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ANNEX

# ANNEX

**to the**

**Commission Delegated Regulation**

**amending Annex VII of Directive (EU) 2018/2001 as regards a methodology for calculating the amount of renewable energy used for cooling, including district cooling**

# ANNEX

## “ANNEX VII”

## ACCOUNTING OF RENEWABLE ENERGY USED FOR HEATING AND COOLING

PART A: ACCOUNTING OF RENEWABLE ENERGY FROM HEAT PUMPS USED FOR HEATING

The amount of aerothermal, geothermal or hydrothermal energy captured by heat pumps to be considered to be energy from renewable sources for the purposes of this Directive, $E_{RES}$, shall be calculated in accordance with the following formula:

$E_{RES} = Q_{usable} * (1 – 1/SPF)$

where

| | | | |
|---|---|---|---|
| — | $Q_{usable}$ | = | the estimated total usable heat delivered by heat pumps fulfilling the criteria referred to in Article 7(4), implemented as follows: Only heat pumps for which SPF > 1,15 * 1/η shall be taken into account, |
| — | SPF | = | the estimated average seasonal performance factor for those heat pumps, |
| — | η | = | the ratio between total gross production of electricity and the primary energy consumption for the production of electricity and shall be calculated as an EU average based on Eurostat data. |

PART B: ACCOUNTING OF RENEWABLE ENERGY USED FOR COOLING

### 1. DEFINITIONS

When calculating renewable energy used for cooling  the following definitions shall apply:

(1) ‘cooling’ means the extraction of heat from an enclosed or indoor space (comfort application) or from a process in order to reduce the space or process temperature to, or maintain it at, a specified temperature (set point),; for cooling systems, the extracted heat is rejected into and absorbed by the ambient air, ambient water or the ground, where the environment (air, ground, and water) provides a sink for the heat extracted and thus functions as a cold source.

(2) ‘cooling system’ means an assembly of components consisting of a heat extraction system, one or several cooling devices and a heat rejection system, complemented in the case of active cooling with a cooling medium in the form of fluid that work together to generate a specified heat transfer and, thus, ensures a required temperature.

- (a) for space cooling, the cooling system can be either a free cooling system or a cooling system embedding a cooling generator, and for which cooling is one of the primary functions.

(1) (b)for process cooling, the cooling system is embedding a cooling generator, and for which cooling is one of the primary functions.

(3) 'free cooling' means a cooling system using a natural cold source to extract heat from the space or process to be cooled via fluid(s) transportation with pump(s) and/or fan(s) and which does not require the use of a cooling generator.

(4) 'cooling generator' means the part of a cooling system that generates a temperature difference allowing heat extraction from the space or process to be cooled, using a vapour compression cycle, a sorption cycle or another energy-driven thermodynamic cycle. It is used when the cold source is unavailable or insufficient.

(5) 'active cooling' means the removal of heat from a space or process, for which an energy input is needed to meet the cooling demand, used when the natural flow of energy is unavailable or insufficient and can occur with or without a cooling generator.

(6) 'passive cooling' means the removal of heat by the natural flow of energy through conduction, convection, radiation or mass transfer without the need for moving a cooling fluid to extract and reject heat or to generate a lower temperature with a cooling generator, including decreasing the need for cooling by building design features such as building insulation, green roof, vegetal wall, shading or increased building mass, by ventilation or by using comfort fans.

(7) 'ventilation' means the natural or forced movement of air to introduce ambient air inside a space with the aim to ensure appropriate indoor air quality, including temperature.

(8) 'comfort fan' means a product that includes a fan and electric motor assembly to move air and provide summer comfort by increasing the air speed around human body giving a thermal feeling of coolness.

(9) 'renewable energy quantity for cooling' means the cooling supply that has been generated with a specified energy efficiency expressed as a Seasonal Performance Factor calculated in primary energy.

(10) 'heat sink' or 'cold source' means an external natural sink into which the heat extracted from the space or process is transferred; it can be ambient air, ambient water in the form of natural or artificial water bodies and geothermal formations beneath the surface of solid earth.

(11) 'heat extraction system' means a device that removes heat from the space or process to be cooled, such as an evaporator in a vapour compression cycle .

