European Commission

JRC TECHNICAL REPORTS

Development of Green Public Procurement Criteria for Water-based Central Heating Generators

Technical report and draft criteria proposal

Rocío Rodríguez Quintero, Elena Rodríguez Vieitez, Oliver Wolf (JRC-IPTS)

April 2014

Joint Research Centre

European Commission
Joint Research Centre
Institute for Prospective Technological Studies

Contact information
Address: Edificio Expo. c/ Inca Garcilaso, 3. E-41092 Seville (Spain)
E-mail: rocio.rodriguez-quintero@ec.europa.eu
Tel.: +34 954488318
Fax: +34 954488300

http://susproc.jrc.ec.europa.eu/product_bureau/
http://ipts.jrc.ec.europa.eu
http://www.jrc.ec.europa.eu

Luxembourg: Publications Office of the European Union, 2014

Printed in Spain

Table of contents

Abbreviations

AHWG	– Ad-Hoc Working Group
BAT	– Best Available Techniques
BED	– Boiler Efficiency Directive
BREF	– Reference Document on Best Available Techniques
CE	– Conformité Européene – European Conformity
CEN TC	– European Committee for Standardization Technical Committee
CHP	– Combined Heat and Power
CEN TC	– European Committee for Standardization Technical Committee
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, n_s	– Seasonal space heating energy efficiency
etason	– Seasonal space heating energy efficiency in on-mode
GHG	– Greenhouse Gas (emissions)
GPP	– Green Public Procurement
GWP_{100}	– Global Warming Potential (effect estimated over 100 years)
HC	– Hydrocarbons
"Heating generator"	– Water-based central heating generator
ISO	– International Standardisation Organisation
kWh	– Kilowatt-hour
LCA	– Life-cycle assessment
MS	– Member State
NO_x	– Nitrogen Oxides (often measured as NO_2 – nitrogen dioxide)
PAH	– Polycyclic Aromatic Hydrocarbons
PBB	– Polybrominated biphenyls
PBDE	– Polybrominated diphenyl ethers
PM	– Particulate Matter
POP	– Persistent Organic Pollutants
RoHS	– Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Directive

SEDBUK	– Seasonal Efficiency of Domestic Boilers in the UK
SO_x	– Sulphur Dioxides
TEWI	– Total Equivalent Warming Impact
TWh	– Terawatt hours = 10^9 kWh
VOC	– Volatile organic compounds
WEEE	– Waste Electrical and Electronic Equipment

INTRODUCTION

Green Public Procurement (GPP) is defined in the Commission Communication "Public procurement for a better environment"[1] 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." This is a voluntary instrument, which public authorities can use to provide industry with incentives for developing and marketing more environmentally sound products[2].

The primary goals of establishing GPP criteria for water-based central heating generators (also referred to as "heating generators" in this document) are to increase the energy efficiency during operation and to reduce greenhouse gas emissions, as the use-phase has been identified to contribute the most to the environmental impacts caused by this product group. In addition to energy efficiency and greenhouse gas emissions, other environmental impact parameters and environmental improvement potentials are taken into account when developing the criteria, such as: lower air emissions related to energy production and consumption, lower resource consumption, potentially higher resource efficiency management (with respect to the issue of recycling and recyclability), etc. Finally, the products covered by the GPP criteria should also bring public customers direct cost savings when evaluated using a life-cycle cost perspective (e.g. lower overall costs due to lower energy bills).

The document consists of the following chapters. Chapter 1 briefly presents the project background and motivation for this study. Chapter 2 introduces and discusses the product definition and scope, and a summary of the overall comments from stakeholders to date. Chapter 3 presents the general guidelines for assessment and verification, followed by the proposed criteria in Chapter 4. A summary of the technical analysis in support of the abovementioned proposed GPP criteria is presented in an Appendix (Chapter 5). The corresponding technical background report is available at the project's website[3]. This technical analysis is based on a life-cycle analysis of different heating technologies. The technical background report includes a summary of the life-cycle analysis methodology and results, and a discussion on environmental improvement potential that the EU GPP criteria for this product group may bring with respect to the heating technologies currently existing and used in the market today.

[1] 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

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

[3] "Development of European Ecolabel and Green Public Procurement Criteria for Water-based Central Heating Generators. Draft Report. Policy Analysis", Nov. 2011, Van Holsteijn en Kemna BV (VHK), http://susproc.jrc.ec.europa.eu/heating/stakeholders.html

1. PROJECT BACKGROUND

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 water-based central heating generators. This study is being carried out by the Joint Research Centre Institute for Prospective Technological Studies (JRC-IPTS) supported by VHK consultancy, in cooperation with all the interested parties.

The purpose of this pilot project is to develop the EU Ecolabel and Green Public Procurement criteria for water-based central heating generators.

The preliminary results of the study are available at the project's website (http://susproc.jrc.ec.europa.eu/heating/) and the proposals for the future GPP criteria, which can be feasible for the product group under study, are presented in the current working document.

The preliminary results of the study show that the main environmental aspects associated to heating generators are related to their use phase i.e. the consumption of energy and associated greenhouse gas emissions during operation.

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 heating generator is installed, in which type of building, and in which climate. This is especially so for heat pumps, where the energy efficiency is critically sensitive to all these issues. The GPP criteria will take these issues into account, and as part of the criteria will provide advice to the consumer and to the installer on how to best install the generators.

Regarding the choice of heating technologies, the public procurer 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 GPP criteria here assume in principle that the public procurer has total freedom for choosing heating technology, fuel, etc. The GPP criteria should be seen as a guidebook for green public procurement, but then the specific purchasing situation may provide other constraints to select the appropriate heating generator choices for the specific situation.

While the first working documents referred to "heating systems", it was decided to rename the product group "heating generators", which is considered a better description of the product definition and scope as will be explained in Chapter 2, developed in consistency with Ecodesign Lots 1 and 15, and in consultation with stakeholders.

The Green Public Procurement website at the European Commission[4] contains a number of documents and toolkits that facilitate member states to develop national GPP criteria. Studies commissioned by DG ENV have found that individual member states frequently follow the EU GPP criteria to develop their own national GPP criteria, which helps them minimize costs and duplication of efforts.

A study commissioned by DG ENV on the "Collection of statistical information on GPP in the EU"[5] analysed the uptake of EU GPP in seven member states: Austria, Denmark, Finland, Germany, Netherlands, Sweden and United Kingdom. The study found a high uptake of GPP requirements in these member states, that were similar to the ones developed in EU GPP criteria. These seven countries are also the ones with the most developed national plans on public procurement in the EU.

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

[5] "Collection of statistical information on Green Public Procurement in the EU: Report on methodologies", Ecofys, Significant, and PricewaterhouseCoopers (2007)

The study also mentions that one of the important objectives of the EU GPP program should be to identify how to account for CO_2 emissions in GPP, and the financial impacts of GPP.

A review of the existing studies on GPP programs in the EU, including member states public procurement programs, indicates that only a few criteria sets exist for heating generator products[6], despite of the significant environmental impact and improvement potential of this product group. GPP criteria for heating generators are only available for cogeneration units (at the EU level and in the UK). Criteria also exist on electricity and district heating, but these two groups are out of the scope of the heating generators product group. The report showed however that the EU GPP criteria on the first 10 product/service groups (not including heating generators) developed by the Commission were very much used by member states' GPP programs.

1.1 Market considerations

Public authorities are major consumers in Europe, spending about 19% of the EU's gross domestic product. Therefore, any shift of public spending towards products with lower environmental impacts has the potential to make an important contribution to EU sustainable production and consumption. Green public procurement also has the potential to influence the market by providing industry with incentives for developing more environmentally-friendly technologies and products.

The technical report associated with this study and available at the project website[7] describes a detailed market analysis for heating generators, which is dominated by gas/oil boilers (representing around 90% of the total sales in 2010), followed by heat pumps (6.6%) and biomass boilers (3.3%). The report also includes estimates of future trends in which the EU Ecolabel and GPP criteria influence the current market. A stock model was built to quantify savings on energy consumption and emissions. The "Business-as-usual" scenario is set up as a stock model calculation, which calculates the effects of changes in the stock ("STOCK") through changes in sales and product characteristics of new products entering the stock ("NEW"). The analysis is quantitative because the model calculates for the years 2010-2030[8] the environmental aspects of the stock (energy consumption and environmentally relevant emissions).

1.2 Cost considerations

In the development of Green Public Procurement criteria, one of the most important aspects to take into account is a life-cycle cost analysis of the best environmentally-performing products with respect to average products in the market. Cost considerations (using a life-cycle perspective) are especially important in public procurement because of the need to justify public spending. Member states should be encouraged to make choices that are a good value in the long-term and compatible with wider policies.

---

[6] "Assessment and Comparison of National Green and Sustainable Public Procurement Criteria and Underlying Schemes in Ten Countries", AEA, November 2010, http://ec.europa.eu/environment/gpp/studies_en.htm

[7] In: "Development of European Ecolabel and Green Public Procurement Criteria for Water-based Central Heating Generators. Draft Report. Product definition, market analysis and technical analysis " (June 2011), and "Development of European Ecolabel and Green Public Procurement Criteria for Water-based Central Heating Generators. Draft Report. Policy analysis " (Nov. 2011), http://susproc.jrc.ec.europa.eu/heating/stakeholders.html

[8] Preceding years, as of 1990 (or even 1980 for certain products/aspects), are also calculated, but this is mainly done to produce a realistic stock as of 2010.

Heating generators are one of the products where life-cycle impacts depend the most on the use-phase (mostly use-phase energy consumption). Therefore, purchase costs are only a comparatively (or very) small part of the total life-cycle cost of the products. A number of available studies on cost considerations in GPP[9] have also concluded that higher purchasing prices are usually compensated for by lower operating costs for products where energy consumption is a major cost factor. A typical example is found e.g. in high-efficient heating installations. During the whole life cycle of the heating installation, the mentioned study found that approximately 95% of the total costs were determined by operating costs. It is therefore concluded that public procurement decisions based only on the purchase price will likely lead to misinvestment.

The technical background report associated with this study[10] presents a detailed life-cycle cost analysis of heating generators, and a summary of key conclusions is presented here.

The total life-cycle costs of the different heating generator options (including purchase, maintenance and running costs) are found to be very susceptible to current energy costs. In particular, some studies[11] have shown that governmental decisions on energy tariffs may render a boiler option from positive economic effects to negative economic effects. Especially electric heat pumps and cogeneration boilers appear sensitive to such effects.

Heat pumps were found to be still relatively expensive options, especially if the necessary works for the complete installation (realisation of heat source system and heat sink / emitter/system) are incorporated.

Specific data on life cycle costs for different heating generators evaluated can be found in Part 3.3 ("Improvement potential") of the technical background report available at the project website[12]. Table 1 (from the technical report) gives the life-cycle costs at LLCC and BAT levels. It shows savings at LLCC level of up to 16% for the smaller size classes (up to L) and 30-46% for the largest sizes. The savings at BAT level indicate that, apart from the smallest XXS level, the BAT-solutions do not save as much as LLCC-solutions but are still more economical than the base case.

[9] "Costs and Benefits of Green Public Procurement in Europe", Öko-Institut e.V. and ICLEI, 2007

[10] In: "Development of European Ecolabel and Green Public Procurement Criteria for Water-based Central Heating Generators. Draft Report. Product definition, market analysis and technical analysis " (June 2011), http://susproc.jrc.ec.europa.eu/heating/stakeholders.htm

[11] magazine VV+, March 2010, p.178

[12] In: "Development of European Ecolabel and Green Public Procurement Criteria for Water-based Central Heating Generators. Draft Report. Product definition, market analysis and technical analysis ", June 2011, http://susproc.jrc.ec.europa.eu/heating/stakeholders.html

Table 1. Life cycle costs and savings LLCC- and BAT- levels versus base case level.

Size-Class	Heat output (kW)	En Eff (%) Base Case	En Eff (%) LLCC	En Eff (%) BAT	BaseCase lifecycle costs	LLCC lifecycle costs	BAT lifecycle costs	LLCC savings	LLCC saving in %	BAT saving	BAT Savings in %
XXS	10	53	77	165	€ 9.085	€ 8.716	€ 10.943	€ 369	4%	-€ 1.858	-20%
S	19	52	79	165	€ 14.172	€ 12.313	€ 13.352	€ 1.859	13%	€ 820	6%
M	22	54	78	135	€ 18.750	€ 15.797	€ 16.859	€ 2.953	16%	€ 1.891	10%
L	29	55	78	135	€ 24.119	€ 20.259	€ 21.262	€ 3.860	16%	€ 2.857	12%
XL	60	44	77	130	€ 57.697	€ 37.851	€ 38.668	€ 19.846	34%	€ 19.029	33%
XXL	115	45	101	130	€ 108.111	€ 65.623	€ 73.738	€ 42.488	39%	€ 34.373	32%
3XL	250	43	98	115	€ 272.770	€ 164.057	€ 190.187	€ 107.943	40%	€ 81.813	30%
4XL	750	43	99	115	€ 904.288	€ 487.237	€ 495.964	€ 417.051	46%	€ 408.324	45%
Calculated with Ecoboiler Integrated model version 5a											

The BAT (Best Available Technology) or BNAT (Best Not yet Available Technology) levels are mostly based on heat pump technology sometimes with an add-on benefit from solar installations. Some explanations were added in the study:

- Heat pumps cannot be universally applied. Especially 'geothermal' or 'vertical' ground-source heat pumps require special permissions from the waterworks and/or the commune, etc.
- Specialist installers and special equipment are necessary and (as yet) not abundant.
- The efficiency of the heat pump is highly dependent on the lay-out and installation.
- Often a heat pump is a base-load device, which means that a hybrid device (e.g. with a conventional boiler) may often be an economical solution to capture both base and peak loads.
- The energetic benefits are highly dependent on the climate, especially with air-based heat pumps and of course with solar energy.
- As a result of the above, the pay-back time will vary widely per country and circumstance.

Even larger savings are possible by adding complementing equipment: thermostats with better response can improve the central heating efficiency by optimizing the boiler heat output to the (expected) heat demand, heat pumps using ambient heat and/or solar thermal systems reduce the fossil fuel or electric energy input. The model was extended to incorporate these technologies as well. More detailed cost data can be found in the technical background report.

2. PRODUCT DEFINITION AND SCOPE

A "product group" is defined 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. This definition is consistent with the life-cycle analysis approach in this study, which compares different technologies where 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 heating generators is to help consumers to make a choice between different kinds of heating technologies that provide heating to a water-based central distribution system.

A preliminary definition of the product scope is detailed below, mainly based on the product scope of the Energy Labelling and Ecodesign Lot 1 (Regulation (EU) No 813/2013 and Regulation (EU) No 811/2013), in line with achieving greater harmonization between different product policy initiatives.

