Development of EU Ecolabel and GPP Criteria for Heating and Cooling Systems

Draft Preliminary Study Task 1
Product Group Definition

Elena Rodriguez Vieitez & Oliver Wolf

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Executive summary

The overall objective of this research activity is to contribute to the development of EU Ecolabel and GPP criteria for "heating and cooling systems, in residential, commercial and industrial buildings. Energy consumption in buildings accounts for around 40% of the total primary energy consumption in the EU-27 (of about 76 700 PJ per year in 2005). A large fraction of the primary energy consumed in buildings is used for heating and cooling functions: for residential buildings, this fraction is 60-70%; when considering all kinds of buildings, on average this fraction is around 50-60%. This means that 20-30% of the total primary energy consumption in the EU-27 is used in the heating and cooling of buildings, that is, roughly 20 000 PJ per year. This quantity is approximately equal in absolute terms to the total energy used for transport in the EU.

The implementation of the newly revised EU ecolabel Regulation for heating and cooling systems, which refers to the 10-20% best-performing products of a given product group, is expected to result in a significant potential for positive environmental impact, with presumably limited costs and efforts. However, up to today, the only heating/cooling system for which Ecolabel criteria have been developed are "heat pumps". There are however ongoing studies under GPP on four types of heating and cooling systems (central-heating boilers, room air conditioners and heat pumps, and combined heat and power units), as well as many Ecodesign preparatory studies, Energy Label, Nordic Swan, and Blue Angel. In addition to these product policy schemes, a number of pieces of EU legislation are relevant for heating and cooling systems, in particular: the Boiler Directive (92/42/EEC), the Energy Performance of Buildings Directive, or EPBD (2002/91/EC), the Cogeneration Directive (2004/8/EC), and the Energy Efficiency Directive (2006/32/EC), among others.

The EU Ecolabel follows the mission and guidelines of the broader Integrated Product Policy (IPP) in Europe, where sustainable consumption policy measures should be developed to first address the consumption of products with the greatest overall life-cycle environmental impact in Europe, and therefore those products for which sustainable consumption policies have the potential to achieve a greatest impact.

In developing Ecolabel criteria, the following environmental impacts are considered: energy use, greenhouse gas (GHG) emissions, environmental and health impacts of air and water pollution, eutrophication/acidification, rare or precious resource use, biodiversity, and toxicity, not excluding other future environmental impact categories. For energy-using and energy-related products (EuP/ErP), such as for heating and cooling systems, the environmental impact is usually dominated by the energy consumed during use phase, and climate-change emissions (CO_2 and other gases) – which are as well directly related to the energy consumed during the use phase of the products.

Ecolabel criteria should be developed taking into account Annex I of the EU Ecolabel regulation (Regulation EC 66/2010). The criteria shall be based on the best products available on the Community market in terms of environmental performance throughout the life cycle (10-20% of the products, to be discussed) but allowing the necessary flexibility in the exact percentage for promoting the most environmental friendly products and, at the same time, ensuring that consumers are provided with the sufficient choice. Criteria shall take into consideration the net environmental balance between the environmental benefits and burdens and be based on the most significant environmental impacts depending on the heating/cooling systems classification. The criteria shall be expressed as far as possible via technical key environmental performance indicators.

This task 1 report aims at defining the scope of the product group "heating and cooling systems".

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List of Abbreviations

CH	**Central Heating**
CHP	**Combined Heat and Power**
EUEB	**European Union Ecolabel Board**
EPBD	**Energy Performance of Buildings Directive**
ErP	**Energy-related Products**
EuP	**Energy-using Products**
GHG	**Greenhouse Gas**
GPP	**Green Public Procurement**
HFC	**Hydrofluorocarbon**
MEEUP	**Methodology study Eco-design of Energy-Using Products**
PRODCOM	**PRODucts of the European COMmunity databse**
WuP	**Water-using Products**

1 Preface

This report is part of the study on the development of Ecolabel criteria for "heating and cooling" systems in buildings. Buildings can be residential, commercial or industrial.

Buildings account for significant environmental impacts. Around 40% of the total primary energy consumption in the EU-27 (of around 76 700 PJ per year in 2005) takes place in buildings. A large fraction of the primary energy consumed in buildings is used for heating and cooling functions: for residential buildings, this fraction is 60-70%; when considering all kinds of buildings, on average this fraction is around 50-60%.

This means that 20-30% of the total primary energy consumption in the EU-27 is used in the heating and cooling of buildings, that is, roughly 20 000 PJ per year. This quantity is approximately equal in absolute terms to the total energy used for transport in the EU.

Ecodesign preparatory studies of heating and cooling systems have provided evidence that their main environmental impact derives from **energy consumption during the use phase**, also directly related to their **greenhouse gas emissions**.

For all these reasons, the heating and cooling product group has been identified as a high priority for the development of new Ecolabel criteria. The implementation of new Ecolabels, which are awarded to the 10-15% best-performing products of a given product group, is expected to result in a significant potential for positive environmental impact, with presumably limited costs and efforts. However, up to today, the only heating and cooling systems for which Ecolabel criteria have been developed are "heat pumps", and their criteria will expire at the end of 2010.

There are however some ongoing studies under Green Public Procurement (GPP) on three types of heating and cooling systems, many Ecodesign studies, Ecolabel criteria, Energy Star, and several other state labels' criteria.

While ecolabel programs focus on individual heating and cooling products, one of the main goals of the label is to contribute to energy-saving measures in the heating and cooling of buildings (since the use of energy is the main source of environmental impact for energy-using products). That is, aside from installing the best environmentally-performing products, the way these products are used and installed plays a role in how much energy can be saved. According to a recently published book on sustainable energy (MacKay, 2009), there are three practical approaches for saving energy in heating and cooling buildings: reducing the temperature difference between the indoors and the outdoors of a building (by using thermostats), reducing the leakiness of heating or cooling from a building (for example by improving the insulation materials of the building), and the third one is to increase the energy efficiency of the heating and cooling products. The Ecolabel can mainly play a role in the energy efficiency part, and can also include recommendations regarding the best way in which to installing the products, taking into account the mentioned factors such as the indoor-outdoor temperature interval, and the leakiness of the building, but also recommending to what type of geographical area, or type/size of building the product is most recommended for. In addition to energy efficiency, Ecolabel also takes into account broader environmental impact measures, such as pollution due to air emissions, the control of toxic materials in the products, or the recyclability of materials.

One of the main motivations of this study is to investigate ways that will result in a greater harmonization between the different mandatory and voluntary programs related to the environmental performance of products, in particular: Ecodesign, Ecolabel, GPP, and other programmes. A greater harmonization between the Ecolabel and other schemes and Commission regulations is mentioned for example in the Impact

Assessment of the revised Community Ecolabel Award Scheme[1]. This impact assessment recommends, among others, to "design regulation to better fit into the other sustainable production and consumption actions of the Commission".

As a first step (Chapter 2), this paper aims to achieve an accurate and comprehensive product group definition, providing a categorization of products into central and space systems.

Chapter 3 presents a review of the applicable EU legislation, including a list of existing Ecodesign preparatory studies. Chapter 4, the central part of this paper, presents an overview of the individual heating and cooling systems as addressed by different product policy schemes, a list of criteria used in studies of prioritization of products, and a detailed product-by-product description of their market and environmental impact using relevant data extracted from the literature. Chapter 5 introduces some thinking with the aim of generating discussion on creating a single benchmark common to all heating and cooling products, towards the development of an "umbrella" set of Ecolabel criteria for the "heating and cooling systems product group", which would not depend on the specific heating and cooling technology. Chapter 6 is a summary.

2 EU Ecolabel of heating and cooling systems: product group scope and definition

The European Union Ecolabel program is an environmental policy initiative that gives producers the opportunity, on a voluntary basis, to apply for an award that distinguishes the 10-15% top environmental-performing products within a given defined category. Aside from the EU, there are other ecolabel voluntary programs, such as: the Nordic Swan, the German Blue Angel, the Austrian Ecolabel, and the Japanese Ecomark (all of them of a voluntary character). There are also other two relevant labels which mainly consider energy efficiency performance in the award of the criteria: the voluntary Energy Star (originally from the US but adopted also by the EU), and the mandatory EU Energy Label.

The voluntary labels (all of the above except for the Energy Label) are considered "instruments of self-regulation". According to the academic literature, self-regulation has been a developing new trend since the 1980s, as an alternative to governmental command-and control approaches. A significant amount of research has been devoted to studies on the effectiveness of these types of self-regulatory product-policy instrument (Houe and Grabot, 2009; Galarraga Gallastegui, 2002; Hale, 1996; Goggin, 1994; Clift, 1993). The literature points out at some disadvantages of the self-regulatory schemes, which in some instances have been claimed to be more responsive to demands and interests of certain sectors of the industry, and less to what the public demands.

Ecolabels constitute a market-based technique that is used to communicate to consumers information about their demand for products that respect the environment. They are therefore based on the willingness of consumers to choose those products among other less environmentally-friendly alternatives.

It is also important to put Ecolabels in the wider context. Aside from Ecolabels, there are many other policy initiatives that governments undertake in order to protect the environment. Alternatives are: mandatory requirements on minimum environmental performance of products (the most relevant of which is Ecodesign), and a range of EU Directives aimed at promoting and providing incentives for example for the increased use of renewable energy sources in general, the use of renewable energy and increased energy

[1] Revision of the Ecolabel scheme draft document:
http://ec.europa.eu/environment/ecolabel/about_ecolabel/pdf/ep_proposal.pdf
Impact assessment of the revision of the Ecolabel scheme, draft document:
http://ec.europa.eu/environment/ecolabel/about_ecolabel/revisions/ecolabel_ia.pdf

efficiency in buildings (promoted by the Energy Performance of Buildings Directive), the promotion of cogeneration in buildings (promoted by the Cogeneration Directive), etc.

Product group scope and definition

A product group is defined in the revised EU Ecolabel Regulation[2] (Article 3) as: "any set of goods or services that serve similar purposes and are similar in terms of use, or have similar functional properties, and are similar in terms of use and consumer perception". The initiative for selecting a product group for the development of Ecolabel criteria is taken by the Commission in conjunction with the European Union Ecolabel Board (EUEB). A feasibility and market study is carried out to collect data on the following aspects: the market structure and the various types of product groups on the EU market, the opinions of all interested parties, the key environmental impacts and key elements relating to the product's fitness for use, an inventory of eco-labels, standards, test methods and studies. Consumer perception, functional differences between types of products and the need for identifying sub groups are also assessed.

In developing Ecolabel criteria, the following environmental impacts are considered: energy use, greenhouse gas (GHG) emissions, environmental and health impacts of air and water pollution, eutrophication/acidification, rare or precious resource use, biodiversity, and toxicity, not excluding other future environmental impact categories.

For energy-using products (EuP), the environmental impact is usually dominated by the energy consumed during use phase, and climate-change emissions (CO_2 and other gases) – which are as well directly related to the energy consumed during the use phase of the products.

