Preparatory Studies for Ecodesign Requirements of EuPs (III)

ENER Lot 20 – Local Room Heating Products
Task 1: Definition

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Introduction

The Ecodesign Directive

This report documents the preparatory study for local room heating products (the "ENER Lot 20 study") on behalf of the European Commission (DG ENER) in the context of the **Directive 2009/125/EC on the Ecodesign of Energy-related Products**. This framework Directive does not directly introduce binding requirements for specific products, but defines conditions and criteria for setting, through subsequent implementing measures, requirements regarding environmentally relevant product characteristics.

According to the Directive, the implementing measures can be proposed for product categories which meet the following criteria:

- Significant volume of products placed on the EU market
- Significant environmental impact
- Significant potential for improvement

The implementing measures are to be based on an environmental assessment taking into account the product's characteristics and functionalities. Technologies available on the market should be taken as a reference.

The first step, in considering whether and which Ecodesign requirements should be set for a particular product group, is a preparatory study recommending ways to improve the environmental performance of the product.

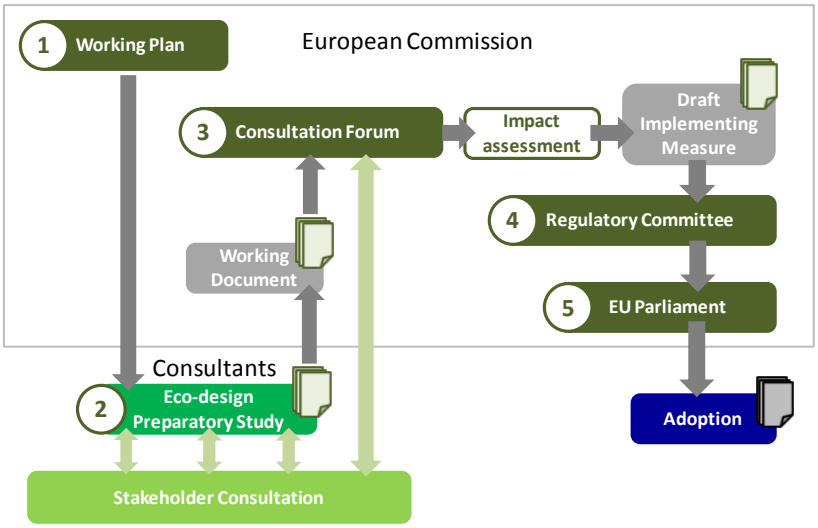

Figure 1: The Ecodesign process: based on a working plan (1) preparatory studies (2) are launched to establish the evidence base before any implementing measures are proposed

The preparatory study will provide the necessary information to prepare for the next phases in the policy process (carried out by the Commission) and in particular the impact assessment, the consultation forum, and the possible draft implementing measures laying down Ecodesign requirements for ErPs (see Figure 1).

As in all Ecodesign preparatory studies, a common and coherent methodology (MEEuP)[1] is used for analysing the environmental impacts and improvement potential of the products and Ecodesign options are analysed from a life cycle cost perspective. This methodology consists of eight main tasks which will be conducted in an iterative manner (see Figure 2):

- Task 1: Definition
- Task 2: Economic and market analysis
- Task 3: Consumer behaviour and local infrastructure
- Task 4: Technical analysis of existing products
- Task 5: Base-cases
- Task 6: Technical analysis of BAT (Best Available Technology) and BNAT (Best Not yet Available Technology)
- Task 7: Improvement potential
- Task 8: Final analysis: scenario, policy, impact, and sensitivity analysis

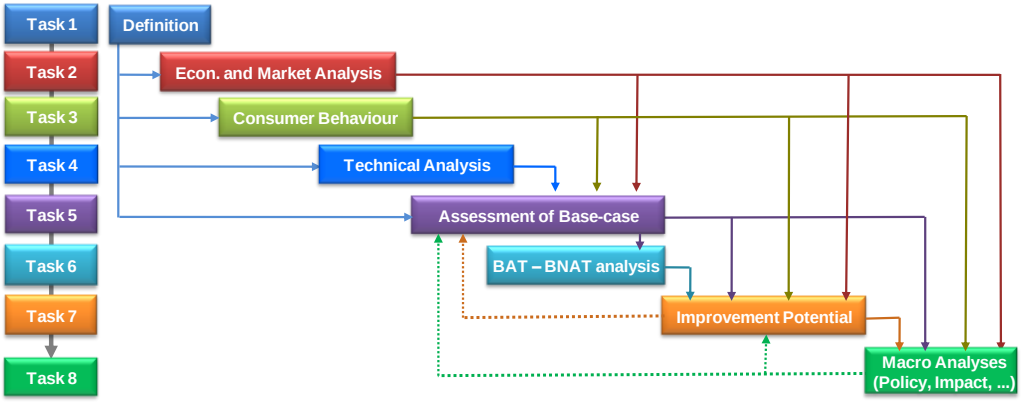

Figure 2: The task structure of the MEEuP methodology and the interrelationships between tasks

The latest version of this and other task reports can be found on: www.ecoheater.org/lot20/

[1] VHK (2005) Methodology for Eco-design of Energy-using Products (MEEuP), Final Report, European Commission (DG ENTR). Available at: ec.europa.eu/enterprise/eco_design/finalreport1.pdf

Task 1: Definition

The objective of this task is to discuss definition and scope issues related to the Ecodesign preparatory study for local room heating products: ENER Lot 20[2]. It consists of the categorisation of products, descriptions of product definitions, identification of key parameters for the selection of relevant products to perform detailed analysis and assessment during the next steps of the study, and scope definition.

Further, existing harmonised test standards and sector specific procedures for product testing will be identified and discussed, covering the test protocols for:

- Primary and secondary functional performance parameters (functional unit)
- Energy use during product-life
- Safety (electricity, electromagnetic compatibility, stability of the product, etc.)
- Other product specific test procedures.

Finally, this task will identify and analyse existing legislations, voluntary agreements, and labelling initiatives at EU level, in Member States (MS), and in countries outside the EU.

1.1 Product category and performance assessment

The main objective of this subtask is to set a solid foundation for the ENER Lot 20 preparatory study by defining the product scope for local room heaters, and to understand these products from a functional, technical, environmental, and economic point of view. This subtask will also structure appropriate product groups while providing a first screening on the basis of their sales and stock volumes, environmental impacts, and improvement potential.

1.1.1 Wider context of local room heaters

Space heating is the largest component of household energy use in the European Union (EU) and has already been identified as a priority by the European Commission as it represents significant energy efficiency potential[3]. Several studies under the Ecodesign Directive on space heating related products have already been initiated. These are:

- TREN[4] Lot 1 – Central heating boilers (www.ecoboiler.org)
- TREN Lot 2 – Water heaters (www.ecohotwater.org)

[2] Preparatory studies are being managed both by DG ENER and DG ENTR. In order to differentiate between the different lots, the prefix «ENER» is used here.

[3] European Environment Agency (2008) Energy and environmental report 2008, EEA Report, No. 6/2008

[4] The different use of abbreviations are due to the first preparatory studies were launched under DG Transport and Energy (TREN). Since 2010 DG Energy (ENER) was split from DG Mobility and Transport.

- ENTR Lot 4 – Industrial and laboratory furnaces and ovens (www.eco-furnace.org)
- ENTR Lot 6 – Air-conditioning and ventilation systems (www.ecohvac.eu)
- TREN Lot 10 – Room conditioning appliances (www.ecoaircon.eu)
- TREN Lot 15 – Solid fuel small combustion installations (www.ecosolidfuel.org)
- ENER Lot 21 – Central heating products using hot air (www.ecoheater.org)
- ENER Lot 22 – Domestic and commercial ovens (www.ecocooking.org)
- ENER Lot 23 – Domestic and commercial hobs and grills (www.ecocooking.org)

This study will not repeat work already done in other preparatory studies but will be careful of leaving out any loopholes. Therefore, before analysing the specificities of the products covered by this study, it is important to establish clear links and interfaces between product groups.[5]

Local room heating products can be defined as appliances that provide heat to indoor spaces by generating heat at the same location as it is needed. They are self-contained heating units that are typically portable, wall-mounted or chimney bound. This is in contrast to central heating systems where heat generation occurs at one central place, such as a boiler room in a house or a mechanical room[6] in a large building, and then gets distributed, typically by forced-air through ductwork, by water circulating through pipes, or by steam fed through pipes. However, similar to central heating systems, local room heating products produce and distribute heat through convection and/or radiation.

Central heating products are covered in ENER Lots 1 and 21, hydronic (using water to distribute heat) and dry (using air to distribute heat) systems respectively. Both these product groups rely on the same heating principles and are alternative solutions to meet the same functional needs, i.e. indoor space heating. This study acknowledges their functional similarities and the eventual similarity or divergence in environmental impacts (especially during the use phase) and energy efficiency. This depends to a large extent on the type of fuel used, and the combustion or electricity use efficiency.

Some local room heating products already fall into the scope of TREN Lot 15 (small combustion installations) which explicitly includes direct heating products whose energy source derives from solid fuels (coal, biomass, pellets, etc.). The ENER Lot 20 study will thus focus on the other fuel types, such as electricity, gas, liquid fuel, etc. Nevertheless, some products may have functional similarities with those covered in TREN Lot 15 (see Figure 1-1).

[5] The European Commission has mandated CEN and CENELEC to provide European standards to enable the implementation of the Ecodesign Directive. Work in the Commission is also going on in relation to a harmonised methodology for the calculation of the environmental footprint of products.

[6] A "mechanical room" is the term used for "boiler house" in case of larger installations

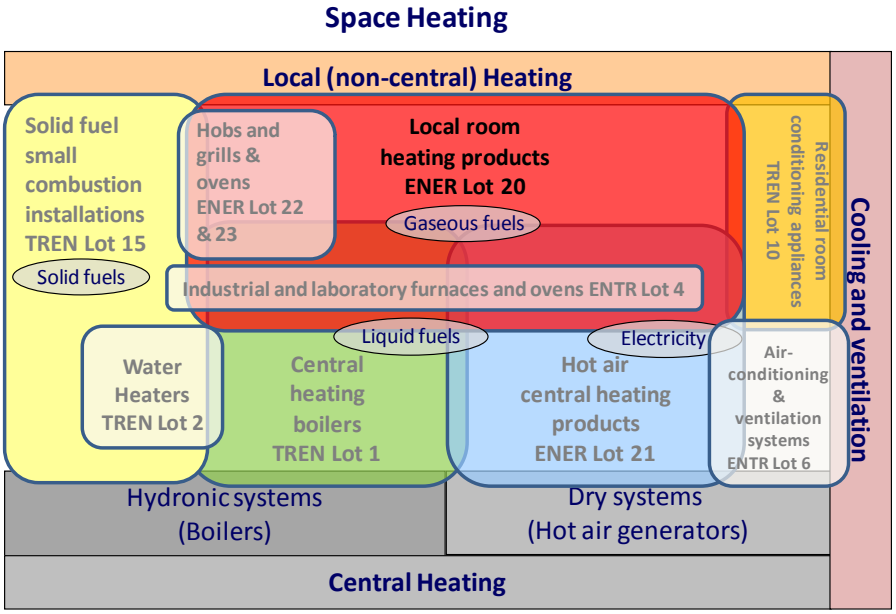

Figure 1-1: The interfaces and differences in scope of the Ecodesign preparatory studies compared to local room heating products

TREN Lot 10 includes air conditioning appliances that besides cooling are also capable of providing heat (reversible air conditioners/heat pumps), but do not consider appliances that solely provide heat for indoor spaces. Likewise some cooking appliances have a dual functionality of space heating, but these are expected to be covered in ENER Lot 22 when their primary function is cooking. In a same manner, as a secondary functionality, some of the industrial and laboratory ovens and furnaces can heat the space around them (due to heat losses from these appliances). Heat recovery techniques can also be used to extract heat from the flue gases of these appliances which can in turn be used to heat indoor spaces. The similarity between the installation of these combustion installations with ENER Lot 20 products could be of interest to this study, however, the heating functionality of these appliances are covered in DG ENTR Lot 4 study. Finally, drying cabinets, which were considered in TREN Lot 16 (laundry dryers), could be classified as local room heaters, but again their primary function is to remove moisture from clothes and not to heat space.

To ensure that no space heating product is overlooked in relation to the Lots covered by the Ecodesign Directive, this study will **cover all decentralised space heating products**. The work conducted in other preparatory studies will be followed closely throughout this study. In close collaboration with DG ENER, stakeholders and the consortiums performing other preparatory studies, the responsibility of overlapping products will be defined and coordinated with other lots.

1.1.2 Definitions

The first step for elaborating relevant product definitions is to review existing product categories that are commonly used to classify local room heating products. Possible definitions are derived

from market statistics (Eurostat/PRODCOM[7]), technical standards (CENELEC/CEN/ISO/IEC), labelling schemes (Energy Star, etc.) and legislations and are compiled for a comparative analysis that will serve as a reference.

The second step is identification of additional criteria (technical, functional, design, market based criteria, etc.) which allows the scope of this preparatory study to be defined in a precise manner and complements the elaboration of the product definitions for the purpose of this study. The preliminary analysis[8] of the technical and functional parameters and expected environmental impacts of typical products provides the input for determining the functional unit.

Finally, an assessment of the product-system interactions from a broader perspective will identify if key parameters linked to the system can influence the environmental impacts and improvement potential linked to the products.

- **Criteria for defining the scope**

The local room heating industry is very fragmented and manufactures equipment and components for a multitude of applications. Local room heating product group encompasses several products which could be included in this study. The following parameters are considered before establishing the product definitions:

- Heating principles: radiation vs. convection
- Functionality of the appliance
- Type of fuel used (energy source)
- Application type (fixed/built-in/installed typically for primary heating) and portable typically for auxiliary/secondary heating)
- Application area (domestic, commercial or industrial sector)
- Power output capacity of the appliance
- EU trade classifications (such as PRODCOM categories)
- Classifications employed by standard organisations (such as CENELEC, CEN or ISO standards)
- Existing legislations, labels and voluntary agreements (such as Eco-labels)

Each parameter individually may not provide enough information on the appliances to develop a relevant classification. For instance, the source of energy used is a key parameter for determining the environmental impacts of combustion appliances, but it cannot be the only parameter used to classify appliances as one given appliance can be fed by different types of fuels and also the functionally of appliances fed by the same fuel can be very different. Consequently, paying attention to the all relevant parameters will be of key importance for the next tasks of this study, in particular for defining the base cases (assessed in Task 5).

[7] PRODCOM Classification: List of PRODucts of the European COMmunity
[8] A more detailed technical analysis of the products included in the scope of ENER Lot 20 will be performed in Task 4.

1.1.2.1 *Heating principles*

Room heaters can be classified by the manner in which they transfer heat to the area to be heated, i.e. by **radiation** or **convection**. Each type of heat is suitable for different circumstances. Some room heaters rely on convection (the circulation of air in a room) to heat a room. Others rely on radiant heating, that is, they emit infrared radiation that directly heats up objects and people that are within their line of sight. In reality, many heaters make use of both convection and radiation.

Convection heaters provide warmth by heating the air in a room. Air is blown or drawn over a heated surface and then distributed to the entire room. Figure 1-2 shows the schematic of a convection heater where cool air is drawn in and passed over gas or electric heating elements. Warm air moves out into the room by natural convection. Most convector heating systems include electronic temperature controls that adjust the heat output to maintain an even temperature in the room.

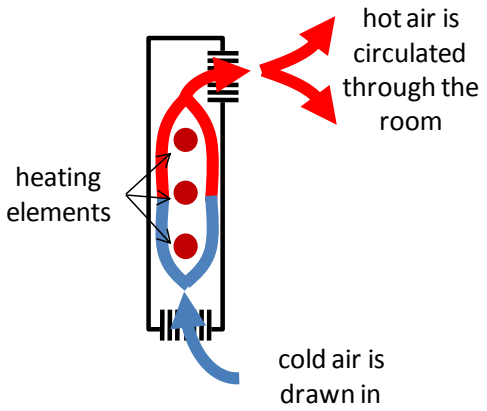

Figure 1-2: Schematic of a convection heater

Radiant heaters, as shown in Figure 1-3, generate infrared radiation, which heats objects directly and not the air in the room. As they provide focused heat rather than heating the whole room volume, radiant heaters are an efficient choice for tall and medium sized buildings. They also allow for quick heating of objects, and zone heating with different temperature requirements within the same room (see Figure 1-4). Most radiant heating systems include electronic temperature controls that adjust heat output to maintain an even temperature.