(12) 'cooling device' means a device designed to perform active cooling.

(13) ‘heat rejection system’ means the device where the final heat transfer from the cooling medium to the heat sink occurs, such as the air-to-refrigerant condenser in an air-cooled vapour compression cycle .

(14) ‘energy input’ means the energy needed to transport the fluid (free cooling), or the energy needed to transport the fluid and to drive the cooling generator (active cooling with a cooling generator).

(15) ‘district cooling’ means the distribution of thermal energy in the form of chilled liquids, from central or decentralised sources of production through a network to multiple buildings or sites, for the use of space or process cooling.

(16) ‘primary seasonal performance factor’ means a metric of the primary energy conversion efficiency of the cooling system.

(17) ‘equivalent full load hours’ means the number of hours a cooling system runs with full load to produce the amount of cooling that it actually produces during a year but at varying loads.

(18) ‘Climate Degree Days’ means the climate values computed with a base of 18 °C used as input to determine equivalent full load hours.

## 2. SCOPE

1. When calculating the amount of renewable energy used for cooling, Member States shall count active cooling, including district cooling, regardless of whether it is free cooling or a cooling generator is used.

2. Member States shall not count:

a) passive cooling, although where ventilation air is used as a heat transport medium for cooling, the corresponding cooling supply, which can be supplied either by a cooling generator or by free cooling is part of renewable cooling calculation.

b) the following technologies or processes of cooling:

- cooling in means of transportation[1];
- cooling systems whose primary function is to produce or store perishable materials at specified temperatures (refrigeration and freezing);
- cooling systems with space or process cooling temperature set points lower than 2°C;
- cooling systems with space or process cooling temperature set points above 30°C;
- cooling of waste heat resulting from energy generation, industrial processes and the tertiary sector (waste heat)[2].

[1] The renewable cooling definition concerns only stationary cooling.

c) energy used for cooling in power generation plants; cement, iron and steel manufacturing; wastewater treatment plants; information technology facilities (such as data centres); power transmission and distribution facilities; and transportation infrastructures.

Member States may exclude more categories of cooling systems from the renewable cooling energy calculation in order to preserve natural cold sources in specific geographic areas for environmental protection reasons. Examples are the protection of rivers or lakes from the risk of overheating.

## 3. METHODOLOGY FOR ACCOUNTING OF RENEWABLE ENERGY FOR INDIVIDUAL AND DISTRICT COOLING

Only cooling systems operating above the minimum efficiency requirement expressed as primary Seasonal Performance Factor ($SPF_p$) in section 3.2, second paragraph shall be considered to produce renewable energy .

### 3.1. Renewable energy quantity for cooling

The renewable energy quantity for cooling ($E_{RES\text{-}C}$) shall be calculated with the following formula:

$$E_{RES-C} = (Q_{C_{Source}} - E_{INPUT}) \times s_{SPF_p} = Q_{C_{Supply}} \times s_{SPF_p}$$

where:

$Q_{C_{Source}}$ is the amount of heat released to the ambient air, ambient water or to the ground by the cooling system[3].

$E_{INPUT}$ is the energy consumption of the cooling system, including energy consumption of the auxiliary systems for measured systems, such as district cooling.

$Q_{C_{Supply}}$ is the cooling energy supplied by the cooling system[4].

$s_{SPF_p}$ is defined at cooling system level as the share of the cooling supply that can be considered as renewable according to the SPF requirements, expressed as a percentage. The

[2] Waste heat is defined in Article 2(9) of this Directive. Waste heat can be accounted for the purposes of Articles 23 and 24 of this Directive.

[3] The quantity of cold source corresponds to the quantity of heat absorbed by ambient air, ambient water and the ground acting as heat sinks. Ambient air and ambient water correspond to ambient energy as defined in Article 2(2) of this Directive. The ground correspond to geothermal energy as defined in Article 2(3) of this Directive.

[4] Thermodynamically, cooling supply corresponds to a portion of the heat released by a cooling system to ambient air, ambient water or to the ground, which function as a heat sink or cold source. Ambient air and ambient water corresponds to ambient energy as defined in Article 2(2) of Directive (EU) 2018/2001. The heat sink or cold source function of the ground corresponds to geothermal energy as defined in Article 2(3) of Directive (EU) 2018/2001.

