh
Zone	Scenario	U value	g value	Cooling Season	Heating Season	Cooling Season	Heating Season	Social Housing - Window Area (m2)	Cooling	Heating	Total	Total
Zone 1 (Northern Europe)	Baseline	2.19	0.69	13.78	-48.96							
	Scenario 1 (Typical)	1.00	0.46	9.20	8.52	4.58	57.48	133458658	611,240,654	7,671,542,119	8,282,782,773	8,283
	Scenario 2 (Typical)	1.40	0.46	9.20	-27.08	4.58	21.88	133458658	611,240,654	2,920,413,892	3,531,654,546	3,532
	Scenario 3 (Best)	0.90	0.34	6.80	-8.02	6.98	40.94	133458658	931,541,433	5,464,135,915	6,395,677,348	6,396
Zone 2 (Central)	Baseline	2.93	0.75	24.11	-43.88							
	Scenario 1 (Typical)	1.65	0.45	14.55	-17.70	9.56	26.18	69249708	662,027,206	1,813,099,913	2,475,127,119	2,475
	Scenario 2 (Best)	0.90	0.34	11.34	14.36	12.77	58.24	69249708	884,318,767	4,033,245,542	4,917,564,310	4,918
Zone 3 (Southern Europe)	Baseline	3.85	0.80	88.30	64.57							
	Scenario 1 (Typical)	3.50	0.56	60.20	16.24	28.10	-48.33	27843120	782,391,686	-1,345,676,982	-563,285,297	-563
	Scenario 2 (Best)	1.95	0.37	40.50	23.78	47.80	-40.79	27843120	1,330,901,159	-1,135,739,854	195,161,306	195

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