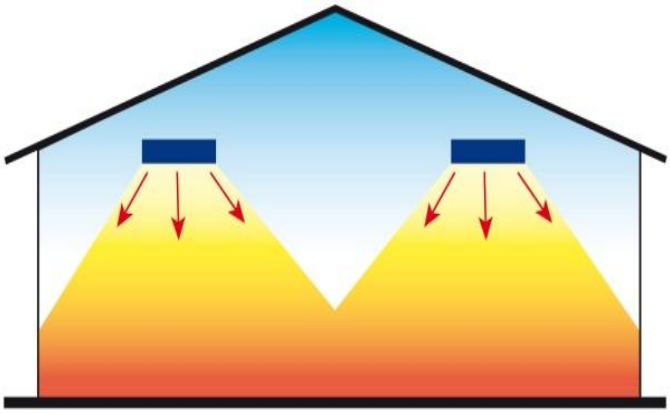

Figure 1-3: Schematic of a radiant heater [SBM]

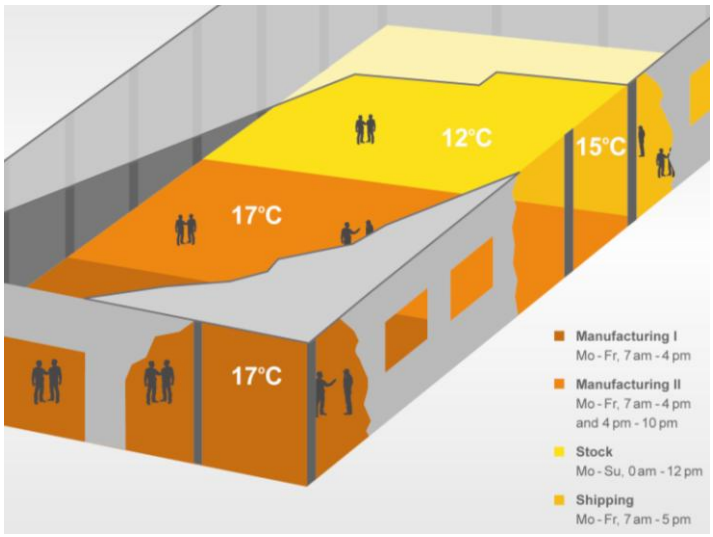

Figure 1-4: Schematic of zone heating by a radiant heater [Schwank]

For wider distribution, models exist with parabolic reflectors or oscillating motion.

1.1.2.2 *Functionality*

Local room heating products are distinguished as appliances that produce heat at the location where it is needed and serves single spaces. They are designed to heat either entire rooms or specific zones within a room. Other products that are related in functionality to local room heaters are:

- **Fireplaces** provide direct local heat to rooms, but are often valued for their decorative appearances (sometimes more than their ability to provide heat). Originally designed for solid fuels (e.g. wood, coal, etc.), electric, gas, liquid fuel and fuel gel (ethanol) fireplaces also exist. Solid fuel fireplaces are covered in TREN Lot 15, but fireplaces that run on other fuel types will be covered in this study.
- **Sauna heaters**, which promote sweating and induce relaxation, may also be classified as a type of local room heaters as they serve to heat up small rooms to temperatures over 80°C. Sauna heaters can be either based on hot air (convective) or infrared heating

(radiant). The annual sale of these products and their geographical presence in EU needs to be verified to determine whether they should be included in this study.

- **Heated towel racks or towel warmers/dryers** are used in bathrooms to dry towels and clothes. The conventional technology for these products is identical to oil-filled radiators or immersion heaters, however nowadays, dry element technology (no liquids inside the towel rails) based towel racks are also produced. Towel warmers can be divided in two groups: room heaters of more than 200W and towel warmers with a power of 30W to 150W. The first ones usually work with a thermostat to get a proper environment in the bathroom and are often equipped with a "boost" function that gives full power for on or two hour to warm or dry a towel. The second ones work without thermostat and are not aimed for room heating but only for towel warming or drying. Some stakeholders recommended keeping the low power "only towel warming" out from the scope.
- **Underfloor electrical floor heating systems** are electric heating cables, mats or films that are typically installed under the floor[9]. They are mostly installed when single rooms are being renovated but in some countries they are also used for heating entire buildings. Although similar in functionality to the hydronic underfloor heating systems, the electric systems are however not dependent on a central heating system and can be installed locally. The annual sales data for these products needs to be determined before making a decision on their inclusion/exclusion in the scope of this study.
- **Air curtains** discharge a controlled flow of (warm/cold) air across an opening to create an air seal that separates different climatic environments, e.g. store entrances. While allowing unhindered and unobstructed passage through the opening, air curtains help preserve the indoor temperature by forming a barrier to resist the ingress of outdoor air. Although air curtains do contribute to the heating of space, their primary function is a thermal replacement for a door. The annual sales data for these products needs to be determined before making a decision on their inclusion/exclusion in the scope of this study.
- **Heat storage cookers** have dual cooking and household heating functionality. Different models of such cookers run on natural gas, propane gas, electricity and oil (kerosene or diesel). It is expected that heat storage cookers will be covered in ENER Lot 22 (domestic and commercial ovens).
- **Reversible air-conditioners** are capable of providing both cooling and heat which makes them versatile for providing thermal comfort indoors. Reversible air-conditioners below 12 kW cooling power are covered in TREN Lot 10 (Room air conditioning appliances). Larger reversible air conditioners (above 12 kW) will be covered in both the preparatory studies for ENER Lot 21 (Central heating using air) and ENTR Lot 6 (Air-conditioning and ventilation systems) from a heating and cooling perspective respectively.
- **Dehumidifiers** draw moisture from the air by condensing it over a refrigerated coil and then returning reheated dry air. They are used in domestic households, construction sites

[9] These electric heating cables, mats or films can also be installed in the ceilings or walls. However, ceiling heating is not so widely used as underfloor heating.

and for industrial purposes first and foremost to reduce the level of humidity in the air. Although dehumidifiers have a local room heating function, they are considered outside the scope of this study as heating is not their primary function.

- **Steam humidifiers or vaporisers** boil water and releases warm steam into the room to add moisture to the air. Again, although they possess a room heating function, it is not their primary function and therefore not within the scope of this study. Both humidifiers and dehumidifiers were considered in TREN Lot 10 room conditioning appliances but subsequently delimited from the preparatory study. Likewise they will not be considered in this study.
- Local room heating products imply that the products to be considered in this study are used within rooms of houses or buildings, workshops, offices, warehouses, garages, hospitals, etc. and thus not outdoors. **Outdoor heating products** (e.g. terrace or patio for local spot heating) are therefore intended to be excluded from this study on the basis that outdoor heating equipment is designed specifically for outdoor use and thus have functions and operating conditions that differ from local room heating products.

Besides the above mentioned functionalities, local room heaters can provide secondary functionalities such as air filtering, (fan only) ventilation, light, mobility (handles or wheels), etc. Although not typical, some local room heater with more peculiar functionalities, such as foot massage, aromatherapy, FM radio and humidifying functions, do exist.

1.1.2.3 Energy source

Local room heating products use a variety of energy sources to produce heat. Some heating products are able to use multiple fuels, but most products are defined by their primary energy source.

As TREN Lot 15 (Solid fuel small combustion installations) covers all the solid fuels such as traditional mineral fuels (coal of various ranks, lignite), manufactured solid mineral fuels (coke, manufactured mineral fuel briquettes or ovoids), peat and biomass (woods, straw, charcoal, other solid biomass), this study will cover the remaining energy sources relevant to local room heaters. These are:

- Electric (mains or household power – in the EU 230 V ±10% and 50 Hz)
- Gas (natural gas, propane/butane/liquid petroleum gas (LPG), biogas)
- Liquid fuels[10] (paraffin/kerosene, gas oil/diesel,, (bio)ethanol)
- Gel (isopropyl alcohol (IPA), (bio)ethanol)

Electrical appliances convert electrical energy into heat whereas the other energy sources generate heat from combustion.

[10] Diesel is used in some non-domestic heaters but these are only used on construction sites and outdoors. They are therefore not considered in this study.

1.1.2.4 *Application type*

Local room space heaters are either used for primary or secondary heating. Primary heating systems provide heat for most of the heating season whereas secondary heating systems usually supplement or substitute the installed primary heating system (i.e. are often only used for a few hours on cold days).

Heaters that are built-in or fixed to the building shell (i.e. installed) are typically used as the primary heating system. Free-standing or portable heaters tend to be used as secondary heating systems but also can be used as primary heating, when no heating system is installed at all.

Portable and installed space heaters need to be differentiated during the analysis in this study due to the differences presented in Table 1.1.

Table 1.1: Characteristic of portable and installed/fixed/built-in local room space heaters[11]

Portable/Free-standing	Installed/Fixed/Built-in
Mostly serve auxiliary space heating purpose or where no heating system is installed	Usually used for primary heating purpose[12], but also common as auxiliary heating for occasional heating of single rooms
Typically lower product purchasing price	Typically higher product purchasing price
Usually bought off the shelf	Often installed professionally
Standards for these appliances are product specific	Standards applicable to both appliances (safety, efficiency) and systems (energy performance of buildings)

1.1.2.5 *Application area*

Local room heaters are used in many different indoor environments which include households, offices, shops, garages, building construction sites, workshops, factories, warehouses, hospitals, churches, etc. The choice of heater type is also determined by the type of room it is supposed to heat. Although mainly used to achieve a warm temperature indoors, local room heating products are also used outdoors in semi-open environments like outdoor markets and shops. Many manufacturers classify space heaters for residential or industrial/commercial/public sector buildings (devices with larger heating capacities) use[13]. The distinction between heaters for domestic and non-domestic uses is also apparent in the test standards (see Section 1.2).

[11] According to the definition stated in the IEC/EN 60675 standard, portable heaters are heaters, which can be easily moved. Fixed heaters are installed on a wall or a ceiling, and built-in heaters are installed within the walls, ceilings or floors.

[12] An exception to this are fixed or built-in fireplaces, which are generally used for auxiliary heating only.

[13] Please note that the use of heating products for agricultural buildings is more related to process heating than room heating. They are therefore assumed to be outside the scope of the ENER Lot 20 study. Their functions and operating conditions differ from other local room heating products. Their function is part of a production process that depends more on the performance and growth of the animals or plants, than on the heating itself.

Local room heaters can be used to:

- Provide comfortable heat to human beings;
- Keep objects and indoor spaces warm and dry; or,
- To provide both above functionalities.

There is no common convention to what constitutes a 'local room'. Besides being understood as a single space inside a building, it could refer to relatively small rooms (e.g. a bedroom, bathroom, living room) or very large spaces (e.g. a warehouse, factory or airport hall). Although local room heaters are relatively small in size compared to central heating systems, some local room heaters are well suited as substitutes for central heating systems. They can work together in a house or large space and provide heat in a comparable way to central heating systems. In some instances, local room heating products are used in spaces that only need heating occasionally such as in churches, which often use room heaters instead of central heating because of the low usage rate.

The buildings where local room heaters are usually used can be typically classified into the following categories:

- Residential buildings:
  - Single-family detached dwelling
  - Low-rise multi-family buildings (<5 storeys, 6 flats / building)
  - High-rise multi-family building (> 4 storeys, 20 flats/building)
  - Offices
- Non-residential buildings:
  - Workshops, small factories, garages
  - Large factories, production plant, logistic buildings
  - Material storages, warehouses
  - Supermarket, showrooms
  - Sport halls, churches
  - Transportation buildings (train station, airport), airplane hangars/military buildings

1.1.2.6 *Types of heaters*

The most common types of local room heating products (excluding solid fuel appliances[14]) are electric heaters, but liquid and gaseous fuel heaters are also popular in many EU Member States. The term "space heater" or "direct heating equipment" is often used to describe local room heating products and can be found in manufacturers' descriptions, standards, and legislations that concern local room heating products. Such devices that serve as local room heaters are shown in Table 1.2.

Table 1.2: Common local room heating products

Type of local room heaters		Domestic (D) or Non-Domestic (ND)
Installed heaters	Panel heaters (convectors and radiant heaters)	D and ND
	Storage heaters (static, integrated, combi and dynamic)	D and ND
	Electric floor heating systems	D and ND
	Oil-filled heaters	D
	Fan heaters	D
	Fireplaces (electric/gas/gel)	D
	Glowing radiant heaters	D and ND
	Gas radiant heaters	ND
	Air curtains (electric/gas)	ND
	Electric sauna heaters	D and ND
	Industrial unit heaters (electric/gas/oil)	ND
Portable heaters	Convector/radiation heaters (electric/gas/liquid fuel)	D and ND
	Oil-filled heaters	D
	Fan heaters	D

ENER Lot 20 encompasses a large variety of different products and a general description of the main types of products is provided below. Furthermore, some of the product types described below can be combined to provide additional functionality.

1.1.2.6.1 *Electric room heaters*

Electric room heaters work by passing an electric current through a resistive element which generates heat. The heat generated from this process is then delivered to users via radiation or convection or a combination of both. Electric room heaters include a wide variety of products

[14] For the scope of this study, wood fired heating products (such as open fireplaces, wood stoves, and pellet burner appliances), can be potentially excluded as these products are discussed in TREN Lot 15.

with a price range from €50 to €1800, are quick and easy to install, and do not (directly) produce pollutant emissions. Electric room heaters can be portable, but also fixed and even hard wired for larger outputs.

Most electric heaters have thermostats. Almost all fixed electric heaters have electromechanical or electronic thermostats. In addition to this, some of the heaters can have more advanced programmable thermostat systems to control the operating time and room temperature. These are either built-in or optional plug-in solutions. Portable electric heaters will normally have a mechanical thermostat as they are intended for additional heat under supervision. However, portable models with advanced electronic thermostats are also available on the market. These control systems add to the initial cost of these appliances.

The output of portable electric space heaters is generally limited by an input of 2.4 kW (10 A) or in some cases 3.6 kW (special 15 A plug). Larger inputs are possible, but these generally have to be hard wired and installed. Convection based units often have a fan, allowing distribution of heat around the room. Some units also have features like: tip/tilt alarms or cut offs, overheating shut-off functions and obstruction sensors (for convection based units, if the heat outlet is partially or fully covered). These special features are primarily provided for safety reasons.

Electric room heaters for residential households can be split into the following main types: convector heaters, fan heaters, oil-filled column heaters, glowing radiant heaters, storage heaters and thin film or cable heating systems. These are discussed in further detail below. Other types of electrical heaters are electric fireplaces, sauna heaters, industrial unit heaters and air curtains. These will be considered under their own sections.

- **Convector heaters**

Electric convectors use the principle of natural convection to heat the ambient air. A electric resistive heating element inside the convector produces heat. The air in contact with the convector surface heats up and becomes lighter, rising up. The heat is diffused throughout the room and the ambient temperature can be controlled.

Besides a few exceptions, fixed convector heaters do not have fans. The major heat output is by convection. However, depending on the heat demand the share of radiation increases as the heater is working at a high duty cycle. Convector heaters provide an even and comfortable heat (thermal comfort) to all parts of the room as horizontal temperature gradients are minimal. The warm flow of air ensures that the surroundings are evenly heated to bring the equilibrium between air temperature and the furniture walls, ceiling and floor. These heaters may have overheating shut-off functions and/or obstruction sensors, which shut off the heater if the heat outlet vents are covered.

Most of the recent convector heaters come with electronic thermostats and adjustable heat settings and timers. .

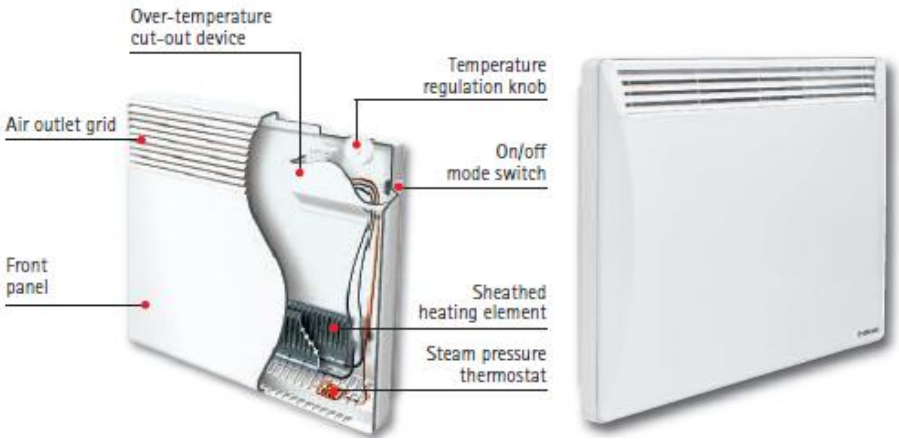

Figure 1-5: Electric convector heaters: mounted electric convector heater [Groupe Atlantic]

Typical power ranges are 400 – 3000 W. These heaters are either wall mounted or supplied with a standing kit.

- **Radiant heaters**

Electric heaters which provide heat to humans and objects in the heated space via a larger portion of radiation compared to convectors are categorised as radiant heaters.

- Radiant panel heaters

One of the most common types of radiant heaters is radiant panel heaters which emit infrared waves that pass through the air until they reach a surface at which point the energy is turned into heat. As the heating plates also warm up the external surfaces of the appliance, it does create some convective heating. The radiant heaters provide an even and comfortable heat (thermal comfort) in the room by radiation and convection. The heating elements can be integrated into ceramic, micathermic or even glass or stone and resin. Extruded aluminium is the most common heating element used for radiant panel heaters. These types of heaters are available from 500 W to 2000 W power output capacity.

Figure 1-6: Radiant panel heaters from left to right: a wall-mounted radiant panel heater [Chatsworth Heating], a glass heater [Verelec] and a micathermic panel heater [Bionaire]

- Glowing radiant heaters

Glowing radiant heaters are also known as strip or bar heaters that heat objects with infrared waves. These heaters use electric elements packed inside a quartz glass tube or a halogen lamp and radiates heat to warm people and objects and are therefore best at spot heating. These heaters are available in both portable and fixed models. Power output ranges for these heaters are around 500 – 3000 W.

Figure 1-7: Infrared heaters from Eurolux (left) and Soleus Air (right)

- Radiators

The main types of electric radiators are oil-filled radiators and glass/cast iron/aluminium facade radiators. The electric radiators have power range between 500-3000 W. They are available in both portable and fixed models.

Glass/cast iron/aluminium facade radiators resemble radiant panel heaters but they have their heating element extruded in glass or cast iron or aluminium. These heaters have low surface temperatures. The glass/cast iron/aluminium facade gives heating inertia to the radiations. Radiator heaters provide an even and comfortable heat to all parts of the room. An example of cast iron and aluminium facade radiators is shown in the figure below.

