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Bottom up methodologies in the scope of streamSAVE Priority Actions

Annex III of Deliverable D2.1 – Second PA round

Version N°1

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Introduction

For the second round of Priority Actions falling under the scope of streamSAVE, the bottom-up (BU) calculation methodologies (incl. cost-effectiveness) already available within the Member States are summarized in this Annex III. Similar to the first round, a template has been designed to collect the available data in a uniform format, including the following elements:

- Description of the action;
- Application area or scope of the standardized calculation methodology (e.g. subsector; boundary conditions of methodology);
- Calculation formula to estimate the savings and costs; parameter definition and indicative values (e.g. lifetime), including a description of sources for these standardized values;
- How the baseline consumption has been determined for each action; how frequently and according to which criteria and data these baselines should be updated; and
- Correction factors for behavioural effects (e.g. rebound effects) and/or geographical factors.

The information herein presented is based on a review carried out by all partners for all BU methodology catalogues identified in Member States and information from recent project reports. The information was collected from:

- Existing catalogues within Member States. This is the main source of information.
- Estimation methods (incl. cost-effectiveness) used by public authorities to estimate savings *(Article 7 – EEO and alternative measures)* or expected energy consumption *(Article 3 – target setting)* by 2020 or 2030. This information was retrieved from the streamSAVE's online survey and interviews, or from official EU reporting, for example from the National Energy Efficiency Action Plans NEEAPs, and the National Energy and Climate Plans NECPs. These are the most reliable sources of information, when there were no catalogues available and in the case MS use alternative measures in the frame of Article 7.
- Existing methodologies for savings calculation and/or energy consumption reduction prepared by other projects (like multEE and EMEEES) have been examined and considered in the analysis, as well as other initiatives, scientific literature, grey reports, etc., offering guidance on bottom-up methodologies for energy savings calculation.

The chapters are organized by the five Priority Actions (PA), such as *"Small-scale RES central space heating (incl. hot water)"*, *"Measures alleviating (also) Energy Poverty"*, *"Anticipated motor replacement"*, *"Providing feedback about energy use and tailored advice toward households: behavioural changes"* and *"Modal shift for freight transport"*. To distinguish between the different methodologies, the heading titles of the chapters and sub-chapters provide information about the methodology and from which Member State it was collected. In the chapter "Hors category", several collected methodologies are presented that do not fit entirely in the five PAs but can provide useful inputs for future methodologies to be developed.

Chapter 1 Small-scale RES central space heating (incl. hot water)

1.1 Central space heating in non-residential buildings – Austria

The existing heating system in a non-residential building is replaced by a more efficient technology. The hot water generation is supplied by electrically operated, decentralized micro storage tanks and is not changed as part of this measure, except in hotels and restaurants.

For the non-residential building types "office buildings", "kindergartens and compulsory schools", "high schools and universities", "hotels" and "restaurants" of the categories “building stock (before 1919)”, “building stock (1919-2000)” and “building stock (from 2001)”, indicative values are available for the heating demand, the efficiency of the pre-existing heating systems and for the efficiency of the efficient heating systems (for heat pumps, district heating, natural gas or oil condensing boilers). The calculations are based on the reference buildings as defined in the Austrian catalogue of bottom-up methodologies.

The savings from heat pumps operated with natural gas cannot be calculated with this methodology.

In order to use this methodology and the corresponding indicative calculation values, the following specifics have to be met:

- The installed air heat pump should have a seasonal heating efficiency (η_s) of 110 % (55 °C) or 135 % (35 °C) at average climate conditions
- The installed geothermal or groundwater heat pump should have a seasonal heating efficiency (ηs) of 125 % (55 °C) or 150 % (35 °C) at average climate conditions
- Additionally to the installation of the heat pump, the heating system is planned installed in a way that ensures optimal operation.

Note: This methodology also features the installation of condensing boilers fuelled by oil and gas. As such actions are no longer accountable in the EED 2021 – 2030 period, the translation of this methodology focusses on the installation of heat pumps and connections to the district heating grid.

1.1.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.1.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = A \times \left((HD + HWD) \times eff_{baseline} - (HD + HWD) \times eff_{action}\right) \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [kWh/a]
A	Gross floor area of the building [m²]
HD	Area specific heating demand of the building [kWh/m²a]
HWD	Area specific hot water demand of the building [kWh/m²a]
$eff_{baseline}$	Efficiency of a reference heating system [-]
eff_{action}	Efficiency of the efficient heating system [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

Standardized calculation values

Table 1: Indicative values for calculation of final energy savings (Article 7).

HD [kWh/m²a]	Office Buildings	Kinder-gardens and compulsory schools	High schools and universities	Hotels	Restaurants
building stock (before 1919)	133	132	129	148	185
building stock (1919-2000)	110	107	105	116	151
building stock (from 2001)	43	43	42	38	71
HWD [kWh/m²a]					
	0	0	0	12.8	6.4
$eff_{baseline}$ [-]					
building stock (before 1919)	1.23	1.23	1.22	1.39	1.35
building stock (1919-2000)	1.28	1.27	1.28	1.51	1.43
building stock (from 2001)	1.38	1.37	1.41	1.93	1.65
eff_{action} [-]					
building stock (before 1919)					
groundwater heat pump	0.27	0.27	0.28	0.31	0.30
geothermal heat pump	0.32	0.31	0.32	0.35	0.34
air heat pump	0.37	0.37	0.38	0.45	0.42
district heating	1.04	1.04	1.04	1.09	1.08

building stock (1919-2000)					
groundwater heat pump	0.29	0.28	0.29	0.33	0.31
geothermal heat pump	0.32	0.32	0.33	0.37	0.35
air heat pump	0.38	0.38	0.39	0.49	0.44
district heating	1.05	1.05	1.06	1.14	1.12
building stock (from 2001)					
groundwater heat pump	0.30	0.30	0.32	0.42	0.35
geothermal heat pump	0.35	0.35	0.37	0.47	0.40
air heat pump	0.41	0.41	0.43	0.67	0.52
district heating	1.08	1.08	1.11	1.33	1.19
Lifetime of savings [a]					
groundwater heat pump	18				
geothermal heat pump	20				
air heat pump	20				
district heating	30				

Methodological aspects:

This methodology was published in the Austrian catalogue on bottom-up calculation methodologies (Anlage 1 BGB1. II, Nr. 172, 2016), which is Annex to the Directive 172 on Energy Efficiency. The document is published in German language.

The formula multiplies the gross floor area of a non-residential building with the area specific heating demand and hot water demand of this building, multiplied with the efficiency of a reference heating system in comparison to the efficiency of the more efficient heating system to be installed. The efficiency of the heating systems is calculated as follows:

$$eff = \frac{HED}{HD + HWD}$$

Where:

eff	Efficiency of the heating system [-]
HED	Area specific heating energy demand [kWh/m²a]
HD	Area specific heating demand [kWh/m²a]
HWD	Area specific hot water demand [kWh/m²a]

Data sources for indicative calculation values

All calculations are based on the reference buildings as defined in the Austrian catalogue on bottom-up calculation methodologies. Those buildings are based on statistical data on the Austrian building stock.

For the efficiency of the reference heating system, a weighted average of the efficiencies of heating systems installed in the Austrian non-residential building stock is used.

The efficiency of the heating system in case of the installation of a heat pump is based on market averages.

The calculation of the efficiencies of the heating systems is performed using software for the calculation of energy certificate and takes into account minimum standards stipulated in the Austrian building code.

The lifetime of savings for heat pumps are defined according to VDI 2067 (Economic efficiency of building installations - Fundamentals and economic calculation). The lifetime of savings for district heating connections are defined according to ÖNORM M 7140:2013 (Economic comparison calculation of energy systems based on dynamic calculation methods).

1.1.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

1.1.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.1.5 Bibliography

Anlage 1 BGB1. II, Nr. 172 (2016). Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen, 100–103. https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2016_II_172/COO_2026_100_2_1241958.pdfsig

VDI (2012). VDI 2067 Blatt 1, Wirtschaftlichkeit gebäudetechnischer Anlagen - Grundlagen und Kostenberechnung, https://www.vdi.de/richtlinien/details/vdi-2067-blatt-1-wirtschaftlichkeit-gebaeudetechnischer-anlagen-grundlagen-und-kostenberechnung-1

Austrian Standards (2013). ÖNORM M 7140 - Betriebswirtschaftliche Vergleichsrechnung für Energiesysteme nach dynamischen Rechenmethoden - Nationale Ergänzungen und nationale Erläuterungen zu ÖNORM EN 15459-1. https://shop.austrian-standards.at/action/de/public/details/477072/OENORM_M_7140_2013_07_01

1.2 Heat pumps in newly built residential buildings – Austria

Instead of an average heating system, a heat pump is installed in a newly built residential building. The heat pump is used for both heating and hot water supply. Indicative calculation values are available for single-family homes (SFH), multifamily homes (MFH) and apartment buildings (AB) for electric heat pumps. The savings from heat pumps operated with natural gas cannot be calculated with this methodology.

In order to use this methodology and the corresponding indicative calculation values, the following specifics have to be met:

- The installed air heat pump should have a seasonal heating efficiency (η_s) of 110 % (55 °C) or 135 % (35 °C) at average climate conditions
- The installed geothermal or groundwater heat pump should have a seasonal heating efficiency (ηs) of 125 % (55 °C) or 150 % (35 °C) at average climate conditions
- Additionally to the installation of the heat pump, the heating system is planned installed in a way that ensures optimal operation.

1.2.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.2.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = A \times \left((HD + HWD) \times eff_{baseline} - (HD + HWD) \times eff_{action}\right) \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [kWh/a]
A	Gross floor area of the building or dwelling [m²]
HD	Area specific heating demand of the building or dwelling [kWh/m²a]
HWD	Area specific hot water demand of the building or dwelling [kWh/m²a]
$eff_{baseline}$	Efficiency of a reference heating system [-]
eff_{action}	Efficiency of the heat pump [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

Standardized calculation values

Table 2: Indicative values for calculation of final energy savings (Article 7).

	SFH	MFH	AB	Unit
A	172.2	101.1	86.1	[m²]
HD	52.7	45.0	35.6	[kWh/m²a]
HWD	12.8	12.8	12.8	[kWh/m²a]
$eff_{baseline}$	1.11	1.69	1.61	[-]
eff_{action}:				
Air heat pump	0.38	0.52	0.50	[-]
Geothermal heat pump	0.32	0.43	0.41	[-]

Groundwater heat pump	0.29	0.42	0.40	[-]
Lifetime of savings	For air heat pumps: 18 For geothermal or groundwater heat pumps: 20			[a]

Methodological aspects:

This methodology was published in the Austrian catalogue on bottom-up calculation methodologies (Anlage 1 BGB1. II, Nr. 172, 2016), which is Annex to the Directive 172 on Energy Efficiency. The document is published in German language.

The formula multiplies the gross floor area of a building or dwelling equipped with a heat pump with the area specific heating demand and hot water demand of this building, multiplied with the efficiency of a reference heating system in comparison to the efficiency of a heat pump. The efficiency of the heating systems is calculated as follows:

$$eff = \frac{HED}{HD + HWD}$$

Where:

eff	Efficiency of the heating system [-]
HED	Area specific heating energy demand [kWh/m²a]
HD	Area specific heating demand [kWh/m²a]
HWD	Area specific hot water demand [kWh/m²a]

Data sources for indicative calculation values

All calculations are based on the reference buildings as defined in the Austrian catalogue on bottom-up calculation methodologies. Those buildings are based on statistical data on the Austrian building stock (for stock buildings) and minimal requirements of the national building code (for newly built buildings).

For the efficiency of the reference heating system, a weighted average of the efficiencies of heating systems installed in the Austrian building stock is used.

