Review of Regulation 206/2012 and 626/2011

Air conditioners and comfort fans

Task 1 report

Final version

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Table of contents

List of tables

List of figures

Abbreviations

Cdc, Cdh	The cycling degradation coefficient for air conditioners in cooling (heating) mode
COP	Coefficient of Performance for air conditioners in heating mode
CDD	Cooling Degree Day
EER	Energy Efficiency Ratio for air conditioners in cooling mode
EPS	External Static Pressure for air conditioners
GNI	Gross national income
GWP	Global warming potential
H_{TO}	The number of hours the unit is considered to work in thermostat off mode for air conditioners
H_{SB}	The number of hours the unit is considered to work in standby mode for air conditioners
H_{CK}	The number of hours the unit is considered to work in crankcase heater mode for air conditioners
H_{OFF}	The number of hours the unit is considered to work in off mode for air conditioners
P_{TO}	The electricity consumption during thermostat off mode for air conditioners
P_{SB}	The electricity consumption during standby mode for air conditioners
P_{CK}	The electricity consumption during crankcase heater mode for air conditioners
P_{OFF}	The electricity consumption during off mode.
Q_{CE}	The reference annual cooling demand for air conditioners in cooling mode
Q_{HE}	The reference annual heating demand for air conditioners in heating mode
SHR	Sensible Heat Ratio for air conditioners
SEER	Seasonal Energy Efficiency Ratio for air conditioners, cooling mode
SCOP	Seasonal Coefficient of Performance for air conditioners, heating mode
VRF	Variable Refrigerant Flow

Introduction to the task reports

This is the introduction to the interim report of the preparatory study on the Review of Regulation 206/2012 and 626/2011 for air conditioners and comfort fans. The interim report has been split into five tasks, following the structure of the MEErP methodology. Each task report has been uploaded individually in the project's website. These task reports present the technical basis to define future ecodesign and energy labelling requirements based on the existing Regulation (EU) 206/2012 and 626/2011.

The task reports start with the definition of the scope for this review study (i.e. task 1), which assesses the current scope of the existing regulation in light of recent developments with relevant legislation, standardisation and voluntary agreements in the EU and abroad. Furthermore, assessing the possibility of merging implementing measures that cover the similar groups of products or extend the scope to include new product groups. The assessment results in a refined scope for this review study.

Following it is task 2, which updates the annual sales and stock of the products in scope according to recent and future market trends and estimates future stocks. Furthermore, it provides an update on the current development of low-GWP alternatives and sound pressure level.

Next task is task 3, which presents a detailed overview of use patterns of products in scope according to consumer use and technological developments. It also provides an analysis of other aspects that affect the energy consumption during the use of these products, such as component technologies. Furthermore, it also touches on aspects that are important for material and resource efficiency such as repair and maintenance, and it gives an overview of what happens to these products at their end of life.

Task 4 presents an analysis of current average technologies at product and component level, and it identifies the Best Available Technologies both at product and component level. An overview of the technical specifications as well as their overall energy consumption is provided when data is available. Finally, the chapter discusses possible design options to improve the resource efficiency.

Simplified tasks 5 & 6 report presents the base cases, which will be later used to define the current and future impact of the current air condition regulation if no action is taken. The report shows the base cases energy consumption at product category level and their life cycle costs. It also provides a high-level overview of the life cycle global warming potential of air conditioners and comfort fans giving an idea of the contribution of each life cycle stage to the overall environmental impact. Finally, it presents some identified design options which will be used to define reviewed ecodesign and energy labelling requirements.

Task 7 report presents the policy options for an amended ecodesign regulation on air conditioners and comfort fans. The options have been developed based on the work throughout this review study, dialogue with stakeholders and with the European Commission. The report presents an overview of the barriers and opportunities for the reviewed energy efficiency policy options, and the rationale for the new material/refrigerant efficiency policy options. This report will be the basis to calculate the estimated energy and material savings potentials by implementing these policy options, in comparison to no action (i.e. Business as Usual – BAU).

The task reports follow the MEErP methodology, with some adaptations which suit the study goals.

1 Task 1

Task 1 follows the MEErP methodology and includes the following:

- Product scope: Identification and assessment of relevant categories based on the existing ecodesign regulation, standardisation and measurement method activities and other relevant schemes and activities outside EU. Defining preliminary product scope, definitions and categorisations.
- Test standards: EU, Member State and third country level.
- Legislation: EU, Member State and third country level.

1.1 Product scope

The current scope of Commission Regulation (EU) No 206/2012 covers electric mains-operated air conditioners with a rated capacity of ≤ 12 kW for cooling, or heating if the product has no cooling function, and comfort fans with an electric fan power input ≤ 125W.

The current scope of Commission Delegated Regulation (EU) No 626/2011 covers electric mains-operated air conditioners with a rated capacity of ≤ 12 kW for cooling, or heating if the product has no cooling function.

The definition of air conditioners is presented and discussed in the next sub-section.

1.1.1 Existing definitions and categories

1.1.1.1 Existing definitions and categories in Ecodesign Regulation (EU) No 206/2012

Commission Regulation (EU) No 206/2012 establishes ecodesign requirements for air conditioners and comfort fans. The product definitions employed in the regulation are listed below.

Products and components that are within the scope of the Regulation are defined as:

Air conditioner means a device capable of cooling or heating, or both, indoor air, using a vapour compression cycle driven by an electric compressor, including air conditioners that provide additional functionalities such as dehumidification, air-purification, ventilation or supplemental air-heating by means of electric resistance heating, as well as appliances that may use water (either condensate water that is formed on the evaporator side or externally added water) for evaporation on the condenser, provided that the device is also able to function without the use of additional water, using air only.

Double duct air conditioner means an air conditioner in which, during cooling or heating, the condenser (or evaporator) intake air is introduced from the outdoor environment to the unit by a duct and rejected to the outdoor environment by a second duct, and which is placed wholly inside the space to be conditioned, near a wall.

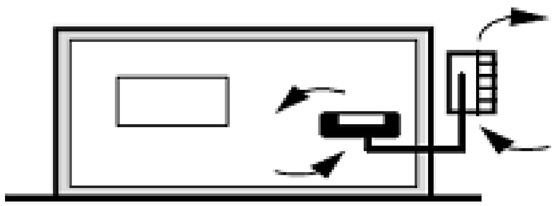
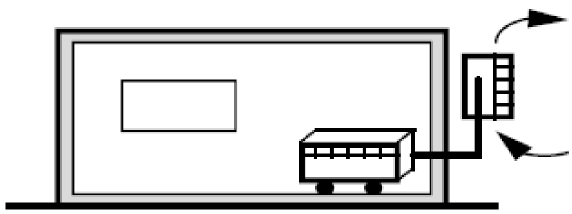
Single duct air conditioner means an air conditioner in which, during cooling or heating, the condenser (or evaporator) intake air is introduced from the space containing the unit and discharged outside this space.

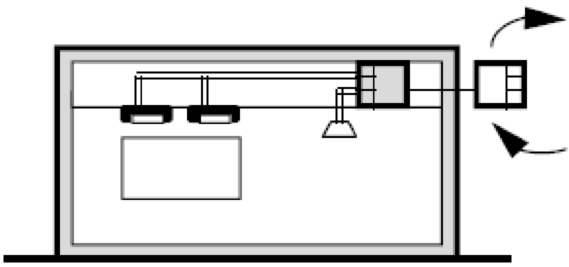
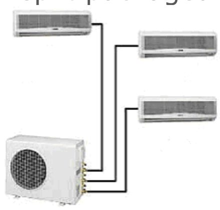
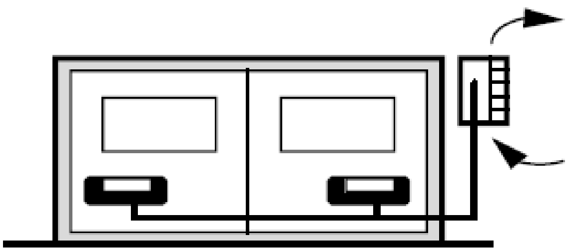
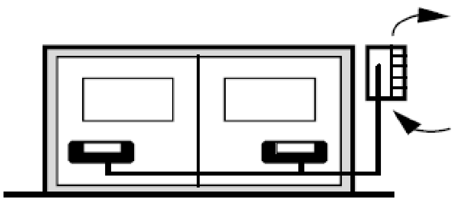
Comfort fan means an appliance primarily designed for creating air movement around or on part of a human body for personal cooling comfort, including comfort fans that can perform additional functionalities such as lighting.

Capacity limitation: the scope for air conditioners is limited to "air conditioners with a rated capacity of ≤ 12 kW for cooling, or heating if the product has no cooling function".

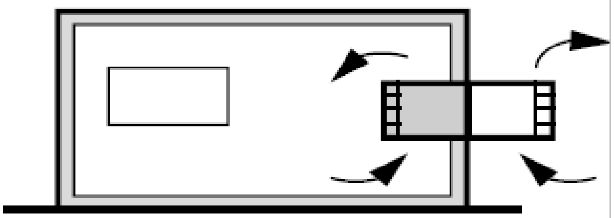
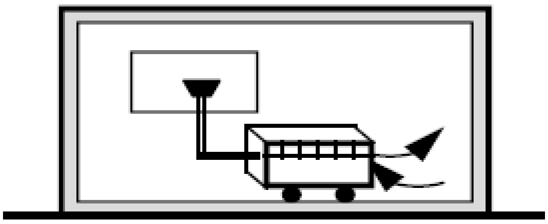
Table 1 below describes what are the common products within the scope of regulation 206/2012 as interpreted by the study team.

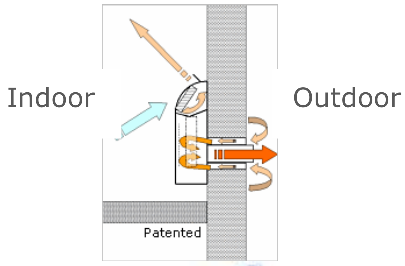
Table 1. Products in scope, categorisation and definitions.

Product group	Product category	Definition
Air conditioners - cooling only and reversible	Split (Non-ducted fixed split-packaged unit)  	A split-packaged unit is defined as a factory assembly of components of a refrigeration system fixed on two or more mountings to form a matched unit. This type of appliance comprises two packages (one indoor and one outdoor unit) connected only by the pipe that transfers the refrigerant. The indoor unit includes the evaporator (respectively condenser in heating mode) and a fan, while the outdoor unit has a fan, compressor and a condenser (respectively evaporator in heating mode). Fixed non-ducted indoor units can be mounted high on a wall, floor-mounted or as 'cassette', ceiling-suspended, built-in horizontal or built-in vertical.
	Mobile Split (Non-ducted split packaged unit with mobile indoor unit)  	Indoor unit(s) can be also be non-ducted and mobile. Mobile split units are often categorised at points of sales as mobile or portable air conditioners. Opposed to fixed split, the compressor is located in the indoor unit, while the outdoor unit only contains the condenser heat exchanger and fan. The outdoor unit for a mobile split can be either fixed or mobile.

Product group	Product category	Definition
	Ducted split packaged unit  	Indoor unit(s) for split can also be ducted. Ducted indoor units can deliver cool air to several rooms or to several spots within a single room.
	Multi-split packaged units  	Multi-split packaged units comprise several interior units (up to 4) connected to one exterior unit. These units are similar to split interior and exterior units. Indoor units can be ducted or non-ducted.
	Multi Variable Refrigerant Flow (VRF) units[1]  	This type of product is similar to multi-split packaged units, except instead of having one refrigerant connection between each indoor unit and the outdoor unit, the refrigerant is distributed in the building via a single connection to the outdoor unit. This product may allow to have heating and cooling in different zones of the building and heat recovery between zones, these options are not available for multi-split package air conditioners. These have been mostly non-residential products, but recently some manufacturers offer smaller systems ≤ 12 kW.

[1] Images source: http://york-vrf.com/

Product group	Product category	Definition
	Single-packaged unit, through the wall  	Single-packaged units, commonly known as 'window' or 'through-the-wall' air conditioners (respectively they are called "room air conditioners" and "package terminal air conditioners" in the USA), are strictly defined as a factory assembly of components of a refrigeration system fixed on a common mounting to form a single unit. This type of equipment comprises a single package, one side of which is in contact with the outside air heat release outside, while the other side provides direct cooling to the air inside. The two sides of the appliance are separated by a dividing wall, which is insulated to reduce heat transfer between the two sides. This type of air conditioners has relatively low sales in the EU but is more common in the USA.
	Single duct mobile air conditioner  	Single-packaged mobile units, commonly known as 'mobile' or 'portable' air conditioners comprise a single package, one side of which extracts indoor air to cool the condenser and releases it outdoor, while the other side provides direct cooling to the air indoor. The two sides of the appliance are separated by a dividing wall, which is insulated to reduce heat transfer between the two sides.

Product group	Product category	Definition
	Double duct air conditioner (through the wall installation)  	A double duct air conditioner is an evolution of the single duct. There are two main types. The first type is exactly similar to a single duct but a second hole at the condenser enables to take the condenser air from outside thus reducing outside air infiltration inside the room to be cooled. The second type is similar, but of a more permanent installation through the wall and in that case, the two ducts may be concentric.
Comfort fans	Comfort fans 	Comfort fans primary function is to increase air speed in such a manner the end user may feel more comfortable. Since air speed must not be increased too much to get acceptable comfort conditions and that comfort is likely to be increased if the air stream attains a larger part of the body, the function of the unit would then be “to move air inside a room” and the performance parameter to be kept is the air flow rate supplied by the fan. Comforts fans can be e.g. desk fans, floor standing fans, wall mounted fans, ceiling fans, tower fans, box fans, etc. The floor units typically have a high fan velocity and they are moving on the vertical axe, while the ceiling mounted unit has a lower fan velocity.

Comments on the definitions: Air conditioners can reject heat to different outdoor fluids (outdoor air, ventilation exhaust air, water/brine). Cooling can also be supplied to recycled air or to outdoor air (case of ventilation exhaust heat pumps / air conditioners). This is not clearly defined in the present regulation.

The definitions and scope of different ecodesign regulations should make sure all air conditioner / air to air heat pump types are covered. This is discussed in more details in part 1.1.3.

1.1.1.2 Existing definitions and categories in Ecodesign Regulation(EU) No 2016/2281

Commission Regulation (EU) No 2016/2281 is not under the current review, however the Regulation establishes definitions of various heat pumps, air conditioners and comfort chillers. These definitions are useful for understanding the differences between air conditioners and heat pumps covered by the different EU regulations, especially in relation to part 1.1.2 and 1.1.3, where the scope alignment and possible extension for the different types of air conditioners and heat pumps are discussed.

Heat pump means an air heating product:

A. of which the outdoor side heat exchanger (evaporator) extracts heat from ambient air, ventilation exhaust air, water, or ground heat sources;
B. which has a heat generator that uses a vapour compression cycle or a sorption cycle;
C. of which the indoor side heat exchanger (condenser) releases this heat to an air-based heating system;
D. which may be equipped with a supplementary heater;
E. which may operate in reverse in which case it functions as an **air conditioner**;

And the following types of heat pumps are defined as:

Air-to-air heat pump means a heat pump which has a heat generator that uses a vapour compression cycle driven by an electric motor or internal combustion engine and whereby the outdoor side heat exchanger (evaporator) allows heat transfer from ambient air and the indoor side condenser delivers the heat to the indoor air.

Water/brine-to-air heat pump means a heat pump which has a heat generator that uses a vapour compression cycle driven by an electric motor or internal combustion engine and whereby the outdoor side heat exchanger (evaporator) allows heat transfer from water or brine

Rooftop heat pump means an air-to-air heat pump, driven by an electric compressor, of which the evaporator, compressor and condenser are integrated into a single package.

Sorption cycle heat pump means a heat pump which has a heat generator that uses a sorption cycle relying on external combustion of fuels and/or other type of supply of heat.

Multi-split heat pump means a heat pump incorporating more than one indoor units, one or more refrigerating circuit, one or more compressors and one or more outdoor units, where the indoor units may or may not be individually controlled.

Air conditioner is defined differently by Regulation (EU) No 2016/2281 than from Regulation (EU) No 206/2012:

Air conditioner means a cooling product that provides space cooling and:

A. of which the indoor side heat exchanger (evaporator) extracts heat from an air-based cooling system (heat source)
B. which has a cold generator that uses a vapour compression cycle or a sorption cycle.
C. of which the outdoor side heat exchanger (condenser) releases this heat to ambient air, water or ground heat sink(s) and which may or may not include heat transfer that is based on evaporation of externally added water.
D. may operate in reverse in which case it functions as a **heat pump**;

Air-to-air air conditioner means an air conditioner which has a cold generator that uses a vapour compression cycle driven by an electric motor or internal combustion engine and whereby the outdoor side heat exchanger (condenser) allows heat transfer to air.

Water/brine-to-air air conditioner means an air conditioner which has a cold generator that uses a vapour compression cycle driven by an electric motor or internal combustion engine and whereby the outdoor side heat exchanger (condenser) allows heat transfer to water or brine.

Rooftop air conditioner means an air-to-air air conditioner, driven by an electric compressor, of which the evaporator, compressor and condenser are integrated into a single package.

Multi-split air conditioner means an air conditioner incorporating more than one indoor units, one or more refrigeration circuits, one or more compressors and one or more outdoor units, where the indoor units may or may not be individually controlled.

Sorption cycle air conditioner means an air conditioner which has a cold generator that uses a sorption cycle relying on external combustion of fuels and/or supply of heat.

Air-to-water comfort chiller means a comfort chiller that has a cold generator that uses a vapour compression cycle driven by an electric motor or internal combustion engine and whereby the outdoor side heat exchanger (condenser) allows heat transfer to air, including heat transfer that is based on evaporation into this air of externally added water, provided that the device is also able to function without the use of additional water, using air only.

Water/brine-to-water comfort chiller means a comfort chiller that has a cold generator that uses a vapour compression cycle driven by an electric motor or internal combustion engine and whereby the outdoor side heat exchanger (condenser) allows heat transfer to water or brine, excluding heat transfer that is based on evaporation of externally added water.

Sorption cycle comfort chiller means a comfort chiller which has a cold generator that uses a sorption cycle relying on external combustion of fuels and/or supply of heat.

Fan coil unit means a device that provides forced circulation of indoor air, for the purpose of one or more of heating, cooling, dehumidification and filtering of indoor air, for the thermal comfort of human beings, but which does not include the source of heating or cooling nor an outdoor side heat exchanger. The device may be equipped with minimal ductwork to guide the intake and exit of air, including conditioned air. The product may be designed to be built in or may have an enclosure allowing it be placed in the space to be conditioned. It may include a Joule effect heat generator designed to be used as back-up heater only.

Air heating product means a device that:

A. incorporates or provides heat to an air-based heating system;
B. is equipped with one or more heat generators; and
C. may include an air-based heating system for supplying heated air directly into the heated space by means of an air-moving device.

A heat generator designed for an air heating product and an air heating product housing designed to be equipped with such a heat generator shall, together, be considered as an air heating product.

Cooling product means a device that:

A. incorporates, or provides chilled air or water to, an air-based cooling system or water-based cooling system; and
B. is equipped with one or more cold generator(s).

A cold generator designed for use in a cooling product and a cooling product housing designed to be equipped with such a cold generator shall, together, be considered as a cooling product.

1.1.1.3 Prodcom (Eurostat) categories

There are a number of PRODCOM codes that relate to air conditioners and associated products that may be within scope of any potential future update to the ecodesign Regulation on air conditioners. The PRODCOM categories which are covering products relevant for this study are listed in the table below.

Table 2. Prodcom categories covering products relevant for this study.

	PRODCOM code	PRODCOM Nomenclature
Air conditioners	28.25.12.20	Window or wall air conditioning systems, self-contained or split-systems
	28.25.12.50	Air conditioning machines with refrigeration unit (excluding those used in motor vehicles, self-contained or split-systems machines)
	28.25.30.10	Parts for air conditioning machines (including condensers, absorbers, evaporators and generators)
Comfort fans	27.51.15.30	Table, floor, wall, window, ceiling or roof fans, with a self-contained electric motor of an output <= 125 W

1.1.1.4 Labelling categories (EU Energy Label and Eco-label)

EU Energy Label – The definitions used in the Energy Labelling Regulation 626/2011 are identical to the definitions in the ecodesign regulation. The definitions are listed in 1.1.1.1 Existing definitions

Eco-label – The EU Eco-label[2] for heat pumps has no specific definition of an air conditioner. The Eco-label specification describes the product category as heat pumps which also includes e.g. brine to water heat pumps and includes heat pumps driven by electricity, gas and gas absorption. The product group is defined as:

- The product group 'electrically driven, gas driven or gas absorption heat pumps' shall comprise heat pumps, which can concentrate energy present in the air, ground or water into useful heat for the supply of space heating or the opposite process for space cooling. A 'heat pump' is the device or set of devices as delivered by the manufacturer or importer to the distributor, retailer or installer. This delivery may or may not include the delivery of circulating pumps at the sink or source side, however for calculation of coefficient of performance (COP) values the methodology of EN14511:2004 is refered to (which includes part of circulator consumption). For gas absorption heat pumps the methodology shall be according to EN12309-2:2000.

1.1.2 Product scope alignment

There are several types of equipment available on the market which all are categorised as products for "space heating". These space heating products and corresponding regulations are presented in Figure 1. For simplicity, the figure categorises the different products into:

[2] http://ec.europa.eu/environment/ecolabel/eu-ecolabel-products-and-services.html

central heating or local (non-central) heating products, hydronic systems or dry systems products and cooling and ventilation. Local space heaters have the heat generator in the same room as the room that needs heating such as single duct air conditioners. Split/multisplit, double duct and multi variable refrigerant flow units are examples of central space heating units.

As the illustration below shows are multiple products somehow related to the products within the scope of EU 206/2012.

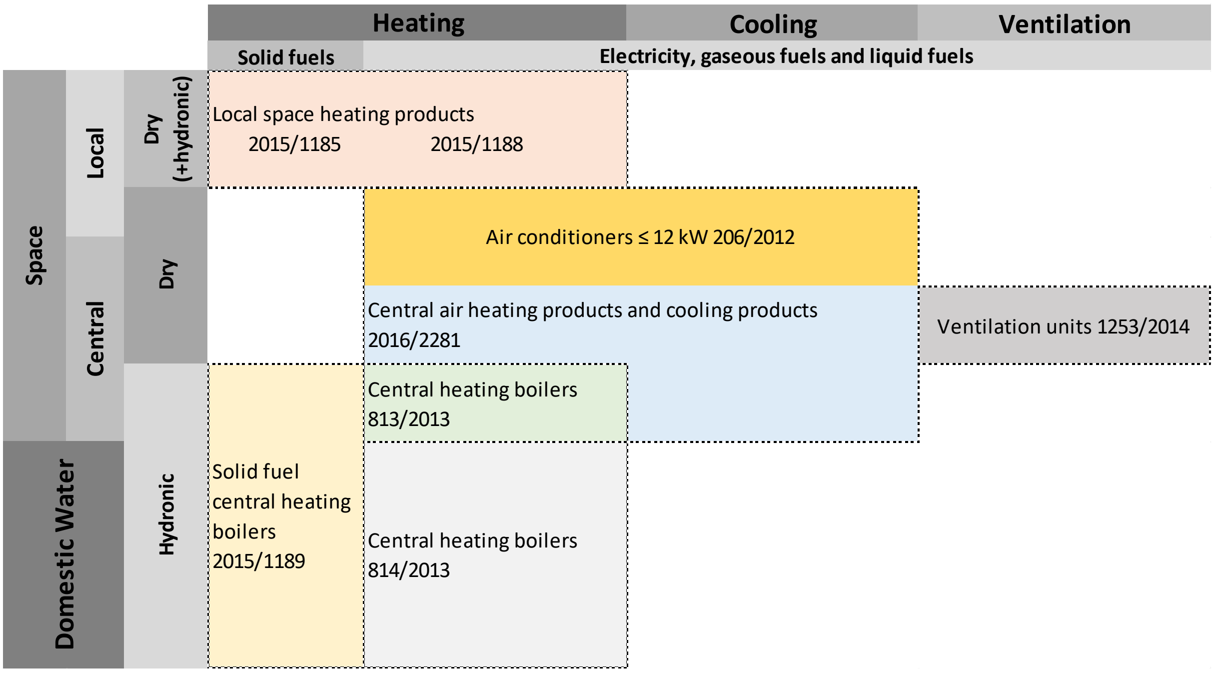


Figure 1: Division of the different products for space heating into sub-categories.[3]

The following regulations are closely connected to the EU regulation No 206/2012 (in the borders of the scope): Regulation (EU) No 2015/1188, Regulation (EU) No 2015/1185, Regulation (EU) No 2016/2281 and Regulation (EU) No 1253/2014. Their scope is described below and in general aligns well with the scope of Regulation No 206/2012:

Commission Regulation (EU) No 2015/1188 with regard to ecodesign requirements for local space heaters. Local space heaters are products that emit heat by direct heat transfer possibly in combination with heat transfer to a fluid. They are situated within the indoor space (rooms of houses or buildings, workshops, offices, warehouses, garages, hospitals, etc.) which they heat and in some cases they can in addition deliver heat to other spaces. The local space heaters under this Regulation are electric, gaseous or liquid fuel local space heaters. Outdoor heating products (e.g. terrace) are not within the scope. Air conditioners are also provided with heating functions but are though not within the scope due to scope exemption a) in the regulation.
This Regulation includes domestic local space heaters with a nominal heat output of 50 kW or less and commercial local space heaters with a nominal heat output of the product or of a single segment of 120 kW or less.

