Development of European Ecolabel Criteria for Hydronic Heaters

TECHNICAL REPORT

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Abbreviations

AHWG	– Ad-Hoc Working Group
BED	– Boiler Efficiency Directive
CE	– Conformité Européene – European Conformity
CEN TC	– European Committee for Standardization Technical Committee
CHP	– Combined Heat and Power
CLP	– Classification, Labelling and Packaging of substances and mixtures
CO	– Carbon Monoxide
CO_2	– Carbon Dioxide
dB(A)	– A-weighted decibel (sound pressure level)
EPA	– United States Environmental Protection Agency
EPBD	– Energy Performance of Buildings Directive
ErP	– Energy-related Product
EuP	– Energy-using Product
etas, η_s	– Seasonal space heating energy efficiency
etason	– Seasonal space heating energy efficiency in active-mode
GCV	– Gross Calorific Value
GHG	– Greenhouse Gas
GPP	– Green Public Procurement
GWP_{100}	– Global Warming Potential over a 100-year period
HC	– Hydrocarbons
HM	– Heavy metals
ISO	– International Organization for Standardization
kt	– Thousand tonne
kWh	– Kilowatt-hour
LCA	– Life-cycle assessment
LFO	– Light Fuel Oil
MJ	– Megajoule
MS	– Member State
Mt	– Million tonne
NCV	– Net Calorific Value
Nm^3	– Normal cubic metre (at 101.325 kPa, 273.15 K)
NMVOC	– Non-Methane Volatile Organic Compounds
NO_x	– Nitrogen Oxides (often measured as NO2 – nitrogen dioxide)
PAH	– Polycyclic Aromatic Hydrocarbons
PBB	– Polybrominated biphenyls
PBDE	– Polybrominated diphenyl ethers
PJ	– Petajoule
PM	– Particulate Matter
POP	– Persistent Organic Pollutants
PVC	– Polyvinyl Chloride
RoHS	– Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Directive
SVHC	– Substance of Very High Concern
SEDBUK	– Seasonal Efficiency of Domestic Boilers in the UK
SO_x	– Sulphur Dioxides
TEWI	– Total Equivalent Warming Impact
VOC	– Volatile organic compounds
WEEE	– Waste Electrical and Electronic Equipment

1. INTRODUCTION

The EU Ecolabel[1] is an element of the European Commission's action plan on Sustainable Consumption and Production and Sustainable Industrial Policy[2] adopted on 16 July 2008. This is a voluntary scheme established to encourage manufacturers to produce goods and services that are environmentally friendlier. The EU Ecolabel flower logo facilitates consumers and organisations (i.e. public and private purchasers) recognising the best environmentally performing products and making environmentally sound choices more easily. A product (good or service) awarded with this label must meet high environmental and performance standards. The EU Ecolabel covers a wide range of products, and its scope is constantly being widened. The consultation of experts and all interested parties is a key point in the process of establishing the criteria.

Green Public Procurement (GPP) is defined in the Commission Communication on Public procurement for a better environment[3] as "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured." GPP is a voluntary instrument, which public authorities can use to provide industry with incentives for developing and marketing environmentally sounder products.[4]

The primary goals of establishing EU Ecolabel and GPP criteria for hydronic heaters are to increase the energy efficiency during operation of heaters and reduce their greenhouse gas emissions, as the use phase has been identified to contribute most to the environmental impacts caused by this product group. Further, other aspects related to the product's life cycle, which improvement can bring environmental benefits, are also considered.

Establishing the ecological criteria for hydronic heaters and promoting appropriately the awarded products, if accepted by a wider range of producers and users, will contribute to environmentally friendlier products which shall reduce the consumption of energy. Besides, this should also result in other environmental benefits, such as lower air emissions related to energy production and consumption, lower resource consumption, potentially higher resource efficiency management (in relation with product materials, recycling and

[1] EU Ecolabel website: http://ec.europa.eu/environment/ecolabel/about_ecolabel/what_is_ecolabel_en.htm

[2] *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions – on the Sustainable Consumption and Production and Sustainable Industrial Policy Action Plan*, COM (2008) 397, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0397:FIN:en:PDF

[3] *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*, COM (2008) 400, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0400:FIN:EN:PDF

[4] GPP website: http://ec.europa.eu/environment/gpp/what_en.htm

recyclability issues), etc. Finally, the ecolabelled products should also bring private and public customers direct cost savings (e.g. lower water bills).

The following Technical Background Report only reports on EU Ecolabel criteria (GPP criteria are dealt in a separate document) and consists of the following sections. Section 2 briefly presents the project background and motivation for this study. Section 3 introduces and discusses the product definition and scope, and a summary of the overall comments from stakeholders. Section 4 describes the assessment and verification procedure that is essential for the application of the EU Ecolabel. Section 5 presents the proposed EU Ecolabel criteria along with the rationale and a summary of the overall comments from stakeholders and Section 6 concludes the document. Two appendices complete the document: Appendix 1 (Section 7) contains units and conversion factors while Appendix 2 (Section 8) summarises the technical analysis in support of the abovementioned proposed EU Ecolabel criteria.

2. PROJECT BACKGROUND

2.1 Overview

The European Commission's Directorate General for the Environment has initiated a project directed towards developing a joint evidence base for the EU policy making in the area of hydronic heaters. This study has been carried out by the Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) and VHK consultancy, in cooperation with all the interested parties. All the results are presented on a dedicated website: http://susproc.jrc.ec.europa.eu/heating

The purpose of this project is to develop the EU Ecolabel and Green Public Procurement criteria for hydronic heaters. In the framework of the criteria development process three Ad-hoc Working Group (AHWG) meetings took place:

- 1st AHWG meeting was held on 28th June 2011 in Seville, Spain,
- 2nd AHWG meeting was held on 29th November 2011 in Brussels, Belgium,
- 3rd AHWG meeting was held on 17th January 2012 in Brussels, Belgium.

The purpose of these meetings was the presentation of the study results and a following discussion with all interested parties. The discussions and stakeholders' feedback received during the meetings and additionally in a written form along the open consultation phase aided in drafting the proposed EU Ecolabel criteria.

The following tasks have been performed in the frame of the project (and respective reports prepared):

1) Scoping,
2) Product definition,
3) Economic and market analysis,
4) Consumer behaviour,
5) Technical analysis,
6) Policy analysis

All reports for these tasks constitute the Preliminary Report accompanying the Draft Criteria Proposal. They can be downloaded from the previously mentioned project's website.

One of the main outcomes of the environmental assessment of this product group is that the key environmental impacts along the product's life cycle are related to the use phase i.e. the consumption of energy and associated greenhouse gas emissions during operation.

Establishing EU Ecolabel criteria to award the most energy efficient hydronic heaters is expected to result in environmental benefits of energy savings and reduction in greenhouse gas emissions, and consequently reducing environmental impacts caused particularly by energy production, air pollutants, etc.

2.2 Limitations

It is in general recognised that the energy efficiency of different heating technologies depends not only on the technical characteristics of the main unit, but also on how the hydronic heater is installed, in which type of building, and in which climate. This applies especially for heat pumps, where the energy efficiency is critically sensitive to all these issues. While the EU Ecolabel takes it into account, and as part of the criteria provides advice to the consumer on how to best install the hydronic heaters, it is, however, not possible to control the fact that an ecolabelled heat pump might be poorly installed, therefore missing the potential to reduce environmental impacts.

Regarding the choice of heating technologies, the consumer may not always be totally free to select the most environmentally preferable technology in a given situation. For example, the particular building/neighbourhood might have access to district heating only. The EU Ecolabel here assumes that the consumer in principle has total freedom for choosing heating technology, fuel, etc. Also, a house might have insufficient insulation, or have poorly built distribution systems for the heating water, which might lead to increased heat losses and therefore reduced environmental benefits for the same installed ecolabelled heating product. It is thus necessary to be aware of some of these practical limitations, which however are out of the scope of the EU Ecolabel scheme.

Apart from the system design, user behaviour is a crucial aspect affecting energy consumption. There is a wide variety of issues which play a key role. Besides the regional differences, which can be to a certain extent connected with the climatic conditions, the cultural aspects are of importance too. Furthermore, the habits vary significantly among users. Consumer behaviour is also related to environmental consciousness. In summary, user behaviour is a complex issue, and in the frame of this study, a number of assumptions had to be made.

3. PRODUCT DEFINITION AND SCOPE

3.1 Overview of the product group and scope

The product group analysed in the study is hydronic (water-based) heaters. The approach taken is based on a life-cycle analysis perspective with comparing different technologies which all share a common function: the production of one unit of heat for ambient heating, e.g. 1 kWh of useful heat. The objective of this functional approach to hydronic heaters is to help consumers to make a choice between different kinds of heating technologies that provide heating to a hydronic central distribution system. Therefore, considering such product group is consistent with Article 3 of the EU Ecolabel Regulation[5] which defines a "product group" as a set of products that serve similar purposes and are similar in terms of use, or have similar functional properties, and are similar in terms of consumer perception.

The product group "hydronic heaters" shall comprise products that are used to generate heat as part of a hydronic central heating system, where the heated water is distributed by means of circulators and heat emitters in order to reach and maintain the indoor temperature of an enclosed space such as a building, a dwelling, or a room, at a desired level. The operation of the heat generator can be based on a number of processes and technologies, such as:

- Combustion of gaseous, liquid or solid fossil fuels,
- Combustion of gaseous, liquid or solid biomass,
- Use of the Joule effect in electric resistance heating elements,
- Capture of ambient heat from air, water or ground source, and/or waste heat,
- Capture of latent heat from the exhaust gas of combination heaters,
- Cogeneration (the simultaneous generation in one process of heat and electricity),
- Solar energy (auxiliary),

The maximum output power of the hydronic heaters shall be 400 kW.

Combination heaters are included in the scope of this product group, provided that their primary function is to provide ambient heat.

The following products are excluded from the scope of this product group:

- heaters whose primary function is to provide hot drinking or sanitary water;
- heaters for heating and distributing gaseous heat transfer media such as vapour or air;

[5] Regulation (EC) No 66/2010, OJ L 27, 30.1.2010, p. 1.

- cogeneration heaters with a maximum electrical capacity of 50 kW or above;
- space heaters that combine both indirect heating, using central heating system, and direct heating, by direct emission of heat into the room or space the appliance is installed.

Although it is not explicitly stated in the definitions above, it may be that the circulator is an integral part of the heater. For larger heaters the circulator is usually supplied separately, and therefore the circulator itself is out of the scope.

In the case that heaters incorporate a circulator for circulation of heated water in the pipe work and emitters for distributing heat, the circulator shall not be included in the measurement of electric power consumption. For heat pumps, measured according to EN 14511, this means that only the electric power consumption of the circulator needed to overcome internal resistance of the equipment itself shall be included. Nevertheless, pumps used for transportation of fuel or the secondary refrigerant or other purposes shall be included in the consideration of electric power consumption.

3.2 Rationale for product scope and definition

As a first remark, though the product group was referred to “heating systems” at the beginning of the project, it was decided based on stakeholder consultation to rename it into “hydronic heaters”, which is considered as a better description of the product group definition and scope. This is also consistent with Ecodesign Lot 1 on space heaters and combination heaters[6] and Ecodesign Lot 15 on Solid fuel small combustion installations[7]. More generally, the scope and definition of the product group have been aligned to the extent possible with the Ecodesign Lots 1 and 15.

The scope of the product group is hydronic heaters, in all relevant combinations, up to a maximum output power of 400 kW (except for cogeneration which is limited to 50 kW). Defining such power limit is in line with the Boiler Directive[8] and Ecodesign Lots 1 and 15.

The open scope to all types of technologies reflects the discussions with stakeholders and means that any technology is in principle acceptable, provided that the hydronic heater meets all the relevant criteria, in particular (but not only) the ones on energy efficiency and greenhouse gas (GHG) emissions. For instance coal boilers are part of the scope, but technically, it is highly unlikely that they can meet the GHG emission benchmarks. As another example, oil boilers are in the scope but it is highly unlikely that a boiler fuelled with

[6] See for more information: http://www.ecoboiler.org/
[7] See for more information: http://www.ecosolidfuel.org/
[8] Directive 92/42/EEC, OJ L 167, 22.6.1992, p. 17.

only fossil oil will meet the required benchmarks. Instead, the liquid fuel will likely need to include at least some percentage of biomass or the oil boiler should be "hybridised" (combined with for instance solar collectors or a heat pump) in order to meet the criteria. In a broader perspective, the criteria never mention the origin of the fuel (fossil vs. biomass) and only refer to as e.g. gas fuel boilers, liquid fuel boilers, etc.

The exclusion from the scope of heaters mainly providing hot water or based on gaseous heat transfer media and cogeneration space heaters with electrical capacity ≥ 50 kW is in line with the Ecodesign Lot 1.

The exclusion of heaters combining both indirect and direct heating comes from the fact that the performance and heat balance of such appliances is different to heaters intended for connecting to a central heating system only.

The exclusion of the circulator from the scope when computing the energy efficiency is also in line with the Ecodesign Lot 1.

3.3 Summary of stakeholder feedback on product scope and definition

From stakeholders' feedback, hydronic heaters are considered as an appropriate product group with accounting for the largest share of the environmental impact of heating buildings, not only in terms of energy consumption but also taking into account a number of other impacts including greenhouse gas and other air emissions. They account for more than 80 % of the environmental impact of all types of space heaters in buildings in the EU-27 (including hydronic and air-based central heaters and room heaters). Moreover, they also represent one of the largest environmental impacts among all kinds of consumer products in the EU-27.

Investigating a common benchmark approach was strongly supported by the AHWG to make different heating technologies comparable. Main arguments are gathered below:

- Strong support was given to the common benchmark approach comparing the different heat generator technologies, which can provide useful information to the consumer in making an appropriate choice for heating a building and allow for a fair comparison and selection of the best products from an environmental perspective with respect to the function of ambient heating, per one unit of heating (functional unit). It is to be noted that no ecolabelling scheme so far has developed criteria for all hydronic heaters taken together as a group, and instead have developed criteria for individual heating products. The current approach may provide an added value of a more holistic approach to the heating market compared to the approach followed by other available ecolabels.

- The EU Ecolabel criteria development should take into account the methodology of previous product policies such as Ecodesign, Energy Labelling and the Energy Performance of Buildings Directive (EPBD). There was a broad consensus among stakeholders especially to follow closely the methodology developed for the Ecodesign Lot 1. Past research and criteria development exercises have revealed rather broad methodological differences between Ecodesign (mandatory minimum standards) and EU Ecolabel (award to the best ~20% performing products within a product group), which are mainly caused by the different aim and characteristics of the instruments. While keeping this in mind, the research results from this study should be used to contribute as far as possible to an increased coherence among related product policy instruments.
- It is necessary to take into account different climate zones, and was suggested to follow the same methodology as in the Ecodesign Lot 1.
- The heating system needs to be matched with the type of building where it is installed, as is done in the application of the EPBD. It is not possible to compare just hydronic heaters alone, but a factor needs to be introduced to take into account what type of building the system is installed in.

Some concerns with the presented EU Ecolabel/GPP approach were also raised by some stakeholders. These opinions and our position are noted below:

- The "systems" or "technology-neutral" approach is claimed not to fit with the market reality, and a risk is perceived that the common benchmark approach could lead to market distortions and the discrimination in favour of commercially available packaged heat generators vs. ad-hoc installed heat generators (not available off-the-shelf). However, our position is that EU Ecolabel criteria need to address the current market, i.e. the products existing on the market. Products not available for purchase on the market are out of the scope.
- A few stakeholders stated that no market advantage should be given to packaged systems. A packaged system is defined as a hybrid (hydronic) heater that is composed of a number of individual heat generators, which are separately available on the market, and which are combined at point installation. In summary, while it is reasonable that the EU Ecolabel could apply to hybrid systems, some stakeholders requested that it cannot be applied to packaged combinations of products that are

available on the market separately. Our position is that EU Ecolabel criteria need to address the current market, i.e. the products existing on the market, which includes hybrid or packaged systems.

- Stakeholders raised some questions about how to address hybrid systems. Opinions diverge regarding whether the hybrid systems should be ecolabelled as a product package or only given to the individual products of which hybrid systems are comprised (an approach that might be considered easier and more practical). As explained above, our position is that hybrid systems are available and sold on the market and as such should be eligible for the EU Ecolabel criteria (with specific criteria whenever needed).
- It was expressed that the information content of common benchmark criteria is too low to be worthwhile. Our position is that, in order to address effectively the large impact currently caused by hydronic heaters in the EU (40% of the primary energy consumed in Europe is consumed in the heating and cooling of buildings), a combination of approaches and measures (mandatory and voluntary) will be needed. While mandatory measures imposing certain minimum performance of hydronic heaters and energy performance of buildings might be seen as the most effective, the voluntary EU Ecolabel will with no doubt provide valuable information to the consumers in their choice of the most environmentally sound hydronic heaters and will contribute positively to the reduction of energy consumption and greenhouse gas emissions from heating of buildings in the EU.
- In the opinion of some stakeholders, the EU Ecolabel should not be awarded to fossil-fuelled hydronic heaters, and instead the development of EU Ecolabel criteria should focus on renewable fuels. Our position is that the development of a common benchmark is not necessarily in opposition to this comment. The study provides data that allows a fair comparison of different heat generator technologies employing different fuels. No technology or fuel is excluded a priori from the analysis. However, as a result of the analysis, some technologies or fuels has been found not to meet the needed minimum performance requirements to be awarded the EU Ecolabel, on the basis of the scientific evidence from a life cycle analysis perspective collected during the study.
- Regarding the comments on the different fuel mixes from MS (Member State) to another, it was agreed with stakeholders that the EU grid is interconnected and therefore that the development of EU Ecolabel criteria does not need to take into account different fuel mixes.

Other feedback from stakeholders is summarised below:

- Some experts asked to consider including district heating as part of the scope. District heating represents a significant market of the total heating market in a few EU MS, such as Austria, Germany and Sweden. For example in Sweden, the heating market is composed almost entirely of equal fractions of: district heating, heat pumps and biomass heaters; in Austria, district heating has a market share of 21 % of the residential heating market. However, district heating is not significant in most EU MS at the moment and it is estimated to represent about 10% of the total heating market in the EU-27, a relatively small although not insignificant fraction. District heating is not part of the scope of the Ecodesign Lot 1. In addition, the provision of district heating can be regarded more as a “service” rather than a specific product that can be purchased by end consumers. From a methodological point of view, there are also some challenges in developing an energy efficiency criterion consistent with the other types of hydronic heaters addressed within the scope of this study. The energy efficiency calculation for district heating is very different from the other types of heat generating products (it partly explains why it was not included in the scope of the Ecodesign Lot 1). Finally, the capacity of district heating is typically larger than 400 kW[9], thus out of the scope of the Ecodesign Lot 1 and the present study. Therefore, district heating was proposed to be excluded from the scope, while leaving space for possible future development of EU Ecolabel criteria for district heating when criteria for hydronic heaters are revised.
- Some experts suggested including also room heating products, such as biomass stoves. It was reported that these space heating systems are increasingly being used in low-energy and zero-energy buildings or replacing old heating systems in thermally renovated buildings. However, the scope of the EU Ecolabel criteria was decided to focus on central heating products only (not room heating products), as it done for Ecodesign (where central and room heating products are considered separately). Additionally room heating systems still represent a small market in the EU-27 as a whole. Also, they could be addressed in a separate EU Ecolabel criteria set for space heating products in the near future.
- A few stakeholders suggested excluding all electrically-driven appliances. The study did not exclude any type of technology or energy source from the start, with assuming that if products, whether or not electrically-driven, are able to meet the energy efficiency and greenhouse gas emission benchmarks, it would be difficult to find

justification to exclude these products from the scope. For example, several types of electrically-driven heat pumps may be very energy efficient and have low climate change impact and therefore should be eligible for the EU Ecolabel.

- Some stakeholders proposed to allow renewable fuels only. Again the approach was to have a common benchmark or standard to select those products that are energy efficient and which have low greenhouse gas emissions, without pre-judging on the type of fuel (renewable vs. non-renewable). It is likely that a number of hydronic heaters fuelled with renewable sources may meet the benchmarks proposed, while most (if not all) hydronic heaters fuelled with non-renewable sources only cannot. Stakeholders have expressed that fossil-fired condensing boilers have not been state-of-the-art for at least the past 15 years and should not be supported by an ecolabel. Nevertheless, the benchmark is set so that only the most efficient technologies can pass, which will drive this product group to better environmental performance, and in the case of stand alone condensing boilers, to our knowledge no model currently on the market can reach the energy efficiency threshold proposed for the EU Ecolabel in the whole range of operation temperatures.. The EU Ecolabel may have a positive impact therefore in driving innovation in the heating technologies market as a whole. It was mentioned that in some MS (such as Austria and Germany) fossil-fired condensing boilers are not given public financial incentives anymore. This in itself is however not enough reason to exclude the best products from acquiring the EU Ecolabel, since the mentioned financial incentives and ecolabels are different product policy initiatives which have different aims and goals.

- Solid fuels boilers (see the Ecodesign Lot 15) cover a range of solid fuels such as anthracite and other coal types, peat, manufactured mineral fuels, biomass (wood log, chips, pellets, etc.) and waste. Several stakeholders specifically requested to exclude coal entirely. It should be noted that coal has, among fossil fuels, one of the highest greenhouse gases emissions per kWh useful heat output, above 600 g CO_2-equivalent/kWh heat output for the base case analysed in the life-cycle analysis, compared to ~30-50 g CO_2-equivalent/kWh heat output for biomass boilers (see the Preliminary Report). The environmental performance of coal boilers is therefore much lower than solid biomass boilers, which may explain that no existing ecolabels include coal-fired systems among their scope. However, the idea for the EU Ecolabel is to have a technology neutral approach as much as possible. It does therefore not by default exclude boilers using fossil fuels. However, the way the benchmarks are proposed for the different criteria, in reality, gathered information shows that the only

[9] See for more information: www.euroheat.org/

fossil fuel that could be labelled, would be the very best gas boilers in combination with renewable energy (and not a stand alone gas boiler). This means that no current coal-fired heater can meet the proposed criteria.

- Some stakeholders have proposed a harmonization of the definitions used in EU Ecolabel with the definitions of Ecodesign and Energy Labelling, in order to avoid confusion and to reach a real alignment between the EU product policies.
- Some stakeholders support the alignment of EU Ecolabel scope with the Energy labelling regulation which covers heaters and packages with a rated heat output ≤ 70 kW, instead of the Ecodesign scope, which covers up to 400 kW devices. The argument behind this proposal is that for the higher heat output range of above 70 kW, a professional service assists the customer to choose the product to be installed. From our point of view, this is not sufficient reason to remove products from the scope which was initially agreed. The scope of EU Ecolabel proposal is aligned to Ecodesign scope, and it allows EU Ecolabel to cover those applications beyond individual residential applications: collective residential and non-residential. The aim of this scope is providing the information of the best environmental-performance products to any kind of purchaser of a space heater (a flat-owner, a building-owner, a joint ownership), which optimises the potential of environmental improvement of the EU Ecolabel.
- Some MS propose to remove the technologies based on the capture of latent heat from the exhaust gas of combination heaters, since the passive flue heat recovery devices have been removed from Ecodesign and Energy Labelling. To our understanding of Ecodesign scope and definitions, this type of technology is covered by the definition of heat pump within Article 2*:"a space heater using ambient heat from an air source, water source or ground source, and/or waste heat for heat generation; a heat pump space heater may be equipped with one or more supplementary heaters using the Joule effect in electric resistance heating elements or the combustion of fossil and/or biomass fuels"*. That means that the technologies based on the capture of latent heat from the exhaust gas of combination heaters are heat pumps able to recover this waste heat and they are included in the scope of Ecodesign. This comment might derive from some differences in the product definitions between the EU Ecolabel and Ecodesign and Energy Labelling, that can be solved by mean of the harmonization proposed above.
- Some feedback suggests applying a biomass exclusion from the EU Ecolabel scope, in the same way as Ecodesign, which doesn't apply to heaters specifically designed

for using gaseous or liquid fuels predominantly produced from biomass. The argument that supports this proposal is the correct application of the methodology provided by Ecodesign to calculate the energy efficiency. The introductory text of the Ecodesign regulation explains that "heaters that are designed for using gaseous or liquid fuels predominantly (more than 50 %) produced from biomass have specific technical characteristics which require further technical, economic and environmental analyses. Depending on the outcome of the analyses, ecodesign requirements for those heaters should be set at a later stage, if appropriate". It is our understanding that this exclusion is due to difficulty of setting a benchmark on this type of technology but that currently work in on-going also within the Ecodesign framework for biomass (Lot 15).

3.4 Description of products included in the scope

The scope of hydronic heaters considered for EU Ecolabel and GPP criteria development in the current project covers hydronic heaters in domestic, commercial or industrial premises with the primary aim of heating indoor spaces by providing heat to a water-based central heating system, in order to reach and maintain the indoor temperature of an enclosed space such as a building or a dwelling at a desired level.