The efficiency of the heating system in case of the installation of a heat pump is based on market averages.

The calculation of the efficiencies of the heating systems is performed using software for the calculation of energy certificate and takes into account minimum standards stipulated in the Austrian building code.

The lifetime of savings are defined according to VDI 2067 (Economic efficiency of building installations - Fundamentals and economic calculation).

1.2.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

1.2.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.2.5 Bibliography

Anlage 1 BGB1. II, Nr. 172 (2016). Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen, 100–103. https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2016_II_172/COO_2026_100_2_1241958.pdfsig

VDI (2012). VDI 2067 Blatt 1, Wirtschaftlichkeit gebäudetechnischer Anlagen - Grundlagen und Kostenberechnung, https://www.vdi.de/richtlinien/details/vdi-2067-blatt-1-wirtschaftlichkeit-gebaeudetechnischer-anlagen-grundlagen-und-kostenberechnung-1

1.3 Heat pumps in thermally refurbished residential buildings – Austria

Instead of an average heating system, a heat pump is installed in a thermally refurbished residential building. The heat pump is used for both heating and hot water supply. Indicative calculation values are available for single-family homes (SFH), multifamily homes (MFH) and apartment buildings (AB) for electric heat pumps. The savings from heat pumps operated with natural gas cannot be calculated with this methodology.

In order to use this methodology and the corresponding indicative calculation values, the following specifics have to be met:

- The installed air heat pump should have a seasonal heating efficiency (η_s) of 110 % (55 °C) or 135 % (35 °C) at average climate conditions
- The installed geothermal or groundwater heat pump should have a seasonal heating efficiency (ηs) of 125 % (55 °C) or 150 % (35 °C) at average climate conditions
- Additionally to the installation of the heat pump, the heating system is planned installed in a way that ensures optimal operation.

A building is considered as “thermally refurbished” in case at least two of the following options were conducted 10 years prior to the exchange of the heating system:

- Insulation of the top storey ceiling
- Insulation of the exterior walls
- Refurbishment of windows

1.3.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.3.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = A \times \left((HD + HWD) \times eff_{baseline} - (HD + HWD) \times eff_{action}\right) \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [kWh/a]
A	Gross floor area of the building or dwelling [m²]
HD	Area specific heating demand of the building or dwelling [kWh/m²a]
HWD	Area specific hot water demand of the building or dwelling [kWh/m²a]
$eff_{baseline}$	Efficiency of a reference heating system [-]
eff_{action}	Efficiency of the heat pump [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

Standardized calculation values

Table 3: Indicative values for calculation of final energy savings (Article 7).

	SFH	MFH	AB	Unit
A	172.2	101.1	86.1	[m²]
HD	67.0	58.0	46.6	[kWh/m²a]
HWD	12.8	12.8	12.8	[kWh/m²a]
$eff_{baseline}$	2.25	2.35	2.30	[-]
eff_{action}:				
Air heat pump	0.36	0.52	0.50	[-]
Geothermal heat pump	0.30	0.43	0.41	[-]
Groundwater heat pump	0.28	0.41	0.39	[-]
Lifetime of savings	For air heat pumps: 18 For geothermal or groundwater heat pumps: 20			[a]

Methodological aspects:

This methodology was published in the Austrian catalogue on bottom-up calculation methodologies (Anlage 1 BGB1. II, Nr. 172, 2016), which is Annex to the Directive 172 on Energy Efficiency. The document is published in German language.

The formula multiplies the gross floor area of a building or dwelling equipped with a heat pump with the area specific heating demand and hot water demand of this building, multiplied with the efficiency of a reference heating system in comparison to the efficiency of a heat pump. The efficiency of the heating systems is calculated as follows:

$$eff = \frac{HED}{HD + HWD}$$

Where:

eff	Efficiency of the heating system [-]
HED	Area specific heating energy demand [kWh/m²a]
HD	Area specific heating demand [kWh/m²a]
HWD	Area specific hot water demand [kWh/m²a]

Data sources for indicative calculation values

All calculations are based on the reference buildings as defined in the Austrian catalogue on bottom-up calculation methodologies. Those buildings are based on statistical data on the Austrian building stock (for stock buildings) and minimal requirements of the national building code (for newly built buildings).

For the efficiency of the reference heating system, a weighted average of the efficiencies of heating systems installed in the Austrian building stock is used.

The efficiency of the heating system in case of the installation of a heat pump is based on market averages.

The calculation of the efficiencies of the heating systems is performed using software for the calculation of energy certificate and takes into account minimum standards stipulated in the Austrian building code.

The lifetime of savings are defined according to VDI 2067 (Economic efficiency of building installations - Fundamentals and economic calculation).

1.3.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

1.3.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.3.5 Bibliography

Anlage 1 BGB1. II, Nr. 172 (2016). Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen, 100–103. https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2016_II_172/COO_2026_100_2_1241958.pdfsig

VDI (2012). VDI 2067 Blatt 1, Wirtschaftlichkeit gebäudetechnischer Anlagen - Grundlagen und Kostenberechnung, https://www.vdi.de/richtlinien/details/vdi-2067-blatt-1-wirtschaftlichkeit-gebaeudetechnischer-anlagen-grundlagen-und-kostenberechnung-1

1.4 Central space heating in the residential building stock – Austria

The space heating systems of a residential building is replaced by a more efficient, new system. It is used for both space heating and the preparation of domestic hot water. Indicative calculation values are available for single-family homes (SFH), multifamily homes (MFH) and apartment buildings (AB), all either thermally refurbished or un-refurbished.

The methodology prepares indicative calculation values for biomass boilers as well as gas and oil fired condensing boilers as new heating systems. For the heating system before the replacement, values are prepared for either a weighted average of all technologies used in the Austrian building stock or solid fuel boilers.

In order to use this methodology and the corresponding indicative calculation values, the following specifics have to be met:

- Biomass boilers installed have to meet at least the efficiency indicated by "Österreichisches Umweltzeichen" (Austrian Ecolabel). Only boilers which are integrated in the building's heating system can be reported – boilers for single room heating are not accountable.
- Additionally to the installation of the heat pump, the heating system is planned installed in a way that ensures optimal operation.

A building is considered as "thermally refurbished" in case at least two of the following options were conducted 10 years prior to the exchange of the heating system:

- Insulation of the top storey ceiling
- Insulation of the exterior walls
- Refurbishment of windows

Note: As gas and oil fired boilers are no longer accountable in the EED 2021 – 2030 period, the translation of this methodology focusses on **biomass boilers**.

1.4.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.4.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = A \times \left((HD + HWD) \times eff_{baseline} - (HD + HWD) \times eff_{action}\right) \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [kWh/a]
A	Gross floor area of the building or dwelling [m²]
HD	Area specific heating demand of the building or dwelling [kWh/m²a]
HWD	Area specific hot water demand of the building or dwelling [kWh/m²a]
$eff_{baseline}$	Efficiency of a reference heating system [-]
eff_{action}	Efficiency of the biomass boiler [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

Standardized calculation values

Table 4: Indicative values for calculation of final energy savings (Article 7) for un-refurbished buildings.

	SFH	MFH	AB	Unit
A	172.2	101.1	86.1	[m²]
HD	170.2	130.7	89.6	[kWh/m²a]
HWD	12.8	12.8	12.8	[kWh/m²a]
$eff_{baseline}$ – Weighted average	1.69	1.75	1.79	[-]
$eff_{baseline}$ – Solid fuel boiler	2.15	2.57	2.67	[-]
eff_{action} Biomass boiler	1.34	1.41	1.43	[-]
Lifetime of savings	20			[a]

Table 5: Indicative values for calculation of final energy savings (Article 7) for refurbished buildings.

	SFH	MFH	AB	Unit
A	172.2	101.1	86.1	[m²]
HD	67.0	58.0	46.6	[kWh/m²a]
HWD	12.8	12.8	12.8	[kWh/m²a]
$eff_{baseline}$ – Weighted average	2.25	2.35	2.30	[-]
$eff_{baseline}$ – Solid fuel boiler	3.13	3.89	3.81	[-]
eff_{action} Biomass boiler	1.53	1.72	1.66	[-]
Lifetime of savings	20			[a]

Methodological aspects:

This methodology was published in the Austrian catalogue on bottom-up calculation methodologies (Anlage 1 BGB1. II, Nr. 172, 2016), which is Annex to the Directive 172 on Energy Efficiency. The document is published in German language.

The formula multiplies the gross floor area of a building or dwelling equipped with an efficient boiler with the area specific heating demand and hot water demand of this building, multiplied with the efficiency of a reference heating system in comparison to the efficiency of the efficient boiler. The efficiency of the heating systems is calculated as follows:

$$eff = \frac{HED}{HD + HWD}$$

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Where:

eff	Efficiency of the heating system [-]
HED	Area specific heating energy demand [kWh/m²a]
HD	Area specific heating demand [kWh/m²a]
HWD	Area specific hot water demand [kWh/m²a]

Data sources for indicative calculation values

All calculations are based on the reference buildings as defined in the Austrian catalogue on bottom-up calculation methodologies. Those buildings are based on statistical data on the Austrian building stock (for stock buildings) and minimal requirements of the national building code (for newly built buildings).

For the efficiency of the reference heating system, a weighted average of the efficiencies of heating systems installed in the Austrian building stock is used.

The efficiency of the heating system in case of the installation of a biomass boiler is based on the average efficiency of all biomass boilers that meet the requirements of the Austrian Ecolabel available on the market.

The calculation of the efficiencies of the heating systems is performed using software for the calculation of energy certificate and takes into account minimum standards stipulated in the Austrian building code.

The lifetime of savings are defined according to ÖNORM M 7140:2013 (Economic comparison calculation of energy systems based on dynamic calculation methods).

1.4.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

1.4.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.4.5 Bibliography

Anlage 1 BGB1. II, Nr. 172 (2016). Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen, 100–103. https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2016_II_172/COO_2026_100_2_1241958.pdfsig

Austrian Standards (2013). ÖNORM M 7140 - Betriebswirtschaftliche Vergleichsrechnung für Energiesysteme nach dynamischen Rechenmethoden - Nationale Ergänzungen und nationale Erläuterungen zu ÖNORM EN 15459-1. https://shop.austrian-standards.at/action/de/public/details/477072/OENORM_M_7140_2013_07_01

1.5 Solar hot water generation – Austria

This methodology deals with the installation of solar thermal panels for domestic hot water generation. The amount of heat generated reduces the energy demand of the main heating system. Indicative values are available for the installation of flat plate collectors and vacuum tube collectors in residential buildings.

Note: This methodology was prepared for the EED period 2014 – 2020. As from the 2021 – 2030 periods onwards, only final energy savings are accountable, the methodological approach is no longer viable.

1.5.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.5.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = A \times EO \times eff_{mhs} \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [kWh/a]
A	Installed collector surface area [m²]
EO	Average annual energy output per m² of collector surface [kWh/m²a]
eff_{mhs}	Efficiency of the main heating system [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

Standardized calculation values

Table 6: Indicative values for calculation of final energy savings (Article 7).

EO	[kWh/m²a]
flat plate collector	380
vacuum tube collector	435
eff_{mhs}	[-]
Single-family home	1.69
Multi-family home	1.52
Apartment building	1.57
Lifetime of savings	[a]
Lifetime of savings	20

Methodological aspects:

This methodology was published in the Austrian catalogue on bottom-up calculation methodologies (Anlage 1 BGB1. II, Nr. 172, 2016), which is Annex to the Directive 172 on Energy Efficiency. The document is published in German language.

The formula is based on reducing the energy demand of the main heating system due to heat generated by the solar thermal collectors. The collector surface area is multiplied with

the area specific energy output of the solar collector and the efficiency of the main heating system.