[3] http://www.eceee.org/static/media/uploads/site-2/ecodesign/products/lot-20-local-room-heating-products/bio-eup-lot20-task-1-final-report.pdf

The regulation does not apply to:

a) local space heaters using a vapour compression cycle or sorption cycle for the generation of heat driven by electric compressors or fuel;
b) local space heaters specified for purposes other than indoor space heating to reach and maintain a certain thermal comfort of human beings by means of heat convection or heat radiation;
c) local space heaters that are specified for outdoor use only;
d) local space heaters of which the direct heat output is less than 6 % of the combined direct and indirect heat output at nominal heat output;
e) air heating products;
f) sauna stoves;
g) slave heaters.

Commission Regulation (EU) No 2015/1185 with regard to ecodesign requirements for solid fuel local space heaters. Solid fuel space heaters are also local space heaters but are fired by solid fuels with a nominal heat output of 50 kW or less. Products within this scope are e.g. stoves and fireplaces and will not further be described here.

Commission Regulation (EU) No 2016/2281 with regard to ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units. See definitions of the products covered by this Regulation in Section 1.1.1.2. This regulation exempts the products that are already covered by an ecodesign regulation, air conditioners and comfort fans within the scope of Regulation (EU) No 206/2012 are clearly out of the scope by the exemption item b), see below.
The regulation of air heating products includes:

a) air heating products with a rated heating capacity not exceeding 1 MW;
b) cooling products and high temperature process chillers with a rated cooling capacity not exceeding 2 MW;
c) fan coil units.

The regulation has the following exemptions:

a) products covered by Commission Regulation (EU) 2015/1188 with regard to ecodesign requirements for local space heaters;
b) products covered by Commission Regulation (EU) No 206/2012 with regard to ecodesign requirements for air conditioners and comfort fans;
c) products covered by Commission Regulation (EU) No 813/2013 with regard to ecodesign requirements for space heaters and combination heaters;
d) products covered by Commission Regulation (EU) 2015/1095 with regard to ecodesign requirements for professional refrigerated storage cabinets, blast cabinets, condensing units and process chillers;
e) comfort chillers with leaving chilled water temperatures of less than + 2 °C and high temperature process chillers with leaving chilled water temperatures of less than + 2 °C or more than + 12 °C;
f) products designed for using predominantly biomass fuels;
g) products using solid fuels;
h) products that supply heat or cold in combination with electric power (‘cogeneration’) by means of a fuel combustion or conversion process;

i) products included in installations covered by Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions;
j) high temperature process chillers exclusively using evaporative condensing;
k) custom-made products assembled on site, made on a one-off basis;
l) high temperature process chillers in which refrigeration is effected by an absorption process that uses heat as the energy source; and
m) air heating and/or cooling products of which the primary function is the purpose of producing or storing perishable materials at specified temperatures by commercial, institutional or industrial facilities and of which space heating and/or space cooling is a secondary function and for which the energy efficiency of the space heating and/ or space cooling function is dependent on that of the primary function.

Commission Regulation (EU) 1253/2014 with regard to ecodesign requirements for ventilation units. This Regulation applies to ventilation units and establishes ecodesign requirements for their placing on the market or putting into service. Some ventilation units are equipped with a regenerative heat exchanger which means that a rotary heat exchanger incorporating a rotating wheel for transferring thermal energy from one air stream to another air stream. These types of products have a different function/purpose and are therefore not further described.
In this regulation, reference is made to ventilation exhaust heat pumps for air heating purpose because of possible additional pressure losses, but ventilation exhaust air heating heat pumps and air cooling air conditioners are not in the scope of this regulation.

Commission Regulation (EU) 327/2011 with regard to ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW. The products that falls under the scope of this regulation are not considered as a local space heater, though it is assessed in relation to comfort fans. The scope includes fans between 125 W and 500 kW, which aligns well with the scope of No 206/2012 for comfort fans ≤125 W. Regarding fans included in air conditioners with cooling power below 12 kW, there is a limited overlap with Regulation (EU) No 206/2012; it regards parts of the fans in ducted outdoor and indoor units, for larger static pressure difference and cooling capacity ranges (and thus air flows).

Commission Regulation (EC) No 640/2009 with regard to ecodesign requirements for electric motors. and its amendment Commission Regulation (EU) No 4/2014. The current scope includes electric three-phase AC motors with output in the range 0.75-375 kW. With the current scope, there is no overlapping of motors used for comfort fans ≤125 W. All fan motors covered by Regulation (EU) 206/2012 have unitary power well below 0.75 kW and motors of compressors are not included in Commission Regulation (EC) No 640/2009 because they are hermetic motors incorporated in the compressor shell (hermetic non accessible).

1.1.3 Assessment of extending product scope

This assessment focuses on products that are not included in any regulation and whether they should be included in the scope of this study. This assessment is made to assure alignment of the different regulations and to avoid any loopholes.

Air Conditioners

Air conditioners – Air conditioners are covered by Regulation (EU) No 206/2012 and 626/2011 if their cooling capacity is lower than or equal to 12 kW. Table 3 proposes a synthesis of the different air conditioner and cooling generator types and of their inclusion in existing Ecodesign and labelling regulations.

Table 3: Synthesis of the different air conditioner and cooling generator types and of their inclusion in existing Ecodesign and labelling regulations

Product in scope					
Outdoor side	Indoor side	Capacity threshold	Usual product names	Ecodesign Regulation	Labelling regulation
Outdoor air	Recycled air	≤ 12 kW	Split, multi-split, window, through-the-wall, double duct air conditioners	206/2012	626/2011
Exhaust air	Recycled air	≤ 12 kW	Single duct air conditioners	206/2012	626/2011
Other relevant products					
Outdoor side	Indoor side	Capacity threshold	Usual product names	Ecodesign Regulation	Labelling regulation
Outdoor air	Recycled air	> 12 kW	Split, multi-split, VRF, Rooftop air conditioners	2281/2016	None
Water/ brine	Recycled air	None	Water cooled air conditioners / heat pumps	2281/2016	None
Exhaust air	Outdoor air	≤ 12 kW	Ventilation exhaust air-to-air heat pumps and air conditioners (possibly reversible)	None or 206/2012?	None
Exhaust air	Outdoor air	> 12 kW	Ventilation exhaust air-to-air heat pumps and air conditioners (possibly reversible)	2281/2016	None
Air	Water	None	Air cooled chillers (cooling only)	2281/2016	None
Water/ Brine	Water	None	Water cooled chillers (cooling only)	2281/2016	None
Air	Water	≤ 400 kW (Ecodesign) / ≤ 70 kW (Label)	Air-to-water reversible chillers (heating function only)	813/2013	811/ 2013
Water/ Brine	Water	≤ 400 kW (Ecodesign) / ≤ 70 kW (Label)	Water/brine-to-water reversible chillers (heating function only)	813/2013	811/ 2013
Outdoor air	Recycled air	None	Cooling/heating electric vapor compression cycle generators in air handling units (except rooftops)	None	None

There are several product groups considered for scope extension of the regulation of air conditioners:

Air conditioners > 12 kW are not within the scope of regulation No 206/2012. This was a potential loophole until the adoption of regulation (EU) No 2016/2281 with regard to ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units. This regulation covers all air conditioners above 12 kW and up to a rated heating capacity not exceeding 1 MW.

Water/brine-to-air air conditioners and heat pumps, which were not covered in Regulation (EU) No 206/2012, are now covered by Regulation (EU) No 2016/2281: 'heat generator' definition includes 'ambient air, ventilation exhaust air, water or ground heat source(s)';'cold generator' definition specifies that heat extracted can be 'transferred to a heat sink, such as ambient air, water or ground'. Ecodesign requirements regarding water/brine-to-air air conditioners are information requirements defined in Annex II / 5 / a / 4 of the Regulation (EU) No 2016/2281. Ecodesign requirements regarding water/brine-to-air heat pumps are covered by information requirement in Annex II / 5 / a / 6 of Regulation (EU) No 2016/2281.

Ventilation exhaust air-to-air heat pumps and air conditioners ≤ 12 kW are not explicitly in the scope of regulation No 206/2012, nor are they clearly excluded, as the type of indoor air used in the definition of air conditioners is unspecified ("a device capable of cooling or heating, or both, indoor air"). These products with rated capacity of 12 kW and above are quoted in regulation No 2016/2281 in the definition of 'heat pump' Information requirements in regulation No 2016/2281 apply to them, although there is not yet any part load conditions for these products to rate SEER and SCOP performances; residential exhaust air-to-air heat pumps often have cooling / heating capacity ≤ 12 kW, these are not currently included other regulations. It is advised to include these products in the scope of Regulation (EU) No 206/2012 and 626/2011 when their thermal power is below or equal to12 kW and to specify SEER and SCOP rating conditions. This also implies better specification of which air is used indoor and outdoor for air conditioners and heat pumps in Regulation (EU) No 206/2012. Test conditions for temperature and load to enable calculation of SEER / SCOP are proposed in Annex 1 to this report.

Ventilation exhaust air-to-air heat pump and air conditioners > 12 kW appears to be covered in Regulation (EU) No 2016/2281, 'ventilation exhaust air' is included in the 'heat generator' definition as a possible heat source; 'cold generator' definition specifies that heat extracted can be 'transferred to a heat sink, such as ambient air, water or ground', although it does not target explicitly 'ventilation exhaust air', it does not exclude it. Standard rating conditions are given for these products in Regulation Annex III table 16. Information requirements table for both air-to-air air conditioners (Annex II table 11) and air-to-air heat pumps (Annex II table 14) could be used. However, it should be noticed that there is not yet any specific part load conditions defined for exhaust-air-to-outdoor-air heat pump and air conditioners in EN14825:2016 nor in Regulation (EU) No 2016/2281.

Air or water cooled chillers (cooling only) are a possible air conditioner competitor in residential or service premises. However, these are covered by regulation (EU) No 2016/2281.

Air-to-water reversible chillers are a possible air conditioner competitor in residential or service premises. Regulation (EU) No 2016/2281 covers in general chillers, however it should be noted that Commission Regulation (EU) No 813/2013 only covers the chiller heating function. Thus, it is recommended also to include the cooling as the secondary function of air-to-water reversible chillers when revising the Regulation (EU) No813/2013.

Water/brine-to-water reversible chillers are a possible air conditioner competitor in residential or service premises. Regulation (EU) No 2016/2281 covers in general chillers, however it should be noted that Commission Regulation (EU) No 813/2013 only cover the chiller heating function only. Thus, it is recommended to include the cooling as the secondary function of water / brine-to-water reversible chillers when revising the Regulation (EU) No 813/2013.

Cooling generators in air handling units (except rooftops) are not sold separately (as rooftop) but sold as a component of a specific air handling unit to pre-cool / pre-heat fresh air. According information available to the study team, these are not included in any EU Ecodesign or Labelling regulation. As a component of air handling units, these products were considered in ENTR Lot 6 study for air-conditioning and ventilation systems, but they were excluded from product scope because of low sales volumes. If cooling generators in air handling units should be included in any regulation, it should then be in regulations (EU) No 2016/2281 or in (EU) No 2014/1253.

Secondary functions of air conditioners
Air conditioners now commonly propose several functions in addition to heating and cooling. This includes air purifying, dehumidification and air movement (only the indoor fan is on). These additional functions are mentioned in Regulation (EU) No 206/2012 definition for air conditioners.

However, room air conditioning products with other primary functions than space cooling/heating and air movement creation were excluded from the scope of preparatory study for air conditioners based on their low market sales and consequent low EU energy consumption. This regards in particular dehumidifiers and air purifiers. There was no reliable data showing these markets became significant enough to justify ecodesign measures, however it should be noted that these are growing markets. The preparatory study to establish the Ecodesign Working Plan 2015-2017[4] reported a lack of data for EU-27, and an estimated annual primary energy consumption of dehumidifiers of 0.25 TWh, much greater consumption found for humidifiers of 23.6 TWh, especially steam humidifiers.

The dehumidification capability, measured by the sensible- heat ratio (SHR), is drastically reduced when operating in cooling mode, according to EU test laboratories. It means that to dehumidify, end-users would need to use the separate dehumidification mode of air conditioners or to buy an additional equipment for dehumidifying in the cooling season. However, there is presently no standardized operating conditions to establish the performance of the dehumidification function of air conditioners.

Comfort fans
Comfort fans are covered by Regulation (EU) No 206/2012 and 626/2011 if their fan power input is lower than 125 W.

Table 4 proposes a synthesis of the different fan types and of their inclusion in existing Ecodesign and labelling regulations.

Table 4: Synthesis of the different fan types and of their inclusion in existing Ecodesign and labelling regulations

Capacity threshold	Usual product names	Ecodesign Regulation	Labelling regulation
< 125 W	Comfort fans	206/2012	626/2011
Capacity threshold	Usual product names	Ecodesign Regulation	Labelling regulation
> 125 W	Fans, ventilation units	327/2011	None
nominal heat output of < 50 kW	Residential fan heaters	2015/1188	None

4 https://www.vdma.org/documents/266687/344832/Ecodesign+WP3_Draft_Task_3_report_20140616_1500.pdf/d7f57d0c-3158-4194-aa89-d376894d7307

There are several product groups considered for scope extension of comfort fans however the following assessment shows that none of the product groups requires modification of the scope of the Regulation (EU) No 206/2012 and 626/2011. The product groups considered are:

Comfort fans with ≥ 125 W input power are not within the scope of the regulation No 206/2012. Instead these products are included in the regulation (EU) No 327/2011 with regard to ecodesign requirements for fans driven by motors with an electric input power between 125 W and 500 kW. The current assessment shows that there is no loophole for comfort fans with an input power of 125 W or above, and not necessary to extend the scope of No 206/2012.

Residential fan heaters are not within the scope of the regulation No 206/2012 though part of them are able to provide the same service as comfort fans when heating is turned off; comfort fans are defined in Regulation No 206/2012 as ' appliance[s] primarily designed for creating air movement around or on part of a human body for personal cooling comfort', whereas the primary function of fan heaters is likely to be heating. Residential fan heaters are included in the regulation (EU) No 2015/1188 for local space heaters and are specified as a portable local room heater in the explanatory notes[5].Hence their primary function is already covered in Regulation (EU) No 2015/1188. With much higher energy consumption for heating as compared to the comfort fan function only, ecodesign should stay focused on the primary function. However, as they are able to compete with comfort fans, it would have an added value for end-users to have comparable information for the secondary function as is required for comfort fans. Thus, it is recommended to include information requirement on the "air movement" function of residential fan heaters in Regulation (EU) No 2015/1188 (similar to the information requirement for comfort fans in Regulation 206/2012).

Evaporative coolers such as “misting fans” are not within the scope of Regulation No 206/2012, as the main principle for cooling is the evaporation of water, not air movement created by a fan.

1.1.4 Recommended product scope

In conclusion, the scope of ecodesign regulations of different air cooling and heating product are well aligned, however there are two concerns.

First of all, there is a possibility that ventilation exhaust air-to-air heat pumps and air conditioners ≤ 12 kW are not clearly covered by any regulation. They are not especially excluded from Regulation No 206/2012, hence it is recommended to include ventilation exhaust air-to-air heat pumps and air conditioners with heating or cooling capacity ≤ 12 kW in the revised scope. The draft definitions of exhaust air-to-air heat pumps and air conditioners are:

- ‘Ventilation exhaust air to outdoor air heat pump” means a heat pump that extracts heat from the exhaust air of a building to supply it to the ventilation supply air for the thermal comfort of human beings by a compression cycle or a sorption cycle. The ventilation outdoor air passes through the condenser of the heat pump before entering the building. The exhaust air passes through the evaporator of the heat

[5] http://edit.eceee.org/ecodesign/products/solid_fuel_small_combustion_installations/LRHS-20120716ExplanatoryNotesFINAL.PDF

pump before being rejected outdoors. The unit can also be equipped with a heat recovery heat exchanger.

- ‘Ventilation exhaust air to outdoor air conditioner” means an air conditioner that extracts heat from the ventilation inlet air of a building to supply it to the ventilation exhaust air for the thermal comfort of human beings by a compression cycle or a sorption cycle. The ventilation outdoor air passes through the evaporator of the air conditioner before entering the building. The exhaust air passes through the condenser of the air conditioner before being rejected outdoors. The unit can also be equipped with a heat recovery heat exchanger.

The definition of a heat pump and air-to-air heat pump will also be added to the regulation. The definitions will be adapted from Regulation (EU) No 2016/2281 and are described above in section 1.1.1.2. Secondly, an additional function of residential fan heaters, currently covered by Regulation (EU) No 2015/1188, could be “creating air movement around or on part of a human body for personal cooling comfort”. This means it could be a competitor for comfort fans, information requirements on the “air movement” function of residential fan heaters could give end-users valuable comparable information. It is recommended that during the revision of Regulation (EU) No 2015/1188, similar information requirements for comfort fans are proposed for residential fan heaters targeting this secondary function. However, these are not proposed to be included in Regulation No 206/2012.

Regarding cooling and heating, the regulation (EU) No 2012/206 did not include non-electric energy sources. In fact, there is presently no product using gas or other energy sources besides electricity for air conditioners. Extending the scope of Regulation (EU) No 206/2012 to non-electric energy sources would make it difficult for manufacturers to design products using non-electric energy sources, as they may not be able to reach the efficiency limit, at the same time it may also hinder innovation for air conditioners using renewable energy sources, such as biogas. Consequently, it is advised to keep non-electric energy sources outside of the scope.

The exemptions to the product scope are still as follows:

a. appliances that use non-electric energy sources;
b. air conditioners of which the condenser side or evaporator side, or both, do not use air for heat transfer medium.

The proposed product scope for Regulation 206/2012 is summarised in Table 5.

Table 5: Recommended product scope.

Categories	Products included	Scope limits
Outdoor air / recycled air	Split, multi-split, window, through-the-wall, double duct, multi-split mini VRF	Cooling (heating) power ≤12 kW
Exhaust air / recycled air	Single duct	
Exhaust air / outdoor air	Heat recovery ventilation heat pump / air conditioner	Cooling (heating) power ≤12 kW
Comfort fans	Desk fans, floor standing fans, wall mounted fans, ceiling fans, tower fans, box fans, etc. Portable fan heater with comfort fan mode.	Electric fan power ≤ 125W

1.2 Test standards (EU, Member State and third country level)

There is a significant number of EN standards either published, or under development, to support European Union environmental legislation. To a certain extent, they cover air conditioners. This relevant EU environmental legislation includes:

- Ecodesign Directive[6]
- Machinery Directive[7]
- Waste Electrical and Electronic Equipment Directive (WEEE)[8]
- Restriction of Hazardous Substances Directive (RoHS)[9]
- Electromagnetic Compatibility Directive (EMC)[10]
- Low Voltage Directive (LVD)[11]
- Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) Regulation[12]
- Regulation EU 517/2014 regarding fluorinated greenhouse gases

We focus hereafter on main standards as regards air conditioners and comfort fans, which are described by main domain:

- Energy performance for primary function
- Energy performance for secondary functions of air conditioners
- Noise
- Safety (including refrigerant and electricity)
- WEEE and RoHS standards

1.2.1 Energy performance for primary functions

According to the preparatory study[13], the main environmental impact of products in the scope of Regulation 206/2012 and 626/2011 is due to energy consumption in the use phase. Standards related to rating the energy performance of air conditioning and comfort fans are described below.

1.2.1.1 European standards

Standards regarding energy performance of EU Regulation 206/2012/EU and EU Regulation – 626/2011 are:

- **EN14511** which defines the rated performance and measurement methods to be used for all air conditioners in cooling and in heating mode, with the exception of air conditioners with evaporatively-cooled condensers whose ratings are defined in **EN15218** standard.
- For other than single duct, double duct and evaporatively cooled air conditioners, the standard **EN14825** defines the calculation and testing points to calculate the seasonal energy efficiency (SEER) and seasonal coefficient of performance (SCOP) and completes where required measurement methods defined in standard EN14511.

[6] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0125
[7] http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32006L0042&from=FR
[8] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0019
[9] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011L0065
[10] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004L0108
[11] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014L0035
[12] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006R1907
[13] Preparatory study on the environmental performance of residential room conditioning appliances (airco and ventilation), Contract TREN/D1/40-2005/LOT10/S07.56606. CO-ORDINATOR: Philippe RIVIERE, ARMINES, France. Air conditioners, final report. December 2008. This report can be downloaded from DG ENERGY website: https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficient-products.

- **Standby and off** mode power consumption measurement method is specified in EN14511-3 for single duct and double duct air conditioners, in EN15218 for evaporatively cooled single duct or double duct air conditioners and in the EN14825 standard for other air conditioners. For comfort fans, the horizontal standard for measurement of standby and off mode consumption indicated in the transitional methods[14] is EN60321:2005, now replaced with EN50564:2011.
- Regarding the energy efficiency of comfort fan, measured through their service value (SV) ($m^3.min^{-1}.W^{-1}$), there is no harmonized standard and transitional methods refer to standard **IEC 60879**:1986/COR1:1992, which is described in the International standards section.

EN 14511:2013 Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling. The standard is divided in 4 parts which are: scope, terms and definitions, test conditions, test methods and requirements. This standard defines test conditions for rating the performances of the units at their maximum available capacity for these operating conditions; only the tests in the standard conditions are mandatory, application conditions are facultative. The test conditions are defined in cooling mode and the heating mode following the classification by outdoor side and indoor side fluids. Rating conditions in heating and cooling mode are given in Table 6 and Table 7.

Table 6: Air to air, testing conditions in the heating mode (EN14511-2:2013)

		Outdoor heat exchanger		Indoor heat exchanger	
		Inlet dry bulb temperature °C	**Inlet wet bulb temperature °C**	**Inlet dry bulb temperature °C**	**Inlet wet bulb temperature °C**
Standard rating Conditions	Outdoor air / recycled air (e.g. window, double duct, split units)	7	6	20	15 max
	Exhaust air / recycled air (e.g. single duct heat pump)	20	12	20	12
	Exhaust air / outdoor air	20	12	7	6
Application rating conditions	Outdoor air / recycled air (e.g. window, double duct, split units)	2	1	20	15 max.
	Outdoor air / recycled air (e.g. window, double duct, split units)	- 7	- 8	20	15 max.
	Outdoor air / recycled air (e.g. window, double duct, split units)	- 15	-	20	15 max.
	Exhaust air / outdoor air	20	12	2	1
	Exhaust air / outdoor air	20	12	-7	-8

[14] http://eur-lex.europa.eu/legal-content/FR/TXT/?uri=uriserv:OJ.C_.2012.172.01.0001.01.FRA&toc=OJ:C:2012:172:TOC

Table 7: Air to air, testing conditions in the cooling mode (EN14511-2:2013)

		Outdoor heat exchanger		Indoor heat exchanger	
		Inlet dry bulb temperature °C	**Inlet wet bulb temperature °C**	**Inlet dry bulb temperature °C**	**Inlet wet bulb temperature °C**
Standard rating Conditions	Comfort (outdoor air / recycled air) (e.g. window, double duct, split units)	35	24 [a]	27	19
	Comfort (exhaust air / recycled air)	27	19	27	19
	Comfort (exhaust air / outdoor air)	27	19	35	24
	Single duct[b,c]	35	24	35	24
	Control cabinet	35	24	35	24
	Close control	35	24	24	17
Application rating conditions	Comfort (outdoor air / recycled air) (e.g. window, double duct, split units)	27	19 [a]	21	15
	Single duct [b,c]	27	19	27	19
	Comfort (outdoor air / recycled air)	46	24 [a]	29	19
	Control cabinet	50	30	35	24
	Close control	27	19	21	15

[a] The wet bulb temperature condition is not required when testing units which do not evaporate condensate.
[b] When using the calorimeter room method, pressure equilibrium between indoor and outdoor compartments shall be obtained by introducing into indoor compartment, air at the same rating temperature conditions.
[c] The pressure difference between the two compartments of the calorimeter room shall not be greater than 1,25 Pa. This pressure equilibrium can be achieved by using an equalizing device or by creating an open space area in the separation partition wall, which dimensions shall be calculated for the maximum airflow of the unit to be tested. If an open space is created in the partition wall, an air sampling device or several temperature sensors shall be used to measure the temperature of the air from the outdoor compartment to the indoor compartment.

Rated capacity conditions for inverter air conditioners (except single duct)

The rated cooling capacity of the unit is determined at standard rating conditions (outdoor air 35 °C / indoor air 27 °C / chosen compressor frequency). For units with single speed compressors, this used to be the maximum capacity of the unit in cooling mode. However, for inverter drive compressor units, this is a design choice made by the manufacturer. This is the rated capacity that appears in product information and, as such, this value is used to determine if the unit is included or excluded in Regulation (EU) No 206/2012 (included if the cooling capacity lies below 12 kW). The rated cooling capacity and performance at standard rating conditions is an input to the SEER according to EN14825:2016 standard (see below). This means that the compressor frequency chosen to declare the cooling capacity has an influence on the energy performance, in cooling mode.

However, in heating mode, if the capacity standard rating conditions (outdoor air 7 °C / indoor air 20 °C / chosen frequency) is still used for heating only air-to-air heat pumps to classify the unit in the scope of Regulation (EU) No 206/2012 (if heating capacity is lower than 12 kW), this capacity and related COP are not used in SCOP calculation. It means that the manufacturers freely can adjust the frequency of this point to optimize the declared rated heating capacity and/or sound power value. Consequently, the reference to standard rated conditions in heating mode is to be modified in Regulation (EU) No 206/2012 to take this point into account.

Testing method, measurement uncertainty

Two testing methods are defined, namely the enthalpy method, which consists in the direct measurement of the thermal (heating or cooling) capacity by measurement of air flow rates and inlet and outlet enthalpies. The other method is the indirect “calorimeter room” method that measures the heat (and water for the cooling mode) that have been removed from the ambiance by the indoor heat exchanger. This latter method is reputed less uncertain than the direct measurement method. It is explicitly mentioned that "the cooling capacity of air conditioners and of air-to-air heat pumps having a cooling capacity below or equal to 12 kW shall be determined by measurements in a calorimeter room". There is a problem to test multisplit units with too many indoor units for all EU test laboratories (the precise number varies depending on the indoor unit type and the test cell size, but for instance it is not possible to test more than 4 indoor wall units).