The scope of this GPP study is "water-based central heating generators (or hydronic central heating generators)", in all relevant combinations, up to a maximum output power of 400 kW, a limit proposed in consistency with the Boiler Directive[13] and with Ecodesign Lot 1. Water-based central heating generators, also referred to as heating generators in this document, are used to generate heat as part of a water-based 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 heating 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 biofuels
- Use of the Joule effect in electric resistance heating elements
- Capture of ambient heat from air, water or ground source, and/or waste heat
- Cogeneration (the simultaneous generation in one process of heat and electricity)
- Solar (auxiliary)
- Hybrid generators: certain combinations of the above

Although it is not explicitly stated in the definitions above, it may be that the circulator is an integral part of the heating generator. For larger heating generators the circulator is usually supplied separately, and therefore the circulator itself will be out of the scope of this criteria development, as is the case in the Ecodesign calculation methodology for seasonal efficiency as defined in Lot 1.

For heaters that incorporate a circulator for circulation of heated water in the pipework and emitters for distributing heat, this means that the circulator shall not be included in the measurement of electric power consumption. For heat pumps, measured according 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. Pumps used for transportation of fuel or the secundary refrigerant or other purposes shall also be included in the consideration of electric power consumption.

[13] Boiler Efficiency Directive, 92/42/EEC

Out of the scope are also water-based central heating generators which can only provide hot water for sanitary use, as these do not meet the definitions of a 'heater'.

Also out of scope are 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. The performance and heat balance of such appliances is fundamentaly different to heaters intended for connecting to a central heating system only.

Rationale for product scope and definition

The product group "water-based heaters" is consistent with Ecodesign Lot 1 on space heaters and combination heaters and Ecodesign Lot 15 on Solid fuel small combustion installations[14]. More generally, the scope and definition of the product group have been aligned to Ecodesign Lots 1 and 15.

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

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 water-based 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 and fossil oil boilers are part of the scope, but technically, it is unlikely that they can meet the GHG emission benchmarks. Instead, the fuel would need to include at least some percentage of biomass or the 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 just 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 electric power consumption of the circulator when computing the energy efficiency is also in line with the Ecodesign Lot 1.

From stakeholders' feedback, water-based 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 water-based 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

[14] See for more information: http://www.ecosolidfuel.org/

[15] Directive 92/42/EEC, OJ L 167, 22.6.1992, p. 17.

selection of the best products from an environmental perspective with respect to the function of ambient heating, per one unit of heating (functional unit).

- The EU GPP 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.
- 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 water-based 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 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 GPP 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.
- In the opinion of some stakeholders, the EU Ecolabel should not be awarded to fossil-fuelled water-based heaters, and instead the development of EU GPP 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 have been found not to meet the needed minimum performance requirements to be awarded the EU GPP, 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 GPP criteria does not need to take into account different fuel mixes.

2.1 Description of products included in the scope

The scope of heating generators considered for Ecolabel and GPP criteria development in the current project covers heating generators 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.

Heating generators within the scope of Directive 2010/75/EU, or whose primary aim is to provide domestic sanitary hot water, or for heating and distribution of 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 water-based central heating system constitutes a part of a set of several elements, including pipe work, the heating generator itself, radiators, heat exchangers, hot water storage cylinders 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 heating generator 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 "water-based central heating generators", also called "heating generators" shall comprise the following types of heating generator technologies:

- **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 vapor of flue gases, and are significantly more energy efficient. Boilers that provide sanitary hot water as a secondary function, are called central heating combi-boilers (CH combis) 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 water-based central heating generators, 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, natural gas, biogas, wood, biomass, 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 horizontally address and compare different water-based central heating technologies as one single product group. The product group "water-based central heating generators" represents a very large group. As presented in Table 7 of the Draft Task 1 Report on the "Development of EU Ecolabel and GPP Criteria for Heating and Cooling Systems" (IPTS, 2010), the group of water-based central heating generators accounts for roughly 86% of the total use-phase primary energy consumption by heating generators (central and space heating generators together) in the EU, therefore representing most of the environmental impact of all types of heating generators taken together.

The most cited performance parameter of the boiler is the (nominal) power output in kW[16]. The scope of boilers is set to a maximum of 400 kW consistently with the Boiler Directive[17]. The heating

---

[16] 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.

[17] Boiler Efficiency Directive, 92/42/EEC

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 combi-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 2.

A first assessment of Prodcom sales data (more detailed analysis presented in the technical background report) showed an annual production of 6.9 million boilers in 2009 (for gas and oil-fired boilers). Considering the limited value of import and export (respectively some 230 and 807 million euro) it can be concluded that most of the EU production is meant for the EU market.

Lot 1 study estimated in 2010 boiler sales of around 6.9 million units (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 some 600 Mton, and SOx emissions are some 700 kton. The screening analysis shows that central heating boilers are among the product groups with the highest energy-consumption in Europe. Development of environmental policies, like EU Ecolabel or Green Public Procurement criteria, appears feasible, also given the current proposals for Ecodesign requirements for 'boilers' and Energy labeling of 'boilers'.

Table 2. Summary of scope of product group.

Component of heating system	Fuel	Nominal power output	Working principle
Gas/liquid boiler	Gas (natural, propane, biogas) or liquid (oil, bio-oil)	thermal output: 4-400 kW	Combustion
Biomass boiler	Biomass (logs or pellets)	thermal output: 4-400 kW	Combustion
Heat pump	Electricity	thermal output: 4-400 kW	Electric compressor, driving a vapour cycle
	Gas (possibly in combination with waste heat and/or solar heat)		Gas driven engine, driving a compressor for a vapour compression cycle Gas-fired combustion, driving a sorption process
CHP or cogeneration	Gas (natural, propane, biogas) or liquid (fossil oil, bio-oil)	thermal output: 4-400 kW max. electric output: 50 kWe	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 heat generator to fulfil heating demands in all circumstances)	Not applicable (sized depends on location, budget and application)	Capturing and storage of solar irradiation

3. 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 it 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 their 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 3** and **Table 4** (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. The methodology to calculate the seasonal space heating emissions for solid fuel boilers is indicated in **Table 5**.

Table 3. 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 4. 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

Noise emission	
EN ISO 3744	Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane (ISO 3744:2010)
EN ISO 3746	Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Survey method using an enveloping measurement surface over a reflecting plane (ISO 3746:2010)
EN 12102	Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling - Measurement of airbone noise - Determination of the sound power level

Table 5. Methodology to calculate the seasonal space heating emissions

Type of solid fuel boiler	**Formula**
Manually stoked solid fuel boilers that can be operated at 50% of the rated heat ouput in continuous mode, and automatically stoked solid fuel boilers	$E_s=0.85\times E_{s,p}+ 0.15\times E_{s,r}$
Manually stoked solid fuel boilers that cannot be operated at 50% or less of the rated heat output in continuous mode, and solid fuel cogeneration boilers	$E_s=E_{s,r}$
Where E_s are the seasonal space heating emissions. $E_{s,p}$ are the emissions of respectively particulate matter, organic gaseous compounds, carbon monoxide and nitrogen oxides measured at 30% or 50% of rated heat output, as applicable. $E_{s,r}$ are the emissions of respectively particulate matter, organic gaseous compounds, carbon monoxide and nitrogen oxides measured at rated heat output.	

Table 5 addresses the operating conditions to measure the emissions of solid fuel boilers, and the methodology to calculate the average value of emissions measured at the different test conditions. Last version of Ecodesign Lot 15 Regulation set a methodology based on the term "Seasonal space heating energy emissions *Es*":

$E_s = 0.85 \cdot E_{s,p} + 0.15 \cdot E_{s,r}$

$E_{s,p}$: emissions measured at 30% (automatic) or 50% (manual) of rated heat output;

$E_{s,r}$: emissions measured at rated heat output.

In order to achieve an optimal alignment to Ecodesign regulations that allows the comparison between the limit values set by the EU product policies, the operating conditions to measure the NOx, CO, OGC and PM emissions will be the following:

- Gas and liquid fuel boilers, cogenerations and heat pumps: at standard rating conditions as defined in Ecodesign Lot 1.
- Solid fuel boilers: seasonal space heating energy emissions as defined in **Table 5**

4. GREEN PUBLIC PROCUREMENT CRITERIA

The Communication on Green Public Procurement states that the GPP criteria shall be determined on a scientific basis considering the whole life cycle of products. In the frame of the project a number of base cases have been defined and a preliminary environmental evaluation of various stages of the product life has been completed, as described in the technical background document available on the project's website[18]. Within data uncertainties and methodological limitations, the analysis allowed for identifying the main issues contributing to the environmental impacts.

Based on the life-cycle analysis conducted in the frame of the study and on the analysis of the European and non-European labelling schemes, the key issues to be considered in the process of EU Ecolabel and GPP criteria development are proposed and presented in the following chapter, and outlined below:

1. **Energy efficiency:** Energy efficiency will be evaluated in terms of the "seasonal space heating energy efficiency" (such as in the imminent Energy Label and Ecodesign Implementing Measures), and the rated capacity depending on the climate zone, for all types of heating generators. These calculation methods were developed during the Ecodesign Lot 1 preparatory study after several rounds of consultation with the expert group and have been extended to apply to solid fuel boilers as well. Expert feedback strongly suggested that the energy efficiency criterion should strictly follow Ecodesign Lot 1.
2. **Greenhouse gas emissions:** The calculation of greenhouse gas emissions (GHG) is mainly based on CO_2 emissions, with default emission factors for each fuel type, together with energy efficiency and 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.
3. **Refrigerant:** Criteria on refrigerants used in heat pumps are needed because some refrigerants have environmental impacts related to climate change due to possible leakage of refrigerant, mainly during use-phase or end-of-life.
4. **Other air emissions:** Air emissions of different substances have impacts on environment (example acidification), and on health (air quality). Indicators evaluated in the life-cycle analysis include: NOx and SOx emissions (acidification potential), volatile organic compounds (VOC), persistent organic pollutants (POP), heavy metals (HM) in air, polycyclic aromatic hydrocarbons (PAH), particulate matter (PM), organic carbon (OGC), and carbon monoxide (CO). Some of these indicators are grouped in a few air emission parameters that are usually part of Ecolabel criteria for heating generators.
5. **Sound power level:** Sound power level (or noise) is an issue mainly identified in heat pumps and cogeneration units. Because of some different opinions and methodologies for testing, and scarcity of data, a quantitative measure for sound power level is not always possible.
6. **Product design:** This criterion is related to the promotion of reuse, recycling, and generally a sound end-of-life management, and it can be measured using parameters such as: design for recycling, design for repair/warranty and spare parts, etc.

[18] http://susproc.jrc.ec.europa.eu/heating/stakeholders.html

7. **Installation, user information:** This criterion includes consumer information/user instructions for installation, operation and end-of-life management.

After discussion at the AHWG meetings and from the feedback received, it was proposed to group the criteria areas into two blocks, which are:

Common benchmark criteria:

1. Minimum energy efficiency
2. Greenhouse gas emissions limit

Additional criteria:

3. Refrigerant (secondary)
4. Nitrogen oxides (NOx) emissions limit
5. Organic carbon (OGC) emissions limit
6. Carbon monoxide (CO) emissions limit
7. Particulate matter (PM) emissions limit
8. Noise emission limits
9. Product design
10. Installation and user information

Table 6 Applicability of the different criteria to each of the heating generator technologies

Heating generator technology / Criteria	fuel boiler		heat pump boiler			cogeneration boiler	
combustion type	(direct)	(direct)	(none)	external combustion	internal combustion	external combustion	internal combustion
fuel type	gaseous, liquid	solid fuel	electrically driven	gaseous, liquid fuel	gaseous, liquid fuel	gaseous, liquid fuel	gaseous, liquid fuel
1- Minimum energy efficiency	X	X	X	X	X	X	X
2 – Greenhouse gas emissions	X	X	X	X	X	X	X
3 – Refrigerant and secondary refrigerant			X	X	X		
4 – Nitrogen oxides (NOx) emissions limit	X	X		X	X	X	X
5 – Organic carbon (OGC) emissions limit		X					
6 – Carbon monoxide (CO) emissions limit		X		X	X	X	X
7 – Particulate matter (PM) emissions limit		X			X (liquid only)	X	X
8 – Noise	X	X	X	X	X	X	X
12- Product design	X	X	X	X	X	X	X
13 – Installation and user information	X	X	X	X	X	X	X

The following criteria are proposed for the Green Public Procurement for water-based space heating generators. The criteria are classified as core, comprehensive and award.

Different environmental areas are addressed i.e. energy efficiency, greenhouse gas emissions, other air emissions, etc. The criteria on minimum energy efficiency and maximum GHG emissions limit are considered, from an LCA point of view, the key environmental impact parameters, and therefore are included as both core and comprehensive. An overview of all the proposed GPP criteria is presented in Table 4.

The list in Table 7 covers the proposed criteria which were developed based on current GPP criteria and others which are based on the EU Ecolabel criteria for heating generators as well as on other ecolabel and GPP criteria from member states. In this chapter we will present, for each criteria area, proposed parameters, specific limit values and testing methods. The rationale for the development of the parameters and values was based on the presented life-cycle environmental assessment performed, and information from other existing ecolabels and GPP criteria in different individual member states, or European Commission GPP criteria when available.

In general, "award criteria" can be used for two purposes: in the first place when a purchaser is not sure that the market will be able to supply products or services that comply with all requirements, and in the second place when a purchaser wants to stimulate the suppliers to come forward with offers that are richer in functionality or promise a better performance. If used in that way, award criteria can be regarded as a method of stimulating innovation.

Table 7. Overview of Green Public Procurement criteria proposal for heating generators.

		Criterion	Core	Comprehensive	Key area and aspect addressed
SELECTION CRITERIA	1	Ability of the tenderer – only in case of installation works	SC	SC	Energy efficiency, lifetime of product, GHG emissions
TECHNICAL SPECIFICATIONS	1	Minimum energy efficiency	TS	TS	Energy efficiency
	2	Maximum greenhouse gas emissions (GHG) limit	TS	TS	Climate change contribution due to type of fuel used and also dependent on energy efficiency
	3	Product longevity and warranty	TS	TS	Lifetime of the product
	4	Installation and user information	TS	TS	Needed for best environmental performance of product (energy efficiency, GHG emissions, etc.), environmental information and awareness
	5	Primary and Secondary refrigerant		TS	Environmental (e.g. climate change) and health (subsurface water quality) risks
	6	Nitrogen oxides (NOx) emissions limit		TS	Environmental and health risks (e.g. acidification); air quality
	7	Organic carbon (OGC) emissions limit		TS	Environmental and health risks; air quality
	8	Carbon monoxide (CO) emissions limit		TS	Environmental and health risks; air quality
	9	Particulate matter (PM) emissions limit		TS	Environmental and health risks; air quality
AWARD CRITERIA	1	Additional energy efficiency	A	A	Energy efficiency
	2	Additional GHG emission reduction	A	A	Climate change contribution due to type of fuel used and also dependent on energy efficiency
	3	Noise emission limit	A	A	Health and quality of life
	4	Product design	A	A	Resource efficiency; facilitate recycling; sound end-of-life management

SC = Selection criterion; TE = Technical specification; A = Award criterion

4.1 SELECTION CRITERIA

4.1.1 Criterion 1 - Ability of the tenderer – only in case of installation works

4.1.1.1 Formulation as core and comprehensive criterion

Where water-based heaters are being installed, the contractor shall demonstrate that suitably qualified and experienced personnel will undertake the installation or replacement of the products. Fitters, dealers and service personnel shall be fully trained. Training should comprise the following elements:

- Assembly, installation and commissioning of heating systems.
- Safety tests applicable under the national legislation
- Adjustment of the equipment and environmentally friendly settings
- Maintenance and repair of heating systems
- Air emissions measurement techniques.
- Technical and legal documentation of the heating systems (test reports, certificates, permits)

4.1.1.2 Verification

The tenderer shall supply a list of comparable projects recently carried out (number and time frame of projects to be specified by the contracting authority), certificates of satisfactory execution and information on the qualifications and experience of staff.