The efficiency of the heating systems is calculated as follows:

$$eff = \frac{HED}{HD + HWD}$$

Where:

eff	Efficiency of the heating system [-]
HED	Area specific heating energy demand (HED) [kWh/m²a]
HD	Area specific heating demand (HD) [kWh/m²a]
HWD	Area specific hot water demand (HWD) [kWh/m²a]

Data sources for indicative calculation values

The values for the average annual energy output for flat plate collectors and vacuum tube collectors have been simulated using T*Sol and climatic conditions of various Austrian cities.

For the efficiency of the reference heating system, a weighted average of the efficiencies of heating systems installed in the Austrian building stock is used.

The lifetime of savings is defined according to VDI 2067 (Economic efficiency of building installations - Fundamentals and economic calculation).

1.5.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

1.5.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.5.5 Bibliography

Anlage 1 BGB1. II, Nr. 172 (2016). Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen, 100–103. https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2016_II_172/COO_2026_100_2_1241958.pdfsig

VDI (2012). VDI 2067 Blatt 1, Wirtschaftlichkeit gebäudetechnischer Anlagen - Grundlagen und Kostenberechnung, https://www.vdi.de/richtlinien/details/vdi-2067-blatt-1-wirtschaftlichkeit-gebaeudetechnischer-anlagen-grundlagen-und-kostenberechnung-1

1.6 Installing an air / water or water / water type heat pump for heating needs of residential buildings– Bulgaria

This methodology sets out the conditions, specifies the practical procedures and regulates the method for calculating energy savings as well as indicates the format of the outgoing

energy documents for the implementation of installing an air/water or water/water heat pump for heating needs of residential buildings.

This methodology is applicable both to households and service sector.

Furthermore, this methodology:

- Is applied when replacing a natural gas boiler and other conventional fuels with an air/water or water/water heat pump
- Is applied to the installation of an air/water pump or water/water for the heating needs of residential buildings and the production of hot water for domestic use.

1.6.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the impact on energy consumption within the framework of Article 3 is provided.

$$\mathrm{FES_{kwh}} = \mathrm{EC_{boiler}} - \mathrm{EC_{hp}}\mathrm{EC}_{hp} = \mathrm{EC_{boiler}} * \left(\frac{h_{boiler}}{COP_{hp}}\right) + P_{vent} * H_{vent} * 365\mathrm{PES_{kwh}}$$
$$= \mathrm{EC_{boiler}} * e_p - \mathrm{EC_{hp}} * e_{pel}$$

1.6.2 Calculation of final energy savings (Article 7)

The calculation method takes into account the difference between the energy consumed by an existing boiler and a new heat pump.

$$\mathrm{FES_{kwh}} = \mathrm{EC_{boiler}} - \mathrm{EC_{hp}}$$

$$\mathrm{EC}_{hp} = \mathrm{EC_{boiler}} * \left(\frac{h_{boiler}}{COP_{hp}}\right) + P_{vent} * H_{vent} * 365$$

Where:

FES_{kWh}	Final energy savings delivered by a heat pump [kWh]
EC_{boiler}	Energy consumption of the existing boiler [kWh/yr]
EC_{hp}	Energy consumption of the heat pump [kWh_{el}/yr]
h_{boiler}	Performance ratio of the existing boiler
COP_{hp}	Coefficient of Performance of heat pump (according to manufacturer's data)
P_{vent}	Fan power 0.05 kW (the set value to be used if there is no other data or according to manufacturer's data)
H_{aven}	Fan operating hours: 2 hrs/day (set value to be if no other data available or according to the manufacturer's data)

The calculation of the primary energy savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = \mathrm{EC_{boiler}} * e_p - \mathrm{EC_{hp}} * e_{pel}$$

Where:

PES_{kWh}	Primary energy savings delivered by a heat pump [kWh]
e_p	Factor taking into account losses for energy extraction/production and transmission for the used fuels
e_{pel}	Factor taking into account losses for energy extraction/production and transmission for the case of electricity

Standardized calculation values

Table 7: Indicative values for calculation of primary energy savings (Article 3).

Type of fuel used	e_p	
Industrial gas oil, diesel	1.10	
Oil	1.10	
Natural gas	1.10	
LPG	1.10	
Black coal	1.20	
Lignite/Brown coal	1.20	
Brown coal	1.20	
Anthracite coal	1.20	
Coal briquettes	1.25	
Firewood, pellets	1.05	
Heat from central heat supply system	1.30	
Electricity	3.00	
Lifetime of savings	[a]	
Lifetime of savings	15	
Climatic zone Z	COP - source air/water	COP - source air/water
1	3.5	4
2	3.25	4.5
3	3	4.2
4	3.68	3.9
5	3.4	4
6	3.5	4
7	3.6	4
8	3.4	4
9	3.3	4

Methodological aspects:

This methodology for assessing the delivered energy savings has been approved by order of the Minister of Energy and has been published by SEDA, which is a legal entity at state budget support and has the status of an executive agency within the Ministry of Energy.

Data sources for indicative calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Energy (2022).

1.6.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.6.4 Calculation of CO_2 emission savings

The calculation of the CO_2 emission savings is performed by the following equation:

$$CO_2 = \left(EC_{boiler} * f_r - EC_{hp} * f_i\right) / 10^6$$

Where:

CO_2	CO_2 emission savings delivered by a heat pump [tCO_2/yr]
f_r	CO_2 emission factor for the used fuels
f_{il}	CO_2 emission factor for the case of electricity

Standardized calculation values

Table 8: Indicative values for calculation of CO_2 emission savings.

Type of fuel used	f_i (tCO_2/GWh)
Industrial gas oil, diesel	267
Oil	279
Natural gas	202
LPG	227
Black coal	341
Lignite/Brown coal	364
Anthracite coal	354
Coal briquettes	351
Firewood, pellets	43
Heat from central heat supply system	290
Electricity	819

1.6.5 Bibliography

Ministry of Energy (2022). Methodology for estimating energy savings when installing an air / water or water / water type heat pump for heating needs of residential buildings, Methodology no 9.

https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwaniq-utwyrdeni-ot-me

1.7 Using small systems for combined production of electricity and heat (co-generators) for household needs– Bulgaria

This methodology sets out the conditions, specifies the practical procedures and regulates the method for calculating energy savings as well as indicates the format of the outgoing energy documents for the implementation of installing small systems for the combined production of electricity and heat (micro-CHP plant) to be used for heating and cooling purposes in buildings and/or production of hot water in households.

This methodology is applicable to all households. The energy produced will only be used to cover heating and cooling needs of households. For this methodology, measuring equipment is required.

1.7.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the impact on energy consumption within the framework of Article 3 is provided.$\mathrm{FES_{kwh}} = \left(E_e + {EF_{th}}/{n_{t,r}} + {Ef_f}/{l_f}\right) - EF_{fuel}\mathrm{PES_{kwh}} = \left(E_e * e_p + {EF_{th}}/{n_{t,r}} * e_p + {Ef_f}/{l_f} * e_p\right) - EF_{fuel} * e_p$

1.7.2 Calculation of final energy savings (Article 7)

The calculation method takes into account the difference between the energy consumed by an existing boiler and a new CHP unit. The savings are calculated by taking into account the relationship between the Performance Ratio of the new micro-CHP plant and the existing boiler.

$$\mathrm{FES_{kwh}} = \left(E_e + {EF_{th}}/{n_{t,r}} + {Ef_f}/{l_f}\right) - EF_{fuel}$$

Where:

FES_{kWh}	Final energy savings delivered by a CHP unit [kWh]
E_e	Net electricity generated from the new micro-CHP plant [kWh_{el}/yr]
EF_{th}	Heat supplied to the consumer [kWh/yr]
EF_f	Cooling energy supplied to the consumer [kWh/yr]
EF_{fuel}	Produced energy from the fuel consumption in the micro-CHP plant kWh/yr]

$\eta_{t,r}$	$\eta=0.77+0.03*\log_{10}(P_n)$ heat Performance Ratio of the existing boiler
$I_f=3$	Cooling efficiency factor of the existing installation, not less than 1.5 if there is no data available

The calculation of the primary energy savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = \left(E_e * e_p + {EF_{th}}/{n_{t,r}} * e_p + {Ef_f}/{l_f} * e_p\right) - EF_{fuel} * e_p$$

Where:

PES_{kWh}	Primary energy savings delivered by a CHP unit [kWh]
e_p	Factor taking into account losses for energy extraction/production and transmission for the used fuels

Standardized calculation values

Table 9: Indicative values for calculation of primary energy savings (Article 3).

Type of fuel used	e_p
Industrial gas oil, diesel	1.10
Oil	1.10
Natural gas	1.10
LPG	1.10
Black coal	1.20
Lignite/Brown coal	1.20
Brown coal	1.20
Anthracite coal	1.20
Coal briquettes	1.25
Firewood, pellets	1.05
Heat from central heat supply system	1.30
Electricity	3.00
Lifetime of savings	[a]
Lifetime of savings	20

Methodological aspects

This methodology for assessing the delivered energy savings has been approved by order of the Minister of Energy and has been published by SEDA, which is a legal entity at state budget support and has the status of an executive agency within the Ministry of Energy.

Data sources for indicative calculation values:

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Energy (2022).

1.7.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.7.4 Calculation of CO_2 emission savings

The calculation of the CO_2 emission savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = \left(E_e * f_r + {EF_{th}}/{n_{t,r}} * f_r + {Ef_f}/{l_f} * f_r\right) - EF_{fuel} * f_r \Big/ 10^6$$

Where:

CO_2	CO_2 emission savings delivered by a heat pump [tCO_2/yr]
f_r	CO_2 emission factor for the used fuels

Standardized calculation values

Table 10: Indicative values for calculation of CO_2 emission savings.

Type of used fuel	f_i (tCO_2/GWh)
Industrial gas oil, diesel	267
Oil	279
Natural gas	202
LPG	227
Black coal	341
Lignite/Brown coal	364
Anthracite coal	354
Coal briquettes	351
Firewood, pellets	43
Heat from central heat supply system	290
Electricity	819

1.7.5 Bibliography

Ministry of Energy (2022). Methodology for estimating energy savings when using small systems for combined production of electricity and heat (cogenerators) for household needs, Methodology no 8. https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwaniq-utwyrdeni-ot-me

1.8 Installing an air/air heat pump in buildings– Bulgaria

This methodology sets out the conditions, specifies the practical procedures and regulates the method for calculating energy savings as well as indicates the format of the outgoing energy documents for the installation of an air/air heat pump in buildings.

In order to apply this methodology, the following information is required to be assessed:

- Certificate for installation of an air/air heat pump;
- Seasonal Coefficient of Performance (SCOP).

In addition, this methodology has the following specificities:

- Measuring equipment is required;
- For authentication, the installation of the air/air heat pump requires document from the manufacturer.

1.8.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the impact on energy consumption within the framework of Article 3 is provided.

1.8.2 Calculation of final energy savings (Article 7)

The calculation method takes into account the difference between the energy consumed by using conventional heating system and an air/air heat pump system for heating purposes in a building.

$$\mathrm{FES}_{\mathrm{kwh}} = FES$$

Where:

$\mathrm{FES}_{\mathrm{kWh}}$ = FES	energy savings at end-user's site per building [kWh/yr]

Standardized calculation values

Table 11: Indicative values for calculation of final energy savings (Article 3).