Heating and cooling systems is a product group composed of those systems (or their components) that contribute to the maintenance of an optimum ambient indoor temperature in buildings (or parts of buildings). These are appliances that generate and/or transfer heat or cooling. Buildings could be residential, commercial, or industrial. The most common method of heat generation in buildings today involves the combustion of fossil fuel in a furnace or boiler.

Rationale for the classification of heating and cooling systems:

This study categorizes heating and cooling systems in two broad groups, according to how the heat is generated and/or distributed:

- **Central heating/cooling systems (centralized):** A central heating system is designed to provide heat to all the interior of a building (or a multi-room part of it). What makes the system to be called central is that the heat is generated in one point and then transferred to the rooms that need to be heated by means of a heat distribution system.
- **Space heating/cooling system (decentralized):** A space heating system provides heat to one or a few rooms. What defines a space heating system is that the heat is delivered at the same place where it is generated, without the need of a heat distribution system.

For the case of central heating/cooling systems, these products perform only a part in a series of steps of the heating/cooling process, and they can be classified by the part of the heating/cooling function that they perform:

- The generation of heating/cooling itself
- The distribution of heating/cooling → examples: circulators, motors, pumps

[2] The text of the new Ecolabel regulation (2010) can be downloaded from: http://ec.europa.eu/environment/ecolabel/about_ecolabel/documents_en.htm

- By forced-air through ductwork
- By water circulating through pipes
- By steam fed through pipes

Different heating and cooling systems employ different physical media to receive the heating/cooling:

- Heating water
- Cooling water
- Heating the indoor ambient air of the room or building
- Cooling the indoor ambient air of the room or building
- Combinations of the above

Heating and cooling systems employ a variety of sources of energy

- Natural gas (fossil)
- Liquid fuel (fossil)
- Liquid fuel (biofuel)
- Electricity
- Solid fuel (fossil)
- Solid fuel (biomass)

In this study we broadly classify heating and cooling systems into central and space (decentralized) systems, and a list of the individual products that are addressed in this report is summarized below:

CENTRAL HEATING AND COOLING SYSTEMS

Central heating and cooling systems can be divided into two categories: (1) generation of heating/cooling, and (2) distribution of heating/cooling

(1) Generation of heating/cooling: (provide info on what medium gets heated, what is the fuel):

- Central heating boilers (CH boilers)
- Water heaters
- Central heating combis (CH combis)
- Central air conditioning and ventilation
- Combined heat and power units

(2) Distribution of heating/cooling:

- Circulators in buildings

SPACE HEATING AND COOLING SYSTEMS

- Heat pumps
- Room air conditioners
- Local mechanical ventilation
- Solid fuel small combustion installations

3 Relevant legislation for heating and cooling systems

This section provides an overview of the existing legislation related to heating and cooling systems, and introduces definitions of key terms that will be used in this paper. Some of the pieces of legislation refer to mandatory and others to voluntary practices.

The ISO (International Organization for Standarization) has attempted to standardise the principles, practices and key characteristics relating to three major voluntary environmental labelling types:

- Type 1 environmental labelling: A voluntary, multiple-criteria-based, third-party program that awards a license. Most eco-label schemes are Type 1.
- Type 2: Self-declaration claims.
- Type 3: Environmental declarations.

European environmental legislation has addressed: energy-using products (EuP), energy-related products (ErP), and water-using products (WuP). Heating and cooling products belong to one or more of those three categories of products.

- Energy-using products (EuP): "Energy-using products (EuP) are those which are dependent on energy input (electricity, fossil fuels, and renewable energy sources), or which generate, transfer and measure such energy".
- Energy-related products (ErP): While not necessarily depending on energy input, their use results in the indirect consumption of energy.
- Water-using products (WuP): Those products that "use water in order to fulfil their intended function".

The following is a summary of environmental legislation related to product policy that is relevant for heating and cooling systems, at the EU level but also at some individual member states, the US, and other countries. In particular, the EU has established partnerships with: the US, China, Japan, Thailand, and Taiwan.

Table 1 summarizes some of the most important mandatory and voluntary policy instruments that are applicable to heating and cooling products in the EU.

Table 1. Policy instruments that are relevant for heating and cooling products in the EU.

	Mandatory	**Voluntary**
Labelling	Energy Label	EU Ecolabel Energy Star Nordic Swan Blue Angel
Policy instruments introducing minimum efficiency performance standards	Ecodesign Boiler Directive Energy Performance of Buildings Directive Cogeneration Directive Renewable Energy (RES) Directive	Self-regulation

Ecodesign

The Ecodesign scheme is a mandatory program that sets minimum environmental performance requirements needed for a product to be allowed to be sold on the market. The Ecodesign Directive (2005/32/EC) establishes requirements on energy performance and emissions, and one of its important missions is to do so while at the same time contributing to the improvement in the functioning of the internal market.

In accordance with Article 16 (1) of the Ecodesign Directive[3], the Commission has established a working plan setting out a list of energy-using product groups which will be considered as priorities for the adoption of implementing measures between 2009 and 2011[4]. The 2009-2011 Working Plan under the Ecodesign Directive (EC, 2008a) indentified a number of products as priorities (for a transitional period and beyond). A prior "Study for preparing the first working plan of the Ecodesign directive" (EPTA, 2007) was conducted in order to help identifying the priority products.

Among these priority products, some are related to heating and cooling systems, in particular: heating and water-heating equipment, electric motor systems, HVAC (heating/ventilating/air conditioning); electric and fossil-fuelled heating equipment. The products are used in the domestic, tertiary and industrial sectors. The criteria that are used for the prioritization analysis are:

(a) The product group represents a significant volume of sales and trade, i.e., more than 200 000 units sold per year within the Community.

(b) The product group has a significant environmental impact within the Community resulting from the energy-using products during their life cycle. In particular:

- High primary energy consumption[5] within the indentified product groups (indicatively > 1 000 PJ/year) and significant amounts of related emissions such as greenhouse gases, acidifying substances or heavy metals and waste generation. This gives a first indication of prioritization, in line with the screening indicator in the study.
- Long operating times (up to 24 hours a day). Predicted increase in energy consumption in the next decade due to a high-growth market.
- Use of water. Materials or components responsible for other resource consumption, waste generation or specific emissions, such as electronics, displays, refrigerants, oils, wastage in use or emissions of exhaust gases and micro-dust, etc.

(c) The product group presents a significant potential for improvement (> 20%) in terms of its environmental impact without entailing excessive costs. Improvement can be achieved by: reducing the weight or the volume of the product, using recycled materials, reducing emissions, extending the product's minimum guaranteed lifetime, or ensuring upgradeability, reparability, easy recycling, existing third-country specifications (such as the Minimum Energy Performance Standards in Japan (MEPS), or the Energy Star scheme in the US).

[3] Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005, establishing a framework for the setting of ecodesign requirements for energy-using products.

[4] These website contain links to the working plan and the Ecodesign preparatory studies:
http://ec.europa.eu/energy/efficiency/ecodesign/working_plan_en.htm,,
http://ec.europa.eu/enterprise/policies/sustainable-business/sustainable-product-policy/ecodesign/

[5] "Primary energy" means energy contained in fossil fuels and renewable energy sources that has not been subject to any conversion or transformation process. Primary energy is the source of all energy on earth and therefore the ultimate source of all useful work. All sources of primary energy are limited. For example only a finite amount of oil is available in the crust of the earth, and wind and solar energies are only available intermittently.
Primary energy consumption is given in PJ (peta Joules, 10^{15} Joules). The reference year was 2006. To convert electricity from the public grid (secondary energy) into primary energy, a factor of 10.5 MJ/kWh_e was applied

A number of energy-using products have been identified as priorities for Ecodesign by the European Climate Change Programme, a number of them related to heating and cooling: heating and water-heating equipment, electric motor systems, and HVAC (heating/ventilating/air conditioning) systems.

During the transitional period (2005-2008), 19 preparatory Ecodesign studies were conducted on a number of these priority products[6] (identified by the European Climate Change Programme). Out of these 19 groups, the following are related to the heating and cooling product group:

- **Boilers and combi-boilers** (gas/oil/electric): www.vhk.nl (DG-TREN LOT 1)
- **Water heaters**: www.vhk.nl (DG-TREN LOT 2)
- **Air conditioning and ventilation** (residential), http://www.ecoaircon.eu/ (DG-TREN LOT 10)
- **Electric motors (1-150 kW), water pumps, circulators in buildings, ventilation fans (non-residential),** http://www.ecomotors.org/, by AEA (DG-TREN LOT 11)
- **Solid fuel small combustion installation (or solid fuel boiler)**: BIO, http://www.ecosolidfuel.org/ (DG-TREN LOT 15)
- **Local room heating products (all decentralized direct-heating appliances),** BIO, http://www.ecoheater.org/lot20/ (DG-TREN LOT 20) (ONGOING). This product group (private communication) addresses heating appliances that use electricity, gaseous and liquid (oil) fuels. It does not include solid fuel combustion installations (DG-TREN LOT 15) or hydronic systems (DG-TREN Lot 1). Reversible air conditioners and heat pumps with a cooling capacity up to 12 kW (regardless of heating capacity) are covered in DG-TREN LOT 10.
- **Central heating products using hot air to distribute heat** (other than CHP): indirect heating appliances that use ductwork to distribute heat to several spaces in a building http://www.ecoheater.org/lot21/ (DG-TREN LOT 21) (ONGOING). This product group (private communication) addresses heating appliances that use electricity, gaseous and liquid (oil fuels). It does not include solid-fuelled appliances. It is still unclear whether heat pumps (and combined hybrid systems) will be included in Lot 21, but there could be (pending comments from the Commission regarding Task 1 of the studies). Combined heat and power units are however clearly out of the scope of the study.
- **Air-conditioning and ventilation,** http://www.ecohvac.eu/ (DG-ENTR Lot 6) (ONGOING). Lot 6 study covers air conditioning and ventilation systems, including systems used for ventilation only. The scope was already in the Working Plan under the Ecodesign Directive (COM 2008 660). The lot 6 study should investigate air conditioning and ventilation systems that are not already covered by previous EuP studies. The work already done in previous studies about a given product should not be duplicated, even if this product is not covered by an Ecodesign implementing measure yet. However, the tender may propose to update, complement or deepen the analysis done in previous studies about a given product, if the tenderer deems it is appropriate. Since this is an ongoing study, there is potential for synergy with Ecolabel: the work could be done in parallel for better coherence between Ecolabel and Ecodesign.

The EU Ecolabel

The EU Ecolabel scheme is part of the sustainable production and consumption policy of the Community, which aims at reducing the negative impact of production and consumption on the environment, health, climate, and on natural resources. The revised Ecolabel Regulation, published in early 2010 (EC, 2010), highlights the objective of achieving greater harmonization of the EU Ecolabel with other states' labels, as well as with GPP and Ecodesign.

The Ecolabel criteria should be simple to understand and to use, and should be based on scientific evidence, taking into consideration the latest technological developments. Those criteria should be market-oriented and **limited to the most significant environmental impacts of products during their full life cycle**.