4.1.1.3 Rationale for selection criteria

The performance of the product might be undermined in case of ill-installation or inappropriate maintenance, thus a selection criterion to ensure qualified personnel is a necessary requirement.

4.2 TECHNICAL SPECIFICATIONS

4.2.1 Criterion 1 – Minimum energy efficiency

4.2.1.1 Formulation as core criterion

The energy efficiency of the water-based central heating generator shall be as follows.

Type of heating generator	**Minimum seasonal space heating energy efficiency (η_s)**
All types of water-based central heating generators, except those intended for combustion of solid biomass fuels *: this includes heaters designed for combustion of solid fossil fuel (e.g. coal-fired heaters). **: this includes heaters designed for combustion of liquid and gaseous biofuels (or allow combustion of a mixture of gaseous/liquid fossil fuels and biofuels)	$\eta_s \geq 90\%$
water-based central heating generators intended for combustion of solid biomass fuels only*** ***: for example water-based heaters designed for combustion of biomass pellets, wood logs or wood chips	$\eta_s \geq 75\%$

4.2.1.2 *Formulation as comprehensive criterion*

The seasonal space heating energy efficiency (η_s) of the water-based central heating generator shall be as follows.

Type of heating generator	Minimum seasonal space heating energy efficiency (η_s)
All types of water-based central heating generators, except those intended for combustion of solid biomass fuels *: this includes heaters designed for combustion of solid fossil fuel (e.g. coal-fired heaters). **: this includes heaters designed for combustion of liquid and gaseous biofuels (or allow combustion of a mixture of gaseous/liquid fossil fuels and biofuels)	$\eta_s \geq 96\%$
water-based central heating generators intended for combustion of solid biomass fuels only*** ***: for example water-based heaters designed for combustion of biomass pellets, wood logs or wood chips	$\eta_s \geq 77\%$

The seasonal space heating energy efficiency shall be calculated in accordance with

1) the procedures set out in Annex III of Ecodesign Regulation for space heaters and combination heaters[19]
2) the harmonised standards and the transitional methods of measurement and calculation for the implementation of the Ecodesign and Energy Labelling Regulations

In addition to the procedures 1) and 2), the procedures set out in Annex VII to Energy Labelling Regulation of space heaters, combination heaters and packages of space heater[20] shall apply to the packages of space heaters.

[19] Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters

[20] Commission Delegated Regulation (EU) No 811/2013 of 18 February 2013 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

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

(a) the calculation of ηs shall be based on the gross calorific value of the wet fuel (as received) GCVar, which corrects for the moisture content in the fuel and includes 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 or equivalent shall apply to estimate ηs, while GCVar shall be used for the calculation of ηs, instead of the net calorific value of the wet fuel (as received), NCVar,

(b) for determining the gross calorific value of the wet fuel (as received) GCVar, the principles laid down in Standard EN 14918 or equivalent shall apply.

4.2.1.3 *Verification*

Products holding the EU Ecolabel for water-based heaters (Commission Decision 2014/…/EC[21]) or another relevant Type 1 Eco-label fulfilling the listed requirements will be deemed to comply. Other appropriate means of proof will also be accepted, e.g. a declaration of compliance with this criterion, together with test results conducted in accordance with testing procedure indicated in respective EN standards or equivalent standards for the given kind of product (see **Table 3** and **Table 4**).

4.2.1.4 *Rationale*

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 and use, as well as economic benefits for the users reducing their energy bills and thus lower life cycle costs.

All the reviewed ecolabels and GPP criteria include as primary criteria area the energy efficiency criterion (e.g. Nordic Swan and Blauer Engel). Improvements in energy efficiency result in reduced resource depletion, reduced emissions from the fuel life cycle by exploration, extraction, refining, processing, transportation and storage, and a reduction in direct emissions of CO_2 and other polluting substances from the combustion of the fuel.

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

- Solid fuel heaters, and especially the small manually operated solid biofuel boilers, have the lowest nominal efficiency.
- Regarding electricity consumption, the electrically-driven heat pumps are associated with the highest electricity consumption but they still represent a saving when compared to most other heaters when compared on the basis of primary energy consumption.
- Cogeneration heaters provide both power and useful heat in such way that the fuel consumption is lower when it is compared to the separate generation of heat and power from a boiler and from the grid.

For all types of heating generators the efficiency in this study is based on the "seasonal space heating efficiency" as defined in the Ecodesign Implementing Measures for boilers, and it is expressed in terms of the gross calorific value, as decided by the Commission in consultation with

[21] It refers to the Commission Decision establishing the EU Ecolabel criteria for water-based heaters, which will be published in 2014

stakeholders during the Lot 1 study on boilers[22]. Seasonal efficiency provides a weighted average of boiler 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. Feedback from stakeholders has shown strong support for the use of seasonal space heating efficiency as the criterion for energy efficiency.

With the minimum energy efficiency set **under core criteria** at 90% and 75% for solid biomass boilers, the following is an estimate of the selectivity of the criterion proposed:

- For gas boilers, it will be required that they meet the Energy Label Class A (90-98%), representing the best class of gas boilers.
- For solid biomass heaters the 75% minimum efficiency required is not less than the minimum 90% NCV efficiency required to obtain a Blue Angel label, once it is referred to GCVar. This confirms that the proposed minimum efficiency requirement is a reasonable benchmark to select the best performing biomass boilers. The Blue Angel label for biomass boilers (wood pellet boilers, RAL-UZ-112) is a successful label with 16 vendors and more than 60 products with licenses. This value is also harmonized with the EU Ecolabel criteria for water-based space heaters.
- For heat pumps, this benchmark will mean that all of them comply, being consistent with the Blue Angel heat pump label, which relies only on the TEWI calculation. Anyhow, the proposed criterion will require the testing and report of the efficiency (etas) of the heat pumps because it is in any case a requirement of Ecodesign implementing measures, and it is needed to calculate the greenhouse gas emissions following the TEWI formula as will be seen in Criterion 2.
- For cogeneration, as well as for oil/gas boilers, it will be required that heating generators meet the Energy Label Class A (90-98%), which is also reasonable.

With the minimum energy efficiency set **under comprehensive criteria** at 96% and 77% for solid biomass boilers, the following is an estimate of the percentage of heating generator products of each type of technology which will be able to meet the criterion:

- For heaters that combust gaseous or liquid fossil fuels, the 96% GCV threshold will allow best condensing boilers and cogeneration heaters. In order to get additional points by the award criterion the condensing boilers would need to be combined with solar thermal collectors
- For biomass boilers there is no energy label or ecodesign in force, it is currently under development (Ecodesign Lot 15). The last version available proposed a seasonal space heating energy efficiency of 77%, which matches to the best performance biomass BAT boilers.

It is proposed that for all types of heating generators the unit for measuring energy efficiency shall follow the calculation method of "seasonal space heating efficiency" (η_s, or "etas"), as developed in the Ecodesign Implementing Measures for boilers and described in Annex II of the accompanying technical background report[23]. The Ecodesign and Energy labelling were approved by the

---

[22] 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 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.

[23] See Annex II: Working documents Ecodesign/Energy Labelling. In: "Development of European Ecolabel and Green Public Procurement Criteria for Water-based Central Heating Generators. Draft Report. **Policy Analysis**", Nov. 2011, http://susproc.jrc.ec.europa.eu/heating/stakeholders.html

Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters (*OJ L 239, 6.9.2013, p. 136–161)* and Commission Delegated Regulation (EU) No 811/2013 of 18 February 2013 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 (*OJ L 239, 6.9.2013, p. 1–82).*

According to the methodology developed in Ecodesign Lot 1, the seasonal space heating efficiency, "etas", shall be calculated as the seasonal steady-state space heating efficiency, corrected by contributions accounting for turndown ratio, temperature control, auxiliary electricity consumption, standby heat loss, ignition flame energy consumption, and in addition for cogeneration boilers the seasonal electric efficiency, where applicable.

Although biomass boilers are not within scope of the Lot 1 Ecodesign requirements for space heaters, it is proposed to apply the same methodology to increase the harmonisation between these types of heaters. The actual calculation of the 'etas' for solid fuel heaters is currently still being developed under Lot 15

Stakeholders pointed out that the currently applied methodology to measure energy efficiency in biomass boilers uses net calorific value (NCV, as defined in EN303-5) instead of gross calorific value (GCV) which is used in the seasonal space heating efficiency methodology of Ecodesign Lot 1.

This document proposes a methodology to calculate energy efficiency for biomass boilers in terms of GCV in order to bring the calculation for solid fuel in line with that of other fuel boilers described under Ecodesign Lot 1

The efficiency established on the basis of NCV of the wet fuel (as defined in EN 303-5) can be converted to an efficiency on the basis of the GCV of the wet fuel, following the methodology as described in section 5. The conversion requires as known values: the moisture content of the fuel, the hydrogen content of the fuel, the GCV value of the dry fuel (if measured as 'ash free' also the ash content of the fuel must be known) and the efficiency on the basis of the wet fuel. These parameters are usually tested under EN 303-5.

Some existing labels include additional parameters related to energy efficiency of a heating generator, 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 efficiency ("etas" or η_s) calculation developed in Ecodesign Lot 1 in consultation with stakeholders. Since the energy efficiency criterion in the current Ecolabel is based on the "etas", then those two effects are already taken into account, and no separate criterion is required, which leads to more simplified Ecolabel criteria.

Table 8. 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)]**
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 %	98%	0,0612 Q_N + 105.94	N/A	N/A

		A: 90-98 %				
Liquid 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 %	98%	N/A	N/A	N/A
Solid fuel boiler	N/A	N/A	98% for fossil fuel 79% for biomass fuel	≤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
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 %)	No limit (98%)	No limit	Not HFC refrigerant: 80 % HFC refrigerant (GWP < 1000): 90 % HFC refrigerant (GWP < 2000): 92 %	N/A
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 %)	No limit (98%)	No limit	Not HFC refrigerant: 80 % HFC refrigerant (GWP < 1000): 90 % HFC refrigerant (GWP < 2000): 92 %	N/A

Cogeneration	86 % (100 %)	A+++: ≥ 150 % A++: 125-150 % A+: 98-125 % A: 90-98 %	98%	Gas fuel: 89 % (full load); 87 % (50 % load) Liquid fuel: 85 % (full load); 83 % (50 % load)	N/A	N/A
Electric boiler	30 % (36 %)	A+++: ≥ 150 % A++: 125-150 % A+: 98-125 % A: 90-98 %	98%	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: water-based heaters.

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.

Additional feedback reflected that most manufacturers have models which could potentially meet the thresholds proposed. There is a risk the energy efficiency benchmark for the comprehensive criterion will restrict the good fossil-fuel based solutions, whereas it will not be discriminatory against most, if not all, heat pump solutions. While this statement is correct, we should point out that by adding the greenhouse gas emission limit, only efficient heat pumps will be able to meet the overall common benchmark criteria.

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. So, a gaseous or liquid fuelled boiler is always more efficient than a solid fuel boiler. This statement is true and for this reason a lower minimum 'etas' is proposed for solid biofuel (wood, pellets) heaters only, as the environmental impacts related to solid biofuel use, such as resource depletion and greenhouse gas emissions, are not as prominent as for other types of heaters. Furthermore the current proposal for solid biofuels is based on the GCV of the wet fuel, which contains a correction for the moisture content of the fuel and gives consideration to the possible recovery of latent heat from water formed during combustion (condensing solid biofuel boilers are currently available on the market).

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 approach (which includes also the effect of the energy efficiency of the heat pump in its mathematical expression). Indeed, the greenhouse gas emissions are to a large extent proportional to the energy efficiency of the product. Despite of this, the criterion on energy efficiency is absolutely necessary for solid biomass boilers and for boilers that use mixes of biomass and fossil fuels, since GHG emissions limit value by itself does not filter the most efficient installations in those cases. So, only for a limited set of heaters (fossil fuel heaters and cogeneration heaters, not equipped for use of biofuels) the relationship between energy efficiency and greenhouse gas emissions is more or less fixed.

According to some of the feedback received, the definition of the criterion should take into account the mandatory energy label classes of a heating generator product, and use this scale as a "first pass filter". This means that a heating generator product would only be allowed to apply for EU GPP criteria if the product was in the top one or two classes on the energy label, after which a broader range of environmental criteria would be looked at for complying with GPP criteria This would ensure that the EU GPP criteria take into account mandatory Ecodesign and Energy Label criteria, while at the same time being differentiated by incorporating additional and broader environmental performance parameters. To our understanding, a reference to the Energy Labelling would not cover the whole scope (up to 400 kW), since this regulation just applies to space heaters up to 70 kW. Furthermore, a reference to the A-G scale would mean a delay, since it would be bound to the approval of Energy labelling regulation for Lot 15 and its biomass label factor (BLC).

However, this argument has been taken into account by setting the minimum efficiency at 98% for the 'non-solid fuel' heaters as comprehensive criterion, as this aligns with the A+ class. For solid biomass boilers the A-G scale is still under development.

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 GPP 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 4)

<u>Rationale for verification</u>

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. For most of the products this requirement will not increase costs for compliance that much, since many product safety standards already require third part certification.

4.2.2 Criterion 2 – Greenhouse gas emissions limit

4.2.2.1 Formulation as core criterion

The applicant shall demonstrate that the greenhouse gas emissions, expressed in grams of CO_2-equivalents per kWh of heating output calculated using the Total Equivalent Warming Impact (TEWI) formulas defined below, shall not exceed the value(s) established in this criterion.

Type of heating generator	**Max. greenhouse gas emissions** **(g CO_2-equivalents per kWh of heating output)**
All heaters, except heat pump heaters	220 g CO_2-equivalents per kWh of heating output
Heat pump heaters	170 g CO_2-equivalents per kWh of heating output

4.2.2.2 Formulation as comprehensive criterion

The applicant shall demonstrate that the greenhouse gas emissions, expressed in grams of CO_2-equivalents per kWh of heating output calculated using the Total Equivalent Warming Impact (TEWI) formulas defined below, shall not exceed the value(s) established in this criterion.