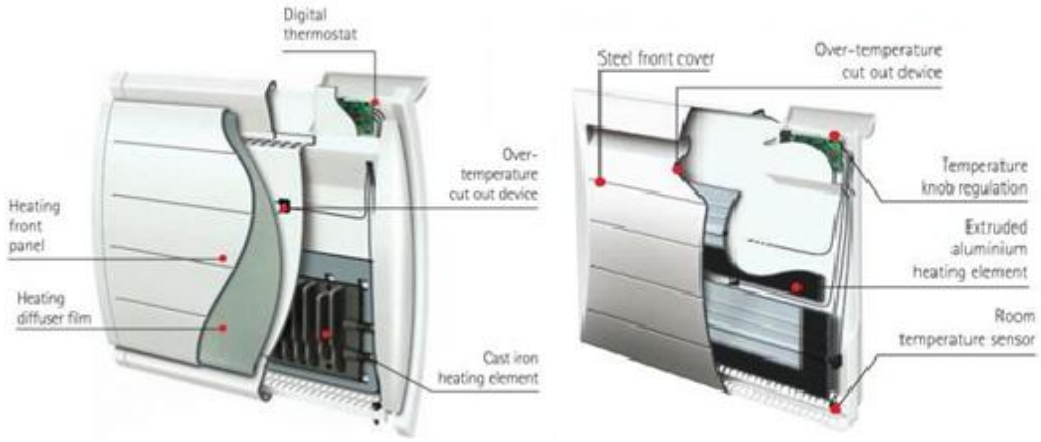

Figure 1-8: Cast iron and aluminium facade electric radiators [Groupe Atlantic]

Oil-filled (other liquids can also be used) heaters resemble convectional hydronic radiators. These heaters have a smooth or corrugated metal outer case which is filled with oil or another heat transferring liquid. It has an electric element that is immersed in the oil, which heats the unit's outer casing through convection flow of the oil. These units have thermostats to control temperature (adjustable heat settings) and usually have timers, and over-heating shut off functions. Some of the oil-filled radiator models come with wheels so they are easy to move. An example is shown in Figure 1-9.

Figure 1-9: Oil-filled radiators for left to right: a typical towel heater [Acova], a wall-mounted model [Acova] and a portable fan-assisted version [De'Longhi]

Column heaters are used for heating small to medium-sized rooms over a long period, but take some time to warm the room up. Models with a fan distribute the warm air more evenly around the room. Towel heaters are very similar to wall-mounted liquid-filled heaters, just with smaller power capacity.

- **Fan heaters**

A fan heater (Figure 1-10) induces forced convection using an electric fan to speed up the airflow. This reduces the thermal resistance between the heating element and the surroundings, allowing heat to be transferred more quickly. They draw in air and warm it over a resistive element, then blow it back into the space to be warmed. They have features similar to panel heaters, but are generally portable and may have tip/tilt alarms or cut off switches to avoid overheating. Heater fans use a standard metal-coil element that is placed in front of the fan to help distribute heat to a room. These convection fans provide a minimal source of heat for a small area, but not an entire room.

Figure 1-10: Fan heaters from Micromark (left), Holmes (centre) and Stadler Form (right)

Heater fans usually have a good price point and often are available in a variety of sizes and colours. Fan heaters usually create more noise than other types of room heaters due to the forced movement of air[15]. Fan heaters for domestic use have a power capacity of 500 – 3000 W,

[15] With a fan heater the noise can be higher, when compared to other products, but this is due to the heat being transferred by forced convection. The noise is generated by the air movement caused by the fan; this is called air born noise.

whilst industrial fan heaters can be as powerful as 12 kW. Fan heaters may be portable or fixed to walls, floors, ceilings or foot panels (plinth heaters).

- **Storage heaters**

A storage heater is an electrical appliance which stores heat at a time when base load electricity is available at a low price, usually during the night, and releases it during the day. Heat is usually stored in clay bricks or other ceramic material because of its low cost and high specific heat capacity. The process of charging and discharging is controlled by a thermostat. Storage heaters usually have two controls - a charge control (often called "input"), which controls the amount of heat stored, and the draught control (often called "output"), which controls the rate at which heat is released. Many units also contain a conventional electric heater which can be used to give a boost in heat output during the day.

Figure 1-11: Storage heater left [Dimplex] and right [Stiebel Eltron]

Storage heaters are further compromised of three main types, which include:

- Static storage heaters
- Integrated storage heaters
- Dynamic storage heaters

Static storage heaters are based on the principle of natural convection to distribute heat. They incur static heat loss and may use a flap to boost their output. Integrated storage heaters on the other hand have a reduced static heat loss and use direct radiant heat transfer on top of natural convection to distribute heat. Dynamic storage heater units have a reduced static heat loss and include a thermostatically controlled fan to accurately control the temperature in the heated area. Static storage heaters have input power ratings from 0.85 kW to 3.4 kW (roughly corresponds to 7 hour charges of about 6 kWh to 24 kWh), whilst dynamic storage versions can have a performance range between 2 kW to 7.5 kW (corresponding to 7 hour charges between 14 kWh to 52 kWh).

- **Electric thin film and cable (underfloor) heating systems**

Electric thin film and cable heating systems are thin electric heating cables or mats that can be installed under floor surfaces, such as tiles, concrete, carpets, vinyl and hardwood, or less commonly also in the ceiling and in the wall. Typically used in bathrooms and kitchens or in case

of new buildings in all types of rooms. Underfloor heating systems provide an even and comfortable heat (thermal comfort) to all parts of the room. They typically deliver between 50-150 W/m^2. In rare cases, when fast reaction time is needed, 200W/m^2 installations are used. The choice of power range of the cable heating system is influenced by the type of building and the application area as per following:

- Old buildings: 120-250 W/m^2
- New buildings (very well insulated): 50-80 W/m^2

As the heat in thin film heating systems travels in both directions, it is necessary to insulate behind the heating system to avoid large energy losses. These heating systems are typically controlled by a thermostat mounted on the wall in the room. Although most of these heating systems are installed in the building shell (and therefore part of a system), they can also just be installed under carpets more similar to a stand-alone products.

Figure 1-12: Underfloor heating mat [Danfoss]

- **Electric fires**

Electric fires are often chosen more because of their decorative appearance than for the heat they generate. The ambience an open fire wood log fireplace creates is appreciated by many, but as they require a chimney, kindling, reloading of logs, cleaning, etc., some consumers opt for more convenient appliances that resemble traditional fires. Electrical fires are decorative local heating devices that imitate the appearance of solid fuel fireplaces. The heat is provided in the same way as convector heaters whilst the flickering flame effect is created by electrical lights. Their heat output is typically in the range of 0.5-2.4 kW.

Figure 1-13: An electric fireplace [Bionaire]

1.1.2.6.2 *Gas heaters*

Gas heaters or stoves are also categorised as combustion type room heaters because they involve the burning of fuels to produce heat. Natural gas heaters are the most common type of gas room heaters although many of the appliances can be adapted to different types of gas. The heat is distributed by both radiation and natural convection or by forced convection when the heater it is fan-assisted. The burner systems can be pilot or electronic ignition systems. Gas fire and heaters can either be flueless (unflued) or flued[16].

- **Flued gas appliances**

Flued gas heaters/fires are wall-fixed or built-in as they require a vent to the outside. Power flue or fan-flue type gas heaters/fires have a fan attached to remove the products of combustion to the outside. Most conventional gas heaters/fires have an open-fronted combustion chamber that is inset into a standard sized chimney (see figure below). The air that the heater/fire uses for combustion is drawn from inside the heated space and flue gases are expelled via the chimney.

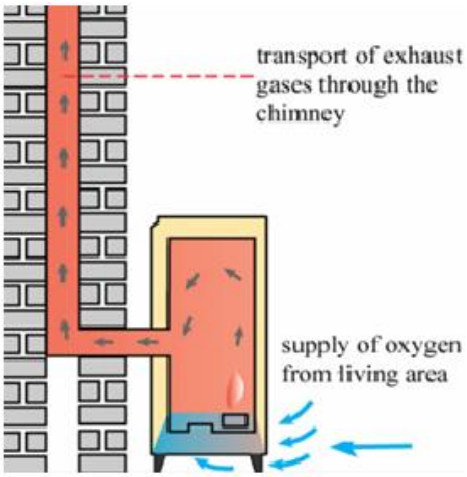

Figure 1-14: A traditional open combustion (chimney connected) setup of a typical flued gas based heater/fire [Drugasar]

In contrast to open combustion gas heaters/fires, a balanced flue gas heater/fire is room-sealed unit which uses natural convection to draw the combustion air from outside the building and expels the flue gases to the outside via a separate compartment of the flue (see Figure 1-15). Open combustion flued heaters/fires require constant ventilation and often consume more energy than the balanced flued heaters/fires.

[16] There are three types of flue classifications according to EN standards:

- Type A – flueless (air for combustion is drawn in from inside the room and all exhaust gases are vented into the room)
- Type B – open flue (air for combustion is drawn from inside the room and the exhaust gases are evacuated through a chimney or special outlet)

Type C – room sealed (air for combustion is drawn from outside and the exhaust gases are evacuated through a chimney or special outlet)

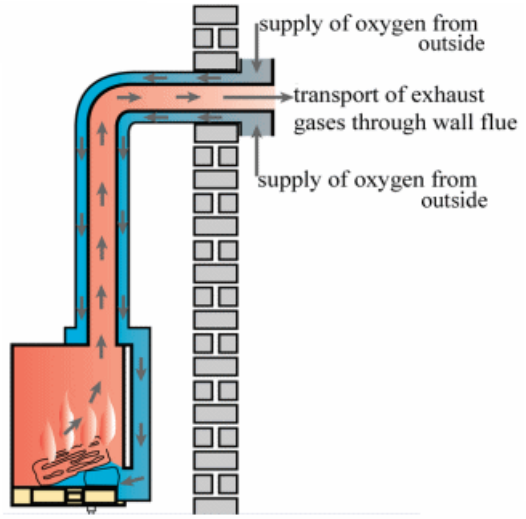

Figure 1-15: Closed combustion (balanced flue) setup of a typical flued gas based heater/fire [Drugasar]

The combustion in balanced flue gas appliances is sealed from the room. These appliances can be freestanding, hanging or built in. They do not need a fan to extract the flue gasses.

- Flued gas heaters

Flued gas heaters models are available in both open combustion (chimney connected) and closed combustion (balanced flue) types (see Figure 1-16). The balanced flue heaters can be connected via a wall flue. The heat losses because of the vent opening are minimal since the space around the vent can easily be insulated so no air can come through. Open combustion (chimney connected) gas heaters make use of an existing chimney and their efficiencies are mostly not in access of 85% in order to prevent condensation.

Figure 1-16: Flued gas heaters: open flued gas heater from Drugasar (left) and balanced flue gas heater from Drugasar (right)

These heaters provide both radiant and convective heat. The capacities of flued gas heaters range from 2-20 kW.

- Flued gas fires

Flued gas fires are mostly free standing, built in or wall hung units. They can use natural gas and/or propane gas. Flued gas fires models are available in both open combustion (chimney connected) and closed combustion (balanced flue) types (see Figure 1-17).

Figure 1-17: Flued gas fires: open combustion flued gas fire from Drugasar (left) and balanced flue gas fire from Drugasar (wall mounted in centre and free standing on right)

Open combustion fires use a chimney, flue system or extraction fan to expel the flue gas outside the heated space. The air for combustion is taken from inside the heated space. The efficiency of these fires is generally low but can be high when they are glass fronted. A balanced flue fire uses a concentric flue channel and takes the air for burning directly from outside, the flue gases are transported outside via the same concentric pipe. Besides vertical flueing, these units can also be flued horizontally. Efficiencies are generally high and kept below condensation level. The flued fires provide radiant as well as convective heat. The capacities of flued gas fires range from 2-20 kW.

- **Flueless gas systems**
  - Flueless gas heaters

Flueless gas heaters also known as "*unflued gas heaters*" are easier and cheaper to install than flued heaters. Their use is prohibited in rooms generally kept closed, such as bathrooms and bedrooms. Flueless heaters typically provide 2 – 4.2 kW heating output. They must be equipped with an oxygen depletion sensor. These heaters are obliged to have an air opening in the room due to which a considerate amount of heat is lost and furthermore they create a lot of humidity in the heated space and therefore make continuous ventilation a necessity. The overall heating efficiency of these heaters is therefore less than 100%.

Liquefied Petroleum Gas (LPG) which is a mixture of propane and butane, is a by-product derived from refining natural gas and crude oil. LPG heaters are often portable, so they can be taken out for special occasions, and self-contained, which means they do not need to be hooked to external gas lines or electricity. Portable heaters usually do not need a vent or electricity. They are attached to a portable tank of LPG, and wheeled around for easy transport. Permanent LPG heaters can be mounted to the floor, wall, or ceiling, and often require a building permit. Often, they have a forced air component that distributes the warmth. This fan must be powered by electricity, so these fan-assisted heaters are plugged into an electrical outlet. Since propane uses oxygen to burn, any enclosed space with a LPG heater must be ventilated to replenish the oxygen supply in the room.

Figure 1-18: A portable LPG heater [De'Longhi]

- Flueless gas fire

Companies like Burkley (UK), Smeg (FR) and focal point (UK) offer flueless gas fires.

1.1.2.6.3 *Liquid fuel heaters*

As liquid fuel heaters are usually unvented, all combustion products are released into the indoor air. Among these are soot, sulphur dioxide, carbon dioxide, as well as carbon monoxide. The use of liquid fuel heaters in a poorly ventilated home, especially in modern well insulated ones, can pose a health risk and most manufacturers suggest that a window be left slightly open.

- **Kerosene heaters**

A kerosene heater, also known as a paraffin heater, is a portable, unvented, kerosene-fuelled, space heating device. In the United States, they are used mainly for supplementary heat or as a source of emergency heat during a power outage. In some countries, particularly in Japan, they are used as the primary source for home heating.

Figure 1-19: Kerosene heater [Zibro]

Most kerosene heaters produce between 3 and 7 kW (10,000 to 24,000 Btu per hour). A kerosene heater operates much like a large kerosene lamp. A circular wick made from fibreglass is integrated into a burner unit mounted above a font (tank) filled with 1-K kerosene. The wick draws kerosene from the tank via capillary action. Once lit, the wick emits flames into the burner unit which heats air via convection or nearby objects via radiation. The burner is designed to properly oxygenate and distribute the flames. The flame height is controlled by raising or lowering the exposed wick height inside the burner unit via an adjusting mechanism. The kerosene heater is extinguished by fully retracting the wick into a cavity below the burner, which will snuff out the flame. Kerosene heaters require no electricity to operate. Most heaters contain a battery-operated or piezo-electric ignitor to light the heater without the need for matches. If the ignitor should fail, the heater can still be lighted manually.

- **Liquid fuel based fires**

Liquid fuel/Gel fireplaces burn (bio) ethanol to create flames like that of a traditional open fire. As long they are used in well ventilated rooms, they do not require any particular installation and can be free standing, wall mounted or simply inserted into a traditional fireplace. They produce heat output in the range of 0.4 – 3 kW[17].

Figure 1-20: An ethanol fireplace [Bio Factory]

1.1.2.6.4 *Sauna heaters*

Sauna heaters are similar to local room heaters but heat smaller spaces (sauna rooms) to much higher temperatures (above 80 °C). Electric (convector) sauna heaters (without fans) are the most common type, but wood, gas and infrared radiant sauna heaters also exist. Most sauna heaters have stones on top so that water can be thrown on top to instantly increase the humidity in the sauna. Small domestic sauna heaters have a typical power output of 2 – 6 kW, whilst larger sauna heaters for professional use (e.g. fitness centres, spas, swimming pools, etc.) can be up to 22 kW.

Figure 1-21: An electric sauna heater [Tylö]

1.1.2.6.5 *Radiant heaters*

- **Radiant gas-fired heaters**

Radiant gas heaters are heating appliances typically used in industrial, commercial and public buildings, such as factories, warehouses, logistic buildings, vehicle repair buildings, sports halls, religious buildings, supermarkets, show rooms, shops, etc. These heaters work by heating a

[17] Please note that in Germany fireplaces with ethanol or similar fuels may only be used with a chimney if they are considered to be combustion installations; this is generally the case at a fuel input above 0.5 l/hr. For inputs below 0.5 l/hr they are considered to be decorative appliances not suitable for heating as good ventilation is needed.

material with gas, thus emitting heat rays towards people and objects in the room. Two main types of gas-fired radiant heaters exist:

- Luminous heaters (ceramic surface used as heat exchanger)
- Tube heaters (metal tube used as heat exchanger)

Figure 1-22: A luminous gas radiant heater by SBM (left) and a gas radiant tube heater by SCHWANK (right)

The power inputs of these appliances typically range from 2.5 to 60 kW. Both types are used as global heating systems, with professional design and planning for each project. Therefore, the energy efficiency improvement potential needs to be analysed from a systems perspective. Most systems are used with thermostats and timers for accurate room temperature control.

- **Electric radiant cassettes**

Electric cassettes use radiant heat to directly warm a specific area. They are mounted (see Figure 1-23) on the ceiling and particularly suitable in bigger environments – even up to five metres from the floor. Their installation is relatively straightforward and they can be controlled with a variety of timers, thermostats or heat regulators. The power inputs of these appliances typically range from 1 to 4 kW.