Hydronic heaters within the scope of Directive 2010/75/EU[10], heaters whose primary aim is to provide domestic sanitary hot water, heaters for heating and distributing gaseous heat transfer media such as vapour or air, or cogeneration heaters with a maximum electrical capacity of 50 kW or above, are excluded from the scope.

A hydronic central heating system consist of a set of several elements, including the hydronic heater itself, the circulator (if not integrated in the heater), radiators, heat exchangers, hot water storage cylinders, pipe work, and insulation. The exact nature of the different elements will depend on the type of distribution of the heating. Heating in any house or building is a key component of the overall building energy efficiency, and the heater unit is the main element that will influence the overall environmental impact of the system. The most common devices for achieving the heat distribution are circulators, which pump the hot water to the final emission points.

The product group shall comprise the following types of heat generator technologies:

[10] OJ L 334, 17.12.2010, p. 17

- **Central heating boilers (CH boilers)** are devices designed to provide hot water for space heating, with a variety of energy sources (natural gas, oil, biomass, electricity, etc.), and different technologies such as condensing or non-condensing technologies. Condensing boilers recover the latent heat of evaporation contained in the water vapour of flue gases, and are significantly more energy efficient. Boilers that provide sanitary hot water as a secondary function are called central heating combination boilers and they are also part of the scope.
- **Heat pumps** are used to extract heat from a variety of sources: ground rock, ground water, surface water, air, etc. They also have a large variety of applications. Heat pumps can be used to heat water as hydronic heaters, typically providing heat delivery by under-floor heating.
- **Combined heat and power (CHP),** or **cogeneration units** are based on the simultaneous generation of thermal energy and electricity and/or mechanical energy. Micro-CHP units are defined as those with < 50 kWe capacity and are within scope. Outside the scope are small-scale CHP as those with < 1 MWe capacity. CHP units may be powered by a variety of energy sources.
- **Solar thermal assisted technologies** are also used as part of the solution, but in combination with other heating technologies.

Typical sources of energy depend on the specific heating technology, but may include electricity, solar thermal, heat transfer from ground, water or air by heat pump technology, liquid fuels from fossil or biomass origin, gas from fossil or biomass origin, wood, coal, etc., and combinations of energy sources. Solar thermal heating appears to be on the increase for ambient heating and hot water provision in buildings.

This study analyses the feasibility of developing a common benchmark to address and compare horizontally different hydronic central heating technologies as one single product group. Hydronic heaters represent a very large group. This group accounts for roughly 86% of the total use phase primary energy consumption by space heaters (central and room space heaters together) in the EU (see the Preliminary Report[11]), therefore representing most of the environmental impact of all types of space heaters taken together.

[11] For more information, see Table 7 from: IPTS (2010), Development of EU Ecolabel and GPP Criteria for Heating and Cooling Systems, Draft Task 1 Report, available at: http://susproc.jrc.ec.europa.eu/heating/docs/1%20IPTS%20Scope%20Draft%201%20-%20Heating&Cooling%20Systems.pdf

The most cited performance parameter of the boiler is the (nominal) power output in kW[12]. The scope of boilers is set to a maximum of 400 kW consistently with the Boiler Directive. The heating capacity is an essential parameter for correct sizing of boiler to the building load. The heating capacity of boilers should be sufficient to cover the space heating need of a dwelling or building on the coldest day of the year or rather the last decade (as defined in relevant test standards). On the other days the boiler will function in part load.

For that reason, the test standards, discussed in the technical background report for the present study distinguish between heating energy efficiency not only at full load, but also at 30% part-load and – on occasion – in stand-by/zero load. As will be argued in the following chapters, this is still a very crude approximation of what happens in real-life. Various studies have shown that the average load over the heating season is more in the range of 10% of the nominal boiler capacity. This not only due to the outdoor temperature variations over a heating season, but also due to over-sizing and – especially for an instantaneous combination boiler – due to sizing of the boiler primarily for the water heating function.

A summary of scope of the product group is presented in Table 1.

Table 1. Summary of scope of product group

Heat generator technology	Fuel	Nominal power output	Working principle
Gas fuel boiler	- Fossil fuel: natural gas, propane - Biomass: biogas	4-400 kW (thermal)	Combustion
Liquid fuel boiler	- Fossil fuel: LFO - Biomass: bio-oil	4-400 kW (thermal)	Combustion
Solid fuel boiler	- Fossil fuel: coal - Biomass: wood logs, wood chips, wood pellets	4-400 kW (thermal)	Combustion
Electric boiler	Electricity	4-400 kW (thermal)	Joule effect
Fuel-driven heat pump	- Fossil fuel: natural gas, propane, LFO - Biomass: biogas, bio-oil - Other (in combination): waste heat, solar heat	4-400 kW (thermal)	Gas driven engine, driving a compressor for a vapour compression cycle Gas-fired combustion, driving a sorption process
Electrically-driven	Electricity	4-400 kW (thermal)	Electric compressor driving

[12] The maximum nominal power output refers to the energy output expressed as kW thermal energy at nominal conditions. Nominal conditions are standardised test conditions (also known as standard rating conditions) for certain set system parameters (flow rate of medium, etc.). Nominal power output is not the same as nominal power input, because the boiler introduces generator losses (except for heat pumps, where the nominal power input in electric kW is lower than the power output in kW of heat, since the renewable energy input is not counted). However, for smaller boilers (e.g. <50 kW) the nominal rating often refers to OUTPUT power.

heat pump			a vapour cycle
Cogeneration	- Fossil fuel: natural gas, propane, oil - Biomass: biogas, bio-oil	4-400 kW (thermal) < 50 kWe (electric)	Micro: external combustion (Stirling engine) Mini: internal combustion (piston engine driving a generator) Other: fuel cells, based on electrochemical principles
Solar thermal	Solar energy in combination with electric energy for pumps/controls (needs other technology to fulfil heating demands in all circumstances)	Not applicable (size depends on location, budget and application)	Capturing and storage of solar irradiation

As detailed in the Preliminary Report, the technical study estimated an average EU heating demand of 7500 kWh per dwelling per year. In manufacturing terms, Prodcom data show an annual EU production of 6.9 million boilers in 2009 (for gas and oil-fired boilers) and most of them are produced for the EU market (considering the limited value of import and export, respectively some 230 and 807 million euro).

In addition, the Ecodesign Lot 1 estimated boiler sales of around 6.9 million units in 2010 (excluding solid fuel boilers), a boiler stock of approximately 110.9 million boilers and an annual primary energy consumption of 10.5 PJ. The CO_2 emissions were estimated to be about 600 Mt, and SOx emissions about 700 kt. The screening analysis shows that central heating boilers are among the product groups with the highest energy-consumption in Europe.

4. ASESSMENT AND VERIFICATION

4.1 General guidelines for assessment and verification

The specific assessment and verification requirements are indicated within each criterion; nevertheless several general issues regarding this process are indicated below:

- Where the applicant is required to provide declarations, documentation, analyses test reports, or other evidence to show compliance with the criteria, these may originate from the applicant or his supplier or both.
- Where possible, the testing shall be performed by laboratories that meet the general requirements of European Standard EN ISO 17025 or equivalent.
- Test methods for each criterion, unless specified otherwise, shall be those described in the relevant Standards as indicated in Table 2 and Table 3 (where applicable). Where appropriate, test methods other than those indicated for each criterion may be used if the competent body assessing the application accepts their equivalence.
- Where appropriate, competent bodies may require supporting documentation and may carry out independent verifications.

Table 2. Relevant standards for test methods

Number	Title
Gas fuel boiler heaters	
EN 676	Forced draught burners for gaseous fuels
EN 15502-1	Gas-fired heating boilers – Part 1: General requirements and tests
Liquid fuel boiler heaters	
EN 267	Automatic forced draught burners for liquid fuels
EN 303-1	Heating boilers - Part 1: Heating boilers with forced draught burners - Terminology, general requirements, testing and marking
EN 303-2	Heating boilers – Part 2: Heating boilers with forced draught burners – Special requirements for boilers with atomizing oil burners
EN 303-4	Heating boilers - Part 4: Heating boilers with forced draught burners - Special requirements for boilers with forced draught oil burners with outputs up to 70 kW and a maximum operating pressure of 3 bar - Terminology, special requirements, testing and marking
EN 304	Heating boilers – Test code for heating boilers for atomizing oil burners
Solid fuel boiler heaters	
EN 303-5	Heating boilers – Part 5: Heating boilers for solid fuels, manually and automatically stoked, nominal heat output of up to 500 kW –

	Terminology, requirements, testing and marking
Electric boiler heaters	
EN 60335-2-35	Household and similar electrical appliances – Safety – Part 2-35: Particular requirements for instantaneous water heaters
Fuel-driven heat pump heaters	
EN 12309 series	Gas-fired absorption and adsorption air-conditioning and/or heat pump appliances with a net heat input not exceeding 70 kW
DIN 4702, Part 8	Central heating boiler; determination of the standard efficiency and the standard emissivity
Electrically-driven heat pump heaters	
EN 14511 series	Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling
EN 14825	Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling – Testing and rating at part load conditions and calculation of seasonal performance
Cogeneration heaters	
EN 50465	Gas appliances – Combined Heat and Power appliance of nominal heat input inferior or equal to 70 kW
ISO 3046-1	Reciprocating internal combustion engines – Performance – Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods – Additional requirements for engines for general use

Table 3. Additional relevant standards for test methods of air emissions

Number	Title
Nitrogen oxide emissions	
EN 14792	Stationary source emissions – Determination of mass concentration of nitrogen oxides (NOx) – Reference method: Chemiluminescence
Carbon monoxide emissions	
EN 15058	Stationary source emissions – Determination of the mass concentration of carbon monoxide (CO) – Reference method: Non-dispersive infrared spectrometry
Organic gaseous carbon emissions	
EN 12619	Stationary source emissions – Determination of the mass concentration of total gaseous organic carbon – Continuous flame ionisation detector method
Particulate matter emissions	
EN 13284-1	Stationary source emissions – Determination of low range mass concentration of dust – Part 1: Manual gravimetric method

4.2 Test laboratory

The analysis laboratory must meet the general requirements pursuant to standard EN ISO 17025 or be an officially GLP-approved analysis laboratory.

The applicant's analysis laboratory/measurement may be approved to conduct analyses and measurements if:

- The authorities monitor the sampling and analysis process, or
- The manufacturer has a quality system incorporating testing and analyses and which is certified in accordance with ISO 9001, or
- The manufacturer's test laboratory can be approved to conduct testing to document effectiveness if the following additional requirements are met:
  - It must be possible for ecolabelling organisations to monitor the performance of testing.
  - The ecolabelling organisation must have access to all data on the product.

4.3 Procedure for acceptance of a test laboratory

Regarding assessment and verification, it is stated above that "Where possible, the testing should be performed by laboratories that meet the general requirements of EN ISO 17025 or equivalent". There is a need for a common practice on how this shall be interpreted, and the following paragraphs describe a hierarchy of situations and conditions for acceptance of a laboratory. The situation in paragraph 1 is preferred; if this is not possible, paragraph 2 comes into force, etc.

The national competent body or ecolabelling board will consider the applications individually taking into account the following approach and making a decision according to the concrete situation without prejudice to the credibility of the European ecolabelling scheme.

1. Laboratory tests shall be performed by laboratories that are accredited for the specified test method according to ISO 17025 or GLP, where possible. The Competent Bodies accept accredited laboratories in all Member States in the EU/EEA and in countries that have signed the mutual recognition agreement according to ILAC, the international accreditation organisation. If in the Member State where the applicant submits its dossier or where the company or the concerned production plant or service is based, one or more laboratories are accredited according to ISO 17025 or GLP, applicants shall use such a laboratory, either in that Member State or another.

2. Laboratories with an accreditation for other tests than those required by the criteria can be accepted if they submit a declaration that the tests are done following the same quality management procedures as the tests for which they obtained an accreditation. In case of doubt, the competent body or national board shall inspect the lab that carries out the tests or shall select an accredited auditor who will be charged to do so.
3. If neither point 1 or 2 is possible, applicants should call on a non-accredited independent laboratory certified or approved by a Government Department or other public body in a Member State. In case of doubt, the competent body or national board shall inspect the lab that carries out the tests or shall select an accredited auditor who will be charged to do so.
4. If none of points 1 - 3 are possible, applicants may have the tests performed by an independent laboratory that is neither accredited nor approved by authorities according to point 3. Laboratories with a quality management system shall be preferred. A laboratory situated in an organisation holding an ISO 9001- certificate, may be accepted if the scope of the certification includes the laboratory. The competent body or national board shall verify the competence of the laboratory that carries out the tests or shall select an accredited auditor who will be charged to do so.
5. If none of the above mentioned points can be fulfilled, the applicant may have the tests carried out in a company laboratory (that is not accredited ISO 17025 or GLP, as this would be covered by point 1). The competent body or national board shall ensure that the tests are properly carried out or shall select an accredited auditor who will be charged to do so. In this case, the laboratory shall have a quality management system. A laboratory within an organisation holding an ISO 9001 certificate is accepted as being under appropriate quality management if the scope of the certification includes the laboratory. This option may also be used for continuous monitoring of the production, including discharges and emissions, and for testing fitness for use when no standard test method exists.

4.4 Summary of feedback received

The majority of the feedback received coincides in that commonly-used and international standards should be used in order to avoid unnecessary costs and additional burdens to industry. The majority of stakeholders agreed on requiring third-party certification, i.e. testing must be conducted by a third party, rather than relying on a declaration of compliance by the producers (supported by the results of tests conducted within the company). Only institutes which are accredited to these standards shall be allowed for testing. Stakeholders' feedback has suggested that small changes in the testing design and incorrectly scaled instruments lead to incorrect results, and that non-accredited institutes have been producing results that were very different than the results from accredited institutes. Therefore there was strong support to require that testing shall be done by accredited institutions.

5. PROPOSED ECOLABEL CRITERIA

5.1 Overview

The following section presents the criteria proposed for hydronic heaters. Their selection is based on JRC IPTS work conducted in the frame of the project[13], stakeholders' written feedback and the discussions conducted during the AHWG meetings for the criteria development. Further, taking into account the recommendation of the EU Ecolabel Regulation to seek for harmonisation of the EU Ecolabel scheme and national ecolabelling schemes in MS, criteria from existing national and also industrial ecolabelling schemes were considered.

The EU Ecolabel Regulation states that the EU Ecolabel criteria shall be determined on a scientific basis considering the whole life cycle of products. In the frame of the project, a life-cycle analysis of 12 base cases were performed (see the Preliminary Report) and the analysis allowed for identifying the main issues contributing to the environmental impacts, within data uncertainties and methodological limitations. Here are the main issues:

- **Energy efficiency:** Energy efficiency is a key issue since energy consumption during the use phase contributes most significantly to the overall environmental impact of hydronic heaters. Work carried out for other EU policy schemes (Ecodesign and Energy Labelling) is taken on board and the energy efficiency shall be tested and evaluated with following the Ecodesign Lot 1 methodology.
- **Greenhouse gas emissions:** The calculation of greenhouse gas emissions (GHG) is mainly based on CO_2 emissions, together with refrigerant leakage (if applicable). The effect of refrigerant leakage depends on the assumption of leakage rate, and on the global warming potential (GWP) of the refrigerant substance. The overall calculation of GHG emissions is expressed in grams CO_2 equivalent per kWh of heat output produced.
- **Refrigerant:** Criteria on refrigerants used in heat pumps are needed because some refrigerants have environmental impacts related to ozone depletion and climate change due to possible leakage of refrigerant, mainly during use phase or end-of-life.
- **Other air emissions:** Air emissions of different substances have impacts on the environment (e.g. acidification) and health (indoor air quality). Indicators evaluated in the life-cycle analysis include: nitrogen oxides (NO_x), sulphur oxides (SO_x), carbon monoxide (CO), volatile organic compounds (VOC), organic carbon (OGC), persistent organic pollutants (POP), heavy metals (HM) in air, polycyclic aromatic hydrocarbons

(PAH) and particulate matter (PM). Some of these indicators are grouped in a few air emission parameters that are usually part of ecolabelling schemes for hydronic heaters.

- **Noise:** Noise is an issue mainly identified for heat pumps and for some cogeneration units.
- **Materials (hazardous substances[14] and plastic parts):** The material composition should not contain hazardous substances (hazardous substances can be released during different life cycle phases of the product). These criteria have been developed on the basis of Articles 6(6) and 6(7) of the EU Ecolabel Regulation.
- **Product design for sustainability:** This criterion is related to the promotion of reuse, recycling and generally a sound end-of-life management; it can be measured using parameters such as: design for repair and spare part availability, warranty, sound end-of-life management, etc.
- **Installation instruction and user information, and information appearing on the EU Ecolabel:** These two criteria include consumer information/user instructions for installation, operation and end-of-life management, and the information appearing on the EU Ecolabel indicating the main environmental benefits of using the purchased product.

The list of criteria derived from the main environmental issues presented below is as follows:

Common benchmark criteria:

1. Minimum energy efficiency
    a. Minimum seasonal space heating energy efficiency
    b. Minimum water heating energy efficiency
2. Greenhouse gas emission limits

Additional criteria:

3. Refrigerant and secondary refrigerant
4. Nitrogen oxide (NO_x) emission limits
5. Carbon monoxide (CO) emission limits

[13] For details please see the project's website: http://susproc.jrc.ec.europa.eu/heating/

[14] Annex I of the the Ecolabel Regulation specifically requires the "analysis of the possibilities of substitution of hazardous substances by safer substances, as such or via the use of alternative materials or designs, wherever technically feasible, in particular with regard to substances of very high concern as referred to in Article 57 of Regulation (EC) No 1907/2006".

6. Organic gaseous carbon (OGC) emission limits
7. Particulate matter (PM) emission limits
8. Noise emission limits
9. Hazardous substances and mixtures
10. Substances listed in accordance with Article 59(1) of Regulation (EC) 1907/2006
11. Plastic parts
12. Product design for sustainability
13. Installation instructions and user information
14. Information appearing on the EU Ecolabel

Table 4 presents the applicability of the different criteria to each heat generator technology. In the case of a hybrid heater, it shall comply with all the criteria applicable to each of the heat generator technologies it is made of.

Table 4. Applicability of the different criteria to each of the heat generator technologies

Criteria \ Heat generator technology	Gas boiler heaters	Liquid fuel boiler heaters	Solid fuel boiler heaters	Electric boiler heaters	Fuel-driven heat pump heaters	Electric-ally-driven heat pump heaters	Cogene-ration heaters
1(a) – Minimum seasonal space heating energy efficiency	x	x	x	x	x	x	x
1(b) – Minimum water heating energy efficiency (applicable to combination heaters only)	x	x		x	x	x	x
2 – Greenhouse gas emission limits	x	x	x	x	x	x	x
3 – Refrigerant and secondary refrigerant					x	x	
4 – Nitrogen oxide (NOx) emission limits	x	x	x		x		x
5 – Carbon monoxide (CO) emission limits	x	x	x		x		x
6 – Organic carbon (OGC) emission limits			x				
7 – Particulate matter (PM) emission limits		x	x				x

8 – Noise emission limits					x	x	x
9 – Hazardous substances and materials	x	x	x	x	x	x	x
10 – Substances listed in accordance with Article 59(1) of Regulation (EC) 1907/2006	x	x	x	x	x	x	x
11– Plastic parts	x	x	x	x	x	x	x
12– Product design for sustainability	x	x	x	x	x	x	x
13 – Installation instructions and user information	x	x	x	x	x	x	x
14 – Information appearing on the EU Ecolabel	x	x	x	x	x	x	x

The remaining of the Section will present, one by one, each criterion and associated testing methods as well as the rationale behind and the main stakeholder feedback.

5.2 Common benchmark criteria

5.2.1 Introduction

The common benchmark approach is composed of two parameters, which are the two main key areas: energy efficiency and GHG emissions. The energy efficiency (criterion 1) is defined as a minimum to achieve and applies to both space heating and, if applicable, water heating (in the case of combination heater). GHG emission limit (criterion 2) is a threshold not to exceed, defined in grams CO_2-equivalent per kWh of heat output produced. To the extent possible, limit values of the common benchmark have been set for each parameter independently of the heat generator technology. In addition, any product applying for the EU Ecolabel on hydronic heaters shall meet both criteria.

In the following, criteria 1 and 2 are discussed separately.

5.2.2 Criterion 1 – Minimum energy efficiency

5.2.2.1 Criterion 1(a) – Minimum seasonal space heating energy efficiency

5.2.2.1.1 Proposed criterion

The seasonal space heating energy efficiency η_s of the hydronic heater shall not fall below the limit values set out in Table 5.

Table 5. Minimum requirements for seasonal space heating energy efficiency by heat generator technology

Heat generator technology	Minimum seasonal space heating energy efficiency

All heaters except solid biomass boiler heaters	$\eta_s \geq 98$ %
Solid biomass boiler heaters	$\eta_s \geq 79$ %

The seasonal space heating energy efficiency shall be calculated with following the procedures set out in Annex III to Regulation (EU) No … implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters [Number of the Regulation and OJ reference in footnote to be inserted[15]] and in Annex VII to Regulation (EU) No … supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to the energy labelling of space heaters, combination heaters, packages of space heater, temperature control and solar device and packages of combination heater, temperature control and solar device [Number of the Regulation and OJ reference in footnote to be inserted[16]], including, where applicable, the transitional methods set in Commission Communication No … [Number of the Regulation and OJ reference in footnote to be inserted[17]].

For solid fuel boiler heaters, η_s shall be calculated according to the aforementioned procedures with taking into account the following provisions:

(a) the calculation of η_s shall be based on the gross calorific value of the wet fuel (as received) GCV_{ar}, which corrects for the moisture content in the fuel but includes in the energy content the latent heat energy stored in hydrogen that is oxidised to water in the combustion process. The principles laid down in Standard EN 303-5:1999 shall apply to estimate η_s, while GCV_{ar} instead of the net calorific value of the wet fuel (as received) NCV_{ar} shall be used for the calculation of η_s.

(b) for determining the calorific value of solid biomass, the principles laid down in Standard EN 14918:2009 shall apply.

(c) The gross calorific value of the wet fuel at constant volume $GCV_{ar,V}$ can be derived as follows:

$$GCV_{ar,V} = GCV_{dry,V} \times (100 - m) / 100 \text{ [MJ/kg]}$$

where:

m is the moisture content of the wet fuel (percentage by mass)

[15] This refers to Ecodesign Lot 1.
[16] This refers to Energy Labelling Lot 1.
[17] This refers to the Commission Communication describing the transitional methods applicable to Ecodesign and Energy Labelling Lot 1, to be replaced by harmonised standard(s).

$GCV_{dry,V}$ is the gross calorific value of the dry fuel (moisture-free) at constant volume

(d) The gross calorific value of the dry fuel at constant volume $GCV_{dry,V}$ can be derived as follows:

$$GCV_{dry,V} = NCV_{dry,P} + 0.2122 \times H_{dry} + 0.0008 \times (O_{dry} + N_{dry}) \text{ [MJ/kg]}$$

where:

$NCV_{dry,P}$ is the net calorific value of the dry fuel (including ash) at constant pressure

H_{dry} is the hydrogen content of the dry fuel (percentage by mass)

O_{dry} is the oxygen content of the dry fuel (percentage by mass)

N_{dry} is the nitrogen content of the dry fuel (percentage by mass)

(e) The net calorific value of the dry fuel at constant pressure $NCV_{dry,P}$ can be derived as follows:

$$NCV_{dry,P} = NCV_{ar,P} \times 100 / (100 - m) + 2.443 \times m / (100 - m) \text{ [MJ/kg]}$$

where:

$NCV_{ar,P}$ is the net calorific value of the wet fuel at constant pressure

(f) It shall be noted that with combining (c), (d) and (e), $GCV_{ar,V}$ can be derived from $NCV_{ar,P}$ as follows:

$$GCV_{ar,V} = NCV_{ar,P} + [0.2122 \times H_{dry} + 0.0008 \times (O_{dry} + N_{dry})] \times (100 - m) / 100 + 0.02443 \times m \text{ [MJ/kg]}$$

Assessment and verification:

5.2.2.1.2 Assessment and verification

The applicant shall declare that the product complies with this criterion and provide test results conducted in accordance with the testing procedure indicated in the EN standards (including transitional methods where applicable) applicable to the given type of product (see Table 2). Measurements and calculations shall be made using the methodology of seasonal space heating energy efficiency of packages following the procedures mentioned above. For solid fuel boiler heaters, the provisions mentioned above apply.

5.2.2.1.3 Rationale

As a general fact, energy consumption during the use phase contributes most significantly to the overall environmental impact of hydronic heaters. In addition, the technical analysis conducted in the frame of this study together with a review of other product policy initiatives showed that one of the most important parameters with the highest associated environmental benefits is improvements in energy efficiency. Improvements in energy efficiency will result in significant resource saving (reduced primary resource depletion due to energy production), decreased greenhouse gas and other pollutant emissions related to energy generation (exploration, extraction, refining, processing, transportation and storage) and use (combustion of the fuel), as well as economic benefits for the users reducing their energy bills.