Type of heating generator	**Max. greenhouse gas emissions** **(g CO_2-equivalents per kWh of heating output)**
All heaters, except heat pump heaters	210 g CO_2-equivalents per kWh of heating output
Heat pump heaters	150 g CO_2-equivalents per kWh of heating output

The greenhouse gas emissions will be calculated following the TEWI formulas below (different formulations, for fossil fuel (gas/oil) boilers, electrically-driven heat pumps, gas-driven heat pumps, cogeneration units, and hybrid generators).

Each TEWI formula consists of two parts, one dependent only on the efficiency of the heating generator (expressed in terms of the seasonal space heating efficiency, n_s) and the carbon intensity of the fuel (represented by $\beta_{elec.}$ and β_{gas}, for electricity and natural gas, respectively), and the second part (which has a value different than zero only for heat pumps) dependent 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 use-phase (expressed as an annual leakage rate, ER, in % 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).

The following TEWI formulas, which provide the GHG emissions in CO_2-equiv per kWh of heat output shall be used:

Table 9. TEWI formulae by heat generator technology

Heat generator technology	TEWI formula (g CO_2-equivalent/kWh heating output)
Boiler heaters	$\frac{\beta_{fuel}}{\eta_{sl}}$
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	$\frac{\beta_{fuel}}{\eta_{thermal}} - \frac{\eta_{el} \times \beta_{elec}}{\eta_{thermal}}$
Package of heaters	$(1 - s_{HP}) \times \frac{\beta_{fuel}}{\eta_{s,B}} + s_{HP} \times (\delta \times \frac{\beta_{fuel}}{\eta_{s,HP}} + (1-\delta) \times \frac{\beta_{elec}}{2.5 \times \eta_{s,HP}}) + \frac{GWP_{100} \times m \times (ER \times n + \alpha)}{P \times h \times n}$

The main parameters in the TEWI formulae above are described in **Table 10**.

Table 10. 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 11
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 12
η_{el}	Electrical efficiency	[-]	See Table 12
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	According to Annex I to Regulation (EC) No

		period]	842/2006 and Annex 1.1(7) to Regulation (EU) No 206/2012 ([24]).
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, meaning they take into account the losses due to transmission and distribution of electricity.

Table 11 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.

([24]) OJ L 72, 10.3.2012, p. 7

Table 11. 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 % × $\beta_{fuel\ N}$)

Source: 2010 Guidelines from Defra / DECC's GHG Conversion Factors for Company Reporting

Table 12 describes how to evaluate parameters $n_{thermal}$ and n_{el} in the TEWI formula for cogeneration heaters.

Table 12. Parameters $\eta_{thermal}$ and η_{el} to compute the TEWI formula for cogeneration heaters

Parameter	Expression
$\eta_{thermal}$	$\eta_{thermal} = \eta_s - 2.5 \times \eta_{el}$
η_{el}	For cogeneration space heaters not equipped with supplementary heaters $\eta_{el} = \eta_{el,CHP100+Sup0}$
	For cogeneration space heaters equipped with supplementary heaters $\eta_{el} = 0.85 \times \eta_{el,CHP100+Sup0} + 0.15 \times \eta_{el,CHP100+Sup100}$

Where:

η_s means the seasonal space heating energy efficiency as defined in Regulation (EU) No 813/2013

η_{el} means the electrical efficiency as defined in Regulation (EU) No 813/2013

$\eta_{el,CHP100+Sup0}$ means the electrical efficiency at rated heat output of cogeneration space heater with supplementary heater disabled, as defined in Regulation (EU) No 813/2013

$\eta_{el,CHP100+Sup100}$ means the electrical efficiency at rated heat output of cogeneration space heater with supplementary heater enabled, as defined in Regulation (EU) No 813/2013

The formulas used in **Table 12** are adapted from the Draft Communication including the transitional methods of measurement and calculation for the implementation of Ecodesign Lot1 [25]that hasn't been published yet. Once this communication is published, the methods to calculate the etas of cogeneration might change, and in that case, an update of the formulas in **Table 12** might be necessary.

Explanation for the formula for package of space heaters:

The heat output of the hybrid generator is first split up into a fossil fuel boiler and a heat pump part. This can be based on an approach involving a bivalent point, i.e. the outside temperature below which the gas boiler takes over from the heat pump. The calculation for the fossil fuel boiler part is then fairly straightforward. The calculation for the heat pump part includes a correction of 2.5 to convert the efficiency on primary energy basis to secondary energy (electricity) since the specific carbon emissions apply to kWh_{elec}. Finally, the contribution corresponding to the direct emissions (annual plus end-of-life refrigerant leakage) from the heat pump part is added.

4.2.2.3 Verification

Products holding the EU Ecolabel for water-based heaters (Commission Decision 2014/…/EC[26]) or another relevant Type 1 Eco-label fulfilling the listed requirements will be deemed to comply. Other appropriate means of proof will also be accepted, e.g. a declaration of compliance with this criterion, together with test results conducted in accordance with testing procedure indicated in respective EN standards or equivalent standards for the given kind of product (see **Table 3** and **Table 4**).

4.2.2.4 Rationale

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

[25] http://www.eup-network.de/product-groups/drafts-regulations/

[26] It refers to the Commission Decision establishing the EU Ecolabel criteria for water-based heaters, which will be published in 2014

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 CO2 per kWh of heating output , or per kWh of primary energy input .

More importantly, this second criterion allows the renewable nature of biomass to be included in the assessment. A method is proposed 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 support for the TEWI approach to calculating the greenhouse gas emission benchmark. The TEWI approach for the GHG emissions was developed in consultation with Blauer Engel. TEWI was first applied in the Blauer Engel criteria for "Energy-Efficient Heat Pumps using an Electrically Powered Compressor" (RAL-UZ 121). For other types of heat pumps, such as the current Blauer Engel criteria for "Energy-Efficient 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 Blauer Engel 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 for heating generators. In the ongoing Blauer Engel 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.

In addition to a review of other labels, 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. Biomass boilers, while having less energy efficiency, have nevertheless much lower GHG emissions than other boilers, since the CO_2 production of combustion is considered to be zero (except in the production phase of wood pellets).

Rationale for the value GHG = maximum 220 gCO2eq./kWh heat output for all heaters except heat pumps, as core criterion

Results from the technical analysis confirm that best available technology for gas boilers is able to achieve maximum greenhouse gas emissions of around 217 grams of CO_2-equiv./kWh heat output; this was the rationale to set the benchmark at 220 grams of CO_2-equiv./kWh heat output. Thus, this threshold is focused on discriminating those fuels that are more CO_2 intensive.

Rationale for the value GHG = maximum 170 gCO2eq./kWh heat output for all heat pumps heaters, as core criterion:

The rationale to add a separate GHG limit of 170 grams CO_2/kWh heat output for electrically-driven heat pumps is as follows. Setting this limit is realistic for this type of technology, and setting a higher limit will not lead to pushing the market to best environmental performance. On the other hand, if the limit of 170 grams CO_2/kWh heat output was to be set also for gas condensing boilers and gas-driven heat pumps, it will in practice almost drive these technologies out of eligibility. 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.

It is therefore not always possible for the procurer to have access to electrically-driven heat pumps and biomass boilers. If the GPP criteria for heating generators allow also the inclusion of best performing gas boilers and gas-driven heat pumps, it is less discriminative for the market, while still providing valuable environmental benefits. The GPP criteria will be revised in future years to accommodate for corresponding market and technological changes.

The TEWI limit value and formulae work as a *bonus-malus* mechanism to penalize higher GWP refrigerants heat pumps with stricter energy efficiency requirements, and to reward low GWP refrigerants heat pumps with a more relaxed energy efficiency threshold. The value of 170 gCO2/kWh heat output has been set to select those heat pumps that:

i. fulfil the RES Directive 2009/28/EC [27] criterion to be considered as renewable source (SCOP = 2.6 for the average climate conditions of Strasbourg, ecodesign etas = 101%), and
ii. use a conventional HFC refrigerant (R410A) since the HFC refrigerants share more than 95% of heat pumps currently available in the market in a ratio charge (kg) /heat output (kW) equal to 1/3.

The same heat pump using the refrigerant R507 (GWP = 3985) would need a SCOP of 3.1 (ecodesign etas = 120%), hence a stricter threshold of energy efficiency offsets the GHG gases emissions due to the refrigerant leakages.

<u>Rationale for the value GHG = maximum 210 gCO2eq./kWh heat output for all heaters except heat pumps, as core criterion</u>:

Results from the technical analysis confirm that if the seasonal efficiency of gas fuel heaters is 96% the greenhouse gas emissions are approximately 210 grams of CO_2-equiv./kWh heat output; The technical analysis has also confirmed that this benchmark corresponds also to values achieved by cogeneration heaters.

The technical analysis on biomass boilers has shown that, regardless of whether manual or automatic, or fed with wood, wood pellets, or wood chips, biomass boilers emit less than 50 grams of CO_2-equiv./kWh heat output. Coal-fired heaters however exceed the maximum threshold for 200 grams, even if the seasonal efficiency is 96%..

<u>Rationale for the value GHG = 150 gCO2eq./kWh heat output pumps for all heat pumps heaters as comprehensive criterion</u>:

Differences in GHG emissions among different types of electrically-driven heat pumps are mainly due to the different seasonal efficiencies (mostly due to heat source: air-to-water has lowest efficiencies, water or brine-to-water the highest), but also on the type of refrigerant. Leakage of refrigerants is also a relevant factor for the calculation of GHG, and in relaity depends on type of technology used (single-package units have lower leakage than split-package units). The calculation of the GHG is based on fixed (default) leakage rates as the actual real-life leakage is not known beforehand and is also dependent on end-of-life leakage and general maintenance - aspects that cannot be covered beforehand in an award procedure.

As explained above, the TEWI limit values and formulae work as a *bonus-malus* mechanism. The value of 150 gCO2/kWh heat output has been set to select those heat pumps that

i. fulfil the RES Directive criterion to be considered as renewable source (SCOP = 2.6 for the average climate conditions of Strasbourg),
ii. using CO_2 (GWP = 1) as refrigerant in a ratio charge (kg) /heat output (kW) equal to 1/3.

[27] OJ L 140 5.6.2009, p. 16

The same heat pump using R410A (GWP = 2000) would need a SCOP of 3.1 (etas = 120%), and thus a stricter threshold of energy efficiency offsets the GHG gases emissions due to the refrigerant leakages. For the refrigerant R507 (GWP=3985), another common HFC blend, would require a SCOP of 3.6 (etas = 140%) to fulfil the TEWI of 150 gCO2/kWh heat output.

Therefore, the selectivity of this criterion is ensured by mean of two parameters: GWP of the refrigerant and the seasonal space energy efficiency.

Regarding GWP value of the refrigerant, the market penetration of non-HFC refrigerants (CO_2, hydrocarbons) is currently very low: approximately 95% of heat pumps place in the European market use HFC refrigerants, according to the report of the Environmental Investigation Agency (EIA) *Availability of low GWP alternatives to HFCs (May 2012).* HFC blends featuring low GWP are able to reach a GWP of 150 with the addition of unsaturated HFCs (partially fluorinated olefins or HFOs), mainly HFC-1234yf (refrigerant) and HFC-1234ze (foam blowing agent, aerosol propellant, and refrigerant). According to the *Preparatory study for a review of Regulation (EC) No 842/2006 on certain fluorinated greenhouse gases (September 2011)*, the unsaturated HFCs are not yet commercially available of the necessary scale. In conclusion, too strict GWP threshold would excessively limit the procurement options.

In the case of the energy efficiency, the market segmentation shows that 40 – 50% of air-water heat pumps are able to reach the SCOP of 3.1 (etas = 120%) and 5 – 10% of air-water heat pumps attain a SCOP of 3.6 (etas = 140%) (estimations based on a sample of 780 models of air-water heat pumps provided by German Federal Office of Economics and Export Control, BAFA). These market shares should be considered together with the penetration of heat pumps in the heat generators market, which is less than 10% (3% according to EHPA), and also the sales of air-water heat pumps compared to the total sales of heat pumps, which is 55% (according to the data from EHPA). The analysis is focused on the air-water technology because it performs the lowest efficiencies compared to water-water heat pumps, but it is the most accessible technology compared to water source, both technically and economically. This justifies that the TEWI limit value is designed to rule out the worst air-water heat pumps, since the most efficient heat pump technology is constrained enough due to the more complex and expensive installation.

<u>Feedback from the stakeholders</u>:

The TEWI methodology was considered a good approach by the majority of stakeholders.

The proposed two levels for GHG emission values, depending on the heating technology were supported by several stakeholders, mainly because of the possibility to increase innovation in the heat pump market, and offering incentive and helping push the heat pump technology towards improved performance.

Some stakeholders also added the suggestion to even increase the differentiation of GHG emission limits for different heat pump technologies. Therefore, they suggested additional adjustments. From our understanding, this would break down the technology neutral approach, leading to multiple choices, and thus the decision-making process would be much more complex. Ultimately, it would require the procurer to choose the space heating technology (gas boiler, heat pumps or biomass boiler) to be purchased before setting the criteria, and such early choice is very likely to be based on the technology price.

4.2.3 Criterion 3 – Product longevity and warranty

4.2.3.1 Formulation as core criterion

Repair or replacement of the product shall be covered by the warranty terms for minimum four years. The tenderer shall further ensure that genuine or equivalent spare parts are available (direct or via other nominated agents) for at least ten years from the date of purchase. This clause will not apply to unavoidable temporary situations beyond the manufacturer's control such as natural disasters.

.

4.2.3.2 Formulation as comprehensive criterion

Repair or replacement of the product shall be covered by the warranty terms for minimum five years. The tenderer shall further ensure that genuine or equivalent spare parts are available (direct or via other nominated agents) for at least ten years from the date of purchase. This clause will not apply to unavoidable temporary situations beyond the manufacturer's control such as natural disasters.

4.2.3.3 Verification

Products holding the EU Ecolabel for water-based heaters (Commission Decision 2014/…/EC) or another relevant Type 1 Eco-label fulfilling the listed requirements will be deemed to comply.

Other appropriate means of proof will also be accepted, such as a self- declaration from the manufacturer stating that the above requirement will be met.

4.2.3.4 Rationale

The requirement for spare parts availability (10 years after the purchase) is similar to the one included in the EU Ecolabel criteria for air heat pumps and the EU Ecolabel for water-based heaters. For warranty coverage, the period of four years is seen as reasonable, going beyond the legal 2 year warranty. The period of five years proposed as comprehensive criterion is aligned to the EU Ecolabel for water-based heaters.

4.2.4 Criterion 4 – Installation instructions and user information

4.2.4.1 Formulation as core and comprehensive criterion

The product shall be supplied with the following installation instructions and user information in printed (on the packaging and/or on documentation accompanying the product) and/or in electronic format:

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

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

(c) 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) for heat pumps, clear indication that substances classified as environmentally hazardous or constituting a health hazard as defined by Council Directive 67/548/EEC([28]) and its subsequent amendments shall not be used

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

(d) operating instructions for service personnel;

(e) 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;

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

4.2.4.2 *Verification*

Products holding a relevant Type 1 Eco-label fulfilling the listed requirements will be deemed to comply. Other appropriate means of proof will also be accepted, such as written evidence from the manufacturer that the above clause will be met.