Figure 1-23: An ceiling mounted electric radiant cassette

1.1.2.6.6 *Air curtains*

Air curtains discharge a controlled flow of (warm) air across an opening to create an air seal that separates different climatic environments, e.g. store entrances. While allowing unhindered and unobstructed passage through openings, air curtains help preserve the indoor temperature by forming a barrier to resist the ingress of cold air.

Although air curtains do contribute to the heating of space, their primary function is a thermal replacement for a door. Air curtains can be stand alone products (like local room heaters they

generate heat in the same place as it is delivered), or they can be connected to the central heating system in commercial buildings. The air in such systems is typically heated by hydronic heat exchangers but they can also be operated on electricity or natural gas. The typical power capacity of air curtains ranges between 3 – 24 kW for commercial buildings and 12 – 50 kW for industrial buildings.

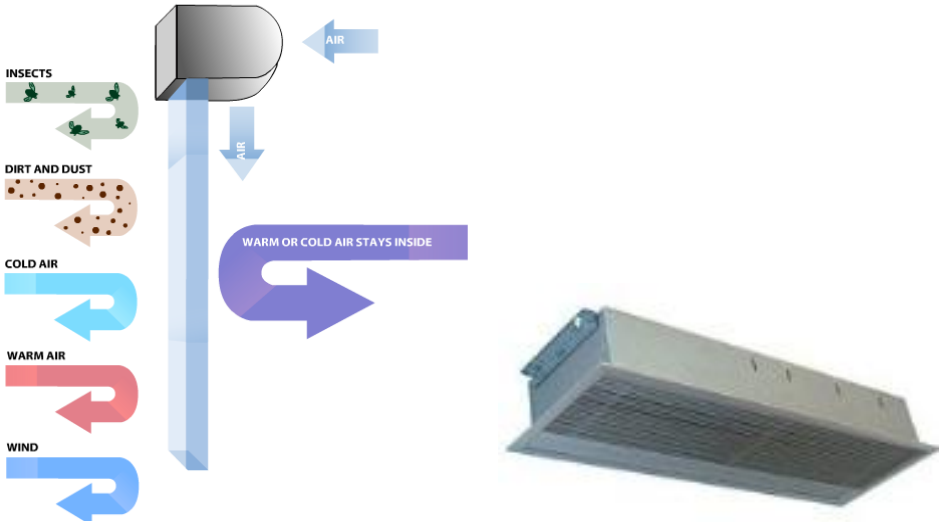

Figure 1-24: The principle function of an air curtain and an example [Claudgen Consort]

1.1.2.6.7 *Industrial unit heaters*

Industrial unit heaters are powerful heating appliances typically used in industrial, commercial and public buildings, such as garages, factories, warehouses, sports halls, etc. Industrial unit heaters have a fan that circulates air over the surface of a heat exchanger. The heat source for unit heaters can be hot water or steam supplied by a central heating system or alternatively the heat is generated locally by electricity, oil or gas. When unit heaters are run on electricity, gas or oil, their functionality is similar to local room heating products as they are direct heating stand-alone products, except for the fact that their heating capacity range tends to be much higher (from 10 – 400 kW).

Figure 1-25: Industrial unit heaters: a ceiling mounted electric unit heater [Kampmann], a stand-alone gas-fired unit heater [Colt] and a ceiling suspended oil-fired unit heater [Ambirad]

Industrial unit heaters are generally used to heat up large spaces. As they generate heat at the same place (or just next to) where it is needed, they can be classified as decentralised heating products, however, they may also use ducts to transfer heat for heating a distant space. As several industrial unit heaters can be configured to form a heating system to heat one very large space (e.g. airport, warehouse, factory, etc.) the energy efficiency improvement potential needs to be analysed from a systems perspective.

1.1.2.7 Power capacity

Local room heating products can also be classified according to their heating capacity, which measures the ability of the appliance to add heat to an enclosed space. Currently there is no generally agreed definition for a 'local' room heating product, but for the residential local room heaters this is implicitly meant to cover sizes of rooms that are common in households. The size of the room is not the only determinant, the outdoor climate, indoor temperature, insulation, etc. also plays a role in determining the amount of heat required to warm the room.

In general, lower capacity space heaters (below 12 kW) are mostly used in the residential sector. The middle capacity range of local space heaters (12 kW - 20 kW) can be often found in commercial, larger non-residential and institutional buildings, e.g. schools, show rooms, etc. The upper range of direct heating appliances (20-100 kW and above) consists of industrial unit heaters (or air handling units) that are mostly used to provide direct heating to large single spaces such as warehouses, arenas, sports halls, etc. The division of power capacity in relation to sectors is however not consistent. Whilst it is possible to distinguish between domestic and non-domestic heaters, multiple industrial unit heaters and gas-fired radiant heaters can be configured to provide heating to very large indoor spaces. The capacity ranges shown in Figure 1-26 are indicative and the boundaries are not always absolute.

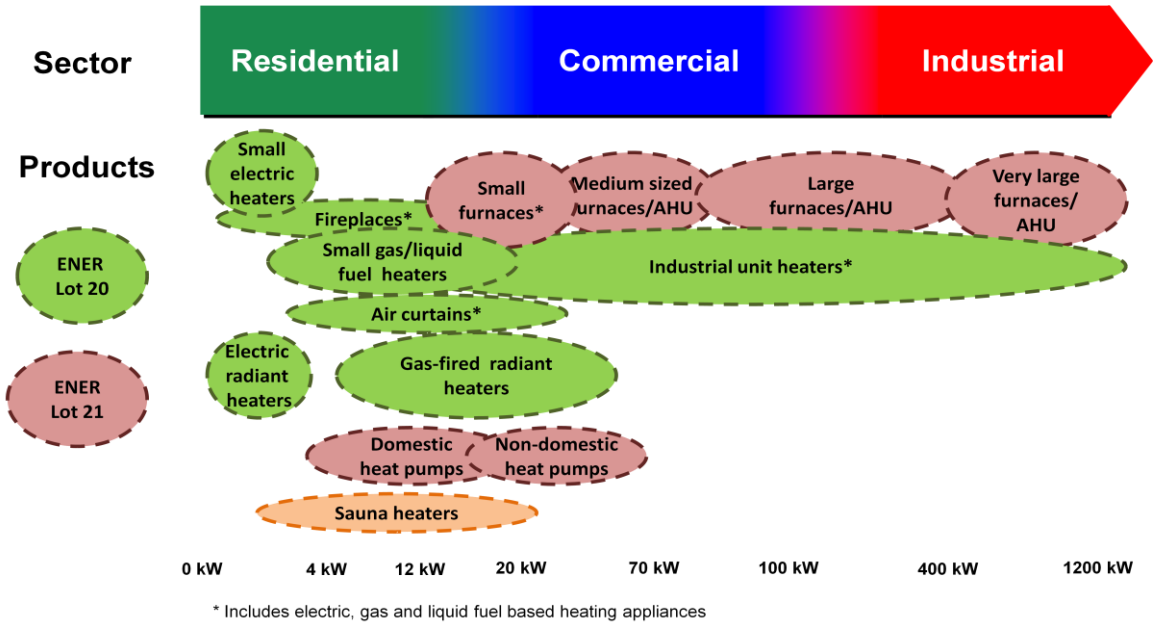

Figure 1-26: Indicative range of uses and sizes of ENER Lot 20 and ENER Lot 21 appliances

1.1.2.8 *Interactions with user and equipment surroundings*

Local room heating products interact to a great extent with their surroundings as their main function is to maintain temperature in the room where they are used. As part of a thermal equilibrium, they are interacted with the other system components: outdoor temperature, solar irradiation, ventilation needs, type of building (size, insulation quality, internal loads…), and inner temperature setting and control. These elements can be classified into three groups: climate, user behaviour and surrounding equipments.

Space heating and cooling of buildings is one of the most climate sensitive end-uses of energy. Energy loss through the building envelop is indeed directly proportional to the temperature difference between indoor and outdoor environments. In the same way, energy gains due to solar irradiation on the walls or through the windows are depending on climatic data.

The duration and frequency of use of room heater, as well as the indoor temperature setting are all parameters depending on the user's behaviour. In case of manual control, the user is also in charge of keeping this indoor temperature at its required setting. By using other appliances emitting heat (computers, lighting, ovens…) the user can strongly modify the thermal balance. The ventilation need is also a relevant parameter that depends on the using conditions (room occupancy in terms of people number and duration) and sometimes on the heating product type. Indeed, some local room heating products such as gas and liquid fuel heaters must be properly ventilated. Besides the requirement for ventilation or flue pipe installation (if applicable) for certain types of local room heaters, they are in general independent devices that only need to be connected to a fuel source (electricity, gas, liquid fuel) to function.

Finally, the quality of the building insulation (walls, celling…) is an important factor, determining for the reduction of the heat losses through the envelope, particularly for underfloor heaters. Also control systems are with building performance a relevant parameter as they are intended for optimizing the energy needed to meet the indoor temperature.

1.1.2.9 *Control systems*

Local room heaters within Lot 20 come with a range of different possibilities of control. Fixed and portable products use different types of controls, and there are different control devices for electric and fuel heating devices.

- The simplest level of control is manual such as on/off and selection of the power setting.. However, many models on the market come with automatic temperature regulation. For fixed electric heaters they are designed to maintain a precise and stable temperature in the room throughout the heating season without any manual intervention. Programmable automatic day- and night temperature (set-back) control is common for most local room heaters used as primary heating. Besides variable power settings, timers and pre-set programmes, additional control functions include automatic shut-off with presence and window opening detection, remote control, frost protection, communication between appliances and demand management systems (e.g. smart grids). The thermostat controls can be located in the units themselves or be mounted on a nearby wall. Most room heaters have built-in controls to prevent overheating if airflow is restricted. Depending on the type of local room heater, several control systems are used to regulate temperature. These can be integrated electronic thermostats or ambient thermostats (remote thermostats). Thermostats maintain set temperatures, preventing overheating of a room. Programmable thermostats are especially useful, as appropriate temperatures can be pre-set for different times of the day and overnight[18]. A range of heat settings (e.g. high, medium or low) allows control of the output of the heater to an appropriate setting (the lowest comfortable temperature is recommended to minimise running costs). Thermostats can cut running costs by up to 50%. For every 1°C increase in temperature, the running costs can increase by 7%, and even by 10 to 15% for degrees over 20°C.[19]
- Timers are also part of the control system of many local room heating products and allows set up of the heater to turn on and off as required. Some heaters have these already installed, or they can be bought separately and plugged in at the wall socket.
- Remote control devices allow heating appliances to be operated and controlled from a distance. Several heaters and zones in the house can be conveniently controlled from a single point by a remote.
- Frost protection is a typical standard feature on many local room heaters. This function prevents the ambient temperature in the room to fall below 7 °C ± 3 °C.
- Safety switches automatically turn off heaters if they overheat or are knocked over (tip-over switch).

[18] Sustainable Energy Authority-Victoria, AU, 2004 "Info Fact Sheet-Electric Space Heating"
[19] Sustainable Energy Authority-Victoria, AU, 2004 "Info Fact Sheet-Portable Heaters"

1.1.2.10 PRODCOM classification

PRODCOM classifies local room heating products in the categories NACE 27.51 "manufacture of electric domestic appliances" and NACE 27.52 "manufacture of non-electric domestic appliances". In its subcategories different types of local room heating products are listed as presented in Table 1.3.

Table 1.3: PRODCOM classification of local room heating products

PRODCOM code	PRODCOM Category
27.51.26.30	Electric storage heating radiators
27.51.26.50	Electric radiators, convection heaters and heaters or fires with built-in fans
27.51.26.90	Other electric space heaters[20]
27.52.12.33	Iron/steel gas domestic appliances with an exhaust outlet (including heaters, grates, fires and braziers, for both gas and other fuels; excluding cooking appliances and plate warmers)
27.52.12.35	Iron/steel gas domestic appliances (including heaters, grates, fires and braziers, for both gas and other fuels radiators; excluding cooking appliances and plate warmers, those with an exhaust outlet)
27.52.12.50	Iron or steel liquid fuel domestic appliances, including heaters, grates, fires and braziers (excluding cooking appliances and plate warmers)
27.52.13.00	Air heaters/hot air distributors n.e.c., of iron or steel, non- electric

A detailed market analysis of these local space heating product categories will be carried out in Task 2.

1.1.2.11 EN-, ISO- and other classifications used by standardisation bodies

International and European standards cover some local room heating products.

- **International Classification of Standards (ICS)**

The International Classification of Standards (ICS) classifies domestic, commercial and industrial heating appliances under ICS 97.100. Local heating room products fall under "Heating applications in general" with subcategories that include electric, gas, and liquid fuel heaters. Table 1.4 shows the ICS standards covering ENER Lot 20 products. A search under this

[20] Not specified in detail by Eurostat, but includes electric space-heating and soil-heating apparatus without built-in fan and excluding convection heaters and liquid-filled radiators.

classification did not provide any more categorisation relevant to this study. See the section on subtask 1.2.1 for more information on international standards.

Table 1.4: ICS standards for ENER Lot 20 products[21]

ICS	Field
27.060.01	Burners and boilers in general
27.060.10	Liquid and solid fuel burners
27.060.20	Gas fuel burners
97.100.01	Heating appliances in general
97.100.10	Electric heaters
97.100.20	Gas heaters
97.100.40	Liquid fuel heaters

- **International Electrotechnical Commission (IEC)**

The International Standard IEC 60675 *Household electric direct-acting room heaters –Methods for measuring performance* provides a categorisation for electric direct-acting room heaters that can be portable, fixed, or built-in:

- Panel heater (the temperature rise of all surfaces in contact with the circulating air does not exceed 75 K in normal use)
- Convector heater (the temperature rise of at least one non-visible part in contact with the circulating air exceeds 75 K in normal use. The air is discharged through one or more outlets)
- Fan heater (the movement of air through it is accelerated by a fan)
- Radiant heater (the temperature rise of at least one visible surface exceeds 75 K in normal use)
- Visibly glowing radiant heater (the heating element is visible from the outside of the heater and has a temperature of at least 650 °C in normal use)

The standard does not cover **thermal-storage room heaters** as these are covered in IEC 60531. Likewise heating appliances (such as thin film or cable heating systems) incorporated in the building structure and wall-paper, carpets or drapes incorporating flexible heating elements are not part of this standard.

The safety standard for household and similar electrical appliances (IEC 60335) provides the following classifications of products related to electrical local room heaters:

- Room heaters (IEC 60335-2-30)
- Thermal storage room heaters (IEC 60335-2-61)
- Sauna heating appliances (IEC 60335-2-53)

[21] ISO standards catalogue

- Flexible sheet heating elements for room heating installed in building structure (IEC 60335-2-96)
- Heated carpets and for heating units for room heating (IEC 60335-2-106)
- Gas, oil and solid-fuel burning appliances having electrical connections (IEC 60335-2-102)

International Mechanical Code

The International Mechanical Code, produced by the United States based International Code Council (ICC), distinguish between the following types of appliances that might be included in this study:

- Fireplace Stoves and Room Heaters
- Vented Wall Furnaces (gas/oil convective heaters fixed to a wall)
- Floor Furnaces (gas/oil convective heaters installed in to the floor)
- Infrared Radiant Heaters
- Sauna Heaters
- Unit Heaters
- Vented Room Heaters (gas/oil convective heaters)
- Kerosene and Oil-fired Stoves

For gas heaters, a number of standards specify different types of space heaters (see Section 1.2.2for more information). In European Standard EN 1596:1998 space heating appliances[22] are defined as appliances whose air delivery temperature does not exceed the ambient by more than 80 °C.

Most standards classify devices according to gas type then define them according to whether they are flued or flueless. Sometimes the nominal heat input is also specified.

Standards AUSTRALIA

The Australian Standard 4553 (AG 103) - Gas Space Heating Appliances lists the following types of gas space heaters with a consumption not exceeding 150 MJ/h (≈ 42 kW)[23]:

- Flued appliances
- Flued radiant heater (a space heater with an effective output mainly in the form of radiation)
- Flued convection heater (a space heater with an effective output of heated air and no visible source of radiation)

[22] Please note that this definition is only applicable to dedicated liquefied petroleum gas appliances – mobile and portable non-domestic forced convection direct fired air heaters

[23] Mark Ellis & Associates et al. (2002) Energy Labelling & Minimum Energy Performance Standards for Domestic Gas Appliances, Final report, Sustainable Energy Authority Victoria. Available at http://www.energyrating.gov.au/library/pubs/200217-gasreview.pdf

- Flued radiant/convection heater (a space heater with an effective output of both radiation and heated air)
- Flued wall Furnace.
- Room sealed appliance (an indoor appliance which is sealed from the room in which it is installed so that it directly discharges combustion products to, and takes air from, outside the building)
- Balanced flue appliance (a room sealed appliance which has combustion air ducted from, and combustion products ducted to, a common terminal assembly located externally)
- Indoor unflued appliances (includes appliances designed to discharge their combustion products into the same room or space in which they are installed):
  - Unflued radiant heater (a space heater with an effective output mainly in the form of radiation)
  - Unflued convection heater (a space heater with an effective output of heated air and no visible source of radiation)
  - Unflued radiant/convection heater (a space heater with an effective output of both radiation and heated air)
  - Portable appliance (an appliance designed to be carried by the user from place to place, as required)

American National Standards Institute (ANSI)

Similarly, the American National Standards Institute (ANSI) specifies safety standards according to the following categories of appliances (see section 1.2.1):

- Unvented Gas Room Heaters **(ANSI Z21.11.2)**
- Vented Gas-Fired Space Heating Appliances **(ANSI Z21.86)**
- Gas-Fired Infrared Heater **(ANSI Z83.6)**

See Table 1.5 to Table 1.11 for an overview of categories and how they relate to relevant standards.