From the technical analysis conducted in this study, some conclusions regarding energy efficiency were reached:

– Biomass boilers, and especially the small automatic biomass boilers, have the lowest nominal efficiency;

– Regarding the electricity component of the primary energy used, the highest electricity consumption was obtained for the electrically-driven heat pumps (as was expected). The electricity consumption was negative (meaning net electricity production) for the cogeneration boiler.

Table 6 presents minimum energy efficiency requirements from several product policy schemes. In the table (and also in subsequent tables throughout this document), “N/A” means that no criteria have been developed for a specific technology within a given product policy scheme, while "no limit" means that the specific technology is covered by the given policy scheme, but no requirements have been set for the considered parameter (here energy efficiency).

Table 6. Comparison of minimum energy efficiency in different product policy schemes

Heat generator technology	Ecodesign[1)]	Energy Labelling[2)]	EU Ecolabel[3)]	Blue Angel[4)]	Nordic Ecolabel[5)]	Austrian Eco-label[6)]	GPP[7)]
Gas fuel boiler	≤ 70 kW: 86 % > 70 kW and ≤ 400 kW: 86 % (full load); 94 % (30 % load)	A+++: ≥ 150 % A++: 125-150 % A+: 98-125 % A: 90-98 %	N/A	0,0612 Q_N + 105.94	N/A	N/A	Condensing: 100 % (≤10 kW); 101 % (>10 kW) Non-condensing: (1/60) Q_N + 95.83
Liquid fuel	≤ 70 kW: 86 %	A+++: ≥	N/A	N/A	N/A	N/A	(1/60) Q_N +

boiler	> 70 kW and ≤ 400 kW: 86 % (full load); 94 % (30 % load)	150 % A++: 125-150 % A+: 98-125 % A: 90-98 %					91.77
Solid fuel boiler	N/A	N/A	N/A	≤12 kW: 90 % (full load); 89 % (30% load) >12 kW: 90 %	Automatic: 75 + 6 log Q_N (full load); 86 % (partial load) Manual: 73 + 6 log Q_N	Automatic: 90 % Manual: 71.3 + 7.7 log Q_N	Automatic: 75 + 6 log Q_N Manual: 73 + 6 log Q_N
Fuel-driven heat pump	Low temperature: 115 % (125 %) Other: 100 % (110 %)	A+++: ≥ 150 % (≥ 175 %) A++: 125-150 % (150-175 %) A+: 98-125 % (123-150 %) A: 90-98 % (115-123 %)	Air/water: 124 % Brine/water: 172 % Water/water: 204 %	No limit	Not HFC refrigerant: 80 % HFC refrigerant (GWP < 1000): 90 % HFC refrigerant (GWP < 2000): 92 %	N/A	Air/water: 136 % Brine/water: 189 % Water/water: 224 %
Electrically-driven heat pump	Low temperature: 115 % (125 %) Other: 100 % (110 %)	A+++: ≥ 150 % (≥ 175 %) A++: 125-150 % (150-175 %) A+: 98-125 % (123-150 %) A: 90-98 % (115-123 %)	Air/water: 124 % Brine/water: 172 % Water/water: 204 %	No limit	Not HFC refrigerant: 80 % HFC refrigerant (GWP < 1000): 90 % HFC refrigerant (GWP < 2000): 92 %	N/A	Air/water: 124 % Brine/water: 172 % Water/water: 204 %
Cogeneration	86 % (100 %)	A+++: ≥ 150 % A++: 125-150 % A+: 98-125 % A: 90-98 %	N/A	Gas fuel: 89 % (full load); 87 % (50 % load) Liquid fuel: 85 % (full load); 83 % (50 % load)	N/A	N/A	75-80 %
Electric boiler	30 % (36 %)	A+++: ≥ 150 % A++: 125-150 % A+: 98-125 % A: 90-98 %	N/A	N/A	N/A	N/A	N/A

Note: Q_N = nominal heat output.
1) Implementing Measure proposal for Ecodesign Lot 1 (as of 13/03/2013); into brackets is given the second-tier values (4 years after the entry into force).
2) Energy labelling proposal (as of 18/02/2013); into brackets is given values for low temperature heat pumps.
3) EU Ecolabel criteria for: electrically driven, gas driven or gas absorption heat pumps.

4) Blue Angel criteria for: gas-fired calorific-value heating devices; wood-pellet boilers; heat pumps using absorption and adsorption technology or operating by use of combustion engine-driven compressors; heat pumps using an electrically powered compressor; small-scale gas-fired cogeneration modules; and small-scale liquid-fired cogeneration modules.
5) Nordic Ecolabelling criteria for: solid biofuel boilers; and heat pumps.
6) Austrian Eco-Label criteria for: wood-fired heating systems.
7) EU GPP criteria for: combined heat and power; and EU GPP preparatory work for: boilers; and heat pumps and air conditioning.

As shown in Table 6, the energy efficiency requirements are not harmonised from one scheme to another, neither in terms of definition nor for thresholds, but all policy schemes include an energy efficiency criterion (e.g. Nordic Ecolabel[18] and Blue Angel[19]). The definition and threshold limits for the energy efficiency requirements applicable for the EU Ecolabel criterion are explained below.

The efficiency in this study is based on the "seasonal space heating energy efficiency" as defined in the Ecodesign Lot 1 and is expressed in terms of the Gross Calorific Value (GCV)[20]. Though this method does not apply officially to solid fuel heaters, it is technically possible to apply the same methodology with the aim to foster harmonisation of performance standards across products that deliver comparable performances. Seasonal efficiency provides a weighted average of heater efficiencies at different loads e.g. 30% and 100% to take into account the variation in operating loads in response to seasonal and heating demand fluctuations.

Energy efficiency depends on type of building, how the heating system is installed, and the climate zone. Also the methods and standards for measuring energy efficiency differ in various schemes. For the EU Ecolabel, the Ecodesign Lot 1 methodology (methods and standards) will apply.

The threshold limits for the energy efficiency requirements are set so that only best hydronic heaters can pass. In terms of selectivity, the proposed value of $\eta_s \geq 98$ % for all heaters (except solid biomass boilers) means that this efficiency can be achieved by all heat pumps and most cogeneration, comprising in total some 10-15% of the market. No fossil fuel boilers only can achieve the threshold but packaged fossil fuel boilers (hybrid heaters combining a fossil fuelled boiler with solar device, heat pump or cogeneration unit) may do. For instance, a good condensing boiler would need to be combined with approximately 3.7 m² solar collector to reach 98%. Beyond the selectivity, the proposed threshold represents a better alignment of purchase costs across products. Indeed, current market best condensing boilers

18 See for more information: http://www.nordic-ecolabel.org/
19 See for more information: http://www.blauer-engel.de/en/blauer_engel/index.php
20 It is important to be aware of the means of measuring boiler efficiency when comparing different types of boilers. Efficiency can be based on the net or gross calorific value of the fuel and will therefore vary depending on the methodology used. Gross calorific value (used in the seasonal space heating energy efficiency) is the heat released when a certain fuel is burned completely with oxygen at constant pressure and when the products of combustion are returned to ambient temperature, in kWh.

achieving efficiency above 90 % (but below 98 %) may cost some 1500 euro (including standard installation). Heat pumps cost closer to 3-5 times that amount, even excluding installation and this also goes for cogeneration. The requirement for a minimum space heating energy efficiency of 98% requires combination of (condensing) fossil fuel heaters with either solar thermal installations or heat pump solutions, or even cogeneration units. The extra purchase costs of these solutions are not entirely identical to that of ground source heat pumps for instance, but the price gap is reduced. The higher purchase costs make the playing field a bit more level.

For solid fuel biomass boilers, setting a value of $\eta_s \geq 98$ % would mean that a biomass boiler with best combustion efficiency would still need over 25 m^2 of solar collector to meet the 98 % threshold, which would not be feasible in practice. Instead, it is proposed to aim at the best biomass boilers on the market, which results in a seasonal energy efficiency of 79 %. A lower limit is defendable since the resource depletion of energy is not as big of a problem as with fossil fuel boilers. In terms of selectivity, $\eta_s \geq 79$ % based on GCV means an energy efficiency over 90 % based on NCV (net calorific value) with applying Standard EN 303-5:1999, which is indicative for the best 20-25% of the biomass boilers on the market. A combination with solar collectors is not required, since the biomass fuels do not have the resource problem of fossil fuels.

There will be a limited number of “worst case” installations (buildings without options for renewable energy, cogeneration or solid biomass) for which no EU Ecolabel eligible alternative will be available. These worst case installations might be due to the characteristics of the local technical infrastructure or local regulations (noise, access to roof for solar devices or soil for ground-coupled heat pumps, or existing chimney solutions that do not allow use of condensing technology, etc.). However, it is worth mentioning that setting requirements to a level achievable by all installation situations would require a threshold lower than the foreseen Ecodesign requirements, which is not an option for EU Ecolabel.

Regarding the assessment and verification, it is interesting to note that some ecolabelling schemes require third party testing and a certification process, which covers independent measurements in certified laboratories; while other rely just on the producers’ “Declaration of Conformity” with the required criteria (sometimes supported by testing results), and signed and dated by authorised personnel. Both of these approaches have their advantages and disadvantages. Usually, external certification is considered as more reliable, ensuring the high quality of the tests conducted; nevertheless they are more costly, which can constitute a potential barrier for SMEs in applying for a label. Given the importance of the energy efficiency criterion, it is proposed to require third party verification of the energy efficiency criterion (where possible).

5.2.2.1.4 Summary of stakeholder feedback

Feedback from stakeholders has shown strong support for the use of seasonal space heating energy efficiency as the criterion for energy efficiency.

The great majority of responses regarding energy efficiency concluded that a lot of effort has already been devoted to the development of the seasonal space heating energy efficiency for Ecodesign and Energy Labelling. There is wide agreement from stakeholders that this concept should be directly used by the EU Ecolabel, as it is considered very good and arrived after extensive consultation.

Some existing ecolabels include additional parameters related to the energy efficiency of hydronic heaters, in particular criteria for maximum heat radiation losses via the surface of the boiler and maximum auxiliary power demand. It is to be noted that both effects are included within the seasonal space heating energy efficiency calculation (η_s) developed in the Ecodesign Lot 1 in consultation with stakeholders. Since the energy efficiency criterion in the EU Ecolabel is based on η_s, then those two effects are already taken into account, and no separate criterion is required, which leads to more simplified EU Ecolabel criteria.

Additional feedback reflected that most heating products have models which could be potentially ecolabelled. There is a risk to put some products out of the market with the common energy efficiency benchmark. As the common benchmark for energy efficiency is drafted, the energy efficiency limit will be almost meaningless for heat pumps because they are all very efficient. While this statement is correct, we should point out that by adding the greenhouse gas emission limits (criterion 2), only the most efficient heat pumps will be able to meet the overall common benchmark criteria.

Some stakeholders offered sceptic views on the proposal to establish a common benchmark criterion for energy efficiency. In this view, efficiency should be technology-specific in order to separate better products from worse ones, within a given technology. The argumentation for this position is based on the opinion that a consumer chooses first a given technology/fuel, and afterward picks the brands or models for that pre-selected technology/fuel. Thus in this view, the EU Ecolabel should be developed technology by technology, to offer information about the best performing products within a given technology.

Other stakeholders expressed that energy efficiency largely depends on the type of fuel. For example, biomass contains water, and this lowers the caloric value when combusted, when compared to fossil fuels. Hence, a fossil-fuelled boiler is always more efficient than a biomass boiler.

According to other stakeholders, energy efficiency should not be part of the criteria, and the common benchmark approach should be done based only on greenhouse gas emissions. It should be noted that this approach has been found in the Blue Angel criteria for heat pumps, where the greenhouse gas emissions are calculated using the TEWI (Total Equivalent Warming Impact) approach (which includes also the effect of the energy efficiency of the heat pump in its mathematical expression).

According to some of the feedback received, the development of the EU Ecolabel criteria should take into account the mandatory Energy Labelling classes for hydronic heater products, and use this scale as a "first pass filter" for EU Ecolabel qualification. This means that a hydronic heater would only be allowed to apply for the EU Ecolabel if the product was in the top one or two classes of the Energy Labelling, after which a broader range of environmental criteria would be looked at for EU Ecolabel qualification. This would ensure that the EU Ecolabel takes into account mandatory Ecodesign and Energy Labelling criteria, while at the same time being differentiated by incorporating additional and broader environmental performance parameters.

Some experts doubt that the EU Ecolabel should include a requirement on the energy efficiency, as there is already the mandatory Energy Labelling scheme. There should not be an overlap between these two schemes. Nevertheless, if energy efficiency needs to be a parameter, it should strictly follow the approach of the Ecodesign Lot 1, which has been done.

Finally, some stakeholders expressed that if biomass fuels are used, the contracting authority should ensure that the fuel used conforms to certain quality standards or that it is from an accredited renewable source. In addition, stakeholder feedback expressed that for biomass generators, it is important to require that the fuel meets certain quality criteria to guarantee the best possible combustion performance which will lead to high energy efficiency and low air emissions. In Austria, Germany and Nordic countries there are international standards and even ecolabel criteria for wooden chips, pellets (wood and bark), energy crops and straw (for example, ÖNORM M 7133, ÖNORM M 7135, DIN plus, and EN 12946). This comment has been integrated in the EU Ecolabel criteria with requesting the provision of information to the consumer on the best types of fuels to be used, how to store in the proper conditions for optimum combustion and energy efficiency, etc. (see Criterion 13).

5.2.2.2 Criterion 1(b) – Minimum water heating energy efficiency

5.2.2.2.1 Proposed criterion

The water heating energy efficiency η_{wh} of combination heaters or hybrid heater containing one or more combination heaters shall not fall below 65 %. This criterion shall not apply to solid fuel boiler heaters.

The water heating energy efficiency shall be calculated in accordance with the procedures set out in Annex III to Regulation (EU) No …[Number of the Regulation to be inserted[21]] and in Annex VII to Regulation (EU) No … [Number of the Regulation to be inserted[22]].

5.2.2.2.2 Assessment and verification

The applicant shall declare that the product complies with this criterion and provide test results conducted in accordance with the testing procedure indicated in the EN standards (including transitional methods where applicable) applicable to the given type of product (see Table 2). Measurements and calculations of the seasonal space heating energy efficiency shall be made using the methodology of seasonal space heating energy efficiency of packages and in accordance with the procedures mentioned above.

5.2.2.2.3 Rationale

For the hydronic heater product group, water heating can be considered as secondary compared to space heating. However for hydronic heaters combining the water heating function, it appears relevant to require minimum water heating energy efficiency as the energy used for water heating can make up a considerable share of total energy use of the heater. Besides, the measurement and requirements on water heating for combination heaters is also included in Ecodesign and Energy Labelling proposals (Lot 1 and Lot 2).

Nevertheless, the proposed threshold (65 %) is set in order not to be too selective as the EU Ecolabel criteria for hydronic heaters are not targeting water heating but space heating improvement. However, the threshold will still bring some environmental benefits since it is set on an A-class medium sized combination heater basis. The typical usage for a medium sized combination heater is two showers and a sink at 55 °C. Note that combination heaters of larger size with water heating efficiency of 65 % are ranked as B-class (the larger size, the bigger efficiency expected), which means that the criterion can be considered as more relaxed for larger combination heaters. The water heating efficiency of 65 % may be less easy to achieve for combination heaters smaller than medium size, but these products have a very low market share.

[21] This refers to Ecodesign Lot 1.
[22] This refers to Energy Labelling Lot 1.

The criterion shall however not apply to solid fuel boiler heaters. On-going Ecodesign and Energy label work for these kinds of heaters (Lot 15) has shown that, for biomass combination boilers, not enough data exist to assess the implications of regulating through a specific number and this indicator is thus not intended to be used for Ecodesign Lot 15. With little data available, it would be very difficult to propose any suitable limit.

Instead, the same approach is taken as in Ecodesign and the Energy label; the water heating energy efficiency in the criterion is defined in the same way and the limit value suggested builds on the work for Lot 1, Lot 2 and Lot 15.

5.2.3 Criterion 2 – Greenhouse gas (GHG) emission limits

5.2.3.1 Proposed criterion

The greenhouse gas (GHG) emissions of the hydronic heater, expressed in grams of CO_2-equivalent per kWh of heating output calculated using the Total Equivalent Warming Impact (TEWI) formulas defined below, shall not exceed the values set out in Table 7.

Table 7. GHG emission limits by heat generator technology

Heat generator technology	GHG emission limits
All heaters, except heat pump heaters	200 g CO_2-equivalent/kWh heating output
Heat pump heaters	150 g CO_2-equivalent/kWh heating output

The GHG emissions shall be calculated following the TEWI formulae as set out in Table 8 (the formula depends on the heat generator technology). Each TEWI formula may consist of two parts, one depending solely on the heater efficiency (expressed in terms of the seasonal space heating energy efficiency, η_s) and the fuel carbon intensity (represented by the β parameter), and the second part (only applicable to heat pump heaters) depending on the greenhouse gas emissions due to refrigerant leakage. The GHG emissions from the refrigerant leakage depend on the global warming potential (GWP_{100}) of the refrigerant and the refrigerant leakage during the use phase (expressed as an annual leakage rate, ER, in percentage of the total mass of the refrigerant per year) and at end-of-life (expressed as a percentage of the total mass of the refrigerant, α).

Table 8. TEWI formulae by heat generator technology

Heat generator technology	TEWI formula (g CO_2-equivalent/kWh heating output)

Boiler heaters	$\frac{\beta_{fuel}}{\eta_s}$
Heat pump heaters	$\delta \times \frac{\beta_{fuel}}{\eta_s} + (1-\delta) \times \frac{\beta_{elec}}{2.5 \times \eta_s} + \frac{GWP_{100} \times m \times (ER \times n + \alpha)}{P \times h \times n}$
Cogeneration heaters	$\frac{\beta_{fuel}}{\eta_{thermal}} + \frac{\eta_{cogen} \times \beta_{elec}}{\eta_{thermal} \times 2.5}$
Hybrid heaters	$(1-s_{HP}) \times \frac{\beta_{fuel}}{\eta_{s,B}} + s_{HP} \times \left(\delta \times \frac{\beta_{fuel}}{\eta_{s,HP}} + (1-\delta) \times \frac{\beta_{elec}}{2.5 \times \eta_{s,HP}} \right) + \frac{GWP_{100} \times m \times (ER \times n + \alpha)}{P \times h \times n}$

The main parameters in the TEWI formulae above are described in Table 9.

Table 9. Main parameters for computing the TEWI formulae

Parameter	Description of parameter	Units	Constant value or test to be performed in order to obtain the parameter
β_{elec}	GHG emission intensity of electricity	[g CO_2-equivalent/kWh_{elec}]	384
β_{fuel}	GHG emission intensity of the fuel used by the heater	[g CO_2-equivent/kWh]	See Table 10
η_s	Seasonal space heating energy efficiency	[-]	To be tested and declared by the applicant (Criterion 1)
$\eta_{s,B}$	Seasonal space heating energy efficiency of the boiler heater part for average climate conditions	[-]	To be tested and declared by the applicant; this corresponds to the seasonal space heating energy efficiency of the package minus supplementary heat pump, as stated in the product fiche of packages
$\eta_{s,HP}$	Seasonal space heating energy efficiency of the heat pump heater part for average climate conditions	[-]	To be tested and declared by the applicant; this corresponds to the seasonal space heating energy efficiency of the supplementary heat pump, as stated in the product fiche of

			packages
$\eta_{thermal}$	Thermal efficiency	[-]	See Table 11
η_{cogen}	Cogeneration efficiency	[-]	See Table 11
δ	Proxy	[-]	= 0 if electrically-driven heat pump heater = 1 if fuel-driven heat pump heater
GWP_{100}	Global warming potential (effect over 100 years)	[g CO_2-equivalent/g refrigerant, over 100 year period]	According to Annex I to Regulation (EC) No 842/2006
m	Refrigerant mass	[g]	To be declared by the applicant
ER	Refrigerant loss per year	[%/yr]	A value of ER = 3.5 %/yr shall be used.
n	Lifetime	[yr]	A value of n = 15 shall be used.
α	Refrigerant loss at end of life (disposal loss)	[%]	A value of α = 35 % shall be used.
P	Design load	[kW]	To be declared by the applicant.
h	Full load operating hours	[h/yr]	2000
s_{HP}	Share of heat output from the heat pump heater part over the total heat output	[-]	= (16 − T_{HP}) / 26 where T_{HP} is the temperature (ºC) at which the (primary) heat pump efficiency equals the primary boiler efficiency. It is assumed that below this temperature the boiler fulfils the heat demand, while above this temperature the heat pump supplies the heat demand.

The value of β elec. = 384 g CO2-equiv./ kWhelec is based on the average EU-27 carbon intensity of electricity corresponding to the period 2010-2020, as used in the MEErP methodology of 2011. These values are expressed in terms of kWh of electricity at the final consumer, so they take into account the losses due to transmission and distribution of electricity.

Table 10 describes how to evaluate parameter β_{fuel} in the TEWI formulae above depending on the fuel used by the heater. In case the boiler is designed for a fuel not listed in the table, the closest match of fuel shall be selected, based on the origin (fossil or biomass) and form (gaseous, liquid or solid) of the fuel used.

Table 10. Parameter β_{fuel} (GHG emission intensity) to compute the TEWI formulae

Fuel used by the heater	**GHG emission intensity**	**Value (g CO_2-equivalent/kWh)**
Gaseous fossil fuels	$\beta_{fuel} = \beta_{gas}$	202
Liquid fossil fuels	$\beta_{fuel} = \beta_{oil}$	292
Solid fossil fuels	$\beta_{fuel} = \beta_{coal}$	392
Gaseous biomass	$\beta_{fuel} = \beta_{bio\text{-}gas}$	98
Liquid biomass	$\beta_{fuel} = \beta_{bio\text{-}oil}$	149
Wood logs	$\beta_{fuel} = \beta_{bio\text{-}log}$	19
Wood chips	$\beta_{fuel} = \beta_{bio\text{-}chip}$	16
Wood pellets	$\beta_{fuel} = \beta_{bio\text{-}pellet}$	39
Blends of fossil fuels and biomass	β_{fuel} = weighted average derived from the sum of the weight fractions of the individual fuels multiplied by their GHG emission parameter	Σ (Fuel X % × $\beta_{fuel\ X}$) + (Fuel Y % × $\beta_{fuel\ Y}$) + … (Fuel N % × $\beta_{fuel\ N}$)

Table 11 describes how to evaluate parameters $\eta_{thermal}$ and η_{cogen} in the TEWI formula for cogeneration heaters.

Table 11. Parameters $\eta_{thermal}$ and η_{cogen} to compute the TEWI formula for cogeneration heaters

Parameter	Expression	Remarks
$\eta_{thermal}$	$= \eta_{son} - \sum_{i=1}^{4} F(i)$	η_{son} means the seasonal space heating energy efficiency in active mode as defined in Regulation (EU) No … [Number of the Regulation] F(*i*) means corrections F(1), F(2), F(3) and F(4) as defined in Commission Communication 2012/C…/…[Number of the Communication]
η_{cogen}	= F(5)	F(5) means correction F(5) as defined in Commission Communication 2012/C…/…[Number of the Communication]

5.2.3.2 Assessment and verification

A certificate signed by the manufacturer declaring compliance with this criterion shall be submitted to the awarding competent body, together with the relevant documentation. The applicant shall provide the calculated GHG emissions following the proposed TEWI formulae and detail all the parameters used to calculate the GHG emissions.

5.2.3.3 Rationale and stakeholder feedback

The second main criterion is the relative contribution of the product to greenhouse gas emissions. Although this criterion is very much linked to the first criterion on energy efficiency, there are significant differences. The first criterion only describes how well the unit is capable to transform primary energy into useful heat. But this does not take into account the differences there are in greenhouse gas emissions of various fuels, nor greenhouse gas emissions of other (non fuel) substances. These aspects are covered by the second criterion.

The key importance of the greenhouse gas emissions limit together with the energy efficiency have been confirmed by the literature review, other ecolabels and environmental policies, and stakeholders' feedback. For example, based on the technical analysis and previous work from national ecolabels, there should be at least a common benchmark for greenhouse gas emissions limit, given in maximum amount of grams of CO_2 per kWh of heating output[23], or per kWh of primary energy input[24].

More importantly, this second criterion allows the renewable nature of biomass to be included in the assessment. It is proposed a method that allows consideration of fuels (energy carriers) in all forms: primary or secondary, fossil or renewable, gaseous, liquid or solid form. It is based on default greenhouse gas factors per kWh of fuel/electricity, with proper consideration of existing Commission documents regarding the greenhouse gas saving potential of renewable fuels.