SPF is established without accounting for distribution losses. For district cooling, this means that the SPF is established per cooling generator, or at free cooling system level. For cooling systems where standard SPF can apply, this means that the F(1) and F(2) coefficients according to Commission Regulation (EU) 2016/2281[5] are not used as correction factors.

The calculation steps needed for $Q_{C_{Supply}}$ and $s_{SPF_p}$ are explained in Sections 3.2-3.4.

### 3.2. Calculation of the share of Seasonal Performance Factor that qualifies as renewable energy – $s_{SPF_p}$

$s_{SPF}$ is the share of cooling supply that can be counted as renewable. The $s_{SPF_p}$ increases with increasing $SPF_p$ values. The $SPF_p$[6] is defined as described in Commission Regulation (EU) 2016/2281 and Commission Regulation (EU) No 206/2012[7], except that the default primary energy factor for electricity has been updated to 2.1 in Directive (EU) 2018/2002 of the European Parliament and of the Council[8]. Boundary conditions from the EN14511 standard shall be used.

The minimum efficiency requirement of the cooling system expressed in primary seasonal performance factor shall be at least [1.4] ($SPF_{LOW}$). For $s_{SPF_p}$ to be 100% the minimum efficiency requirement of the cooling system shall be at least [9.5] ($SPF_{HIGH}$). For all the other cooling systems the following calculation shall be applied:

$$s_{SPFp} = \frac{SPF_p - SPF_{p\_LOW}}{SPF_{p\_HIGH} - SPF_{p\_LOW}} \%$$

$SPF_p$ is the efficiency of the cooling system expressed as primary seasonal performance factor.

$SPF_{LOW}$ is the minimum seasonal performance factor expressed in primary energy and based upon the efficiency of standard cooling systems (minimum eco-design requirements).

$SPF_{HIGH}$ is the upper threshold for seasonal performance factor expressed in primary energy and based on best practices for free cooling used in district cooling[9].

5 Commission Regulation (EU) 2016/2281 of 30 November 2016 implementing Directive 2009/125/EC of the European Parliament and of the Council establishing a framework for the setting of ecodesign requirements for energy-related products, with regard to ecodesign requirements for air heating products, cooling products, high temperature process chillers and fan coil units (OJ L 346, 20.12.2016, p. 1).

6 In case the real operating conditions of cooling generators lead to SPF values substantially lower than planned in standard conditions because of different installation provisions, Member States may exclude these systems from the scope of the renewable cooling definition (e.g. a water cooled cooling generator using a dry cooler instead of a cooling tower to release heat to ambient air).

7 Commission Regulation (EU) No 206/2012 of 6 March 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air conditioners and comfort fans (OJ L 72, 10.3.2012, p. 7).

8 Directive (EU) 2018/2002 of the European Parliament and of the Council of 11 December 2018 amending Directive 2012/27/EU on energy efficiency (OJ L 328, 21.12.2018, p. 210).

9 ENER/C1/2018-493, Renewable cooling under the revised Renewable Energy Directive, TU-Wien, 2021.

## 3.3. Calculation of renewable energy quantity for cooling using standard and measured $SPF_p$

*Standard and measured SPF*

Standardised SPF values are available for electric vapour compression cooling generators and combustion engine vapour compression cooling generator due to the Ecodesign requirements in Regulation (EU) No 206/2012 and (EU) 2016/2281. Values are available for these cooling generators up to 2 MW for comfort cooling and up to 1.5 MW for process cooling. Other technologies and capacity scales standard values are not available. As regards district cooling, standard values are not available but measurements are used and available; these allow to compute SPF values at least on a yearly basis.

To calculate the quantity of renewable cooling, standard SPF values may be used where available. Where standard values are not available or measurement is standard practice, measured SPF values shall be used, separated by cooling capacity thresholds. For cooling generators with a cooling capacity below 1.5 MW, standard SPF can be used, while measured SPF shall be used for district cooling, for cooling generators with cooling capacities higher than or equal to 1.5 MW and cooling generators for which standard values are not available.

In addition, for all cooling systems without standard SPF, which includes all free cooling solutions and heat activated cooling generators, a measured SPF shall be established in order to take advantage of the calculation methodology for as renewable cooling.