[6] The list of preparatory studies can be found here: http://ec.europa.eu/energy/efficiency/studies/ecodesign_en.htm

The specific impacts that are important to consider are: impact on climate change, impact on nature and biodiversity, energy and resource consumption, generation of waste, emissions to all environmental media, pollution through physical effects, and use and release of hazardous substances. The potential to reduce environmental impacts due to durability and reusability of products shall be considered.

Ecolabel criteria for a product group shall take into account criteria established for other environmental labels, particularly officially recognised, nationally or regionally, EN ISO 14024 Type I labels, where they exist for that product group, so as to enhance synergies. In such cases, the shortened criteria development procedure laid down in Part B of Annex I may apply provided that the proposed criteria have been developed in line with Part A of Annex I.

Each product group has ecological and performance criteria, which are revised every 3 years to reflect technological advances. Criteria are developed by the European Ecolabel Board (EUEB) and the Commission.

Green public procurement (GPP)

The Communication on "Public procurement for a better environment"[7] lists ten priority sectors for GPP, which have already been addressed up until 2009. During 2010, work is being carried out at DG-ENV of the European Commission with preparatory studies for ten additional product groups.

These twenty product groups were selected on the basis of their potential for environmental improvement, reduction in public expenditure, potential impact on the supply side, example-setting for private or corporate consumers, political sensitivity, existence of relevant and easy-to-use criteria, market availability and economic efficiency. Among the first batch of ten product groups, the first four priority groups were: construction, food and catering services, transport and transport services, and energy (including electricity, and heating and cooling coming from renewable energy sources).

Three specific heating and cooling products are included among the second set of ten priority product groups for GPP: boilers, air conditioning and heat pumps, and cogeneration plants (CHP).

Energy label

The Energy Labelling Framework Directive 92/75/EEC was established with the goal of providing information about energy consumption of domestic appliances, in order to encourage consumers to buy more energy-efficient products, to create market transparency (and comparability for consumers of performance across technologies), and to provide incentives for innovation. The Energy Label is a 7-step graded system with A being the most and G the least energy efficient of the item among other products in the same group. With recent improvements in efficiency of certain products, some additional levels such as A+, A++ or A+++ have been introduced.

The mandatory Energy Labeling is usually applied to products that consume significant amounts of energy and show disparity in their energy efficiency. Minimum energy performance standards (MEPS) are usually based on life-cycle cost assumptions that take the learning capability and associated potential for cost reduction into account.

Individual Member State governments may then impose minimum energy efficiency standards in order for a certain appliance to be sold on the market.

[7] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, "Public procurement for a better environment", http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0400:FIN:EN:PDF

Energy Star

The Energy Star regulation is the Regulation (EC) No 106/2008 of the European Parliament and of the Council of 15 January 2008 on a Community energy-efficiency labelling programme for office equipment. While the Energy Star is a voluntary label, the Regulation makes use of the underlying requirements mandatory for central government authorities and Community Institutions in public procurement contracts falling within the scope of the Public Procurement Directives. Energy Star is widely used both in the US and in Europe, and it uses its own categorization of products, different than the product codes from Eurostat.

Nordic Swan

Nordic Swan is an environmental label that is widely used in Denmark, Norway, Iceland, Sweden and Finland, http://www.svanen.nu/Default.aspx?tabName=StartPage .

Blue Angel

The Blue Angel is the national environmental label in Germany, http://www.blauer-engel.de/en/index.php

The Boiler Directive, 92/42/EEC

The Council Directive 92/42/EEC of 21 May 1992 (EC, 1992b) on efficiency requirements for new hot-water boilers fired with liquid or gaseous fuels is also called the Boiler Directive. This Directive applies to "boilers", defined as hot-water boilers fired by liquid or gaseous fuels (not solid fuels) with a rated output between 4 kW and 400 kW. It refers to the combined boiler plus burner unit, designed to transmit to water the heat released from burning. The directive specifies minimum efficiency requirements, depending on boiler type, power and fuel.

Other definitions in the directive:

- Standard boiler: boiler for which the average water temperature can be restricted by design.
- Back-boiler: boiler designed to supply a central-heating system and to be installed in a fireplace recess as part of a backboiler/gas fire combination.
- Low-temperature boiler: a boiler which can work continuously with a water supply temperature of 35 to 40 °C, possibly producing condensation in certain circumstances, including condensing boilers using liquid fuel.
- Gas condensing boiler: boiler designed to condense permanently a large part of the water vapour contained in the combustion gases

The Energy Performance of Buildings Directive, EPBD (EC, 2002).

The Energy Performance of Buildings Directive, EPBD (2002/91/EC), was established to promote energy end-use efficiency in buildings. The transposition date was in January 2006 with a grace period until January 2009.

Through the EPBD Directive, Member States are obligated to apply minimum efficiency requirements in buildings, and develop energy auditing systems for all final consumers, leading to the award of a certification to the buildings meeting certain performance requirements. In order to achieve this, the directive predicted the adoption of a common methodology for calculating the energy performance of buildings, and the adoption of minimum standards on energy performance of both new and existing buildings.

Regarding heating and cooling systems, the EPBD Directive in particular establishes that there should be regular inspections of boilers, at least of those fired by non-renewable liquid or solid fuel with an effective rated output of 20 to 100 kW. Such inspection may also be applied to boilers using other fuels. The EPBD also sets guidelines on inspections of air-conditioning systems. In addition, the EPBD makes a specific

reference to heating and cooling systems for new buildings: "For new buildings with a total useful floor area over 1000 m^2, Member States shall ensure that the technical, environmental and economic feasibility of alternative systems such as: **decentralised energy supply systems based on renewable energy, CHP, district or block heating or cooling (if available), and heat pumps (under certain conditions),** is considered and is taken into account before construction starts.

The most recent action of the EU towards sustainable building is the proposal for Directive (COM/2008/0780 final—COD 2008/0223) of the European Parliament and of the Council of the energy performance of buildings (recast) (EC, 2008c). The aim of the recast of the EPBD is to extend the scope of the directive and make it more effective by clarifying certain provisions; requiring Member States to set up minimum energy performance requirements when a major renovation is to be carried out; reinforcing the provisions on energy performance certificates, inspections, and their respective awarding systems; and finally stimulating Member States to develop frameworks for higher market uptake of low- or zero-energy and-carbon buildings. The final aim of the revised EPBD is for all new buildings to be nearly zero energy by 2020.

Directive 2006/32/EC on energy end-use efficiency and energy services

This Directive, relevant in the field of sustainable buildings, aims at making end-use of energy more economic and efficient, by establishing incentives and legal frameworks in order to eliminate market barriers that prevent efficient end-use of energy. A major aim of this directive is to enhance the formation and operation of 'energy service companies' (ESCOs), which will deliver energy services and/or other energy efficiency improvement measures in facilities or premises, carrying some degree of the financial risk of investment, as this is seen to be an effective tool to promote energy efficiency.

Directive 2004/8/EC, "Cogeneration Directive" (EC, 2004). The Directive acknowledges that cogeneration as a way to save energy in Europe has been underutilized. Cogeneration saves primary energy, avoiding network losses and reducing emissions. A greater reliance on cogeneration could help Europe meet Kyoto protocol targets. However, some research in the academic literature questions whether the energy savings afforded by a more widespread application of CHP would be a signification contribution towards meeting climate change target goals, or if otherwise would constitute a distraction from applying other more effective strategies.

4 Analysis of individual heating and cooling products

Table 2 presents an overview of heating and cooling systems including their coverage by different product policy schemes: EU Ecolabel, GPP, Ecodesign, and other Member States' labels. The three product groups mentioned under GPP correspond to studies that were ongoing during 2010; it is not meant to say that GPP criteria for these three product groups will be developed in the near future.

Table 2. Coverage of heating and cooling systems by different product policy schemes

Ecolabel	GPP[8]	Ecodesign Study	Ecodesign Implementing Measures	Nordic Swan	Blue Angel
	CH-Boilers (ongoing in 2010)	CH-Boilers	CH-Boilers (expected Dec. 2010)	Boilers and burners for liquid and gas fuels, up to 120 kW (criteria expired in 2009) Solid biofuel boilers, up to 300 kW	Gas-fired calorific-value heating devices, RAL-UZ 61 Wood pellet boilers, RAL-UZ 112
		Water heaters			Hot water storage tanks, RAL-UZ 124
		CH-Combis			
		Central air conditioning and ventilation			
	Combined heat and power plants (ongoing in 2010)				Small gas-fired cogeneration units, RAL-UZ 108 Small liquid-fired cogeneration units, RAL-UZ 109
		Circulators	Circulators (July 2009)		
Heat pumps (revision due 9 Nov. 2010 – 31 Dec. 2011)	Climate control: heat pumps and air conditioning systems (ongoing in 2010)	Air conditioning and ventilation	Room air conditioning (expected Dec. 2010)	Heat pumps	Heat pumps using absorption and adsorption technology or operating by use of combustion engine-driven compressors, RAL-UZ 118 Heat pumps using an electrically powered compressor, RAL-UZ 121
		Solid fuel small combustion engines		Closed fireplaces fired by biofuel	Wood pellet stoves, RAL-UZ 111

"Boilers" or "CH-Boilers" both refer to Central Heating Boilers
"CH-Combis" means Central Heating Combis (combination of boiler and water heater)

[8] The three product groups mentioned under GPP correspond to studies that were ongoing during 2010. We do not mean to say that GPP criteria for these three product groups will be developed in the near future.

Table 1 shows that so far **only heat pumps have been covered by the EU Ecolabel**. Almost all products (except for combined heat and power units) have at least Ecodesign preparatory studies, and some of them also Ecodesign implementing measures. The state labels (Nordic Swan and Blue Angel) also cover a majority of products, favouring biomass- over fossil-fuelled units. The table also shows discrepancies and lack of harmonization regarding the product group definitions. A major discrepancy is the case of heat pumps and air conditioners. The GPP studies for example place all those appliances in a single product group, while the EU Ecolabel has only developed criteria for heat pumps and not air conditioners.

A recent discussion paper by IPTS (Genty et al., 2010) provided a methodology for the prioritization of product groups for upcoming studies leading to the development of Ecolabel criteria. This prioritization study addressed large product groups, one of them heating and cooling systems. Below we list criteria that are used in the prioritization of products.

One of the criteria relates to the market significance of the product (stock volume, sales): the product group should have annual sales in the EU of at least 200 000 units, and be sold in at least 5 Member States, as published in the ErP Directive. All the heating and cooling products considered here meet this criterion. Other prioritization criteria, in order of decreasing importance, are:

- (a) Product groups with significant environmental impacts.
- (b) With the aim of promoting harmonisation between EU Ecolabel and GPP, those products already covered by the GPP scheme should be given priority. Product groups with different definitions in the EU Ecolabel vs. the GPP scheme should also be given priority, with the aim of increasing coherence between the two programs.
- (c) Demand for ecolabelling by industry and observed uptake rates in other ecolabel programs.
- (d) Coverage through national ecolabels. A product group will be assigned a high priority if it has also been addressed by other national ecolabels, in particular the Nordic Swan and the Blue Angel ecolabels.