Comments received from stakeholders have offered support for the TEWI approach to calculating the greenhouse gas emission benchmark. The TEWI approach for the GHG emissions was developed in consultation with Blue Angel. TEWI was first applied in the Blue Angel criteria on heat pumps using an electrically powered compressor (RAL-UZ 121). For other types of heat pumps, such as the current Blue Angel criteria on heat pumps using absorption and adsorption technology or operating by use of combustion engine-driven compressors (RAL-UZ 118), the approach does not include a TEWI requirement among the criteria, but instead a criterion on energy efficiency, among others. However, the Blue Angel criteria for heat pumps are under revision. The revision consists in the development of criteria that will be applicable both to electrically-driven and gas-driven heat pumps, and therefore it is a good basis to use as guidance for the EU criteria on hydronic heaters. In the

[23] The background document for the development of EU Ecolabel for heat pumps establishes that the global warming impact of heat pumps must not be greater than 210 g CO_2/kWh useful heat as an average during a year.
[24] Electricity production is considered to have a conversion efficiency of 40% (in the conversion of primary energy to electricity).

ongoing Blue Angel criteria development, a GHG emissions TEWI-based formula is proposed in terms of CO_2-equivalent emissions per unit of kWh of heating output, which is consistent with the type of GHG emissions criterion that is proposed here.

The TEWI approach analyses the GHG emissions from a life cycle point of view and takes into account the heater efficiency, the fuel specific emission factor (fuel type is linked to heater characteristics), and, if applicable, the type of refrigerant and the refrigerant losses. If a hydronic heater is specifically designed for a certain fuel type (e.g. bio-oil), the calculation should be based on that fuel type. Regarding the refrigerant losses, they have been subject to much debate and various loss factors are mentioned in literature. In order to reduce unverifiable differences in claims by applicants, it has been decided to set reasonable fixed leakage rates that cannot be changed by the applicant.

In addition to a review of other ecolabels, the proposal is also based on the technical analysis available at the project's website. The technical analysis provided evidence of the major differences between e.g. biomass boilers and fossil fuel boilers (see for example Figure 2 and Figure 3 in Appendix 2 of this document). Biomass boilers, while having a lower energy efficiency, have nevertheless much lower GHG emissions than other boilers, since the CO_2 production of combustion is considered to be zero (only the CO_2 emissions due to the production phase of biomass is accounted). As discussed in the technical analysis, the greenhouse gas emissions from biomass boilers are the lowest, and the heat pump achieves a reduction of 20% compared to the gas condensing boiler.

Feedback from some stakeholders has suggested an approximate limit of 200 g CO_2 per kWh of heating output, calculated using the TEWI approach. This limit is established in order to reduce the environmental impacts of the hydronic heater, regardless of the technology (except for heat pump as explains below). As a consequence of setting this common GHG emissions benchmark (200 g CO_2-equivalent/kWh heating output), a different percentage of each type of technology might be able to meet the benchmark. For example, biomass boilers can pass this benchmark easily, even if their average efficiencies are lower. For cogeneration, the criterion is also not difficult to achieve because of the displaced central electricity production emissions. This limit value can also be achieved by hybrid heaters with energy efficiency of 98 % or more. However, in the case of hybrid heaters combining liquid fossil fuel boilers with solar/heat pump, an energy efficiency of 98 % will not suffice, and the hybrid heater will need to be compatible with liquid biomass in order to decrease the TEWI (the combination of biomass compatibility and efficiency determines whether the threshold is met). As for energy efficiency, it has to be noted that no fossil fuel boilers only can achieve the threshold (for instance, best available technology condensing gas boilers are able to achieve maximum GHG emissions of around 217 CO_2-equivalent/kWh heating output).

Regarding heat pumps, the limit of 200 g CO_2-equivalent/kWh heating output could lead to solutions applying for the EU Ecolabel with efficiencies lower than currently required under the existing Ecolabel criteria for heat pumps, which situation is undesirable. In addition, the uncertainties in the GHG emissions (due to refrigerant leakage) are higher than the uncertainties in the GHG emissions from other types of hydronic heaters (e.g. gas boilers). Therefore, a separate stricter threshold is defined for heat pumps. In the Blue Angel, electrically-driven heat pumps are required to achieve a minimum SCOP (Seasonal Coefficient of Performance) of 3.365 for air/water units. When applying the TEWI approach with the assumption applied in the criterion (3.5% annual leakage, 35% end-of-life leakage, EU average of 394 g CO2-equivalent/kWh electricity and 2088 g CO2-equivalent/g refrigerant for GWP of R410a), this value corresponds to 148 g CO_2-equivalent/kWh thermal. The proposed criterion for heat pumps (150 g CO_2-equivalent/kWh) is based on this adapted Blue Angel value, which will increase the efficiency level to beyond that of the existing EU Ecolabel criteria for the air/water heat pumps and allows the same flexibility in using refrigerants and efficiency as in the Blue Angel approach. Setting this limit is realistic for heat pump technology, while setting a higher limit would not lead to pushing the market to best environmental performance. For electrically-driven heat pumps, the seasonal efficiency plays a major role, but the type and leakage of refrigerant is an important element in the calculation. For fuel-driven heat pumps equipped with external combustion, the criterion could be achieved with an energy efficiency of 135 %. For fuel- driven heat pumps equipped with internal combustion, the efficiency would need to be at least 160 %. These values appear attainable according to manufacturer information.

The rationale not to set a benchmark of 150 g CO_2-equivalent/kWh for all heat generator technologies is as follows. Setting such strict benchmark for all heat generator technologies would in reality allow only biomass boilers and some heat pumps to comply with, which is not here the aim of the EU Ecolabel. The market reality is that there are a variety of factors depending on location, climate, availability of ground or water sources to set-up certain heat pump technologies, availability of biomass fuels, etc., which makes not always possible for the consumer to have access to heat pumps and biomass boilers. Other technologies should also be accepted, at least within a hybrid heater solution, which still provides valuable environmental benefits. Future revision of EU Ecolabel criteria will accommodate for corresponding market and technological changes.

5.3 Additional criteria

5.3.1 Introduction

Although energy efficiency and GHG emissions are the key areas for hydronic heaters, other parameters that have associated health and environmental impacts need also to be covered. They include:

- Refrigerant and secondary refrigerant
- Other air emissions (NO_x, CO, OGC and PM)
- Noise emissions
- Materials (hazardous substances and plastic parts)
- Product design for sustainability
- Installation instructions and user information
- Information appearing on the EU Ecolabel

Refrigerant and secondary refrigerant contribute to environmental impacts such as climate change, ozone layer depletion and underground toxic emissions, and then require to be addressed.

Hydronic heaters potentially release a number of air emissions, including: carbon dioxide (CO_2), carbon monoxide (CO), nitrogen oxides (NO_x), sulphur oxides (SO_x), volatile hydrocarbons (HC), methane (CH_4), non-methane volatile organic compounds (NMVOC) and particulate matter (PM). Note that CH_4 and NMVOC form the volatile organic compounds (VOC) and VOC are typically measured with volatile HC as organic gaseous carbon (OGC). Other emissions from hydronic heaters include persistent organic pollutants (POP), heavy metals (HM) and polycyclic aromatic hydrocarbons (PAH). The technical analysis of 12 base cases (see the Preliminary Report) have shown that all these air emissions and associated environmental impacts vary depending on the fuel used, the heat generator technology and the use of any appropriate abatement measures. The main environmental and health impacts of each air emission are detailed in the criteria on air emissions (criterion 4 to 7). For example, NO_x and SO_x emissions can contribute towards acidification of sensitive ecosystems through acid rain or dry deposition.

It is important to understand that the results of the environmental impact analysis are presented by impact category (e.g. global warming potential, acidification potential, etc.) but the impact categories are not further aggregated nor ranked on any basis. Any impact category is considered, a priori, of equal importance and any conclusion of superiority of one technology over another one cannot be drawn (except if a given technology were performing better over all the impacts). To make comparison, priorities need first to be set. For instance, if climate change is considered a priority, then biomass boilers appear more desirable than fossil fuel boilers. However,, if other air pollution indicators are considered important, then biomass combustion is not as “clean” as good gas or oil combustion, as shown below:

- NO_x and SO_x emissions by biomass boilers and EU electricity production appear most significant, while the cogeneration units achieve a net reduction of acidifying emissions.
- VOC: the manual stoked wood log boiler performs the worst, which relates to both combustion efficiency and type of fuel.
- POP: the automatic stoked pellet boiler performs the worst, which is mainly due to the type of fuel (pellets).
- HM (to air): again it is the pellet boiler that performs the worst, but the electric heat pump has significant emissions as well.
- PAH: the biomass boilers emit the most PAH but the differences with other technologies are less apparent than in other impact categories.
- PM: the biomass boilers perform the worst, especially in the case of manual stoked wood log boiler.

This is the reason why some local and national policies limit the emissions allowed for biomass boilers. More generally, the life cycle analysis shows that air emissions are very dependent on the heating technology, which entails to set for the EU Ecolabel criteria specific technology-dependent limits for each air emission.

Noise emission is like air emissions very dependent on the heating technology and therefore technology-dependent limits are defined (for technologies where the problem is acute). This is not the case for the other parameters of relevance (materials, product design, installation instructions and user information and information appearing on the EU Ecolabel), for which requirements apply to any technology in the same way.

In the following, criteria 3 to 14 are discussed one by one.

5.3.2 Criterion 3 – Refrigerant and secondary refrigerant

5.3.2.1 Proposed criterion

Refrigerant

The global warming potential over a 100 year period (GWP_{100}) of the refrigerant shall not exceed a value of 2000. GWP_{100} values shall be those set out in Annex I to Regulation (EC) No 842/2006 ([25]).

Secondary refrigerant

If applicable, the design of the hydronic heater shall not be based on secondary refrigerant, brine or additives classified as environmentally hazardous or constituting a health hazard within the meaning of Regulation (EC) No 1272/2008([26]), and installation instructions shall clearly indicate that substances classified as environmentally hazardous or constituting a health hazard shall not be used as a secondary refrigerant.

5.3.2.2 Assessment and verification

Refrigerant

The names of refrigerant(s) used in the product shall be submitted with the application, along with their GWP_{100} values as defined in Regulation (EC) No 842/2006. The GWP_{100} values of refrigerants shall be calculated in terms of the 100-year warming potential of one kilogram of a gas relative to one kilogram of CO_2. Sources of references for the GWP_{100} values should be those defined in Annex 1.1(7) to Regulation (EU) No 206/2012 ([27]).

For the secondary refrigerant(s) only

The name(s) of the secondary refrigerant(s) used shall be submitted with the application.

5.3.2.3 Rationale and stakeholder feedback

Refrigerants are of environmental concern because they may be the source of ozone depletion effects and contribute to climate change. Refrigerants are used only by heat pump technology.

For the main refrigerant, GHG emissions may be significant if the refrigerant has a high GWP_{100} and if it leaks. Several ecolabels set criteria related to the main refrigerant, including:

- Maximum GWP_{100} limit value for the refrigerant;
- Requirements for reduced leaking rates from the heat pump units;
- Sometimes, requirements for completely leak-free units;
- Also sometimes, energy efficiency limits depending on the GWP_{100} value of the refrigerant.

[25] OJ L 161, 14.6.2006, p. 1.
[26] OJ L 353, 31.12.2008, p. 1.

These examples of requirements for the main refrigerant are used as a basis for defining the proposed criterion.

In addition to the main refrigerant, some heat pumps – in particular certain types of ground-source heat pumps – may have a secondary refrigerant which is circulated through pipework to the ground. The criterion proposed for this secondary refrigerant is meant to avoid the leakage of hazardous (toxic) substances such as glycol to the underground.

Table 12 shows the specific GWP_{100} limits and related energy efficiency and other (e.g. leakage) requirements proposed by different product policy schemes.

Table 12. GWP_{100} limit values of the refrigerant and related energy efficiency and other requirements in different product policy schemes

Product policy scheme	GWP_{100} limit value	Energy efficiency and other requirements
Ecodesign Lot 1	No GWP_{100} limit	If $GWP_{100} < 150$: Lower energy efficiency
EU Ecolabel	$GWP_{100} < 2000$	If $GWP_{100} > 1000$: Higher energy efficiency If $GWP_{100} < 150$: Energy efficiency reduced by 15%
Nordic Ecolabel	$GWP_{100} < 2000$	If $GWP_{100} > 1000$: Higher energy efficiency If $GWP_{100} < 150$: Energy efficiency reduced by 15% If $GWP_{100} > 100$: Unit must be leakage-free
GPP	$GWP_{100} < 2000$	If $GWP_{100} > 1000$: Higher COP efficiency If $GWP_{100} < 150$: COP efficiency reduced by 15%

Some stakeholders propose a lower GWP_{100} limit value as these type of refrigerants are currently available in the market. As suggested by Table 12, a GWP_{100} limit value of 2000 seems reasonable to reduce environmental concerns of refrigerants, while allowing a significant portion of the heat pump market to be included. Lowering the GWP_{100} of the refrigerant is only realistically possible for some types of heat pumps, such as the gas-absorption heat pump (GAHP) which may use natural refrigerants ($GWP_{100} = 0$).

As shown by Table 12, some schemes establish different efficiency limits depending on the GWP_{100} of the refrigerant. However, since the EU criteria for hydronic heaters establishes an efficiency limit that most heat pumps are able to comply with, it does not make sense to adopt the different efficiency limits depending on the GWP_{100}. In addition, the relationship

[27] OJ L 72, 10.3.2012, p. 7

between energy efficiency and the GWP_{100} of the refrigerant is partly addressed already by Criterion 2 (GHG emissions). Following the formulae for the GHG calculations, a low GHG emission value can be achieved for example by increased energy efficiency (for refrigerants with higher GWP_{100} values) or by using refrigerants with lower GWP_{100} values (if the heat pump unit has lower energy efficiency).

There is currently a lot of discussion on the phase out of all gases that contain fluorine, known as F-gases, which are regulated by Regulation (EC) No 842/2006[28] (also known as the F-gas Regulation). F-gases include perfluourinated carbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF_6), of which HFCs make up approximately 90%. In this context, there is a gradual shift to Hydrocarbons (HC) and Carbon Dioxide (CO_2) as replacement refrigerants.

Carbon dioxide (CO_2) has a GWP_{100} of 1 whereas HFC134a, the most widely used refrigerant, has a GWP_{100} of 1300 (based on IPCC 3rd Assessment Report[29]).

It is interesting to note that the Danish Government now charges a stringent tax on all HFCs with plans to phase these out altogether. For instance, the tax on R-134a is approximately €14/kg[30]. This groundbreaking piece of legislation is also placing pressure on other EU MS to follow the Danish approach.

5.3.3 Criterion 4 – Nitrogen oxide (NOx) emission limits

5.3.3.1 Proposed criterion

The nitrogen oxide (NO_x) content of the exhaust gas shall not exceed the limit values indicated in Table 13 (not applicable to electrical heaters). NO_x emissions shall be measured as the sum of nitrogen monoxide and nitrogen dioxide. The unit of measurement shall be given in mg/kWh energy input or in mg/Nm³, as appropriate.

Table 13. NO_x emission limits by heat generator technology

Heat generator technology	NO_x emission limit
Gas fuel heaters	Equipped with internal combustion: 170 mg/kWh energy input Equipped with external combustion: 45 mg/kWh energy input
Liquid fuel heaters	Equipped with internal combustion: 380 mg/kWh energy input Equipped with external combustion: 100 mg/kWh energy input

[28] This Regulation is under review.
[29] See for more information: http://www.grida.no/publications/other/ipcc_tar/
[30] See for more information: http://www.care-refrigerants.co.uk/hmpg/hmpgdisplaylev2.asp?where=lev2&catid=4&catid2=21

Solid fuel heaters	Using wood pellet and wood log fuels: 150 mg/Nm³ at 10 % O2 Using wood chip and other solid fuels: 150 mg/Nm³ at 10 % O2

5.3.3.2 Assessment and verification

A certificate signed by the manufacturer declaring compliance with this criterion shall be submitted to the awarding competent body, together with the relevant documentation.

The NO_x emissions in the exhaust gas shall be determined as standard emission factors according to the relevant standards included in Table 2 and Table 3 (where applicable).

5.3.3.3 Rationale and stakeholder feedback

NO_x air emissions cause acidification and are produced during combustion of the fuels. However, NO_x emissions are the result of chemical reactions between air molecules triggered by the specific combustion conditions, in particular by the reaction between the oxygen and nitrogen molecules in the air. This occurs only when there is enough air around, when the temperature is high enough (above 1200 °C) and when there is enough time (residence time) for the reaction to take place at this high temperature.

Stakeholders expressed that there are differences regarding the formation of NO_x emissions depending on the heat generator technology. NO_x emissions depend on the boiler technology itself in the case of gas boilers, while these emissions are more dependent on the type of biomass fuel for biomass boilers. Nevertheless, NO_x emissions tests are generally considered as one of the relevant air emission criteria.

NO_x requirements from several product policy schemes are presented in Table 14.

Table 14. Comparison of NO_x emission limits in different product policy schemes

Heat generator technology	**Ecodesign[1)]**	**EU Ecolabel[2)]**	**Blue Angel[3)]**	**Nordic Ecolabel[4)]**	**Austrian Eco-label[5)]**	**GPP[6)]**
Gas fuel boiler	56 mg/kWh	N/A	40 mg/kWh	N/A	N/A	Condensing: 60 mg/kWh Non-condensing: 70 mg/kWh
Liquid fuel boiler	120 mg/kWh	N/A	N/A	N/A	N/A	120 mg/kWh
Solid fuel boiler	N/A	N/A	Pellets: 150 mg/Nm³ Chips:190 mg/Nm³	340 mg/m³	Automatic: 100 mg/MJ (pellets); 120 mg/MJ (chips); Manual: 120 mg/MJ	340 mg/Nm³

Fuel-driven heat pump	Gas fuel: 70 mg/kWh (external); 240 mg/kWh (internal) Liquid fuel: 120 mg/kWh (external); 420 mg/kWh (internal)	No limit	External: 40 mg/kWh Internal: 100 mg/Nm³	No limit	N/A	No limit
Electrically-driven heat pump	No limit	No limit	No limit	No limit	N/A	No limit
Cogeneration	Gas fuel: 70 mg/kWh (external); 240 mg/kWh (internal) Liquid fuel: 120 mg/kWh (external); 420 mg/kWh (internal)	N/A	Gas fuel: 250 mg/Nm³ Liquid fuel: 2500 mg/Nm³	N/A	N/A	No limit

[1)] Implementing Measure proposal for Ecodesign Lot 1 (as of 13/03/2013).
[2)] EU Ecolabel criteria for: electrically driven, gas driven or gas absorption heat pumps.
[3)] Blue Angel criteria for: gas-fired calorific-value heating devices; wood-pellet boilers; heat pumps using absorption and adsorption technology or operating by use of combustion engine-driven compressors; heat pumps using an electrically powered compressor; small-scale gas-fired cogeneration modules; and small-scale liquid-fired cogeneration modules. In the Blue Angel, emissions of solid biomass boilers are measured at 13 % O_2 and should be multiplied by 1.375 to be at 10 % O_2.
[4)] Nordic Ecolabelling criteria for: solid biofuel boilers; and heat pumps.
[5)] Austrian Eco-Label criteria for: wood-fired heating systems. The Austrian Eco-Label sets NO_x emissions in mg/MJ: 100 mg/MJ ≈ 206 mg/Nm³; 120 mg/MJ ≈ 248 mg/Nm³.
[6)] EU GPP criteria for: combined heat and power; and EU GPP preparatory work for: boilers; and heat pumps and air conditioning.

As general remarks (this applies to NO_x but will also apply to CO, OGC and PM emissions), Energy labelling is not included in Table 14, since this policy scheme does not include limits for air pollutants (only restricted to energy efficiency); and there is no limits for air pollutants applicable to electrically-driven heat pumps while they are established for fuel-driven heat pumps. As shown in Table 14, the NO_x requirements are not harmonised from one scheme to another. The threshold limits for the criterion have been set as follows:

- Gas fuel heaters (including boilers, heat pump and cogeneration): distinction is made between internal and external combustion like in the Ecodesign Lot 1 (note: gas boilers are only based on external combustion); values are based on Blue Angel criteria, though set a bit stricter for external combustion (40 mg/Nm³ at 13 0_2 % = 55 mg/Nm³ at 10 0_2 %) and with an average value for internal combustion (heat pump vs. cogeneration).
- Liquid fuel heaters (including boilers, heat pump and cogeneration): distinction is made between internal and external combustion like in the Ecodesign Lot 1 (note: oil

boilers are only based on external combustion); values are based on Ecodesign requirements with additional effort for external combustion (120 mg/kWh vs. 100 mg/kWh in the criterion).

- Solid fuel heaters: distinction is made between wood pellets and chips in the Blue Angel and Austrian Eco-label; with values in the Blue Angel criteria (150 mg/Nm³ at 13 0_2 % = 206 mg/Nm³ at 10 0_2 %; and 190 mg/Nm³ at 13 0_2 % = 261 mg/Nm³ at 10 0_2 %) and Austrian Eco-label criteria (100 mg/MJ = 206 mg/Nm³ at 10 0_2 %; and 120 mg/MJ = 248 mg/Nm³ at 10 0_2 %). On-going discussion for Ecodesign Lot 15 (solid fuel boiler heaters) are however currently indicating a level of 200 mg/Nm3 at 10% O2 for both wood pellets and chips. European Commission experts on air emissions suggest that 150 mg/Nm3 at 10% O2 would be achievable for the best products and hence a suitable level in the Ecolabel criteria, but reflections on this from the EUEB are highly welcome.

5.3.4 Criterion 5 – Carbon monoxide (CO) emission limits

5.3.4.1 Proposed criterion

The carbon monoxide (CO) content of the exhaust gas shall not exceed the limit values indicated in Table 15 (not applicable to electrical heaters). The unit of measurement shall be given in mg/kWh energy input or in mg/Nm³, as appropriate.

Table 15. CO emission limits by heat generator technology

Heat generator technology	CO emission limit
Gas fuel heaters	Equipped with internal combustion: 150 mg/Nm³ at 5 % O_2 Equipped with external combustion: 25 mg/kWh energy input
Liquid fuel heaters	Equipped with internal combustion: 200 mg/Nm³ at 5 % O_2 Equipped with external combustion: 50 mg/kWh energy input
Solid fuel heaters	Automatically stoked: 90 mg/Nm³ at 10 % O_2 Hand stoked: 250 mg/Nm³ at 10 % O_2

5.3.4.2 Assessment and verification

A certificate signed by the manufacturer declaring compliance with this criterion shall be submitted to the awarding competent body, together with the relevant documentation.

The CO emissions in the exhaust gas shall be determined as standard emission factors according to the relevant standards included in Table 2 and Table 3 (where applicable).

5.3.4.3 Rationale and stakeholder feedback

CO is a product of incomplete combustion and it poses environmental and health risks. CO limit values should be applicable in principle to boilers, fuel-driven heat pumps (but not electrically-driven heat pumps) and cogeneration units.

Some stakeholders expressed that CO is more a health that an environmental issue but there is a general agreement that CO remains in any case an environmental issue, for example CO contributes to ozone tropospheric formation. Moreover, the EU Ecolabel should consider both health and environmental issues.

CO requirements from several product policy schemes are presented in Table 16.

Table 16. Comparison of CO emission limits in different product policy schemes

Heat generator technology	Ecodesign[1)]	EU Ecolabel[2)]	Blue Angel[3)]	Nordic Ecolabel[4)]	Austrian Eco-label[5)]	GPP[6)]
Gas fuel boiler	No limit	N/A	20 mg/kWh	N/A	N/A	Condensing: 50 mg/kWh Non-condensing: 20 mg/kWh
Liquid fuel boiler	No limit	N/A	N/A	N/A	N/A	20 mg/kWh
Solid fuel boiler	N/A	N/A	≤50 kW: 80 mg/Nm^3 (full load); 180 mg/Nm^3 (30 % load) >50 kW: 70 mg/Nm^3 (full load); 150 mg/Nm^3 (30 % load)	Automatic: 400 mg/m^3 Manual: 2000 mg/m^3 (≤ 100 kw); 1000 mg/m^3 (> 100 kw)	Automatic (full load): 60 mg/MJ (pellets); 150 mg/MJ (chips); Automatic (30 % load): 135 mg/MJ (pellets); 300 mg/MJ (chips) Manual: 250 mg/MJ (full load); 750 mg/MJ (50 % load)	Automatic: 400 mg/m^3 Manual: 2000 mg/m^3 (≤ 100 kw); 1000 mg/m^3 (> 100 kw)
Fuel-driven heat pump	No limit	No limit	External: 20 mg/kWh Internal: 100 mg/Nm^3	No limit	N/A	No limit
Electrically-driven heat pump	No limit	No limit	No limit	No limit	N/A	No limit
Cogeneration	No limit	N/A	Gas fuel: 300 mg/Nm^3 Liquid fuel:	N/A	N/A	No limit

			300 mg/Nm³			

1) Implementing Measure proposal for Ecodesign Lot 1 (as of 13/03/2013).
2) EU Ecolabel criteria for: electrically driven, gas driven or gas absorption heat pumps.
3) Blue Angel criteria for: gas-fired calorific-value heating devices; wood-pellet boilers; heat pumps using absorption and adsorption technology or operating by use of combustion engine-driven compressors; heat pumps using an electrically powered compressor; small-scale gas-fired cogeneration modules; and small-scale liquid-fired cogeneration modules. In the Blue Angel, emissions of solid biomass boilers are measured at 13 % O_2 and should be multiplied by 1.375 to be at 10 % O_2.
4) Nordic Ecolabelling criteria for: solid biofuel boilers; and heat pumps.
5) Austrian Eco-Label criteria for: wood-fired heating systems. The Austrian Eco-Label sets CO emissions in mg/MJ: 60 mg/MJ ≈ 124 mg/Nm³ (10 % O_2); 150 mg/MJ ≈ 309 mg/Nm³ (10 % O_2); 135 mg/MJ ≈ 278 mg/Nm³ (10 % O_2); 300 mg/MJ ≈ 619 mg/Nm³ (10 % O_2); 250 mg/MJ ≈ 516 mg/Nm³ (10 % O_2); 750 mg/MJ ≈ 1547 mg/Nm³ (10 % O_2).
6) EU GPP criteria for: combined heat and power; and EU GPP preparatory work for: boilers; and heat pumps and air conditioning.