*Definition of standard SPF values*

SPF values are expressed in terms of primary energy efficiency calculated using primary energy factors following Regulation (EU) 2016/2281 to determine the space cooling efficiency for the different types of cooling generators[10]. The primary energy factor in Regulation (EU) 2016/2281 shall be calculated as $1/\eta$, where $\eta$ is the average ratio of total gross production of electricity to the primary energy consumption for electricity production in the whole EU. With the amendment of the default primary energy factor for electricity, called coefficient in point (1) of the Annex to Directive (EU) 2018/2002, the primary energy factor of 2.5 in Regulation (EU) 2016/2281 shall be replaced by 2.1 when calculating the SPF values.

When primary energy carriers, such as heat or gas are used as energy input to drive the cooling generator, the default primary energy factor ($1/\eta$) is 1, reflecting the lack of energy transformation $\eta=1$.

The standard operating conditions and the other parameters necessary for the determination of the SPF are defined in Regulation (EU) 2016/2281 and Regulation (EU) 206/2012, depending on the cooling generator category. Boundary conditions are the ones defined in the EN14511 standard.

[10] $SPF_p$ is identical to $\eta_{s,c}$ defined in Regulation (EU) 2281/2016.

For reversible cooling generators (reversible heat pumps), which are excluded from the scope of Regulation (EU) 2016/2281 because their heating function is covered by Commission Regulation (EU) No 813/2013[11] with regard to Ecodesign requirements for space heaters and combination heaters, the same SPF calculation that is defined for similar non reversible cooling generators in Regulation (EU) 2016/2281 shall be used.

For instance, for electric vapour compression cooling generators, the $SPF_p$ shall be defined as follows (the index $p$ is used to clarify that the SPF is defined in terms of primary energy):

- For space cooling: $SPF_p = \frac{SEER}{\frac{1}{\eta}} - F(1) - F(2)$

-For process cooling: $SPF_p = \frac{SEPR}{\frac{1}{\eta}} - F(1) - F(2)$

Where:

- SEER and SEPR are seasonal performance factors[12] (SEER stands for "Seasonal Energy Efficiency Ratio", SEPR stands for "Seasonal Energy Performance Ratio") in final energy defined according to Regulation (EU) 2016/2281 and Regulation (EU) 206/2012,

- η is the average ratio of total gross production of electricity to the primary energy consumption for electricity production in the EU ($\eta = 0.475$ and $1/\eta=2.1$),

F(1) and F(2) are correction factors according to Regulation (EU) 2016/2281. These coefficients do not apply to process cooling in Regulation (EU) 2016/2281 as the SEPR final energy metrics is directly used. In absence of adapted values, the same values used for SEER conversion shall be used for the SEPR conversion.

*SPF boundary conditions*

For defining the SPF of the cooling generator, the SPF boundary conditions defined in Regulation (EU) 2281/2016 and in Regulation (EU) 206/2012 shall be used. In the case of water-to-air and water-to-water cooling generators, the energy input required to make the cold source available is included via the F(2) correction factor. The SPF boundary conditions are shown in Figure 1. These boundary conditions shall apply for all cooling systems, either free cooling systems or systems containing cooling generators.

These boundary conditions are similar to the ones for heat pumps (used in heating mode) in Commission Decision 2013/114/EU[13]. The difference is that for heat pumps, the electricity

[11] Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters (OJ L 239, 6.9.2013, p. 136)

[12] Part 1 of the study ENER/C1/2018-493 on "Cooling Technologies Overview and Market Share" provides more detailed definitions and equations for these metrics in chapter 1.5 "Energy efficiency metrics of state-of-the-art cooling systems".

[13] 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 (OJ L 62, 6.3.2013, p. 27).

consumption corresponding to auxiliary power consumption (thermostat-off mode, standby mode, off mode, crankcase heater) is not taken into account to evaluate the SPF. However, as in the case of cooling both standard SPF values and measured SPF will be used, and given the fact that in the measured SPF auxiliary consumption is taken into account, it is necessary to include auxiliary power consumption in both situations.