Until today, the only heating and cooling product for which Ecolabel criteria have been developed is heat pumps, for which a revision is due between 9 Nov. 2010 and 31 Dec. 2011. This task 1 study should take into account the need to develop the revision of criteria for heat pumps that needs to be completed by the end of 2011.

GPP was developing background studies for three product groups during 2010: boilers, climate control (heat pumps and air conditioners), and combined heat and power. Applying criterion (b), these three could be appropriate candidates for the development of new Ecolabel criteria (after the consideration of significant environmental impacts), so as to increase harmonization between Ecolabel and GPP, especially if GPP criteria are finally developed for these product groups. Among these three, combined heat and power offers less potential for harmonization, since the only existing CHP studies correspond to GPP (background research ongoing) and the Blue Angel (there are no Ecodesign or Nordic Swan criteria).

Below are the criteria affecting environmental impact, which can be used to prioritize the products:

- Market data: units sold per year in the EU-27, market projections (expected future trends), EU-27 stock. One of the criteria to consider that a product has a significant market is a sales value of 200,000 units per year in the EU-27. However, a more important criterion than the mere number of units is the overall environmental impact of the product (dominated by energy consumption during use phase, and greenhouse gas emissions).

- Assessment of the environmental impact:
    - Energy consumption during use phase
    - Greenhouse gas emissions (CO_2, refrigerants)
- Assessment of the environmental improvement potential

Information gathered from existing studies for each of the heating and cooling product sub-groups is presented below, classified by central and space systems. The main studies providing relevant information are Preparatory Studies for the development of Ecodesign Criteria. Other studies belong to the EU Ecolabel program, as well as Member States Labelling schemes such as the Nordic Swan and the Blue Angel.

CENTRAL HEATING AND COOLING SYSTEMS

(1) Generation of heating/cooling: (provide info on what medium gets heated, what is the fuel)

1.1 Central heating boilers (CH-boilers)

Product definition: A central-heating boiler burns fuel (gas, oil, wood, etc.) in a combustion chamber, by means of a burner with an addition of air. The heat produced is used to heat up water; a heat exchanger is used for that purpose. The hot water is circulated in a distribution system to radiators for heating of different rooms in a building. A CH-boiler may be designed (but not necessarily) to also provide domestic hot water or other functions. A "boiler" is defined as the combined boiler body and burner unit designed to transmit to water the heat released from combustion (EPBD, 2002).

Central-heating boilers represent the product group within the heating and cooling systems with the largest market share in terms of sales figures in the EU-27. Different studies on boilers (with slightly varied product group definition) provide data on sales between 5 and 7 million units per year. The EU-27 stock is around 160 million units (data from 2005).

Product application: The primary function of a CH-boiler is the capability to reach and maintain the indoor climate of an enclosed space (building, dwelling, room) at a desired level through heating, using hydronic heat emitters.

Source of energy: CH boilers use one or more of the following heat generation processes:

- Combustion of gaseous and/or liquid fossil fuel ("oil")
- Use of the Joule effect in electric resistance heating elements
- Capturing solar thermal energy
- Capturing ambient heat, including but not limited to transformation processes to bring the heat to a higher exergy level
- Solid fuel, fossil or renewable

Ecodesign preparatory study: Yes (Lots 1, 15)

Ecodesign Implementing Measures: Yes (expected Dec. 2010)

Covered by Ecodesign MEEUP methodology (VHK study on 10 product cases) (VHK, 2005): Yes. The MEEUP study uses PRODCOM 2005 data. Types of boilers addressed in the MEEUP and their corresponding PRODCOM 2005 codes are below:

- Gas-fired CH-boilers, 28.22.12.03: Boilers for central heating, 4-400 kW using gas
- Oil-fired CH-boilers, 28.22.12.05: Boilers for central heating, 4-400 kW using liquid fuel, or oil fuel
- Solid-fuel boilers, 28.22.12.07: Boilers for central heating, using other types of energy
- Miscelaneous, 28.22.12.00: Boilers for central heating other than those of HS 8402 (only if gas or oil fired)

Performance parameters of boilers are: heating capacity (in kW), and efficiency (defined as the ratio of the heating energy output to energy input). The Ecodesign criteria are restricted to boilers with a heating capacity up to **400 kW** (this power limit is taking from the boiler directive, which distinguishes two broad categories of boilers, above and below 400 kW). In any boiler there are heat losses (to the flue gases produced in the combustion, through the boiler casing or the boiler room). If the total amount of energy produced by combustion was transferred to the heating system water, the efficiency would be 100%. Losses cause the efficiency to decrease below 100%. The efficiency in condensing boilers (which capture and recycle latent heat, by condensing the water vapour from the flue gases) can be greater than 100%.

Ecodesign standards introduce minimum efficiency requirements for different types of boilers, on the order of 85 to 95%, depending on the type of boiler. The Energy Star labelling program for example sets the minimum efficiency at 85% for non-condensing, and at 95% for condensing boilers.

The largest fraction of all the different types of CH boilers is composed of the gas- and oil-fired boilers. In this study, we extracted the sales, stock, energy consumed during use phase and other environmental impact statistics from the **gas- and oil-fired boilers**, as provided by the MEEUP Product Cases report and the Ecodesign Preparatory Study (Lot 1). This provides a simplified analysis for this preliminary study, while realistic enough since this corresponds to the majority of the installed boilers today. The estimated use-phase primary energy consumption of the stock is 9500 Peta Joules (PJ), and the associated greenhouse gas emissions 570 million tonnes of CO_2 per year (Mt/yr), according to the Ecodesign preparatory study (Lot 1). These statistics are also presented on Table 7.

Trends in the market seem to point to an increased interest in solid biomass-fuelled boilers, and in condensing boilers.

Nordic Swan: The Nordic Swan program has developed criteria for two separate product groups within boilers: **"boilers and burners for liquid and gas fuels"**, and **"solid biofuel boilers"**. However, it is important to note that the criteria for "boilers and burners for liquid and gas fuels" has expired in 2009, and the Nordic Swan board has decided not to renew the criteria, because of an interest in promoting renewable energy sources. There are however some licences granted under "solid biofuel boilers". This fact provides support to the observed trend of boilers transitioning from natural gas and fossil liquid fuel towards solid biomass fuel, and additional incentives to the switch towards renewable fuels.

Nordic Swan criteria for "boilers and burners for liquid and gas fuels" (expired). This product group encompasses installations for heating dwellings. The installations are designed to be fired with liquid or gas fuel only; in other words: oil burners and oil burner/boiler combinations and gas burners/boiler combinations. The oil burners encompassed by the documents are for burning light fuel oil with low sulphur content or liquid bio-fuel produced from renewable energy sources. Gas burners encompassed by the documents may be fuelled with natural gas or gas produced from renewable sources. Moreover, oil and gas burners may be combined with solar collectors.

The product group encompasses installations of up to **120 kW**, that is, installations for meeting most of the heating needs of a dwelling, including hot water for general use. If the installation is combined with a solar collector system, this system will cover part of the heating requirement and in that case a smaller boiler will be needed.

To qualify for a Swan label, boilers and burners for liquid or gas fuel must comply with criteria in the following categories:

- Emissions into the atmosphere of nitrogen oxide (NO_x), volatile hydrocarbons (HC), and carbon monoxide (CO) and soot values
- Energy use
- Heavy metals and flame retardants in plastic parts
- Heavy metals and organic solvents in surface treatment agents
- Halogenated solvents in degreasing agents
- Substances with a climatic effect in foaming agents used in insulating materials

The criteria for energy efficiency apply only to burner/boiler combinations and not to burners alone. Boiler efficiency is defined in accordance with CEN 303 and 304. y is the required efficiency and x is the performance of the boiler in kW.

Energy efficiency must as a minimum be: $y = (1/60)x + b$

b = 91.77 for liquid fuel, and b = 95.93 for gas fuel

For example, for a 120-kW liquid-fuel burner, the minimum energy efficiency required is y = 93.77%

Nordic Swan label of "solid biofuel boilers" A Swan-labelled boiler is fired on solid biofuel only, meaning wood, pellets made of wood, or an alternative biofuel. Fuel can be fed manually or automatically (wood is generally fed manually, while pellets for example automatically). The product group comprises combined solid biofuel boilers/burners with an output of up to **300 kW.** Solid biofuel specifically refers to split logs, briquettes, pellets and chips as defined by EN 303-5. Straw is also included as a solid biofuel.

A wood-fired boiler is generally run periodically since the hot water is stored in a hot-water tank. Criteria are related to emission of particles, CO, and hydrocarbons; they are also related to the energy efficiency.

Normally separate burners cannot be awarded the Swan label. But if a burner is tested together with a defined boiler, the burner may be Swan-labelled if it is sold together with the defined boiler.

Single-room heat sources such as stoves, slow heat release fireplaces and open fireplaces are covered by a separate criteria document.

According to information from the Nordic Swan website, today there are 2 companies with labeled solid biofuel boilers, corresponding to about 10 licensed products.

Blue Angel: The Blue Angel scheme has developed criteria for two types of boilers:

- Low-emission and energy-saving gas-fired calorific-value heating devices, RAL-UZ-61
- Wood pellet boilers, RAL-UZ-112

For the case of the RAL-UZ-61, the award is given to "gas-fired calorific-value heating devices which emit much less nitrogen oxide (NO_x) and carbon monoxide (CO) and make more efficient use of the fuel than would be required under current DIN Standards and whose auxiliary power demand is much lower than usually". The criteria apply for **heating devices with a nominal thermal output (also called heat load) below 70 kW**. Criteria are given as maximum limits for pollutant emissions such as NOx and carbon monoxide. Regarding energy efficiency, the "nominal utilization ratio" (equivalent to the energy efficiency benchmark in Ecodesign) should be above 100% for 10 kW, and 101% for 70 kW at temperatures of 75/60 ^{o}C. At temperatures of 40/30 ^{o}C, the nominal utilization ratio must be above 103% for 10 kW and 104% for 70 kW.

Concerning uptake rate, **only one vendor has been granted a Blue Angel award, corresponding to one product license** (according to information from the Blue Angel website, updated 20 April 2010).

The Blue Angel criteria for wood pellet boilers (RAL-UZ-112) refer to **wood pellet boilers with a rated thermal output of up to 50 kW which are exclusively designed for the use of wood pellet fuel**. Criteria focus on energy efficiency and low emissions during operation. The reasons that only wood pellet fuel is allowed, is to prevent worsened efficiency and emission behaviour of the same appliance if fuelled by some other kind of fuel (not wood). The criteria apply to the boilers (with incorporated burners), and they exclude appliances that are only burners. The criteria establish that the efficiency must not fall below 90% when operating at either rated load (that is, full load) or partial load. The criteria also set maximum limits for nitrogen oxides (NO_x), carbon monoxide (CO) and other pollutants such as total carbon and dust particles in the exhaust gas.

Concerning uptake rate, there is evidence that wood-pellet boilers are much more in demand from industry than the gas-fired ones. Until the 20 April 2010, the Blue Angel website reports to have granted **63 licenses to 17 vendors**.