As shown in Table 16, the CO requirements are not harmonised from one scheme to another. The threshold limits for the criterion are applicable to full load and have been set as follows:

- Gas fuel heaters (including boilers, heat pump and cogeneration): distinction is made between internal and external combustion like for the NO_x requirements (Criterion 4); values are based on Blue Angel criteria, at the same level for external combustion (20 mg/Nm³ at 13 0_2 % = 27.5 mg/Nm³ at 10 0_2 %) and with an average value for internal combustion (heat pump vs. cogeneration).
- Liquid fuel heaters (including boilers, heat pump and cogeneration): distinction is made between internal and external combustion like for the NO_x requirements (Criterion 4); values are derived from gas fuel heaters, though slightly relaxed.
- Solid fuel heaters: distinction is made between automatic and manual stoking like in the Nordic and Austrian ecolabels; values are based on Blue Angel criteria for automatic stocking (70 mg/Nm³ at 13 0_2 % = 96 mg/Nm³ at 10 0_2 %) and stakeholder feedback for manual stocking.

5.3.5 Criterion 6 – Organic gaseous carbon (OGC) emission limits

5.3.5.1 Proposed criterion

The organic gaseous carbon (OGC) of the exhaust gas also understood as organically bound carbon content shall not exceed the limit values indicated in Table 17 (only applicable to solid fuel boiler heaters). The unit of measurement shall be given in mg/Nm³.

Table 17. OGC emission limits by heat generator technology

Heat generator technology	OGC emission limit
Solid fuel boiler heaters	7 mg/Nm³ at 10 % O_2

5.3.5.2 Assessment and verification

A certificate signed by the manufacturer declaring compliance with this criterion shall be submitted to the awarding competent body, together with the relevant documentation.

The OGC emissions in the exhaust gas shall be determined as standard emission factors according to the relevant standards included in Table 2 and Table 3 (where applicable).

5.3.5.3 Rationale and stakeholder feedback

OGC in the exhaust gas is a measure of formation of volatile organic compounds (VOCs) due to poor or incomplete combustion. The carbon in these compounds comes from the fuel and is an indicator of how much fuel was subject to incomplete combustion. Causes of incomplete combustion are: lack of sufficient air/oxygen or too low temperature in the fuel to permit oxidation (combustion) to occur. Incomplete combustion also produces CO (Criterion 5), which is an environmental and health hazard. The measurement of OGC therefore serves to identify whether the combustion conditions lead to incomplete combustion, and consequently may lead to the atmospheric release of environmental or health hazards.

OGC requirements from several product policy schemes are presented in Table 18.

Table 18. Comparison of OGC emission limits in different product policy schemes

Heat generator technology	Ecodesign[1)]	EU Ecolabel[2)]	Blue Angel[3)]	Nordic Ecolabel[4)]	Austrian Eco-label[5)]	GPP[6)]
Gas fuel boiler	No limit	N/A	No limit	N/A	N/A	No limit
Liquid fuel boiler	No limit	N/A	N/A	N/A	N/A	No limit
Solid fuel boiler	N/A	N/A	5 mg/Nm³	Automatic: 25 mg/m³ Manual: 70 mg/m³ (≤ 100 kw); 50 mg/m³ (> 100 kw)	Automatic (full load): 3 mg/MJ (pellets); 5 mg/MJ (chips); Automatic (30 % load): 3 mg/MJ (pellets); 10 mg/MJ (chips) Manual: 30 mg/MJ (full load)	Automatic: 25 mg/m³ Manual: 70 mg/m³ (≤ 100 kw); 50 mg/m³ (> 100 kw)
Fuel-driven heat pump	No limit	No limit	No limit	No limit	N/A	No limit
Electrically-driven heat pump	No limit	No limit	No limit	No limit	N/A	No limit

Cogeneration	No limit	N/A	No limit	N/A	N/A	No limit

[1)] Implementing Measure proposal for Ecodesign Lot 1 (as of 13/03/2013).
[2)] EU Ecolabel criteria for: electrically driven, gas driven or gas absorption heat pumps.
[3)] Blue Angel criteria for: gas-fired calorific-value heating devices; wood-pellet boilers; heat pumps using absorption and adsorption technology or operating by use of combustion engine-driven compressors; heat pumps using an electrically powered compressor; small-scale gas-fired cogeneration modules; and small-scale liquid-fired cogeneration modules. In the Blue Angel, emissions of solid biomass boilers are measured at 13 % O_2 and should be multiplied by 1.375 to be at 10 % O_2.
[4)] Nordic Ecolabelling criteria for: solid biofuel boilers; and heat pumps.
[5)] Austrian Eco-Label criteria for: wood-fired heating systems. The Austrian Eco-Label sets CO emissions in mg/MJ: 3 mg/MJ ≈ 6 mg/Nm³ (10 % O_2); 5 mg/MJ ≈ 10 mg/Nm³ (10 % O_2); 10 mg/MJ ≈ 21 mg/Nm³ (10 % O_2).
[6)] EU GPP criteria for: combined heat and power; and EU GPP preparatory work for: boilers; and heat pumps and air conditioning.

As shown in Table 18, the OGC in the different product policy schemes is only tested for solid fuel (biomass) boilers and is not harmonised from one scheme to another. The threshold limits for the criterion are applicable to full load and have been set as follows:

– Solid fuel boilers: the value has been set on the basis of Blue Angel criteria (5 mg/Nm³ at 13 0_2 % = 7 mg/Nm³ at 10 0_2 %) and Austrian Eco-label criteria (3 mg/MJ = 6 mg/Nm³ at 10 0_2 %), without distinguishing between automatic and manual stoking.

– Any other technology: no limit as in any other scheme.

5.3.6 Criterion 7 – Particulate matter (PM) emission limits

5.3.6.1 Proposed criterion

The particle matter (PM) content of the exhaust gas shall not exceed the limit values indicated in Table 19. The unit of measurement shall be given in mg/Nm³.

Table 19. PM emission limits by heat generator technology

Heat generator technology	PM emission limit
Liquid fuel heaters	Equipped with internal combustion: 1 mg/Nm³ at 5 % O_2 Equipped with external combustion: no limit
Solid fuel heaters	Using wood pellet and wood log fuels: 15 mg/Nm³ at 10 % O_2 Using wood chip and other solid fuels: 15 mg/Nm³ at 10 % O_2

5.3.6.2 Assessment and verification

A certificate signed by the manufacturer declaring compliance with this criterion shall be submitted to the awarding competent body, together with the relevant documentation.

The PM emissions in the exhaust gas shall be determined as standard emission factors according to the relevant standards included in Table 2 and Table 3 (where applicable).

5.3.6.3 Rationale and stakeholder feedback

PM, also called dust or soot, is produced by incomplete combustion of the fuel. PM emissions are primarily dependent on the grade of fuel fired in the hydronic heater. Generally, PM levels from natural gas are significantly lower than those of oils and biomass. PM emission limit values are mentioned in Directive 1999/30/EC[31] (which shows that these emissions are considered by policy makers as an important issue). In fact, the emission limits on a weight bases are four times more stringent than those for NO_x.

PM is potentially an issue for heat generator technologies such as biomass boilers, gas-driven heat pumps and some types of cogeneration systems.

Stakeholders pointed out that there are some problems with the current testing method for particulate matter. In particular, stakeholders stated that measurement methods for PM are not yet harmonised. One of the most common methods appears to be TS 15883 Annex A, but it needs to be supplemented by e.g. an OGC measurement. Several schemes (such as Austrian Eco-Label and Nordic Ecolabel) are working together to find new and more reliable methods for PM measurements.

PM requirements from several product policy schemes are presented in Table 20.

Table 20. Comparison of PM emission limits in different product policy schemes

Heat generator technology	Ecodesign[1)]	EU Ecolabel[2)]	Blue Angel[3)]	Nordic Ecolabel[4)]	Austrian Eco-label[5)]	GPP[6)]
Gas fuel boiler	No limit	N/A	No limit	N/A	N/A	No limit
Liquid fuel boiler	No limit	N/A	N/A	N/A	N/A	No limit
Solid fuel boiler	N/A	N/A	Pellets: 20 mg/Nm³ (full load); 40 mg/Nm³ (30 % load) Chips: 30 mg/Nm³ (full load); 40 mg/Nm³ (30 % load)	Automatic: 40 mg/m³ Manual: 70 mg/m³	Automatic: 15 mg/MJ (pellets); 30 mg/MJ (chips); Manual: 30 mg/MJ	Automatic: 40 mg/m³ Manual: 70 mg/m³
Fuel-driven heat pump	No limit	No limit	150 mg/Nm³	No limit	N/A	No limit
Electrically-driven heat pump	No limit	No limit	No limit	No limit	N/A	No limit

[31] OJ L 163, 29.6.1999, p. 41.

Cogeneration	No limit	N/A	Gas fuel: no limit Liquid fuel: 150 mg/Nm³	N/A	N/A	No limit

1) Implementing Measure proposal for Ecodesign Lot 1 (as of 13/03/2013).
2) EU Ecolabel criteria for: electrically driven, gas driven or gas absorption heat pumps.
3) Blue Angel criteria for: gas-fired calorific-value heating devices; wood-pellet boilers; heat pumps using absorption and adsorption technology or operating by use of combustion engine-driven compressors; heat pumps using an electrically powered compressor; small-scale gas-fired cogeneration modules; and small-scale liquid-fired cogeneration modules. In the Blue Angel, emissions of solid biomass boilers are measured at 13 % O_2 and should be multiplied by 1.375 to be at 10 % O_2.
4) Nordic Ecolabelling criteria for: solid biofuel boilers; and heat pumps.
5) Austrian Eco-Label criteria for: wood-fired heating systems. The Austrian Eco-Label sets CO emissions in mg/MJ: 15 mg/MJ ≈ 31 mg/Nm³ (10 % O_2); 35 mg/MJ ≈ 62 mg/Nm³ (10 % O_2).
6) EU GPP criteria for: combined heat and power; and EU GPP preparatory work for: boilers; and heat pumps and air conditioning.

As shown in Table 20, the PM requirements are not harmonised from one scheme to another. The threshold limits for the criterion are applicable to full load and have been set as follows:

- Gas fuel heaters (including boilers, heat pump and cogeneration): no limit as in any other scheme.
- Liquid fuel heaters (including boilers, heat pump and cogeneration): distinction is made between internal and external combustion like for the NO_x requirements (Criterion 4); no limit is set for external combustion while the value for internal combustion is based on stakeholder feedback.
- Solid fuel heaters: distinction is made between wood pellets and chips in the Blue Angel and Austrian Eco-label; with values for pellets in Blue Angel (20 mg/Nm³ at 13 0_2 % = 27.5 mg/Nm³ at 10 0_2 %) and Austrian Eco-label (15 mg/MJ = 31 mg/Nm³ at 10 0_2 %) criteria; the values for pellets in Blue Angel criteria (30 mg/Nm³ at 13 0_2 % = 41 mg/Nm³ at 10 0_2 %). On-going discussion for Ecodesign Lot 15 (solid fuel boiler heaters) are however currently indicating a level of 20 mg/Nm3 at 10% O2 for both wood pellets and chips. European Commission experts on air emissions suggest that 15 mg/Nm3 at 10% O2 should be achievable and hence a suitable level in the Ecolabel criteria, but reflections on this from the EUEB are highly welcome.

5.3.7 Criterion 8 – Noise emission limits

5.3.7.1 Proposed criterion

The noise emissions shall not exceed the limit values indicated in Table 21. The unit of measurement shall be given in dB(A) or dB(C), as appropriate.

Table 21. Noise emission limits by heat generator technology

Heat generator technology	Measurement	Noise emission limit
Heat pump heaters equipped with external combustion	A-weighted sound power level limit value ($L_{WAd, lim}$)	17 + 36 × log(P_N + 10) dB(A)
Heat pump heaters equipped with internal combustion	A-weighted sound pressure level limit value ($L_{PAd, lim}$)	30 + 20 × log (0.4 × P_N + 15) dB(A)
	C-weighted sound pressure level limit value ($L_{PCd, lim}$)	$L_{PAd, lim}$ + 20 dB(C)
Cogeneration heaters equipped with internal combustion	A-weighted sound pressure level limit value ($L_{PAd, lim}$)	30 + 20 × log (P_E + 15) dB(A)
	C-weighted sound pressure level limit value ($L_{PCd, lim}$)	$L_{PAd, lim}$ + 20 dB(C)

Note: P_N means the nominal (full load) or declared heat output; P_E means the electricity output.

5.3.7.2 Assessment and verification

A certificate signed by the manufacturer declaring compliance with this criterion shall be submitted to the awarding competent body, together with the relevant documentation.

Testing shall be performed in accordance with EN 12102:2008 for heat pump heaters and EN ISO 3744:2009 or EN ISO 3746:2010 for cogeneration heaters using internal combustion. The test report shall be submitted with the application.

5.3.7.3 Rationale and stakeholder feedback

The noise from the heating units is a parameter that should be taken into consideration when deciding where to locate the unit, in order to minimise the noise impact upon the surrounding environment and those living and working nearby.

Noise emissions from central heating products occur mainly from either combustion air / flue gas transport (combustion boilers) or air transport over evaporators / compressor noise (vapour compression cycle heat pumps). In the Ecodesign Lot 1 calculation methodology noise emissions were included to determine distribution losses, the rationale being that the noisier the boiler is, the further it is installed from the main living areas, thereby introducing distribution losses. Discussion in the Ecodesign Lot 1 however showed that there seems to be a lack of data on noise emissions so that noise criterion cannot be set easily. In that perspective, noise is not quantified in the life-cycle analysis of this study.

According to stakeholders, noise is often part of any certification process. A hydronic heater can be installed in different environments and it makes a difference. If they are installed in the central room, the noise issue is less important.

Noise requirements from several product policy schemes are presented in Table 22.

Table 22. Comparison of noise emission limits in different product policy schemes

Heat generator technology	Ecodesign[1)]	EU Ecolabel[2)]	Blue Angel[3)]	Nordic Ecolabel[4)]	Austrian Eco-label[5)]	GPP[6)]
Gas fuel boiler	No limit	N/A	No limit	N/A	N/A	No limit
Liquid fuel boiler	No limit	N/A	N/A	N/A	N/A	No limit
Solid fuel boiler	N/A	N/A	No limit	No limit	No limit	No limit
Fuel-driven heat pump	≤ 6 kW: 60-65 dB(A) > 6 kW & ≤ 12 kW: 65-70 dB(A) > 12 kW & ≤ 30 kW: 70-78 dB(A) > 30 kW: 80-88 dB(A)	No limit	No limit	No limit but noise be tested and reported	N/A	No limit
Electrically-driven heat pump	≤ 6 kW: 60-65 dB(A) > 6 kW & ≤ 12 kW: 65-70 dB(A) > 12 kW & ≤ 30 kW: 70-78 dB(A) > 30 kW: 80-88 dB(A)	No limit	No limit	No limit but noise be tested and reported	N/A	No limit
Cogeneration	No limit	N/A	No limit	N/A	N/A	No limit

1) Implementing Measure proposal for Ecodesign Lot 1 (as of 13/03/2013). The first value of the range refers to indoor level, the second to outdoor level.
2) EU Ecolabel criteria for: electrically driven, gas driven or gas absorption heat pumps.
3) Blue Angel criteria for: gas-fired calorific-value heating devices; wood-pellet boilers; heat pumps using absorption and adsorption technology or operating by use of combustion engine-driven compressors; heat pumps using an electrically powered compressor; small-scale gas-fired cogeneration modules; and small-scale liquid-fired cogeneration modules. In the Blue Angel, emissions of solid biomass boilers are measured at 13 % O_2 and should be multiplied by 1.375 to be at 10 % O_2.
4) Nordic Ecolabelling criteria for: solid biofuel boilers; and heat pumps.
5) Austrian Eco-Label criteria for: wood-fired heating systems. The Austrian Eco-Label sets CO emissions in mg/MJ: 15 mg/MJ ≈ 31 mg/Nm³ (10 % O_2); 35 mg/MJ ≈ 62 mg/Nm³ (10 % O_2).
6) EU GPP criteria for: combined heat and power; and EU GPP preparatory work for: boilers; and heat pumps and air conditioning.

As shown in Table 22, most ecolabels do not consider noise emissions. Only the Nordic Ecolabel requires measuring noise and reporting it, without setting any specific limit. This omission is not meaning that noise is considered as a minor issue, but may be largely explained by that there is not a common agreed testing methodology, which prevents quantitative measure for noise to be part of many ecolabelling schemes. Nevertheless, the

Ecodesign Lot 1 introduces a mandatory maximum level of noise to be measured and certified, though this only applies to heat pumps.

The threshold limits for the criterion have been set as follows:

- Heat pumps: the value is based on stakeholder feedback. The testing procedure refers to Standard EN 12102:2008, which is applicable to electrically-driven heat pumps, but this Standard should also served as a basis for testing fuel-driven heat pumps in case of external combustion.
- Cogeneration heaters: noise could be important for cogeneration in case of internal combustion. The requirement for cogeneration heaters with internal combustion is based on stakeholder feedback. Testing can be done according to either EN ISO 3744:2009 or EN ISO 3746:2010.

As additional information, Figure 1 compares the proposed EU Ecolabel requirements for heat pumps with external combustion with the proposed Ecodesign requirements (outdoors).

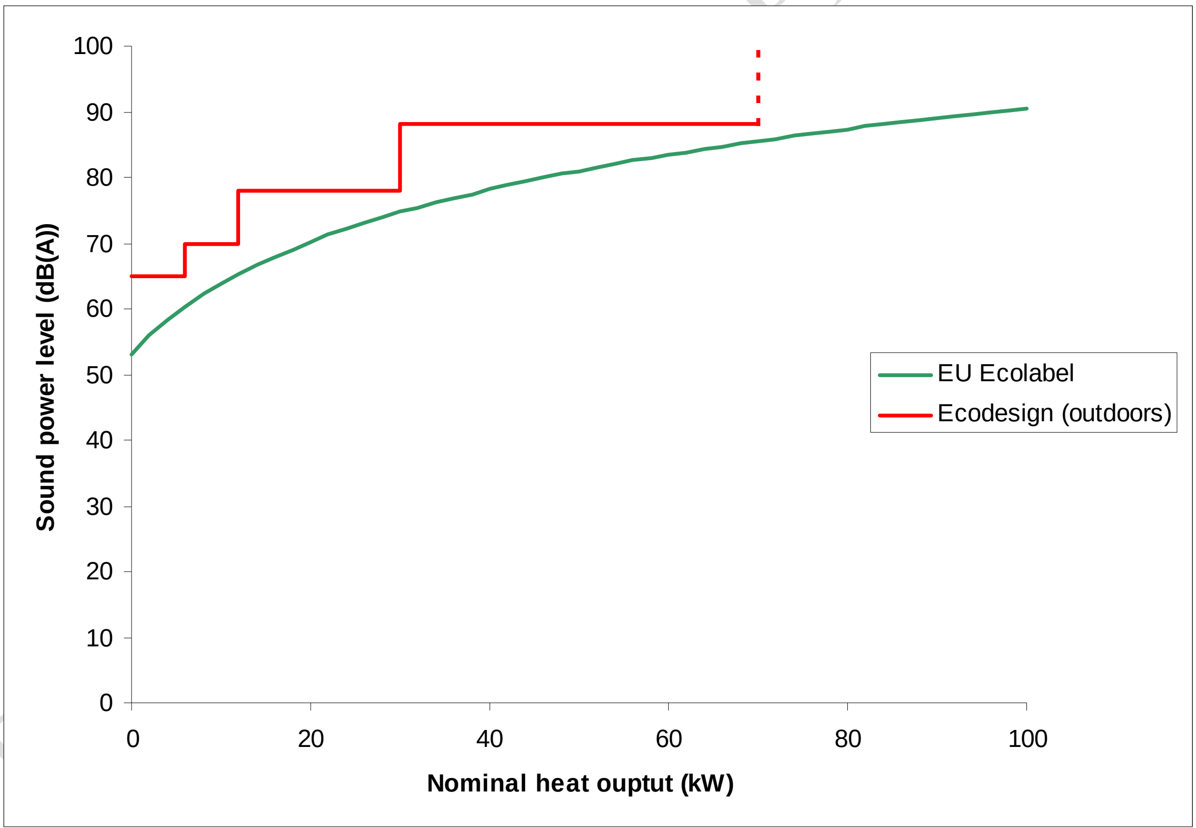

Figure 1: Comparison between the proposed Ecodesign (outdoors) and EU Ecolabel requirements for heat pumps with external combustion

As shown by Figure 1, the Ecodesign requirements are less strict than the EU Ecolabel ones.

5.3.8 Criterion 9 – Hazardous substances and mixtures

5.3.8.1 Proposed criterion

In accordance with Article 6(6) of Regulation (EC) No 66/2010, the product or any article of it shall not contain substances referred to in Article 57 of Regulation (EC) No 1907/2006 nor substances or mixtures meeting the criteria for classification in the following hazard classes or categories listed in Table 23 in accordance with Regulation (EC) No 1272/2008 ([32]).

Table 23. List of hazard statements and risk phrases:

Hazard statement ([33])	Risk Phrase ([34])
H300 Fatal if swallowed	R28
H301 Toxic if swallowed	R25
H304 May be fatal if swallowed and enters airways	R65
H310 Fatal in contact with skin	R27
H311 Toxic in contact with skin	R24
H330 Fatal if inhaled	R23/26
H331 Toxic if inhaled	R23
H340 May cause genetic defects	R46
H341 Suspected of causing genetic defects	R68
H350 May cause cancer	R45
H350i May cause cancer by inhalation	R49
H351 Suspected of causing cancer	R40
H360F May damage fertility	R60
H360D May damage the unborn child	R61
H360FD May damage fertility. May damage the unborn child	R60/61/60-61
H360Fd May damage fertility. Suspected of damaging the unborn child	R60/63
H360Df May damage the unborn child. Suspected of damaging fertility	R61/62
H361f Suspected of damaging fertility	R62
H361d Suspected of damaging the unborn child	R63
H361fd May damage fertility. May damage the unborn child	R62-63
H362 May cause harm to breast fed children	R64
H370 Causes damage to organs	R39/23/24/25/26/27/28
H371 May cause damage to organs	R68/20/21/22
H372 Causes damage to organs	R48/25/24/23

[32] OJ L 353, 31.12.2008, p. 1.
[33] As provided for in Regulation (EC) No 1272/2008.
[34] As provided for in Council Directive 67/548/EEC (OJ 196, 16.8.1967, p. 1).

H373 May cause damage to organs	R48/20/21/22
H400 Very toxic to aquatic life	R50/50-53
H410 Very toxic to aquatic life with long-lasting effects	R50-53
H411 Toxic to aquatic life with long-lasting effects	R51-53
H412 Harmful to aquatic life with long-lasting effects	R52-53
H413 May cause long-lasting effects to aquatic life	R53
EUH059 Hazardous to the ozone layer	R59
EUH029 Contact with water liberates toxic gas	R29
EUH031 Contact with acids liberates toxic gas	R31
EUH032 Contact with acids liberates very toxic gas	R32
EUH070 Toxic by eye contact	R39-41

The use of substances or mixtures in the final product which upon processing change their properties in a way that the identified hazard no longer applies is exempted from the above requirement.

Concentration limits for substances or mixtures meeting the criterion for classification in the hazard classes or categories listed in the table above, and for substances meeting the criteria of Article 57 (a), (b) or (c) of Regulation (EC) No 1907/2006, shall not exceed the generic or specific concentration limits determined in accordance with the Article 10 of Regulation (EC) No1272/2008. Where specific concentration limits are determined, they shall prevail against the generic ones.

Concentration limits for substances meeting criteria of Article 57 (d), (e) or (f) of Regulation (EC) No 1907/2006 shall not exceed 0.1 % weight by weight.

The following substances or mixtures listed in Table 24 are specifically exempted from these requirements.