4.2.4.3 *Rationale*

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

([28]) OJ 196, 16.8.1967, p. 1.

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 GPP perspective.

The correct operation and maintenance of the water-based 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.

In the wider context of the heating system as a whole, it is also important that the system has adequate control mechanisms to ensure that 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.

4.2.5 Criterion 5 – Primary and secondary refrigerant

4.2.5.1 Formulation as comprehensive criterion

The global warming potential over a 100 year period (GWP_{100}) of the primary 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 ([29]).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. For those refrigerants that are not covered by the Regulation (EC) No 842/2006, sources of references for the GWP_{100} values should be those defined in Annex 1.1(7) to Regulation (EU) No 206/2012 ([30]).

Secondary refrigerant

If applicable, the secondary refrigerant, brine or additives, shall not contain substances classified as environmentally hazardous or constituting a health hazard as defined by Council Directive 67/548/EEC ([31]) and its subsequent amendments. The design of the water-based heater shall not be based on secondary refrigerant, brine or additives classified as environmentally hazardous or constituting a health hazard as defined by Council Directive 67/548/EEC

4.2.5.2 Verification

Products holding the EU Ecolabel for water-based heaters (Commission Decision 2014/…/EC) or another relevant Type 1 Eco-label fulfilling the listed requirements will be deemed to comply. Other appropriate means of proof will also be accepted, e.g. a declaration of compliance with this criterion, together with providing the names of refrigerant(s) used in the product along with their GWP_{100} values

.

([29]) OJ L 161, 14.6.2006, p. 1.
([30]) OJ L 72, 10.3.2012, p. 7
([31]) OJ 196, 16.8.1967, p. 1.

4.2.5.3 Rationale

Refrigerants are used only by the heat pump technology, and the most widely used are the HFCs, mainly as substitutes for ozone-depleting substances such as chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs) and halons which are being phased out under the Montreal Protocol. HFC gases are of environmental concern because they contribute to climate change.

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.

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

Table 13. 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	No requirements
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 types of refrigerants are currently available in the market. As suggested by **Table 13**, a GWP_{100} limit value of 2000 seems reasonable to reduce the environmental concerns of refrigerants, while allowing a significant portion of the heat pump market to be included. The GWP of refrigerants is a parameter that is controlled not only by mean of Criterion 5, but also by mean of Criterion 2, since it is included in TEWI formulae. By mean of this approach, the use of low GWP refrigerants in heat pumps.is awarded a lower energy efficiency threshold that is needed to meet the proposed TEWI limit value. Furthermore, the penetration of non-HFC refrigerants and low GWP HFC refrigerants is currently very low.

The criterion 5 formulated as comprehensive criterion is aligned to the EU Ecolabel criterion 3 for water-based heaters, and it is aimed to getting rid of those HFC and HFC blends that perform the highest GWP values, and are widely used in heat pumps. The share of HFC refrigerants in the heat pumps market comprises the most part of appliances currently available (95%), which leads to a formulation as comprehensive criterion to prevent an excessive restriction on the tendering process.

As shown by **Table 13**, some schemes establish different efficiency limits depending on the GWP of the refrigerant. However, the relationship between energy efficiency and the GWP of the refrigerant is also addressed already by Criterion 2 (GHG emissions), which works as *bonus-malus* mechanism.

During 2013, the current F- gas regulation was revised and extended. In December 2013, representatives of the European Parliament and Council agreed on a slightly amended text based on the Commission's proposal. The revision of the F-gas Regulation is now subject to the formal approval of the Parliament and Council. The new legislation on fluorinated gases F-gases will:

- limit the total amount of the most important F-gases (HFCs) that can be sold in the EU, and reduce this in steps to one-fifth of today's sales in 2030 ("phase-down" measure). This will be implemented by mean of a quota system, ensuring that the quantity of hydrofluorocarbons that producers and importers are entitled to place on the market in the EU each year does not exceed the maximum quantity for the year in question.
- ban the use of F-gases in some equipment, such as fridges in homes or supermarkets, in air conditioning, in foams and aerosols, for which less harmful alternatives are widely available today. This ban does not affect to water-based heat pumps.
- prevent emissions of F-gases from existing equipment by requiring controls, proper servicing and recovery of the gases at the end of the equipment's life. Stationary heat pumps shall meet these requirements.

<u>Feedback from stakeholders</u>.

Stakeholders from the Competent Bodies generally supported Criterion 5, and also setting its value around 2000. These experts said that Criterion 5 is very important and should not be eliminated. This criterion should be used to push forward the use of more environmentally-friendly refrigerants.

Regarding the specific value of 2000, some stakeholders said that 2000 is not ambitious enough. Some experts from the Competent Bodies however said that heat pumps are increasingly built to be leak-tight and therefore that the limit at 2000 should be sufficient. Other industry stakeholders proposed to establish two levels for this Criterion, one for sealed and one for non-sealed heat pumps.

Industry stakeholders (heat pumps manufacturers) expressed a preference to exclude the GWP requirement, based on the consideration that Criterion 2 using TEWI should be enough, because it already includes the refrigerant leakage.

Overall, there were some differences in opinion regarding the need to establish Criterion 5, in view that refrigerant leakage is already included as part of Criterion 2. However, a significant part of stakeholders defended keeping Criterion 5, and that the level at 2000 is considered reasonable and ambitious enough. If we kept Criterion 5, and upon consultation from industry, the level set at 2000 is reasonable, as it does not exclude refrigerants commonly used in heat pumps, but it discriminates those ones that perform the highest GWP.

4.2.6 Criterion 6 – Nitrogen oxides (NOx) emissions limit

4.2.6.1 Formulation as comprehensive criterion

The nitrogen oxide (NOx) content of the exhaust gas shall not exceed the limit values indicated in **Table 14** (not applicable to electrical heaters). NOx emissions shall be measured as the sum of nitrogen monoxide and nitrogen dioxide and at the following operating conditions:

- Gas and liquid heaters, at standard rating conditions and rated heat output
- Solid fuel heaters, as seasonal space heating emissions according **Table 5**

Table 14. NO_x emission limits by heat generator technology

Heat generator technology	**NO_x emission limit**
Gas fuel heaters	Equipped with internal combustion engine: 170 mg/kWh GCV energy input Equipped with external combustion: 36 mg/kWh GCV energy input
Liquid fuel heaters	Equipped with internal combustion: 380 mg/kWh GCV energy input Equipped with external combustion: 100 mg/kWh GCV energy input
Solid fuel heaters	150 mg/Nm^3 at 10 % O2

The unit of measurement shall be given in mg/kWh GCV energy input or in mg/Nm^3, as appropriate.. The tests shall be conducted according to the relevant standards or equivalent included in **Table 3** and **Table 4** or equivalent.

4.2.6.2 Verification

Products holding the EU Ecolabel for water-based heaters (Commission Decision 2014/…/EC) or another relevant Type 1 Eco-label fulfilling the listed requirements will be deemed to comply. Other appropriate means of proof will also be accepted, e.g. a declaration of compliance with this criterion, together with test results showing the NO_x emissions in the exhaust gas.

4.2.6.3 Rationale

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 available, 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 15**.

Table 15. 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	36 mg/kWh GCV energy input	40 mg/kWh	N/A	N/A	Condensing: 60 mg/kWh Non-condensing: 70 mg/kWh
Liquid fuel boiler	120 mg/kWh	100 mg/kWh GCV energy input	N/A	N/A	N/A	120 mg/kWh
Solid fuel boiler	N/A	150 mg/Nm³ at 10 % O2	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)	Gas fuel: 36 mg/kWh (external); 170 mg/kWh (internal) Liquid fuel: 100 mg/kWh (external); 380 mg/kWh (internal)	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)	Gas fuel: 170 mg/kWh GCV energy input	Gas fuel: 250 mg/Nm³ Liquid fuel: 2500	N/A	N/A	No limit

	Liquid fuel: 120 mg/kWh (external); 420 mg/kWh (internal)	Liquid fuel 380 mg/kWh GCV energy input	mg/Nm³			

1) Implementing Measure proposal for Ecodesign Lot 1 (as of 13/03/2013).

2) EU Ecolabel criteria for: water-based heaters.

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 15**, 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 15**, the NO_x requirements are not harmonised between one scheme to another. The threshold limits for the criterion are aligned to EU Ecolabel for water based heaters, which were 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 (40 mg/kWh NCV = 36 mg/kWh GCV) 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 O_2 % = 206 mg/Nm³ at 10 O_2 %; and 190 mg/Nm³ at 13 O_2 % = 261 mg/Nm³ at 10 O_2 %) and Austrian Eco-label criteria (100 mg/MJ = 206 mg/Nm³ at 10 O_2 %; and 120 mg/MJ = 248 mg/Nm³ at 10 O_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.

4.2.7 Criterion 7 – Carbon monoxide (CO) emission limit

4.2.7.1 Formulation as comprehensive criterion

The carbon monoxide (CO) content of the exhaust gas shall not exceed the limit values indicated in Table 16 (not applicable to electrical heaters).. CO emissions shall be measured at standard rating conditions and rated heat output.at the following operating conditions:

- Gas and liquid heaters, at standard rating conditions and rated heat output
- Solid fuel heaters, as seasonal space heating emissions according **Table 5**

.Table 16. CO emission limits by heat generator technology

Heat generator technology	**CO emission limit**
Gas fuel heaters	Equipped with internal combustion engine: 150 mg/Nm³ at 5 % O_2 Equipped with external combustion: 25 mg/kWh GCV energy input
Liquid fuel heaters	Equipped with internal combustion engine: 200 mg/Nm³ at 5 % O_2 Equipped with external combustion: 50 mg/kWh GCV energy input
Solid fuel heaters	Automatically stoked: 175 mg/Nm³ at 10 % O_2 Hand stoked: 250 mg/Nm³ at 10 % O_2

The unit of measurement shall be given in mg/kWh energy input GCV or in mg/Nm³, as appropriate. The tests shall be conducted according to the relevant standards or equivalent included in **Table 3** and **Table 4** or equivalent

4.2.7.2 Verification

Products holding the EU Ecolabel for water-based heaters (Commission Decision 2014/…/EC) or another relevant Type 1 Eco-label fulfilling the listed requirements will be deemed to comply. Other appropriate means of proof will also be accepted, e.g. a declaration of compliance with this criterion, together with test results showing the CO emissions in the exhaust gas.

4.2.7.3 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.

CO requirements from several product policy schemes are presented in **Table 17**.

Table 17. Comparison of CO emission limits in different product policy schemes

Heat	**Ecodesign[1)]**	**EU Ecolabel[2)]**	**Blue Angel[3)]**	**Nordic**	**Austrian Eco-**

generator technology				Ecolabel[4)]	label[5)]
Gas fuel boiler	No limit	25 mg/kWh GCV	20 mg/kWh	N/A	N/A
Liquid fuel boiler	No limit	50 mg/kWh GCV energy input	N/A	N/A	N/A
Solid fuel boiler	N/A	Automatically stoked: 175 mg/Nm^3 at 10 % O_2 Hand stoked: 250 mg/Nm^3 at 10 % O_2	≤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)
Fuel-driven heat pump	No limit	See boilers and cogeneration	External: 20 mg/kWh Internal: 100 mg/Nm^3	No limit	N/A
Electrically-driven heat pump	No limit	No limit	No limit	No limit	N/A
Cogeneration	No limit	Gas fuel: 150 mg/Nm^3 at 5 % O_2 Liquid fuel 200 mg/Nm^3 at 5 % O_2	Gas fuel: 300 mg/Nm^3 Liquid fuel: 300 mg/Nm^3	N/A	N/A

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/Nm^3 (10 % O_2); 150 mg/MJ ≈ 309 mg/Nm^3 (10 % O_2); 135 mg/MJ ≈ 278 mg/Nm^3 (10 % O_2); 300 mg/MJ ≈ 619 mg/Nm^3 (10 % O_2); 250 mg/MJ ≈ 516 mg/Nm^3 (10 % O_2); 750 mg/MJ ≈ 1547 mg/Nm^3 (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 17**, the CO requirements are not harmonised between one scheme to another. The threshold limits for the criterion are aligned to EU Ecolabel for water based heaters, which were 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; 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; values are derived from gas fuel heaters, though slightly higher since gaseous fuels present better combustion/oxidation efficiency than liquid fuels.
- 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 stoking (70 mg/Nm³ at 13 02 % = 96 mg/Nm³ at 10 02 % at full load conditions; 150 mg/Nm³ at 13 02 % = 206 mg/Nm³ at 10 02 % at part load conditions). The EU Ecolabel criterion proposal sets a little stricter limit value than Blue Angel, 90 mg/Nm³ at full load conditions and 190 mg/Nm³ at part load conditions. That means a *Seasonal space heating emissions* of 175 mg/Nm³*.* In the case of manual stoked boilers, the value is based on stakeholder feedback for manual stocking, which doesn't need an update because the Seasonal space heating emissions is equal to the emissions at nominal operating conditions (full load conditions) for this type of boilers.

4.2.8 Criterion 8 – Organic gaseous carbon (OGC) emissions limit

4.2.8.1 Formulation as comprehensive 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 18 (only applicable to solid fuel boiler heaters). OGC emissions shall be measured as seasonal space heating emissions according **Table 5**.

Table 18. OGC emission limits by heat generator technology

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

The unit of measurement shall be given in mg/Nm³. The tests shall be conducted according to the relevant standards or equivalent included in **Table 3** and **Table 4** or equivalent

4.2.8.2 Verification

Products holding the EU Ecolabel for water-based heaters (Commission Decision 2014/…/EC) or another relevant Type 1 Eco-label fulfilling the listed requirements will be deemed to comply. Other appropriate means of proof will also be accepted, e.g. a declaration of compliance with this criterion, together with test results showing the OGC emissions in the exhaust gas.

4.2.8.3 *Rationale*

OGC in the exhaust gas is a measure of the 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. 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 emissions which cause environmental or health hazards.

OGC requirements from several product policy schemes are presented in Table 19.

Table 19. 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)]
Gas fuel boiler	No limit	N/A	No limit	N/A	N/A
Liquid fuel boiler	No limit	N/A	N/A	N/A	N/A
Solid fuel boiler	N/A	7 mg/Nm³ at 10 % O_2	5 mg/Nm³ at nominal load and part load conditions	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)
Fuel-driven heat pump	No limit	No limit	No limit	No limit	N/A
Electrically-driven heat pump	No limit	No limit	No limit	No limit	N/A
Cogeneration	No limit	N/A	No limit	N/A	N/A

1) Implementing Measure proposal for Ecodesign Lot 1 (as of 13/03/2013).

2) EU Ecolabel criteria for water-based heaters.