Both the Nordic Swan and the Blue Angel give a greater emphasis than Ecodesign criteria to using biofuels (wood pellets, biomass, etc.).

GPP: Boilers are included in the second set of 10 product groups (ongoing studies). However, there is no information no how many units sold, stock, energy used or emissions at this point.

1.2 Water heaters

Product definition: A water heater is an appliance that is designed to provide hot sanitary water. It may also be designed (but not necessarily) to provide space heating or other functions. A water heater is connected to a given external supply of drinking water and is equipped to generate heat and transfer this drinking water to desired temperature levels and desired quantities, flow rates and intervals.

Product application: The primary function of a water heater is the capability to reach and maintain the desired temperature levels at desired quantities, flow rates and intervals as mentioned in the product definition under normal circumstances.

Source of energy: Water heaters use one or more of the following heat generation processes:

- Combustion of gaseous and/or liquid fossil fuels
- Use of the Joule effect in electric resistance heating elements
- Capturing solar thermal energy
- Capturing ambient heat, including but not limited to transformation processes to bring the heat to a higher exergy level

Ecodesign preparatory study: Yes (Lots 1, 2)
According to the Ecodesign preparatory study, in 2005 water heaters consumed 3790 PJ of primary energy, and emitted 110 million tonnes of CO_2 equivalents per year (approximately 6% of all fuel-related CO_2 emissions in the EU-25 the same year). With a EU internal market of 17 million sold units a year, its stock in the European Union in 2005 was 258 million units.

The Ecodesign and energy label criteria refer to "specific efficiency" of water heaters, based on a calculation of the primary energy consumption of the water heater. Later on, EN standards will be used (once they are adopted and harmonized). The criteria assume an average EU climate. Climate differences are not too relevant for the operation of water heaters[9].

[9] The appliance for which the climate makes a significant difference is the heat pump using outside air (the heat pump in this case performs worse for large outdoors-indoors temperature differences such as in Nordic countries).

The following environmental aspects are identified as significant for water heaters:

- Energy in the use phase
- Emissions in use phase of NO_x, CO, hydrocarbons and particulates

The following products are not included in the product group:

- Water heating devices using solid fuels, including biomass, as an energy source. Water heating devices driven by District Heating ("DH"). These are systems fuelled by waste heat from power plants, waste incineration plants, larger industrial installations, etc.
- Product components, i.e. devices that are not capable of performing the primary function. This includes but is not limited to burners, heat exchangers, storage tanks as well as controls or other provisions for heat generation technologies that are not part of the product

The benchmarks for the best environmental performance are:

- Energy efficiency (depending on type of unit)
- NO_x Emissions – less than 20ppm (this applies to CH-boilers, CH-combis and water heaters)

For other significant environmental parameters the lack of adequate test methods currently rules out the setting of benchmarks.

Ecodesign Implementing Measures: No

Covered by Ecodesign MEEUP methodology (VHK study on 10 product cases): No

Nordic Swan: The Nordic Swan does not have criteria for water heaters.

Blue Angel: The Blue Angel provides criteria for "hot water storage tanks", RANL-UZ 124.

Hot-water storage tanks are defined as heat accumulators, used as an intermediate step between heat supply and heat demand. Hot-water storage tanks are considered to make an efficient use of renewable or fossil energy sources for heating purposes. The Blue Angel award is given to those storage tanks featuring a low heat loss rate, and which therefore make an efficient use of energy resources. The capacity of the tanks must be between 50 and 3000 liters. **Until April 2010 the Blue Angel board has awarded 5 licenses to 5 vendors of hot water storage tanks**.

GPP: No criteria developed yet.

1.3 CH-combis

Product definition: A combination of CH-boiler and water heater

Product application: Functionality of both CH-boiler and water heater.

Source of energy: Gas/liquid fossil fuels, Joule effect, solar thermal, capturing ambient heat

Ecodesign preparatory study: Yes (Lots 1 and 2)

Ecodesign Implementing Measures: No

Covered by Ecodesign MEEUP methodology (VHK study on 10 product cases): No

Nordic Swan: No

Blue Angel: No

GPP: No

The Ecodesign preparatory studies Lot 1 and 2 contain some market and environmental impact data for central-heating combi-boilers (CH combis). The vast majority of CH combis in Europe are wall-hung, gas-fired units, of two types: "conventional" and "storage", with a "medium" size of around 80-liter storage and **20 kW** power. The CH combis represent a EU sales market in 2004 (EU-22) of approximately 4.5 million units. Their average lifetime is estimated in the Ecodesign preparatory studies as 17 years. The EU stock is estimated at 76.5 million units. In the Ecodesign Lot 2 preparatory study, the environmental impact per unit for a "medium" CH-combi appliance is estimated as 241 GJ (giga-Joule) per unit in terms of use-phase primary energy consumption, and 12 tons of CO_2-equivalent emission per unit, both quantities over product life. Using the lifetime of 17 years, the impact per year is: 14.18 GJ of use-phase primary energy consumption per unit per year, and 0.706 tons of CO_2-equivalent emission per unit per year.

For the stock of 76.5 million CH-combis, the corresponding use-phase primary energy consumption and CO_2 emissions per year are 1085 PJ and 54 Mt of CO_2-equivalent, respectively (as listed on Table 7).

For CH-combis, the only product policy program that has developed preparatory studies is the Ecodesign program. There are no Ecodesign implementing measures, and no criteria in any other ecolabel in the EU. Therefore at this point this product has little potential for harmonization across programs.

1.4 Central air-conditioning and ventilation

Product definition: Products used to lower the temperature of buildings, using a centralized system where the cooling is generated at a point and then distributed to the different rooms in the building.

Ecodesign preparatory study: There is no Ecodesign study yet on this product group, and therefore no information on the market, the primary energy consumption, or the environmental impacts.

Ecodesign Implementing Measures: No

Covered by Ecodesign MEEUP methodology (VHK study on 10 product cases): No

Nordic Swan: No

Blue Angel: No

GPP: No

For central air conditioning and ventilation, there are no available preparatory studies yet. This product group has not been addressed by Ecolabel, GPP, Nordic Swan or Blue Angel. Since there is not enough potential for harmonization at this point, it is not analyzed further in this report. There is an ongoing DG-ENTR preparatory study (Lot 6) on air-conditioning and ventilation, which is intended to address products that have not been covered before. This study might address central air-conditioning and ventilation, but no further information is available.

1.5 Combined heat and power (CHP)

Product definition**;** CHP (Combined Heat and Power) is a system that produces a surplus of electricity and heat, beyond what is needed for driving the electrical components within the product. The unit produces heat and power at the same time, which constitutes an efficient means of energy conversion, therefore reducing primary energy consumption and carbon dioxide emissions. CHP units also contribute to the more widespread use of decentralized energy systems.

Product application: Residential, commercial and industrial heating and hot water generation.

Ecodesign preparatory study: No

Ecodesign Implementing Measures: No

Covered by Ecodesign MEEUP methodology (VHK study on 10 product cases): No

Nordic Swan: No

Blue Angel: Yes

- Small-scale gas-fired cogeneration units, RAL-UZ 108
- Small liquid-fired cogeneration units, RAL-UZ 109

Regarding small-scale gas-fired cogeneration units (RAL-UZ 108), the award is given to those units which "make a rational use of the fuel used and emit far less nitrogen oxides and carbon monoxides than conventional CHP systems". Included within the scope are: engine-driven cogeneration systems power by diesel or gasoline engines, and plants driven by Stirling engines. The scope is limited to units with an electric power of up to **30 kW** for use of gaseous fuels. The criteria establish maximum limits for nitrogen oxides (NO_x) and carbon monoxide (CO). The total efficiency must be higher than 89% at full load, and 87% at partial (50%) load.

Regarding small-scale liquid-fired cogeneration units (RAL-UZ 108), the award is given also to those units which "make a rational use of the fuel used and emit far less nitrogen oxides and carbon monoxides than conventional CHP systems". Included within the scope are: engine-driven cogeneration systems power by diesel or gasoline engines, and plants driven by Stirling engines. The scope is limited to units with an electric power of up to **30 kW** for use of liquid fuels. The criteria establish maximum limits for nitrogen oxides (NO_x), carbon monoxide (CO) and dust. The total efficiency must be higher than 85% at full load, and 83% at partial (50%) load.

Regarding uptake rate, no Blue Angel award has been given to either RAL-UZ 108 or 109 cogeneration types of units, as of April 2010.

GPP: Yes (ongoing)

Combined heat and power has not been addressed yet by the Ecodesign scheme or the Nordic Swan. There is however interest from GPP, and there are some criteria developed by the Blue Angel. There are no preparatory studies providing information on the market, primary energy consumption or environmental impact.

Since there is not enough potential for harmonization, it will not be recommended for study in a first instance. However, it may offer the potential for a shortened procedure from the Blue Angel in the near future.

(2) Distribution of heating/cooling

2.1 Circulators in buildings

Product definition: Circulators found in household central heating systems (other types - industrial, non-central heating applications - are excluded). The product group includes standalone circulators only; the circulators that are integrated in the boilers are taken into account within the criteria development for boilers.

Product application: Distribute heat from a central heating unit to different parts of a building.

Ecodesign preparatory study: Yes (Lot 11)

Covered by Ecodesign MEEUP methodology (VHK study on 10 product cases): No

Ecodesign Implementing Measures: Yes, through Commission Regulation (EC) No 641/2009 of July 2009, see (EC, 2009c).

Nordic Swan: No

Blue Angel: No

The Ecodesign preparatory study (Lot 11) included circulators in buildings, electric motors, electric pumps, and ventilation fans. This section restricts only to circulators, in particular "glandless circulators that have the shaft of the motor directly coupled to the impeller and the rotor is immersed in the pumped medium" (also called 'wet running'). **These circulators have a power between 25 and 2500 W**. The smaller sizes are normally used in houses with just one family, and the larger sizes in buildings of multiple occupation, commercial, or industrial buildings. The PRODCOM 2009 code is 28.13.14.17, defined as "glandless impeller pumps for heating systems and warm water supply". The motor is running in the fluid that is being pumped.

There has been a voluntary agreement for EU Energy Labelling of circulators since January 2005 by leading European manufacturers within Europump association[10] has helped to start pushing the market towards more efficient circulators in the residential and commercial buildings. It is expected that the introduction of the Ecodesign requirements will result in a *de facto* technology switch from standard induction motor driven circulators to variable speed permanent magnet circulators. The Ecodesign standard will put the threshold for allowed sales of circulators only if they have the A rating, making the energy label of circulators obsolete after the implementation of the Ecodesign standard.

Most of the circulators in the market are small, of which the most familiar "standalone" type has an average power of about **65 W**. A rapidly growing part of the market is comprised of custom-designed "boiler integrated" circulators that are included in the boiler, and these have an average power consumption of about **90 W**. Boiler integrated circulators are also considered to be components of a boiler, and therefore, policy recommendations on them are included in the Boilers study (Lot 1), and not in this section. Circulators in this study are used primarily for heating applications.