The same test method is to be used at standard rating conditions and at part load as EN14825 standard refers to EN14511-3 as regards steady state test methods.

Maximum values regarding uncertainty of measurement are defined:

- 5 %, for steady state heating or cooling capacities, using the calorimeter room, except for single duct because of the air exchange between the indoor and outdoor compartments for which 10% is required,
- 10 % for transient tests (defrost cycles) and when using the direct measurement on the air side.

For single duct air conditioners and double duct air conditioners, the cooling capacity delivered to the indoor side heat exchanger is decreased in real life conditions because of unbalanced air flows at condenser side. For single duct air conditioners, the air flow entering the condenser and leaving the building must be balanced by hot air entering the building. If the outdoor air temperature is higher than the indoor air set point (27 °C), hot air is introduced into the building and this decreases the real-life capacity of the unit. This infiltration effect is not taken into account for single duct air conditioners because both indoor and outdoor air set points are 27 °C so that the effect of infiltration of outdoor air is null. For double duct units, infiltration occurs in case of condenser air flow leakage into the building. This is however already considered in the present EN14511-3 test standard.

A second effect is that with hot air circulating in ducts inside the building there are heat leaks to the conditioned space (in the case of double duct to be installed directly on the wall, this is probably minimal). This heat is considered in the calorimeter room method but the conditions of tests consider a shorter duct connection(s) for testing constraints than supplied by manufacturers. This effect is then minimized. In addition, the effect is not quantified.

Fan correction

For ducted units, with available static pressure, a correction is made to account only for a portion of the fan electric consumption. For indoor units, the cooling / heating capacity is also corrected.

The standard specifies that: "If a fan is an integral part of the unit (this is the normal situation for products in scope of this study and mainly regards ducted split and multi-split air conditioners), only a fraction of the input of the fan motor shall be included in the effective power absorbed by the unit. The fraction that is to be excluded from the total power absorbed by the unit shall be calculated using the following formula":

$$\frac{q.(\Delta p_e - ESP_{min})}{\eta}$$

- η is equal to η_{target}; as declared by the fan manufacturer according to the ecodesign regulation n°327/2011 for fans driven by motors between 125 W and 500 kW. η is 0.3 by convention, for fans driven by motors below 125 W.
- Δp_e is the measured available external static pressure difference, expressed in Pascal, (positive pressure difference measured between the air outlet section and the air inlet section of the unit, which is available for overcoming the pressure drop of any additional ducted air)
- ESP_{min} is the minimum external static pressure difference specified in Table 8 below, as applicable for an indoor unit, or 30 Pa for an outdoor unit.
- q is the nominal air flow rate, expressed in cubic meters per second.

Table 8: Air to air, testing conditions in cooling mode (EN14511-3:2013)

Standard capacity ratings kW	Minimum external static pressure (ESPmin) a b Pa
0 < Q < 8	25
8 ≤ Q < 12	37
12 ≤ Q < 20	50
20 ≤ Q < 30	62
30 ≤ Q < 45	75
45 ≤ Q < 82	100
82 ≤ Q < 117	125
117 ≤ Q < 147	150
Q 147	175
a: For equipment tested without an air filter installed, the minimum external static pressure shall be increased by 10 Pa. b: If the manufacturer's installation instructions state that the maximum allowable discharge duct length is less than 1m, then the unit can be considered as a free delivery unit and be tested as a non ducted indoor unit with an ESP of 0 Pa.	

It is important to note the formula has changed between EN14511:3 (2010) and EN14511:3 (2013).

The correction formula in 2010 was:

$$\frac{q.(\Delta p_e)}{\eta}$$

The 2010 correction formula was the one in use when the regulation (EU) No 206/2012 was voted. This correction allowed the ratings of non-ducted and ducted split air conditioners to be comparable.

However, in the latest available version of EN14511:3(2013), the correction for ducted units is much lower than in the 2010 version and could have justified differentiating the performance requirements for ducted and non-ducted units in Regulation (EU) No 206/2012.

It can also be noted that this updated fan correction tends to standardise the available static pressure per capacity range, as for ESP larger than ESP_{min}, the impact on performance is non-negligible, particularly under part load conditions, hence on the seasonal performance metrics.

There is a revision of EN14511:3 standard in progress (prEN14511-3:2017), which reinstates the 2010 formula in the future. This is a point to be followed for setting specific requirements of future regulations. Indeed, present published values for ducted fix air conditioners and heat pumps have lower performances that after this standard is enforced.

<u>Standby and off for single duct and double duct air conditioners</u>
After the cooling (heating) rating test, in cooling (heating) mode for cooling only and reversible units (for heating only units), the unit is switched in standby mode with the control device if available. After 10 minutes, the residual energy consumption is measured and assumed to be the standby consumption. It is not stated if network standby consumption is included in the value measured.

<u>Rating of multisplit air conditioners and heat pumps</u>
An informative annex (I), indicates that to rate multisplit units, the power of the indoor unit is to be included in the ratings. The capacity ratio (ratio of the capacity for outdoor unit to the sum of the capacities of indoor units) is set to 100 % +/- 5 %. The Regulation (EU) No 206/2012 specifies a ratio of 1 should be used. Note the ratio in EN14511:3 is supposed to apply to thermal capacities before potential fan corrections (for ducted units).

<u>Operating requirements, marking and instructions</u>
Supplementary requirements are defined in this part:

- a starting test,
- a test at maximum operating conditions (cooling mode),
- a freeze-up test,
- a test outside the operating range,
- a safety test consisting in shutting off the heat transfer medium flows,
- a complete power supply failure test,
- a condensate draining and enclosure sweat test,
- ability to defrost for air-to-air and air-to-water heat pumps.

Instruction is given for the information that should be marked on the plate of the unit (manufacturer and model designation and rated performances).

The information that should be published in the technical documentation of the unit is also described. This information is available to installers or design engineers. It entails:

- a general description (trademark, model designation; power supply (voltage, frequency); denomination of the unit (e.g.: air-to-water); intended use of the unit (e.g.: control cabinet air conditioner); number of separate component units; type and mass of refrigerant charge; overall dimensions and weight of each separate component unit;
- Rating characteristics: the cooling capacity, the effective power input, the EER (EER: Energy Efficiency Ratio) and the SHR (where applicable - the SHR stands for Sensible Heat Ratio); the heating capacity, the effective power input and the COP (Coefficient of Performance) (where applicable); the heat recovery capacity and the type of liquid (where applicable);
- Additional characteristics: flow rates, the rotational speed of fans and external static pressure for ducted units.
- The sound power level and the corresponding test method according to EN 12102.
- Electrical characteristics according to with EN 60335-2-40 (domestic air conditioners and heat pumps) or EN 60204-1 (non domestic)

- The operating range
- A physical description of the unit (fluids including oil type, additional heating devices, control and safety information)
- Instructions for installation
- Instructions for maintenance
- instruction for test house (how to set the required frequencies to reach specified ratings).

As SHR is not commonly communicated in general product documentation (only in the technical documentation), there is no information on the capacity of the unit to dehumidify when working in cooling mode.

Also, despite most air conditioners now propose a dehumidification mode, there is no information required on these alternate modes.

Hence, information to the end-users on dehumidification is absent. This may be a problem in hot and humid parts of Europe (mainly the Mediterranean area), especially since the dehumidification capacity of modern inverter air conditioning units in cooling mode is low. It prevents the end-user to compare the dehumidification capability of the unit with alternatives (dedicated dehumidifiers).

The same is true for ventilation mode, also the impact for the end-user is probably much lower.

EN 15218:2013 Air conditioners and liquid chilling packages with evaporatively cooled condenser and with electrically driven compressors for space cooling — Terms, definitions, test conditions, test methods and requirements

This standard is dedicated to evaporatively cooled air conditioners for space cooling having their condenser cooled by air and by the evaporation of external additional water. Air conditioners evaporating the indoor condensates at their condenser are excluded (included in the EN 14511 standard) since the water must be “external”, except if they have a water tank that can be filled in also with external water. Inside dry and humid bulb temperatures of rating conditions are compatible with the EN14511 standard.

This standard defines the water temperature to be used for those tests:

- for evaporatively cooled condenser air conditioner with continuous water supply circuit, a single water temperature of 15 °C is used,
- for evaporatively cooled condenser air conditioner with a water tank, water temperature is set to 35 °C for air-to-air air conditioners.

As compared to 2006 version, the standard has been complemented to satisfy information requirement and standby and off mode measurement for evaporatively cooled single duct and double duct air conditioners, as requested by European regulations 206/2012 and 626/2011. For standby and off mode measurement, it is not stated if network standby consumption is included in the value measured.

EN 14825:2016 Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling — Testing and rating at part load conditions and calculation of seasonal performance.

"This European Standard provides part load conditions and calculation methods for calculating the Seasonal Energy Efficiency Ratio (SEERon) and Seasonal Coefficient of Performance (SCOPon and SCOPnet) of such units when they are used to fulfil the cooling and heating demands". This the harmonised standard for air conditioner regulation EC/206/2012 and space heater EU regulations No 813/2013 and No 811/2013. The methods and numerical value used are defined in the regulations above. However, the test methods are defined in this specific standard.

This standard has the same scope as defined in EN14511-1 but does not apply to single duct and double duct air conditioners, for which no seasonal performance rating is defined. There is a revision project of EN14825 (prEN14825:2017) to satisfy the requirements of EU regulations 1095/2015 and 2281/2016.

Note that also ventilation exhaust heat pump/air conditioners (exhaust air/outdoor air) are in the scope of EN14511-1, but there is not yet any seasonal performance condition defined to compute SEER and SCOP values.

Cooling mode

A bin method is used to compute a seasonal efficiency ratio in cooling mode noted SEERon which only accounts for hours with non-zero cooling load. A second SEER figure is defined to take into account parasitic electricity power consumption in low power modes: thermostat off mode, standby mode, off mode and crankcase heater consumption.

The reference climate is an average climate for Europe. The load curve is a straight line as a function of outdoor air temperature with no load at 16 °C and 100 % load (matching the full load capacity of the unit) at 35 °C.

The Reference design conditions for cooling (Tdesignc)

Temperature conditions at 35 °C dry bulb (24 °C wet bulb) outdoor temperature and 27 °C dry bulb (19 °C wet bulb) indoor temperature. Part load ratio is defined as:

$$Part\ load\ ratio\ \% = (Tj - 16)\ /\ (35 - 16)$$

The hours of operation in each temperature bin are defined below.

Table 9: bin number j, outdoor temperature Tj in oC and number of hours per bin hj corresponding to the reference cooling season

j #	1	2	3	4	5	6	7	8	9	10	11	12
Tj °C	17	18	19	20	21	22	23	24	25	26	27	28
hj h	205	227	225	225	216	215	218	197	178	158	137	109

j #	13	14	15	16	17	18	19	20	21	22	23	24
Tj °C	29	30	31	32	33	34	35	36	37	38	39	40
hj h	88	63	39	31	24	17	13	9	4	3	1	0

The EER values at each bin are determined via interpolation of the EER values at part load conditions A, B, C, D as mentioned in the tables below with methods as described in Table 10 below. For part load conditions with outdoor temperature superior to temperature of condition A, the same EER values as for condition A are used. For part load conditions with outdoor temperature lower than temperature below part load condition D, the same EER values as for condition D are used.

To compute SEERon and SEER, the formulas to be applied are:

$$SEER_{on} = \frac{\sum_{j=1}^{n} hj\ \times\ Pc(Tj)}{\sum_{j=1}^{n} hj\ \times \left(\frac{Pc(Tj)}{EER(Tj)}\right)}$$

Where:

- *Tj = the bin temperature*
- *j = the bin number*
- *n = the amount of bins*
- *Pc(Tj) = the cooling demand of the building for the corresponding temperature Tj.*
- *hj = the number of bin hours occurring at the corresponding temperature Tj*
- *EER(Tj) = the EER values of the unit for the corresponding temperature Tj.*

$$SEER = \frac{Q_C}{\frac{Q_C}{SEER_{on}} + H_{TO} \times P_{TO} + H_{SB} \times P_{SB} + H_{CK} \times P_{CK} + H_{OFF} \times P_{OFF}}$$

Where:

- *Q_C = The reference annual cooling demand, expressed in kWh*
- *H_{TO}, H_{SB}, H_{CK}, H_{OFF} = the number of hours the unit is considered to work in respectively thermostat off mode, standby mode, crankcase heater mode and off mode. NOTE the number of hours to be used for several types of units is indicated in Annex C*
- *P_{TO}, P_{SB}, P_{CK}, P_{OFF} = the electricity consumption during respectively thermostat off mode, standby mode, crankcase heater mode and off mode, expressed in kW*

$$Q_c = P_{designc} \times H_{ce}$$

For air-to-air air conditioners, up to 12 kW cooling capacity, the number of equivalent cooling hours equals 350.

The 4 testing conditions A, B, C and D are defined for each type of sink-source combination. The conditions for air-to-air units (outdoor air / recycled air) are given in Table 10 below. Note that there is no reference testing conditions for ventilation exhaust air conditioners (that would be exhaust air / outdoor air).

Table 10: Part load conditions for reference SEER and reference SEERon: air to air units

	Part load ratio	Part load ratio %	Outdoor air dry bulb temperature °C	Indoor air dry bulb (wet bulb) temperatures °C
A	(35−16)/(Tdesignc −16)	100	35	27(19)
B	(30−16)/(Tdesignc −16)	74	30	27(19)
C	(25−16)/(Tdesignc −16)	47	25	27(19)
D	(20−16)/(Tdesignc −16)	21	20	27(19)

At full load (= part load condition A), the declared capacity of a unit is considered equal to the cooling load (Pdesignc). There is no oversizing factor considered. In part load conditions B,C,D, the declared capacity of a unit may or may not match the cooling load, if the declared capacity of a unit is matching with the required cooling load, the corresponding EER value of the unit is to be used. This may occur with staged capacity or variable capacity units.

If the declared capacity of a unit is higher than the required cooling load, the unit has to cycle on/off. This may occur with fixed capacity, staged capacity or variable capacity units. In such cases, a degradation factor (Cdc for air-to-air units) has to be used to calculate the corresponding EER value. Such calculation is explained below. For staged capacity units and variable capacity units with capacity steps not matching the required part load conditions (+/- 10 % of DC for capacity staged and variable capacity units), EERx (with x=B, C or D) should be computed by linear interpolation of the cooling capacity and of the power input between the capacity stages the closest to the part load required for the same temperature conditions or alternatively using the cycling formula below.

Cdc correction for air to air air conditioners

$$EER_{bin} = EER_d \times \left(1 - Cdc \times (1 - CR)\right)$$

Where:

- *EERd = the EER corresponding to the declared capacity (DC) of the unit at the same temperature conditions as for part load conditions B, C, D*
- *Cdc = the degradation coefficient*
- *CR = is the capacity ratio, the ratio of the cooling demand (Pc) over the declared capacity (DC) of the unit at the same temperature conditions*

The Cdc value can be determined or by default be 0.25. It takes into account both the power consumption of the unit when the compressor is off and the pressure equalisation that reduces the cooling/heating capacity when the unit is restarted. Test is made at 20 % load over a cycle of 30 min. In practice however, this test is not used for air-to-air air conditioners and the default coefficient of 0.25 is used.

Heating mode

The same procedure is applied in heating mode as in cooling mode. For the purpose of reference SCOP and reference SCOPon, there are 3 reference conditions: average (A), warmer (W) and colder (C). A supplementary SCOPnet, without backup nor consumption of the low power modes, is defined in view of the renewable energy directive (Commission decision 2013/114/EU)[15].

For air-to-water heat pumps, the seasonal space heating efficiency in primary energy η_s [%], defined in regulations (EU) No 811/2013 and (EU) 813/2013 is also included, but does not apply for air-to-air heat pumps as it was not defined in Regulation (EU) 206/2012.

The Reference design conditions for heating (Tdesignh)

- Temperature conditions for average, colder and warmer climates.
- Average: -10 °C dry bulb outdoor temperature and 20 °C dry bulb indoor temperature
- Cold: -22 °C dry bulb outdoor temperature and 20 °C dry bulb indoor temperature
- Warm: +2 °C dry bulb outdoor temperature and 20 °C dry bulb indoor temperature

Bivalent temperature (Tbivalent)

It is the lowest outdoor temperature point at which the heat pump is declared to be able to meet 100% of the heating demand without additional backup.

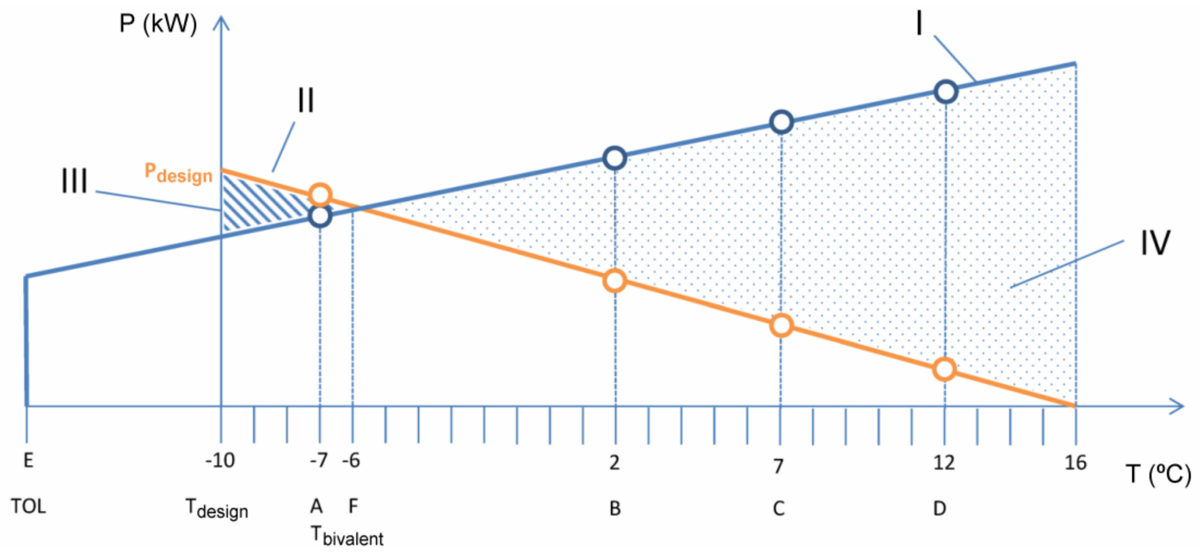
NOTE: Below this point, the unit may still deliver capacity, but additional back up heating is necessary to fulfill the heating demand.

The declared bivalent temperature can be any outdoor temperature within following limits (this is defined in Regulation (EU) 206/2012:

- for the average heating season, the bivalent temperature is +2°CDB or lower

[15] http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32013D0114

- for the colder heating season, the bivalent temperature is -7°CDB or lower
- for the warmer heating season, the bivalent temperature is +7°CDB or lower



Key

T	outdoor temperature (°C)
P	capacity/load (kW)
I	declared capacity line and declared capacities at conditions A, B, C and D
II	load curve and part load capacity at conditions A, B, C, and D
III	electric back up heater
IV	on off cycling
T_{design}	reference design temperature
$T_{bivalent}$	bivalent temperature

Figure 2: Schematic overview of the SCOPon calculation points (for a on-off cycling air to water unit, in EN14825:2016, Annex E, p 74)

The heating bins are given hereunder. The load curve in heating mode is also computed with 16 °C as the balance point temperature (ie outdoor dry bulb temperature with no heating load).

The heating demand Ph(Tj) can be determined by multiplying the full load value (Pdesignh) with the part load ratio % for each corresponding bin. This part load ratio % is calculated as follows:

- For the average climate: Part load ratio % = (Tj-16) / (-10-16) %
- For the warmer climate: Part load ratio % = (Tj-16) / (+2-16) %
- For the colder climate: Part load ratio % = (Tj-16) / (-22-16) %

Table 11: bin number j, outdoor temperature Tj in °C and number of hours per bin hj corresponding to the reference heating seasons —warmer, —average, —colder

j #	Tj °C	Warmer (W) hjW h	Average (A) hjA h	Colder (C) hjC h
1 to 8	−30 to −23	0	0	0
9	−22	0	0	1
10	−21	0	0	6
11	−20	0	0	13
12	−19	0	0	17
13	−18	0	0	19
14	−17	0	0	26
15	−16	0	0	39
16	−15	0	0	41
17	−14	0	0	35
18	−13	0	0	52
19	−12	0	0	37
20	−11	0	0	41
21	−10	0	1	43
22	−9	0	25	54
23	−8	0	23	90
24	−7	0	24	125
25	−6	0	27	169
26	−5	0	68	195
27	−4	0	91	278
28	−3	0	89	306
29	−2	0	165	454
30	−1	0	173	385
31	0	0	240	490
32	1	0	280	533
33	2	3	320	380
34	3	22	357	228
35	4	63	356	261
36	5	63	303	279
37	6	175	330	229
38	7	162	326	269
39	8	259	348	233
40	9	360	335	230
41	10	428	315	243
42	11	430	215	191
43	12	503	169	146
44	13	444	151	150
45	14	384	105	97
46	15	294	74	61
Total		**3590**	**4910**	**6446**

The SCOP and SCOPon are computed as in the cooling mode but considering the electric heating required to cover the heating load below the bivalent point. Default equivalent full load hours are given for air to air reversible units with cooling capacity lower than 12 kW as well as hours for low power mode consumption to compute reference SCOP and SCOPon values. These values are the ones of Regulation (EU) 206/2012). There are differences between values used for air-to-air air conditioners and air-to-water heat pumps that should be further analysed (see part 1.3.1 regarding EU legislation).

Testing methods for active modes

Test methods at reduced capacity of variable speed and staged capacity units are the same as specified in EN14511:3, except when the unit cannot reach a specific rating point B, C or D or when it has to cycle to supply the required cooling load (two points already discussed in the cooling mode section of this standard above). Also, uncertainties of measurement are specified and reported below (only the part useful for air-to-air conditioners). Note that in EN14511:3, air-to-air conditioners have to be rated using the calorimeter method, which allows a better precision of part load performances, as shown below.

"The steady-state heating and cooling capacities determined using the calorimeter method shall be determined with a maximum uncertainty of:

- 5 % when the capacity measured is greater than 2,0 kW;
- 10 % when the capacity measured is between 1,0 kW and 2,0 kW;
- 15 % if it is lower than 1,0 kW.

The heating capacities determined during transient operation (defrost cycles) using the calorimeter method shall be determined with a maximum uncertainty of 10 %. The heating and cooling capacities measured on the air side using the air enthalpy method shall be determined with a maximum uncertainty of (4 + 6/part load ratio) %.

All uncertainties of measurement are independent of the individual uncertainties of measurement including the uncertainties on the properties of fluids. The maximum uncertainty of the measurement of the power input for off, thermostat off, standby and crankcase heater modes shall be ± 0,1 W up to 10 W; ± 1 % for powers greater than 10 W."

Regarding cycling tests, test laboratories are reluctant to use the test method proposed:

- this test was developed for on/off units; for inverter driven units, there is a delay after startup which means that to make such a test, the laboratory should require the manufacturer to modify the software of the unit to enable a 6min on and 24 min off cycle;
- it is a highly consuming test;
- it is a test of unknown precision (probably low) because of very load to be measured (1 kW cooling capacity when on, so only 200 W in average).

Thus, it is advisable at the moment, to use the default Cdc and Cdh values, which anyway has limited impact on the seasonal indices of inverter driven units. It means Regulation (EU) No 206/2012 should be amended not to allow a cycling test until the EN14825 standard be developed to allow these tests to be done.

Standby mode: For cooling only and reversible air conditioners, the standby mode power is measured after the unit has been running for 30 min in "A" test condition (outdoor temperature 35 °C, indoor temperature 27°C). The unit is stopped with the control device and after 10 min, the residual energy consumption is measured. For heating only units, the "D" test is used (outdoor temperature 12 °C, part load ratio 25 %, indoor temperature 20 °C).

Off mode: This test is measured 10 min after the standby mode test.

Thermostat-off: This is measured 30 min after the unit has been running for 30 min in "D" test condition in cooling mode for cooling only and reversible units and in heating mode for heating only units (Cooling mode: outdoor temperature 20 °C, part load ratio 25 %, indoor temperature 27 °C // Heating mode: outdoor temperature 12 °C, part load ratio 25 %, indoor temperature 20 °C). The thermostat set point related to the indoor temperature sensor is increased (decreased in heating mode) until the compressor stops. The time period for measurement is of 60 min.
In cooling mode, standby power consumption is deducted from consumption measured to calculate thermostat-off, but not in heating mode. This deduction in cooling mode is not logical (thermostat-off hours and standby hours are two distinct types of hours with no overlap) and should be corrected.
In EN14825:2016, it is written: " After the unit has been running for 30 min in "D" test condition in cooling mode (for cooling only or reversible units) [...]". Hence, for reversible units, thermostat-off power is measured in cooling mode test condition D.

Crankcase heater: It is included in standby power consumption if the crankcase is activated during the standby test. If not, the following test is performed: after the unit has been operating 30 min in "D" test condition in heating mode, the unit is stopped with the control device, and the consumption is measured for 8 hours starting 10 min after.

Regarding this method, it should be commented that power measurements are made at a certain temperature in each mode and then weighted by a number of hours to represent when the consumption is likely to occur. The impact of outdoor temperature variation is not taken into account here, and this probably makes a difference at least for crankcase heater consumption. Also, there may be for the same unit two distinct thermostat off values, which is not foreseen in Regulation (EU) No 206/2012 (adaptation to be done).

In addition, it is not stated if network standby consumption is included in the value measured, although many units already include network communication capability.

Case of multisplit
For multisplit appliances, the only indication in EN14825:2016 is that data in the test report shall be provided at a capacity ratio of 1 (same capacity for outdoor unit and the sum of the capacity of indoor units), as requested in Regulation (EU) 206/2012.