For district cooling, distribution cold losses and distribution pump electric consumption between the cooling plant and the customer substation shall not be included in the estimation of the SPF.

In the case of air based cooling systems ensuring also the ventilation function, the cooling supply due to ventilation air flow shall not be accounted. The fan power due to ventilation shall also be discounted in proportion of the ratio of the ventilation air flow to the cooling air flow.

In the case of air based cooling systems with internal cold recovery, the cooling supply due to the cold recovery shall not be accounted. The fan power due to the cold recovery heat exchanger shall be discounted in proportion of the ratio of the pressure losses due to the cold recovery heat exchanger to the total pressure losses of the air based cooling system.

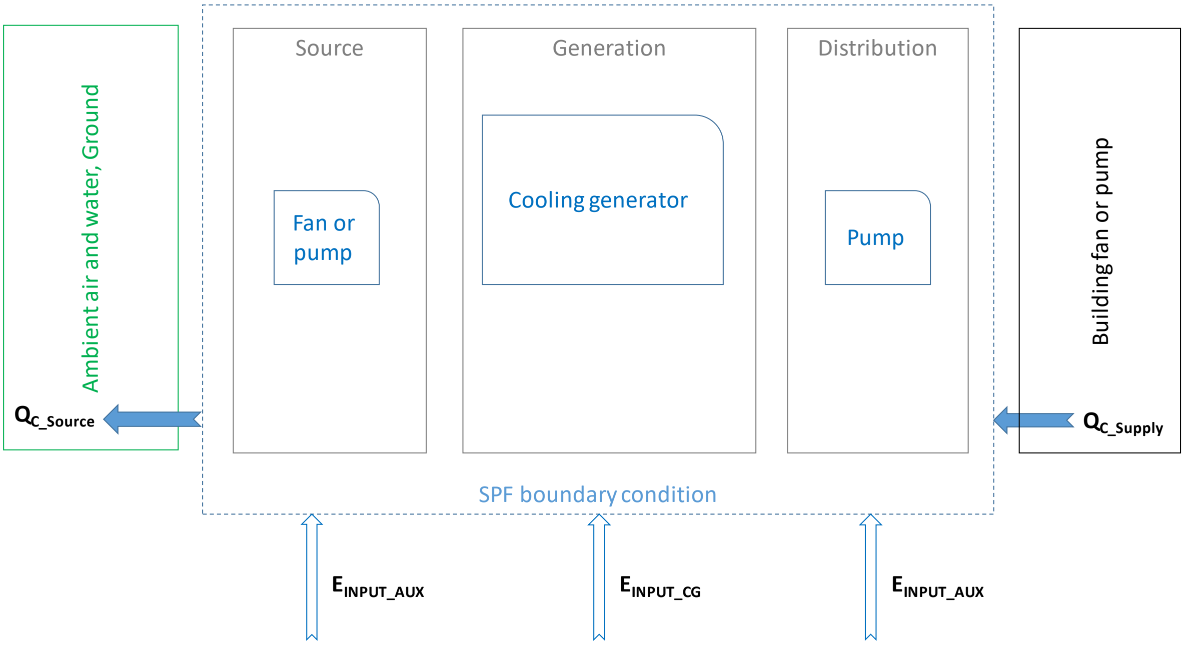


*Figure 1 Illustration of SPF boundary conditions for cooling generator using standard SPF and district cooling (and other large cooling systems using measured SPF), where $E_{INPUT\_AUX}$ is the energy input to fan and/or pump and $E_{INPUT\_CG}$ the energy input to the cooling generator*

## 3.4. Calculation using standard values

A simplified method may be used for individual cooling systems of less than 1.5 MW capacity, for which a standard SPF value is available, to estimate the total cooling energy supplied.

Under the simplified method, the cooling energy supplied by the cooling system ($Q_{Csupply}$) is the nominal cooling capacity ($P_C$) multiplied by the number of equivalent full load hours ($EFLH$). A single Cooling Degree Days (CDD) value may be used for a whole country, or distinct values for different climate zones provided that nominal capacities and SPFs are available for these climate zones.