The annual market for circulators is considered to be 14 million units per year, comprising:

- Standalone (small) circulators 5.5 million per year → used in single household buildings

[10] The Europump association is also called the "Association Européenne des Constructeurs de Pompes", www.europump.org

- Boiler integrated circulators 7.5 million per year
- Standalone (Large) circulators 1.0 million per year → used in commercial and residential buildings

Other estimate given is around 11 million units per year. The EU stock is approximately 103 million units (data from 2005).

Circulators consume much of the energy used in heating systems in buildings. In addition, most standard circulators operate continuously, regardless of heating needs. Circulators are therefore considered one of the priority products for which Ecodesign requirements should be established.

The Ecodesign preparatory study (Lot 11) estimates a use-phase primary energy consumption of 432 PJ, with CO_2 emissions of 19 Mt/year.

SPACE HEATING AND COOLING SYSTEMS

A space heater is defined as a self-contained device for heating an enclosed room or a small number of rooms, where heat production and delivery take place at the same point.

3.1 Heat pumps

Product definition: Product that concentrates energy present in air, ground or water into useful heat for the supply of space heating, or opposite for cooling. A "heat pump" (EPBD, 2002) is a device or installation that extracts heat at low temperature from air, water or earth, and supplies the heat to the building. The advantage of heat pumps is that they help save fossil fuels because they use renewable heat sources (water, geothermal heat, air, etc.).

Ecolabel criteria for heat pumps have been developed and can be found in a Commission Decision (EC, 2007).

Product application: Space heating/cooling function

Source of energy: Electrical, gas

Ecodesign preparatory study: Yes

Covered by Ecodesign MEEUP methodology (VHK study on 10 product cases): No

Ecolabel study and criteria: Yes

The Ecolabel criteria have been specifically developed for "electrically driven, gas driven or gas absorption heat pumps". Heat pumps exclude: heat pumps which only provide hot water, and heat pumps for cooling only. This product group comprises heat pumps which can concentrate energy present in the air, ground or water into useful heat for the supply of space heating or the opposite process for space cooling. The criteria are for heat pump devices with a maximum heating capacity of **100 kW**. It excludes heat pumps which can only provide hot water for sanitary use, and also heat pumps which can only extract heat from a building and eject it to the air, ground or water thus resulting in space cooling.

Heat pumps are regarded as one of the most promising technologies to reduce greenhouse gas emissions and produce heat in a very efficient way. Even though the technical know-how of heat pumping is well proven, it has not reached public recognition worldwide. In Europe, a sustainable market has only been established in countries like Sweden, Switzerland, and parts of Austria. Due to the increasing prices of oil and electricity, and the increase in energy-related taxes, the market for heat pumps has started to grow in all of Europe.

The word heat pump is a collective term for a wide range of products using the same working principle. Ambient air is the most common heat source for heat pump applications worldwide. Ambient air temperature

changes, and the performance of an ambient air heat pump is reduced with lower temperatures of the heat source. At a certain point, the temperature difference between the heat source and the sink will be too large for the heat pump to operate at all and the heat pump has to be stopped. The same appliance can provide heat and cooling. Cooling is achieved by reversing the cycle. Other heat sources are exhaust air, ground water, and surface water. Growing interest in the technology has intensified R&D, leading to a significant improvement of the efficiency during the last decade. Compared to a conventional boiler, a highly efficient heat pump system will reduce the use of fossil fuel and reduce hazardous emissions locally. Heat pumps however contribute to emissions by means of refrigerant leakage over their lifecycle.

A heat pump, when used in heating mode, extracts energy from a low temperature heat source and transforms it to energy at a desirable temperature level by the use of a compressor. The compressor requires power input in order to upgrade the energy. The maximum efficiency that may be achieved by a heat pump is defined by the theoretical "Carnot-process" by which the efficiency is only dependent on the temperature level of the heat source and heat sink.

At present, modern heat pumps operate at a coefficient of performance (COP) in the range of 4-5 at a heat source temperature of 0°C and 35°C heat sink temperature. This means that an electric input of 1 $kWh_{electricity}$ is transformed to 4-5 $kWh_{heating}$. In comparison modern condensing boilers may attain approximately 1.07 $kWh_{heating}$ out of 1 kWh energy content of the fuel in use (that is, primary energy). This means that heat pumps are approximately 4 to 5 times more efficient than boilers.

Table 3 provides a comparison of the primary energy use for different heating devices, and offers evidence of the high efficiency of heat pumps, especially when compared with electric radiators.

Table 3. Efficiency of heat pumps compared to other heating devices

Heating device	Primary energy per kWh useful energy (kWh_{pr}/kWh_u)	Corresponding average overall efficiency (kWh_u/kWh_{pr}) = PER
Oil boiler (100%)	1.45	0.69
Gas boiler (100%)	1.37	0.73
Electric heat pump (95%) + electricity (5%)*	1.05	0.95
Electric radiators (100%)*	2.50	0.40

*Applying 2.5

Low energy prices, which do not fully reflect the external cost of the different energies, are considered a significant barrier to the spread of heat pumps in some European countries. This is often related to the fact that even if a heat pump system is economically competitive, the energy cost difference may be too small for the consumer to decide for the heat pump system, in spite of other benefits that a heat pump system offers, such as reduced CO_2 emissions, more comfort, etc. This barrier can be overcome by offering incentives, grants, renewable energy tax benefits for heat pumps, exempted or reduced CO_2 taxes, etc.

The market for heat pumps is approximately 200 000 units sold per year in the EU-27, from around 60 000 units solid per year in 2002. The EU stock of heat pumps in 2002 was around 833 000 units. The primary energy consumed during use phase of heat pumps was estimated as 131 PJ in the whole EU that

year. Using an estimated European average of CO_2-equivalent emissions of a heat pump, at a value of 56.64 tonnes of CO_2-equivalent per heat pump, and the stock of 833 000, the total EU climate change impact of operating heat pumps is estimated at 48 million tonnes of CO_2-equivalents per year.

Regarding the market success of the EU Ecolabel: up to April 2010, **3 companies have applied for the EU label, with 26 licenses awarded.**

Nordic Swan label for heat pumps:

The annual average efficiency is defined as = E_{prod}/EL_{con} = annual produced useful heat in kWh / annual electricity consumption in kWh. This is the same magnitude as the coefficient of performance (COP) in the Ecolabel for heat pumps.

The Nordic Swan provides criteria for different classes of heat pumps:

- *Class I*: Single heat pump units. The annual average efficiency for heat production should be a minimum of 1.75. If refrigerant in the heat pump is HFC, the annual average efficiency for heat production should be a minimum of 2.5.

(a) Heat pump that directly heats the air in the area to be heated

(b) Exhaust air heat pumps

(c) Heat pumps for sanitary hot water production only

- *Class II*: Heat pump systems. The annual average efficiency for heat production should be at least 2.0. If the refrigerant is HFC< then the annual average efficiency for heat production should be at least 2.25 (for GWP < 1000), and 2.30 (for GWP < 2000).

These minimum standards for the annual average efficiency (same magnitude as the coefficient of performance for the EU ecolabel of heat pumps) are less stringent than the ones of the EU ecolabel (which was between 2.60 and 5.10).

(a) Ground-source, geothermal and air heat pumps with a heat distribution through water or brine.

(b) Air heat pumps with a heat distribution through air ducts.

As of April 2010, only one company has applied for the Nordic Swan, with three labelled products.

Blue Angel: The Blue Angel scheme has developed criteria for **"heat pumps using absorption and adsorption technology or operating by use of combustion engine-driven compressors" (RAL-UZ 118) and "heat pumps using an electrically powered compressor" (RAL-UZ 121)**.

The Blue Angel label is meant to distinguish heat pump systems that require much less primary energy to generate heating energy than would be required using standard heat pumps, or other conventional heating technologies. The drawback of heat pumps is the use of refrigerants, which contribute to global warming if they leak.

In the RAL-UZ 118 criteria, the energy efficiency ratio (ratio of heating output to the electric power input) is set at a minimum of 120%.

In the RAL-UZ 121 criteria, the energetic efficiency of the systems is expressed by the seasonal performance factor (SPF) for the respective systems (water, air), which is defined as the ratio of heating output to the electric power input. The SPF measures the heating efficiency of a system taking the local operating conditions and the course of the year into account. Global warming potential (GWP) in CO_2 equivalents is used to estimate climate impact (with a time horizon of 100 years).

The TEWI (total equivalent warming impact) is used in the heat pump criteria. This parameter measures the impact of a system on the climate by means of a CO_2 equivalent. It considers the influence of the refrigerant as well as the climate change potential arising from the driving energy. To determine the TEWI value, the following parameters are combined: SPF, GWP, and the filling quantity of the refrigerant.

The scope is electrically powered heat pumps for room heating with a total thermal output of up to **100 kW** at a flow temperature of 45 ^{o}C.

The climate change impact for heat pumps is evaluated using TEWI: this allows combining the CO_2 emitted because of the use of energy, and the climate change impact contribution from the refrigerant used.

Regarding uptake rate, so far **no awards have been given either to RAL-UZ 118 or 121 heat pump systems**, as of April 2010.

3.2 Room air conditioners (RAC)

Product definition: As opposed to central air conditioning units, these are smaller units that provide the cooling at the same point where it is generated. Main types of room air conditioners: single-duct (portable); wall/window package; single-split package (indoor/outdoor unit); multi-split package (indoor/outdoor unit).

Product application: Provide cooling for a single room, or a few rooms

Source of energy: Electrical

Ecodesign preparatory study: Yes (Lot 10)

Covered by Ecodesign MEEUP methodology (VHK study on 10 product cases): Yes

Nordic Swan: No

Blue Angel: No

From the Ecodesign preparatory study for room air conditioners, the following table summarizes the scope of products in the study. Here we only consider room air conditioners.

Table 4. Room air conditioners, and other cooling and ventilation products, considered in Ecodesign Lot 10 preparatory study

	Room Air Conditioner (RAC)	Local Air Cooler (LAC)	Comfort fans (CF)
Output power	750 W – 12 kW	≤ 2.2 kW	≤ 125 W
Function	Air conditioning	Cooling a limited area inside a room	Increase flow rate of ambient air
Structure	At least one indoor and outdoor unit	Single-package indoor unit only	
Types of appliance	- ducted and non-ducted split and multi split systems	- single-ducted - double-ducted - window	- tower - ceiling - other fans (table, box, pedestal)

The Ecodesign MEEUP methodology study (10 product cases) (VHK, 2005) has addressed the room air conditioners as well. From this study, the number of units sold per year in the EU is approximately 4.5 million, and the stock is 25 million. The use-phase primary energy consumption is estimated at 241 PJ, and the GWP at 20 Mt/yr of CO_2 equivalent (data from 2005).

3.3 Local mechanical ventilation

Product definition: Ventilation fans. Fans are defined as "rotary bladed machines that are used to maintain a continuous flow of a gas, typically air", or more generally as appliances used to "move gases from one place to another". In Ecodesign there are two separate groups of fans: fans for ventilation in non-residential buildings (originally under electric motors, and therefore studied in Lot 11), and domestic fans (originally under room air conditioners, and therefore studied in Lot 10). The figure below provides pictures of the different types of fans depending on the mechanism of air movement.