Table 1.5: Electricity based (using electricity for heat generation) residential fixed local space heaters product categorisation

Family of heater	Type of heater	Capacity range (in kW)	EU average (in kW)	Relevant standards
Convector heater	Convector panel heater	0.4 – 3.0	1.0	IEC 60335, IEC 60675, IEC 60704, EN 14337
Radiant heaters	Radiant panel heater	0.5 – 2.0	1.0	IEC 60335, IEC 60335-1, IEC 60675, IEC 60675-1, IEC 60704, EN 14337
	Radiator (oil-filled, glass /aluminium/cast iron facade)	0.5 – 2.0	1.0	
	Ceramic heater	0.5 – 2.0	1.0	
	Glowing radiant infra-red heaters	0.5 – 2.0	2.0	
Fan heater	Electric fire	0.5 – 2.0	1.0	IEC 60335, IEC 60675, IEC 60704, IEC 60704-1, EN 14337
	Wall fixed fan heater	1.0 – 3.0	2.0	
Storage heater	Static	0.85 – 3.4*	2.5*	IEC 60531, IEC 60335-2-61-am2, IEC 60704, EN 14337
	Dynamic	2.0 – 7.5*	3.0*	
Underfloor heating	Thin film and cable	50 – 200 (W/m²)**	100 (W/m²)**	IEC 60335-2-96, IEC 60335-2-106, IEC 60675-1, IEC 60800, IEC 62395-2, EN 14337
Towel heaters	For bathrooms (with or without fans)	0.3 - 2.0	0.6	IEC 60335, IEC 60675, IEC 60704, EN 14337

* Represents "input power range" in case of storage heaters

** Represents the typical power unit used for thin film or cable heating systems

Table 1.6: Electricity based (using electricity for heat generation) residential portable local space heaters product categorisation

Family of heater	Type of heater	Capacity range (in kW)	EU average (in kW)	Relevant standards
Convector heater	Convector panel heater	0.4 – 3.0	1.0	IEC 60335, IEC 60675, IEC 60704
Radiant heaters	Radiant panel heater	0.5 – 3.0	1.0	IEC 60335, IEC 60335-1, IEC 60675, IEC 60675-1, IEC 60704
	Radiator (oil-filled, glass/aluminium/cast iron facade)	0.5 – 3.0	1.0	
	Ceramic heater	0.5 – 3.0	1.0	
	Glowing radiant infra-red heaters	0.5 – 3.0	1.5	
Fan heater	Metallic or PTC heating element	0.5 – 2.0	1.0	IEC 60335, IEC 60675, IEC 60704, IEC 60704-1

Table 1.7: Gas based (using natural gas, propane or LPG as fuel for heat generation) residential local space heaters (product categorisation

Types of local room heaters	Portable (P) or Fixed (F)	Open Combustion (OC) or Closed Combustion (CC)	Capacity range (in kW)	EU average (in kW)	Relevant standards
Flued gas heater	F	OC and CC	2 – 20	4.2	EN 521, EN 525, EN 613, EN 1196,EN 1319, EN 12669, EN 60335-2-102, BS 7977-1
Flued gas fire	F	OC and CC	2 – 20	4.2	EN 509, EN 613, EN 777, BS 7977-1
Flueless heater	P and F	OC	1.0 - 4.2	2.5	EN 449, EN 461, EN 14829, BS 7977-1

Table 1.8: Liquid fuel based (using liquid fuel for heat generation) residential local space heaters product categorisation

Types of local room heaters	Capacity range (in kW)	EU Average (in kW)	Relevant standards
Kerosene heaters	3.0 – 7.0	4.0	EN267, EN 13842
Liquid fuel/Gel fireplaces	0.4 – 3.0	2.0	DIN 4734, (Germany)/ D35-586 (France)

Table 1.9: Non-residential space heaters product categorisation

Types of heater	Heat generation fuel	Capacity range (in kW)	EU Average (in kW)	Relevant standards
Warm air unit heater	Electricity	10 – 100	20	EN 525, EN 621, IEC 60335-2-53, EN 1020, EN 1266, EN 1196, IEC 60675-1, IEC 60704-1, AS 3814-2005
	Gas	10 – 1000	55	
	Oil (gas oil, used/waste oil)	12 – >400	100	
Radiant cassettes	Electricity	1 – 4	2.4	
Radiant heaters (luminous)	Gas	2.5 – 40	20	EN 419 – 2
Radiant heaters (tube)	Gas	5 – 120	30	EN 416 – 2, EN 777
Air curtains	Electricity, Gas (water heated), heat pump	3 – 50	18	EN/IEC 60335-1, EN/IEC 60704-2-2, ISO 27327-1

1.1.3 Summary subtask 1.1

As shown above, a large variety of different products can be defined as local room heating products. Given the limited time available for this study and in order to perform a thorough evaluation of the products, it is necessary to determine the precise scope of the study in terms of products to be analysed and those to be excluded.

- **Functional unit**

The functional unit of a local room heating product is to provide a certain amount of heat (measured in kWh) to raise the temperature of indoor spaces to a desired level (as per the thermal comfort of the user e.g. 18 °C).

Scope of the study

Based on the considerations presented here in subtask 1.1, it is proposed to acknowledge the products covered in the scope of this ENER Lot 20 study as decentralised space heating appliances using electricity, gaseous and liquid fuel. The heat power output of these decentralised space heaters range from as low as 0.5 kW to 100 kW or more. Most residential local room heaters operate well under 12 kW (12 kW heaters are capable of heating a room that has up to 40-120 m^2 area and is 2.5 m in height[24]). Industrial unit heaters have capacities well beyond 12 kW. Although, it may be argued that the heating capacities of industrial unit heaters and some gas-fired radiant heaters are well beyond what is needed to heat a "local room", a broad definition is used to ensure that no heating products are overlooked between this study and ENER Lot 21 (central heating products) [25].

In this study local room heating products are defined as decentralised space heating stand-alone devices that convert electricity, gaseous or liquid fuels directly into heat and then distribute it to provide heat indoors. These devices can be portable or installed in the building.

Although electric sauna heaters can be classified as local room heating products, they have a very specific use that is different from the other heaters in this study as they heat spaces up to much higher temperatures. It is proposed that they are considered outside the scope of this study. Thin film or cable heating systems are currently considered in this study, although they might be deemed beyond the scope as it can be argued that they are always installed as part of a system and are not stand alone products.

In relation to the energy efficiency of local room heating products, it is worthwhile noting that the most important factor is the efficiency of providing heat where and when it is needed, which will be essential in achieving significant energy saving. Here system perspectives come to play lead to further savings as room insulation, ventilation, installation/placement of heater and interaction with the primary heating system are important parameters.

Potentially not included in this study are heaters for outdoor use, solid fuel heaters, heat storage cookers, reversible air conditioners, humidifiers, dehumidifiers, and sauna heaters.

This however is a preliminary scope definition and will be evaluated further against three key criteria defined in the Ecodesign Directive, viz. large sales volumes, significant environmental impacts and significant improvement potential. These issues will be dealt with later on in the Task 2, 5 and 7.

[24] Depends on climate conditions, insulation and use.

[25] The final scope definition will be done in accordance with DG ENER and stakeholders. It is important to note that the scope, can be further refined when market and use data are investigated in Task 2 and 3, respectively. Further sub-categorisation may also be introduced based on the technical considerations that will be looked at in Task 4.

1.2 Test standards

The aim of this subtask is to give an overview of existing test standards for the products to be covered by ENER Lot 20 and to identify needs and requirements for standards to be developed.

A "test standard" is a standard that sets out a test method, but that does not indicate what result is required when performing that test. Therefore, strictly speaking, a test standard is different from a "technical standard". Namely, in technical use, a standard is a concrete example of an item or a specification against which all others may be measured or tested. Often it indicates the required performance.

1.2.1 Energy efficiency performance parameters

In order to better understand the test standards relevant for this study, the following provides a short description of the most commonly used energy efficiency performance metrics.

The energy conversion efficiency of appliances that generate heat from combustion is determined by the ratio of the useful output heat provided for a defined period and purpose and the energy (input heat: electricity and fuel) used. This can be measured in several different ways:

- **Combustion Efficiency** is a measure of the furnace burner's ability to burn fuel. It is determined by measuring the amount of unburned fuel and excess air in the exhaust. Well designed burners firing gaseous and liquid fuels operate at excess air levels of 15% and result in negligible unburned fuel. By operating at only 15% excess air, less heat from the combustion process is being used to heat excess air, which increases the available heat for the load. Combustion efficiency is also dependent on the type of fuel.
- **Thermal Efficiency (TE)** is the energy conversion efficiency of furnaces under steady-state peak conditions. It is determined by the ability of the heat exchanger in indirect-fired systems to transfer heat from the combustion process to the warm-air used for space heating. TE is often specified as net or gross depending on whether the net or gross calorific value of fuel is used. The net calorific value of a fuel excludes the latent heat of water vapour in the exhaust, and so is lower than the gross calorific value. Efficiency test results and European standards normally use net calorific values. As warm air heaters are not always used at full heat loads, it is not a good indication of actual efficiency.
- **Annual Fuel Utilization Efficiency (AFUE)** is more commonly used as an indicator for actual energy efficiency. AFUE takes into account the cyclic on/off operation and associated energy losses due to changes in loads during the heating season. Test standards, such as the Canadian test standard CGA P.4, (vented home heating equipment), specify a method and test conditions for determining the AFUE of gas-fired room heaters.
- **Efficiency of electric heaters** is determined by the Joule effect where all electricity is converted into heat. In practical terms, the product efficiency in electric heaters is nearly 100%.

- **Radiant heaters' efficiency** is given by the radiation factor (in %), which measures the share of the energy converted into radiant heat. The ECA Scheme criteria include testing the radiation factor in accordance with the standards EN 416-2:2006, "Single burner gas-fired overhead radiant tube heaters for nondomestic use – Part 2: Rational use of energy". And BS EN 419-2:2006, "Non-domestic gas-fired overhead luminous radiant heaters – Part 2: Rational use of energy".
- **The efficiency of local room heaters at system level** –according to the approach proposed for the ENER Lot 20 preparatory study, should also include insulation factors, energy losses, and interaction of the product, the heating demand and the user. Existing legislation and standards such as **EN 15316-2-1: "**Heating systems in buildings – Method of calculation of system energy requirements and system efficiencies" already include energy efficiency from a system perspective.

It has to be noted that efficiency calculations in the TREN Lot 1 study were performed using gross calorific values. This is due to the fact that many boilers are condensing models, meaning that the exhaust which is passing through the heat exchanger is cooled down until water vapour condensates. Vapour latent heat is thereby recovered which increases the efficiency of the system. However, the products covered by the ENER Lot 21 study are usually not condensing ones. Therefore, efficiency calculations based on net calorific values will preferentially be used.

1.2.2 Standards at European Union level

This subtask analyses the important tests standards for electrical, gas and oil local room heating products. Product standards establish requirements relating to the design, manufacturing, construction, controls (embedded in appliance or external controls), performance (energy efficiency and emissions of pollutants), safety use instructions, marking and also provide test methods for appliances type testing. Few countries regulate electric room heaters (other than air conditioners) for energy efficiency.

At present there are standards (in place and under development) that specify methods for calculating the energy requirements of space heating systems to determine their energy efficiency performance, e.g. EN ISO 13790, EN 15316-2-1, prEN 15316-4-8. These cover both air heating and overhead radiant heating systems.

Currently most European standards that concern ENER Lot 20 products address safety issues, appliances that burn gaseous and liquid fuels, and airborne acoustical noise of household appliances. These standards fall under EU directives such as the Low Voltage Directive (LVD) 2006/95/EC on airborne noise emitted by household appliances, the Directive (2009/142/EEC) on appliances burning gaseous fuels (GAD) for general product safety. Many EN standards on ENER Lot 20 products also correspond to international standards. Nevertheless, product specified European standards are rather limited in relation to ENER Lot 20 products. At this stage, European standards have been identified for gas room heaters, storage room heaters, and oil-fired room heaters (see Table 1.10).

Table 1.10: European CEN and IEC Standards for ENER Lot 20 products

EN/IEC Standards	Product Group
EN 1:1998-05 + A1 2007-04	Flued oil stoves with vaporizing burners
EN 267	Automatic burner with blower for liquid fuels standard specifies requirements for testing, terminology, construction and operation
EN 416-1	Single burner gas-fired overhead radiant-tube heaters (Safety)
EN 416-2	Single burner gas-fired overhead radiant-tube heaters (Rational use of energy)
EN 419-1	Non-domestic gas-fired overhead luminous radiant heaters (Safety)
EN 419-2	Non-domestic gas-fired overhead luminous radiant heaters (Rational use of energy)
EN 449 [2002]	Specification for dedicated liquefied petroleum gas appliances - Domestic flueless[26] space heaters (including diffusive catalytic combustion heaters)
EN 461	Specification for dedicated liquefied petroleum gas appliances flueless non-domestic space heaters not exceeding 10 kW
EN 509	Decorative fuel-effect gas appliances
EN 521	Portable vapour pressure liquefied petroleum gas appliances
EN 525	Gas-fired air heaters without heat exchangers with forced convection for heating non-domestic rooms. nominal heat input not exceeding 300 kW
EN 613	Independent gas-fired convection heaters
EN 621	Non-domestic gas-fired forced convection air heaters for space heating not exceeding a net heat input of 300 kW, without a fan to assist transportation of combustion air
EN 777	Multi-burner gas-fired overhead radiant tube heater systems for non-domestic use – Part 1 - 4
EN 778	Gas-fired air heaters with forced convection for heating non-domestic rooms. nominal heat input not exceeding 70 kW; without a fan to assist transportation of combustion-air and / or exhaust

[26] Flueless signifies an appliance designed for use without connection to a flue for venting the products of combustion to the exterior

EN/IEC Standards	Product Group
EN 1020	Non-domestic gas-fired forced convection air heaters for space heating not exceeding a net heat input of 300 kW, incorporating a fan to assist transportation of combustion air and/or combustion products
EN 1196	Gas-fired air heaters for domestic and non-domestic use - Additional requirements for condensing air heaters
EN 1319	Domestic gas-fired forced convection air heaters for space heating, with fan-assisted burners not exceeding a net heat input of 70 kW
EN 1596	Specification for dedicated liquefied petroleum gas appliances - Mobile and portable non-domestic forced convection direct fired air heaters
EN 1266	Independent gas-fired convection heaters incorporating a fan to assist transportation of combustion air and/or flue gases
EN 12098 – 3	Control for heating systems – Part 3 Outside compensated control equipment for electrical systems
EN 12098 – 4	Control for heating systems – Part 4 Tariff compensated optimum start/stop control equipment for electrical systems
EN 12098 – 5	Control for heating systems – Part 5 Start-stop schedulers for heating systems
EN 12669	Direct gas-fired hot air blowers for use in greenhouses and supplementary non-domestic space heating
EN 13278	Open fronted gas-fired independent space heaters
EN 13410	Gas-fired overhead radiant heaters - Ventilation requirements for non-domestic premises
EN 13842	Oil-fired air heaters. Fixed and transportable for room heating
EN 14337	Heating systems in buildings. Design and installation of direct electrical room heating systems
EN 14829	Independent gas-fired flueless space heaters for nominal heat input not exceeding 6 kW
EN 15217	Energy performance of buildings – Methods for expressing energy performance and for the energy certification of buildings
EN 15316-2-1	Heating systems in buildings – Method of calculation of system energy requirements and system efficiencies
prEN 15316-4-8	Heating systems in buildings – Method of calculation of system energy requirements and system efficiencies – Part 4-8, Space heating generation systems, air heating and overhead radiant heating systems

EN/IEC Standards	Product Group
IEC/EN 60335-1	Household and similar electrical appliances - safety - rated voltage: 250V for single-phase appliances, up to 480V for others, not intended for appliances for domestic use as usual[27]
IEC/EN 60335-2-30	Household and similar electrical appliances - safety - particular requirements for room heaters
IEC/EN 60335-2-53	Household and similar electrical appliances - safety - particular requirements for sauna heating appliances
IEC/EN 60335-2-61	Household and similar electrical appliances - safety - particular requirements for thermal storage room heaters[28]
IEC/EN 60335-2-96	Household and similar electrical appliances - safety - particular requirements for flexible sheet heating elements for room heating (installed in building structure)
IEC/EN 60335-2-102	Household and similar electrical appliances - safety - particular requirements for gas, oil and solid-fuel burning appliances having electrical connections
IEC/EN 60335-2-106	Household and similar electrical appliances - safety - particular requirements for heated carpets and for heating units for room heating
IEC/EN 60531	Household electric thermal storage room heaters - methods for measuring performance[29]
IEC/EN 60675-1	Household electrical direct-acting room heaters – methods for measuring performance
IEC/EN 60704-1	Household and similar electrical appliances - test code for the determination of airborne acoustical noise: particular requirements for electric thermal storage room heaters[30]
IEC/EN 60704-2-2	Test code for the determination of airborne acoustical noise emitted by household and similar electrical appliances. Particular requirements for storage heaters
IEC/EN 60704-2-5	Test code for the determination of airborne acoustical noise emitted by household and similar electrical appliances -- part 2: particular

[27] This standard is applicable to the safety of electric room heaters, their rated voltage being not more than 250 V for single phase and 480 V for other appliances, for household and similar purposes.
[28] Deals with the safety of electric thermal-storage room heaters intended to heat the room in which they are located, their rated voltage being not more than 250 V for single phase and 480 V for other appliances.
[29] Applies to electric storage heaters intended to heat the room in which they are located. It defines the main performance characteristics and describes methods for measuring these characteristics. It does not apply to heating appliances incorporated in the building structure, to central heating systems or to floor heating appliances.
[30] Applies to the electric thermal storage room heaters having forced convection output, designed for placing on the floor, for wall-mounting or f Applies to the electric thermal storage room heaters having forced convection output, designed for placing on the floor, for wall-mounting or for building-in.