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 19, the OGC in the different product policy schemes is only tested for solid fuel (biomass) boilers and is not harmonised between one scheme to another. The threshold limits for the criterion are aligned to EU Ecolabel for water based heaters, which were set as follows:

- Solid fuel boilers: the value has been set on the basis of Blue Angel criteria (5 mg/Nm³ at 13 O_2 % = 7 mg/Nm³ at 10 O_2 % at nominal load and part load conditions) and Austrian Eco-label criteria (3 mg/MJ = 6 mg/Nm³ at 10 O_2 %), without distinguishing between automatic and manual stoking.
- Any other technology: no limit, similar to other schemes.

4.2.9 Criterion 9 – Particulate matter (PM) emissions limit

4.2.9.1 Formulation as comprehensive criterion

The particle matter (PM) content of the exhaust gas shall not exceed the limit values indicated in **Table 20**. PM emissions shall be measured at standard rating conditions and rated heat output at the following operating conditions:

- Liquid heaters, at standard rating conditions and rated heat output
- Solid fuel heaters, as seasonal space heating emissions according **Table 5**

Table 20. 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	20 mg/Nm³ at 10 % O_2

The unit of measurement shall be given in mg/Nm³. The tests shall be conducted according to the relevant standards or equivalent included in **Table 3** and **Table 4** or equivalent

4.2.9.2 Verification

Products holding the EU Ecolabel for water-based heaters (Commission Decision 2014/…/EC) or another relevant Type 1 Eco-label fulfilling the listed requirements will be deemed to comply. Other appropriate means of proof will also be accepted, e.g. a declaration of compliance with this criterion, together with test results showing the PM emissions in the exhaust gas.

4.2.9.3 *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 water-based 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[32].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 21**.

Table 21. 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)]
Gas fuel boiler	No limit	N/A	No limit	N/A	N/A
Liquid fuel boiler	No limit	1 mg/Nm^3 at 5 % O_2	N/A	N/A	N/A
Solid fuel boiler	N/A	20 mg/Nm^3 at 10 % O_2	Pellets: 20 mg/Nm^3 (full load); 40 mg/Nm^3 (30 % load) Chips: 30 mg/Nm^3 (full load); 40 mg/Nm^3 (30 % load)	Automatic: 40 mg/m^3 Manual: 70 mg/m^3	Automatic: 15 mg/MJ (pellets); 30 mg/MJ (chips); Manual: 30 mg/MJ
Fuel-driven heat pump	No limit	No limit	150 mg/Nm^3	No limit	N/A
Electrically-driven heat	No limit	No limit	No limit	No limit	N/A

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

pump					
Cogeneration	No limit	N/A	<u>Gas fuel:</u> no limit <u>Liquid fuel:</u> 150 mg/Nm³	N/A	N/A

1) Implementing Measure proposal for Ecodesign Lot 1 (as of 13/03/2013).

2) EU Ecolabel criteria for: water-based heaters.

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).

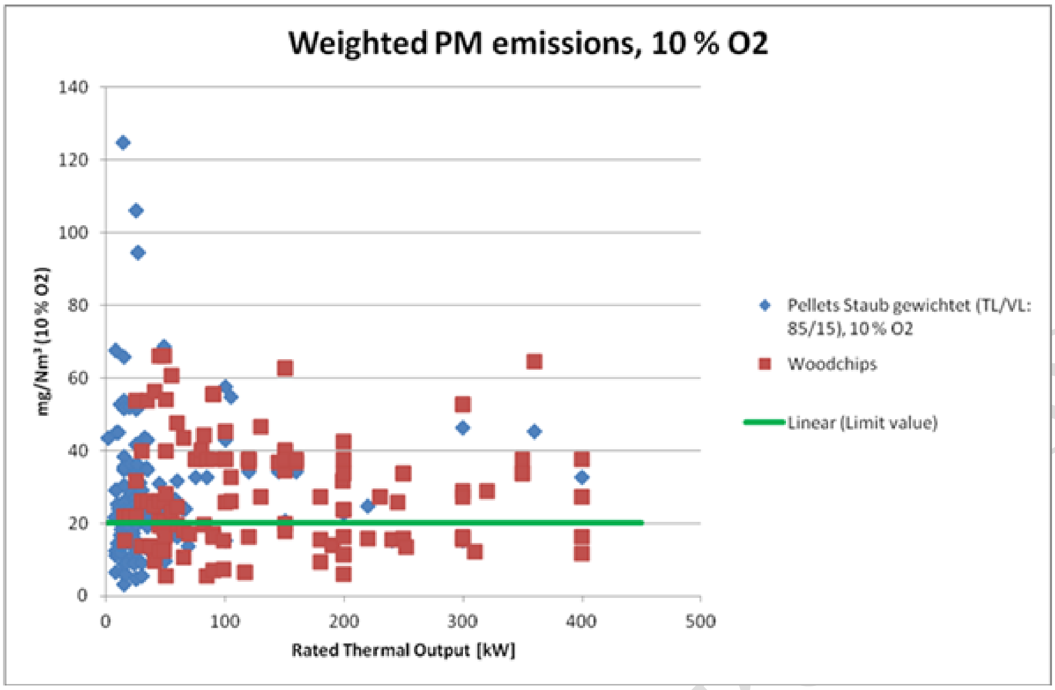
6) EU GPP criteria for: combined heat and power; and EU GPP preparatory work for: boilers; and heat pumps and air conditioning.

As shown in **Table 21**, the PM requirements are not harmonised between one scheme to another. The threshold limits for the criterion are aligned to EU Ecolabel for water based heaters, which were set as follows:

- Gas fuel heaters (including boilers, heat pump and cogeneration): no limit, similar to other schemes.
- 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: On-going discussion for Ecodesign Lot 15 (solid fuel boiler heaters) are currently indicating a level above 20 mg/Nm3 at 10% O2 for both wood pellets and chips, that will be in in force in 2022. The figure of 20 mg/Nm3 for PM emissions that is under discussion is inspired by the BAT biomass boilers.

The stakeholder feedback suggested that the PM limit value of 20 mg/Nm3 measured as seasonal space heating emissions could be too strict for biomass boilers currently on the market. However, an estimation made by the German Federal Environment Agency to calculate weighted emissions of biomass boilers shows that around 30% of boilers complying with the standards RAL-UZ-111 and 112 could reach the threshold proposed [33], as displayed in the following figure.

[33] Data compiled by the German Federal Environment Agency using data from: Bost, Mark et al.: Überarbeitung der Vergabegrundlagen für die Umweltzeichen „Holzpelletöfen (RAL-UZ 111) und Holzpelletkessel (RAL-UZ 112) sowie Überprüfung des Rahmens für ein Umweltzeichen für Hackschnitzelanlagen; Im Auftrag des Umweltbundesamtes, Berlin, November 2010



4.3 AWARD CRITERIA

4.3.1 Criterion 1 - Additional energy efficiency

4.3.1.1 *Formulation as core and comprehensive criterion*

Additional points will be awarded for every 1 % additional increase in the seasonal space heating energy efficiency η_s of the water-based heater as specified under criterion 1.

4.3.1.2 *Verification*

A declaration of compliance with this criterion shall be provided, together with test results conducted in accordance with testing procedure indicated in respective EN standards or equivalent standards for the given kind of product (see **Table 3** and **Table 4**).

4.3.1.3 *Rationale*

Energy consumption is one of the main environmental hotspots identified in product group, and to that extent, additional efforts in the technologies available should be rewarded in the evaluation process.

4.3.2 Criterion 2 – Additional GHG emission reduction

4.3.2.1 *Formulation as core and comprehensive criterion*

Additional points will be awarded for every 5 g of additional reduction in the greenhouse gas emissions of the water-based heater as specified under criterion 2.

4.3.2.2 *Verification:*

A declaration of compliance with this criterion shall be provided, together with the calculated GHG emissions following the proposed TEWI formulae and information on all the parameters used to calculate the GHG emissions.

4.3.2.3 *Rationale*

GHG emission is one of the main environmental hotspots identified in product group, and to that extent, additional efforts in the technologies available should be rewarded in the evaluation process.

4.3.3 Criterion 3 – Noise emission limits

4.3.3.1 *Formulation as core and comprehensive criteria*

Points will be awarded if the noise emissions of the water-based heater do not exceed the limit values set out as follows.

Heat generator technology	**Measurement**	**Noise emission limit**
Heat pump heaters equipped with external combustion and electrically-driven heat pumps	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 engine	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 engine	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) heat output; P_E means the electricity output.

The unit of measurement shall be given in dB(A) or dB(C), as appropriate. The tests shall be conducted according to the relevant standards or equivalent included in **Table 3** and **Table 4** or equivalent.

Points to be awarded shall be calculated as follows:

$$PL = \frac{L_{A,min}}{L_A} \times PL_{A,max} + \frac{L_{C,min}}{L_C} \times PL_{C,max}$$

Where

- *PL* is the noise level points
- $L_{A,min}$ is the lowest A-weighted sound pressure level for a fully compliant offer
- $L_{C,min}$ is the lowest C-weighted sound pressure level for a fully compliant offer
- L_A *is the A*-weighted sound pressure level being evaluated
- L_C *is the C*-weighted sound pressure level being evaluated
- $PL_{A,max}$ is the maximum number of A-weighted sound pressure level points available
- $PL_{C,max}$ is the maximum number of C-weighted sound pressure level points available

4.3.3.2 Verification

A declaration of compliance with this criterion shall be provided together with test results showing the noise emissions.

4.3.3.3 Rationale

The sound power level, or noise, from the heating units is a parameter that should be taken into consideration when deciding whether to purchase and where to locate the heating generator units, in order to minimise the noise impact upon the surrounding environment and those living and working in that environment.

Most ecolabels do not require a criterion on noise limit. A few ecolabels require to measure noise and report it, without giving a specific limit.In certain Ecolabels, noise requirements for heat pumps are only established for heat pump capacities of up to 20 kW; above 20 kW there are no noise limits. Also, units above 20 kW typically belong to the scope of professional, not residential heating generators. Other stakeholders said also that for large heat pumps, noise is less of an issue.

Air-to-water heat pumps use outside air or ventilation air as heat source. The air flow over the heat exchanger (in heating mode: evaporator side) will result in airborne noise, expressed as sound power level.

For split-package units with an outdoor unit, the effects of such airborne noise is very local and determined by local circumstances (position of outdoor unit, dampening applied etc.).

For single-package units, for instance using ventilation air, the effects may be more prone, since the noise is produced indoors and is related to the ventilation system.

Such effects in outdoor or indoor noise cannot yet be quantified, since they are very susceptible to local circumstances, but the effect is present and should be addressed by manufacturers/procurers.

The table below (Table 22) summarizes the noise requirement for all heating generators, showing that the requirement is only applicable to heat pumps.

Table 22. Comparison of noise limits established in different product policy schemes for heating generators.

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)	External combustion $L_{WAd, lim} = 17 + 36 \times \log(P_N + 10)$ dB(A) Internal combustion engine $L_{PAd, lim} = 30 + 20 \times \log(0.4 \times P_N + 15)$ dB(A) ($L_{PCd, lim} = L_{PAd, lim} + 20$ dB(C)	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)	$L_{WAd, lim} = 17 + 36 \times \log(P_N + 10)$ dB(A	No limit	No limit but noise be tested and reported	N/A	No limit
Cogeneration	No limit	Internal combustion engine $L_{PAd, lim} = 30 + 20 \times \log(P_E + 15)$	No limit	N/A	N/A	No limit

		dB(A) ($L_{PCd,\ lim}$ = $L_{PAd,\ lim}$ + 20 dB(C)				

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: water-based heaters.

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

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 the fact that there is no common agreed testing methodology.. 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 are aligned to EU Ecolabel for water based heaters, which were 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 serve 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.

4.3.4 Criterion 4 – Product design

4.3.4.1 Formulation as core and comprehensive criteria

Points will be awarded if the water-based heater is easy to dismantle by professionally trained personnel using commonly available tools, for the purpose of repairs and replacements of worn-out parts, upgrading older or obsolete parts, and separating parts and materials, ultimately for reuse or recycling.

4.3.4.2 Verification

Products holding a relevant Type 1 Eco-label fulfilling the listed requirements will be deemed to comply. Other appropriate means of proof will also be accepted, e.g. a declaration of compliance with this criterion, together with a technical report from the manufacturer showing the dismantling of the product with an exploded diagram labelling the main components as well as identifying any hazardous substances in these components as specified in Annex 2 to Directive 2002/96/EC (WEEE Directive). This diagram shall be available in the manufacturer website. Information regarding hazardous substances shall be provided to the procurer in the form of a list of materials identifying material type, quantity used and position on the water-based heater equipment.

4.3.4.3 Rationale

Based on results from the technical analysis, it is concluded to be worth considering end-of-life management issues relating to heating generators, due to significant potential for environmental harm in this lifecycle phase. End-of-life management is also relevant to elements of heating generator that will need to be replaced throughout the life span of the heating generator as a whole. Heating generators consist of materials that can be recovered and recycled, for example plastics and in particular, metals. In addition, it may be the case that a heating generator is replaced before it has reached its natural end of life. It is generally better in life cycle terms to replace an older heating generator 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: promotion of reuse, recycling and generally a sound end-of-life management. It may in principle include aspects such as: recycled material content, design for recycling, design for repair/warranty and spare parts, criteria regarding easy for reuse/recycle, etc.

Examples from other labels are: the Blauer Engel criterion on recyclable design, Blauer Engel criterion for marking of plastics, guarantee of repairs and maintenance of equipment, product take back requirement. From the GPP preparatory work on heat pumps, the end-of-life management of heat pumps is mainly regulated by the requirements of the WEEE Directive, as such units 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 EC F-gas legislation, when a heat pump is recycled, reclaimed or destroyed, certified personnel must recover over all the fluorine-containing gases in order 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. APPENDIX

The current draft criteria was partly developed based on the results from a life-cycle analysis using 12 base cases, and described in the accompanying technical report[34]. Compared to earlier versions of the life-cycle analysis, more base cases have been added, i.e.: a gas hybrid composed of gas boiler plus electric heat pump, additional heat pump base cases (as to include electrically-driven, gas absorption and other gas-driven heat pumps), and a coal boiler.

The 12 base cases are as follows (their technical characteristics described in detail in the technical report available at the project's website):

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 summarize key findings of the accompanying technical report, representing main environmental impacts including greenhouse gases and other air emissions: NOx, organic carbon (OGC), carbon monoxide (CO) and particulate matter (PM), for the 12 base cases analyzed in the life-cycle analysis.