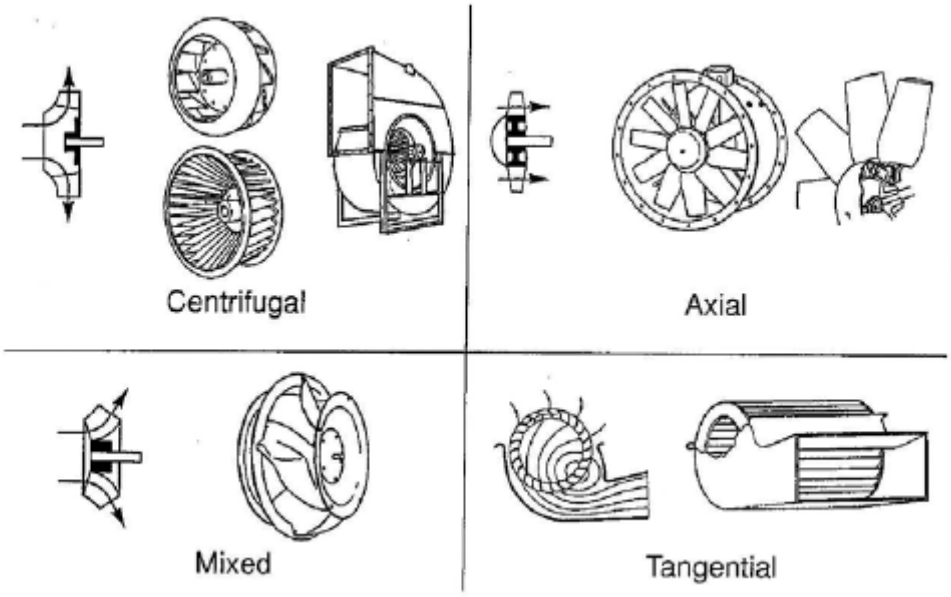


Figure 1. Types of local mechanical ventilation equipment

Product application: Provide ventilation for a single room. The function of the product is to move a specified volume of air with a specified pressure increase.

Source of energy: Electrical

Ecodesign preparatory study: Yes (Lot 11 and Lot 10). Lot 11 covers fans in commercial and industrial buildings. Lot 10 covers fans in residential buildings.

Covered by Ecodesign MEEUP methodology (VHK study on 10 product cases): No

Nordic Swan: No

Blue Angel: No

Table 5 contains categories of ventilation equipment of the non-domestic (Lot 11) and domestic (Lot 10) types. The product group numbering correspond to an older version of PRODCOM list (prior to 2009) so the numbering is different than the current 2009 version used in our study. The description of the categories remains the same for the non-domestic products; the categories have slightly changed for the domestic products (see PRODCOM 2009 list of products in the Appendix).

Table 5. Non-domestic and domestic cooling and ventilation equipment

29.23	**Manufacture of non-domestic cooling and ventilation equipment**
29.23.20	**Fans other than table, floor, wall, window, ceiling or roof fans**
29.23.20.30	Axial fans (excluding table, floor, wall, window, ceiling or roof fans with a self-contained electric motor of an output ≤125 W)
29.23.20.50	Centrifugal fans (excluding table, floor, wall, window, ceiling or roof fans with a self-contained electric motor of an output ≤125 W)
29.23.20.70	Fans (excluding table, floor, wall, ceiling or roof fans with a self-contained electric motor of an output ≤125 W, axial fans, centrifugal fans)
29.71	**Manufacture of electric domestic appliances**
29.71.15	**Fans and ventilating or recycling hoods of the domestic type**
29.71.15.30	Table, floor, wall, window, ceiling or roof fans with a self-contained electric motor of an output ≤ 125 W
29.71.15.33	Roof ventilators
29.71.15.35	Other ventilators
29.71.15.50	Ventilation or recycling hoods incorporating a fan, with a maximum horizontal side ≤ 120 cm

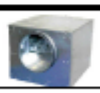
The categories of non-domestic ventilation products (Lot 11), the red square in Table 5, according to PRODCOM 2009 are as follows:

- 28.25.20.30: Axial fans (excluding table, floor, wall, window, ceiling or roof fans with a self-contained electric motor of an output ≤125 W)
- 29.23.20.50: Centrifugal fans (excluding table, floor, wall, window, ceiling or roof fans with a self-contained electric motor of an output ≤125 W)
- 29.23.20.70: Fans (excluding table, floor, wall, ceiling or roof fans with a self-contained electric motor of an output ≤125 W, axial fans, centrifugal fans)

Axial flow fans are those having a static pressure development. Centrifugal fans are those radial flow fans comprising an impeller where the direction of the entry air flow is vertical to the direction of the exit air flow.

Table 6 contains the categories of fans taken into account by Lot 11 Ecodesign preparatory study (non-residential fans).

Table 6. Categories of fans taken into account by Lot 11 Ecodesign preparatory study (non-residential fans)

Product Category	Direction of flow	Type	Typical Sizes [mm]	Example
1	Axial	<= 300 Pa (static pressure)	200 - 1,400	 Source: Helios
2		> 300 Pa (static pressure)	200 - 1,400	
3	Centrifugal	forward curved blades (with casing)	120 - 1,600	 Source: Nicotra
4		backward curved blades (no casing)	120 - 1,600	 Source: ebmpapst
5		backward curved blades (with scroll housing)	120 - 1,600	 Source: Ziehl-Abegg
6	Other	Box fans	100 - 1,000	 Source: Fläktwoods
7		Roof fans	250 - 1,000	 Source: Gebhardt
8		Cross-flow fans	60 - 120	 Source: ebmpapst

From the Ecodesign preparatory study Lot 11 (non-residential ventilation equipment), the average lifetime of these products is estimated as 15 years. The total stock in 2005 for EU-27 is estimated to be between 97.3 and 110.6 million units, and the overall number of units sold in 2005 in the EU-27 was near 10 million. Local mechanical ventilation (non-residential) is estimated to consume 326 PJ of primary energy per year, with associated 15.7 Mt of CO_2 equivalent emissions per year. The primary energy consumption and climate change impact of this product is lower compared to other heating and cooling systems. This product group has not been addressed yet by GPP, the Nordic Swan or the Blue Angel, therefore has low potential for harmonization at this point.

The product definition of Lot 10 (residential fans) includes roof fans, extraction fans, window fans, wall fans and hood fans. Regarding residential local ventilation equipment (Lot 10), also known as "comfort fans", the corresponding Ecodesign preparatory study classifies the group in 8 different types of products. Overall, the EU stock is 176 016 thousand units, with an annual sales volume of 25 960 thousand units per year in the EU in 2005. The stock consumes a total primary energy of 49 PJ per year, and emits 2.6 Mt of CO_2-equivalents per year. Therefore, the residential portion of local ventilation equipment is small compared to the commercial and industrial portions, and is not recommended as a priority for the next development of Ecolabel criteria.

3.4 Solid fuel small combustion installation

Product definition: Fireplaces, stoves. Capacity below 500 kW. Mostly for residential installations.

Product application: Space heating function

Source of energy: Solid fuel combustion: coal, biomass, wood, peat

Ecodesign preparatory study: Yes (Lot 15)

Covered by Ecodesign MEEUP methodology (VHK study on 10 product cases): No

Nordic Swan:

The Nordic Swan has developed criteria for **"closed fireplaces for biofuel"**, fired with solid biofuel (wood, wood pellets, alternative biofuels). They are commonly called stoves. Fuel can be fed manually (most typical for wood) or automatically (most typical for pellets). As the closed fireplace contains the fire, air is supplied through special ducts and flow can be controlled. The criteria provide maximum limits for emissions of organic carbon, carbon monoxide (CO), dust particles, etc; installation requirements, and lists prohibited chemicals. The efficiency is set to a minimum of 60% to 78% depending on the type of stove (sauna, wood, pellets).

This product group has been highly successful. **As of April 2010, 8 companies have applied for labels, and more than 80 products have been licensed.**

Blue Angel:

The Blue Angel scheme has developed criteria for wood pellet stoves (RAL-UZ 111). The criteria are applicable to stoves with rated thermal output below **15 kW**, for exclusive use of wood pellets as fuel. The units must have automatic ignition and combustion control (units with manual operation control are excluded). The unit must be a complete heating system (pellet burners alone are excluded from the award of the label). The units must have low auxiliary power demand (on the order of 1% of the produced thermal output). The criteria give maximum limits for nitrogen oxides (NOx), carbon monoxide (CO), organic substances, and dust.

The label for wood pellet stoves has been quite successful, with 23 licenses granted to 6 vendors, until April 2010.

GPP: No

In the Ecodesign preparatory study, two PRODCOM categories have been analyzed:

- 29.72.11.50: Iron or steel solid fuel domestic cooking appliances and plate warmers (including those with subsidiary boilers for central heating)

- 29.72.12.70: Iron or steel solid fuel domestic appliances (including heaters, grates, fires and braziers; excluding cooking appliances and plate warmers)

The numbers of units sold in the EU in 2006 was around 3.8 million units. The stock is on the order of 73.5 million.

The Ecodesign preparatory study estimates that the product group consumes an overall 2283 PJ per year, and emits 78 Mt CO_2-equivalents per year.

5 Towards the development of a framework Ecolabel benchmark for the heating and cooling systems group

In this section we propose to initiate background research regarding whether it would be feasible and/or desirable to create a common benchmark for all types of heating and cooling products, independent of their specific technology, to achieve a more homogeneous way to determine if individual products should be awarded an Ecolabel. This section will generate possible options for developing a "framework Ecolabel criterion or benchmark" common to all heating and cooling products, under the umbrella of an Ecolabel for Heating and Cooling Systems Product Group.

The framework criterion will be based on a harmonize definition of efficiency, broadly a ratio of heating or cooling delivered vs. primary energy consumed.

6 Summary

The overall objective of this research activity was to contribute to the development of EU Ecolabel criteria for "heating and cooling systems". Within this group, a number of individual heating and cooling products have already been addressed by one or more product policy schemes, such as the EU Ecolabel, Green Public Procurement (GPP), Ecodesign, Energy Label, Energy Star, and individual member states' ecolabel programs (Nordic Swan and Blue Angel).

This task 1 report aimed at defining the scope of the product group "heating and cooling systems".

Table 7 provides a schematic comparison of the market, use-phase primary energy consumption, and CO_2 emissions of heating and cooling systems.

Table 7. Comparison of the market, use-phase primary energy consumption and CO_2 emissions of heating and cooling systems.