Climatic zone	FES, kWh/yr	
	Apartment – SCOP (seasonal conversion factor) >3.9	House - SCOP (seasonal conversion factor) >4.3
1	26897	78621
2	31316	91012
3	18022	51063
4	18000	51000
5	26000	76000
6	19125	54188
7	32000	93000

8	19742	55935
9	21568	61110
Correction factor		
Heating area, m²	Apartment	House
<35	0.5	0.3
<60	0.7	0.5
<70	1	0.6
<90	1.2	0.7
<110	1.5	1
<130	1.9	1.1

The calculation of the primary energy savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = FES * e_p$$

Where:

PES_{kWh}	Primary energy savings delivered by a CHP unit [kWh]
e_p	Factor taking into account losses for energy extraction/production and transmission for the used fuels

Standardized calculation values

Table 12: Indicative values for calculation of primary energy savings (Article 3).

Type of fuel used	e_p
Industrial gas oil, diesel	1.10
Oil	1.10
Natural gas	1.10
LPG	1.10
Black coal	1.20
Lignite/Brown coal	1.20
Brown coal	1.20
Anthracite coal	1.20
Coal briquettes	1.25
Firewood, pellets	1.05
Heat from central heat supply system	1.30
Electricity	3.00
Lifetime of savings	[a]
Lifetime of savings	17

Methodological aspects

This methodology for assessing the delivered energy savings has been approved by order of the Minister of Energy and has been published by SEDA, which is a legal entity at state budget support and has the status of an executive agency within the Ministry of Energy.

Data sources for indicative calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Energy (2022).

1.8.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.8.4 Calculation of CO_2 emission savings

The calculation of the CO_2 emission savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = {}^{FES * f_r}/_{10^6}$$

Where:

CO_2	CO_2 emission savings delivered by a heat pump [tCO_2/yr]
f_r	CO_2 emission factor for the used fuels

Standardized calculation values

Table 13: Indicative values for calculation of CO_2 emission savings.

Type of used fuel	f_i (tCO_2/GWh)
Industrial gas oil, diesel	267
Oil	279
Natural gas	202
LPG	227
Black coal	341
Lignite/Brown coal	364
Anthracite coal	354
Coal briquettes	351
Firewood, pellets	43
Heat from central heat supply system	290
Electricity	819

1.8.5 Bibliography

Ministry of Energy (2022). Methodology for estimating energy savings when installing an air / air heat pump in buildings, Methodology no 10.

https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwaniq-utwyrdeni-ot-me

1.9 Installing an electric heat pump with a system for production of hot water for domestic use in existing installations – Bulgaria

This methodology sets out the conditions, specifies the practical procedures and regulates the method for calculating energy savings as well as indicates the format of the outgoing energy documents for the installation of an electric heat pump with a system for production of hot water for domestic use in existing installations.

The applied methodology is based on the analysis of the effect of reducing the energy consumption for the production of hot water when changing the conventional water heaters (volumetric and flow water heaters) with a heat pump with hot water production system.

The application of this methodology has the following specificities:

- The application shall be carried out by the persons under Art. 43, par. 1 and 2 and Art. 59, par. 1 of the SEE;
- The methodology applies to heat pumps with a nominal transformation coefficient $COP_n \geq 2{,}5$;
- A document is needed to prove that a new heat pump has been installed with a hot water production system replacing an existing electric boiler;
- The nominal Coefficient of Performance, COPN, is determined under standard test conditions (STC). The electricity consumption of the heat pump is influenced by the external air temperature and has a direct impact on its efficiency (transformation coefficient;
- National legislation defines 9 different climatic zones with different monthly average reference external temperatures. Using the data obtained from the graph and taking into account the annual average temperatures for the climate zone, the average annual adjusted transformation factor (COPTY) for each heat pump is calculated. A standard schedule was adopted between 06:00 and 24:00 (Appendix 2).

1.9.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the impact on energy consumption within the framework of Article 3 is provided. $\mathrm{FES_{kwh}} = \frac{E}{\eta} - \frac{E}{\eta/_{COP_{TY}}} E = n * (\rho c)_w * V_w * (\theta_w - \theta_o) = \mathrm{n} * 470 \mathrm{PES_{kwh}} = FES_{kWh} * e_p$

1.9.2 Calculation of final energy savings (Article 7)

The calculation method takes into account the difference between the energy consumed in a typical operation of a system for production of hot water with electric water heaters per year and the consumption of installation of a new heat pump with a hot water production system.

$$\mathrm{FES_{kwh}} = \frac{E}{\eta} - \frac{E}{\eta/_{COP_{TY}}}$$

$$E = n * (\rho c)_w * V_w * (\theta_w - \theta_o) = \text{n} * 470$$

Where:

FES_{kWh}	Energy savings at end-user's site per building [kWh/yr]
$(\rho c)_w$	Thermal capacity of water by volume - 1.161 [kWh/(m³K]
V_w	Annual volume of hot water consumed per household member/occupant – 9m³/yr
θw	Hot water temperature (output boiler temp.) - 55ºC
θ_0	Annual average cold-water temperature (input water temp. into the boiler) - 10ºC
n	The number of inhabitants
η	Performance ratio of the existing system
COP_n	Coefficient of Performance at rated operating mode determined on the basis of Regulation (EU) No 814/2013 of European Commission, August 2nd 2013
COP_{TY}	Transformation factor values for climatic zones 1 to 9 depending on COP_n

Standardized calculation values

Table 14: Indicative values for calculation of final energy savings (Article 3).

COP_n	Climate zone								
	1	2	3	4	5	6	7	8	9
3.5	3.44	3.39	3.44	3.44	3.47	3.44	3.39	3.47	3.50
3.4	3.34	3.29	3.34	3.34	3.37	3.34	3.29	3.37	3.40
3.3	3.24	3.19	3.24	3.24	3.27	3.24	3.19	3.27	3.30
3.2	3.14	3.09	3.14	3.14	3.17	3.14	3.09	3.17	3.20
3.1	3.04	2.99	3.04	3.04	3.07	3.04	2.99	3.07	3.10
3.0	2.94	2.89	2.94	2.94	2.97	2.94	2.89	2.97	3.00
2.9	2.84	2.79	2.84	2.84	2.87	2.84	2.79	2.87	2.90
2.8	2.74	2.69	2.74	2.74	2.77	2.74	2.69	2.77	2.80
2.7	2.64	2.59	2.64	2.64	2.67	2.64	2.59	2.67	2.70
2.6	2.54	2.49	2.54	2.54	2.57	2.54	2.49	2.57	2.60
2.5	2.44	2.39	2.44	2.44	2.47	2.44	2.39	2.47	2.50

The calculation of the primary energy savings is performed by the following equation:

$$\text{PES}_{\text{kwh}} = FES_{kWh} * e_p$$

Where:

PES_{kWh}	Primary energy savings delivered by a heat pump [kWh]
e_p	Factor taking into account losses for energy extraction/production and transmission for the used fuels

Standardized calculation values

Table 15: Indicative values for calculation of primary energy savings (Article 3).

Type of used fuel	e_p
Industrial gas oil, diesel	1.10
Oil	1.10
Natural gas	1.10
LPG	1.10
Black coal	1.20
Lignite/Brown coal	1.20
Brown coal	1.20
Anthracite coal	1.20
Coal briquettes	1.25
Firewood, pellets	1.05
Heat from central heat supply system	1.30
Electricity	3.00
Lifetime of savings	**[a]**
Lifetime of savings	15

Methodological aspects

This methodology for assessing the delivered energy savings has been approved by order of the Minister of Energy and has been published by SEDA, which is a legal entity at state budget support and has the status of an executive agency within the Ministry of Energy.

Data sources for indicative calculation values:

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Energy (2022).

1.9.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.9.4 Calculation of CO_2 emission savings

The calculation of the CO_2 emission savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = {FES_{kWh} * f_r}/{10^6}$$

Where:

CO_2	CO_2 emission savings delivered by a heat pump [tCO_2/yr]
f_r	CO_2 emission factor for the used fuels

Standardized calculation values

Table 16: Indicative values for calculation of CO_2 emission savings.

Type of used fuel	f_i (tCO_2/GWh)
Industrial gas oil, diesel	267
Oil	279
Natural gas	202
LPG	227
Black coal	341
Lignite/Brown coal	364
Anthracite coal	354
Coal briquettes	351
Firewood, pellets	43
Heat from central heat supply system	290
Electricity	819

1.9.5 Bibliography

Ministry of Energy (2022). Methodology for estimating energy savings when installing an electric heat pump with a system for production of hot water for domestic use in existing installations, Methodology no 18.

https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwaniq-utwyrdeni-ot-me

1.10 Solar thermal systems for domestic hot water preparation in residential and service sector buildings - Croatia

This methodology provides a formula for estimating the unit annual energy savings resulting from the installation of solar thermal systems for the preparation and reheating of domestic hot water (DHW) in existing or new residential and service sector buildings.

Unit annual energy savings in direct consumption are calculated by dividing the average heat production per m^2 of solar collector area by the average efficiency of the DHW preparation system in the year of installation of the solar heating system.

The total annual energy savings in direct consumption are obtained by multiplying the unit annual energy savings by the total installed area of solar collectors in m^2.

Considered lifetime of measure is 20 years.

1.10.1 Calculation of impact on energy consumption (Article 3)

No calculation values available for this methodology

1.10.2 Calculation of final energy savings (Article 7)

The following formula is used to calculate the annual final energy savings:

$$UFES = \frac{USAVE}{\eta_{average}}$$

$$FES = \sum_{i=1}^{n} UFES_i \times A_i$$

Where:

UFES [kWh/(m²×a)]	Unit energy savings in direct consumption
USAVE [kWh/(m²×a)]	Average annual heat production per m2 of solar collector area
$\eta_{average}$	Efficiency of the existing domestic hot water (DHW) preparation system
FES [kWh/a]	Total annual energy savings in direct consumption
A [m2]	Total area of installed solar collectors

Standardized calculation values

In the absence of project-specific data, benchmarks should be used:

Table 17: Indicative values for calculation of final energy savings (Article 7).

		Flat-Plate Collectors	Vacuum Collector
USAVE [kWh/(m²×a)]	Coastal	700	840
	Continental	530	640
$\eta_{average}$	0.8*		

* For the calculation of savings, it is important with which source of thermal energy DHW is reheated in periods when solar energy is not sufficient to cover the needs for DHW preparation. These can be gas boilers of different types, oil boilers, biomass boilers or, for example, heat pumps with different degrees of operation. It is recommended to take an average seasonal rate of action of 80%.

Methodological aspects:

This is the official national methodology from the methods catalogue.

Data sources for indicative calculation values:

To calculate the savings, the required data are the total installed area of solar collectors and the performance of the solar collector (plate or vacuum).

Also, it is necessary to know the place in Croatia where solar collectors are installed to determine whether it is continental or coastal [63] (According to the Ordinance on energy audit of buildings and energy certification (OG 48/14)).

Table 18: Required data specific to each project

A	Surface of installed solar collectors	m^2	Real value
USAVE	Average annual heat production per m^2 of solar collector area	$kWh/(m^2 \times a)$	Real/baseline value
$\eta_{average}$	Efficiency of the existing domestic hot water (DHW) preparation system		Real/baseline value

1.10.3 Overview of costs related to the action

n.a.

1.10.4 Calculation of greenhouse gas savings

Annual reduction of greenhouse gas emissions:

$$E_{CO2} = FES \times e/1000$$

Where:

E_{CO2} [t CO_2/a]	Greenhouse gas savings
FES [kWh/a]	Total final energy savings
e [kg CO2/kWh]	Emission factor

If more than one energy source is used for heating, it is necessary to determine the emission factor according to the share of each energy source in the production of thermal energy.

If the data on the used fuel are not known, it is necessary to use the emission factor for natural gas.