EN/IEC Standards	Product Group
	requirements for room heaters of the storage type
IEC 60800	Heating cables with a rated voltage of 300/500 V for comfort heating and prevention of ice formation
IEC/TS 62395-2	Electrical resistance trace heating systems for industrial and commercial applications - Part 2: Application guide for system design, installation and maintenance
ISO 27327-1	Fans - Air curtain units - Part 1: Laboratory methods of testing for aerodynamic performance rating

1.2.2.1 Test standards on environmental requirements

1.2.2.1.1 *Electrical Heaters*

- **IEC/EN 60675-1: Household electrical direct-acting room heaters – Methods for measuring performance**

Appliances: This standard applies to electric **direct-acting room heaters**. They may be portable, stationary, fixed, or built-in.

This standard defines the main performance characteristics of **direct-acting room heaters** and specifies methods for measuring these characteristics, for the information of users.

Energy supply: Electrical power supply

According to type:

- Panel heater
- Convector heater
- Fan heater
- Radiant heater
- Visibly glowing radiant heater

- **IEC/En 60704-1: Household and Similar Electrical Appliances**

Appliances: This part of IEC 60704 applies to electric appliances (including their accessories or components) for household and similar use, supplied from mains or from batteries. By similar use is understood the use in similar conditions as in households, for example in inns, coffee-houses, tea-rooms, hotels, barber or hairdresser shops, launderettes, etc.

Energy supply: Electrical power supply

Devices Classifications: All electric appliances (including their accessories or components) for household and similar use, supplied from mains or from batteries

1.2.2.2 *Test standards on safety*

Below are the most important standards for the safety testing of local room heating products (electrical, gas and oil burning) out and its scope will be briefly explained. Since many standards in the field tests for other standards or to the same standards refer here only the relevant standards identified.

1.2.2.2.1 *Electrical Heaters*

- **IEC/EN 60335-1: Household and similar electrical appliances**

Appliances: This standard deals with the safety of electrical appliances for household and similar purposes, their rated voltage being not more than 250 V for single-phase appliances and 480 V for other appliances.

Appliances not intended for normal household use but which nevertheless may be a source of danger to the public, such as appliances intended to be used by laymen in shops, in light industry and on farms, are within the scope of this standard.

As far as is practicable, this standard deals with the common hazards presented by appliances that are encountered by all persons in and around the home. However, in general, it does not take into account:

- Persons (including children) whose physical, sensory or mental capabilities; or lack of experience and knowledge prevents them from using the appliance safely without supervision or instruction;
- Children playing with the appliance

1.2.2.2.2 *Gas heaters*

- **EN 449: Specification for dedicated liquefied petroleum gas appliances**

Appliances: This standard applies to domestic flueless space heaters, including diffusive catalytic combustion heaters, having a nominal heat input (Hs), not exceeding 4.2 kW burning 3rd family gases at nominal operating pressures not exceeding 50 mbar, referred to in the text as 'appliances'. This standard is applicable to the following types of appliances:

- Fixed heaters burning commercial butane and/or commercial propane
- Portable or mobile heaters burning either commercial butane, or, commercial propane
- There are no specific thermal efficiency requirements appropriate to these types of appliance as:
- All the heat produced by the combustion process is released into the space to be heated
- The requirements with regard to the combustion performance, which is a safety matter, ensure the effective burning of the fuel gas.

It does not cover appliances incorporating electrically operated gas control systems.

Fuels: Propane, Butane, Propane-butane mixture

- **EN 461: Specifications for dedicated liquefied petroleum gas appliances**

Appliances: This standard specifies requirements and test methods for the construction, safety, marking and rational use of energy for independent gas-fired convection heating appliances not exceeding 10 kW.

Fuels: Butane and Butane-Propane mixture

- **EN 521: Specifications for dedicated liquefied petroleum gas appliances**

Appliances: This standard applies to portable appliances with a maximum heat input of 3 kW (Hs) burning liquefied petroleum gases at the vapour pressure within the gas container. Following types of appliances are covered:

- Cooking appliances
- Lighting appliances
- Heating appliances

Appliances covered by this standard are not connected to a flue for the discharge of products of combustion and are not connected to the mains electricity supply.

This standard covers neither appliances supplied with LPG in the liquid phase or those incorporating a fixed gas reservoir which may or may not be refilled by the user. This Standard does not cover gas containers or flexible hose.

Requirements for rational use of energy for heating appliances have not been included in this standard as all the heat produced is discharged into the environment.

Fuels: Butane-butene mixture (maximum pressure of 8 bar (g) at 50 °C), butane-butene-propane-propene mixture (at a pressure between 8-12 bar (g) at 50 °C) and propane-propene mixture (at a pressure above 12 bar (g) at 50 °C)

- **EN 525: Non-domestic direct gas-fired forced convection air heaters for space heating**

Appliances: This standard applies to non-domestic direct gas-fired forced convection air heaters having fully automatic control systems, with heat input based on the net calorific value of 300 kW or less fitted with integral burners intended for use other than in residential dwellings. It also applies to appliances designed for outdoor installation. For indoor appliances provision of the heated air may be by means of ducting or may be directly into the heated space. This standard does not apply to:

- Appliances intended for use in residential dwellings
- Portable or transportable forced convection appliances
- Appliances fitted with gas boosters
- Appliances fitted with air/gas ratio controls
- Appliances which incorporate a main burner having more than one section under a common burner control, of which one or more sections may be extinguished whilst another section remains in operation.

Fuels: Propane and propane-butane mixture

- **EN 613: Independent gas-fired convection heaters**

Appliances: This standard applies to independent gas-fired convection heating appliances which:

- Incorporate a natural draught burner
- Connected directly to an open flue or to a device to evacuate the products of combustion (open-flued appliances, balanced-flued appliances)
- Wall mounted, free-standing or built-in
- Have a nominal heat input not exceeding 20 kW (based on the net calorific value).

In addition, this standard is applicable to live fuel effect appliances.

Fuels: Propane, propane-butane mixture, butane and Natural gas family H, L and E[31]

- **EN 778: Domestic gas-fired forced convection air heaters for space heating not exceeding a net heat input of 70 kW**

Appliances: This standard covers domestic gas-fired air heaters with (an) atmospheric burner(s) and without a fan to assist the transportation of combustion air and/or flue gases, with an input not exceeding 70 kW (net calorific value basis), intended primarily for use in single unit residential dwellings. Provision of the heated air may be by means of ducting. This standard does not apply to appliances:

- Condensing type
- For outdoor installation
- Dual purpose air conditioning (heating and cooling);
- Where the air is heated by an intermediate fluid
- Forced draught burners
- Manual or automatic adjustment of combustion air supply or the combustion products evacuation (including flue dampers)
- Portable or transportable forced convection appliances
- Having multiple heating units with a single draught diverter
- Fitted with more than one flue outlet
- Designed for continuous condensation within the flue system under normal operating conditions
- Products Of Combustion Evacuation Ducts (POCED), that are non-metallic

Fuels: Propane, propane-butane mixture and Natural gas family H, L and E

- **EN 1319: Domestic gas-fired forced convection air heaters for space heating**

Appliances: This standard covers gas-fired air heaters for domestic use with a fan to assist transportation of combustion air and / or combustion products. It applies to appliances designed for a maximum heat input (based on the calorific value) of 70 kW and primarily used for single home dwellings.

[31] The natural gas family H, L and E refer to a characteristic composition of natural gas (e.g. Natural gas family H has a percentage composition by volume as: CH_4-82, C_2H_6-3.3, C_3H_8-0.6, C_4H_{10}-0.3, N_2-12.6, CO_2-1.2)

Fuels: Propane, propane-butane mixture and Natural gas family H, L and E

- **EN 1596: Specification for dedicated liquefied petroleum gas appliances**

Appliances: This standard covers mobile and portable non-domestic forced convection direct-fired air heating with a rated heat input not exceeding 180 kW nominal heat input (Hs). It applies to the following types of gas heaters:

- Low gas pressure appliances operating at pressures of up to and including 50 mbar burning commercial butane and/or commercial propane
- Medium gas pressure appliances operating at pressures of above 50 mbar and up to 2 bar burning commercial butane and/or commercial propane

It does not apply to appliances which are intended to be fixed or permanently installed, or to appliances which incorporate liquid feed burners.

Fuels: Propane and propane-butane mixture

- **EN 12669: Direct gas-fired hot air blowers for use in greenhouses and supplementary non-domestic space heating**

Appliances: This standard applies to direct gas-fired hot air blowers for greenhouses, agricultural zed or supplementary space heating, hereinafter called "appliances". "Supplementary" in this standard means to make up a deficiency, i.e. for the temporary heating of spaces intended for agricultural or commercial use:

- Workshops, sheds, stables, poultry houses, barns, cattle pens, etc
- Factories, workshops, warehouses, storage sheds, mills hangers, drying of buildings, temporary site accommodation, etc.

This standard applies to appliances with heat input 180 kW or less, based on the net calorific value, fitted with integral burners, including appliances designed for outdoor installation.

Fuels: Propane, propane-butane mixture, butane and Natural gas family H, L and E

1.2.2.2.3 *Oil heaters*

- **EN 267: Forced draught oil burners**

Appliances: This standard covers forced draught oil burners supplied with a fuel having a viscosity at the burner inlet in the range of 1.6 – 6 mm^2/s at 20 °C. This standard also applies to the oil function of dual fuel burners designed to operate on liquid and gaseous fuels in which case the requirements of EN 676 will also apply in respect of the gaseous fuel function.

Fuels: Kerosene

- **EN 13842: Oil fired forced convection air heaters**

Appliances: This standard applies to stationary and portable oil-fired air heaters using only draught oil burners. It also covers appliances intended for outdoor installation. Provision of the heated air may be by means of ducting or may be directly into the heated space.

Fuels: Liquid fuels

1.2.3 Standards at Member State level

Currently, in some Member States some new standards are being created. Germany is creating a pre-standard for energy efficiency of heating and ventilation systems in buildings as shown in Table 1.11 that might be relevant for certain types of space heaters. Besides the French and German standards, no other specific standards at Member State level have been identified.

Table 1.11: Standards for fireplaces and energy efficiency of heating and ventilation systems in buildings

Member State	Reference	Title
Denmark	DS 2187	Oil burning, fan-assisted air heaters
Germany	DIN V 4701-10	Energy efficiency of heating and ventilation systems in buildings Part 10: Heating, domestic hot water, ventilation
	DIN 4734-1	Fireplaces for liquid fuels - Decorative device which, using an ethanol-based liquid or gel fuel for flame producing – Use in private households
	DIN V 18599	Energy efficiency of buildings
France	D35-586	Fireplaces for liquid fuels
Netherlands	Bouwbesluit 2003	Building regulations 2003
	EPC standard	Energy use in new built housing
	NPR	Installation specification
UK	OFS A102	Oil Firing Appliance Standard – Room heaters with Atomising or Vaporising Burners with or without Boilers, heat outputs up to 25 kW
	OFS A103	Oil Firing Appliance Standard – Used Lubricating Oil Burners for Space and Water Heating Appliances, heat outputs up to 400 kW
	BS 7977	Specification for safety and rational use of energy of domestic gas appliances. Radiant/convectors.
	Building Regulations 2010	Domestic Building Services Compliance Guide Non-domestic Building Services Compliance Guide

OFTEC: Oil Firing Technical Association, www.oftec.org

The UK Guide to building regulations[32] specifies recommended minimum energy efficiency standards for individual HVAC appliances for domestic and non-domestic buildings.

[32] www.communities.gov.uk/planningandbuilding/buildingregulations/

Table 1.12: Overview of recommended minimum standards for efficiency for ENER Lot 20 products in the UK

Type of building	Type of appliance	Relevant standard	Performance criteria*
Domestic buildings	Gas-fired fixed independent space heaters, primary heating	EN 613, EN 1266, EN13278, BS 7977-1	≥ 63% Gross Calorific Value (≥ 70% Net Calorific Value)
	Gas-fired fixed independent space heaters, secondary heating	EN 613, EN 1266, EN 13278, BS 7977-1, EN 14829 (flueless), EN 449 (flueless)	≥ 63% Gross Calorific Value (new buildings) ≥ 45% Gross Calorific Value (≥ 50% Net Calorific Value) (existing buildings)
	Gas-fired fixed independent space heaters, decorative fuel effect	EN 509	Not specified, but set to 20% in SAP 2009[a]
	Oil-fired fixed independent appliances for primary heating	BS 5410	≥ 60% Gross Calorific Value
Non-domestic buildings	Gas-fired forced convection	EN 621 (without a fan), EN 1020 (with a fan)	≥ 91% Net Thermal Efficiency
	Direct gas-fired forced convection	EN 525	100% Net Thermal Efficiency
	Oil-fired forced convection	EN 13842	≥ 91% Net Thermal Efficiency
	Luminous radiant heater (unflued)	EN 419	≥ 86% Net Thermal Efficiency / ≥ 55% Radiant Efficiency
	Non-luminous radiant heater	EN 416-1	
	Multi-burner radiant heater	EN 777	≥ 91% Net Thermal Efficiency

*Efficiency is heat output divided by the calorific value of the fuel. The net calorific value of a fuel excludes the latent heat of water vapour in the exhaust, and so is lower than the gross calorific value. Efficiency test results and European standards normally use net calorific values.

[a] SAP 2009: Government's Standard Assessment Procedure for Energy Rating of Dwellings, 2009 (www.bre.co.uk/sap2009/)

For non-domestic buildings heating efficiency credits may be awarded if additional measures, such as additional controls that raise the energy efficiency of the system beyond the recommended minimum standards, are also part of the heating system. For gas and oil-fired warm air heaters features such as 'optimised shut down'; 'Hi/Lo burners'; and 'modulating burners' increase the effective heat generator efficiency with 1%, 2% and 3%, respectively. For radiant heating systems controls such as 'optimum stop'; 'optimum start'; and 'zone control' raise the effective heat generator efficiency with 1%, 0.5% and 1%, respectively.

1.2.4 Third country standards

- **International level**

International standards exist for many local room heating appliances, typically originating from industry standards, government agencies, or professional societies, and are eventually adopted by a national or international standardisation body. The leading international standardisation bodies are the International Standardisation Organisation (ISO) and the International Electrotechnical Commission (IEC). All of the IEC standards fall under the International Classification of Standards (ICS) code 97.100.01: heating applications in general, however most of these standards refer to electric heaters only. As can be seen in Table 1.10, many of the international standards relating to these products concern measuring performance characteristics, noise, and safety standards. For gas room heaters at the international level, the International Fuel Gas Code (2006) addresses the design and installation of fuel gas systems and gas-fired appliances through requirements that emphasise performance. This code covers unvented and vented gas room heaters.

In addition specific test standards or methods for energy consumption measurement are sometimes imposed in Minimum Energy Performance Standards (MEPS) of third countries.

- **USA (AHRI, ASHRAE, ANSI)**

The most recognised standards for HVAC design (Heating, Ventilation, and Air Conditioning) under which local room heating products fall) is based on ASHRAE data. ASHRAE is the American Society of Heating, Refrigerating and Air-Conditioning Engineers. In addition, the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) is the American trade association representing manufacturers of air conditioning, heating, and commercial refrigeration equipment. It also develops industry standards and voluntary certification programmes (AHRI performance certification programmes) for local room heating products. The American National Standards Institute (ANSI) also develops national standard for performance testing. Table 1.13 shows relevant ANSI test standards for ENER Lot 20 products operating on gas. The following ANSI standards stipulate safety standards that include test requirements for the safe operation, substantial and durable construction, and acceptable performance of the specified room heater.