Table 24. Derogations for compliance with Article 6(6) of Regulation (EC) No 66/2010

Derogated substances, parts or articles	**Derogations**
Articles with weight below 25 g	All hazard statements and risk phrases
Homogeneous parts of complex articles with weight below 25 g	All hazard statements and risk phrases
Nickel in stainless steel	H351/372 and R40/48/25/24/23

5.3.8.2 Assessment and verification

For each article and/or homogeneous part of complex articles with weight over 25 g the applicant shall provide a declaration of compliance with this criterion, together with the related documentation, such as declarations of compliance signed by the suppliers of substances and copies of relevant Safety Data Sheets in accordance with Annex II to Regulation (EC) No 1907/2006 for substances or mixtures. Concentration limits shall be specified in the Safety Data Sheets in accordance with Article 31 of Regulation (EC) No 1907/2006 for substances and mixtures.

5.3.8.3 Rationale

It is important to ensure that the materials and substances used in heaters do not pose a risk to the environment or end-users. Therefore, materials composing the hydronic heaters should not contain hazardous substances, following Articles 6(6) and 6(7) of the EU Ecolabel Regulation. Specifically, the EU Ecolabel Regulation states that the "substitution of hazardous substances by safer substances, as such or via the use of alternative materials or designs, should be considered wherever it is technically feasible".

Based on research and stakeholder consultation, several substances could be derogated from Article 6(6) based on Article 6(7).

Several ecolabels include statements requiring that the composition of materials and the potential release of hazardous substances during use phase must fulfil the requirements of Directive 2002/95/EC[35] (RoHS Directive). In addition to that, some ecolabels add specific criteria banning certain substances such as:

- Certain heavy metals: In plastic parts, in surface treatments (e.g. surface treatments must not contain pigments based on lead, cadmium, chromium, mercury of their compounds);
- Organic solvents: E.g. criteria establishing that surface treatments must not contain more than a certain maximum percentage of organic solvents, or criteria establishing that degreasing agents must not contain halogenated solvents;
- Phthalates: E.g. criteria excluding certain phthalates in plastic parts;
- Flame retardants: E.g. criteria excluding certain flame retardants in plastic parts;
- Substances having climate change impact: E.g. substances used in insulating materials, refrigerants, etc.

Recent preparatory studies for GPP on certain hydronic heaters, as well as recent EU Ecolabel criteria development (during 2010 and 2011), have however followed a more holistic approach of addressing the chemical characteristics of the substances to mitigate any potential risks arising from the use of these materials. This is achieved by using

[35] OJ L 37, 13.2.2003, p. 19.

appropriate hazard statements and risk phrases in the relevant criteria. By taking this more holistic approach the focus of the criteria is on the chemical and environmental properties of the substances rather than on the chemical family to which they belong and thus does not unduly exclude any group of chemicals.

5.3.8.4 Summary of stakeholder feedback

Feedback confirmed the interest of a number of stakeholders in following this more holistic approach. It was also expressed that this criterion on materials is not one of the most relevant criteria for hydronic heaters. However, they still need to be part of the EU Ecolabel criteria.

Below are detailed some of the specific feedback received on flame retardants and nickel.

Regarding flame retardants, hexabromocyclododecane (HBCDD, also referred to as HBCD) received special attention. HBCDD is included as a Substance of Very High Concern (SVHC) in Annex XIV to Regulation (EC) No 1907/2006 (REACH Regulation), as of February 2011. Annex XIV contains a list of substances that need authorisation before they could be put in the market, and according to stakeholders HBCDD is the only flame retardant included in this list. Though stakeholders mentioned the ban of HBCDD, they however pointed out that it will be not effective until the sunset date in August 2015. In addition, the RoHS Directive lists 2 groups of restricted halogenated flame retardants: PBBs and PBDEs (note that the recast of the RoHS Directive[36] did not extend/change the list of restricted substances).

The Blue Angel restricts halogenated flame retardants in general with some minor exception. Stakeholders expressed that the EU Ecolabel should not adopt the Blue Angel criteria regarding flame retardants. In the stakeholders' view, the general ban on halogenated flame retardants by the Blue Angel is not scientifically justified and leads in combination with the list of restricted R/H-phrase substances to serious issues in terms of technical feasibility. According to the stakeholders, (halogenated) flame retardants are a large group of different chemicals with different properties; the chemical grouping of a flame retardant molecule *per se* can only inform about the way the compound will interact with the fire reaction. This is the reason why it is common industry practice to classify flame retardants depending on the presence of certain elements in the molecules, including halogens. The uptake of that classification for environmental and health profiling has in stakeholders' view no scientific backing, and the presence (or absence) of certain natural elements in a flame retardant compound (e.g. Phosphorous, Aluminium, Magnesium, Chlorine, Bromine, Fluorine, Zinc,

[36] Directive 2011/65/EU, OJ L 174, 1.7.2011, p. 88, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:174:0088:0110:en:PDF

Nitrogen, Antimony, Boron, etc.) is not seen as an indication about their environmental and health profiles.

In summary, stakeholders believe that EU Ecolabel criteria for hydronic heaters and other product groups should rather be in line with recently developed EU Ecolabel criteria such as for notebook computers[37] (e.g. 2011/330/EU), where no discriminative criteria against halogenated flame retardants exist. Stakeholders also expressed the idea that hazardous substances should be generally addressed as chemicals. Moreover, a significant part of stakeholders expressed that flame retardants should not be specifically excluded in the EU Ecolabel criteria, and that including general hazard statements and risk phrases is an appropriate approach.

Regarding feedback received on nickel, stakeholders requested a derogation for Ni. It is considered that a total ban of nickel is not justified. One of the reasons is that the legislation allows for different interpretations. In practice, there is always some level of detectability of nickel, even though its presence does not pose any health or environmental concern.

5.3.9 Criterion 10 – Substances listed in accordance with Article 59(1) of Regulation (EC) 1907/2006

5.3.9.1 Proposed criterion

No derogation from the exclusion in Article 6(6) may be granted concerning substances identified as substances of very high concern and included in the list referred in Article 59 of Regulation (EC) No 1907/2006, present in mixtures, in an article or in any homogenous part of a complex article in concentrations higher than 0.1 % w/w. Specific concentration limits determined in accordance with Article 10 of Regulation (EC) No1272/2008 shall apply in case it is lower than 0,1 % w/w.

5.3.9.2 Assessment and verification

The list of substances identified as substances of very high concern and included in the candidate list in accordance with Article 59 of Regulation (EC) No 1907/2006 can be found here:

http://echa.europa.eu/chem_data/authorisation_process/candidate_list_table_en.asp

Reference to the list shall be made on the date of application.

The applicant shall provide a declaration of compliance with this criterion, together with related documentation, such as declarations of compliance signed by the suppliers of substances and copies of relevant Safety Data Sheets in accordance with Annex II to

[37] Commission Decision 2011/330/EU, OJ L 148, 7.6.2011, p. 5, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2011:148:0005:0012:EN:PDF

Regulation (EC) No 1907/2006 for substances or mixtures. Concentration limits shall be specified in the Safety Data Sheets in accordance with Article 31 of Regulation (EC) No 1907/2006 for substances and mixtures.

5.3.9.3 Rationale and feedback

It is generally agreed that SVHCs should be banned in ecolabelled products. However, the practical implementation of this idea seems more difficult to do. One of the concerns is that a radical ban of SVHCs could potentially hamper the possibility for some environmentally friendly product to comply with the EU Ecolabel requirements. Another difficulty arises from the fact that SVHC is a dynamic concept; therefore, a product may be awarded the EU Ecolabel at a certain date, and then be found that it contains substances that later on are classified as SVHC.

Some stakeholders proposed to have the EU Ecolabel criteria referring to the RoHS Directive only. The EU Ecolabel would be denied to any product containing a substance banned by the RoHS Directive. As an example, the Nordic Ecolabel includes such statement for heat pumps: "The materials in the heat pump must fulfill the requirements of the RoHS Directive (2002/95/EC RoHS)". Given that the RoHS Directive is only mandatory for electrical parts and as some hydronic heaters (e.g. boilers) are not electrical, an EU Ecolabel criterion requiring hydronic heaters to comply with the RoHS Directive would provide an additional environmentally-related requirement beyond RoHS, without being overly prescriptive.

Other stakeholders express their concern about the cut-off value set to any homogeneous part of a complex level and any mixture. This requirement derives from the writing of Article 6 (6) of EU Ecolabel Regulation.

5.3.10 Criterion 11 - Plastic parts

5.3.10.1 Proposed criterion

If any plasticiser substance in the manufacturing process is applied, it shall comply with the requirements on hazardous substances set out in Criteria 9 and 10.

Plastic parts of articles or homogeneous parts of complex articles with weight 25 g or more shall not contain a chlorine content greater than 50 % by weight.

Plastic parts with weight 50 g or more shall be marked according to the requirements of European Standard EN ISO 11469 to ensure they are recycled, recovered, or disposed of in the correct manner during the end-of-life phase.

5.3.10.2 Assessment and verification

The applicant shall provide a declaration of compliance with this criterion, together with related documentation, such as declarations of compliance signed by the suppliers of substances and copies of relevant Safety Data Sheets. The applicant shall provide information on the plasticisers used in the product. The applicant shall provide information on the maximum chlorine content of the plastic parts. A declaration of compliance signed by the plastic suppliers and copies of relevant Safety Data Sheets about materials and substances shall also be provided to the awarding competent body. The applicant shall provide information on the intentionally added substances used as flame retardants.

5.3.10.3 Rationale and feedback

Plastic parts are addressed in a separate criterion because stakeholders raised several points related to this issue.

However, other stakeholders have proposed the removal of this criterion from the EU Ecolabel, since they state that these requirements on plastic parts do not give any added environmental benefits, and it is covered by REACH legislation.

The plastic marking requirement is justified by the fact that stakeholders mentioned the correct marking of materials as important to ensure a proper recycling or disposal at the end-of-life phase. This requirement is also present in Nordic Ecolabel and the applicable 50 g threshold is aligned with the Nordic Ecolabel criteria for heat pumps and solid biofuel boilers.

Several existing ecolabels exclude chlorine-containing plastics. In that perspective, the EU Ecolabel also looks for limiting the chlorine content of plastics.

Some stakeholders reported strong concern over the issue of PVC (polyvinyl chloride) and phthalates content of materials and expressed that these substances should be substituted. However for chlorine containing substances (e.g. PVC), some other stakeholders expressed that requirements should refer to chemicals in general without specifying nor banning any substance.

5.3.11 Criterion 12 - Product design for sustainability

5.3.11.1 Proposed criterion

The product shall be designed in such a way that its exchangeable components can be replaced easily by service personnel. Information about which elements can be replaced shall be clearly indicated in the information sheet attached to the product. The applicant shall further ensure that genuine or equivalent spare parts are available for at least ten years from the date of purchase.

Repair or replacement of the product shall be covered by the warranty terms for at least five years.

The applicant shall undertake to take back free of charge the product at end-of-life and shall ensure proper recycling or material recovery of the product, while non-recyclable product parts shall be disposed of in an environmentally acceptable manner. The product information shall provide the details of the take-back scheme in place.

5.3.11.2 Assessment and verification

The applicant shall provide a declaration of compliance with this criterion, together with relevant documentation, including a sample or samples of the product information sheet and warranty terms.

5.3.11.3 Rationale

Based on results from the technical analysis, it is concluded to be worth considering end-of-life management issues relating to hydronic heaters, due to significant potential for environmental harm in this lifecycle phase. End-of-life management is also relevant to elements of hydronic heaters that will need to be replaced throughout the life span of the product. Hydronic heaters consist of materials that can be recovered and recycled, for example plastics and metals. In addition, it may be the case that a hydronic heater is replaced before it has reached its natural end of life. It is generally better in life cycle terms to replace an older hydronic heater before reaching its end-of-life with a new, more efficient one (also with lower GHG emissions).

The criterion on product design for sustainability includes considerations such as design for repair and spare part availability, warranty and sound end-of-life management. The recycled content of materials was also considered but it appeared that requiring a minimum recycled content for plastics and metals would not bring environmental benefits since these materials are already recycled and/or recovered.

The requirement for spare parts availability (10 years after the prurchase) is similar to the one included in the EU Ecolabel criteria for heat pumps[38]. For warranty coverage, the period of five years is seen as reasonable while going beyond the legal 2 year warranty. Going further might be possible (up to 10 years was even proposed) but might be considered as an excessive requirement.

[38] Commission Decision 2007/742/EC, OJ L 301, 20.11.2007, p. 14, available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:301:0014:0025:EN:PDF

As underlined in the GPP preparatory work on heat pumps[39], the end-of-life management of heat pumps is mainly regulated by the requirements of the WEEE Directive, since such products have to be collected for proper disassembly, treatment and recycling of parts. Much of the components of heat pumps can be recycled with a minimum of treatment, for example plastics and metals. In addition, under the F-gas Regulation[40], when a heat pump is recycled, reclaimed or destroyed, certified personnel must recover over all the fluorine-containing gases to limit the amount of fugitive emissions from disposal of the units and thereby mitigate their impact on the ozone layer (as well as reducing their global warming impact).

5.3.11.4 Summary of stakeholder feedback

Stakeholders expressed that the specification of a minimum recycled content might be appropriate for some materials, but not for materials such as metals and alloys, glass and certain plastics, which are already extensively recycled via well-established recycling markets. In the case of metals, which are expensive, the industry already has a high incentive to recycle them, and some parts of the hydronic heater may by design need a pure metal (with no recycled content).

Furthermore, a specification on recycled content would focus on the manufacturing stage and may make sense for products with short life times, limited market growth and where the recycling industry is not profitable or mature. As the lifetime of hydronic heaters is quite long, a requirement on minimum recycled content is less meaningful for these products. In addition, metal products often have lifetimes of several decades, and recycling markets are steady or growing. Therefore, there does not seem a correlation between the recycled content of a product and its recycling performance when reaching its end-of-life.

Instead of recycled content, stakeholders proposed recyclability as the key criterion for metals, glass and other highly recycled materials.

Stakeholders also expressed that criteria on design for disassembly/recycle were not necessary as they would be difficult to enforce. It is important that materials are marked correctly to ensure they are recycled or disposed of in the correct manner at the end-of-life phase. Stakeholders finally suggested a requirement to mark precious metals and/or rare earth metals in electronic parts as information to facilitate recycling.

Regarding the extended producer responsibility to ensure the product performance, some stakeholders proposed a 10 year warranty (instead of 5 years) where standard provisions apply.

[39] See for more information: http://www.ecolabel.dk/NR/rdonlyres/1FAE9FAA-5275-4035-AF70-916A089EA147/0/AirConandHeatPumpsBackgroundReportFINALMay09.doc

[40] Regulation (EC) No 842/2006.

5.3.12 Criterion 13 – Installation instructions and user information

5.3.12.1 Proposed criterion

The product shall be accompanied by relevant installation instructions and user information, which shall give all the technical details needed for a proper installation and shall provide advice on the product's proper and environmentally friendly use as well as its maintenance. It shall bear the following information in print (on the packaging or on documentation accompanying the product) or in electronic format:

(a) statement informing that the product has been awarded the EU Ecolabel, together with a brief, specific explanation as to what this means in addition to the general information provided alongside the EU Ecolabel logo;

(b) general information on appropriate dimensions of heaters for different building characteristics/size;

(c) information on the energy consumption of the heater.

(d) proper installation instructions, including:

  (i) instructions specifying that the heater shall be installed by fully trained fitters;

  (ii) any specific precautions that shall be taken when the heater is assembled or installed;

  (iii) instructions specifying that the control settings of the heater ("heating curve") shall be adjusted properly after installation;

  (iv) if applicable, details on what air pollution emission values the flue gas shall have during the operating phase and how the heater should be adjusted to achieve it. In particular, the recommendations should mention that:

  – the heater shall be adjusted with the aid of measuring gauges for measuring CO, O_2 or CO_2, NO_x, temperature and soot to ensure that none of the threshold values provided for in criteria 2, 4, 5, 6 and 7 are exceeded;

  – holes shall be made for measuring gauges in the same location as used in laboratory testing;

  – measurement results shall be recorded in a special form or diagram, one copy of which is retained by the end user;

  (v) for low flue gas temperature technology, instructions specifying that the system shall be equipped with corrosion-retarding technology;

(vi) for condensing boiler technology, instructions specifying that the chimney shall be protected against condensate with low pH;

(vii) information on who the fitter can approach for guidance on installation;

(e) operating instructions for service personnel;

(f) user information, including:

(i) references to competent installers and service personnel;

(ii) recommendations on the proper use and maintenance of the heater, including the correct fuels to be used and their appropriate storage for optimum combustion and the regular maintenance schedule to keep;

(iii) advice on how rational use can minimise the environmental impact of the heater, in particular information on proper product's use to minimise energy consumption;

(iv) if applicable, information on how the measurement results should be interpreted and how they can be improved.

(v) information about which spare parts can be replaced;

(g) recommendations on appropriate disposal at product's end-of-life.

5.3.12.2 Assessment and verification

The applicant shall declare that the product complies with this criterion and provide the competent body with a sample or samples of the user information or a link to a manufacturer's website containing this information as part of the application.

5.3.12.3 Rationale

The criterion includes information on installation, operation and end-of-life management.

Correct installation is essential to achieve the maximum efficiencies and lowest emissions, and installation guidelines are a very important issue, since the installation can have a large impact on the overall environmental performance of the heating product. Thus providing all the installation instructions required and highlighting where necessary the need for trained engineers should be seen as a prerequisite in the EU Ecolabel perspective.

The correct operation and maintenance of the hydronic heater that will lead to the maximum benefits in terms of reduced energy consumption and reduced air emissions depends also to a large extent on the user behaviour. It is therefore important that an ecolabelled product is provided with clear information and guidance.

In the wider context of the heating system as a whole, it is also important that the system has adequate control mechanisms to ensure the heating is only on and at the required temperature when there is a demand for it. Other aspects of the system also have potential environmental impacts, for example insulation foams containing greenhouse gases and asbestos-containing fire-retarding materials. This is a particular issue for generators where insulation is replaced, as older materials that have been in-situ for a number of years may contain these gases, which will need to be recovered properly. All the information should then be provided.

5.3.12.4 Summary of stakeholder feedback

Feedback from a majority of stakeholders coincided in the installation and user information with underlining that installation and user behaviour are crucial elements for all types of hydronic heaters, and especially in technologies such as biomass boilers and heat pumps. user and installation manuals are very important and very useful. Some stakeholders suggested the requirement for on-line support with web-based documentation to avoid paper wasting. Web information was also mentioned to be important for purchasing and should be available on the EU Ecolabel website.

Feedback from the Nordic Ecolabel pointed out that the EU Ecolabel criteria should require a competent installer. In that perspective, the EU Ecolabel should provide a system to teach the installer, with teaching programs, and there should be a certification program for installers: the installer would need to be certified in order for the product to be ecolabelled. Stakeholders mentioned that training and certification for installers is especially important in certain technologies such as heat pumps. They gave the example of the EHPA EUCERT[41] which has been developed as a common European training programme for heat pump installers.

Regarding the information related to external controls, feedback from stakeholders has suggested that, while the correct application and use of controls is important, it is not appropriate however to include it as a EU Ecolabel requirement. This is because the EU Ecolabel will only apply to the most environmentally friendly appliances, while external controls should be a requirement of all heating appliances. Including such requirement as part of the criteria could inadvertently provide a message that the application of controls and their correct operation can be ignored will less environmentally friendly appliances. This is seen as a negative consequence to be avoided.

[41] EHPA EUCERT training and certification program for heat pump installers, see for more information: http://www.ehpa.org/eucert/

In addition, some stakeholders have offered specific text proposals for services of the producer, installation instructions and user information, as detailed below.

Services of the producer

- Offer of the initial start-up of the heat generator by the user and/or the installation company;
- Explanation of all parameters for an efficient, low-emission combustion and management (customer training);
- Offer of a maintenance service available at the usual customer service hours;
- Offer of conducting the annual testing of the heater;
- Offer of equipping the system with additional metering accessories (e.g. waste gas thermometer, operating-hours meter etc.);
- Availability of equivalent spare parts for at least 10 years;
- Information with respect to all relevant regulations and standards concerning fuel quality, storage and transportation logistics;
- Information that in the planning and design of a fuel storage for pellets the requirements of standard ÖNORM M 7137 are to be taken into account;
- Technical training for installation companies and vendors.

Installation instructions

To avoid faulty installations the written and graphical documents for the fitter shall be designed in such a way that the entire information required is comprehensible and given in correct order. Furthermore, the documents shall contain at least the following information, if they are of relevance for the requested heat generator:

- Technical information on the heat generator:
    - Boiler class, diameter of flue gas connection, flue gas temperatures during operation as well as required feed pressure, dimensions of filling space, water content, water-side resistance, required cold water pressure, minimum return temperature;
    - Electric supply, fuse protection and circuits, additional sets;
- Technical information on the fuel: type and piece size of fuel, maximum water content and heat output, filling ratios and corresponding combustion period;

- Mounting instructions:
    - Step-by-step fitting and the necessary on-the-spot tests, assembly and alternatives;
    - Information concerning sources of mistakes and their avoidance;
    - Fitting position of all sensing devices for control and reading equipment, setting ranges of the sensing devices, correct settings for the start-up;
- Control of the heat distribution: zone-wise control, timers, thermostatic valves, etc.

Maintenance

The operator shall receive information and instructions on how to check the perfect functioning of the system. Such information shall be divided into owner maintenance and third-party maintenance and shall comprise at least the following points:

- Periodic maintenance during heating operation (interval, scope, ...);
- Weekly controls (e.g. visual control);
- Maintenance and controls of the conveying system;
- Keeping maintenance records;
- Maintenance by the installation company or by a suitable maintenance service (interval, scope of work, etc.).

User information

(1) Pre-selling information:

- Tailoring the dimensions of the system to the required energy service;
- To ensure proper dimensioning of the system, an expert (producer, installation company) shall be consulted;
- Efficient arrangement of boiler room and fuel storage as well as the optimum processing and storage of the fuels;
- Provision of the sources of relevant technical standards or laws for the dimensioning of the system;
- Most important technical data and all emission values;
- Information that in the guidelines for subsidisation of the Federal Provinces different requirements are made on buffer storages.

(2) Operating instructions

The written information material for the user shall be designed in such a way that the parameters that are essential and required for the efficiency of the overall system are described in a comprehensible manner which takes into account also aspects of environmental protection.

To ensure that the high environmental standard of the biomass-fired system that was certified at the test stand can be maintained also in everyday operation, extensive operating instructions containing the below-mentioned points and indications shall be handed over to the user:

- Environmental protection:
    - Clear note that the user can make a vital contribution to the environmentally benign operation of the heat generator only if all requirements listed in the operating instructions are complied with;
    - Use only admissible fuel;
    - No burning of waste;
    - Information about efficient and environmentally benign heating;
    - Information on ash disposal;
    - Information regarding the disposal of the individual components of the system;
- Information on the fuel:
    - Admissible type of fuel (maximum humidity content, size, etc.);
    - Maximum filling height;
    - Combustion period at nominal heat output for each admissible type of fuel;
    - Energy content of one filling of the fuel;
    - Declaration of the test fuel;
- Start-up and operation:
    - Proper firing, putting on, opening, and charging;
    - Functioning and operation of the control system for full- and part-load operation;
    - Information concerning the assessment of the quality of combustion and the operating status by means of visual observations (flame, deposits, ash, flue gas temperature, etc.);

(3) Servicing and maintenance:

- Cleaning: Information on intervals and required equipment;
- Fault: Correct behaviour, fault tracing and trouble-shooting;
- Maintenance: Scope of owner and third-party maintenance, intervals;
- Service phone numbers: Producer, maintenance service, etc.

(4) Additional information for boilers:

- Information on the design of the required boiler return and/or boiler temperature control. Recommendation concerning the installation of a control device (e.g. thermometer);
- Suitability of the boiler control for part-load operation;
- Information on system adjustment to changing fuels (above all in the case of wood-chip furnaces).

(5) Product type label (fixed on the heater):

- Name and company headquarters of the manufacturer and manufacturer's mark, if any;
- Company name and address;
- Trade name or type designation under which the heater is marketed;
- Manufacturer number, type number and year of manufacture;
- Indications on the admissible type and size of fuel;
- Nominal heat output and capacity range in kW for the admissible type of fuel;
- Electric supply (V, Hz, A) and electrical power input in watt (if available);
- Additional information for heating boiler only:
    - Boiler class;
    - Maximum admissible operating temperature in °C;
    - Maximum admissible operating pressure in bar;
    - Water content in litres.

(6) System documentation:

To ensure that, in practice, efficiency, environmental compatibility and operativeness of the overall system can approximately be achieved with the optimised conditions of a test stand measurement, it is of great importance that the system documentation is properly designed.

The system documentation and the completion certificate, respectively, shall therefore comprise at least the following content and test certificates:

- Test report (according to the relevant standard) with the following attachments:
  - Drawing of the system with picture;
  - Description and explanation of all indications provided on the type label;
- Installation certificate with the following statement: "The installation company certifies that the system has been installed professionally and in compliance with the applicable provisions regarding fire protection. It further confirms the conformity of the built-in technical safety devices by the attachment of the test certificates."
- The operator of the system has been familiarised with the operation of the system and has been instructed about the mode of action and the self-control of all safety devices. In the course of the instruction the operating instructions have been handed over to the operator of the system;
- Handover of the operating instructions;
- Handover of all technical documents;
- Handover of all certificates of conformity;
- Handover of the commissioning certificate;
- Listing of all service numbers (manufacturer, fitter, maintenance, etc.);
- In the case of industrial plants with a nominal heat output ≥ 50 kW mention shall be made of the recurrent test according to the Ordinance on Firing Systems.