1.10.5 Bibliography

Ministry of Environmental Protection and Energy, Rulebook on system for monitoring, measurement and verification of energy savings, NN 33/2020, 20.3.2020, https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

1.11 Heat pumps – Croatia

This methodology provides a formula for estimating annual energy savings resulting from the installation of a heat pump as a heat source. The methodology includes the calculation of energy savings resulting from the replacement of the existing heating system and the preparation of a domestic hot water (DHW) with a heat pump or a new installation of a heat pump.

The method is based on the assumption that the heat pump fully meets the thermal needs of the building for space heating and DHW preparation. If the heat pump is used only for heating or only for DHW preparation, the specific annual needs for other purposes are zero.

Lifetime of measures is:

- Air/air 10 years
- Air/water 15 years
- Ground/water 25 years

1.11.1 Calculation of impact on energy consumption (Article 3)

No calculation values available for this methodology

1.11.2 Calculation of final energy savings (Article 7)

In residential and service sector buildings, it is possible to define measures to increase the energy efficiency of heating systems and DHW preparation systems for the following three cases:

- new installation of heat pump for heating and DHW preparation (new buildings)
- replacement of the existing heating system and DHW preparation system with heat pump (replacement of equipment after the end of its life with heat pump)
- earlier replacement of the existing heating system and DHW preparation system with heat pump (forced replacement of equipment before the end of life with heat pump)

a) New installation of heat pump for heating and DHW preparation (new buildings)

In the case of new buildings, in the case of heat pump installation, the savings achieved can be determined by comparing the efficiency of the heating system and the preparation of DHW using a heat pump with the average heating system on the market.

Formulas for calculating energy savings in residential and service sector buildings resulting in the installation of heat pumps - new installation:

This formula calculates **yearly savings:**

$$UFES = \left(\frac{1}{\eta_{average}} - \frac{1}{SPF}\right) \times (SHD + SWD - \Delta E_{other)} \times A$$

$$FES = \sum_{i=1}^{n} UFESi$$

Where:

UFES [kWh/ (unit x a)]	Unit final energy savings
$\eta_{average}$	Efficiency of heating systems of average efficiency in the market
SPF	Seasonal efficiency factor or annual heat multiplier heat multiplier
SHD [kWh/(m2×a)	Specific annual thermal needs of the building

SWD [kWh/(m2×a)	Specific annual energy needs for domestic hot water (DHW) preparation
ΔE_{other} [kWh/(m2×a)]	Energy from other building systems (eg solar panels, biomass boilers, fossil fuel boilers)
A [m^2]	Usable area of the building
FES [kWh/a]	Total annual energy savings in direct consumption

b) Replacement of the existing heating system and DHW preparation system with heat pump (replacement of equipment after the end of its life with heat pump)

Energy savings are achieved by replacing the equipment of the existing heating system and DHW preparation system with a heat pump. In the case of calculating all energy savings, efficiency values related to the existing situation are used (before the implementation of the EnU measure), and in the case of calculating additional energy savings, the efficiency values of average efficiency equipment on the market are used.

Formulas for calculating energy savings resulting from the replacement of heating system and DHW preparation equipment in residential and service sector buildings at the end of the life of the heat pump equipment:

$$All\ energy\ savings: UFES = (\frac{1}{\eta_{init}} - \frac{1}{SPF}) \times (SHD + SWD - \Delta E_{other)} \times A$$

$$Extra\ energy\ savings: UFES = (\frac{1}{\eta_{average}} - \frac{1}{SPF}) \times (SHD + SWD - \Delta E_{other)} \times A$$

$$FES = \sum_{i=1}^{n} UFESi$$

Where:

UFES [kWh/ (unit x a)]	Unit final energy savings
η_{init}	Efficiency of the heating system before the implementation of the EnU measure
$\eta_{average}$	Efficiency of heating systems of average efficiency in the market
SPF	Seasonal efficiency factor or annual heat multiplier heat multiplier
SHD [kWh/(m2×a)	Specific annual thermal needs of the building
SWD [kWh/(m2×a)	Specific annual energy needs for domestic hot water (DHW) preparation
ΔE_{other} [kWh/(m2×a)]	Energy from other building systems (eg solar panels, biomass boilers, fossil fuel boilers)
A [m^2]	Usable area of the building
FES [kWh/a]	Total annual energy savings in direct consumption

c) **Earlier replacement of the existing heating system and DHW preparation system with heat pump (forced replacement of equipment before the end of life with the heat pump)**

$$All\ energy\ savings: UFES = (\frac{1}{\eta_{average}} - \frac{1}{SPF}) \times (SHD + SWD - \Delta E_{other)} \times A$$

$$Extra\ energy\ savings: UFES = (\frac{1}{\eta_{init}} - \frac{1}{SPF}) \times (SHD + SWD - \Delta E_{other)} \times A$$

$\longrightarrow$ *During lifetime of equipment*

$$Extra\ energy\ savings: UFES = (\frac{1}{\eta_{average}} - \frac{1}{SPF}) \times (SHD + SWD - \Delta E_{other)} \times$$

$\longrightarrow$ *After lifetime of equipment*

$$FES = \sum_{i=1}^{n} UFESi$$

Where:

UFES [kWh/ (unit x a)]	Unit final energy savings
η_{init}	Efficiency of the heating system before the implementation of the EnU measure
$\eta_{average}$	Efficiency of heating systems of average efficiency in the market
SPF	Seasonal efficiency factor or annual heat multiplier heat multiplier
SHD [kWh/(m2×a)	Specific annual thermal needs of the building
SWD [kWh/(m2×a)	Specific annual energy needs for domestic hot water (DHW) preparation
ΔE_{other} [kWh/(m2×a)]	Energy from other building systems (eg solar panels, biomass boilers, fossil fuel boilers)
A [m^2]	Usable area of the building
FES [kWh/a]	Total annual energy savings in direct consumption

Standardized calculation values

In the absence of project-specific data, benchmarks should be used:

Table 19: Indicative values for calculation of final energy savings (Article 7).

Baseline/indicative values		
SPF	Air – water	3.0
	Water – water	3.5
	Ground – water	4

SHD [kWh/m2]	160 for private household buildings 175 for service buildings	
SWD [kWh/m2]	**Private (household) buildings**	
	Less than three apartments	12.5
	More than three apartments	16.0
	Service buildings	
	Public like hospitals	3.5
	Commercial like sport	3.5
	Other	0.5
	Efficiencies	
η_{init}	0.595	
$\eta_{average}$	0.739	

Methodological aspects:

This is the official national methodology from the methods catalogue.

Data sources for indicative calculation values:

Attached to the catalogue.

1.11.3 Overview of costs related to the action

n.a.

1.11.4 Calculation of greenhouse gas savings

Formulas for calculating the annual reduction of greenhouse gas emissions:

<u>New installation of heat pump for heating and DHW preparation:</u>

$$E_{CO2} = \sum_{i=1}^{n} [(\frac{ep_{gas}}{\eta_{average}} - \frac{eel_{energy}}{SPF}) \times \frac{(SHD + SWD - \Delta E_{other}) \times A}{1000}]i$$

Replacement of the existing heating system and DHW preparation system with heat pump (replacement of equipment after the end of its life with heat pump) and Earlier replacement of the existing heating system and DHW preparation system with heat pump (forced replacement of equipment before the end of life with heat pump)

$$E_{CO2} = \sum_{i=1}^{n} [(\frac{ep_{gas}}{\eta_{init}} - \frac{eel_{energy}}{SPF}) \times \frac{(SHD + SWD - \Delta E_{other}) \times A}{1000}]i$$

$$E_{CO2} = \sum_{i=1}^{n} [(\frac{ep_{gas}}{\eta_{average}} - \frac{eel_{energy}}{SPF}) \times \frac{(SHD + SWD - \Delta E_{other}) \times A}{1000}]i$$

Where:

ECO2 [t CO2/a]	Greenhouse gas savings
e_{p_gas} [kg CO_2/kWh]	Emission factor of original energy source - natural gas
$E_{elenergy}$ [kg CO_2/kWh]	Emission factor for electricity

Table 20: Indicative values for calculation of greenhouse gas savings.

Factors	[kg CO_2/kWh]
Electricity	0.330
Gas	0.202

Data sources for indicative calculation values:

Attached to the catalogue.

1.11.5 Bibliography

Ministry of Environmental Protection and Energy, Rulebook on system for monitoring, measurement and verification of energy savings, NN 33/2020, 20.3.2020, https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

1.12 Domestic solar hot water systems– Cyprus

The current method refers to the installation of domestic solar hot water systems in residential buildings.

1.12.1 Calculation of impact on energy consumption (Article 3)

The following formula is used to calculate the annual primary energy savings:

$$\mathrm{TPES} = \mathrm{TSC} * \mathrm{AEG} * PEF_{electricity} * 277{,}78/n_{stock\_average\_heating\_system}$$

Where:

TPES	Annual primary energy savings [kWh/a]
TSC	Total area of the solar panels installed for a system [m²]
AEG	Annual energy generated [GJ/m²]
$n_{stock\_average\_heating\_system}$	Efficiency of the average stock water heaters or heating systems in the year when the solar heater was installed
$PEF_{electricity}$	Primary Energy Factor for electricity

Standardized calculation values

Table 21: Indicative values for calculation of impact on energy consumption (Article 3).

AEG	[GJ/m²]
In Households - 2005	2368

In Households - 2006	2368
In Households - 2007	2800
In Households - 2008	2800
$n_{stock\_average\_heating\_system}$	[a]
Value	1
$PEF_{electricity}$	
Value for the period 2011-2016	2.7

Methodological aspects:

This methodology was presented in the 4th National Energy Efficiency Action Plan of Cyprus, which was submitted in 2017.

The proposed methodology for the case of solar water heating in residential and tertiary buildings (equation 2.7) of the document 'Recommendations on measurement and verification methods in the framework of Directive 2006/32/EC on energy end use and energy services' was used in order to calculate the delivered energy savings.

Data sources for indicative calculation values:

The value about the annual energy generated (AEG parameter) was calculated taking into account the official statistics provided by Eurostat on solar hot water production systems.

Moreover, the proposed assumptions by the document 'Recommendations on measurement and verification methods in the framework of Directive 2006/32/EC on energy end use and energy services' were taken into consideration also.

1.12.2 Calculation of final energy savings (Article 7)

No information for the calculation of the final energy savings within the framework of Article 7 is provided.

1.12.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.12.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.12.5 Bibliography

MECIT (2017). 4th National Energy Efficiency Action Plan of Cyprus, page 228.

EU (2008). Recommendations on measurement and verification methods in the framework of Directive 2006/32/EC on energy end use and energy services, page 69.

1.13 Replacement of air conditioners, installation of new air conditioners and Replacement of VRVs and heat pumps– Cyprus

The current method refers to the replacement of air conditioners, the installation of new air conditioners and the replacement of VRVs and heat pumps.

1.13.1 Calculation of impact on energy consumption (Article 3)

The following formula is used to calculate the annual primary energy savings:

$$\text{TFES} = \left(\frac{1}{EER_{average}} - \frac{1}{EER_{best_{perf on_{market}}}}\right) * P_{fn} * n_k * \ PEF_{electricity}$$

$$\text{nk} = \ n_{sh} * f_u$$

Where:

TFES	Annual final energy savings [kWh/a]
$EER_{average}$	Seasonal energy efficiency ratio (supplied cooling power/electric power of the equipment) of the reference equipment
$EER_{best\_perf\_on\_market}$	Seasonal energy efficiency ratio (supplied cooling power/electric power of the equipment) of the high efficiency substituting equipment
P_{fn}	Nominal cooling power of the equipment [kW]
n_k	Annual operation hours at full power [h]
n_{sh}	Annual switch-on hours [h]
f_u	Part-load factor [%]
$PEF_{electricity}$	Primary Energy Factor for electricity

Standardized calculation values

Table 22: Indicative values for calculation of impact on energy consumption (Article 3).