Table 1.13: American (and Canadian) test standards for local room heating products

ANSI Standard	Appliance
ANSI Z21.11.2	Gas-fired room heaters - unvented room heaters
ANSI Z21.50 / CSA 2.22	Vented gas fireplaces
ANSI Z21.60 /CSA 2.26	Decorative gas appliances for installation in solid-fuel burning fireplaces
ANSI Z21.76	Gas-fired unvented catalytic room heaters for use with liquefied petroleum (LP) Gases (input rate ≤ 40,000 BTU/h (≈11.7 kW))
ANSI Z21.84	Manually lighted, natural gas decorative gas appliances for installation in solid-fuel burning fireplaces
ANSI Z21.86 / CSA 2.32	Vented gas-fired space heating appliances (input rate ≤ 400,000 BTU/h (≈117 kW))
ANSI Z21.88 / CSA 2.33	Vented gas fireplace heaters (input rate ≤ 400,000 BTU/h (≈117 kW))
ANSI Z21.91	Ventless firebox enclosures for gas-fired unvented decorative room heaters
ANSI Z83.18	Recirculating direct gas-fired industrial air heaters
ANSI Z83.19 / CSA 2.35	Gas-fired high-intensity infrared heaters (input rate ≤ 400,000 BTU/h (≈117 kW))
ANSI Z83.20 / CSA 2.34	Gas-fired low-intensity infrared heaters (input rate ≤ 400,000 BTU/h (≈117 kW))
ANSI Z83.4 / CSA 3.7	Non-recirculating direct gas-fired industrial air heaters
ANSI Z83.6	Gas-fired infrared heater
ANSI Z83.7-00 / CSA 2.14-00	Gas-fired construction heaters (input rate ≤ 10,000,000 BTU/h (≈ 2,930 kW))
ANSI Z83.8 / CSA 2.6	Gas unit heaters (input rate ≤ 10,000,000 BTU/h (≈ 2,930 kW)), gas packaged heaters, gas utility heaters and gas-fired duct furnaces (input rate ≤ 400,000 BTU/h (≈117 kW))
CAN/CSA-P.4.1-02	Testing method for measuring annual fireplace efficiency
CAN/CSA-P.11-07	Testing method for measuring efficiency and energy consumption of gas-fired unit heaters (input rate ≤ 2,931 kW
CAN/CSA-B140.0-03	Oil-burning equipment: general requirements
CAN/CSA-B140.1	Vapourizing-type oil burners
CAN/CSA-B140.2.2	Pressure atomizing oil burner nozzles

ANSI Standard	Appliance
CAN/CSA-B140.4-04	Oil-fired warm air furnaces
CAN/CSA-B140.8	Portable industrial oil-fired heaters
CAN/CSA-B140.9	Portable kerosene heaters
CAN/CSA-B140.9.1	Portable liquid fuelled catalytic appliances (1,000 BTU/h (≈0.3 kW) < input rating ≤ 15,000 BTU/h (≈4.4 kW)))
CAN3-B140.9.3-M86	Portable kerosene-fired heaters (input rating ≤ 4.4 kW)
CSA-B140.10-06	Oil-fired warm-air heating appliances for mobile housing and recreational vehicles
CSA-B212-00	Energy utilization efficiencies of oil-fired furnaces and boilers (input rate ≤ 66 kW))
CAN1-2.23-M82	Gas-fired portable infra-red heaters (input rate ≤ 400,000 BTU/h (≈117 kW))
UL 731	Oil-fired unit heaters

- Uniform Mechanical Code

Designated as an American National Standard, the Uniform Mechanical Code (UMC) is a model code developed by the International Association of Plumbing and Mechanical Officials to govern the installation and inspection of mechanical (HVAC, combustion, exhaust, refrigeration) systems as a means of promoting the public's health, safety and welfare. The UMC is designed to provide consumers with safe heating and mechanical systems while, at the same time, allowing latitude for innovation and new technologies. The UMC designates certain installation measures that concern local room heating products such as:

- Generally all have to have 36 inches (≈91 cm) of clear space above heater depending radiant or circulating (convection heaters).
- Room heaters are installed on non-combustible floors.

- **Australia**
  - Safety Standards for Room Heaters (AS/NZS 3350.2.30:1997)

This standard deals with the safety of electric room heaters for household and similar purposes, their rated voltage being not more than 250 V for single-phase appliances and 480 V for other appliances. It was published in March 1997. Examples of appliances which are within the scope of this standard are:

- Radiant heaters
- Panel heaters
- Liquid-filled radiators
- Fan heaters
- Convector heaters

- Test Standard for Gas Space Heating Appliances (AS 4553-2000)

This standard deals with the gas emissions, performance and methods of test for new gas space heating appliances (convectors, radiant convectors, wall furnaces) with natural draught or fan assisted combustion systems, constructed totally from new materials and components and intended for use with natural gas, town gas, LPG and Tempered Liquefied Petroleum gas (TLP)[33] with gas consumptions not exceeding 150 MJ/h (≈ 42 kW).

1.3 Existing legislation

The aim of this subtask is to give an overview of existing legislation and voluntary programmes for local room heating products included in the ENER Lot 20. Further, this subtask includes a comparative analysis of such legislation in the context of possible future Ecodesign implementing measures.

1.3.1 Legislation and agreements at European Union level

Local room heaters are products that are especially vulnerable to overheating that may cause burns, fires and other safety hazards, and therefore all the ENER Lot 20 products are covered by the safety related European Directives. They have to comply with these directives to have the obligatory CE marking. In addition, environmental legislation on electrical and electronic equipment also applies to many of ENER Lot 20 products. For the time being, there is no specific legislation regarding environmental or energy performance applicable to local room heating products at EU level.

[33] TLP is propoane (7-26%), propene (0-20%), butane (0-0.1%), butene (0-0.1%), ethyl mercaptan (1-2 ppm) and air (74%). Source: www.originenergy.com.au/files/TemperedLPG.pdf

Table 1.14: Relevant European legislations identified

Scope	Legislation
Energy related legislations	
Product	Besides the Ecodesign Directive 2009/125/EC no other European legislation on energy efficiency for central heating air appliances has been identified.
System	Energy Performance of Buildings Directive (EPBD) 2002/91/EC
Environmental legislation	
Product	Ecodesign Directive 2009/125/EC
	Waste Electrical and Electronic Equipment Directive 2002/96/EC (electrical heaters)
	National emission ceilings for certain atmospheric pollutants Directive 2001/81/EC
	Ambient air quality and cleaner air for Europe Directive 2008/50/EC
	Restriction of the use of certain Hazardous Substances in electric and electronic equipment Directive 2002/95/EC (electrical heaters)
Legislations related to safety	
Product	Machinery Directive 98/37/EC (oil fired heaters)
	Gas Appliance Directive 2009/142/EEC[34] (gas fired heaters)
	Low Voltage equipment Directive 73/23/EEC (electrical; oil and gas fired heaters)
	Electromagnetic compatibility Directive 2004/108/EC (electrical; oil and gas fired heaters)
	Pressure Equipment Directive (97/23/EEC)

1.3.1.1 Energy efficiency related legislations

Besides the Ecodesign Directive of which this preparatory study has been launched under, there is no specific legislation currently in place regarding the environmental or energy performance of local room heating products in Europe. The European Directive on the energy performance of buildings (EPBD) does however concern ENER Lot 20 products as it aims to increase the energy performance of public, commercial and private buildings in all Member States (MS). Although it does not specifically mention local room heating products, energy performance in the Directive is described as *"the amount of energy actually consumed or estimated to meet the different needs*

[34] To undertake a codification of this directive, the Commission has made a proposal for a Directive of the European Parliament and of the Council relating to appliances burning gaseous fuels (Codified version), COM(2007) 633 - COD 2007/0225

associated with a standardised use of the building, which may include, inter alia, heating, hot water heating, cooling, ventilation and lighting"[35].

- **Ecodesign Directive 2009/125/EC on Ecodesign (recast of 2005/32/EC)**

The Directive, under which this preparatory study has been initiated, applies to different categories of energy-using and energy-related products. It establishes a framework for setting Ecodesign requirements (such as energy efficiency requirements) for all energy-using and energy-related products in residential, tertiary, and industrial sectors. Besides the Ecodesign Directive, the most relevant European legislations were identified and presented in Table 1-14..

- **Directive 2010/31/EU on Energy Performance of Buildings Directive (Epbd) (Recast of 2002/91/EC)**

The EPBD aims to set minimum efficiency standards for residential and commercial buildings. The Directive proposes a general framework for a methodology for calculating the integrated energy performance for buildings (Article 3) which includes HVAC and hot water systems, lighting, building shell, outdoor climate, etc. Each Member States must apply a calculation methodology as well as establish minimum requirements concerning the energy performance of new and existing buildings. The EPBD also stipulates that a certification system of the energy performance of buildings is put in place together with regular inspection of HVAC systems. Whilst the Ecodesign Directive regulates what products may be placed on the market, the EPBD aims to ensure proper installation and optimal energy use of technical building systems.

1.3.1.2 Environmental legislation

- **Directive 2002/96/EC on Waste Electrical and Electronic Equipment(WEEE)**

The Directive implements the principle of "extended producer responsibility" where electrical and electronic products manufacturers are responsible for the costs of collection, treatment, recovery and disposal of their own products and hence preventing such object products from entering municipal waste collection systems. With regard to the products studied in ENER Lot 20 space heaters are covered by WEEE as this Directive applies to "large household appliances". Starting from 31st December 2006 this Directive requires 80% of large household appliances to enter a separate WEEE stream, and 75% of this waste by weight should be reused (components) or recycled (materials and substances).

- **Directive 2002/95/EC on Restrictions of the Use of Certain Hazardous Substances in Electric and Electronic Equipment (RoHS)**

The purpose of the RoHS Directive is to restrict the use of hazardous substances in electro-technical products and the protection of human health.

As from 1 July 2006, lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBBs) and polybrominated diphenyl ethers (PBDEs) in electrotechnical products must be replaced by other substances.

[35] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002L0091:EN:HTML

Essentially the RoHS Directive covers the same products as the WEEE Directive and hence needs to be accounted for ENER Lot 20 study.

1.3.1.3 *Legislation related to safety*

The list below presents the main safety legislations relevant to the scope of study of ENER Lot 20 study:

- **Directive 2006/95/EC on Low Voltage (LVD)**
  - Type of assessment: Self declaration + Technical file
  - Scope: Safety of electrical equipment

This Directive is applicable to all electrical equipment designed for use with a voltage rating[36] 50 – 1000 V AC and 75 – 1500 V DC. It requires products to have protection against hazards that could arise from within the product itself or from external influences. All risks arising from the use of electrical equipment, including mechanical, chemical, and all other risks. Noise and vibration, and ergonomic aspects, which could cause hazards, are also within the scope of the directive.

- **Directive 2004/108/EC on Electromagnetic Compatibility**
  - Type of assessment: Self declaration + Technical file
  - Scope: Emissions and immunity of electrical/electronic equipment

The electric room heaters studied under ENER Lot 20 has to comply with restrictions for safety on the emissions of electromagnetic radiation and the immunity against electromagnetic radiation set by this Directive. Countries outside the EU have similar regulations although the detailed requirements differ.

- **Directive 98/37/EC for Machinery**
  - Type of assessment: Third party verification
  - Scope: Safety of machinery

The Directive applies to machinery and lays down the essential health and safety requirements for them. Machinery that conforms to all relevant requirements can then carry the CE mark, showing compliance with the EHSRs of the Machinery Directive and all other relevant Directives.

Regarding the ENER Lot 20 study, the heating appliances must be designed and provide instructions for operation phase to avoid potential hazards thus complying with the Directive in order to obtain the CE mark.

- **Directive 2009/142/EC for Gas Appliances (GAD)**
  - Type of assessment: Third party verification
  - Scope: Safety, emissions and efficiency of gas appliances

[36] Voltage ratings refer to the voltage of the electrical input or output, not to voltages, which may appear inside the equipment.

The Gas Appliance Directive (GAD) covers appliances used for cooking, lighting, washing (including ironing), refrigeration, forced draught burners and heating bodies to be equipped with such burners, space heating for thermal comfort and hot water production (having, where applicable, a normal water temperature not exceeding 105°C.

The Directive also covers safety devices, controlling devices or regulating devices and sub-assemblies separately marked for trade use and designed to be incorporated into an appliance burning gaseous fuel or assembled to constitute such an appliance. This Directive covers various European harmonised standards (CE) for the air space heating appliances falling under the scope of ENER Lot 20 study (as described in task 1.2).

- **Directive 97/23/EEC for Pressure Equipment**
  - Type of assessment: Third party verification
  - Scope: Safety of pressurised equipment

This Directive applies to propane heaters from ENER Lot 20 products as these heaters use high pressure LPG as a fuel.

1.3.2 Legislation and agreements at Member State level

Most of the local heating appliances covered in the ENER Lot 20 study are bound by European Directives at the national levels within EU-27. No specific significant legislation was identified under the scope of the study at Member States levels[37]. Some voluntary schemes have however been identified which are applicable at national level in the concerned Member States. Stakeholder's feedback and inputs regarding the legislation at member State levels will be useful to elaborate this subtask and validate this investigation.

- **Austria**

Austria has requirements for gas-fired and oil-fired room heaters concerning their energy efficiency and environmental emissions. These requirements came into force in 2011. These requirements are based on an agreement between the Austrian Länders[38]. The efficiency and environmental emissions restrictions proposed by these requirements are presented in the tables below.

[37] NAEEEC report 2004/04 on energy labelling and standard programs throughout the world, published by the national appliance and equipment energy efficiency committee, Australia

[38] "Agreement pursuant to Article 15a of the Federal Constitution concerning the placing of small firing installations on the market and the inspection of heat generating and combined heat and power systems" ("Vereinbarung gemäß Art 15a B-VG über das Inverkehrbringen von Kleinfeuerungen und die Überprüfung von Feuerungsanlagen und Blockheizkraftwerken")

Table 1.15: Requirements for environmental emissions of gas-fired and oil-fired heaters in Austria

Type of heater	Fuel type	NOx (mg/MJ)	CO (mg/MJ)
Liquid fuel based heaters	Biogenic fuel	120	20
	Heating oil	35	20
Gaseous fuel based heaters	Natural gas (atmospheric burner)	30	20
	Natural gas (premix burners)	30	20
	LPG (atmospheric burner)	40	35
	LPG (premix burners)	40	20

Table 1.16: Requirements for energy efficiency (based on Net Calorific Value) of gas-fired and oil-fired heaters in Austria

Type of heater	Category	Minimum thermal efficiency (in %)
Decentralised gas and oil based heaters	Up to 4 kW	78%
	Between 4-10 kW	81%
	Above 10 kW	84%

- **France**
  - NF Performance

The NF Performance is a collective certification label in France that guarantees the quality and safety of the products certified. Besides ensuring compliance with existing standards, it specifies additional quality criteria. CdC LCIE 103-13 (for fixed room heating appliances, convectors, radiant heaters and electric radiators) and CdC LCIE 103-12 (for thermal storage heaters) set requirements for electric radiators under the NF Performance.

Table 1.17: Requirements for voluntary labelling for installed electric heaters in France

Reference	Requirement	Defined by
CdC LCIE 103-13	For fixed room heating appliances, convectors, radiant heaters and electric radiators. Category "C" is the highest.	The performance category (B or C) defined by: - the air outlet temperature - the surface temperature rise - the regulation (drift and amplitude of the ambient temperature) - the reliability and endurance - the coefficient of aptitude for the products having a C category

Reference	Requirement	Defined by
CdC LCIE 103-12	For thermal storage heaters. Category "3" is the highest.	The performance category (1, 2 or 3) defined by: - the size and weight - the rated load - the ability to heat a local - the ability to heat retention - the heating of the external surfaces - the heating surfaces surrounding the heater - the temperature stability in the room - the heating function (direct action) - the acoustic level

- **Germany**
  - Ordinance on small and medium size combustion installations (1.BImSchV)

This ordinance regulates the operation of combustion installations that are not subject to licensing. It sets requirements for fuels and the use of fuels that exclude certain products from being used in Germany (e.g. kerosene heaters). Besides it sets limit values for soot and Carbon Monoxide emissions for liquid fuel fired and for exhaust gas losses for gas and oil fired installations. Although for small space heaters these limit values are not controlled regularly, they are controlled for dark radiant heaters.

  - Ordinances on Combustion installations of the German Länder ("Feuerungsverordnung" or "Feuerungsanlagenverordnung"; FeuVO)

These ordinances set safety related requirements for exhaust gas systems (for example, flue gases may not be led into rooms but in chimneys or flue gas pipes (with some exceptions; § 7 M-FeuVO)). This may exclude flueless gas heaters and kerosene heaters from being used in Germany[39].

  - Energieeinsparverordnung (EnEV; Energy Saving Ordinance for buildings)

This ordinance limits the primary energy demand of new and retrofitted buildings. It also includes some specifications for heating systems. DIN V 18599 is mandatory for non-residential buildings, whereas DIN V 4701-10 can also be used for residential buildings[40].

[39] www.is-argebau.de/Dokumente/4231177.pdf and www.is-argebau.de/Dokumente/42311220.pdf (justification)

[40] German: www.zukunft-haus.info/fileadmin/zukunft-haus/energieausweis/Gesetze_Verordnungen/EnEV/EnEV-2009-Lesefassung-nicht-amtliche-Fassung.pdf
English (non-official translation): www.zukunft-haus.info/fileadmin/zukunft-haus/energieausweis/Gesetze_Verordnungen/EnEV_2009_aktuelle_nichtamtliche_Lesefassung_180309_englisch_Internetversion__ohne_Formulare_.pdf

- **United Kingdom (UK)**
  - Enhanced Capital Allowance (ECA) scheme

The Enhanced Capital Allowance (ECA) scheme is a key part of UK's government programme to manage climate change. For a product to appear on the Energy Technology Product List (ETPL), and therefore qualify for an ECA claim, it must meet a set of energy-saving criteria. The ECA certified radiant heaters are minimum 5% more efficient than a standard product available in the market. The ECA scheme provides businesses with 100% first year tax relief on their qualifying capital expenditure. This means that businesses can write off the whole cost of the equipment against taxable profits in the year of purchase. This can provide a cash flow boost and an incentive to invest in energy saving equipment which normally carries a price premium when compared to less efficient alternatives.

The list of product covers by the ECA scheme is reviewed every year so that only the top 25% of best performing products are supported. It is therefore not strictly a standard.