In prEN14825:2017 however, there is a dedicated annex (planned annex N, normative) for multisplit larger than 12 kW (for the purpose of Regulation (EU) No 2281/2016). This annex defines the SEER and SCOP of the outdoor unit only (not in line with present Regulation 206/2012 and 626/2011, which, in the ratings of multisplit air conditioners, also includes the fan power consumption). This annex specifies the number of indoor units to be connected depending on the standard-rated capacity of the multisplit unit. Currently, this is not defined for air conditioners with a capacity less than 12 kW, because all combinations (regardless the indoor unit type) must comply with requirements of Regulation 206/2012.

In annex N, are also given practical indications regarding the number of units to be considered for tests and tolerance on the capacity ratio (100 % more or less 5 %).

EN50564:2011 - Household electrical appliances - Measurement of standby power
This standard defines low power modes (standby and off mode) and measurement methods to be used. Network standby is not explicitly defined in the standard (see mandate M/544

which aims to include network standby), which does not preclude the same measurement methods also could be used for networked standby measurements.

1.2.1.2 Performance difference due to test methods

It is important to keep in mind that for variable speed units, the test requires the manufacturer to supply information on how to fix (or lock-in) the frequency of the compressor (and probably of fans) according to European standards EN14825 and EN14511-3. This is the general method used in performance test standards of air conditioners worldwide.

In Regulation 206/2012 the following is written 'The manufacturer of air conditioners and comfort fans shall provide laboratories performing market surveillance checks, upon request, the necessary information on the setting of the unit as applied for the establishment of declared capacities, SEER/EER, SCOP/COP values and service values and provide contact information for obtaining such information.' This does not mean that the manufacturer is allowed to use a specific software or other means to activate a mode dedicated to standard tests, in which the control of the unit is bypassed (or partially bypassed e.g. in case of the need to defrost).

However, it does mean that the performance of units in real life may differ from the performances measured in standard test conditions.

An alternative is to use a compensation method; in that method, the unit has to maintain the required set point temperature to compensate a given heat load (when working in cooling mode). Figure 3 below shows the comparison of tests realised in locked (lock-in) and unlocked (compensation method) modes for an inverter unit following test conditions of the AS/NZS 3823.4[16] test standard. The efficiency difference may be significant.

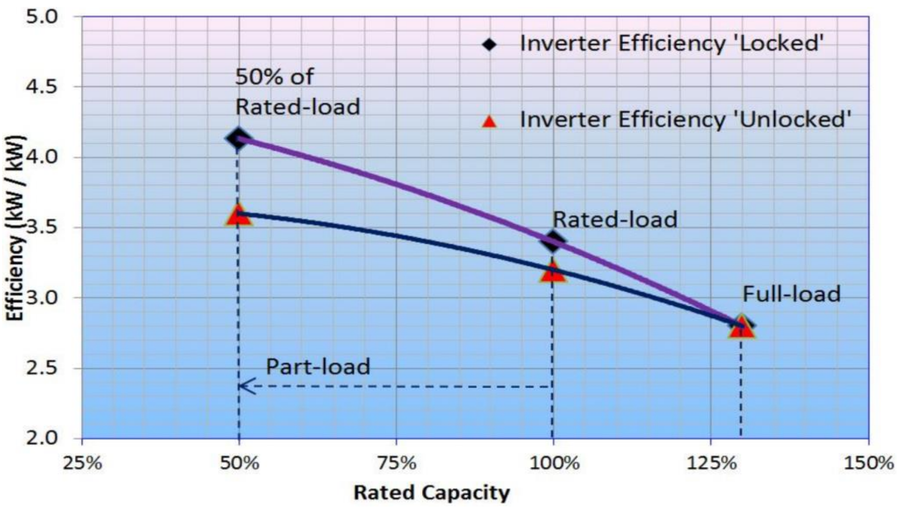


Figure 3: Impact of using lock-in mode versus compensation method on the energy efficiency of an inverter air conditioning unit[17]

[16] Australian Standards: AS/NZS 3823, Performance of electrical appliances – Airconditioners and heat pumps.
[17] Dr Satya Prasad Mavuri , " Field Behaviour of Inverter Air Conditioners Effect on Seasonal Performance" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 8, August 2015 , pp. 018-025 , ISSN 2319 - 4847.

Although test laboratories in Europe are aware of this method and the potential differences in results, there are issues for practical application that remain to be solved:

- there is no such method for ducted units,
- there are repeatability issues because the results obtained are dependent on the control of the unit and then in turn on the air inertia of the cell (and then on its size) and possibly on the control used to maintain the heat load (in cooling mode),
- test results are dependent on the temperature sensor of the unit being tested and on the setting of the indoor temperature (in general with 1 K precision), which may make it difficult to respect the deviation tolerances of the standard or/and may require ad-hoc corrections.
- time for testing increases significantly

Nevertheless, it is important to continue the development of compensation method as it could ultimately lead to seasonal figures closer to real life performances. Such a method is reintroduced for air-to-air air conditioners and heat pumps in case it is not possible to obtain information on how to set lock-in mode from manufacturers in prEN14825:2017. This method is not ready to be considered for this revision, but it might be included in the next revision.

1.2.1.3 International standards

Air conditioners

The main ISO standards relating to **air conditioners** (ISO 5151:2010 - 'Non-ducted air conditioners and heat pumps – Testing and rating for performance', ISO 13253:2011 – 'Ducted air conditioners and heat pumps – Testing and rating for performance', and ISO 15042:2011 Multiple split-system air-conditioners and air-to-air heat pumps – Testing and rating for performance) are not described here as main information is thought to be similar to EN14511 standard content (see description above) and that if there are differences, the EN14511 standard prevails.

Two ISO standards of specific interest for this study are being prepared; they are briefly described and discussed hereafter.

ISO/FDIS 16358-1:2013 Air-cooled air conditioners and air-to-air heat pumps — Testing and calculating methods for seasonal performance factors

This standard is made of 3 parts:

- Part 1: Cooling seasonal performance factor
- Part 2: Heating seasonal performance factor
- Part 3: Annual performance factor

Part 1 specifies the testing and calculating methods for seasonal performance factor of equipment covered by ISO 5151, ISO 13253 and ISO 15042 standards (split and multisplit non ducted and ducted units).

The general outline of the testing and calculating method is similar to standards being used in Asia (in Japan, China and South Korea specifically)[18]. The method was also completed to account for low power modes, as in the EN14825 standard.

[18] Sustainable Industrial Policy – Building on the Ecodesign Directive – Energy-Using Product Group Analysis/2, Lot 6: Air-conditioning and ventilation systems, Contract No. ENTR/B1/35-2009/LOT6/ SI2.549494, CO-ORDINATOR: Philippe RIVIERE, ARMINES, France, Final report - Air-conditioning products, July 2012

The equivalent to the $SEER_{on}$ is noted CSPF (Cooling seasonal performance factor), while the equivalent SEER is noted TCSPF (Total CSPF) and includes inactive energy consumption (which accounts in a single value for the impact of standby, off mode and crankcase heater contributions).

The mandatory minimum number of test points is lower than in the EN14825:2016 standard because modelling is used to assess performances of missing points, although manufacturers may choose to make more tests if they do not want to use default values. In addition, the calculation method is based upon only 3 load levels instead of 4 for the EN14825 standard. Only two points are mandatory (recycled air indoor conditions are fixed at 27/19 (dry bulb / wet bulb) as in the ISO 5151 and EN14511-2 standards):

- Fix capacity units: two tests at maximum capacity for outdoor conditions 35/24 (dry bulb / wet bulb) and 29/19 (dry bulb / wet bulb);
- Capacity staged units: three tests, one at maximum capacity for outdoor conditions 35/24 (dry bulb / wet bulb), the second one at 29/19 (dry bulb / wet bulb) and maximum capacity, and the third one in the same temperature conditions and half capacity;
- Variable capacity units: two tests, one at maximum capacity for outdoor conditions 35/24 (dry bulb / wet bulb), and the second one at 29/19 (dry bulb / wet bulb) and half capacity.

Regarding interpolation procedure, EER is interpolated linearly between operating points along the load curve as in EN14825 for variable capacity units. However, for capacity staged units, interpolation is made by weighting the time required for operation of each stage to satisfy the cooling load which is more realistic than linear interpolation in EN14825 for this type of unit. This has no impact however for air-to-air air conditioners in Europe as there is no capacity staged unit below 12 kW.

A reference climate is given. The weighting coefficients by temperature bins are given in the table below:

Table 12: The weighting coefficients by temperature bins

Bin number j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
Outdoor temperature tj °C	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	—
Fractional bin hours	0.055	0.076	0.091	0.108	0.116	0.118	0.116	0.1	0.083	0.066	0.041	0.019	0.006	0.003	0.002	
Bin hours nj	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10	n11	n12	n13	n14	n15	—
Reference bin hours (nj) h	100	139	165	196	210	215	210	181	150	120	75	35	11	6	4	1 817

It can be commented that the zero load corresponds to an outdoor temperature of 20 °C instead of 16 °C in the EN14825 standard, and the weight of higher temperatures is more important. In addition, a guideline to define regional load curves is given in Annex D.

The hours to be used to compute the TCSPF are given in the table below:

Table 13: Hours to be used to compute the TCSPF

Unit	Active mode h	Inactive mode, Hia h	Disconnected mode h
Cooling only unit	1817	4077	2866
Cooling unit with supplemental heat	1817 (Heating operation: 2 866)	4077	0
Reversible unit	1817 (Heating operation: 2866)	4077	0

The hours in active mode are much higher than in the EN14825 standard. Disconnected mode is a mode where the unit is disconnected from the mains, not present in EN14825 standard. Inactive mode hours are hours without a cooling demand in the building.

For the measurement of the electric power consumption during inactive modes, the following test procedure is used:

- "The unit shall be electrically connected to the main power source after shut-down for 6 h. Indoor and outdoor temperature of 20 °C condition shall be reached. The power consumption shall be measured for one hour after the temperature conditions are stabilized. The same test is repeated with the temperature condition of 5 °C, 10 °C and then 15 °C with the stabilization period of 2 h between each test."
- Power consumption should then be weighted using coefficients that are given for the reference climate (representing number of inactive hours by temperature bins in the reference climate.

Although there is only one mode considered in this standard for low power mode consumption (inactive consumption), instead of four in EN14825, outdoor temperature variation is taken into account (and weighted as a function of temperature occurrence), which may result in a more precise estimate of crankcase power consumption and standby. However, it seems that supplementary thermostat off power consumption due to indoor fan is not considered (although thermostat off hours are clearly included in the inactive mode period according to definition).

According to EU test laboratories, including the impact of temperature on low power mode consumption would represent a certain supplementary burden, which may not be justified: the main interest of low power mode tests is to avoid very high energy consumption in these modes (especially unjustified all year-round use of crankcase heater), which seems have been solved by present test procedure.

Part 2 is dedicated to the HSPF (Heating Seasonal Performance Factor). The method applied is similar as the one for the cooling mode. Again, the number of test points required for the method is reduced as compared to EN14825, with only 2 testing points for on-off units and 3 for other heat pumps including variable capacity heat pumps.

In this standard, manufacturers cannot choose Pdesignc: the heat load is inferred from the heating capacity (P_H (7°C/100%) test at standard rating conditions 7 °C outdoor / 20 °C indoor / maximum capacity as follows:

$$\text{Heating load (equivalent to Pdesignc)} = 0.82 \times \mathrm{P}_H \; (7°\mathrm{C}/100\%)$$

The reason behind this value is: the ratio of the heating operational capacity at 0 °C in non-frosting condition to the standard heating capacity at 7 °C is assumed to be 0.82. So, sizing is supposed to be made for 0 °C outdoor, which is in line with the distribution of temperature occurrences over the season shown in the table below:

Table 14: Distribution of temperature occurrences over the season

Bin number j	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Outdoor tempe-rature tj °C	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3
Fractional bin hours	0	0	0	0	0	0	0	0	0	0.001	0.005	0.012	0.024	0.042
Bin hours nj	n1	n2	n3	n4	n5	n6	n7	n8	n9	n10	n11	n12	n13	n14
Reference bin hours (nj) h	0	0	0	0	0	0	0	0	0	4	15	33	68	119

Bin number j		16	17	18	19	20	21	22	23	24	25	26	27	Total
Outdoor tempe-rature tj °C	4	5	6	7	8	9	10	11	12	13	14	15	16	
Fractional bin hours	0.059	0.07	0.082	0.087	0.091	0.092	0.091	0.085	0.075	0.067	0.053	0.038	0.027	
Bin hours nj	n15	n16	n17	n18	n19	n20	n21	n22	n23	n24	n25	n26	n27	
Reference bin hours (nj) h	169	200	234	250	260	265	260	245	215	192	151	110	76	2866

The climate chosen is definitely hotter than the average EU climate in regulation (EU) 206/2012.

Part 3 defines the calculation of the APF (Annual Performance Factor: ratio of the total thermal energy to the total electricity consumption for cooling and heating) and of the TAPF (including inactive mode consumption).

ISO/WD 18326:2016 - Non-ducted portable air-cooled air conditioners and air-to-air heat pumps having a single exhaust duct —Testing and rating for performance

"This Standard specifies the standard conditions for capacity and efficiency ratings of non-ducted portable air-cooled air conditioners having a single exhaust duct and non-ducted portable air-cooled heat pumps having a single exhaust duct. Such air conditioners and heat pumps may include an evaporatively cooled condenser cooled by air and the evaporation of:

a. condensate collected from the evaporator;
b. external supplementary water stored in a supplementary water tank; or
c. both (a) and (b).

This standard also specifies the test methods for determining the capacity and efficiency ratings.

The scope is thus broader that in the EN14511 standard and also encompasses single duct products evaporating water from a water tank at their condenser (in cooling mode), that are covered by standard EN15218 in Europe.

It is to be noted that the standard rating conditions for both heating and cooling mode are different from the ones in EN14511-2(2013):

- Cooling rating conditions: both exhaust and recycled air conditions are 35/24 (dry bulb / wet bulb), as in EN14511-2 standard;

- Heating rating conditions: both exhaust and recycled air conditions are 20/15, instead of 20/12 in EN14511-2 standard.

The test method is similar to the one in EN14511-3 standard and enables to take into account the impact of duct heat losses on the unit performance (although the duct length is only of 50 cm, while it may be much longer in real life). However, it does not include the impact of outdoor air infiltration on cooling capacity.

Comfort fans

Regarding comfort fans, the reference used in the transitional method for Regulation (EU) 206/2012 is IEC 60879 (Commission communication 2012/C 172/01).

IEC 60879: 1986 (corr. 1992) - Performance and construction of electric circulating fans and regulators

The following information has not changed since the preparatory study.

This standard applies to the following types of electric motor directly driven fans and their associated regulators intended for use on single-phase a.c. and d.c. circuits not exceeding 250 V:

a) Fans for household and similar purposes:
   - ceiling type fans;
   - table type fans;
   - pedestal fans;

b) Fans for use in ships:
   - Deck-head type fans;
   - Cabin type fans.

Note: Wherever applicable the term "fan" used in this standard includes its associated regulator, if any."

This standard does not apply to the following types of fans which are covered in separate standards:

- Jet fans (see IEC Publication 535: Jet Fans and Regulators);
- Ventilating fans (see IEC Publication 665: A.C. Electric Ventilating Fans and Regulators for Household and Similar Purposes).

This standard does not enable a priori to test tower fans but all other types.

The IEC 60879 standard defines an Energy Efficiency Index, called "service value" in English and "indice de qualité" in French, which is of the same nature as an SFP in ventilation: a ratio of the flow generated to the electrical power absorbed. It is an index suitable for the purpose, since there is no pressure difference to be maintained between upstream and downstream, as opposed to ventilation systems where pressure levels matter. It's measured at full speed. The standard does include the energy needed for the oscillating mechanism in the total electricity demand. The flow is measured without the oscillations.

The air delivery in cubic meters per minute divided by electrical power input to the fan in watts at the voltage and frequency specified for the test is named the service value.

In the event of the fan comprising an oscillating mechanism, the electrical input in watts is measured with the fan under normal full-speed conditions, that is with the oscillating mechanism in action, whereas the air delivery is determined with the oscillating mechanism out of action.

This service value (SV) and the "rated air delivery" (flow rate) "shall be supplied on request".

One aspect of the IEC 879 standard is that there are functional requirements and even design values recommended: preferred sizes for ceiling fans, other for table fans, other for pedestal fans, a fact that generates this uniformity of declared characteristics that can be observed on the market.

Another interesting aspect of IEC 879 is that it includes a set of tolerances to apply when only one piece of equipment is tested to check the declarations of a manufacturer: 10% on air flow, which, since electrical power is very certain, means about 10% on "service value".

Even the oscillations are harmonized: "The number of oscillations per minute at full speed shall not be less than four. Whether the angular movement of the mechanism is variable, an angular movement of not less than 60° shall be available […]. A device shall be provided to render the oscillating mechanism inoperative when desired. The method of operating the device shall be indicated. "

It is the same for the speeds: "Regulators shall be capable of reducing the speed of the fan by at least 50 % of the full speed at the voltage and frequency specified for the test, except in the case of fans of the shaded pole type where the speed reduction shall be not less than 20 %. Fans shall be capable of running continuously on any of the contacts of the regulator at the rated voltage or voltages or within the whole rated voltage range, whichever is applicable."

The prescription about noise is not that clear: "The noise level of fans and regulators at all speeds shall be within reasonable limits".

Finally, tolerance is fixed on the rated air flow rate at full speed at 10 %. There is no explicit tolerance on the service vale (SFP) of the product, but it can be estimated.

There is no specific test standard in Europe for testing energy use of comfort fans (that could be easily written on the basis of IEC 879 with extension to tower fans).

1.2.1.4 Third country standards

Comfort fans: No new information on regional performance test standard of comfort fans was identified since last EuP Lot 10 study[19].

Air-to-air air conditioners but single duct / double duct and evaporatively- cooled air conditioners

Most countries in the world still use full capacity ratings based upon ISO 5151, 13253, 15041 standards[20]. However, the development of the ISO/FDIS 16358-1:2013 standard

[19] Preparatory study on the environmental performance of residential room conditioning appliances (airco and ventilation), Contract TREN/D1/40-2005/LOT10/S07.56606. CO-ORDINATOR: Philippe RIVIERE, ARMINES, France. Comfort fans, final report. December 2008. This report can be downloaded from DG ENERGY website: https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficient-products.

[20] www.claspinfo.org

accelerated the adoption of seasonal performance indicators. The first countries to have adopted the ISO standard are Australia and New Zealand, in standard AS/NZS 3823.4.1:2014 - Performance of electrical appliances — Air conditioners and heat pumps. Regional temperature distribution and associated hours for active, inactive and disconnected modes have been developed, with different zones to cover the different climates of the two countries. At least India[21] has followed, in 2015, and Thailand is planning to do so by 2020[22].

Before that, only a few countries had adopted seasonal performance standards or standards including low power modes (although air conditioner standby power consumption may be constrained in some countries, included in horizontal regulations). The description of these standards, which are for the USA, Japan, South Korea and China can be found in the EuP Lot 10 Study on air conditioners[23].

US DOE 10 CFR Parts 429 and 430. Energy Conservation Program: Test Procedures for Portable Air Conditioners; Final Rule[24]

On April 18, 2016, DOE classified portable ACs as covered consumer products under EPCA (Energy Policy and Conservation Act of 1975). DOE proposed a final rulemaking regarding test procedures (published in the Federal Register in June 2016) and associated energy conservation standards for portable ACs (proposed rulemaking published in December 2016, detailed information can be found in part 1.3 of this report).

The final test standard is based on the existing industry procedures[25] (direct air enthalpy method, i.e. measurement of the cooling capacity as the product of the indoor side air flow and enthalpy differences) and modified to account for:

- infiltration of hot air due to unbalanced flows (condenser air flow of single duct air conditioners is compensated by hot air infiltration; difference of air flow between condenser inlet and outlet for double duct air conditioners),
- heat losses of duct connections in the air-conditioned space.

The cooling capacity measured via the enthalpy difference and corrected of these two effects is named ACC for adjusted cooling capacity. The standard industry test is only slightly modified and the corrections are made via calculations.

In addition, a procedure has been designed to rate the seasonal efficiency of these units (Combined Energy Efficiency Ratio - CEER), which account for active cooling mode, thermostat off mode, standby or off mode operation in a single metrics.

Although the methodology used in cooling mode could be applied in heating mode (and was proposed in the first version of the test standard), heating mode was removed from the test procedure as it was considered that heating was not common nor commonly used for this type of units in the USA.

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[21] https://www.bijlibachao.com/air-conditioners/iseer-star-labeling-inverter-air-conditioners-india.html

[22] http://www.aseanshine.org/asean-shine-task-force/d/asean-regional-policy-roadmap-for-harmonization-of-energy-performance-standards-for-air-conditioners

[23] Preparatory study on the environmental performance of residential room conditioning appliances (airco and ventilation), Contract TREN/D1/40-2005/LOT10/S07.56606. CO-ORDINATOR: Philippe RIVIERE, ARMINES, France. Air conditioners, final report. December 2008. This report can be downloaded from DG ENERGY website: https://ec.europa.eu/energy/en/topics/energy-efficiency/energy-efficient-products.

[24] USA Federal Register, Vol 81, No. 105, Wednesday June 1, 2016.

[25] ANSI/AHAM PAC-1-2016: Portable Air Conditioners and ASHRAE standard 128:2011 - Method of Rating Portable Air Conditioners

Impact of infiltration and of duct heat losses on single duct and double duct performances. In May 2014, the USDOE released the results of tests conducted on several products including single duct, double duct and spot coolers air conditioners (the latter is similar to other products except it has no duct - it is not presently included in EU regulations 206/2012 and 626/2011).

The USDOE performed standard tests of these appliances according to USA industry standards (air enthalpy method) and completed it with investigations on the impact of infiltration of hot air. To do so, the calorimeter test method was used with temperature and humidity of the outdoor side maintained at 35°C/24°C (Dry bulb / Wet bulb) conditions and indoor conditions maintained at 26,7°C/19,4 (Dry bulb / Wet bulb).

About the standard rated capacity and efficiency, significant differences were identified with declared values by manufacturers. These results are given below in W for cooling capacity and in W/W for EER. On average, there is an approximate 20 % difference in capacity and EER between DOE tests and declarations, which can only be partly explained by the difference in methodology used by US DOE to rate standard capacity and EER.

Table 15: Baseline test results[26]

Test unit	Cooling capacity (W)			EER (W/W)		
	Rated	Baseline	Reduction (%)	Rated	Baseline	Reduction (%)
SD1	2344.57	1712.33	27.0	2.05	2.00	2.3
SD2	2784.18	1934.21	30.5	2.81	2.17	22.8
SD3	3516.9	3208.42	8.8	2.55	2.19	14.1
SD4	3809.9	2785.82	26.9	2.84	1.93	32
DD1	2784.18	2519.59	9.5	2.75	2.17	21.2
DD2	3809.9	2113.39	44.5	2.61	1.61	38.2
SC1	2930.7	2996.86	- 2.3	2.96	2.82	4.7
SC2	3956.46	3157.75	20.19	3.28	1.97	39.9

In a second step, the impact of air infiltration and of duct losses was established by using the calorimeter method with different temperatures on both sides of the units. These results are given below in W for cooling capacity and in W/W for EER and are compared to the baseline calorimeter approach.

It appears that the impact of the infiltration of hot air may lead to negative capacities (using a single duct unit may lead to heat the room instead of cooling it in hottest days of the Summer). There may also be a strong impact for double duct air conditioners whenever condenser inlet and outlet air flows are unbalanced.

Table 16: Investigation test results[27], impact of air infiltration on unit performance

Test unit	Cooling capacity (W)			EER (W/W)		
	Baseline	Calorimeter	Reduction (%)	Baseline	Calorimeter	Reduction (%)
SD1	1712.33	-137.98	108.1	2.00	-0.16	107.9
SD2	1934.21	-187.98	109.7	2.17	-0.21	109.4
SD3	3208.42	1018.57	68.3	2.19	0.67	69.2
SD4	2785.82	539.66	80.6	1.93	0.39	79.7
DD1	2519.59	990.55	60.7	2.17	0.85	60.9
DD2	2113.39	1008.87	52.3	1.61	0.76	52.7

The dependency of the impact of infiltrations and duct losses was investigated against varying outdoor air conditions to simulate the impact of these effects over the cooling

[26] USDOE, Notice of Data Availability (NODA), May 2014, rulemaking docket EERE-2013-BT-STD-0033.
[27] USDOE, Notice of Data Availability (NODA), May 2014, rulemaking docket EERE-2013-BT-STD-0033.

season. As expected, the closer is the outdoor climate to indoor conditions, the lower the impact. These results are given below in W for cooling capacity and in W/W for EER.

Table 17: Investigation test results[28], impact of varying outdoor conditions of air infiltration on unit performance

Test unit	Cooling capacity (W)				EER (W/W)			
	Test 1 (95/75 °F)	Test 2 (87/69 °F)	Test 3 (82/65 °F)	Test 4 (78/62 °F)	Test 1 (95/75 °F)	Test 2 (87/69 °F)	Test 3 (82/65 °F)	Test 4 (78/62 °F)
SD2	-180.06	1186.44	2063.07	2808.79	-0.21	1.32	2.31	3.12
SD4	539.66	2288.36	3068.13	3589.36	0.39	1.60	2.20	2.64
DD1	990.55	1837.20	2286.25	N/A	0.85	1.62	2.07	N/A
DD2	1008.87	1874.51	2387.74	N/A	0.76	1.46	1.88	N/A

The impact of duct heat losses was also separated by supposing ducts are insulated (correcting the magnitude of heat losses at the indoor side with better duct insulation). These results are given below in W for cooling capacity and in W/W for EER.