Parameter	Value
$EER_{average}$ - Replacement of air conditioners	2.5
$EER_{average}$ - Installation of new air conditioners	2.7
$EER_{average}$ - Replacement of VRVs and heat pumps	2.0
n_{sh}	1400
f_u	58%

$PEF_{electricity}$	2.7
Lifetime of savings	[a]
Lifetime of savings	10

Methodological aspects:

This methodology was presented in the 4th National Energy Efficiency Action Plan of Cyprus, which was submitted in 2017.

The proposed methodology for the case of the installation or replacement of air conditioning split system (<12kW) in residential and tertiary buildings (equation 2.6) of the document 'Recommendations on measurement and verification methods in the framework of Directive 2006/32/EC on energy end use and energy services' was used in order to calculate the delivered energy savings.

Data sources for indicative calculation values:

The default value of 2.50, which was selected for the case of the $EER_{average}$ parameter, was specified in accordance to the software (ISBEM) employed for issuing energy efficiency certificates for buildings in Cyprus.

The data about the $EER_{best\_perf\_on\_market}$, P_{fn} and n_{sh} can be provided by the Cyprus Department of Electrical and Mechanical Services, which is responsible for the replacement of air conditioners and the implementation of the measure in question

Finally, the proposed assumptions by the document 'Recommendations on measurement and verification methods in the framework of Directive 2006/32/EC on energy end use and energy services' were taken into consideration also.

1.13.2 Calculation of final energy savings (Article 7)

No information for the calculation of the final energy savings within the framework of Article 7 is provided.

1.13.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.13.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.13.5 Bibliography

MECIT (2017). 4th National Energy Efficiency Action Plan of Cyprus, page 236.

EU (2008). Recommendations on measurement and verification methods in the framework of Directive 2006/32/EC on energy end use and energy services, page 71.

1.14 Calculating energy savings from heat pumps - Estonia

Estonia does not have an energy saving measures calculation catalogue, but are in the process of putting one together (the work on it will probably begin at the start of 2023).

This is a general calculation methodology which is used for energy savings forecast in National energy and climate plans (NECP).

This formula calculates **cumulative savings**.

$$TFES = (FEC_{before} - FEC_{after}) \times A \times Y = (FEC_{before} - FEC_{before}/COP) \times A \times Y$$

Where:

TFES	Total final energy savings [kWh]
FEC_{before}	Relative annual consumption of thermal energy from district heating [kWh/m²/y]
FEC_{after}	Relative annual consumption of thermal energy using heat pumps [kWh/m²/y]
COP	The coefficient of performance of heat pumps [times]
A	Area of heated rooms [m²]
Y	Duration of the measure implementation [years]

Table 23: Indicative values for calculation of final energy savings.

FEC_{before}	[kWh/m²/y]
Relative annual consumption of thermal energy from district heating	140
COP	[times]
The coefficient of performance of heat pumps *(Used in calculation of NECP).*	3,0

1.14.1 Bibliography

https://kliimamarket.ee/ohksoojuspumbad-ja-ohk-vesi-soojuspumbad-ohksoojuspumba-hind

1.15 Individual biomass boiler - France

The methodology is about energy savings for individual biomass boiler for household sector.

1.15.1 Calculation of impact on energy consumption (Article 3)

For article 3, national statistics are used in France to report energy consumption and no method is available for this specific subject.

1.15.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = (FEC_{before} \times \eta stock) \times (\frac{1}{\eta ib} - \frac{1}{\eta ref})$$

Where:

TFES	Total final energy savings [kWh/a]
FEC_{before}	The average final energy consumption before implementation of the action [kWh/a]
$\eta stock$	Overall yield on the stock
ηib	Overall yield on the installed boiler
ηref	Overall yield on on the reference market

Standardized calculation values

FECbefore and ηstock provided from statistical studies given the reference consumption for house

ηib is 83% in France

ηref is 75% due to ecodesign regulation reference for boilers with a power lower than 20kW

77% for boilers with a power greater than 20kW.

In France the calculation depends on climate area. There are three area. H1 for the north and East France, H2 for moderate climate and H3 for Mediterranean and hot climate.

Table 24: Indicative values for calculation of final energy savings (Article 7).

Climate area	Energy savings kWh Power of the biomass boiler <20kW	Energy savings kWh Power of the biomass boiler >20kW
H1	3550	2985
H2	2905	2442
H3	2259	1899

Climate area	TFES [kWh/a]
H1	3267
H2	2673
H3	2079

In France the energy savings targets and action are recorded in kWh cumac of final energy, cumac being the contraction of “cumulative and actualized”: KWc cumac= TFES X Dc

Table 25: Indicative values for calculation of energy savings certificates.

Lifetime of savings	[a]
Lifetime of savings	17

Dc : Discount coefficient (4%)	12,652

1.15.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.15.4 Calculation of greenhouse gas savings

No information for the calculation of greenhouse gas savings available.

1.15.5 Bibliography

« Opérations standardisées d'économies d'énergie ». Ministère de la Transition écologique, https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie. Accessed April 11, 2022.

BAR-TH-113 : Chaudière biomasse individuelle (PDF - 241.8 Ko)

1.16 Combined solar system - France

The methodology calculated the energy savings for an installation of a combined solar system for heating and the production of domestic hot water.

1.16.1 Calculation of impact on energy consumption (Article 3)

For article 3, national statistics are used in France to report energy consumption and no method is available for this specific subject.

1.16.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**.

$$TFES = (FEC_{heating} \times Crh) + (FEC_{hotwater} \times Crhw)$$

Where:

TFES	Total final energy savings [kWh/a]
$(FEC_{heating}$	Average final energy consumption for heating before implementation of the action [kWh/a]
Crh	Coverage rate for heating
$FEC_{hotwater}$	Average final energy consumption for hot water production before implementation of the action [kWh/a]
$Crhw$	Coverage rate for hot water

Standardized calculation values

Table 1: Indicative values for calculation of final energy savings (Article 7).

Climate area	Heating coverage rate	Hot water coverage rate
H1	40%	55%
H2	40%	65%
H3	40%	83%

Climate area	Energy savings for heating [kWh/a]	Energy savings for hot water [kWh/a]	Total [kWh/a]
H1	7280	2255	9535
H2	5960	2600	8560
H3	3960	3154	7114

Methodological aspects:

In France the energy savings targets and action are recorded in kWh cumac of final energy, cumac being the contraction of "cumulative and actualized": KWc cumac= TFES X Dc

Table 2: Indicative values for calculation of energy savings certificates.

Lifetime of savings	[a]
Lifetime of savings	20
Dc: Discount coefficient (4%)	14,134

Data sources for indicative calculation values:

Since 2010, French (SOLCOMBI2) or European (COMBISOL) programs have made it possible to measure the performance of combined solar system. The results show an average productivity of 450 to 500 kWh/m².year. The coverage rate for heating is evaluated at 40% regardless of the zone geographical. The coverage rate considered for hot water production provided from national energy consumption data depending on the geographical area.

In general, the surface of the collectors implemented in a combined solar system varies between 10 and 20 m², with an average of 11 m² per installation across all geographical areas.

1.16.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.16.4 Calculation of greenhouse gas savings

No information for the calculation of greenhouse gas savings available.

1.16.5 Bibliography

« Opérations standardisées d'économies d'énergie ». Ministère de la Transition écologique, https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie. Accessed April 12, 2022.

BAR-TH-143 : Système solaire combiné (France métropolitaine) (PDF - 88.27 Ko)

1.17 Domestic hot water production using solar thermal systems – Greece

This method refers to the production of domestic hot water in buildings of residential and tertiary sector.

For the baseline, the existing domestic hot water production system is based on the use of oil, gas, etc.

1.17.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.17.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = A * Q_{ave\_yield} * \frac{1}{\eta_{Ref}}$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
A	Installed collector surface [m²]
Q_{ave_yield}	Average yearly heat production per m² of installed collector surface [kWh/m²]
η_{Ref}	Efficiency of the existing Domestic Hot Water (DHW) production system

Standardized calculation values

Table 26: Indicative values for calculation of final energy savings (Article 7).

Parameter	Value
Q_{ave_yield}	520
η_{Ref}	99.7% for residential building sector and 87.1% for tertiary building sector
Lifetime of savings	**[a]**
Lifetime of savings	20

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

The value of the average yearly heat production per m² of installed collector surface (Q_{ave_yield} parameter) has been collected by the national energy balance and the value of the efficiency of the existing domestic hot water production system (η_{Ref}) has been derived by CRES tender (2015) deliverable 13.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.17.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.17.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.17.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU6, http://www.cres.gr/obs/yliko.html.

1.18 Replacement of heat pumps for space heating with new more efficient ones in buildings of residential sector - Greece

This method refers to the replacement of heat pumps for space heating with new more energy efficient ones in buildings of the residential sector. This method does not include the replacement of heat pumps using air as coolant for heating purposes with new more efficient ones.

For the baseline, the available heating systems in the market are taken into consideration in compliance with the Regulation 813/2013 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.18.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.18.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * (SHD + HWD) * \frac{1}{2{,}5} * \left(\frac{1}{n_{sh,Ref} + 3\%} - \frac{1}{n_{sh,Eff} + 3\%} \right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (tertiary/residential)
SHD	Average energy needed for space heating in a residential building prior to energy efficiency interventions [kWh]
HWD	Average energy needed for domestic hot water (DHW) in a residential building prior to energy efficiency interventions [kWh]
$n_{sh,Ref}$	Lowest energy efficiency for seasonal space heating based on Directive 2009/125/EK
$n_{sh,Eff}$	Energy efficiency of seasonal space heating as indicated on the energy label based on Energy labelling Directive
n	Number of buildings

Standardized calculation values

Table 27: Indicative values for calculation of final energy savings (Article 7).

SHD			[kWh]
Building type	Climatic zone	Construction year	Value
Detached dwellings	A	Before 1980	13,624
	A	1980-2010	7,384
	A	After 2010	5,970
	A	Weighted average	10,943
	B	Before 1980	15,836
	B	1980-2010	9,914
	B	After 2010	6,217
	B	Weighted average	13,228
	C	Before 1980	28,114
	C	1980-2010	18,658
	C	After 2010	13,163
	C	Weighted average	23,962
	D	Before 1980	31,008
	D	1980-2010	18,800
	D	After 2010	14,597
	D	Weighted average	25,679
Multifamily building	A	Before 1980	60,148
	A	1980-2010	33,754
	A	After 2010	26,999

	A	Weighted average	48,796
	B	Before 1980	91,308
	B	1980-2010	48,378
	B	After 2010	39,983
	B	Weighted average	72,681
	C	Before 1980	188,036
	C	1980-2010	100,025
	C	After 2010	85,225
	C	Weighted average	149,866
	D	Before 1980	166,106
	D	1980-2010	89,901
	D	After 2010	70,634
	D	Weighted average	132,948
HWD			[kWh]
Building type	Climatic zone	Construction year	Value
Detached dwellings	A	Before 1980	1,632
	A	1980-2010	1,632
	A	After 2010	358
	A	Weighted average	1,610
	B	Before 1980	1,741
	B	1980-2010	2,175
	B	After 2010	482
	B	Weighted average	1,902
	C	Before 1980	1,873
	C	1980-2010	2,339
	C	After 2010	581
	C	Weighted average	2,051
	D	Before 1980	2,000
	D	1980-2010	2,000
	D	After 2010	655
	D	Weighted average	1,980
Multifamily building	A	Before 1980	12,187
	A	1980-2010	12,187

	A	After 2010	3,712
	A	Weighted average	12,040
	B	Before 1980	17,042
	B	1980-2010	17,042
	B	After 2010	5,903
	B	Weighted average	16,874
	C	Before 1980	18,356
	C	1980-2010	18,356
	C	After 2010	7,657
	C	Weighted average	18,216
	D	Before 1980	14,919
	D	1980-2010	14,919
	D	After 2010	6,023
	D	Weighted average	14,785
$\eta_{sh,Ref}$			Value
Room space heaters with heat pump and room space heaters with combined operation with heat pump (55^{0}C) according to the minimum requirements of Regulation 813/2013			1.10
Low temperature heat pump (35^{0}C) according to the minimum requirements of Regulation 813/2013			1.25
Lifetime of savings			[a]
Lifetime of savings			10

Table 28: Division of the Greek territory into climatic zones by prefectures.