[34] "Development of European Ecolabel and Green Public Procurement Criteria for Water-based Central Heating Generators. Draft Report. **Policy Analysis**", Nov. 2011, Van Holsteijn en Kemna BV (VHK), http://susproc.jrc.ec.europa.eu/heating/stakeholders.html

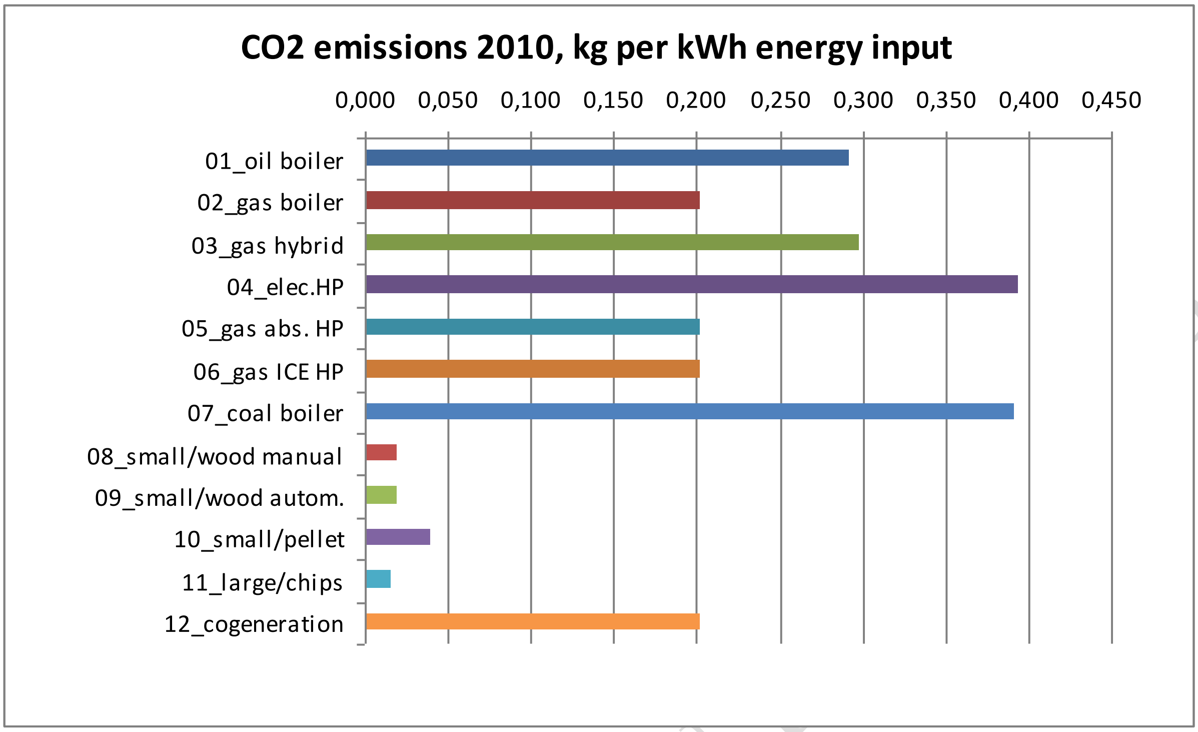


Figure 6. Greenhouse gas emissions in kg CO_2-equivalent per kWh energy input for 12 base cases ("Policy Analysis", Nov. 2011, VHK).

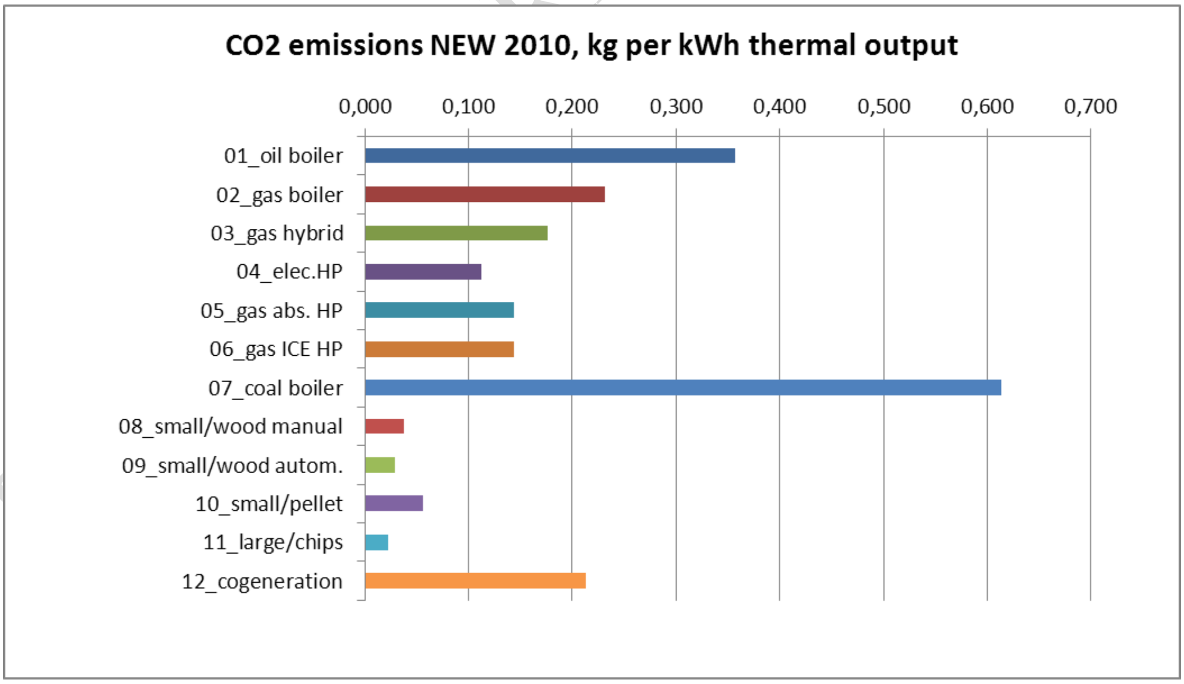


Figure 7. Greenhouse gas emissions in kg CO_2-equivalent per kWh thermal output for 12 base cases ("Policy Analysis", Nov. 2011, VHK).

The comparison shows that the lowest CO2 emissions are achieved by biomass boilers, which is mainly due to political default of zero CO2 combustion emissions. The best non-biomass boiler emissions are by the electric heat pump due to its high energy efficiency and relatively low CO2 emissions per kWh output[35], 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.

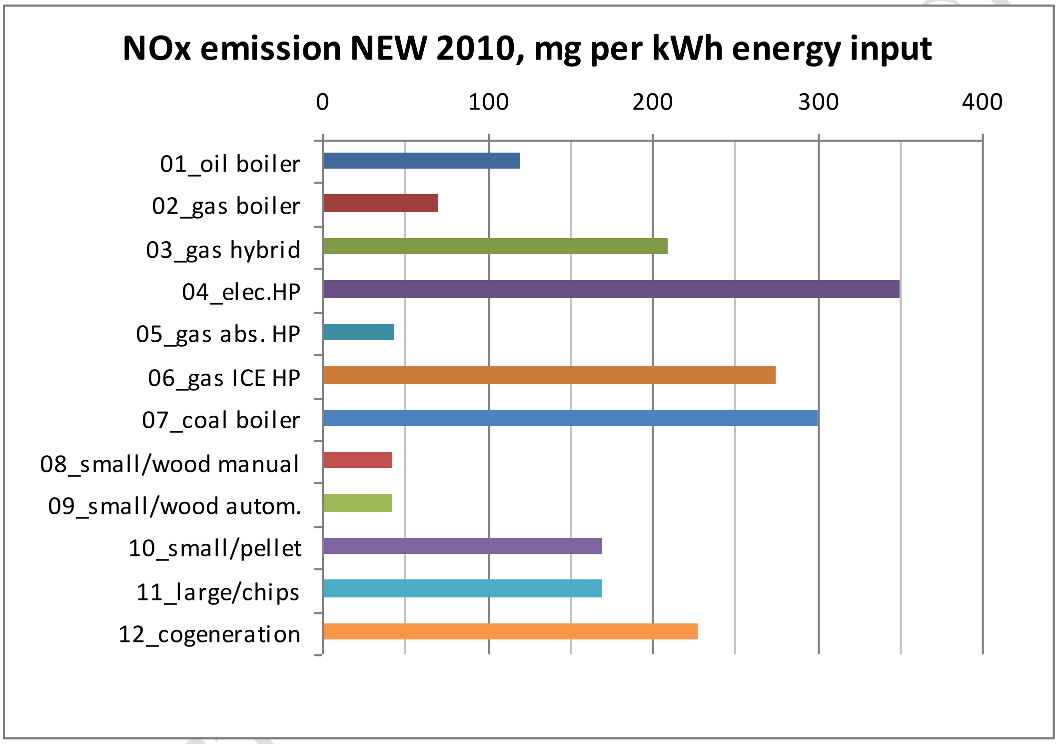


Figure 8. NOx emissions in mg per kWh energy input for 12 base cases ("Policy Analysis", Nov. 2011, VHK).

[35] 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.

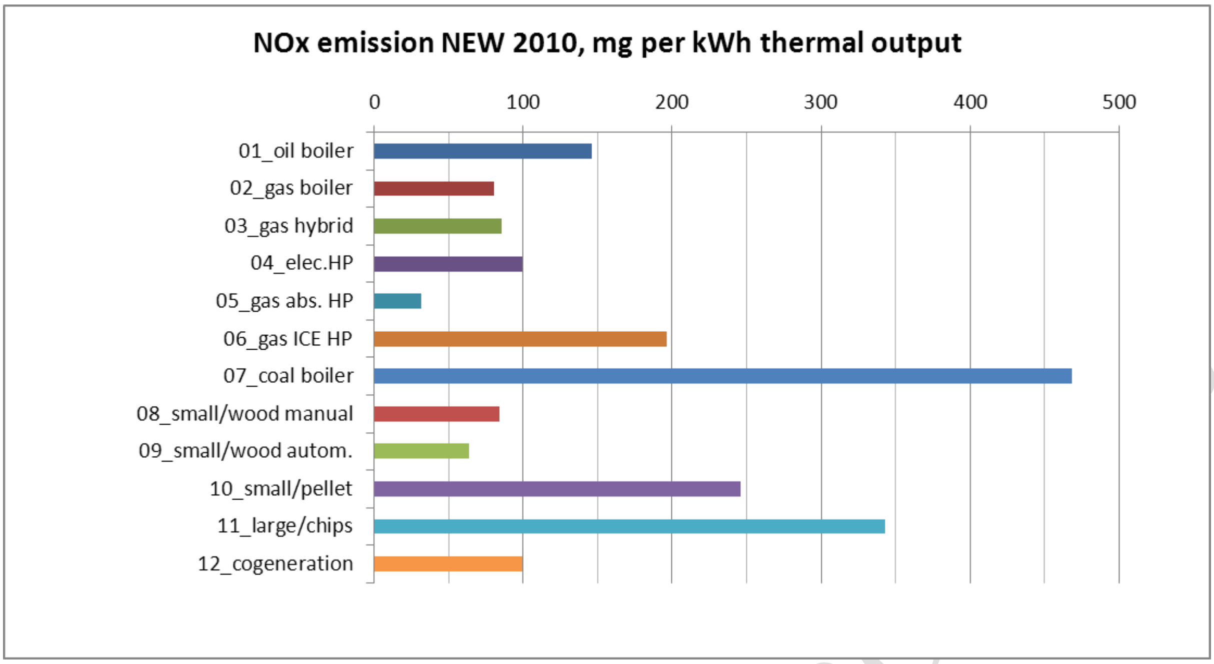


Figure 9. NOx emissions in mg per kWh thermal output for 12 base cases ("Policy Analysis", Nov. 2011, VHK).

The emissions when harmonised per kWh thermal output show large differences over appliance types. 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.

NOx emissions from wood biomass boilers are relatively low due to their low specific emission factor (42 mg/kWh fuel input)[36]. Emissions by pellet and chips boiler apparently emit more NOx, as do other fossil fuel fired boilers.

The gas internal combustion engine and the cogeneration unit have relatively high specific NOx emission factors (more difficult to reduce emissions in these appliances, unless catalyst is used).

[36] Boersma, A, et al, "Emissions of the use of biomass fuels in stationary applications", ECN/TNO, table 4-22, p.38, ECN-BKM-2008-81 (assumesNOx emissions of 150 mg/MJ input)

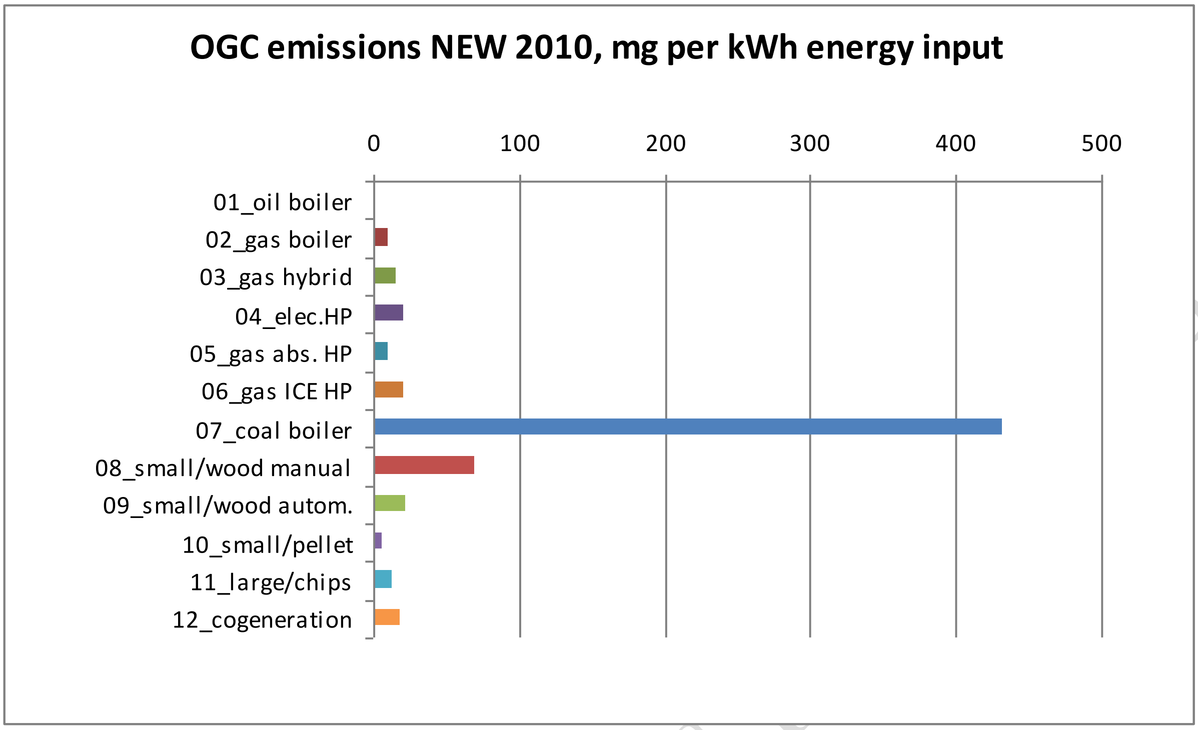


Figure 10. OGC emissions in mg per kWh energy input for 12 base cases ("Policy Analysis", Nov. 2011, VHK).