The following radiant space heaters are covered under the ECA scheme in year 2010:

Table 1.18: Gas and oil radiant heaters covered by ECA scheme[41]

Type of radiant heater		Requirements
Tube	Unitary	Radiant efficiency ≥ 60.0% and Net thermal efficiency ≥ 86.0%
	Multi-burner	Radiant efficiency ≥ 60.0% or Net thermal efficiency ≥ 90.0%
	Continuous	Net thermal efficiency ≥ 90.0%
Plaque		Radiant efficiency ≥ 60.0%
Cone		

Similarly the following industrial unit heaters are also under the ECA scheme:

Table 1.19: Enhanced Capital Allowance eligibility criteria

Type of warm air heating product	Requirements
Direct-fired	• Incorporate a microprocessor-based controller that monitors product's outlet air temperature, and adjusts the product's operation to maintain pre-set temperature(s). • Use modulating burners with a turn down ratio that is greater than, or equal to, 10:1. • Be fitted with a variable speed fan controller, or a variable air volume control system, that can vary the fresh air flow through the product by a factor of at least two to one.
Indirect-fired	Net thermal efficiency ≥ 91.0%

[41] Energy Technology Criteria List (2010) p 114. Available at: www.eca.gov.uk/NR/rdonlyres/80D2C784-D67A-4745-AC34-6513F1847E39/0/ENERGYTECHNOLOGYCRITERIALISTJuly2010FINAL.pdf

Furthermore the requirements for optimising controllers are given for both types of heating systems to be eligible:

- Incorporate a microprocessor based controller that is pre-programmed to:
  - Automatically control the air temperature in one or more zones within a building in an energy efficient manner that reflects predefined zone occupation schedules.
  - Automatically switch warm air heating equipment on and off in accordance with the predefined occupation schedule for each of the zones being controlled.
- Incorporate the following automatic control mechanisms:
  - A frost protection mechanism that monitors internal air temperature, and switches on the warm air heaters to prevent equipment and/or pipework from freezing up.
  - A building fabric protection mechanism that monitors external or internal temperatures and switches heating on to prevent condensation from occurring.
  - An anti-tampering mechanism that prevents the product's control strategy from being modified, and the specified automatic control mechanisms from being disabled, except during commissioning, maintenance or testing.
- Provide facilities that enable building managers to:
  - Define the normal occupation times for the building and for each zone controlled (in intervals of five minutes or less), for each day of the week, including at least two periods of occupation per day (i.e. at least 14 different occupation period per week).
  - Define the temperature set-points for each zone to +/- 1 degree centigrade.
- Provide facilities that enable building users to "temporarily override" the pre-set times when the warm air heating is scheduled to be switched off within an individual zone.
- Conform with the requirements of the EU EMC Directive

1.3.3 Third country legislation

1.3.3.1 Third country mandatory programmes

According to the IEA, the proportion of mandatory labelling for electrical space heating appliances is low[42]. This reflects the limited range of efficiency values amongst products in the market. Most of the third country identified legislations are mandatory Minimum Efficiency Performance Standards (MEPS). The aim of MEPS is to remove the least efficient appliances from the market. The following countries apply MEPS that include local room heating products:

- **USA**
  - Minimum Energy Performance Standard – Space heaters

Under the revised Energy Policy Act (EPAct) of 2005, minimum energy performance standards were set for heating, ventilation and air conditioning (HVAC) systems. In particular, gas room heaters from ENER Lot 20 products fall under this standard. The legislation sets Annual Fuel Utilisation Efficiency (AFUE), which is a thermal efficiency measure of combustion equipment[43]. The AFUE attempts to represent the actual, season-long, average efficiency of that piece of equipment, including the operating transients. The method for determining the AFUE for residential furnaces is the subject of ASHRAE Standard 103. Table 1.20 shows MEPS (AFUE) for gas room heaters.

Table 1.20: Energy efficiency standards for gas room heaters (USA)

Appliance	Capacity BTU/h	AFUE* [%]
Gas heater	Up to 18,000 *[5.3 kW]*	57
	over 18,000 *[5.3 kW]* up to 20,000 *[5.9 kW]*	58
	over 20,000 *[5.9 kW]* up to 27,000 *[7.9 kW]*	63
	over 27,000 *[7.9 kW]* up to 46,000 *[13.4 kW]*	64
	over 46,000 *[13.4 kW]*	65

* Annual Fuel Utilisation Efficiency

A new set of energy conservation standards (10 CFR Part 430) for direct heating equipment were introduced in June 2010 by the Department of Energy under the Energy Conservation Program (see Table 1.21). Compliance with the standards is required from April 2013.

[42] OECD/IEA, Mark Ellis (2007) Experience with Energy Efficiency regulations for Electrical Equipment

[43] AFUE is the seasonal or annual efficiency of a furnace or boiler measured as the percentage of the amount of fuel converted to space heat in proportion to the amount of fuel consumed. It takes into account the cyclic on/off operation and associated energy losses of the heating unit as it responds to changes in the load, which in turn is affected by changes in weather and occupant controls.

Table 1.21: Energy efficiency standards for direct heating equipment in USA from 2013

Fuel type	Appliance	Capacity BTU/h	AFUE* [%]
Direct heating equipment	Gas wall fan type	Up to 42,000 *[12.3 kW]*	75
		Over 42,000 *[12.3 kW]*	76
	Gas wall gravity type	Up to 27,000 *[7.9 kW]*	65
		Over 27,000 *[7.9 kW] and up to 46,000 [13.5 kW]*	66
		Up to 46,000 *[13.5 kW]*	67
	Gas floor	Up to 37,000 *[10.8 kW]*	57
		Over 37,000 *[10.8 kW]*	58
	Gas room	Up to 20,000 *[5.9 kW]*	61
		Over 20,000 *[5.9 kW] and up to 27,000 [7.9 kW]*	66
		Over 27,000 *[7.9 kW] and up to 46,000 [13.5 kW]*	67
		Up to 46,000 *[13.5 kW]*	68
	Gas hearth	Up to 20,000 *[5.9 kW]*	61
		Over 20,000 *[5.9 kW] and up to 27,000 [7.9 kW]*	66
		Over 27,000 *[7.9 kW] and up to 46,000 [13.5 kW]*	67
		Up to 46,000 *[13.5 kW]*	68

* Annual Fuel Utilisation Efficiency

A new set of energy conservation standards (10 CFR Part 430) for direct heating equipment were introduced in June 2010 by the Department of Energy under the Energy Conservation Program (see Table 1.21). Compliance with the standards is required from April 2013.

Table 1.22: Energy efficiency standards for direct heating equipment in USA from 2013

Fuel type	Appliance	Capacity BTU/h	AFUE* [%]
Direct heating equipment	Gas wall fan type	Up to 42,000 *[12.3 kW]*	75
		Over 42,000 *[12.3 kW]*	76
	Gas wall gravity type	Up to 27,000 *[7.9 kW]*	65
		Over 27,000 *[7.9 kW] and up to 46,000 [13.5 kW]*	66
		Up to 46,000 *[13.5 kW]*	67
	Gas floor	Up to 37,000 *[10.8 kW]*	57
		Over 37,000 *[10.8 kW]*	58

Fuel type	Appliance	Capacity BTU/h	AFUE* [%]
	Gas room	Up to 20,000 *[5.9 kW]*	61
		Over 20,000 *[5.9 kW] and up to 27,000 [7.9 kW]*	66
		Over 27,000 *[7.9 kW] and up to 46,000 [13.5 kW]*	67
		Up to 46,000 *[13.5 kW]*	68
	Gas hearth	Up to 20,000 *[5.9 kW]*	61
		Over 20,000 *[5.9 kW] and up to 27,000 [7.9 kW]*	66
		Over 27,000 *[7.9 kW] and up to 46,000 [13.5 kW]*	67
		Up to 46,000 *[13.5 kW]*	68

* Annual Fuel Utilisation Efficiency

- **Canada**
  - Energy Efficiency Regulations (CAN/CSA-P.11-2007 Gas-fired unit heaters)

A minimum energy efficiency standard for self-contained, automatically controlled, vented, gas-burning appliance that distributes warmed air without the use of ducts were introduced in 2008 in Canada. Heaters under this standard must be at least 80% thermal efficient at the maximum heat input nominal capacity.

- **Australia**
  - Minimum Energy Performance Standard (AS 4553-2000 [AG 103-2000] Gas space heating appliances)

This Australian MEPS was established on May 31st, 2000. Energy efficiency requirements apply to new gas space heating appliances (convectors, radiant convectors, wall furnaces) with natural draught or fan assisted combustion systems, constructed totally from new materials and components and intended for use with natural gas, town gas, liquefied petroleum gas (LPG) and tempered liquefied petroleum gas (TLP) with gas consumptions not exceeding 150 MJ/h (41.6 kW)[44].

- **Russia**
  - Minimum Energy Performance Standard for Heat Fans (GOST 17083-87: Electric fan heaters for household use)

This Russian MEPS was established under the Federal Agency on Technical Regulating and Metrology. The Reference Test Standard is IEC 60675. According to the standard GOST 17083-87, specific consumed power should be no more than:

- 1000 W x min/m^3 for fan heaters with capacity of 1.0 m^3/min
- 800 W x min/m^3 for fan heaters with capacity of 1.6 m^3/min
- 520 W x min/m^3 for fan heaters with capacity of 2.5 m^3/min

[44] Source: CLASP (Collaborative Labelling and Appliance Standards Program)

Maximum deviation of consumed power of a fan heater as well as of the heating element from the nominal one cannot exceed plus 5% and minus 10%. This standard has been in place since December 25th, 1987.

- **Japan**
  - Mandatory Label for space heaters

In April 2006, the revised Law Concerning the Rational Use of Energy came into effect that stipulating the obligation of retailers to make efforts for information provision, and a guideline was developed by the Retailer Evaluation Standard Subcommittee under Natural Resources and Energy. It mandates that retailers provide information of products at their stores using "National standard Energy-saving Label" which includes information such as energy consumption and expected electricity cost. The programme has been implemented since October 2006, and currently covers 17 products, of which "space heaters" are included.

1.3.3.2 Third country voluntary programmes

- **Australia**
  - Gas appliance Star Rating Scheme - Space Heaters

As a voluntary programme, the Gas appliance Star Rating label is administered by the Australian Gas Association (AGA). In order for appliances to be approved for sale, technical information must be provided to the AGA. This information allows an assessment of energy efficiency that determines the appliances star rating. Although the programme began in the early 1980's, the current label design was adopted in 1988. The rating system for ducted gas space heater uses Annual Energy Consumption (AEC) as the performance parameter for appliance labelling. The AEC of a heater is calculated based on 600 hours of heating operation per year at a heating load of 0.2 MJ/hr/m^3 (55.6 W/m^3). The Star rating represents the seasonal operating efficiency of the appliance working at heavy and light loads, and takes account of the standby energy consumption. An appliance with a seasonal operating efficiency of 50% is allocated 1 Star, with each additional Star for a 10% increase in efficiency to 90%, which is allocated 5 Stars. A minimum thermal efficiency of 70% is required by the standard (AS 4556, AG 106).

  - Top Energy Saver Award Winner (TESAW) - Space Heaters

This programme also falls under the test standard AS 4553-2000 (AG 103-2000). The Top Energy Saver Award Winner (TESAW) programme was established in 2004 and has replaced the previous Galaxy Energy Awards[45]. Appliances are granted the award if they achieve the efficiency benchmark set by the government (usually the top 5-10% of models on the market). The TESAW label is an endorsement label - it is complementary to the normal star rating label. This enables consumers to instantly recognise the most efficient models on the market. All appliances that carry a comparative energy rating label (gas and electric) are eligible.

[45] The Galaxy Energy Awards were run from 1988 to 2001, and recognised the most energy efficient energy-labelled electric and gas household appliances on the market. The Awards were initiated by the State Electricity Commission of Victoria in 1988 and were managed by the Sustainable Energy Authority of Victoria from 1994 to 1999. In 2000 and 2001, the Awards were jointly managed by Sustainable Energy Authority of Victoria and the Sustainable Energy Development Authority of NSW.

Each year, government officials review the energy efficiency of all products on the market. In consultation with industry, they set minimum energy efficiency criteria (usually a minimum star rating) for TESAW awards for the coming year. Once an award is granted, the manufacturer is eligible to display the TESAW label on the award winning product in retail stores and on promotional material pertaining to the product.

The eligibility criteria for a TESAW award in 2006 for flued gas space heaters (non-ducted) was to have minimum Star rating of 5 at least and that for flueless gas space heaters (non-ducted) was to have a Star rating of 5.8. The non-ducted flueless gas space heater was also required to have a thermostat and a room air circulating fan in order to be considered for the TESAW rating.

- **USA**
  - Gas Appliance Manufacturers Association (GAMA) Certification Program

This programme is managed by the Air conditioning, Heating, and Refrigeration Institute (AHRI) and concerns all gas and oil direct-heating equipment whose energy input ratings are within the parameters outlined below. The appliances covered by the programme are "vented home heating equipment" or "vented heater", which means a class of home heating equipment, not including furnaces, designed to furnish warm air to the living space of a residence, directly from the device, without duct connections (except that booths not to exceed 10 inches beyond the casing may be permitted) and includes: vented wall furnaces, vented floor furnace, and vented room heater.

- **"Vented floor furnaces"** means a self-contained vented heater suspended from the floor of the space being heated, taking air for combustion from outside this space. The vented floor furnace supplies heated air circulated by gravity or by a fan directly into the space to be heated through openings in the casing.
- **"Vented room heater"** means a self-contained, free standing, non-recessed, vented heater for furnishing warmed air to the space in which it is installed. The vented room heater supplies heated air circulated by gravity or by a fan directly into the space to be heated through openings in the casing.
- **"Vented wall furnace"** means a self-contained vented heater complete with grilles or the equivalent, designed for incorporation in, or permanent attachment to, a wall or a residence and furnishing heated air circulated by gravity or by a fan directly into the space to be heated through openings in the casing.

This programme independently verifies the energy efficiency (AFUE), and output (heating capacity, measured in million BTU/h).

- **Japan**
  - Top Runner Standards Program for Gas Space Heaters

The Top Runner standards programme was established in April 2003 and became effective in 2006. It is implemented by the Energy Conservation Centre of Japan. This programme aims to significantly improve energy efficiency of appliances by setting target values based on the current highest efficiency level of each type of product instead of the current average efficiency level. Manufacturers and importers have to ensure the average (sales weighted) efficiency of all

their appliances meets this standard by a specified date (the target year). The Top Runner standards are voluntary as there is no minimum level, however penalties can be evoked if the average efficiency target is not met. The Ministry of Economy Trade and Industry monitor the programme and it is legislated through the Energy Conservation Law. The programmes so far has been quite successful with most manufacturers gearing up to meet the targets. When the target year is reached, new target levels can be established. This programme concerns gas space heaters.

1.3.4 Summary subtask 1.3

In subtask 1.3, the existing legislations and labelling programmes corresponding to ENER Lot 20 products have been briefly presented at EU-27 level and also covering third countries legislations. At the EU level, legislations are in place covering the scope of ENER Lot 20 products, but they only require the heating appliances to adhere to safe operation during use phase and impose binding environmental regulations for end of life disposal and also to avoid use of certain hazardous substances during manufacturing. We could not identify any legislation at EU level which would require the rational use of heating appliances from an energy efficiency perspective.

The MEPS programmes in other countries around the world provide energy performance criteria for certain products covered in the ENER Lot 20 study especially for gas room heaters and electric fan heaters. These findings will be validated and updated using the stakeholders' feedback.

The legislations and labelling programmes concerning energy performance marking covered in this task are summarised in Table 1.23 below:

Table 1.23: Summary of worldwide energy performance legislations concerning ENER Lot 20 products

Country	Year adopted	Product category	Capacity range (kW)	Test standards	Performance criteria	Performance value
USA	2005	Gas room heaters	5.2 - 13.4	ASHRAE Standard 103	AFUE	57 – 65%
Canada	2003	Vented gas fireplace / fireplace heater		CSA-P.4.1-02, CSA 2.22 (fireplace), CSA 2.33 (fireplace heater),	Fireplace efficiency	None (EnerGuide mandatory labelling)
Canada	2008	Gas fired unit heaters		CAN/CSA-P.11-2007	Thermal efficiency	≥ 80%
Australia	2000	Gas space heaters		AS 4553-2000 [AG 103-2000]	Seasonal operating efficiency	
Russia	1987	Electric Fan Heaters		GOST 17083-87	Specific power consumption	

1.4 Conclusions Task 1

Task 1 presents an overview of the existing product categories of commonly used appliances for local space heating purposes. An elaboration of the considerations to define the scope of this ENER Lot 20 study justifies the proposal to treat them as decentralised space heating appliances **having a power capacity up to 20 kW for domestic heaters and up to 400 kW for non-residential heaters**[46]**.** The study defines local room heating products as decentralised space heating stand-alone devices that convert electricity, gaseous or liquid fuels directly into heat and then distribute it to provide heat indoors. These devices can be portable, fixed, or built-in and include:

- Convector heaters (electric, gas and liquid fuel)
- Oil-filled heaters (electric)
- Fan heaters (electric)
- Radiant heaters (electric and gas-fired)
- Storage heaters (electric)
- Thin film/cable heating system (electric)
- Fires (electric, gas and liquid fuel)
- Air curtains (electric and gas-fired)
- Industrial unit heaters (electric, gas and liquid fuel)

Most interpretations of the standards and legislations studied in this task seem to limit their scope to safety and environmental criteria for the local room space heaters with some information on the energy efficiency aspects. The scope of products investigated in this study will be finalised only after consultations with the Commission and the stakeholders.

[46] The final scope definition will be done in accordance with DG ENER and stakeholders. It is important to note that the scope, can be further refined when market and use data are investigated in Task 2 and 3, respectively. Further sub-categorisation may also be introduced based on the technical considerations that will be looked at in Task 4.

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