Product	Units sold per year	EU stock	Use-phase primary energy consumption (PJ)	% of total EU-27 primary energy consumption 2005	CO_2 emissions (million tonnes per year, Mt/yr)
CH boilers from Ecodesign Prep. Study (Lot 1) for the EU-25 (2005), for gas- and oil-fired CH boilers	**6.1 million**	**160.5 million**	**9500**	**12.3%**	**570**
Water heaters	**17 million**	**258 million**	**3790**	**4%**	**110**
CH combis from Ecodesign prep. Studies (Lots 1 & 2), for the EU-22 (2004)	**4.5 million**	**76.5 million**	**1085**	**1.4%**	**54**
Central heating circulators (from 10 product cases; 29122417 glandless impeller pumps)	**11.2 to 14 million**	**103 million**	**432**	**0.56%**	**19**
Heat pumps (RES-H report, 2002)	**61.4 thousand**	**833 thousand**	**131**	**0.17%**	**48**
Room air conditioners (RAC), 10 product cases, 29231229 (window or wall AC).	**4.5 million**	**25 million**	**241**	**0.31%**	**20**
Local mechanical ventilation (non-residential, Lot 11)	**10 million**	**97.3 to 110.6 million**	**326**	**0.43%**	**15.7**
Local mechanical ventilation, or "comfort fans" (residential, Lot 10)	**25 960 thousand**	**176 016 thousand**	**49**	**0.06%**	**2.6**
Solid fuel small combustion installation	**3.8 million**	**73.5 million**	**2283**	**3%**	**78**

Notes:

- The total EU-27 primary energy consumption per year in 2005 was 7,67E+19 Joules (76 700 PJ)
- The products listed above add up to about 22% of the total EU-27 primary energy consumption. It is estimated that all heating and cooling products in the EU-27 account for roughly 20 to 30% of the total EU-27 primary energy consumption.

Figure 2 illustrates the comparison of these heating and cooling systems in terms of their share of use-phase primary energy consumption and CO_2 emissions.

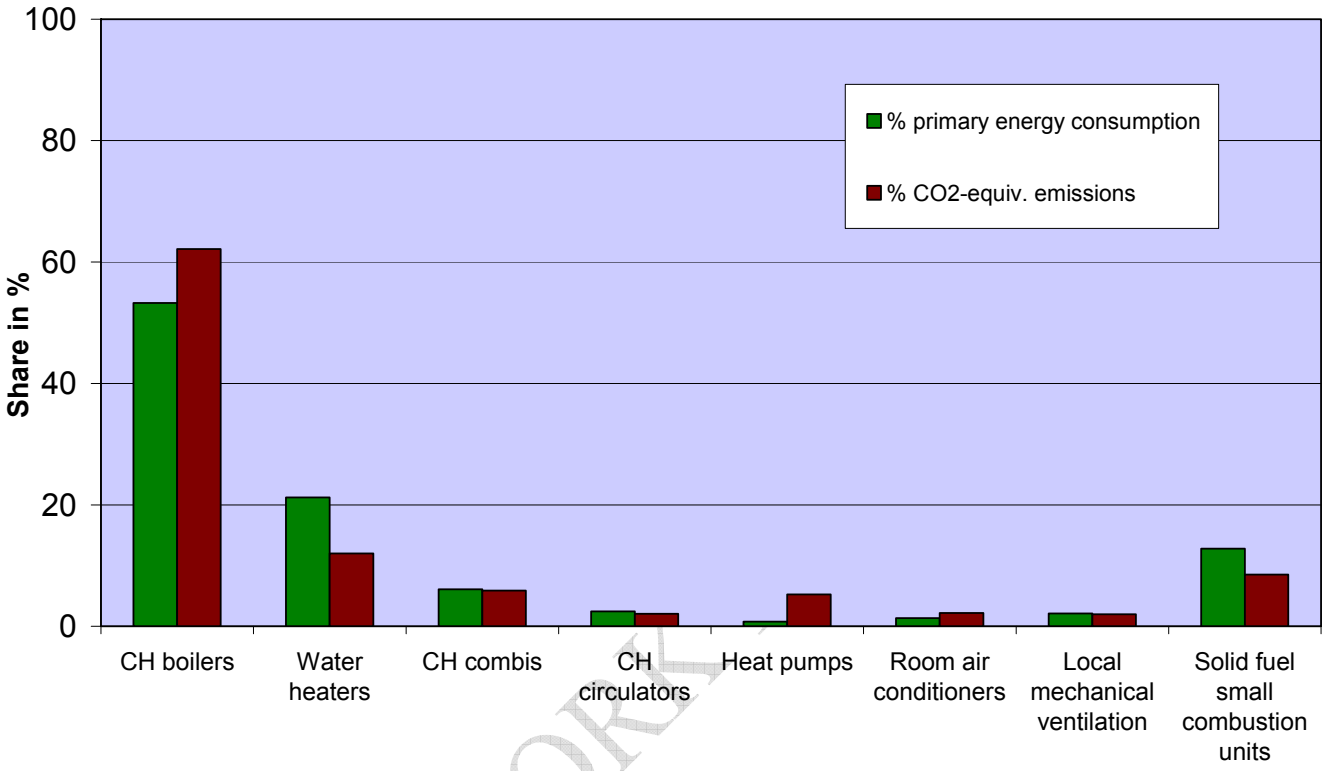


Figure 2. Comparison of heating and cooling products in terms of their share of use-phase primary energy consumption and CO_2-equivalent emissions in the EU-27 (data from 2004-2005)

Table 8 shows a comparison of the uptake rate of EU Ecolabel, Nordic Swan and Blue Angel labels. From this table, it can be appreciated that the most successful products among label programmes are: solid biofuel boilers, and solid biofuel fireplaces or stoves. Heat pumps have shown a significant uptake rate of EU Ecolabel, with 3 companies and 26 licenses, but surprisingly no heat pumps have applied for the Blue Angel label, and only a few for the Nordic Swan.

Table 8. Comparison of the uptake rates of EU Ecolabel, Nordic Swan and Blue Angel labels for heating and cooling products.

EU Ecolabel criteria	Uptake rate of EU Ecolabel	Nordic Swan criteria	Uptake rate of Nordic Swan	Blue Angel criteria	Uptake rate of Blue Angel
		Boilers and burners for liquid and gas fuels, up to 120 kW (criteria expired in 2009)	Label cancelled	Gas-fired calorific-value heating devices, RAL-UZ 61	1 company 1 license
		Solid biofuel boilers, up to 300 kW	2 companies Fewer than 10 licenses	Wood pellet boilers, RAL-UZ 112	17 companies 63 licenses
				Hot water storage tanks, RAL-UZ 124	5 companies 5 licenses
				Small gas-fired cogeneration units, RAL-UZ 108	0 companies 0 licenses
				Small liquid-fired cogeneration units, RAL-UZ 109	0 companies 0 licenses
Heat pumps	3 companies 26 licenses	Heat pumps	1 company 3 licenses	Heat pumps using absorption and adsorption technology or operating by use of combustion engine-driven compressors, RAL-UZ 118	0 companies 0 licenses
				Heat pumps using an electrically powered compressor, RAL-UZ 121	0 companies 0 licenses
		Closed fireplaces fired by biofuel	8 companies 80 licenses	Wood pellet stoves, RAL-UZ 111	6 companies 23 licenses

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9 Unit conversions

- Energy consumption data are given in terms of Total Gross Energy Requirement (GER), that is primary energy, in MJ (Mega Joules) primary.
- The combustion value of fuels used is measured in MJ (Mega Joules).
- 1 kW-h electricity (useful) is equivalent to 2.92 kW-h primary energy used. This conversion assumes a 34% overall efficiency in the European electricity generation.
- Energy consumption is indicated as PJ of primary energy consumption in 2005. "Primary energy" means energy contained in fossil fuels and renewable energy sources that has not been subject to any conversion or transformation process.
- mega (M) = 10^6; giga (G) = 10^9; tera (T) = 10^{12}; peta (P) = 10^{15}; exa (E) = 10^{18}
- Lifetimes and heating and cooling products range from 3-5 years for small appliances to 25 years for central heating devices (MEEUP methodology).
- One tonne of oil equivalent (toe) is a unit of energy corresponding to the amount of energy released by burning one tonne of crude oil, approximately 42 GJ = 4.2 x 10^{10} Joules
- One million tonne of oil equivalent (Mtoe) is the amount of energy released by burning one million tonnes of crude oil, that is, 42 PJ = 4.2 x 10^{16} Joules
- The global warming potential (GWP) of a substance is a measure of its negative impact on the climate. The GWP values are related to CO_2 as a reference substance and a time horizon of 100 years.

Appendix

2009 PRODCOM List of Heating and Cooling Products

Table of Heating and Cooling systems in the PRODCOM List 2009

Code	Description
25.21	Manufacture of central heating radiators and boilers
25.21.11	Central heating radiators, not electrically heated, of iron or steel
25.21.11.00	**Radiators for central heating, not electrically heated, and parts thereof, of iron or steel**
25.21.12	Central heating boilers, for producing hot water or low pressure steam
25.21.12.00	**Boilers for central heating other than those of HS 84.02**
25.21.13	Parts for central heating boilers
25.21.13.00	**Parts of boilers for central heating**
25.30.11.10	**Watertube boilers (excluding central heating hot water boilers capable of producing low pressure steam)**
25.30.11.50	**Vapour generating boilers (including hybrid boilers) (excluding central heating hot water boilers capable of producing low pressure steam, watertube boilers)**
25.30.11.70	**Super-heated water boilers (excluding central heating hot water boilers capable of producing low pressure steam)**
27.51	Manufacture of electric domestic appliances
27.51.15	Fans and ventilating or recycling hoods of the domestic type
27.51.15.30	**Table, floor, wall, window, ceiling or roof fans, with a self-contained electric motor of an output ≤ 125 W**
27.51.15.80	**Ventilating or recycling hoods incorporating a fan, with a maximum horizontal side ≤ 120 cm**
28.13	Manufacture of other pumps and compressors
28.13.14	Other centrifugal pumps for liquids; other pumps
28.13.14.17	**Glandless impeller pumps for heating systems and warm water supply**
28.25	Manufacture of non-domestic cooling and ventilation equipment

Code	Description
28.25.11	Heat exchange units and machinery for liquefying air or other gases
28.25.11.30	**Heat exchange units**
28.25.11.50	**Machinery for liquefying air or other gases**
28.25.12	Air conditioning machines
28.25.12.20	**Window or wall air conditioning systems, self-contained or split-systems**
28.25.12.40	**Air conditioning machines of a kind used in motor vehicles**
28.25.12.50	**Air conditioning machines with refrigeration unit (excluding those used in motor vehicles, self-contained or split-systems machines)**
28.25.12.70	**Air conditioning machines not containing a refrigeration unit;central station air handling units; vav boxes and terminals, constant volume units and fan coil units**
28.25.13.80	**Heat pumps other than air conditioning machines of HS 8415**
28.25.20	fans, other than table, floor, wall , window, ceiling or roof fans
28.25.20.30	**Axial fans (excluding table, floor, wall, window, ceiling or roof fans with a self-contained electric motor of an output ≤ 125 W)**
28.25.20.50	**Centrifugal fans (excluding table, floor, wall, window, ceiling or roof fans with a self-contained electric motor of an output ≤ 125 W)**
28.25.20.70	**Fans (excluding table, floor, wall, ceiling or roof fans with a self-contained electric motor of an output ≤ 125 W, axial fans, centrifugal fans)**

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