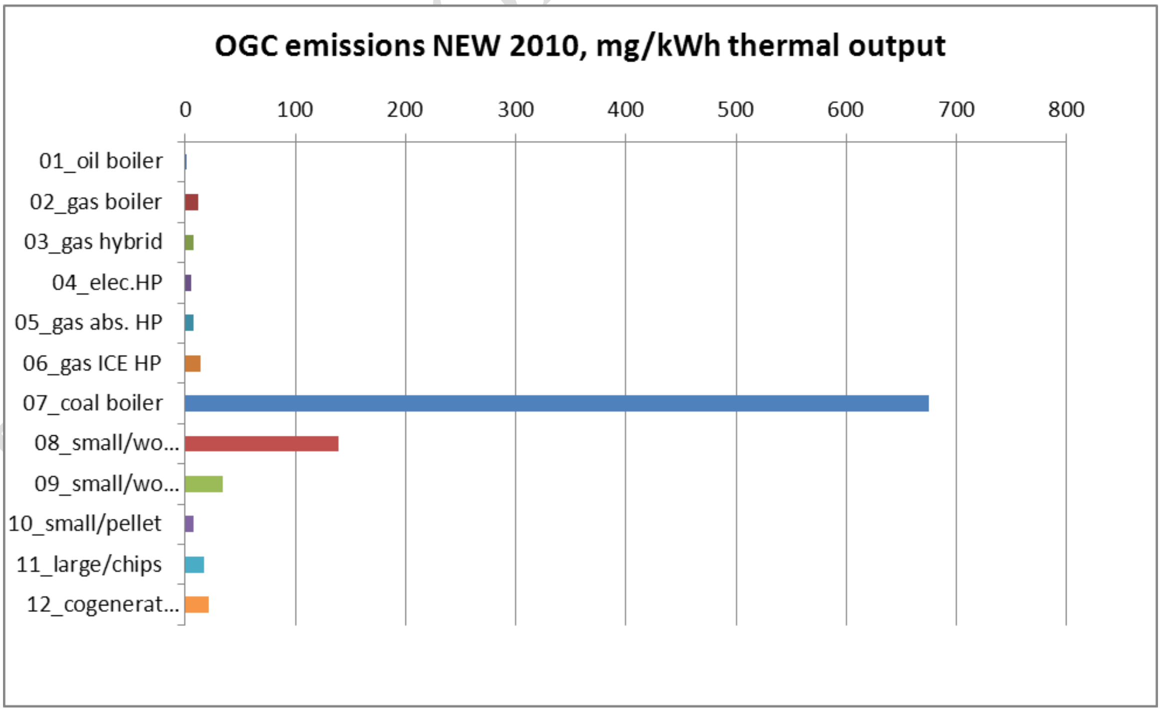


Figure 11. OGC emissions in mg per kWh thermal output for 12 base cases ("Policy Analysis", Nov. 2011, VHK).

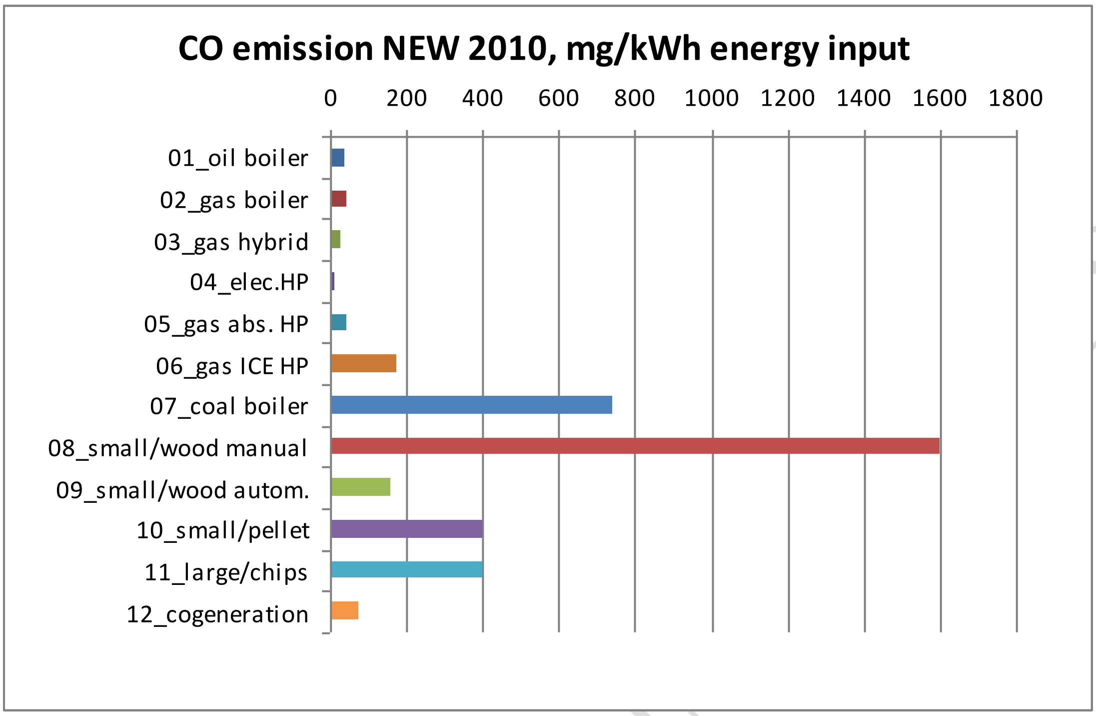


Figure 12. CO emissions in mg per kWh energy input for 12 base cases ("Policy Analysis", Nov. 2011, VHK).

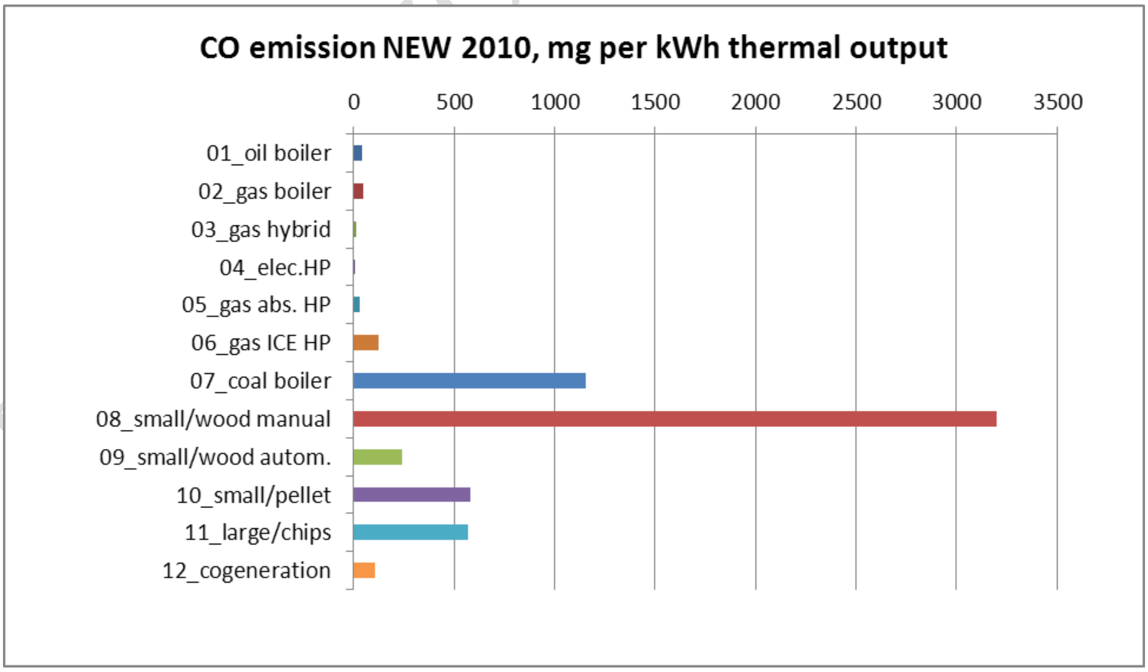


Figure 13. CO emissions in mg per kWh thermal output for 12 base cases ("Policy Analysis", Nov. 2011, VHK).

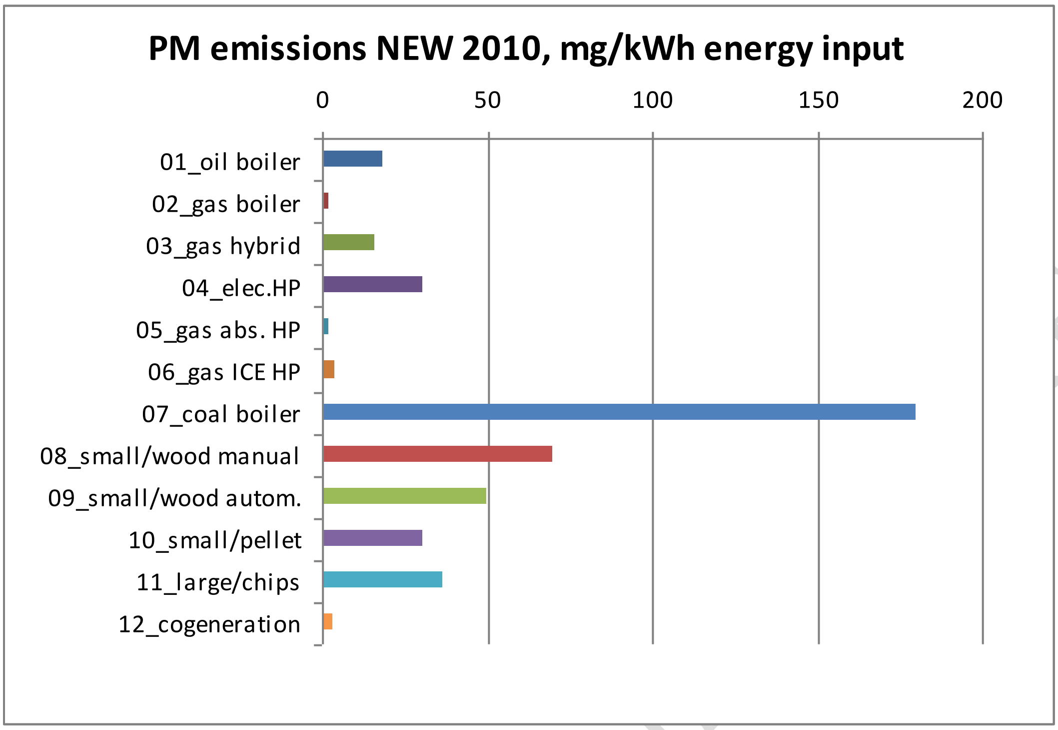


Figure 14. PM emissions in mg per kWh energy input for 12 base cases ("Policy Analysis", Nov. 2011, VHK).

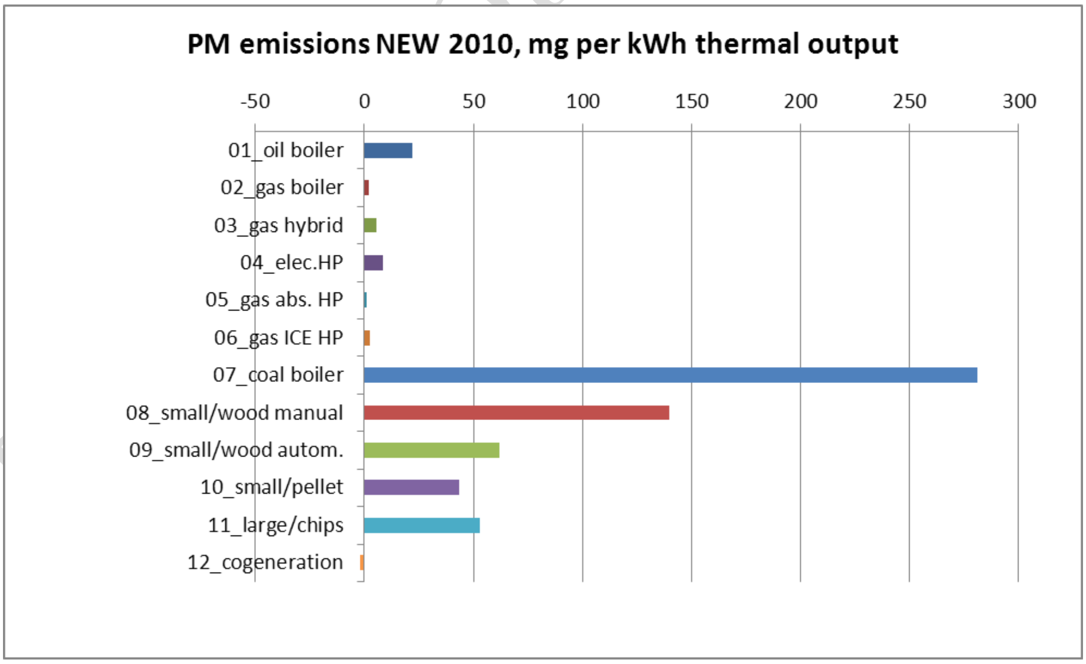
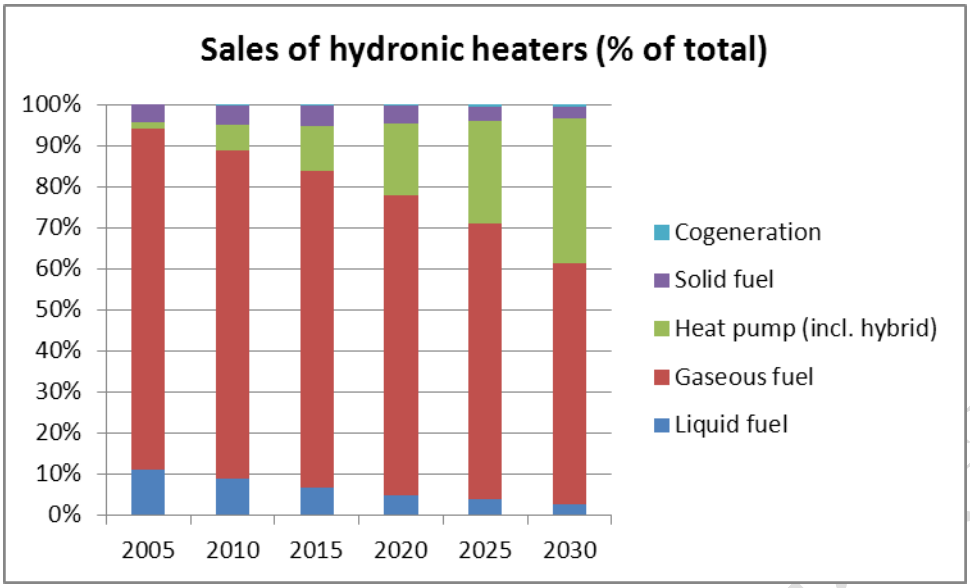


Figure 15. PM emissions in mg per kWh thermal output for 12 base cases ("Policy Analysis", Nov. 2011, VHK)



	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 share in sales of some 10% in 2015. Combined with hybrid solutions (a fossil fuel boiler, combined with a heat pump for base load operation)

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