Table 18: Investigation test results[29], impact of insulating ducts on unit performance (comparison with calorimeter test results, outdoor conditions temperatures 35/24 (dry bulb/wet bulb)

	Cooling capacity (W)			EER (W/W)		
Test unit	Uninsulated	Insulated	Change	Uninsulated	Insulated	Change
SD1	-137.98	-1.47	136.51	-0.16	0.00	0.16
SD2	-187.98	-9.47	178.48	-0.21	-0.01	0.19
SD3	1018.57	1199.19	180.62	0.67	0.80	0.12
SD4	539.66	886.48	346.82	0.39	0.64	0.24
DD1	990.55	1372.16	381.61	0.85	1.15	0.30
DD2	1008.87	1233.65	224.79	0.76	0.92	0.16

This shows this effect has a lower impact than infiltration at high outdoor temperature conditions but should not be neglected. It can be noted that in the EN14511-3 test standard, the impact of these heat losses is normally included.

<u>Adjusting cooling capacity for the impact of air infiltration and of duct heat losses</u>
Consequently, DOE proposed to modify the cooling capacity measurement in US industry standards (direct air enthalpy method) by computing the impact of duct heat losses and infiltrations. The following corrections are described in detail in the final rule test procedure for portable air conditioners published in the USA Federal Register[30]. The method proposed was checked against calorimeter tests and enabled to reach a satisfying agreement.

<u>Standard test conditions</u>
This standard test conditions are adapted from existing US industry standards.

Table 19: USA portable air conditioners final test method: standard test conditions

Test Configuration	Evaporator Inlet Air, °F (°C)		Condenser Inlet Air, °F (°C)	
	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb
3 (Dual-Duct, Condition A)	80 (26.7)	67 (19.4)	95 (35)	75 (23.9)
3 (Dual-Duct, Condition B)	80 (26.7)	67 (19.4)	83 (28.3)	67.5 (19.7)
5 (Single-Duct)	80 (26.7)	67 (19.4)	80 (26.7)	67 (19.4)

[28] USDOE, Notice of Data Availability (NODA), May 2014, rulemaking docket EERE-2013-BT-STD-0033.
[29] USDOE, Notice of Data Availability (NODA), May 2014, rulemaking docket EERE-2013-BT-STD-0033.
[30] USA Federal Register, Vol 81, No. 105, Wednesday June 1, 2016 (with correction published in October 2016)

Adjusted cooling capacities
Cooling capacities obtained by the air enthalpy method are adjusted from air infiltration and duct heat losses, which are calculated according to variables measured during the tests as shown below. Adjusted cooling capacity is computed as follows:

For single-duct portable air conditioners:

$$ACC_{95} = Capacity_{SD} - Q_{duct\_SD} - Q_{infiltration\_95}$$

For dual-duct portable air conditioners:

$$ACC_{95} = Capacity_{95} - Q_{duct\_95} - Q_{infiltration\_95}$$

$$ACC_{83} = Capacity_{83} - Q_{duct\_83} - Q_{infiltration\_83}$$

Where:

- $Capacity_{SD}$, $Capacity_{95}$, and $Capacity_{83}$ = cooling capacity measured in standard test conditions.
- Q_{duct_SD}, Q_{duct_95}, and Q_{duct_83} = duct heat transfer while operating in cooling mode, see calculation below.
- $Q_{infiltration\_95}$ and $Q_{infiltration\_83}$ = total infiltration air heat transfer in cooling mode, see calculation below.

Duct heat losses
For single duct air conditioners:

$$\mathrm{Q}_{\mathrm{duct}_{\mathrm{SD}}} = h \times \mathrm{A}_{\mathrm{duct}_{\mathrm{j}}} \times (T_{\mathrm{duct\_SD\_j}} - T_{\mathrm{ei}})$$

with:

- Q_{duct_SD} = for single-duct portable air conditioners, the total heat transferred from the duct to the indoor conditioned space in cooling mode when tested according to the standard test conditions, in Btu/h
- h = convection coefficient, 3 Btu/h per square foot per °F (17 $W.m^{-2}.K^{-1}$)
- $T_{duct\_SD\_j}$= average surface temperature for the condenser exhaust duct of single-duct portable air conditioners, as measured during testing according to the standard test conditions, in °F
- T_{ei}= average evaporator inlet air dry-bulb temperature, in °F.
- A_{duct_j} = π x d_j x L_j (with d_j the outer diameter of duct "j", including any manufacturer-supplied insulation and L_j its length)

For double duct units, the same calculation is applied, taking into account the two ducts and the different duct temperatures for the two outdoor conditions as follows:

$$\mathrm{Q}_{\mathrm{duct\_95}} = \sum_j \left\{\mathrm{h} \times \mathrm{A}_{\mathrm{duct\_j}} \times \left(\mathrm{T}_{\mathrm{duct\_95\_j}} - \mathrm{T}_{\mathrm{ei}}\right)\right\}$$

$$\mathrm{Q}_{\mathrm{duct\_83}} = \sum_j \left\{\mathrm{h} \times \mathrm{A}_{\mathrm{duct\_j}} \times \left(\mathrm{T}_{\mathrm{duct\_83\_j}} - \mathrm{T}_{\mathrm{ei}}\right)\right\}$$

With Q_{duct_95} and Q_{duct_83} = for dual-duct portable air conditioners, the total heat transferred from the ducts to the indoor conditioned space in cooling mode, in Btu/h, when tested according to the 95 °F dry-bulb and 83 °F dry-bulb outdoor standard test conditions, respectively.

<u>Air infiltration</u>
The total heat contribution of the infiltration air is the sum of the sensible and latent heat (in Btu/h):

$$Q_{infiltration\_95} = Q_{s\_95} + Q_{l\_95}$$

$$Q_{infiltration\_83} = Q_{s\_83} + Q_{l\_83}$$

The sensible component of infiltration air heat contribution is computed as (in Btu/h):

$$Q_{S\_95} = \dot{m} \times 60 \times \left[\left(c_{p_{da}} \times \left(T_{ia\_95} - T_{indoor} \right) \right) + c_{p\_wv} \times \left(w_{ia\_95} \times T_{ia\_95} - w_{indoor} \times T_{indoor} \right) \right]$$

$$Q_{S\_83} = \dot{m} \times 60 \times \left[\left(c_{p_{da}} \times \left(T_{ia\_83} - T_{indoor} \right) \right) + c_{p\_wv} \times \left(w_{ia\_83} \times T_{ia\_83} - w_{indoor} \times T_{indoor} \right) \right]$$

The latent component of infiltration air heat contribution is computed as (in Btu/h):

$$Q_{l\_95} = \dot{m} \times 60 \times H_{fg} \times \left(w_{ia\_95} - w_{indoor} \right)$$

$$Q_{l\_83} = \dot{m} \times 60 \times H_{83} \times \left(w_{ia\_95} - w_{indoor} \right)$$

The notations are as follows:

- $\dot{m}$= dry air mass flow rate of infiltration air in lb/m. It is the measured condenser mass flow for single duct air conditioners and the difference between condenser inlet and outlet air flows for double duct air conditioners.
- c_{p_da}= specific heat of dry air, 0.24 Btu/lb $_m$ − °F.
- C_{p_wv}= specific heat of water vapor, 0.444 Btu/lb $_m$ − °F.
- T_{ai_95}, T_{ai_83}= infiltration air dry-bulb temperatures, 95 °F and 83 °F, respectively.
- T_{indoor}= indoor chamber dry-bulb temperature, 80 °F.
- w_{indoor}= humidity ratio of the indoor chamber air, 0.0112 lb $_w$/lb $_{da}$.
- H_{fg}= latent heat of vaporization for water vapor, 1061 Btu/lb $_m$.
- w_{ia_95}, w_{ia_83}= humidity ratios of the 95 °F and 83 °F dry-bulb infiltration air, 0.0141 and 0.01086 lb $_w$/lb $_{da}$, respectively.
- *60* = conversion factor from minutes to hours.

<u>Seasonal calculation metrics</u>
SACC - Seasonally Adjusted Cooling Capacity.

$$SACC = ACC_{95} \times 0.2 + ACC_{83} \times 0.8$$

Where:

- ACC_{95} *and* ACC_{83} = adjusted cooling capacity, in Btu/h, calculated above.
- *0.2* = weighting factor for ACC_{95}.
- *0.8* = weighting factor for ACC_{83}.

Calculation of annual energy consumption

$$AEC_m = P_m \times t_m \times k$$

$$AEC_T = \sum_m AEC_m$$

Where:

- *AEC*$_m$= Annual energy consumption in each operating mode (except active mode, i.e. cooling) expressed in kilowatt-hours per year (kWh/year).
- *AEC*$_T$= Total annual energy consumption in all modes except cooling (i.e. active mode),
- *P*$_m$= Average power in each mode, in watts.
- *m*= Represents the operating mode (''95'' and ''83'' cooling mode at the 95 °F and 83 °F dry-bulb outdoor conditions, respectively for dual-duct portable air conditioners, ''SD'' cooling mode for single-duct portable air conditioners, ''oc'' off-cycle, and ''ia'' inactive or ''om'' off mode)[31].
- *t*= number of annual operating time in each mode, in hours.
- *K*= 0.001 kWh/Wh conversion factor from watt-hours to kilowatt-hours.

The following annual hours of operation for each mode are given below:

Table 20: USA portable air conditioners: hours to compute energy consumption

Operating Mode	Annual Operating Hours
Cooling Mode, Dual-Duct 95 °F1	750
Cooling Mode, Dual-Duct 83 °F1	750
Cooling Mode, Single-Duct	750
Off-Cycle	880
Inactive or Off	1,355

[1]: these operating mode hours are for the purposes of calculating annual energy consumption under different ambient conditions for dual-duct portable air conditioners, and are not a division of the total cooling mode operating hours. The total dual-duct cooling mode operating hours are 750 hours.

Note: hours of operation are similar to the hours of operation used for room air conditioners (window air conditioners, through the wall air conditioners) in the USA. DOE explains this choice based upon the results of field measurements on the energy consumption of portable air conditioners in residential and commercial premises[32]. In this report, correlations for time of use in different modes against outdoor temperature are derived from field measurement. These correlations could be used to build an ad-hoc EU metrics, in absence of other data.

Calculation of seasonal performance metrics – CEER

$$CEER_{SD} = \left[\frac{(ACC_{95} \times 0.2 + ACC_{83} \times 0.8)}{\left(\frac{AEC_{SD} + AEC_T}{k \times t}\right)}\right]$$

[31] Note that off cycle mode corresponds to thermostat off cycle mode in EN14825:2016 standard.
[32] T. Burke, et al., ''Using Field-Metered Data to Quantify Annual Energy Use of Portable Air Conditioners,'' Lawrence Berkeley National Laboratory, Report No. LBNL–6868E-Rev (December 2014). Available at https://publications.lbl.gov/islandora/object/ir%3A6868E-Rev.

$$CEER_{DD} = \left[\frac{ACC_{95}}{\left(\frac{AEC_{95} + AEC_T}{k \times t} \right)} \right] \times 0.2 + \left[\frac{ACC_{83}}{\left(\frac{AEC_{83} + AEC_T}{k \times t} \right)} \right] \times 0.8$$

Where:

- $CEER_{SD}$ and $CEER_{DD}$= Combined energy efficiency ratio for single-duct and dual duct portable air conditioners, respectively, in Btu/Wh.
- ACC_{95} and ACC_{83}= Adjusted cooling capacity, tested at the 95 °F and 83 °F dry-bulb outdoor conditions, in Btu/h, see calculation above.
- AEC_{SD}= annual energy consumption in cooling mode for single-duct portable air conditioners, in kWh/year, see calculation above.
- AEC_{95} and AEC_{83}= Annual energy consumption for the two cooling mode test conditions, see calculation above.
- AEC_T= Total annual energy consumption attributed to all modes except cooling, in kWh/year, see calculation above.
- t= Number of cooling mode hours per year, 750.
- k= 0.001 kWh/Wh conversion factor for watt-hours to kilowatt-hours.
- *0.2*= Weighting factor for the 95 °F dry-bulb outdoor condition test.
- *0.8*= Weighting factor for the 83 °F dry-bulb outdoor condition test.

1.2.2 Energy performance for secondary functions of air conditioners

"Air movement" functionality of air conditioners is not rated. It would not be a difficult measurement to be added to EN14511 standard, air flow measurement and associated power consumption only are required in order to establish the delivered air flow and service value as for comfort fans.

Dehumidification of air conditioners is rated in EN14511 standard in cooling standard rating conditions using the sensible to heat ratio (SHR). However, there is no standard to rate the dehumidification capability of air conditioner secondary function (when working in separate dehumidification mode). Such rating conditions and test methods could be derived from dehumidifier standard EN 810 described below.

EN810:1997 Dehumidifiers with electrically driven compressors — Rating tests, marking, operational requirements and technical data sheet

This standard only applies to dehumidification using vapor compression cycle with electric compressor; however it does not apply to variable capacity units.

Performance indicator is the dehumidification capacity, in $L.h^{-1}$. Energy efficiency is rated via the dehumidifcation efficiency, the ratio of dehumidification capacity to power consumed, in $L.h^{-1}.W^{-1}$.

Rating conditions are for outdoor air and recycled air 27/21 (dry bulb/wet bulb).

1.2.3 Noise standards

EN 12102:2013 Air conditioners, liquid chilling packages, heat pumps and dehumidifiers with electrically driven compressors for space heating and cooling — Measurement of airborne noise — Determination of the sound power level. The standard EN 12102 defines the testing methods and conditions of operation to measure the sound power level of air conditioners.

This is the harmonised standard for sound power level measurement in regulations 206/2012 and 206/2011.

'Sound power level' means the A-weighted sound power level [dB(A)] indoors and/or outdoors measured at standard rating conditions, which are standard rating conditions defined in EN14511 and EN15218 standards. The standard defines indoor and outdoor measurement, which are differentiated as follows:

L_{Wi}: sound power level radiated by the indoor side.
L_{Wo}: sound power level radiated by the outdoor side.

In addition, for ducted units, it is noted that the 'attended value' (supposedly also used for compliance with regulations 206/2012 and 206/2011) is the sound power level travelling into the duct, which is measured indirectly: 'it is assessed from the sound power level radiated by the air outlet opening of the duct, corrected by the "duct end correction" factor E (method to determine the factor depends on the installation feature and operating conditions).

Hence, the standard also defines indoor and outdoor values for ducted units, which are noted as:

- For the case of a ducted indoor side of a split unit:
    - L_{Wdi} = sound power level travelling into the (discharge or suction) duct of indoor unit.
- For the case of a ducted unit on the outdoor side:
    - L_{Wdo} = sound power travelling into the (discharge or suction) duct of outdoor unit."

It is also to be noted that there are no test conditions referred to in this standard so that, if not defined in other standards, test conditions for sound power should be clearly specified in any regulation.

A draft version of this standard (prEN12102-2016) has been submitted for approval with no major change identified. According to convenor of CEN TC 113 / WG8, this standard could include rating conditions in the future. In order to link SCOP value and sound power measurement in heating mode, it is planned to use the point C in heating mode (outdoor air 7 °C / indoor air 20 °C / capacity 50 %) in order to rate the sound power level of air conditioners in heating mode. This is to be taken into account in any future regulation.

EN 60704-2-7 Household and similar electrical appliances – Test code for the determination of airborne acoustical noise (1997). Part 2. This standard describes the determination of the noise emission of household fans in normal operation at maximum speed. This standard applies to table fans, pedestal fans, ceiling fans and partition fans.

This is the test standard indicated in transitional test methods for comfort fans in European Commission communication C172/1[33].

[33] http://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52012XC0616(05)&from=FR

1.2.4 Refrigerant standards

EN 378:2016 – Refrigerating systems and heat pumps — Safety and environmental requirements. The standard EN 378 (2012 version) has been reviewed to consider particularly new regulations (such as Regulation (EU) No 517/2014) and new refrigerants now available on the European market. This standard has been released in November 2016, with implementation planned at latest on May 31, 2017.

This standard covers all the equipment of refrigeration, air-conditioning and heat pumps except vehicle air conditioning systems. It specifies the requirements for the safety of persons and property, provides guidance for the protection of the environment and establishes procedures for the operation, maintenance and repair of refrigerating systems including the recovery of refrigerants.

- Part 1 specifies the classification and selection criteria applicable to refrigerating systems. The safety of refrigerant fluids is classified based on their toxicity and flammability. Safety requirements for installations depend on the fluid used, the system type (direct vs indirect) and on the location of the system (in an occupied space or in a machine room). Annex E specifies criteria for safety and environmental considerations of different refrigerants used in refrigeration and air conditioning.
- Part 2 is applicable to the design, construction and installation of refrigerating systems including piping, components, and materials. It also specifies requirements for testing, commissioning, marking and documentation. The following annexes explain the link between the EU directives applying to these products and the EN378 standard: Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 2014/68/EC on pressure equipment; Annex ZB (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 2006/42/EC on machinery.
- Part 3 is applicable to the installation site. It specifies requirements on the site for safety, which may be needed because of, but not directly connected with, the refrigerating system and its ancillary components.
- Part 4 specifies requirements for safety and environmental aspects in relation to operation, maintenance, and repair of refrigerating systems and the recovery, reuse and disposal of all types of refrigerant, refrigerant oil, heat-transfer fluid, refrigerating system and part thereof. These requirements are intended to minimise risks of injury to persons and damage to property and the environment resulting from improper handling of the refrigerants or from contaminants leading to system breakdown and resultant emissions of refrigerant.

This standard is applicable to new refrigerating systems but also in the case of the conversion of a system to another refrigerant.

To notice:

- GWP values are given by regulation (EU) No 517/2014 which uses data from 4th Assessment report of IPCC.
- HFO are included in part 1 - annex E as well as new refrigerants referenced by ASHRAE 34 standard[34].
- A2L and B2L classes are introduced in this standard as intermediate levels between A1/B1 and A2/B2 in accordance with ISO 817 :2014 refrigerants – Designation and

[34] ANSI/ASHRAE 34, *Designation and Safety Classification of Refrigerants.* Latest version: 2016.

safety classification. Hydrocarbons such as R-290 are A3 refrigerants. Many HFC-HFO blends with GWP lower than 700 are classified A2L as well as R-1234yf and R-1234ze refrigerant fluids.

EN 16084:2011 - Refrigerating systems and heat pumps - Qualification of tightness of components and joints. "This European Standard is intended to describe the qualification procedure for type approval of the tightness of hermetically sealed and closed components, joints and parts used in refrigerating systems and heat pumps as described in EN 378. The sealed and closed components, joints and parts concerned are, in particular, fittings, bursting discs, flanged or fitted assemblies. The tightness of flexible piping made from non-metallic materials is dealt with in EN 1736. This standard cover metal flexible piping. The requirements contained in this document are applicable to joints of maximum DN 50 and components of internal volume of maximum 5 l and maximum weight of 50 kg. This document is intended to characterise their tightness stresses met during their operations, following the fitting procedure specified by the manufacturer, and to specify the minimal list of necessary information to be provided by the supplier of a component to the person in charge of carrying out this procedure. It specifies the level of tightness of the component, as a whole, and its assembly as specified by its manufacturer. It applies to the hermetically sealed and closed components, joints and parts used in the refrigerating installations, including those with seals, whatever their material and their design are. This European Standard specifies additional requirements for mechanical joints that can be recognised as hermetically sealed joints."[35]

EN 60355-2-40 - Safety of electric heat pumps - covers sanitary hot water heat pumps, air-conditioners, and dehumidifiers incorporating motor-compressors and hydronic room fan coils, their maximum rated voltages being not more than 250 V for single phase appliances and 600 V for all other appliances. This standard also applies to electric heat pumps, air conditioners and dehumidifiers containing flammable refrigerant. The standard establishes the requirements regarding safety of persons and objects. Furthermore, it provides guidance for environmental protection, and establishes procedures for the operation, maintenance and repair of refrigeration systems and the recovery of refrigerants.

This standard also sets requirements for refrigerant charge sizes which might influence the efficiency of air conditioners. Although this is only a standard (so used on a voluntary basis and not legally binding), it is seen by manufacturers as mandatory in particular regarding the safety part. According to (Schleicher et al., 2017)[36], this standard and planned next revision does not allow propane split air conditioners to reach A+++ SEER level. Delonghi reports that this also limits the production of A++ single duct using propane with higher than 2.5 kW. In these conditions, the development of propane and other A3 refrigerants is not ready to start in Europe in the coming years.

EN 14624:2012 - Performance of portable leak detectors and of room monitors for halogenated refrigerants "The purpose of this European Standard is to qualify the performance of portable sniffing leak detectors and room monitors for halogenated refrigerants. These leak detectors are designed for the detection of CFC, HCFC, HFC and

[35] https://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_PROJECT:34680&cs=13FA5F7AB092D02583186A3C19D691C58

[36] Tobias Schleicher, Jonathan Heubes, Ran Liu, Pascal Radermacher, Jens Gröger. The Blue Angel for Stationary Room Air Conditioners – a national eco-label with international impact, Final Draft of the technical Background Report for German Federal Environment Agency. Freiburg, June 2017.

PFC halogenated gases, and their detection limit is checked with a calibration leak or calibration gas."[37]

The lowest sensitivity threshold of these detectors should be of 5000 ppm (threshold when the leak detector is moving), which corresponds to about 3 g/y leakage for R134a, 2.1 g/y for R410A and 1.5 g/y for R32. It gives an indirect evaluation of the best precision that can be achieved during leakage tests performed on installed units (at installation or maintenance time).

1.2.5 WEEE and RoHS standards

ISO 11469:2016 - Plastics - Generic identification and marking of plastics products
The EN ISO 11469 standard identifies specifies a system of uniform plastic material marking system. The standard does not cover every aspect of marking (e.g. the marking process, the minimum size of the item to be marked, the size of the lettering or the appropriate location of the marking) but the marking system described is intended to help identify plastics products for subsequent decisions concerning handling, waste recovery or disposal. The standard refers to ISO 1043-1 for generic identification of the plastics.

EN ISO 1043-2:2011 - Plastics. Symbols and abbreviated terms. Fillers and reinforcing materials. The EN ISO 1043 standard defines abbreviated terms for the basic polymers used in plastics, symbols for components of these terms, and symbols for special characteristics of plastics.

IEC TR 62635:2012 - Guidelines for end-of-life information provided by manufacturers and recyclers and for recyclability rate calculation of electrical and electronic equipment
IEC/TR 62635:2012(E) provides a methodology for information exchange involving electronic and electrical equipment manufacturers and recyclers. The standard also provides a methodology enabling calculation of the recyclability and recoverability rates of to facilitate optimized end of life treatment operations.

EN 50419:2006 - Marking of electrical and electronic equipment in accordance with Article 11(2) of Directive 2002/96/EC (WEEE)
EN 50419 contains the product marking requirements needed to ensure compliance with the WEEE Directive. EN 50419 also contains additional information relating to the marking requirements, including positioning, visibility, dimensions, location and referenced documents. The marking requirements are applicable to all manufacturers and producers of electrical and electronic equipment placing products on the EU market.

EN 50625-1:2014 Collection, logistics & treatment requirements for WEEE - Part 1: General treatment requirements
EN 50625 was prepared as part of a series of standards requested in Commission mandate 518 (detailed in section 3.2) which aim to support implementation and effectiveness of Directive 2012/19/EU (WEEE). The standard contains requirements applicable to the treatment of all types of WEEE and addresses all operators involved in the treatment (including related handling, sorting, and storage) of WEEE. In particular, the standard addresses the following issue areas:

- Management principles

[37] https://standards.cen.eu/dyn/www/f?p=204:110:0::::FSP_PROJECT:28179&cs=1A51FA1204B81FECC2DB08458FA65628A

    - Technical and infrastructural pre-conditions
    - Training
    - Monitoring
    - Shipments
- Technical requirements
    - General
    - Receiving of WEEE at treatment facility
    - Handling of WEEE
    - Storage of WEEE prior to treatment
    - De-pollution (including Annex A normative requirements)
    - De-pollution monitoring (including Annex B normative requirements)
    - Treatment of non de-polluted WEEE and fractions
    - Storage of fractions
    - Recycling and recovery targets (including Annex C & D normative requirements)
    - Recovery and disposal of fractions
- Documentation

The standard applies to the treatment of WEEE until end-of-waste status is fulfilled, or until the WEEE is prepared for re-use, recycled, recovered, or final disposal.

EN 50574 - on the collection, logistics & treatment requirements for end-of-life household appliances containing volatile fluorocarbons or volatile hydrocarbons.

EN 62321 series - Determination of certain substances in electrotechnical products
The purpose of the harmonized EN 62321/IEC 62321 series of standards is to provide test methods that will allow determination of the levels of certain substances of concern in electrotechnical products on a consistent global basis.

EN 50581:2012 - Technical documentation for the evaluation of electrical and electronic products with respect to restriction of hazardous substances
The EN 50581 standard specifies the technical documentation a producer of EEE has to collect for applicable substance restrictions in order to demonstrate compliance with Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS). The technical documentation required to meet the standard includes:

- A general product description
- Documentation of materials, parts and/or sub-assemblies
- Information showing the relationship between the technical documents and respective materials, parts and/or sub-assemblies
- A list of harmonized standards and/or technical specifications used to prepare the technical documents.

1.2.6 Mandates issued by the EC to the European Standardization Organizations

M488 - Mandate to CEN, CENELEC and ETSI for standardisation in the field of air conditioners and comfort fans

This mandate supported the development of harmonised standards regarding regulation 626/2011 and 206/2012 for air conditioners and fans.

M544 – Standardisation mandate to the European standardisation organisations as regards ecodesign requirements for networked standby in support of Regulation (EC) No 1275/2008 and Regulation (EC) No 642/2009
This mandate should allow the introduction of network standby in a future revision of the standard EN50564:2011. Networked air conditioners are common today and if standby and off mode are still defined, in the future, in air conditioner standards EN14511, EN15218 and EN14825, these should be adapted to include corresponding evolutions. Today, it is not clear whether network standby is taken into account or not in the standby measurement tests for air conditioners.