5.3.13 Criterion 14 – Information appearing on the EU Ecolabel

5.3.13.1 Proposed criterion

The optional label with text box shall contain the following text:

- Increased energy efficiency
- Reduced greenhouse gas emissions
- Reduced air emissions

The guidelines for the use of the optional label with the text box can be found in the 'Guidelines for the use of the EU Ecolabel logo' on the website:

http://ec.europa.eu/environment/ecolabel/promo/pdf/logo%20guidelines.pdf

5.3.13.2 Assessment and verification

The applicant shall provide a sample of the printed paper product showing the label, together with a declaration of compliance with this criterion.

5.3.13.3 Rationale and stakeholder feedback

The technical analysis (see the Preliminary Report) showed that energy and greenhouse gas emissions represent the two most environmental impacts of hydronic heaters. Therefore, the requirements on minimum energy efficiency and greenhouse gas emission limits are the two most important criteria to be underlined. This is confirmed by the fact that most existing ecolabelling schemes for hydronic heaters also emphasise these two parameters.

Air pollutants (e.g. NO_x and PM) are another important point and mentioning that the ecolabelled products have reduced air emissions compared to other products is relevant from the environmental point of view.

5.3.13.4 Summary of stakeholder feedback

Stakeholders reported that statements such as "this heat pump is more energy efficient and emits less greenhouse gas emissions than other heat pumps" next to the EU Ecolabel and other ecolabels have been typically used to convey the main advantages of purchasing the ecolabelled product with respect to other products in the market with the same functionality.

Some stakeholders suggested that "reduced greenhouse gas emissions" could be the first point to be conveyed to consumers.

6. CONCLUSION

The life-cycle analysis in this study does not indicate an overall favourable technology. Each hydronic heater type has its specific advantages and drawbacks, depending on which impact category is considered. Because each heating technology entails different magnitudes of environmental impacts in different impact areas, this study concludes that it is important to compare the different technologies horizontally.

From the literature review and information available from product policy schemes in the area of hydronic heaters, it appears that the two most important criteria area are related to energy efficiency and GHG emissions. Therefore, these two parameters were used to set the common benchmark of minimum performance that all hydronic heaters shall fulfil (the specificity of some technologies was also taken into account). The remaining criteria can be applicable to some or all technologies; the relevance of each of the criteria with respect to the heat generator technology is indicated and justified in each of the criterion.

The thresholds for the different criteria have been set with keeping in mind that the EU Ecolabel should aim to award about 10-20% of hydronic heaters on the market, taken together as a product group.

7. APPENDIX 1: UNITS AND CONVERSION FACTORS

7.1 Conversion from one unit to another

7.1.1 Conversion between mg/MJ and mg/Nm³

Air emissions can be expressed in different units. For example, in the Austrian regulations they are typically given in mg/MJ. In other countries, they are given in mg/Nm³ (13.2% O_2). MJ means Megajoules and it refers to the energy production. Nm^3 means normal (standard) m³ air with an oxygen content of 13.2% and it refers to the exhausted fumes. A straightforward (approximate) calculation conversion factor is 1:1.5. For example, 100 mg/MJ NO_x in the Austrian Ecolabel is equivalent to 150 mg/Nm^3 NO_x as expressed in the Blue Angel criteria, but this approximate conversion factor depends on the type of fuel and other combustion or fuel parameters.

Often in ecolabels the air emissions limits are given in: mg/kWh, described as “mg of pollutant per kWh of heat generating material” (i.e. of energy input), where 1 MJ = 0.278 kWh.

7.1.2 Correction for different O_2 value in flue gas

Blue Angel emissions are for instance measured at 0 ^{o}C, 1013 mbar, 13 % O_2 (while 10% O_2 in EN 303-5 for biomass boilers).

The concentration of a substance in the flue gas [mg/Nm3] at an oxygen level different from the concentration at a reference oxygen value can be calculated by the formula given below:

$$C_{\%O_2[\text{required}]} = C_{\%O_2[\text{reference}]} \times \frac{(21 - \%O_2[\text{required}])}{(21 - \%O_2[\text{reference}])}$$

where:

$\%O_2$ [required] = required % O_2;

$\%O_2$ [reference] = reference % O_2;

$C_{\%O_2[\text{required}]}$ = new concentration with the required % O_2;

$C_{\%O_2[\text{reference}]}$ = concentration given with a reference % O_2;

Using this formula many emission limits at a reference oxygen level of 13%, as established in the Blue Angel scheme, can be converted to a limit for an oxygen level of 10%, as established in EN 303-5 for many substances. The correction factor in this case (from 13% to 10% O_2) is 1.375.

7.1.3 Primary energy to electricity conversion

Regarding the conversion factor of primary energy to electricity, it is considered to be equal to 2.5 for all MS, which reflects the average EU-27 efficiency of providing electricity from primary energy sources.

7.2 Conversion factors

7.2.1 GHG emission factors

Table 25 shows the GHG emission factors for different types of fuels.

Table 25. GHG emission factors by fuel (g CO_2-equivalent per kWh fuel or energy, kWh as GCV)

Fuel used by the heater	GHG emission factor	Value (g CO_2-equivalent/kWh_{gas})
Electricity	$\beta_{fuel} = \beta_{elec}$	384
Gaseous fossil fuels	$\beta_{fuel} = \beta_{gas}$	202
Liquid fossil fuels	$\beta_{fuel} = \beta_{oil}$	292
Solid fossil fuels	$\beta_{fuel} = \beta_{coal}$	392
Gaseous biomass	$\beta_{fuel} = \beta_{bio\text{-}gas}$	98
Liquid biomass	$\beta_{fuel} = \beta_{bio\text{-}oil}$	149
Wood logs	$\beta_{fuel} = \beta_{bio\text{-}log}$	19
Wood chips	$\beta_{fuel} = \beta_{bio\text{-}chip}$	16
Wood pellets	$\beta_{fuel} = \beta_{bio\text{-}pellet}$	39
Blends of fossil fuels and biomass	β_{fuel} = weighted average derived from the sum of the weight fractions of the individual fuels multiplied by their GHG emission parameter	Σ (Fuel X % × $\beta_{fuel\ X}$) + (Fuel Y % × $\beta_{fuel\ Y}$) + … (Fuel N % × $\beta_{fuel\ N}$)

In case the boiler is designed for a fuel not listed above, the closest match of fuel shall be selected, based on origin of fuel (fossil or biofuel) and form (gaseous, liquid or solid).

7.2.2 GWP factors

As regards the GWP factors for refrigerants, it is proposed to refer to the sources of references for the GWP_{100} values mentioned in Annex 1.1(7) to Regulation (EU) No 206/2012. For fluorinated refrigerants, it means the GWP values published in the Third Assessment Report adopted by the Intergovernmental Panel on Climate Change, and for non-fluorinated refrigerants GWP values published in the First Assessment Report. When refrigerants are not covered by any IPCC Assessment Report, it is proposed to use the values presented in the Preparatory study for a review of the F-gas Regulation[42], which will allow for more internal consistency within Commission Documents. Table 26 summaries the GWP_{100} to be used.

Table 26. GWP_{100} factors for refrigerants (source: Schwarz *et al.*, 2011)

Table 2-1: List of gases and global warming potentials included in the model AnaFgas[7]

Industrial Designation or Common Name	Chemical Formula	GWP (100yr)		
		2nd AR	3rd AR	4th AR
Carbon dioxide	CO_2	1	1	1
HFC blends				
404A	44% 125, 4% 134a, 52% 143a	3,260	3,784	3,922
407C	23% 32, 25% 125, 52% 134a	1,526	1,653	1,774
507	50%125, 50% 143a	3,300	3,850	3,985
410A	50% 32, 50% 125	1,725	1,975	2,088
Substances controlled by the Montreal Protocol				
CFC-11	CCl_3F	3,800	4,600	4,750
CFC-12	CCl_2F_2	8,100	10,600	10,900
HCFC-22	$CHClF_2$	1,500	1,700	1,810
HCFC-141b	CH_3CCl_2F	600	700	725
HCFC-142b	CH_3CClF_2	1,800	2,400	2,310
Hydrofuorocarbons				
HFC-23	CHF_3	11,700	12,000	14,800
HFC-32	CH_2F_2	650	550	675
HFC-125	CHF_2CF_3	2,800	3,400	3,500
HFC-134a	CH_2FCF_3	1,300	1,300	1,430
HFC-143a	CH_3CF_3	3,800	4,300	4,470
HFC-152a	CH_3CHF_2	140	120	124
HFC-227ea	CF3CHFCF3	2,900	3,500	3,220
HFC-236fa	$CF_3CH_2CF_3$	6,300	9,400	9,810
HFC-245fa	$CHF_2CH_2CF_3$		950	1,030
HFC-365mfc	$CH_3CF_2CH_2CF_3$		890	794
HFC-43-10mee	$CF_3CHFCHFCF_2CF_3$	1,300	1,500	1,640
Sulphur hexafuoride	SF_6	23,900	22,200	22,800
Nitrogen trifuoride	NF_3	–	10,800	17,200
PFC-14	CF_4	6,500	5,700	7,390
PFC-116	C_2F_6	9,200	11,900	12,200
PFC-218	C_3F_8	7,000	8,600	8,830
PFC-318	$c\text{-}C_4F_8$	8,700	10,000	10,300
PFC-3-1-10	C_4F_{10}	7,000	8,600	8,860
		Not listed in IPCC AR		
unsaturated Hydrofuorocarbons				
HFC-1234yf		4		
HFC-1234ze		6		
Hydrocarbons and other compounds - Direct Effects				
290 propane	C_3H_8	3		
600a isobutane	C_4H_{10}	4		
pentanes	C_5H_{12}	5		
fluoroketone FK 5-1-12	$C_6F_{12}O$	1		

[7] The GWPs of unsaturated HFCs in this list are not included in any IPCC report.

[42] W. Schwarz, B. Gschrey, A. Leisewitz *et al.* (2011): Preparatory study for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases, Final Report, Öko-Recherche GmbH, Prepared for the European Commission in the context of Service Contract No 070307/2009/548866/SER/C4.

7.2.3 Conversion of NCV_{wet} to GCV_{ar} for solid fuels

The EN303-5 standard prescribes the calculation of the energy efficiency of the equipment, based on the net calorific value (NCV) of the wet fuel ('wet fuel' means the energy content of 1 kg of fuel is corrected for the moisture content of that fuel). The proposed measures for the Ecodesign Lot 1 and the calculation of seasonal efficiency in those measures are, however, based on the gross calorific value (GCV) of the fuel (for Ecodesign Lot 1 heaters, the difference between the dry fuel and the wet fuel – as received – is not significant as natural gas and fuel oil do not contain significant amounts of moisture).

The GCV value assumes recovery of latent heat (condensation of moisture occurs) whereas the NCV value assumes no condensation of moisture occurs, which entails GCV > NCV. In addition, both values can be based on fuel with (wet-based = wet) or without (dry-based = dry) moisture. For dry-based NCV/GCV, only the moisture that is generated from the combustion process itself is counted (H and O atoms react to form H_2O). This is the basis for GCV/NCV of natural gas and oil, since these fuels can be considered as dry-based (no additional moisture). However, solid biomass fuels contain significant share of moisture, ranging from indicatively 5% (weight basis) for pellets to over 30% for wood chips, while fresh chips may contain 50-60% moisture. As a result, the NCV_{wet} for solid biomass fuels is lower than the NCV_{dry} since the wet-based value ignores the large potential of latent heat recovery.

In order to use the same basis for computing the seasonal space energy efficiency according to the Ecodesign Lot 1 methodology, the efficiency based on NCV_{wet} (established according to EN 303-5) can be converted to an efficiency based on GCV_{wet}, which corrects for the moisture content in the fuel but includes in the energy content the latent heat energy stored in hydrogen that is oxidised to water in the combustion process. The conversion is based on formulae that are widely recognized as robust enough for such conversions[43].

The rationale to use GCV_{wet} for solid fuel boilers is as follows. The energy efficiency of a heater is by definition the heat output divided by the heat input. The heat output of a solid biomass condensing boiler includes a share of latent energy from additional moisture (not created during combustion, but already present in the fuel). If the denominator (heat input) in the efficiency calculation does not include any form of latent heat, as it is the case with NCV values, the efficiency can in theory be beyond 100% (more output than counted as input). In the case where GCV_{dry} is used, the latent heat from combustion processes is then included, but the detrimental effect of additional moisture that first needs to be heated up and

[43] A good overviwe of the conversion is described in the UK CGPQA document "Guidance Note 29" as issued under the UK Quality Assurance program for combined heat and power equipment. The notes are used to allow calculation of energy efficiency when using fuels of variable moisture content. See for more information: https://www.chpqa.com/guidance_notes/GUIDANCE_NOTE_29.pdf

evaporated (which uses energy and lowers heat output) is neglected. By using GCV_{wet}, the latent heat from combustiion is included (as in GCV of all other fuels), but the efficiency loss from additional moisture is already accounted for. If this additional moisture (beyond that of the combustion process) is to be recovered, it will not result in efficiencies beyond 100% because the moisture required energy to heat up and evaporate in the first place.

The difference between GCV and NCV depends on the moisture content and the hydrogen content of the fuel. For natural gas, which is effectively dry and is composed predominantly of methane (25% hydrogen and 75% carbon by weight) NCV is approximately 10% lower than GCV. For most dry fuels the difference is less than 10%, typically 4% – 6% for coals and oil fuels but can be much greater for fuels that contain large proportions of moisture. For wood containing 60% moisture the ratio NCV/GCV is approximately 0.75.

Below is detailed how to obtain GCV_{wet}.

The dry-based gross calorific value GCV_{dry} of a fuel (in MJ/kg) depends on its chemical composition and can be estimated as follows[44]:

$$GCV_{dry} = 0.3491 \times C_{dry} + 1.1783 \times H_{dry} + 0.1005 \times S_{dry} - 0.0151 \times N_{dry} - 0.1034 \times O_{dry} - 0.0211 \times A_{dry}$$

where:

- C_{dry} is the carbon content of the dry fuel (percentage by mass)
- H_{dry} is the hydrogen content of the dry fuel (percentage by mass)
- O_{dry} is the oxygen content of the dry fuel (percentage by mass)
- N_{dry} is the nitrogen content of the dry fuel (percentage by mass)
- S_{dry} is the sulphur content of the dry fuel (percentage by mass)
- A_{dry} is the ash content of the dry fuel (percentage by mass)

As a result, GCV_{dry} differs slightly from one fuel to another. For the average wood-based fuel, the GCV_{dry} is approximately 19.5 MJ/kg.

The gross calorific value of the wet fuel (GCV_{wet}) can be calculated by correcting GCV_{dry} with the moisture content of the fuel:

$$GCV_{wet} = GCV_{dry} \times (100 - m)/100$$

where: m = moisture content (% of weight).

[44] Source: Handbook of biomass combustion, equation 2.1.

If the chemical composition of the fuel is not entirely known, the GCV_{dry} can be based on the net calorific value of the fuel, which can be:

- NCV_{daf}: net claorific value of the dry fuel, ash free
- NCV_{dry}: net calorific value of the dry fuel (including ash)
- NCV_{wet}: net calorific value of the wet fuel

with using one or more of the formulas below:

$NCV_{wet} = NCV_{dry} \times (100 - m)/100 - 2.442 \times m/100$

$NCV_{dry} = NCV_{daf} * (100 - Ash_{dry})/100$

$GCV_{dry} = NCV_{dry} + (2.442 \times 8.936 \times H_{dry})/100$

where:

Ash_{dry} = the ash content of the dry fuel (% weight)

H_{dry} = the hydrogen content of the dry fuel (% weight)

As guiding values, H_{dry} is 6% for woody fuels and 5.5% for herbaceous fuels.

8. APPENDIX 2: SUMMARY OF THE TECHNICAL ANALYSIS

The EU Ecolabel criteria were partly developed based on the results from a life-cycle analysis using 12 base cases, described in the Preliminary Report[45]. The 12 base cases are as follows:

1. Oil boiler
2. Gas boiler
3. Gas hybrid: The gas boiler represents 50% of the total thermal demand (i.e., of the total heat output of the hybrid unit); the remaining 50% is an electric heat pump
4. Electrically-driven heat pump
5. Gas absorption heat pump
6. Gas ICE (internal combustion engine) heat pump
7. Coal boiler
8. Small/wood manual biomass boiler
9. Small/wood automatic biomass boiler
10. Small pellet biomass boiler
11. Large wood chips biomass boiler
12. Cogeneration

The following figures (from Figure 2 to Figure 11) summarise the key findings of the Preliminary Report on the main environmental impacts, including GHG and other air emissions (NO_x, OGC, CO and PM), for the 12 base cases analysed in the life-cycle analysis.

Figure 2 and Figure 3 show the GHG emissions in kg CO_2-equivalent per kWh energy input and per thermal output, respectively.

[45] VHK (2011): Development of European Ecolabel and Green Public Procurement Criteria for Hydronic Central Heating Generators, Policy Analysis, Draft Report, November 2011, Prepared for the European Commission, JRC-IPTS, available at: http://susproc.jrc.ec.europa.eu/heating/stakeholders.html

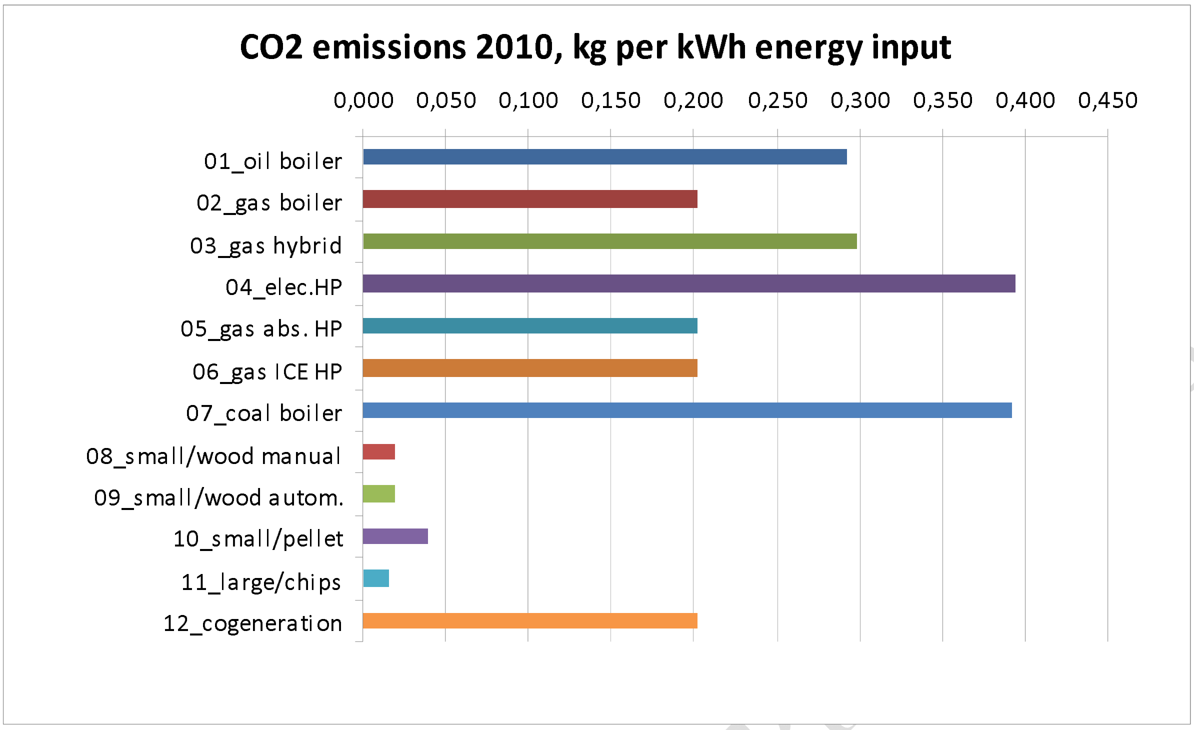

Figure 2. GHG emissions in kg CO_2-equivalent per kWh energy input for 12 base cases (Source: VHK, 2011)

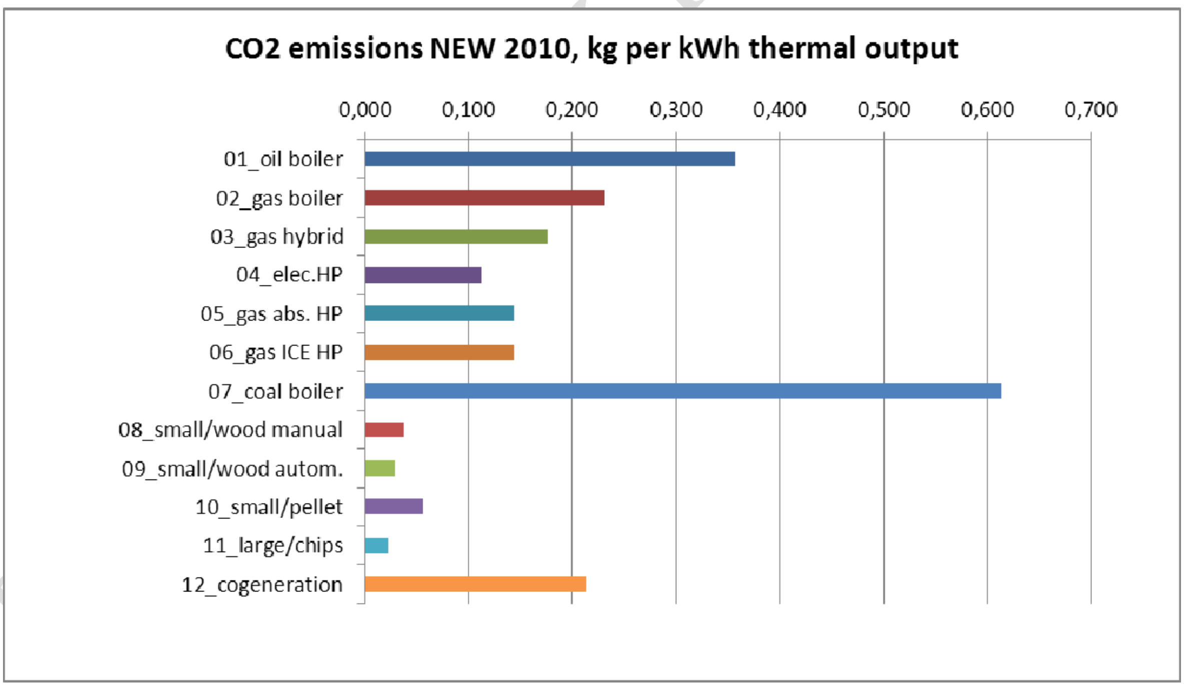

Figure 3. GHG emissions in kg CO_2-equivalent per kWh thermal output for 12 base cases (Source: VHK, 2011)

The comparison from Figure 3 shows that the lowest GHG emissions (CO_2 equivalent) are achieved by biomass boilers, which is mainly due to political default of zero CO_2 combustion emissions. The best non-biomass boiler in terms of GHG emissions is electric heat pump due to its high energy efficiency and relatively low CO2 emissions per kWh output[46], followed closely by gas heat pumps and the gas hybrid solutions. The oil boiler is relatively more polluting than the gas boiler due to lower average efficiency and a higher specific emission factors. The most polluting is the coal boiler, which has the worst efficiency and specific emission factor.

Figure 4 and Figure 5 show the NO_x emissions in mg per kWh energy input and per thermal output, respectively.