Climatic zone	Prefectures
A	Heraklio, Chania, Rethymno, Lassithi, Cyclades, Dodecanese, Samos, Messinia, Laconia, Argolida, Zakynthos, Kefallinia & Ithaca, Kythira & Saronic islands (Attica), Arcadia (lowland)
B	Attica (except of Kythira & Saronic islands), Corinth, Ilia, Achaia, Aitoloakarnania, Fthiotida, Fokida, Viotia, Evia, Magnesia, Lesvos, Chios, Corfu, Lefkada, Thesprotia, Preveza, Arta
C	Arcadia (mountainous), Evritania, Ioannina, Larissa, Karditsa, Trikala, Pieria, Imathia, Pella, Thessaloniki, Kilkis, Halkidiki, Serres (except of Northeast section), Kavala, Xanthi, Rodopi, Evros
D	Grevena, Kozani, Kastoria, Florina, Serres (Northeast section), Drama

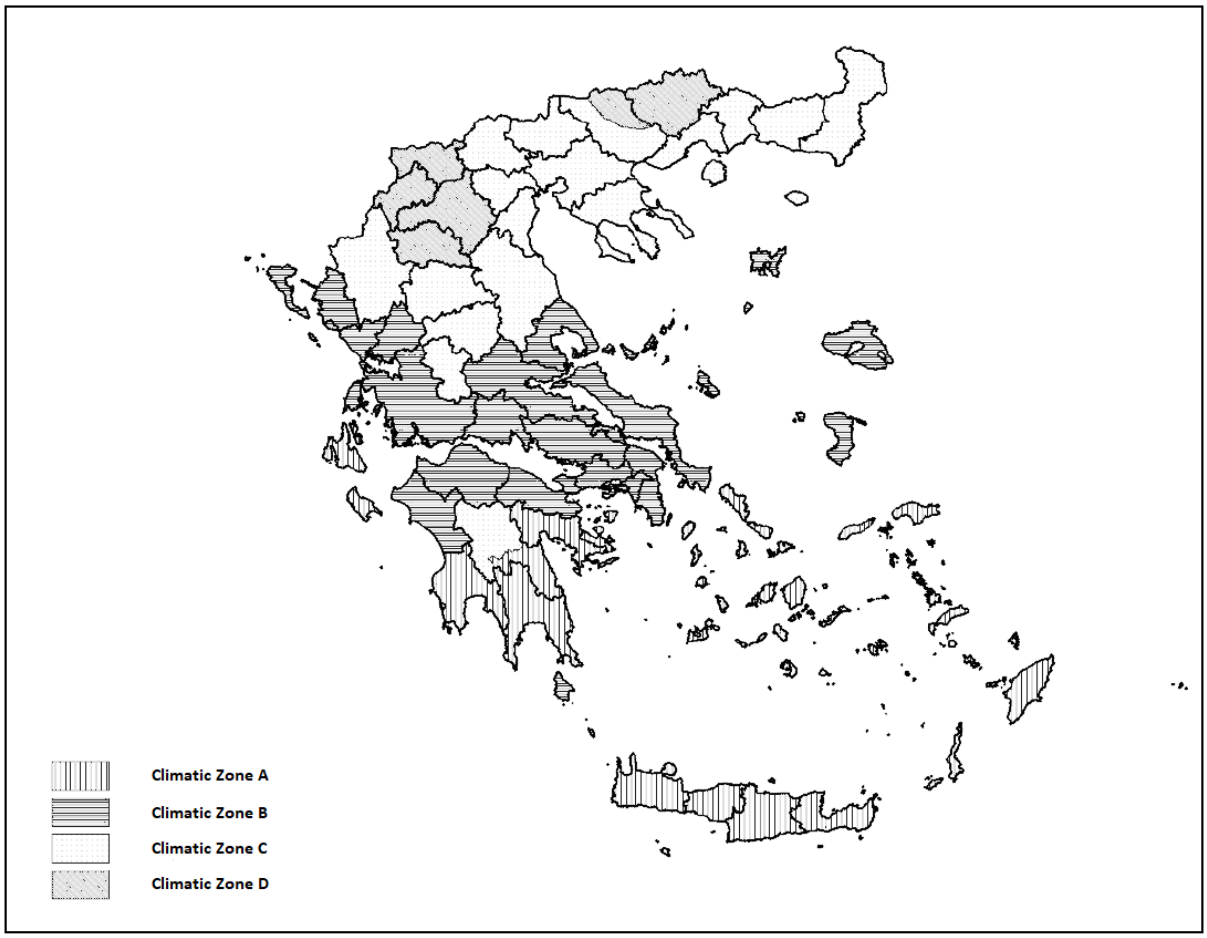

Figure 1: Schematic illustration of the climatic zones of the Greek territory.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $n_{sh,Eff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.18.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.18.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.18.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU19b, http://www.cres.gr/obs/yliko.html.$TFES = \sum_1^i n * (SHD + HWD) * \left(\frac{1}{n_{sh,Ref}} - \frac{1}{n_{sh,Eff}}\right)$

1.19 Energy up-grading of existing air-conditioning systems of up to 12 kW in buildings of residential sector – Greece

This method refers to the replacement of air-to-air air-conditioning systems/units (cooling) of up to 12 kW power output with new more efficient cooling systems (only in the case of split units) in residential buildings.

For the baseline, the available cooling systems in the market are taken into consideration in compliance with the Regulation 206/2012 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.19.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.19.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_1^i n * SCD * \left(\frac{1}{SEER_{Ref}} - \frac{1}{SEER_{Eff}}\right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (residential)
SCD	Average energy needed for space cooling in a residential building prior to energy efficiency interventions [kWh]
$SEER_{Ref}$	Lowest seasonal cooling efficiency ratio based on Directive 2009/125/EK
$SEER_{Eff}$	Seasonal efficiency of the new cooling system based on Energy Labelling Regulation

Standardized calculation values

Table 29: Indicative values for calculation of final energy savings (Article 7).

SCD			[kWh]
Building type	Climatic zone	Construction year	Value
Detached dwellings	A	Before 1980	3,700
	A	1980-2010	4,993
	A	After 2010	6,321
	A	Weighted average	10,404
	B	Before 1980	5,562
	B	1980-2010	6,267
	B	After 2010	8,328
	B	Weighted average	4,090
	C	Before 1980	2,964
	C	1980-2010	3,547
	C	After 2010	3,612
	C	Weighted average	3,416
	D	Before 1980	2,156
	D	1980-2010	2,756
	D	After 2010	2,882
	D	Weighted average	33,522
Multifamily building	A	Before 1980	19,930
	A	1980-2010	21,480
	A	After 2010	27,763
	A	Weighted average	61,464
	B	Before 1980	37,618
	B	1980-2010	35,686
	B	After 2010	51,159
	B	Weighted average	32,196
	C	Before 1980	20,487
	C	1980-2010	19,881
	C	After 2010	27,136
	C	Weighted average	17,465
	D	Before 1980	10,740

	D	1980-2010	12,324
	D	After 2010	14,588
	D	Weighted average	3,700
$SEER_{REf}$			Value
Air-to-air heat exchanger cooling system of less than 6 kW			4.3
Air-to-air heat exchanger cooling system of between 6 – 12 kW			4.1
Lifetime of savings			[a]
Lifetime of savings			15

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $SEER_{Eff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.19.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.19.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.19.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU20a-i, http://www.cres.gr/obs/yliko.html.

1.20 Energy up-grading of existing air-conditioning systems of up to 12 kW in buildings of tertiary sector – Greece

This method refers to the replacement of air-to-air air-conditioning systems/units (cooling) of up to 12 kW power output with new more efficient cooling systems/units (only in the case of split units) in tertiary buildings.

For the baseline, the available cooling systems in the market are taken into consideration in compliance with the Regulation 206/2012 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.20.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.20.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * SCD * \left(\frac{1}{SEER_{Ref}} - \frac{1}{SEER_{Eff}}\right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (residential)
SCD	Average energy needed for space cooling in a residential building prior to energy efficiency interventions [kWh]
$SEER_{Ref}$	Lowest seasonal cooling efficiency ratio based on Directive 2009/125/EK
$SEER_{Eff}$	Seasonal efficiency of the new cooling system based on Energy Labelling Regulation

Standardized calculation values

Table 30: Indicative values for calculation of final energy savings (Article 7).

SCD			[kWh/m²]
Building type	Climatic zone	Construction year	Value
Offices	A	Before 1980	61.2
	A	1980-2010	37.4
	A	After 2010	40.2
	A	Weighted average	49.0

	B	Before 1980	73.9
	B	1980-2010	48.9
	B	After 2010	46.0
	B	Weighted average	61.8
	C	Before 1980	36.3
	C	1980-2010	25.4
	C	After 2010	24.5
	C	Weighted average	31.1
	D	Before 1980	30.5
	D	1980-2010	21.9
	D	After 2010	21.6
	D	Weighted average	26.7
$SEER_{REf}$			Value
Air-to-air heat exchanger cooling system of less than 6 kW			4.3
Air-to-air heat exchanger cooling system of between 6 – 12 kW			4.1
Lifetime of savings			[a]
Lifetime of savings			17

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $SEER_{Eff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.20.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.20.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.20.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU20a-ii, http://www.cres.gr/obs/yliko.html.

1.21 Energy up-grading of existing cooling systems in buildings of residential sector – Greece

This method refers to the replacement of air-conditioning system/ units with new energy efficient ones in residential buildings.

For the baseline, the available cooling systems in the market are taken into consideration in compliance with the Regulation 2281/2012 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.21.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.21.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * SCD * \frac{1}{2,5} * \left(\frac{1}{\eta s, c_{Ref} + 3\%} - \frac{1}{\eta s, c_{Eff} + 3\%}\right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (residential)
SCD	Average energy needed for space cooling in a residential building prior to energy efficiency interventions [kWh]
$\eta_{s,cRef}$	Lowest seasonal space cooling efficiency based on Directive 2009/125/EK
$\eta_{s,cEff}$	Energy efficiency of seasonal space cooling based on Energy Labeling regulation
n	Number of buildings

Standardized calculation values

Table 31: Indicative values for calculation of final energy savings (Article 7).