If networked standby is to be taken into account then air conditioners fits the definition of edge equipment in the draft version prEN 50643 which is: **Edge equipment** is networked equipment that can be connected to a network and interact with that network or other equipment and that does not have, as its primary function, the passing of network traffic to provide a network.

Regarding networked standby there are some useful definitions from the regulation (EU) No 801/2013 amending regulation (EC) No 1275/2008[38]:

Network means a communication infrastructure with a topology of links, an architecture, including the physical components, organisational principles, communication procedures and formats (protocols).

Networked equipment means equipment that can connect to a network and has one or more network ports

Networked standby means a condition in which the equipment is able to resume a function by way of a remotely initiated trigger from a network connection;

M543 – Material Efficiency
In December 2015, the EC published a standardisation request to the European standardisation organisations (ESO's) covering ecodesign requirements on material efficiency aspects for energy-related products in support of the implementation of Directive 2009/125/EC.[39] It was noted in the mandate, that the absence of adequate metrics is one of the reasons for the relative lack of ecodesign requirements related to material efficiency in previous ecodesign implementing measures. The mandate therefore requests that the ESOs draft new European standards and European standardisation deliverables on material efficiency aspects for energy-related products in support of the ecodesign Directive 2009/125/EC. This standardisation request clarifies that the following material efficiency aspects should be covered:

- Extending product lifetime.
- Ability to re-use components or recycle materials from products at end-of-life.
- Use of re-used components and/or recycled materials in products

[38] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02008R1275-20170109&from=EN
[39] European Commission Mandate 543 on Material Efficiency, available from http://ec.europa.eu/growth/tools-databases/mandates/index.cfm?fuseaction=search.detail&id=564

1.3 Legislation

Air conditioners and comfort fans are currently covered by a number of pieces of legislation, both within the EU and third party countries, which attempt to address the environmental impacts of these products through mandatory measures.

1.3.1 EU legislation

There are several pieces of environmental legislation which either directly or indirectly address products within the scope of this review project.

EU Directive 2009/125/EC - Ecodesign for Energy-Related Products [40]

The Ecodesign Directive provides consistent EU-wide rules for improving the environmental performance of products placed on the EU market. This EU wide approach ensures that Member States' national regulations are aligned so that potential barriers to intra-EU trade are removed.

The Directive's main aim is to provide a framework for reducing the environmental impacts of products throughout their entire life cycle. As many of the environmental impacts associated with products are determined during the design phase, the ecodesign Directive aims to bring about improvements in environmental performance through mandating changes at the product design stage.

The Ecodesign Directive is a framework directive, meaning that it does not directly set minimum requirements rather the aims of the Directive are implemented through product-specific Regulations, which are directly applicable in all EU member states. For a product to be covered by under the Ecodesign Directive it needs to meet the following criteria:

- have a volume of sales that exceeds 200,000 units per year throughout the internal European market
- have a significant environmental impact within the internal market
- present significant potential for improvement in environmental impact without incurring excessive costs

EU Regulation 206/2012/EU - Ecodesign Requirements for air conditioners and comfort fans[41]

The European Commission published Commission Regulation (EU) No 206/2012 implementing ecodesign requirement measures for air conditioners and comfort fans. The Regulation includes:

- Requirements on the energy efficiency for all air conditioners in scope
- Requirements on maximum energy consumption in off mode and standby mode including power management demand for single duct, double duct and comfort fans
- Requirements for maximum sound power level for all air conditioner types in scope
- Information requirements for both air conditioners and comfort fans

The Regulation applies to:

- electric mains-operated air conditioners with a rated capacity of ≤ 12 kW for cooling, or heating if the product has no cooling function, and comfort fans with an electric fan power input ≤ 125W.

[40] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0125&from=EN
[41] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:072:0007:0027:en:PDF

The minimum efficiency requirements are:

Table 21: Regulation 206/2012 - minimum efficiency requirements

	Air conditioners, except double and single duct air conditioners		**Double duct airconditioners**		**Single duct air conditioners**	
	SEER	SCOP (heating season: Average)	EER rated	COP rated	EER rated	COP rated
If GWP of refrigerant > 150 for < 6 kW	4.60	3.80	2.60	2.60	2.60	2.04
If GWP of refrigerant ≤ 150 for < 6 kW	4.14	3.42	2.34	2.34	2.34	1.84
If GWP of refrigerant > 150 for 6-12 kW	4.30	3.80	2.60	2.60	2.60	2.04
If GWP of refrigerant ≤ 150 for 6-12 kW	3.87	3.42	2.34	2.34	2.34	1.84

The requirements for maximum power consumption in off-mode and standby mode for single duct air conditioners, double duct air conditioners and comfort fans are:

Table 22: Regulation 206/2012- The requirements for maximum power consumption in off-mode and standby

Mode	Description
Off mode	Power consumption of equipment in any off-mode condition shall not exceed 0.50 W.
Standby mode	The power consumption of equipment in any condition providing only a reactivation function, or providing only a reactivation function and a mere indication of enabled reactivation function, shall not exceed 0.50 W.
	The power consumption of equipment in any condition providing only information or status display, or providing only a combination of reactivation function and information or status display shall not exceed 1.00 W.
Availability of standby and/or off mode	Equipment shall, except where this is inappropriate for the intended use, provide off mode and/or standby mode, and/or another condition which does not exceed the applicable power consumption requirements for off mode and/or standby mode when the equipment is connected to the mains power source.
Power management	When equipment is not providing the main function, or when other energy- using product(s) are not dependent on its functions, equipment shall, unless inappropriate for the intended use, offer a power management function, or a similar function, that switches equipment after the shortest possible period of time appropriate for the intended use of the equipment, automatically into: • standby mode, or • off mode, or • another condition which does not exceed the applicable power consumption requirements for off mode and/or standby mode when the equipment is connected to the mains power source. The power management function shall be activated before delivery.

The maximum requirements for sound power level of air conditioners are dependent on the rated capacity. The requirements are shown in Table 23. It is to be noted that for ducted air conditioners, the sound power should be measured in-duct. In addition, these values are dependent on the rating conditions which refer to standard rating conditions in the Regulation. Requirements should be adapted if the sound power rating conditions vary in the future.

Table 23: Requirements for maximum sound power level of air conditioners

Rated capacity ≤ 6 kW		**6 < Rated capacity ≤12 kW**	
Indoor sound power level in dB(A)	Outdoor sound power level in dB(A)	Indoor sound power level in dB(A)	Outdoor sound power level in dB(A)
60	65	65	70

Besides the above-mentioned requirements also requirements concerning product information are set out in the regulation. The information requirements for air conditioners, except double duct and single duct air conditioners are shown in Table 24.

Table 24: Information requirements for air conditioners, except double duct and single duct air conditioners

Function (indicate if present)				**If function includes heating: Indicate the heating season the information relates to. Indicated values should relate to one heating season at a time. Include at least the heating season 'Average'.**			
cooling	Y/N			Average (mandatory)	Y/N		
heating	Y/N			Warmer (if designated)	Y/N		
				Colder (if designated)	Y/N		
Item	symbol	value	unit	Item	symbol	value	unit
Design load				Seasonal efficiency			
cooling	Pdesignc	x.x	kW	cooling	SEER	x.x	—
heating/Average	Pdesignh	x.x	kW	heating/Average	SCOP/A	x.x	—
heating/Warmer	Pdesignh	x.x	kW	heating/Warmer	SCOP/W	x.x	—
heating/Colder	Pdesignh	x.x	kW	heating/Colder	SCOP/C	x.x	—
Declared capacity (*) for cooling, at indoor temperature 27(19) °C and outdoor temperature Tj				Declared energy efficiency ratio (*), at indoor temperature 27(19) °C and outdoor temperature Tj			
Tj = 35 °C	Pdc	x.x	kW	Tj = 35 °C	EERd	x.x	—
Tj = 30 °C	Pdc	x.x	kW	Tj = 30 °C	EERd	x.x	—
Tj = 25 °C	Pdc	x.x	kW	Tj = 25 °C	EERd	x.x	—
Tj = 20 °C	Pdc	x.x	kW	Tj = 20 °C	EERd	x.x	—
Declared capacity (*) for heating/Average season, at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance (*)/Average season, at indoor temperature 20 °C and outdoor temperature Tj			
Tj = – 7 °C	Pdh	x.x	kW	Tj = – 7 °C	COPd	x.x	—
Tj = 2 °C	Pdh	x.x	kW	Tj = 2 °C	COPd	x.x	—
Tj = 7 °C	Pdh	x.x	kW	Tj = 7 °C	COPd	x.x	—
Tj = 12 °C	Pdh	x.x	kW	Tj = 12 °C	COPd	x.x	—
Tj = bivalent temperature	Pdh	x.x	kW	Tj = bivalent temperature	COPd	x.x	—
Tj = operating limit	Pdh	x.x	kW	Tj = operating limit	COPd	x.x	—
Declared capacity (*) for heating/Warmer season, at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance (*)/Warmer season, at indoor temperature 20 °C and outdoor temperature Tj			
Tj = 2 °C	Pdh	x.x	kW	Tj = 2 °C	COPd	x.x	—
Tj = 7 °C	Pdh	x.x	kW	Tj = 7 °C	COPd	x.x	—
Tj = 12 °C	Pdh	x.x	kW	Tj = 12 °C	COPd	x.x	—
Tj = bivalent temperature	Pdh	x.x	kW	Tj = bivalent temperature	COPd	x.x	—

Tj = operating limit	Pdh	x.x	kW	Tj = operating limit	COPd	x.x	—
Declared capacity (*) for heating/Colder season, at indoor temperature 20 °C and outdoor temperature Tj				Declared coefficient of performance (*)/Colder season, at indoor temperature 20 °C and outdoor temperature Tj			
Tj = – 7 °C	Pdh	x.x	kW	Tj = – 7 °C	COPd	x.x	—
Tj = 2 °C	Pdh	x.x	kW	Tj = 2 °C	COPd	x.x	—
Tj = 7 °C	Pdh	x.x	kW	Tj = 7 °C	COPd	x.x	—
Tj = 12 °C	Pdh	x.x	kW	Tj = 12 °C	COPd	x.x	—
Tj = bivalent temperature	Pdh	x.x	kW	Tj = bivalent temperature	COPd	x.x	—
Tj = operating limit	Pdh	x.x	kW	Tj = operating limit	COPd	x.x	—
Tj = – 15 °C	Pdh	x.x	kW	Tj = – 15 °C	COPd	x.x	—
Bivalent temperature				Operating limit temperature			
heating/Average	Tbiv	x	°C	heating/Average	Tol	x	°C
heating/Warmer	Tbiv	x	°C	heating/Warmer	Tol	x	°C
heating/Colder	Tbiv	x	°C	heating/Colder	Tol	x	°C
Cycling interval capacity				Cycling interval efficiency			
for cooling	Pcycc	x.x	kW	for cooling	EERcyc	x.x	—
for heating	Pcych	x.x	kW	for heating	COPcyc	x.x	—
Degradation co-efficient cooling (**)	Cdc	x.x	—	Degradation co-efficient heating (**)	Cdh	x.x	—
Electric power input in power modes other than 'active mode'				Annual electricity consumption			
off mode	POFF	x.x	kW	cooling	QCE	x	kWh/a
standby mode	PSB	x.x	kW	heating/Average	QHE	x	kWh/a
thermostat-off mode	PTO[42]	x.x	kW	heating/Warmer	QHE	x	kWh/a
crankcase heater mode	PCK	x.x	kW	heating/Colder	QHE	x	kWh/a

[42] There are in fact two values for PTO, one in cooling mode and the other one in heating mode. It means that there could be 4 different set of values for power input in non active modes.

Capacity control (indicate one of three options)		Other items			
fixed	Y/N	Sound power level (indoor/outdoor)	LWA	x.x/x.x	dB(A)
staged	Y/N	Global warming potential	GWP	x	kgCO2 eq.
variable	Y/N	Rated air flow (indoor/outdoor)	—	x/x	m3/h
Contact details for obtaining more information	Name and address of the manufacturer or of its authorised representative.				

The information requirements for single duct and double duct air conditioners are shown in Table 25.

Table 25: Information requirements for single duct and double duct air conditioners.

Description	Symbol	Value	Unit
Rated capacity for cooling	Prated for cooling	[x.x]	kW
Rated capacity for heating	Prated for heating	[x.x]	kW
Rated power input for cooling	PEER	[x.x]	kW
Rated power input for heating	PCOP	[x.x]	kW
Rated Energy efficiency ratio	EERd	[x.x]	—
Rated Coefficient of performance	COPd	[x.x]	—
Power consumption in thermostat-off mode	PTO	[x.x]	W
Power consumption in standby mode	PSB	[x.x]	W
Electricity consumption of single/double duct appliances (indicate for cooling and heating separately)	DD: QDD SD: QSD	DD: [x] SD: [x.x]	DD: kWh/a SD: kWh/h
Sound power level	LWA	[x]	dB(A)
Global warming potential	GWP	[x]	kgCO2 eq.
Contact details for obtaining more information	Name and address of the manufacturer or of its authorised representative.		

Regarding information requirements, there is no information required on backup heater capacity so that the unit plus the backup heater may supply Pdesignh capacity at the Tdesign temperature. This information is required in Regulation (EU) no 813/2013 for air-to-water heat pumps. The reason is that for air-to-water heat pumps, an electric backup heater is commonly included in the heat pump or heat pump system, while no air-to-air heat pump manufacturer supplies additional backup inside the unit. As it was not included in air-to-air unit, information on backup heater was not included. However, this seems to create confusion according to comments received from stakeholders, Pdesignh is sometimes understood as the heat pump capacity, while in fact it highly depends on the choice of the bivalent temperature.

Keeping a variable bivalent temperature may be useful for the end-user (see Task 3 part 3.1.5 for more information). However, it is necessary to indicate additional backup heater capacity required to reach Pdesignh even if it is not included in the unit. So it is proposed to require the following additional information requirement under the heading "backup heater":

- Required additional backup heater capacity: 3 values in kW to be supplied for warm / average/cold climates; this corresponds to the difference between Pdesignh for a specific climate and unit capacity of the unit at Tdesignh;

- Backup heater included in the unit: Yes or No (3 values for the 3 different climates).

The information requirements for comfort fans are shown in Table 26.

Table 26:Information requirements for comfort fans

Description	Symbol	Value	Unit
Maximum fan flow rate	F	[x.x]	m3/min
Fan power input	P	[x.x]	W
Service value	SV	[x.x]	(m3/min)/W
Standby power consumption	PSB	[x.x]	W
Fan sound power level	LWA	[x]	dB(A)
Maximum air velocity	c	[x.x]	meters/sec
Measurement standard for service value	[state here the reference to measurement standard used]		
Contact details for obtaining more information	Name and address of the manufacturer or of its authorised representative.		

Regarding information to enable the products to be tested, this Regulation requires that "*The manufacturer of air conditioners and comfort fans shall provide laboratories performing market surveillance checks, upon request, the necessary information on the setting of the unit as applied for the establishment of declared capacities, SEER/EER, SCOP/COP values and service values and provide contact information for obtaining such information.*" For inverter units, it means that SEER/SCOP performance indicators cannot be checked independently of the manufacturer/importer and some laboratories report that in some case it is not possible to get testing information via the contact indicated in the product fiche. It is thus proposed that testing information required to set up the machine to reach claimed values be indicated in the technical documentation of the product instead of being provided upon request or to include it in the compliance part of the EU label database (where it can only be accessed by market surveillance authorities). To make it mandatory in the product information would also help the development of competitive surveillance systems where manufacturers can check the claims of their competitors.

This regulation also defines the SEER and SCOP values for air conditioners and heat pumps, as well as their calculation. Regarding the calculation method, following input from test laboratories reported in the description of standard EN14825 paragraph 1.2.2, it is advised not to allow performance tests to measure cycling performance degradation coefficients Cdc and Cdh, but to use the default value 0.25 instead as there is no proof the value can be measured satisfactorily for inverter units.
In the future, SEER and SCOP values should be replaced by primary energy efficiency ratio in cooling and in heating mode following the example of more recent regulations (e.g. Regulation (EU) No 2281/2016).
In addition, there are small differences in the number of equivalent active mode hours for heating, when compared to Regulation (EU) No 813/2013. Harmonisation is to be studied,

keeping in mind that the destination (residential / commercial) of heating products in both regulations may differ.
Regarding low power modes, in the EN 14825:2016, the crankcase heater consumption is measured in test condition D in both heating and cooling mode, it means that for the average climate, there are two values for P_{CK}, and thus potentially also for P_{TO}, P_{SB} and P_{OFF}..
Above that, the impact of outdoor temperature on crankcase heating consumption is not accounted for presently while it is in ISO/FDIS 16358-1:2013. The impact and feasibility to include this variation in the calculation of SEER and SCOP value should be investigated; in ISO/FDIS 16358-1:2013, different hours are used for low power mode calculation (including cranckase heater), and this is to be compared with values in Regulation 206/2012; any change in the crankcase heater average power or in the number of hours should be done keeping in mind the total impact of crankcase heater on the final SEER / SCOP metrics. In addition, present regulation does not specify if network connection consumption is to be included in low power modes values (which reflects in present standard EN14511, EN15218 and EN14825).
For heating only units, the 12 kW threshold should be related to other than present standard rating conditions as these conditions are not used to compute SCOP values. It is suggested that the declared heating capacity of the unit refer to point A in heating mode for the average climate in standard EN14825:2016 (outdoor air temperature - 7°C).
It is also suggested that the test conditions to measure sound power level in heating mode are specified. The planned test conditions are heating mode point C in EN14825:2016 (outdoor air temperature + 7°C / declared capacity 50 %).

Lastly, crankcase heater mode and off mode hours have been updated in the test standards in EN14825 and therefore the relevant table in the Regulation should be updated accordingly.

EU Regulation – 626/2011 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of air conditioners

The European Commission published Commission Regulation (EU) No 626/2011 implementing labelling requirement measures for air conditioners and requirements for the execution of the label itself. The Regulation applies to:

- electric mains-operated air conditioners with a rated capacity of ≤ 12 kW for cooling, or heating, if the product has no cooling function.

This Regulation introduces two energy efficiency scales based on the primary function and on specific aspects important to consumer. Given that air conditioners are used mainly in part load conditions, the efficiency testing was changed to a seasonal efficiency measurement method, except for single and double duct air conditioners. The seasonal measurement method takes better into account the benefits of the inverter driven technology and the conditions in which these appliances are used. The new efficiency calculation method with an Ecodesign implementing measure setting minimum energy efficiency requirements higher than the current A level, will lead to a reclassification of these appliances. Consequently, split, window and wall air conditioners should have a new A-G energy efficiency class scale with a '+' added on the top of the scale every two years until the A+++ class has been reached.

For double duct and single duct air conditioners, steady-state energy efficiency performance indicators should continue to be applied, as there are currently no inverter units on the market. As no reclassification of these appliances is appropriate, single and double duct air conditioners should have an A+++-D scale. While these, inherently less efficient than split appliances, can go only up to an A++ energy efficiency class in a scale of A+++-D, the more efficient split appliances can reach up to the A+++ energy efficiency class.

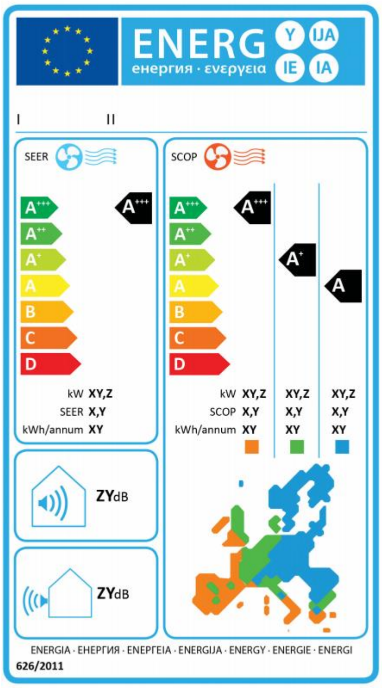

Figure 4: Example of an energy label for a reversible air conditioner

The energy efficiency classes are dependent on the type of air conditioner and the related SEER and SCOP. The Energy efficiency classes for air conditioners, except double ducts and single ducts are shown in Table 27.

Table 27: Regulation 626/2011 – Energy efficiency classes for air conditioners, except double ducts and single

Energy Efficiency Class	SEER	SCOP
A+++	SEER ≥ 8.50	SCOP ≥ 5.10
A++	6.10 ≤ SEER < 8.50	4.60 ≤ SCOP < 5.10
A+	5.60 ≤ SEER < 6.10	4.00 ≤ SCOP < 4.60
A	5.10 ≤ SEER < 5.60	3.40 ≤ SCOP < 4.00
B	4.60 ≤ SEER < 5.10	3.10 ≤ SCOP < 3.40
C	4.10 ≤ SEER < 4.60	2.80 ≤ SCOP < 3.10
D	3.60 ≤ SEER < 4.10	2.50 ≤ SCOP < 2.80
E	3.10 ≤ SEER < 3.60	2.20 ≤ SCOP < 2.50
F	2.60 ≤ SEER < 3.10	1.90 ≤ SCOP < 2.20
G	SEER < 2.60	SCOP < 1.90

The Energy efficiency classes for double ducts and single ducts are shown in Table 28.

Table 28: Regulation 626/2011 – Energy efficiency classes for double ducts and single ducts are

Class	Double ducts		Single ducts	
	EER rated	COP rated	EER rated	COP rated
A+++	≥ 4.10	≥ 4.60	≥ 4.10	≥ 3.60
A++	3.60 ≤ EER < 4.10	4.10 ≤ COP < 4.60	3.60 ≤ EER < 4.10	3.10 ≤ COP < 3.60
A+	3.10 ≤ EER < 3.60	3.60 ≤ COP < 4.10	3.10 ≤ EER < 3.60	2.60 ≤ COP < 3.10
A	2.60 ≤ EER < 3.10	3.10 ≤ COP < 3.60	2.60 ≤ EER < 3.10	2.30 ≤ COP < 2.60
B	2.40 ≤ EER < 2.60	2.60 ≤ COP < 3.10	2.40 ≤ EER < 2.60	2.00 ≤ COP < 2.30
C	2.10 ≤ EER < 2.40	2.40 ≤ COP < 2.60	2.10 ≤ EER < 2.40	1.80 ≤ COP < 2.00
D	1.80 ≤ EER < 2.10	2.00 ≤ COP < 2.40	1.80 ≤ EER < 2.10	1.60 ≤ COP < 1.80
E	1.60 ≤ EER < 1.80	1.80 ≤ COP < 2.00	1.60 ≤ EER < 1.80	1.40 ≤ COP < 1.60
F	1.40 ≤ EER < 1.60	1.60 ≤ COP < 1.80	1.40 ≤ EER < 1.60	1.20 ≤ COP < 1.40
G	< 1.40	< 1.60	< 1.40	< 1.20

In addition, to differentiate single duct air conditioners, it is specified in Article 3 (g) that: "single ducts shall be named 'local air conditioners' in packaging, product documentation and in any advertisement material, whether electronic or in paper." This distinction is supposed to advertise the end-users about the functionality of the air conditioners which is able to cool locally and also able to heat due to air infiltration. However, the "local air conditioner" term cannot be found in practice.

Hence, the only difference in information obtainable for end-users today between single duct air conditioners and standard split systems is the use of the EER versus the SEER on the label. However, the distinction between EER and SEER is not obvious to end-users and therefore it is unlikely that the end-users can differentiate the different types of air conditioners and understand that the energy efficiency scale and the principles of operations are different.

Thus, is it recommended to ensure the energy efficiency ratings of split and of single and double duct air conditioners are indeed comparable, or that the energy efficiency information is communicated to the end-user for these products (comparative label, information label, warnings, and so on) are explicitly two different product types.

Stakeholders have raised the questions about the appropriateness of the label in cold climates where they believe the label is almost unusable. Today the end user has to know the meaning of Pdesign to determine whether the air conditioner is useful. A possible solution could be:

- to publish together with the SCOP the capacity and efficiency of the heat pump and/or the capacity of the complementary heating required at Tdesign
- or capacity efficiency at Tbiv

Stakeholders of northern countries have also suggested to make it mandatory to show SCOP for cold climates on the energy label. This could be useful and possible since most manufactures have special models for cold climates.

Tolerances and uncertainties in Regulation 206/2012 and 626/2011

Ecodesign and Energy Labelling Regulations No 206/2012 and 626/2011 define tolerances regarding the measured efficiency value compared to the declared value by manufacturer as follows:

- 8 % on SEER and SCOP values for fixed air conditioners
- 10 % on EER and COP for portable air conditioners

For portable air conditioners, uncertainty of measurement in standard EN14825:2016 is of 10 %. Hence, for these products, both values are aligned, which is in agreement with Regulation (EU) 2282/2016[43] regarding tolerances: as tolerance is larger or equal than uncertainty of measurement, a value measured in a laboratory with minimum value according to uncertainty still fits in the tolerance limit fixed by the product regulation.

However, for fix air conditioners, uncertainties of measurement in EN14825:2016 have been set as follows:

- 5 % on EER and COP values for capacities measured that are higher than 2 kW
- 10 % for capacities between 1 and 2 kW
- 15 % for capacities below 1 kW
- And regarding standby/off mode, thermostat off and crankcase heater, 0.1 W for value measured up to 10 W and 1 % above

With individual EER/COP uncertainty levels, for certain products, the SEER and SCOP compound uncertainty is higher than regulation tolerances. The study team tested this hypothesis on real units of various sizes and efficiency levels. Declared values are real unit efficiency values. Capacities were decreased to the declared values minus maximum allowed uncertainty, and power consumed in standby/thermostat-off/crankcase was increased by maximum allowed uncertainty. Results are presented in Table 29 (problematic cases are highlighted in red).