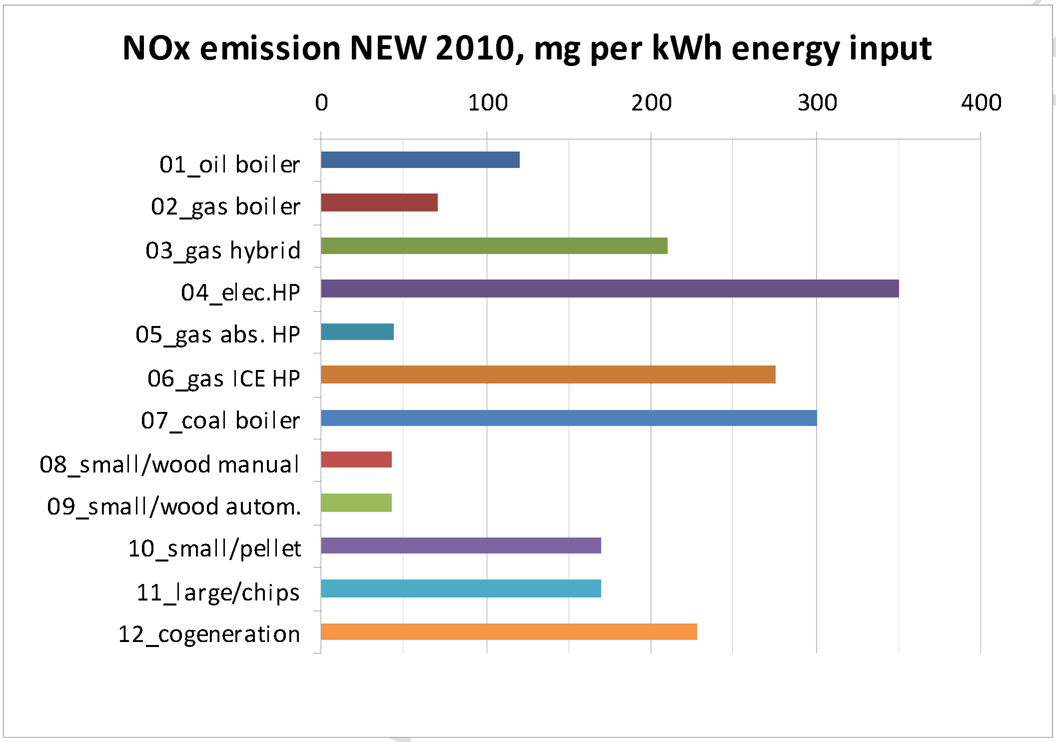

Figure 4. NO_x emissions in mg per kWh energy input for 12 base cases (Source: VHK, 2011)

[46] If the 0.394 kgCO2/kWh input for the electric heat pump (year 2010) is divided by 2.5, the specific emission per primary input is 0.158 kg CO2/kWh, which is lower than that for gas.

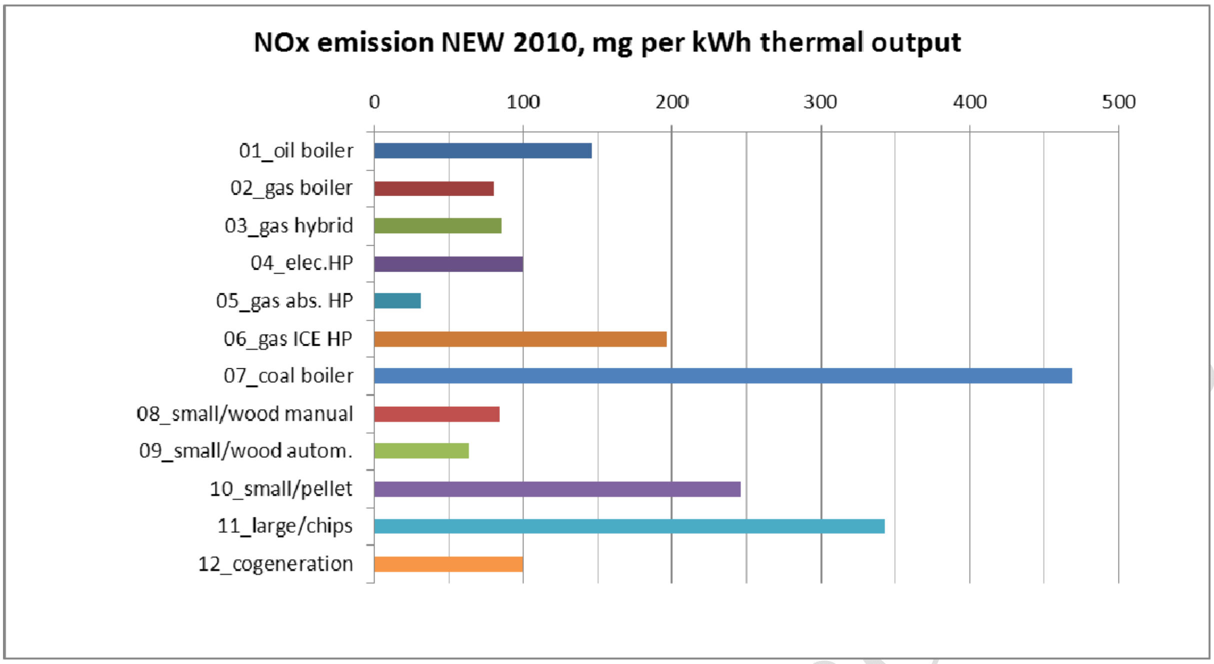

Figure 5. NO_x emissions in mg per kWh thermal output for 12 base cases (Source: VHK, 2011)

The NO_x emissions when harmonised per kWh thermal output show large differences over appliance types (Figure 5). Lowest emissions are achieved by the gas absorption heat pump, since this appliance combines a high efficiency with a very low pollution specific emission factor. NO_x emissions from wood biomass boilers are relatively low due to their low specific emission factor (42 mg/kWh fuel input)[47]. Pellet and chips boiler apparently emit more NO_x, as do other fossil fuel fired boilers. The gas internal combustion engine and the cogeneration unit have relatively high specific NO_x emission factors (more difficult to reduce emissions in these appliances, unless catalyst is used).

Figure 6 and Figure 7 show the OGC emissions in mg per kWh energy input and per thermal output, respectively.

[47] Assuming NO_x emission factor of 150 mg/MJ input. For reference, see table 4-22, p.38 in: Boersma, A, *et al.* (2008): Emissions of the use of biomass fuels in stationary applications, ECN/TNO, ECN-BKM-2008-81

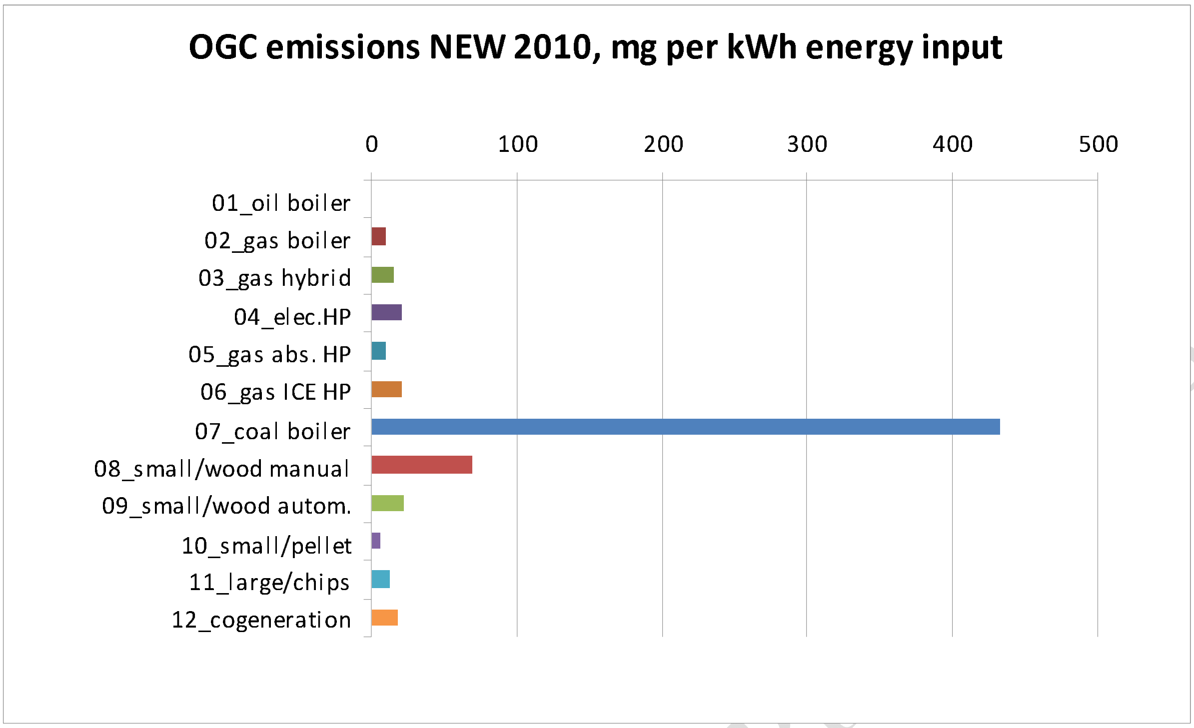

Figure 6. OGC emissions in mg per kWh energy input for 12 base cases (Source: VHK, 2011)

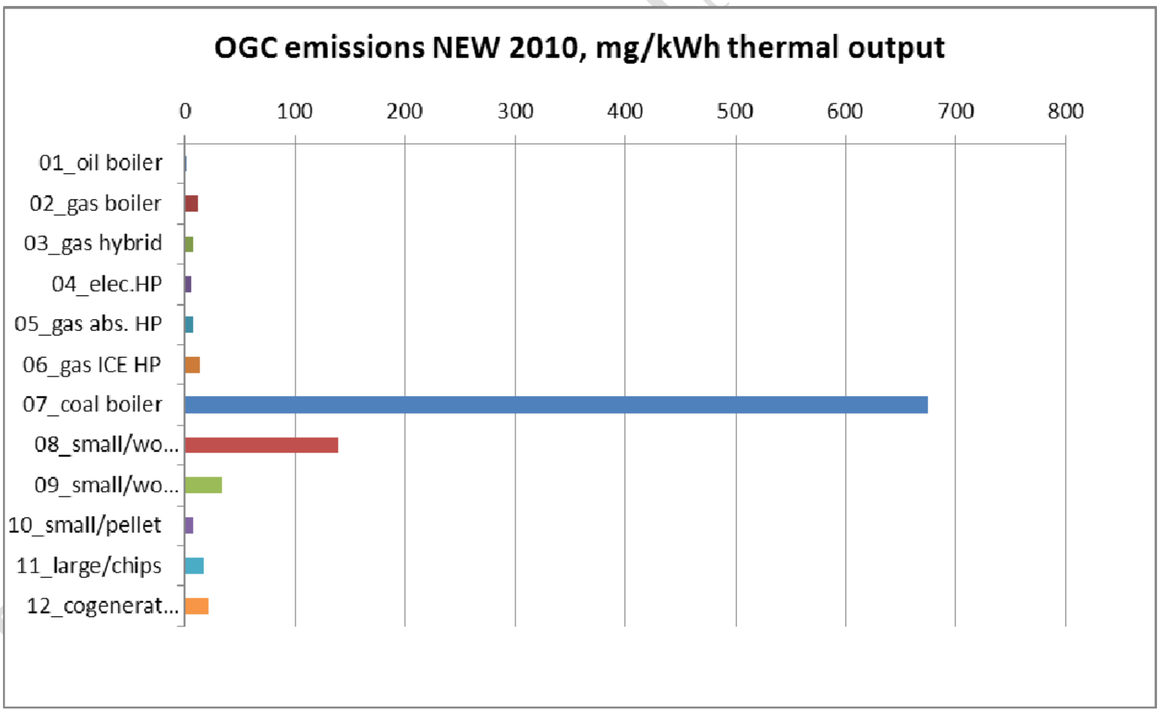

Figure 7. OGC emissions in mg per kWh thermal output for 12 base cases (Source: VHK, 2011)

Figure 8 and Figure 9 show the CO emissions in mg per kWh energy input and per thermal output, respectively.

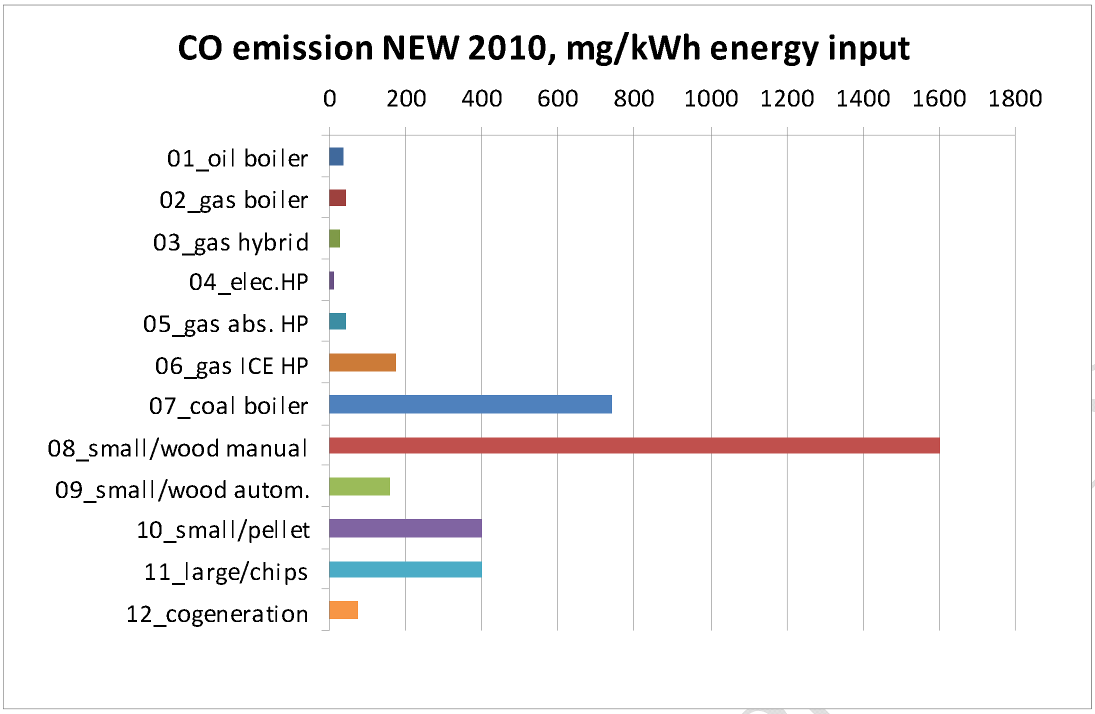

Figure 8. CO emissions in mg per kWh energy input for 12 base cases (Source: VHK, 2011)

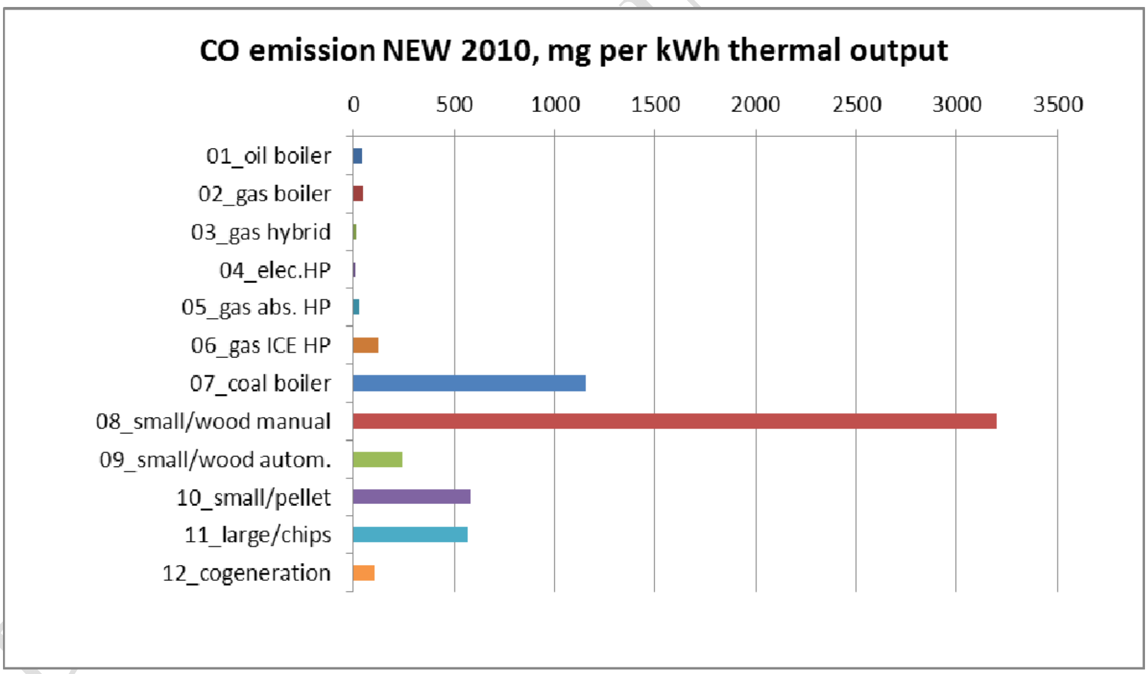

Figure 9. CO emissions in mg per kWh thermal output for 12 base cases (Source: VHK, 2011)

Figure 10 and Figure 11 show the PM emissions in mg per kWh energy input and per thermal output, respectively.

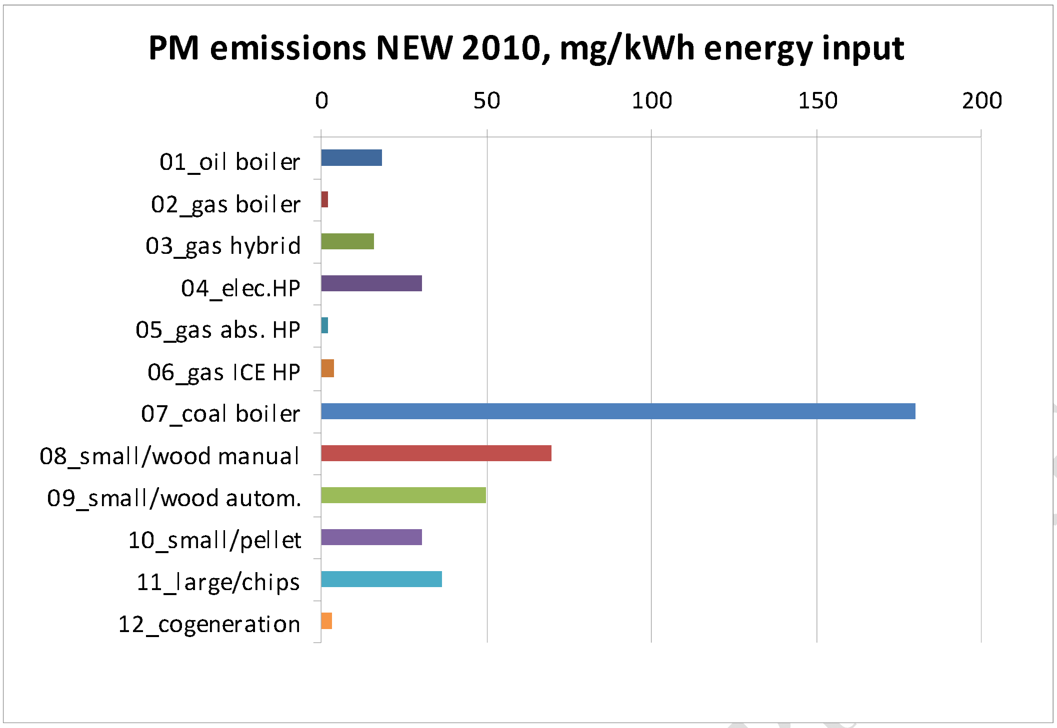

Figure 10. PM emissions in mg per kWh energy input for 12 base cases (Source: VHK, 2011)

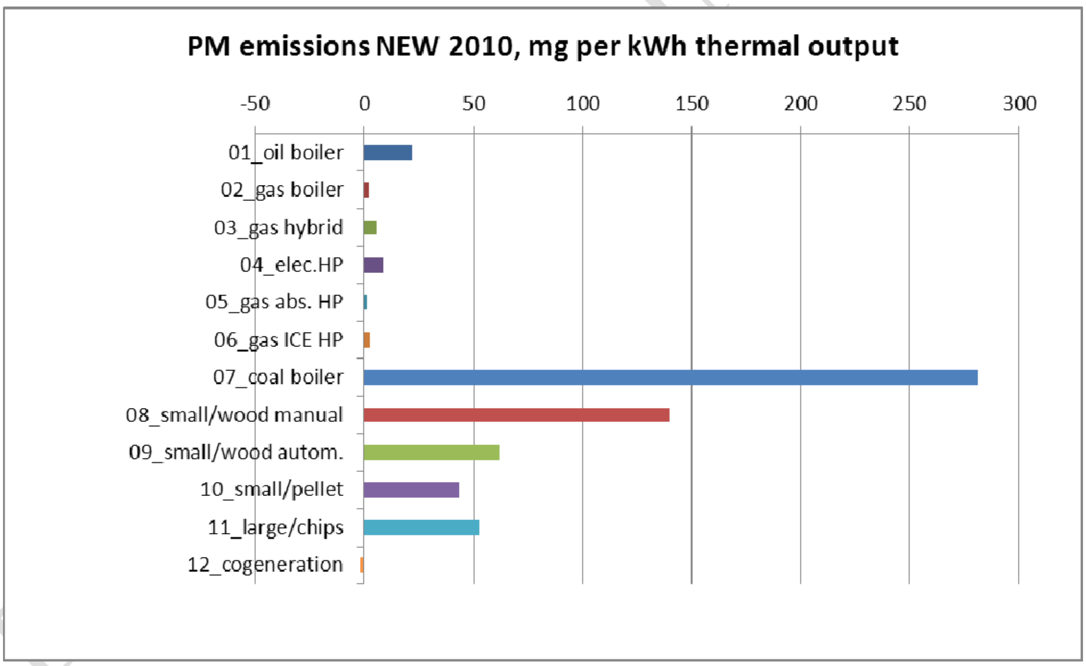

Figure 11. PM emissions in mg per kWh thermal output for 12 base cases (Source: VHK, 2011)

Figure 12 and Table 27 show the current and expected market shares of the different central heating technologies over the period 2005-2030.

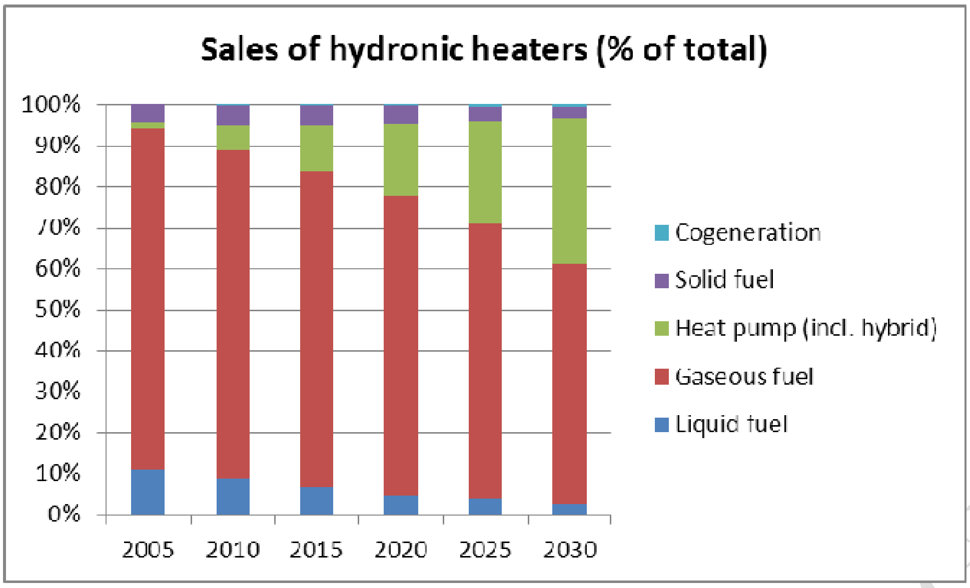

Figure 12. Market shares of the hydronic heaters (Source: VHK, 2011)

Table 27. Market shares of the hydronic heaters (Source: VHK, 2011)

Technology	2005	2010	2015	2020	2025	2030
Liquid fuel	11%	9%	7%	5%	4%	3%
Gaseous fuel	83%	80%	77%	73%	67%	59%
Heat pump (incl. hybrid)	2%	6%	11%	18%	25%	35%
Solid fuel	4%	5%	5%	4%	4%	3%
Cogeneration	0%	0%	0%	0%	0%	0%

The assumptions for the sales of heat pumps for the years beyond 2010 are based upon estimates by the EHPA. This source predicts an overall market share for heat pumps of some 10 % in 2015 including hybrid solutions (e.g. a fossil fuel boiler combined with a heat pump for base load operation).

Table 28 shows the past, current and expected sales (in thousand units) of the different central heating technologies over the period 1990-2030.

Table 28. Sales of the hydronic heaters (Source: VHK, 2011)

Sales ('000)	1990	1995	2000	2005	2010	2015	2020	2025	2030
01_oil boiler	860	882	833	779	650	529	403	324	246
02_gas boiler	3918	4632	5118	5709	5847	6036	6052	5670	4982
03_gas hybrid	0,0	0,0	0,0	0,0	3	50	269	486	923
04_elec.HP	0	6	42	112	451	812	1165	1531	1722
05_gas abs. HP	0	0	0	0	1	5	21	87	308
06_gas ICE HP	0	0	0	0,0	0,1	0,3	0,7	1,3	20,5
07_coal boiler	11	11	11	11	4	4	3	3	2
08_small/wood manual	185	185	185	185	83	87	50	28	6
09_small/wood autom.	22	32	42	53	222	226	220	205	187
10_small/pellet	0	2	4	7	46	71	69	59	53
11_large/chips	0	11	23	34	2	1	1	1	1
12_cogen_ext.c."Stirling"	0	0	0	0	0,5	4,0	23	31	41
13_cogen_int.c."Otto"	0	0,25	0,5	1,75	3,0	6,0	8	10	14
share of "Otto" in total	100%	100%	100%	100%	85%	60%	25%	25%	25%
IPTS total sales	4995	5761	6259	6891	7311	7831	8284	8437	8504