The following default methods may be used to compute $EFLH$:

-for space cooling in the residential sector: EFLH = 96 + 0.85 * CDD

- for space cooling in the tertiary sector: EFLH = 475 + 0.49 * CDD

- for process cooling: EFLH = $\tau_s$ * (7300 + 0.32 * CDD)

Where:

$\tau_s$ is an activity factor to account for the operation time of the specific processes (e.g. all year long $\tau_s$=1, not on weekends $\tau_s$=5/7). There is no default value.

### *3.4.1. Calculation using measured values*

Systems for which no standard values exist, as well as cooling systems larger than 1.5 MW capacity and district cooling systems**,** shall calculate their renewable cooling based on the following measurements:

*Measured energy input:* The measured energy input includes all energy sources for the cooling system i.e. electricity, gas, heat etc. for cooling generator. It includes also auxiliary pumps and fans for the cooling system but not for the distribution of cooling to a building or a process. In case of air-based cooling with ventilation function, only the additional energy input due to cooling shall be included in the energy input of the cooling system.

*Measured cooling energy supply:* The cooling energy supply shall be measured as the output from the cooling system and subtracted any cold losses in order to estimate the net cooling energy supply to the building or process that is the end-user of the cooling. The cold losses include losses in a district cooling system and in the cooling distribution system in a building or an industrial site. In case of air-based cooling with ventilation function, the cooling energy supply shall be net of the effect of fresh air introduction for ventilation purposes.

The measurements need to be carried out for the specific year to be reported i.e. all energy input and all cooling energy supply for the whole year.

### *3.4.2. District cooling: additional requirements*

For district cooling systems the net cooling supply at customer level shall be accounted when defining the net cooling supply, denoted as $Q_{C\_Supply\_net}$. Thermal losses occurring in the distribution network($Q_{C\_LOSS}$) shall be deducted from the gross cooling supply ($Q_{C\_Supply\_gross}$) as follows:

$$Q_{C\_Supply\_net} = Q_{C\_Supply\_gross} - Q_{C\_LOSS}$$

3.4.2.1. *Division in subsystems*

Cooling systems at district level can be divided in subsystems, which comprise at least one cooling generator or free cooling system. This requires the measurement of the cooling energy supply and of the energy input for each sub-system as well as the allocation of cold losses per sub-system as follows:

$$Q_{C\_Supply\_net\_i} = Q_{C\_Supply\_gross\_i} x \left(1 - \frac{Q_{C_{LOSS}}}{(\sum_{i=1}^{n} Q_{C_{Supply_{gross_i}}})}\right)$$

3.4.2.2. *Auxiliaries*

When dividing a cooling system into subsystems, the auxiliaries (e.g. controls, pumps and fans) of the cooling generator(s) and/or free cooling system(s) must be included in the same subsystem(s). Auxiliary energy corresponding to cooling distribution inside the building, e.g. secondary pumps and terminal units (e.g. fan coils, fans of air handling units) are not accounted for.

For auxiliaries which cannot be allocated to a specific subsystem, for instance district cooling network pumps which deliver the cooling energy supplied by all cooling generators, their primary energy consumption shall be allocated to each cooling subsystem in the proportion of the cooling energy supplied by the cooling generators and/or the free cooling systems of each subsystem as with cold losses in the network as follows

$$E_{INPUT\_AUX\_i} = E_{INPUT\_AUX1\_i} + E_{INPUT\_AUX2} * \frac{Q_{C\_Supply\_net\_i}}{\sum_{i=1}^{n} Q_{C\_Supply\_net\_i}}$$

where:

$E_{INPUT\_AUX1\_i}$ is the auxiliary energy consumption of subsystem "i".

$E_{INPUT\_AUX2}$ is the auxiliary energy consumption of the entire cooling system, which cannot be allocated to a specific cooling subsystem

## 3.5. Calculation of renewable energy quantity for cooling for the overall renewable shares and for the heating and cooling renewable energy shares

For the calculation of the overall renewable energy shares, the renewable energy quantity for cooling shall be added both to the numerator 'gross final consumption of energy from renewable sources' and to the denominator 'gross final consumption of energy'

For the calculation of the heating and cooling renewable energy shares the renewable energy quantity for cooling shall be added both to the numerator 'gross final consumption of energy from renewable sources for heating and cooling' and to the denominator 'gross final consumption of energy for heating and cooling'