[43] http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1490878675216&uri=CELEX:32016R2282

Table 29: Impact of maximum uncertainty level according to EN14825:2016 standard on SEER and SCOP declared values

	Unit	Indicator	SEER/SCOP	SEER/SCOP w uncertainties	Variation %
1.7 kW	1	SEER	5.70	5.10	-12.30%
		SCOP	4	3.5	-13.80%
2.5 kW	2	SEER	10.5	9.5	-10.30%
		SCOP	5.2	4.8	-9.00%
	3	SEER	7.8	7.1	-10.40%
		SCOP	4.6	4.2	-10.50%
3.5 kW	4	SEER	6.1	5.6	-8.20%
		SCOP	3.8	3.4	-10.80%
	5	SEER	6.5	6.1	-6.70%
		SCOP	4	3.7	-9.30%
	6	SEER	6.1	5.6	-8.70%
		SCOP	3.8	3.5	-9.40%
	7	SEER	7.8	7.2	-8.10%
		SCOP	4.6	4.2	-9.30%
	8	SEER	8.5	7.8	-9.00%
		SCOP	4.6	4.2	-11.50%
	9	SEER	10	9.2	-8.80%
		SCOP	5.9	5.4	-9.30%
5 kW	10	SEER	6.3	5.9	-6.00%
		SCOP	4	3.7	-9.20%
	11	SEER	6	5.7	-6.20%
		SCOP	4.3	3.9	-9.00%
7.1 kW	12	SEER	6.1	5.7	-6.20%
		SCOP	4	3.7	-7.80%
	13	SEER	7.4	7.1	-4.70%
		SCOP	4.4	4.1	-7.30%
	14	SEER	6.4	6.1	-5.30%
		SCOP	3.9	3.6	-7.50%
	15	SEER	5.3	5	-5.30%
		SCOP	3.9	3.6	-7.70%
	16	SEER	6	5.7	-5.20%
		SCOP	3.8	3.5	-7.70%
	17	SEER	7.1	6.7	-6.20%
		SCOP	4	3.7	-9.30%
10 kW	18	SEER	4.7	4.5	-5.70%
		SCOP	3.8	3.5	-7.70%
	19	SEER	6.1	5.8	-5.20%
		SCOP	4	3.7	-7.80%

Between 6 and 12 kW, there is no unit for which measurement uncertainties is higher than allowed tolerances. Measurement uncertainties are higher in heating mode because of the 10 % individual uncertainty on COP in frost conditions (supposed to apply for all units at +2 °C).

Problems are related to units below 6 kW. It is enough that one of the declared capacity points are below 2 kW to have uncertainty levels higher than the tolerance. For tolerances to cover the worst-case situation of provisions for measurement uncertainties in EN14825:2016, these should be increased to 14 % for SCOP for 1.7 kW unit (13 % for SEER), 12 % for SCOP for 2.5 and 3.5 units (10 % for SEER) and to 10 % for SCOP for 5 kW units (7 % for SEER).

These values are in line with APF (annual performance factor compound of the equivalent to SEER and SCOP in Japanese standards) tolerances in Japan (as reported in the Preparatory study for 2004 and 2006 JRA standards) of 10 % for commercial air conditioners (above 4 kW) and 15 % for residential units (below 4 kW). Nevertheless, these are very high values in view of setting labeling requirements.

Zero tolerance is applied in the USA, and according to discussions with EU manufacturers during this review study, this corresponds to measurements uncertainties as low as 2 to 3 % on the measurement of SEER and SCOP (HSPF in the USA). Such low uncertainty levels are thought to be the result of regular Round Robin tests and harmonization efforts between laboratories.

The ISO 16358:2013 standard uses the 5 % maximum uncertainty value as a basis (reference also used for standard rating conditions tests in ISO5151). The case when measurement uncertainty is above 5 % is not envisaged for variable capacity air conditioners / heat pumps, whereas a test at 50 % capacity at 35 °C outdoor temperature and 27 °C indoor is mandatory. This means that all laboratories using this standard should be able to maintain a 5 % uncertainty level at capacity down to 1.7/2=0.85 kW (1.7 kW is the lowest capacity unit identified on the EU market).

Base on the above assessment, it can be concluded that:

- in order for tolerances to be higher than maximum measurement uncertainties implied by individual uncertainties mentioned in EN14825, these would have to be increased to: 14 % and13% (respectively for SCOP and SEER) for below 2 kW capacities, 12 % and10% (respectively SCOP and SEER) for between 2 and 6 kW, 10 % and8% (respectively SCOP and SEER) between 6 and 12 kW.
- nevertheless, manufacturers have suggested to reduce both tolerances and measurement uncertainties; this requires investments to be done by laboratories (and thus could result in higher test costs for manufacturers and the market surveillance authorities); Round Robin tests should be made on a regular basis in order to improve repeatability; possibly, the EN14825 standard should be enriched in specifying in more details the measurement equipment required and installation conditions in order to help improving repeatability. A first objective to be met with such measures could be uncertainties of 5 % for capacities equal or above 1 kW and 10 % for capacities below 1 kW and for frost conditions. This would help decreasing maximum uncertainties, and consequently tolerances to the following levels: 10 % and8 % (respectively SCOP and SEER) for below 6 kW, 9 % and 6 % (respectively SCOP and SEER) for above 6 kW. This is a more optimal approach for revising tolerances.

EU Regulation 1275/2008/EU - Ecodesign Requirements for standby and off mode, and networked standby, electric power consumption of electrical and electronic household and office equipment[44]

EU ecodesign requirements are mandatory for all manufacturers and suppliers wishing to sell products consuming electric power in standby and off mode in the EU. A wide range of equipment – computers, TVs, audio and video equipment, dishwashers, microwave ovens, and electric toys – can have standby modes so the regulation covers a wide range of products. The complete list of products is presented in annex 1 in the regulation. The requirements for products listed in annex 1 is:

- Standby and off mode ≤ 0.5 Watts
- Standby with display ≤ 1 Watts
- Networked standby ≤ 3 Watts
- HiNA equipment ≤ 8 Watts

It should be noted that air conditioners not are included in the standby regulation but the requirements for standby in Regulation 206/2012 (with and without a display) and off mode are in line with the standby regulation. Stakeholders have raised the question whether air conditioners also should comply with the requirements of networked standby and HiNA equipment. The standby consumption is already included in the SEER calculation and leaves more room for development for manufacturers. It should though be investigated in later task whether it is feasible to include the requirements.

EU Draft Commission Regulation implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for electronic displays[45]

In principle, displays of air conditioners are in the scope of the proposed draft regulation. However, there is an exemption which potentially excludes the displays of all air conditioners today on the market. In article 1, point 5, the following exemption is stated: Displays of a surface area smaller than or equal to 1 square decimetre.

EU Directive 2012/19/EU - WEEE Directive [46]

The Waste Electrical and Electronic Equipment (WEEE) Directive implements the principle of "extended producer responsibility" where producers of EEE are expected to take responsibility for the environmental impact of their products at the end of life. As such, the WEEE Directive aims to reduce environmental impacts through setting targets for the separate collection, reuse, recovery, recycling and environmentally sound disposal of WEEE.

As EEE, air conditioners and comfort fans fall under the scope of the WEEE Directive. Ecodesign requirements for air conditioners and comfort fans could therefore be used to assist the WEEE Directive aims via the introduction of product design requirements that enhance reuse, material recovery and effective recycling.

[44] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02008R1275-20170109&from=EN
[45] http://ec.europa.eu/growth/tools-databases/tbt/en/search/?tbtaction=search.detail&Country_ID=EU&num=433&dspLang=en&basdatedeb=&basdatefin=&baspays=&basnotifnum=433&basnotifnum2=&bastypepays=&baskeywords
[46] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32012L0019&from=EN

EU Regulation 1907/2006/EC - REACH Regulation [47]

The Regulation on the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) addresses chemicals, and their safe use, and aims to improve the protection of human health and the environment through a system of Registration, Evaluation, Authorisation and Restriction of Chemicals. The REACH Regulation places greater responsibility on industry to manage the risks from the chemicals they manufacture, import and market in the EU. Companies are required to demonstrate how substances can be used safely and risk management measures must be reported to users. The REACH Regulation also establishes procedures for collecting and assessing information on the properties and hazards of substances and requires that companies register their substances in a central database. The entries in the database are then assessed to determine whether the risks of the substances can be managed. The REACH Regulation allows for some chemicals to be determined "substances of very high concern (SVHC)" due to their large potential negative impacts on human health or the environment. The European Chemicals Agency must be notified of the presence of SVHCs in certain products and the use of SVHCs may then be subject to prior authorisation. Substances can also be banned were risks are deemed to be unmanageable. As such, REACH encourages substitution of the most dangerous chemicals when suitable alternatives have been identified.

As REACH applies to all chemical substances, which implies that it also covers the chemicals that are used in air conditioners and comfort fans that are within scope of this review project.

EU Directive 2011/65/EU - RoHS Directive[48]

The Restriction of Hazardous Substances (RoHS) Directive aims to reduce hazardous substances from electrical and electronic equipment (EEE) that is placed on the EU market. A number of hazardous substances are listed in the Directive along with maximum concentration values that must be met. The RoHS Directive does contain some exemptions where it has been decided that it may not be possible to manufacture some products without the use of one or more of the banned substances.

EU Directive 2006/42/EC - Machinery Directive[49]

The Directive has the dual aim of harmonising the health and safety requirements applicable to machinery on the basis of a high level of protection of health and safety, while ensuring the free circulation of machinery on the EU market. The revised Machinery Directive does not introduce radical changes compared with the previous versions. It clarifies and consolidates the provisions of the Directive with the aim of improving its practical application. This directive applies to products which are not residential and includes some of the same safety standards as for residential air conditioners.

EU Directive 2004/108/EC - Electromagnetic Compatibility Directive [50]

The Electromagnetic Compatibility Directive (EMC) Directive has the primary aim of protecting the electromagnetic spectrum. The Directive requires that products must not emit unwanted electromagnetic interference and must be protected against a normal level of interference. The vast majority of complete electrical products must comply independent of whether they are mains or battery powered. The EMC Directive does contain exemptions

[47] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02006R1907-20140410&from=EN
[48] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32011L0065&from=EN
[49] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02006L0042-20160420&from=EN
[50] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:390:0024:0037:en:PDF

for a range of components with no intrinsic function and some products that are already covered by other directives such as medical, military and communications equipment.

The new EMC directive (2014/30/EU) has been published and will come into force on the 20th April 2016.[51]

EU Directive 2006/95/EC - Low Voltage Directive [52]

The Low Voltage Directive (LVD) ensures that electrical equipment that operates within certain voltage limits, provides a high level of protection. The LVD Directive covers all health and safety risks of electrical equipment operating with a voltage of between 50 and 1000 volts for alternating current and between 75 and 1500 volts for direct current. Consumer goods with a voltage below 50 for alternating current or 75 for direct current are covered by the General Product Safety Directive (GPSD) (2001/95/EC).

The new Low Voltage Directive (2014/35/EU) will come into force on the 20th April 2016.[53]

Most air conditioners that are within scope of this review project would fall under the scope of the LVD Directive.

EU Directive 97/23/EC – Pressure directive[54]

The Pressure Equipment Directive aims to guarantee free movement of these products in the internal market while ensuring a high level of safety. The directive covers a very broad range of products such as vessels, pressurised storage containers, heat exchangers, steam generators, boilers, industrial piping, safety devices and pressure accessories. Such equipment is widely used in the process industries (oil & gas, chemical, pharmaceutical, plastics and rubber and the food and beverage industry), high temperature process industry (glass, paper and board), energy production and in the supply of utilities, heating, air conditioning and gas storage and transportation.

EU Directive 2010/31 – Energy Performance of Buildings[55]

Buildings are responsible for 40% of energy consumption and 36% of CO2 emissions in the EU. While new buildings generally need fewer than three to five litres of heating oil per square meter per year, older buildings consume about 25 litres on average. Some buildings even require up to 60 litres. The energy performance of buildings also includes inspections of air conditioners since they are important to the overall energy performance of buildings.

The EPBD defines an air-conditioning system as "a combination of all components required to provide a form of air treatment in which temperature is controlled or can be lowered, possibly in combination with the control of ventilation, humidity, and air cleanliness". Moreover, "the effective rated output (expressed in kW) is the maximum calorific output specified and guaranteed by the manufacturer as being deliverable during continuous operation while complying with the useful efficiency indicated by the manufacturer". However, even after defining those terms, article 9 remains unclear because the 12-kilowatt limit can be defined in several ways. Member States will have to define the meaning of the 12-kilowatt limit through a cost/benefit analysis[56].

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[51] http://ec.europa.eu/growth/sectors/electrical-engineering/directives/index_en.htm
[52] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2006:374:0010:0019:en:PDF
[53] http://ec.europa.eu/growth/sectors/electrical-engineering/directives/index_en.htm
[54] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:01997L0023-20130101&from=EN
[55] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32010L0031&from=EN
[56] Dupont M. and Adnot J., present by the ECEEE 2005 Summer Study, Mandelieu, Côte d'Azur,

That limit is associated on the one hand to an energy saving potential and on the other hand to a workload (number of inspections). The lower the limit (the wider the scope), the higher the workload but the higher the energy savings. One can understand the weight of consequences generated by that definition. There are 4 main ways to understand the boundary:

- 12 kW per cooling system. Only systems with an effective rated output over 12 kilowatts will be taken into account.
- 12 kW per temperature controlled zone. Every cooling system included in the same thermal zone (bound by a common control system) but with a total effective rated output of the zone over 12 kW is taken into account. (The rated output of each system can be lower than 12kW)
- 12 kW per building. Every cooling system included in the same building (bound by exterior walls) but with a total effective rated output for the building over 12 kW is taken into account. (The rated output of each system can be lower than 12kW)
- 12 kW per owner (or tenant) in a given building. Based on previous technical definitions, the scope may be extended to the real ownership in case of a share of the building.

Directive 2009/28 – renewable energy[57]
The Renewable Energy Directive establishes an overall policy for the production and promotion of energy from renewable sources in the EU. It requires the EU to fulfil at least 20% of its total energy needs with renewables by 2020 – to be achieved through the attainment of individual national targets. Air conditioners are able to obtain a considerable amount of renewable energy. Each Member State shall adopt a national renewable energy action plan. The national renewable energy action plans shall set out Member States' national targets for the share of energy from renewable sources consumed in transport, electricity and heating and cooling in 2020, taking into account the effects of other policy measures relating to energy efficiency on final consumption of energy.

- **Commission Decision of 1 March 2013** establishing the guidelines for Member States on calculating renewable energy from heat pumps from different heat pump technologies pursuant to Article 5 of Directive 2009/28/EC of the European Parliament and of the Council

Commission Decision of 1 March 2013 – establishing the guidelines for Member States on calculating renewable energy from heat pumps from different heat pump technologies pursuant to Article 5 of Directive 2009/28/EC of the European Parliament and of the Council.

The gross final consumption of energy from renewable sources in each Member State shall be calculated as the sum of:

a. gross final consumption of electricity from renewable energy sources
b. gross final consumption of energy from renewable sources for heating and cooling
c. final consumption of energy from renewable sources in transport

Aerothermal, geothermal and hydrothermal heat energy captured by heat pumps shall be taken into account for the purposes of paragraph (b) provided that the final energy output

France, 30 May-4 June 2005.
[57] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0028&from=EN

significantly exceeds the primary energy input required to drive the heat pumps. The quantity of heat to be considered as energy from renewable sources for the purposes of this Directive shall be calculated

F-gas Regulation - (EU) No 517/2014[58]

A first F-gas Regulation was adopted in 2006 and succeeded in stabilising EU F-gas emissions at 2010 levels. A new regulation, which replaces the first and applies from 1 January 2015, strengthens the existing measures and introduces a number of far-reaching changes. By 2030 it will cut the EU's F-gas emissions by two-thirds compared with 2014 levels. The F-gas regulation also covers air conditioners and there are two relevant prohibitions for air conditions which are described in Table 30.

Table 30: Prohibition of high GWP refrigerants

Placing on the market prohibitions	Date of prohibition
Movable room air-conditioning equipment (hermetically sealed equipment which is movable between rooms by the end user) that contain HFCs with GWP of 150 or more	1 January 2020
Single split air-conditioning systems containing less than 3 kg of fluorinated greenhouse gases, that contain, or whose functioning relies upon, fluorinated greenhouse gases with GWP of 750 or more	1 January 2025

Besides the prohibitions of refrigerants with a high GWP for portable air conditioners and single split air conditioners there is also a quota system that applies to all products using hydrofluorocarbons if a viable alternative to the hydrofluorocarbons exist.

The maximum quantity shall be calculated by applying the percentages shown in Table 31 of the annual average of the total quantity placed on the market into the Union during period 2009 to 2012, and subsequently subtracting the amounts for exempted uses, on the basis of available data.

The maximum quantity, reference values and quotas for placing hydrofluorocarbons on the market shall be calculated as the aggregated quantities of all types of hydrofluorocarbons, expressed in tonne(s) of CO2 equivalent.

Table 31: Quotas for hydrofluorocarbons

Years	Percentage to calculate the maximum quantity of hydrofluorocarbons to be placed on the market and corresponding quotas
2015	100 %
2016–17	93 %
2018–20	63 %
2021–23	45 %
2024–26	31 %
2027–29	24 %
2030	21 %

This quota system will cut the use of hydrofluorocarbons with more than 2/3 by 2025 for products with a viable alternative to hydrofluorocarbons.

[58] http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0517&from=EN

EU Regulation 66/2010/EC - EU Ecolabel [59, 60]

The EU Ecolabel is a voluntary labelling scheme, enforced in EU Regulation (66/2010/EC), that includes a large number of criteria, which aim to identify products which have low environmental impacts across many impact categories. Manufacturers can apply the logo to products, which meet all of the EU Ecolabel criteria.

Some of these criteria's concern the energy efficiency of the air conditioner and are listed below in Table 32 and Table 33.

Table 32: Ecolabel minimum requirements of the coefficient of performance (COP)

Type of heat pump	Outdoor unit [°C]	Indoor unit [°C]	Min. COP
air/air	Inlet dry bulb: 2 Inlet wet bulb: 1	Inlet dry bulb: 20 Inlet wet bulb: 15 max	2.90

Table 33: Ecolabel minimum requirements of the energy efficiency ratio (EER)

Type of heat pump	Outdoor unit [°C]	Indoor unit [°C]	Min. EER
air/air	Inlet dry bulb: 35 Inlet wet bulb: 24	Inlet dry bulb: 27 Inlet wet bulb: 19	3.20

These requirements are outdated and there is a clear need to revise the Ecolabel criteria for air conditioners.

1.3.2 Member State legislation

Since Member States follow the European Directives, ecodesign and energy labelling regulations are directly imposed in the Member States, there appears to be no other particularly outstanding legislation at member state level with relevance for the scope of this study. Though some countries have previously implemented alternative Ecolabels and different taxes to limit the use of e.g. fluorinated greenhouse gasses.

F-gas (Fluorinated greenhouse gases) regulation – regarding reduction of F-gas emissions.

In Germany, the German Regulation "Chemikalien-Klimaschutzverordnung" entered into force on 1 August 2008 and includes national measures which are stricter than those of the Regulation 2006/842/EC on fluorinated greenhouse gases. The German law sets the following maximum limits for the leakage of hydrofluorocarbons from systems installed after 30 June 2008: 1% per year for systems containing more than 100 kg of refrigerant and 3% for systems with less than 10 kg of HFCs.

Regarding the situation in Austria, the responsible body, the Federal Ministry of Agriculture, Forestry, Environment and Water Management is considering an amendment, aiming at a rescission of the former position.

At least one country, France, has specific limitations for the use of refrigerating equipment that contain refrigerant in buildings intended to welcome public, in addition to existing EN 378 standard.

Furthermore, a number of countries have adopted different kinds of tax systems on hydrofluorocarbons. Among them e.g. Denmark, France and Spain. In Denmark, the tax

[59] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:027:0001:0019:en:PDF
[60] http://ec.europa.eu/environment/ecolabel/index_en.htm

was applied 2001 concerning both production and import though there is no production in Denmark. A part of the revenue from this tax system is invested back in into the refrigeration industry through the establishment of the Knowledge Centre for HFC-Free Refrigeration[61]. Norway has also a tax on import and production of HFCs. In 2017 this tax was ca 48€ (450 NOK) pr. GWP-tonnes of gas. The same amount is refunded if used gas is delivered for safe destruction.

Blue Angel RAL-UZ 204: Stationary air conditioners

The Blue Angel is a German ecolabel and is a voluntary, state-run ecolabel. The criteria are established by the German Federal Environment Agency and awarded by an independent Jury to products that are environmentally friendlier than others serving the same use. It is to assist consumers in their purchase decisions. The basic criteria for stationary air conditioners includes requirements regarding e.g. SEER, SCOP and noise. Some of the requirements are:

- SEER ≥ 7
- SCOP ≥ 4.6
- Refrigerant: The air conditioner must be free of refrigerants containing halogens. In addition, it is not permitted to use ammonia as a refrigerant.
- Air filter: The indoor units of the devices (evaporator) must be fitted with air filters that can be easily cleaned either manually or automatic. Also, requirements regarding the heat exchanger exists.
- Noise emissions: The noise emissions of the devices must comply with the following requirements:

Table 34: Blue Angel requirements for the sound power level at rated capacity

Rated capacity (P_{rated}) in cooling or heating operation	Requirements for the sound power level at rated capacity	
	Indoor units	Outdoor units
≤ 4.5 kW	≤ 50 dB(A)	≤ 58 dB(A)
4.5 kW < Prated ≤ 6 kW	≤ 55 dB(A)	≤ 62 dB(A)
6 kW < Prated ≤ 12 kW	≤ 58 dB(A)	≤ 68 dB(A)

- Material requirements: Different requirements of exclusion of hazardous and carcinogenic substances.
- Environmentally friendly product design: Unless there are compelling technical reasons to the contrary, the following principles for the recyclable design of technical products must be observed and declared in writing:
  - The avoidance of non-detachable material connections between different materials
  - The avoidance of composite materials
  - Components that are easy to dismantle, also for the purpose of repair
  - Reduction in the diversity of the materials used

  In addition, the manufacturer must provide a written declaration of compliance with the following requirements when applying for the environmental label:

[61] http://www.igsd.org/documents/NationalLegislationonHydrofluorocarbons_9.11.151.pdf

- Product components made of plastic with a weight of more than 25 g must be labelled with an abbreviated term in accordance with DIN EN ISO 1043-116 or DIN ISO 162917 (rubber) or DIN ISO 207618 (chemical fibres).

1.3.3 Third country legislation

There are a number of pieces of legislation that have already been adopted, or are in the process of being developed, which address the energy efficiency of air conditioners and comfort fans.

Australia – Greenhouse and Energy Minimum Standards (Air Conditioners and Heat Pumps) Determination 2013[62]

The Australian regulation covers the following types of air conditioners:

- single and three phase non-ducted or ducted room air conditioners of the vapour compression type of up to 65kW cooling capacity (commercial or residential)
- Units with a single or multiple refrigeration systems with a single indoor control such as single packaged units (unitary)
- packaged ducted units (unitary)

The measure of energy efficiency of air conditioners is the Energy Efficiency Ratio (EER) for cooling and the coefficient of Performance (COP) for heating. The EER and COP are defined as the capacity output divided by the power input. The Star Rating Index is calculated on the measured values for energy and capacity during a rating test, rather than the nameplate or rated values.

The MEPS are set in terms of full load performances. Starting from 2011, the full load EER T1 is replaced by an "annual EER" value computed for a typical annual operating profile including low power mode consumption (it does not account for reduced temperature and part load impact however). In the same manner, the heating mode coefficient of performance COP is replaced with a ACOP.

Table 35: MEPS: MINIMUM EER FOR AIR COOLED CONDENSER AIRCONDITIONERS (from AS/NZS 3823.2-2009)

Product Description	MEPS 2006-07	MEPS 2010	MEPS 2011(**)
Unitary (*) - all types, <10kW, all phases	2.75	2.84	2.84
Unitary (*) – all types, 10kW to <19kW, all phases	2.75	2.75	2.75
Split systems – all types, <4kW, all phases	3.05	3.33	3.33
Split systems – all types, 4kW to <10kW, all phases	2.75	2.93	2.93
Split systems – all types, 10kW to <19kW, all phases	2.75	2.75	2.75
Ducted systems – all types, <19kW, single phase	2.50	2.75	2.75
Ducted systems – all types, <10kW, three phase	2.50	2.75	2.75
Ducted systems – all types, 10kW to <19kW, three phase	2.75	2.75	2.75
All configurations, all types, 19kW to 39kW, all phases	3.05	3.05	3.05
All configurations, all types, <39kW to 65kW, all phases	2.75	2.75	2.75

(*) unitary refers here to window and package units.

(**) values based on « annual EER »

[62] https://www.legislation.gov.au/Details/F2013L01672

Labelling

The original star rating equations for air conditioners were developed in 1987. These were revised (re-graded) in 2000 and again in 2010 to take account of the substantial improvement in the energy efficiency of products over this period. Until 2010, all energy labels showed possible star ratings from a minimum of 1 star to a maximum of 6 stars. In 2010, the star rating system for refrigerators and air conditioners was expanded to show up to 10 stars for products that have exceptional energy efficiency. Products that achieve up to 6 stars continue to use a normal 6-star energy label. They were further revised in 2011.

The 2011 star rating system is based on an annual efficiency calculation which includes any non-operational energy consumption such as standby and power consumption of crank case haters (where present).

Australia has been considering the extension of the energy label and minimum performance requirements to portable air conditioners since 2009. However, there are not yet any minimum energy performance requirements or requirements of an energy label. A study was conducted in 2009 to assist for the development of labels for single duct air conditioners and spot coolers[63]. The study consisted of testing information display to customers that were planning to buy a portable air conditioner and to customers that had already bought it. It was advised by technical experts not to include a scale system (stars in the case of the Australia and New-Zealand) due to technical issues with standards and the relatively low EER dispersion. The display of cooling capacity and EER values was also tested but together with a complex message regarding the test conditions (similar indoor and outdoor temperatures as in EN14511 standard) and thus it was not helpful to the customers. Furthermore, several messages and information label designs were tested to inform the hot air infiltration during summer, but all suggestions became too complicated. The final proposal of the study is shown below. Note that this label was not adopted, although the study dates back to 2009.

Figure 5: Proposed label designs for single duct air conditioners in Australia in 2009[64]. Text on the label: "This product has a cooling function when ducted to the outside, but during hot weather hot air is drawn into the building to replace the exhausted hot air. Over time this may result in an increase in indoor temperatures in other parts of the building. Please ask your retailer about alternatives."

[63] http://www.energyrating.gov.au/sites/new.energyrating/files/documents/200917-portable-space-cond-spot-coolers_0.pdf

[64] http://www.energyrating.gov.au/sites/new.energyrating/files/documents/200917-portable-space-cond-spot-coolers_0.pdf

Japan

Japan operates with a program called the Top Runner standards program. This program aims to 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 meet this standard by a specified date (the target year). The program allows a continuum for improvement over time making manufacturers constantly increase the efficiency of appliances.

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 program and it is legislated through the Energy Conservation Law. The program 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. Regarding air conditioners, 2007 is the latest fiscal year with target on the full load efficiency. The targets are COP values, i.e. for reversible units, to be understood as "(EER+COP) / 2" with ISO notations. These targets are still active and are reported below.

The EER and COP are the reference ISO 5151, as used in Europe.

Table 36: Japan full load MEPS for air conditioners

Category			Standard energy consumption efficiency (COP)
Unit form	**Cooling capacity**	**Category name**	
Non-ducted wall-mounted type (except multi-type operating indoor units individually)	Up to 2.5kW	b	5.27
	Over 2.5kW up to 3.2kW	c	4.90
	Over 3.2kW up to 4.0kW	d	3.65
	Over 4.0kW up to 7.1kW	e	3.17
	Over 7.1kW up to 28.0kW	f	3.10
Other non-ducted type (except multi-type operating indoor units individually)	Up to 2.5kW	g	3.96
	Over 2.5kW up to 3.2kW	h	3.96
	Over 3.2kW up to 4.0kW	i	3.20
	Over 4.0kW up to 7.1kW	j	3.12
	Over 7.1kW up to 28.0kW	k	3.06
Ducted type (except multi-type operating indoor units individually)	Up to 4.0kW	l	3.02
	Over 4.0kW up to 7.1kW	m	3.02
	Over 7.1kW up to 28.0kW	n	3.02
Multi-type operating indoor units individually	Up to 4.0kW	o	4.12
	Over 4.0kW up to 7.1kW	p	3.23
	Over 7.1kW up to 28.0kW	q	3.07

In addition to these full load targets, new targets are planned in terms of APF or energy consumption value E. Both consider a weighted average of a SEER for the cooling season and a HSPF (Heating Seasonal Performance Factor) for the heating season with the climate of Tokyo. It is not possible to compare directly with standard EER and COP values with APF and energy consumption because these seasonal indicators take account of part load performance and of the impact of outdoor air temperature on the performance, while EER and COP do not.

Table 37: Japan APF Top Runner efficiency target - Air conditioners for home use - Non-duct and wall-hung type: Fiscal year 2010

Category			Standard energy consumption efficiency (APF)
Cooling capacity	**Dimension type of indoor units**	**Category name**	
Up to 3.2kW	Dimension -defined type	A	5.8
	Free-dimension type	B	6.6
Over 3.2kW up to 4.0kW	Dimension -defined type	C	4.9
	Free-dimension type	D	6.0

Table 38: Japan APF Top Runner efficiency target - Air conditioners for home use - Others: Fiscal year 2012

Category			Standard energy consumption efficiency (COP)
Unit form	**Cooling capacity**	**Category name**	
Non-ducted wall-mounted type (except multi-type operating indoor units individually)	Up to 2.5kW	b	5.27
	Over 2.5kW up to 3.2kW	c	4.90
	Over 3.2kW up to 4.0kW	d	3.65
	Over 4.0kW up to 7.1kW	e	3.17
	Over 7.1kW up to 28.0kW	f	3.10
Other non-ducted type (except multi-type operating indoor units individually)	Up to 2.5kW	g	3.96
	Over 2.5kW up to 3.2kW	h	3.96
	Over 3.2kW up to 4.0kW	i	3.20
	Over 4.0kW up to 7.1kW	j	3.12
	Over 7.1kW up to 28.0kW	k	3.06
Ducted type (except multi-type operating indoor units individually)	Up to 4.0kW	l	3.02
	Over 4.0kW up to 7.1kW	m	3.02
	Over 7.1kW up to 28.0kW	n	3.02
Multi-type operating indoor units individually	Up to 4.0kW	o	4.12
	Over 4.0kW up to 7.1kW	p	3.23
	Over 7.1kW up to 28.0kW	q	3.07

Table 39: Japan APF Top Runner efficiency target - Air conditioners for business use: Fiscal year 2015

Category				Standard energy consumption efficiency or calculation formula thereof
Form & function	**Indoor unit type**	**Cooling capacity**	**Category name**	
Combination of plural types or any type other than following	4-directional cassette type	Less than 3.6 kW	aa	E = 6.0
		Not less than 3.6 kW but less than 10.0 kW	ab	E = 6.0 - 0.083×(A - 3.6)
		Not less than 10.0 kW but less than 20.0 kW	ac	E = 6.0 - 0.12×(A - 10)
		Not less than 20.0 kW and up to 28.0 kW	ad	E = 5.1 - 0.060×(A - 20)
	Other than 4-directional cassette type	Less than 3.6 kW	ae	E = 5.1
		Not less than 3.6 kW but less than 10.0 kW	af	E = 5.1 - 0.083×(A - 3.6)
		Not less than 10.0 kW but less than 20.0 kW	ag	E = 5.1 - 0.10×(A - 10)
		Not less than 20.0 kW and up to 28.0 kW	ah	E = 4.3 - 0.050×(A - 20)
Multi-type controlling operation of indoor units individually		Less than 10.0 kW	ai	E = 5.7
		Not less than 10.0 kW but less than 20.0 kW	aj	E = 5.7 - 0.11×(A - 10)
		Not less than 20.0 kW but less than 40.0 kW	ak	E = 5.7 - 0.065×(A - 20)
		Not less than 40.0 kW and up to 50.4 kW	al	E = 4.8 - 0.040×(A - 40)
Ducted type whose indoor unit is set on floor or any like type	Non-ducted type	Less than 20.0 kW	am	E = 4.9
		Not less than 20.0 kW and up to 28.0 kW	an	E = 4.9
	Ducted type	Less than 20.0 kW	ao	E = 4.7
		Not less than 20.0 kW and up to 28.0 kW	ap	E = 4.7

Remarks: *1. "Ducted type" indicates systems connected to ducts at the outlet.*
2. "Multi-type" indicates a type that has two or more indoor units connected to an outdoor unit.
3. E and A represents the following values respectively. E: standard energy consumption efficiency (unit: yearly energy consumption efficiency). A: Cooling capacity (unit: kilowatts)

A study for CLASP on benchmarking main requirements and metrics suggests that Japanese minimum performance requirements for less than 3.2 kW units (Japanese Annual Performance Factor of 6.6 for residential free dimension single split wall units) roughly corresponds to an EU SEER value of 8 (close to the EU label A+++ limit of 8.5), with lower values of about 6.5 for larger single split wall units with free dimensions (APF of 4.5). Study concludes that there is still an important margin for increasing minimum performance requirements in cooling mode[65].

China

<u>China Energy Label and Minimum Energy Performance Standard (MEPS)</u>

The China Energy Label program was introduced in China in 2005. Fixed speed air conditioners were the first product group meaningful label was implemented for, but the China Energy Label can be now found for a range of household appliances and products on the Chinese market. Each product label is supported by a standard that specifies what the grades mean and the allowable limits for each grade. In the 2004 edition, there are 5 grades in the scale, and in 2010 edition, only 3 grades are left. In the 2010 edition, grade 3 is the minimum requirement and grade 1 is the best grade, due to the fast increasing efficiency of air conditioners. Consumers should use the 2010 edition as the purchasing reference. See the labels in Figure 6.

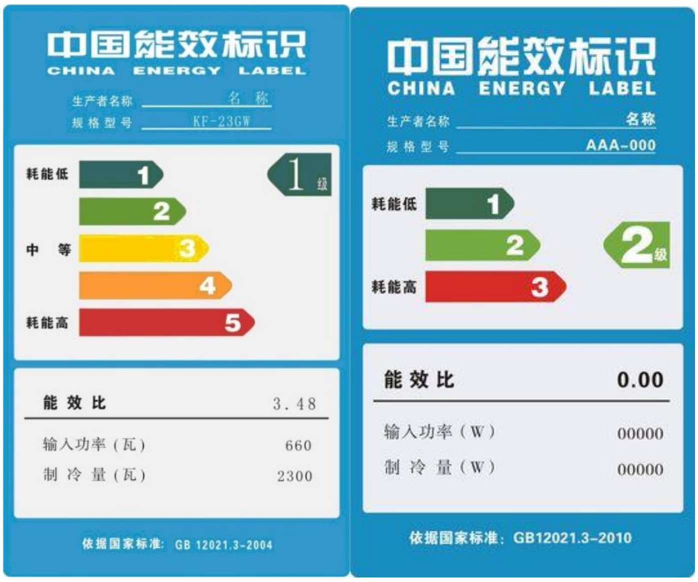

Figure 6 China Energy Label for air conditioners 2004 version that is out of use (left) and the currently in use 2010 version (right)[66]

As shown in the figure, the 2010 version refers to the Minimum Energy Performance Standard (MEPS) for fixed speed air conditioners: GB 12021.3-2010 the minimum allowable value of the energy efficiency and energy efficiency grades for room air conditioners, which replaced the GB 12021.3-2004. This standard specifies the national minimum requirements for air conditioners which is equal to the requirement for grade 3, as well as the allowable efficiency for different grades, see Table 40 for the requirements.

[66] http://www.top10.cn/English/recommendations/Recommendation-fix-speed-air-conditioner.html&fromid=

Table 40 Minimum requirement and energy label allowable limits[67]

Type	Cooling capacity	Energy Efficiency Ratio (EER) W/W		
		Grade 1	Grade 2	Grade 3
Window/through-the-wall		3.30	3.10	2.90
Split	≤ 4500W	3.60	3.40	3.20
	> 4500 W and ≤ 7100 W	3.50	3.30	3.10
	> 7100 W and ≤ 14000 W	3.40	3.20	3.00

The MEPS for variable speed (VS) air conditioners GB 21455 was implemented in 2008. New version has been released in 2013. See the label in Figure 7.

Figure 7 China Energy Label for variable speed air conditioners according to MEPS GB 21455 -2013[68]

In the standard GB 21455 -2013, requirements for Annual Performance Factor (APF) was defined (see Table 41), this is the parameter to measure energy efficiency of VS air conditioners with heating pump, whereas the seasonal energy efficiency ratio (SEER), as originally defined in GB 21455 -2008, is the parameter to measure energy efficiency of VS air conditioners without heating function. See the changes to SEER requirements in Table 42.

Table 41 APF requirement and energy label allowable limits for variable speed air conditioners according to MEPS GB 21455 -2013

Rated cooling capacity	Annual Performance Factor (APF) Wh/Wh		
	Grade 1	Grade 2	Grade 3
≤ 4500W	4.5	4.0	3.5
> 4500 W and ≤ 7100 W	4.0	3.5	3.3
> 7100 W and ≤ 14000 W	3.7	3.3	3.1

[67] GB 12021.3-2010 the minimum allowable value of the energy efficiency and energy efficiency grades for room air conditioners
[68] http://www.topten.eu/uploads/File/EEDAL15_Luting_Huang_MEPS_China.pdf

Table 42: SEER requirement and energy label allowable limits for variable speed air conditioners according to MEPS GB 21455 – 2008 and GB 21455 – 2013

Rated cooling capacity	SEER Wh/Wh							
	Grade 1		Grade 2		Grade 3		Grade 4	Grade 5
	2008	2013	2008	2013	2008	2013	2008	2008
≤ 4500W	5.2	5.4	4.5	5.0	3.9	4.3	3.4	3.0
> 4500 W and ≤ 7100 W	4.7	5.1	4.1	4.4	3.6	3.9	3.2	2.9
> 7100 W and ≤ 14000 W	4.2	4.7	3.7	4.0	3.3	3.5	3.0	2.8

<u>Technical standard GB/T 7725 - 2004</u>

The testing method specified in the standard GB 12021.3-2010 and GB 21455 -2008 refers to GB/T 7725 - 2004. According to the measurement standards, the SEER of variable speed air conditioners is calculated based on the testing of 100% and 50% of the rated cooling capacity. The definition of the cooling season plays an essential role in the calculation of the SEER. The technical testing standard (GB/T 7725-2004) defines the cooling season with a using time of 2399 hours, while the MEPS (GB 21455 – 2008) defines the cooling season with a using time of 1136 hours. The difference in cooling hours leads to different SEER results. Generally, the resulting SEER based on the GB/T 7725 – 2004 is higher than the SEER based on the GB 21455 – 2008. The China energy labeling program adopted GB 21455 – 2008 as the basis of the labeling scheme. However, the manufacturers also indicate SEER of GB/T 7725 – 2004 on the nameplate of the product in parallel with GB 21455 –2008[69].

The results of measurement of SEER or Heating Seasonal Performance Factor (HSPF) according to Chinese standard GB/T 7725 – 2004 and SEER or SCOP according the European standard EN 14825 cannot be directly compared, much higher value for SEER and HSFP/SCOP can be obtained when measured with European standard.

USA

Minimum standards of energy efficiency for many major appliances were established by the U.S. Congress in the National Appliance Energy Conservation Act (NAECA) of 1987, and in the National Appliance Energy Conservation Amendments of 1988. Standards for some fluorescent and incandescent reflector lamps, plumbing products, electric motors, and commercial water heaters, heating, ventilation and air conditioning (HVAC) systems were added in the Energy Policy Act of 1992 (EPACT). The US Department of Energy (DOE) is responsible for developing the standards and test procedures for the Appliance Standards Program as well as periodically issuing new standards for specific appliances.

The USA has an extensive MEPS program for air conditioners and heat pumps, that includes the following product types:

- residential room air conditioners (Window/wall)
- Portable air conditioners
- package terminal air conditioners (wall units with an air change function included)
- central air conditioners and heat pumps
- small commercial package air conditioners and heat pumps
- large commercial package air-conditioners and heat pumps

[69] TopTen, Energy efficient room air conditioners – best available technology(BAT)

Requirements for residential room air conditioners and portable air conditioners are reported hereunder.

Residential air conditioners (window/wall)
The program covers single-phase air conditioners that are not packaged terminal air conditioners. Products with and without louvered sides are defined as distinct categories. The product is required to be tested in accordance with Federal test procedures to meet mandatory efficiency standards. This test procedure can be found in the current U.S. Code of Federal Regulations (CFR, Title 10, Part 430 Appendix F). Minimum performance thresholds are based on the CEER metrics, which is a full load metrics integrating thermostat off, standby and off mode in a single figure.

Table 43: Minimum performance thresholds based on CEER (USA)

Product Class	Cooling (Heating) Power in Btu/h	CEER, effective as of June 1, 2014
Cooling Only		
with louvered sides	Less than 6000	11.0
	6000 to 7999	11.0
	8000 to 13999	10.9
	14 000 to 19999	10.7
	20000 to 27999	9.4
	20000 and over	9.0
without louvered sides	Less than 6000	10.0
	6000 to 7999	10.0
	8000 to 13999	9.6
	14000 to 19999	9.5
	20 000 or more	9.3
Cooling and Heating		
with louvered sides	less than 20000	9.8
	and 20000 or more	9.3
without louvered sides	less than 14 000 (4.10)	9.3
	and 14 000 (4.10) or more	8.7
Casement-Only		9.5
Casement-Slider		10.4

Central air conditioners (includes split and multisplit air conditioner)
Central air conditioners and heat pumps. The energy conservation standards defined in terms of the heating seasonal performance factor are based on Region IV, the minimum standardized design heating requirement, and the sampling plan stated in § 430.24(m). Central air conditioners and central air conditioning heat pumps manufactured on or after January 1, 2015, shall have a Seasonal Energy Efficiency Ratio and Heating Seasonal Performance Factor not less than the values shown in the below table.

Table 44: Seasonal Energy Efficiency Ratio and Heating Seasonal Performance minimum requirements for central air conditioners

Product class	Seasonal energy efficiency ratio (SEER)	Heating seasonal performance factor (HSPF)
(i) Split-system air conditioners	13	
(ii) Split-system heat pumps	14	8.2
(iii) Single-package air conditioners	14	
(iv) Single-package heat pumps	14	8
(v) Small-duct, high-velocity systems	13	7.7
(vi)(A) Space-constrained products—air conditioners	12	
(vi)(B) Space-constrained products—heat pumps	12	7.4

In addition to meeting the applicable requirements in Table 44, products in product classes (i) and (iii) in Table 44 (i.e., split-system air conditioners and single-package air conditioners) that are manufactured on or after January 1, 2015, and installed in the States of Arizona, California, Nevada, or New Mexico shall have a Seasonal Energy Efficiency Ratio not less than 14 and have an Energy Efficiency Ratio (at a standard rating of 95 °F dry bulb outdoor temperature) not less than the following values in the table shown below.

Table 45: Energy Efficiency Ratio for central air conditioners in selected states

Product class	Energy efficiency ratio (EER)
(i) Split-system rated cooling capacity less than 45,000 Btu/hr	12.2
(ii) Split-system rated cooling capacity equal to or greater than 45,000	11.7
(iii) Single-package systems	11

Central air conditioners and central air conditioning heat pumps manufactured on or after January 1, 2015, shall have an average off mode electrical power consumption not more than the following values in the below table.

Table 46: Minimum requirements for average off mode electrical of central air conditioners

Product class	Average off mode power consumption $P_{W,OFF}$ (watts)
(i) Split-system air conditioners	30
(ii) Split-system heat pumps	33
(iii) Single-package air conditioners	30
(iv) Single-package heat pumps	33
(v) Small-duct, high-velocity systems	30
(vi) Space-constrained air conditioners	30
(vii) Space-constrained heat pumps	33

A study for CLASP on benchmarking main requirements and metrics suggest that for split air conditioners[70], the present requirement in US of SEER 13 is comparable to EU SEER 4.4, which is the requirement for larger than 6 kW units. For reversible units, SEER 14 would be equivalent to an EU SEER value of 4.8.

[70] http://clasp.ngo/Resources/Resources/PublicationLibrary/2012/Cooling-Benchmarking-Study

Portable air conditioners

The regulation for portable air conditioners are not yet in force and still needs to be approved.

"Portable air conditioner" means a portable encased assembly, other than a "packaged terminal air conditioner," "room air conditioner," or "dehumidifier," that delivers cooled, conditioned air to an enclosed space, and is powered by single-phase electric current. It includes a source of refrigeration and may include additional means for air circulation and heating.

In the USA, portable air conditioners are supposed to be bought as other types of room air conditioners and used similarly. Consequently, the US DOE decided to use similar seasonal performance metrics as for room air conditioners, corrected for air infiltration and duct heat losses.

The suggested regulation applies a minimum allowable combined energy efficiency ratio (CEER) standards, which are expressed in British thermal units (Btu) per watt-hour (Wh), and are shown in table below.

Table 47: Energy Conservation Standards for Portable Air Conditioners

Portable Air Conditioner Product Class	Minimum CEER (Btu/Wh)	Note
Single-duct and dual-duct portable air conditioners	$1.04 \times \frac{SACC}{(3.7117 \times SACC^{0.6384})}$	SACC is the representative value of Seasonally Adjusted Cooling Capacity, in Btu/h, as determined in accordance with the DOE test procedure at title 10 Code of Federal Regulations (CFR) 430, subpart B, appendix CC and applicable sampling plans.

1.4 Conclusions and recommendations

Product scope

The scope of ecodesign regulations for different air cooling and heating products are well aligned, except for one subset of air to air heat pumps and air conditioner that uses ventilation exhaust air, these products with capacity over 12 kW are already covered by another regulation, so to avoid potential loophole, it is recommended that **ventilation exhaust air-to-air heat pumps and air conditioners with heating or cooling capacity ≤ 12 kW** to be included in the revised scope of Regulation 206/2012. The rest of the product scope remains unchanged: "electric mains-operated air conditioners with a rated capacity of ≤ 12 kW for cooling, or heating if the product has no cooling function, and comfort fans with an electric fan power input ≤ 125W".

The exemptions to the product scope are still as follows:

a. appliances that use non-electric energy sources;
b. air conditioners of which the condenser-side or evaporator side, or both, do not use air for heat transfer medium.

The proposed product scope for Regulation 206/2012 is summarised in Table 48.

Table 48: Recommended product scope.

Categories	Products included	Scope limits
Outdoor air / recycled air	Split, multi-split, window, through-the-wall, double duct	Cooling (heating) power ≤12 kW
Exhaust air / recycled air	Single duct	
Exhaust air / outdoor air	Heat recovery ventilation heat pump / air conditioner	Cooling (heating) power ≤12 kW
Comfort fans	Desk fans, floor standing fans, wall mounted fans, ceiling fans, tower fans, box fans, etc. Portable fan heater with comfort fan mode.	Electric fan power ≤ 125W

Energy labelling Regulation (EU) No 626/2011should follow the recommended scope of ecodesign Regulation, with the exception of comfort fans.

Test standards

Regarding air conditioners other than single duct and double duct, the EN14825 harmonised standard addresses the requirements of the Regulation (EU) No 206/2012. However, seasonal performance rating conditions are missing for ventilation exhaust air heat pumps and air conditioners, if these products are to be included in the scope.

It can be noted that there are possible improvements for test method in Regulation (EU) 2012/206, i.e. EN14825, EN15218 and EN14511 test standards. Improvements include network standby, (at the moment it is neither defined in regulation nor in test standards, it should be taken into account as there are already units with network capabilities), cycling test in EN14825 (it is proposed to use default values for Cdc and Cdh and not to allow to measure the value), low power modes power measurement and weighting hours and total cooling / heating hours.

Regarding single duct and double duct air conditioners, US DOE proposed a seasonal performance metrics which enables to account for air infiltration of hot air inside the zone to be cooled and for thermostat off mode and standby. This is a progress axis in Europe as it would enable to make efficiency figures of single/double duct and split air conditioners comparable.

It can be noted that outside of EU, there is ongoing improvement of test standards in different countries striving for closer testing conditions to real-life operation conditions. In this attempt, it appeared clearly that the present test methods for rating the performances of air conditioners are not fully satisfactory. This is because the control of the unit is bypassed and instead manufacturers choose the control parameters to be fixed for each different test. To avoid this, a compensation method can be used; the unit is set free to work in a room with a given heat load to compensate. Such a method is to be included in the next version of the EN14511-3 to help to test the unit when it is not possible to contact the manufacturer / its representative to set the control parameters. However, this method is not thought to be mature enough to become the standard test method yet. In the meanwhile, it is proposed to require manufacturers to include information on product set-up for performance tests if and when Regulations (EU) 206/2012 and 626/2011 are rerevised.

Legislations

The new F-gas regulation introduced a quota system that will cut the use of hydrofluorocarbons by more than 2/3 by 2025 for products with a viable alternative to hydrofluorocarbons. Though, the challenge remains in finding these alternatives for air conditioners which not are widely available today. Besides the quota system, prohibition on the use of refrigerants with a high GWP is introduced. For split air conditioners, refrigerants with a GWP higher than 750 is prohibited to use by 2025. As a result of the F-gas regulation, the industry will be required to reduce the impact of high GWP refrigerants and the need for a bonus system for air conditioners using low GWP refrigerant in the revised ecodesign regulation is reduced.

Third country legislations show that there is a trend for increasing the stringency of requirements for air conditioner efficiency, although it is often not directly comparable with the EU requirement due to the differences in testing method. A study from CLASP on benchmarking main requirements suggests that there is still an important margin for increasing minimum performance requirements in cooling mode[71] in the EU. Both the US and Japan have more ambitious requirements today than the EU.

Regarding policies for portable air conditioners, there are different approaches worldwide. In 2009, a study for national authorities of Australia and New Zealand suggested it could be counterproductive to label the energy performance of single duct air conditioners and that it could be of higher value to inform the customer on the problem linked to the outdoor air infiltration instead. Meanwhile in Europe, there is a A+++ - G energy label for portable air conditioners similar to the one for fixed air conditioners, with an indication of single duct products being "local air conditioner" in the product fiche and other marketing documentation, however this indication is rather "weak" because the difference of local air conditioner is rarely ever understood by the consumers as intended. Therefore, it should be considered that single duct and double duct products and other air conditioners could be rated on the same efficiency scale on the energy labels to enable comparison by the consumers.

As mentioned, a seasonal performance standard was developed by US DOE in 2016 for portable air conditioners based on existing metrics and including the impact of infiltration air so that portable cooling performance metrics may be comparable to the metrics of other room air conditioners in the USA. Currently in the EU, air infiltration is not measured by the standard, nor is the problem disseminated to the consumers. Since air infiltration is not included, it is not clear that a product with a better EER leads to a better field performance; false expectation would be given to the consumers, as an increased EER may mean an increased condenser air flow and hence more infiltration. Therefore, it is worth considering the infiltration issue for single duct in the current review. The US DOE experience has further shown that air infiltration was also an issue for double duct air conditioners; if it is worth considering the air infiltration issue for double duct air conditioners too in the current review, it should be reminded that the impact of infiltration is already accounted for in Europe for these products thanks to the use of the calorimeter room test method.

[71] Heating mode metrics were not compared in the frame of the study.