SCD			[kWh]
Building type	Climatic zone	Construction year	Value
Detached dwellings	A	Before 1980	3,700
	A	1980-2010	4,993
	A	After 2010	6,321
	A	Weighted average	10,404
	B	Before 1980	5,562
	B	1980-2010	6,267
	B	After 2010	8,328
	B	Weighted average	4,090
	C	Before 1980	2,964
	C	1980-2010	3,547
	C	After 2010	3,612
	C	Weighted average	3,416
	D	Before 1980	2,156
	D	1980-2010	2,756
	D	After 2010	2,882
	D	Weighted average	33,522
Multifamily building	A	Before 1980	19,930
	A	1980-2010	21,480
	A	After 2010	27,763
	A	Weighted average	61,464
	B	Before 1980	37,618
	B	1980-2010	35,686
	B	After 2010	51,159
	B	Weighted average	32,196
	C	Before 1980	20,487
	C	1980-2010	19,881
	C	After 2010	27,136
	C	Weighted average	17,465
	D	Before 1980	10,740

	D	1980-2010	12,324
	D	After 2010	14,588
	D	Weighted average	3,700
$SEER_{REf}$			Value
Air to water cooler with rated output power <400 kW when having electric motor drive			149
Air to water cooler with rated output power >=400 kW when having electric motor drive			161
Water to water cooler with rated output power <400 kW when having electric motor drive			196
Water to water cooler with rated output power >=400 kW and <1,500 kW when having electric motor drive			227
Water to water cooler with rated output power >=1,500 kW when having electric motor drive			245
Air to air air-containing driven by electric motors with the exception of rooftop air-conditioning			181
Rooftop air-conditioning			117
Lifetime of savings			[a]
Lifetime of savings			15

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $\eta_{s,cEff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.21.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.21.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.21.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU20b-i, http://www.cres.gr/obs/yliko.html.

1.22 Energy up-grading of existing cooling systems in buildings of tertiary sector – Greece

This method refers to the replacement of air-conditioning system/ units with new energy efficient ones in tertiary sector buildings.

For the baseline, the available cooling systems in the market are taken into consideration in compliance with the Regulation 2281/2012 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.22.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.22.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * A * SHD * \frac{1}{2,5} * \left(\frac{1}{\eta s, h_{Ref} + 3\%} - \frac{1}{\eta s, h_{Eff} + 3\%}\right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (tertiary)
SCD	Average energy needed for space cooling in office buildings of the tertiary sector prior to energy efficiency interventions [kWh/m2]
A	Cooled space surface area of each renovated building [m2]
$\eta_{s,cRef}$	Lowest seasonal space cooling efficiency based on Directive 2009/125/EK
$\eta_{s,cEff}$	Energy efficiency of seasonal space cooling based on Energy Labeling Regulation.
n	Number of buildings

Standardized calculation values

Table 32: Indicative values for calculation of final energy savings (Article 7).

SCD			[kWh/m²]
Building type	Climatic zone	Construction year	Value
Offices	A	Before 1980	61.2
	A	1980-2010	37.4
	A	After 2010	40.2
	A	Weighted average	49.0
	B	Before 1980	73.9
	B	1980-2010	48.9
	B	After 2010	46.0
	B	Weighted average	61.8
	C	Before 1980	36.3
	C	1980-2010	25.4
	C	After 2010	24.5
	C	Weighted average	31.1
	D	Before 1980	30.5
	D	1980-2010	21.9
	D	After 2010	21.6
	D	Weighted average	26.7
$\eta_{s,cRef}$			Value
Air to water cooler with rated output power <400 kW when having electric motor drive			149
Air to water cooler with rated output power >=400 kW when having electric motor drive			161
Water to water cooler with rated output power <400 kW when having electric motor drive			196
Water to water cooler with rated output power >=400 kW and <1,500 kW when having electric motor drive			227
Water to water cooler with rated output power >=1,500 kW when having electric motor drive			245
Air to air air-containing driven by electric motors with the exception of rooftop air-conditioning			181
Rooftop air-conditioning			117
Lifetime of savings			[a]
Lifetime of savings			17

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $\eta_{s,cEff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.22.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.22.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.22.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU20b-ii, http://www.cres.gr/obs/yliko.html.

1.23 Energy up-grading of existing heating systems of up to 12 kW in buildings of residential sector– Greece

This method refers to the replacement of air to air heating systems of up to 12 kW power output with new more efficient systems (only in the case of split units) in residential buildings.

For the baseline, the available heating systems in the market are taken into consideration in compliance with the Regulation 206/2013 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.23.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.23.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * SHD * (\frac{1}{SCOP_{Ref}} - \frac{1}{SCOP_{Eff}})$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (residential)
SHD	Average energy needed for space heating in residential buildings prior to energy efficiency interventions [kWh]
$SCOP_{Ref}$	Lowest seasonal performance factor based on Directive 2009/125/EK.
$SCOP_{Eff}$	Most efficient seasonal performance factor based on Energy label Regulation
n	Number of buildings

Standardized calculation values

Table 33: Indicative values for calculation of final energy savings (Article 7).

SHD			[kWh]
Building type	Climatic zone	Construction year	Value
Detached dwellings	A	Before 1980	13,624
	A	1980-2010	7,384
	A	After 2010	5,970
	A	Weighted average	10,943
	B	Before 1980	15,836
	B	1980-2010	9,914
	B	After 2010	6,217
	B	Weighted average	13,228
	C	Before 1980	28,114
	C	1980-2010	18,658
	C	After 2010	13,163
	C	Weighted average	23,962
	D	Before 1980	31,008
	D	1980-2010	18,800
	D	After 2010	14,597
	D	Weighted average	25,679
	A	Before 1980	60,148

Multifamily building	A	1980-2010	33,754
	A	After 2010	26,999
	A	Weighted average	48,796
	B	Before 1980	91,308
	B	1980-2010	48,378
	B	After 2010	39,983
	B	Weighted average	72,681
	C	Before 1980	188,036
	C	1980-2010	100,025
	C	After 2010	85,225
	C	Weighted average	149,866
	D	Before 1980	166,106
	D	1980-2010	89,901
	D	After 2010	70,634
	D	Weighted average	132,948
$SCOP_{Ref}$			Value
Reference system			3.6
Lifetime of savings			[a]
Lifetime of savings			15

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $SCOP_{Eff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.23.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.23.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.23.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU21a-i, http://www.cres.gr/obs/yliko.html.

1.24 Energy up-grading of existing heating systems of up to 12 kW in buildings of tertiary sector – Greece

This method refers to the replacement of air-to-air heating systems of up to 12 kW power output with new more efficient systems (only in the case of split units) in buildings of the tertiary sector.

For the baseline, the available heating systems in the market are taken into consideration in compliance with the Regulation 206/2013 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.24.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.24.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * A * SHD * \left(\frac{1}{SCOP_{Ref}} - \frac{1}{SCOP_{Eff}}\right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (residential)
SHD	Average energy needed for space heating in office buildings of tertiary sector prior to energy efficiency interventions [kWh/m^2]
A	Heated surface area of each of the renovated building [m^2]
$SCOP_{Ref}$	Lowest seasonal performance factor based on Directive 2009/125/EK.
$SCOP_{Eff}$	Most efficient seasonal performance factor based on Energy label Regulation
n	Number of buildings

Standardized calculation values

Table 34: Indicative values for calculation of final energy savings (Article 7).

SHD			[kWh/m²]
Building type	Climatic zone	Construction year	Value
Offices	A	Before 1980	17.8
	A	1980-2010	9.3
	A	After 2010	3.9
	A	Weighted average	13.4
	B	Before 1980	20.3
	B	1980-2010	7.6
	B	After 2010	4.4
	B	Weighted average	14.1
	C	Before 1980	57.9
	C	1980-2010	27.7
	C	After 2010	18.4
	C	Weighted average	43.4
	D	Before 1980	76.7
	D	1980-2010	38.3
	D	After 2010	25.2
	D	Weighted average	59.5
$SCOP_{Ref}$			Value
Reference system			3.6
Lifetime of savings			[a]
Lifetime of savings			17

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $SCOP_{Eff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.24.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.24.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.24.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU21a-ii, http://www.cres.gr/obs/yliko.html.

1.25 Energy up-grading of existing air-heating systems in buildings of residential sector – Greece

This method refers to the replacement of air-heating systems with new more efficient systems in residential buildings.

For the baseline, the available heating systems in the market are taken into consideration in compliance with the Regulation 2281/2013 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.25.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.25.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * SHD * \frac{1}{2{,}5} * \left(\frac{1}{\eta s, h_{Ref} + 3\%} - \frac{1}{\eta s, h_{Eff} + 3\%}\right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (residential)
SHD	Average energy needed for space heating in residential sector buildings prior to energy efficiency interventions [kWh]

$\eta_{s,hRef}$	Lowest seasonal space cooling efficiency based on Directive 2009/125/EK
$\eta_{s,hEff}$	Energy efficiency of seasonal space cooling efficiency based on Directive 2009/125/EK
n	Number of buildings

Standardized calculation values

Table 35: Indicative values for calculation of final energy savings (Article 7).

SHD			[kWh]
Building type	Climatic zone	Construction year	Value
Detached dwellings	A	Before 1980	13,624
	A	1980-2010	7,384
	A	After 2010	5,970
	A	Weighted average	10,943
	B	Before 1980	15,836
	B	1980-2010	9,914
	B	After 2010	6,217
	B	Weighted average	13,228
	C	Before 1980	28,114
	C	1980-2010	18,658
	C	After 2010	13,163
	C	Weighted average	23,962
	D	Before 1980	31,008
	D	1980-2010	18,800
	D	After 2010	14,597
	D	Weighted average	25,679
Multifamily building	A	Before 1980	60,148
	A	1980-2010	33,754
	A	After 2010	26,999
	A	Weighted average	48,796
	B	Before 1980	91,308
	B	1980-2010	48,378
	B	After 2010	39,983
	B	Weighted average	72,681
	C	Before 1980	188,036

	C	1980-2010	100,025
	C	After 2010	85,225
	C	Weighted average	149,866
	D	Before 1980	166,106
	D	1980-2010	89,901
	D	After 2010	70,634
	D	Weighted average	132,948
$\eta s,h_{Ref}$			Value
Air to water heat pumps driven by electric motor, except rooftop heat pumps			133
Rooftop heat pumps			115
Air to air heat pumps driven by internal combustion engine			120
Lifetime of savings			[a]
Lifetime of savings			15

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $\eta s,h_{Eff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.25.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.25.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.25.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU21b-i, http://www.cres.gr/obs/yliko.html.

1.26 Energy up-grading of existing air-heating systems in office buildings of tertiary sector – Greece

This method refers to those air-heating systems that do cover the replacement of existing water heat pumps for heating purposes. On the contrary, this method regards the replacement of air-heating systems with more efficient ones in office buildings of the tertiary sector.

For the baseline, the available heating systems in the market are taken into consideration in compliance with the Regulation 2281/2013 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.26.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.26.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * A * SHD * \frac{1}{2,5} * \left(\frac{1}{\eta s, h_{Ref} + 3\%} - \frac{1}{\eta s, h_{Eff} + 3\%}\right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (offices/tertiary)
SHD	Average energy needed for space heating in office buildings of tertiary sector prior to energy efficiency interventions [kWh/m2]
A	Heated surface area of each renovated building [m2]
$\eta_{s,hRef}$	Lowest seasonal space cooling efficiency based on Directive 2009/125/EK
$\eta_{s,hEff}$	Energy efficiency of seasonal space cooling efficiency based on Directive 2009/125/EK
n	Number of buildings

Standardized calculation values

Table 36: Indicative values for calculation of final energy savings (Article 7).

SHD			[kWh/m²]
Building type	Climatic zone	Construction year	Value
Offices	A	Before 1980	17.8

	A	1980-2010	9.3
	A	After 2010	3.9
	A	Weighted average	13.4
	B	Before 1980	20.3
	B	1980-2010	7.6
	B	After 2010	4.4
	B	Weighted average	14.1
	C	Before 1980	57.9
	C	1980-2010	27.7
	C	After 2010	18.4
	C	Weighted average	43.4
	D	Before 1980	76.7
	D	1980-2010	38.3
	D	After 2010	25.2
	D	Weighted average	59.5
$\eta s,h_{Ref}$			Value
Air to water heat pumps driven by electric motor, except rooftop heat pumps			133
Rooftop heat pumps			115
Air to air heat pumps driven by internal combustion engine			120
Lifetime of savings			[a]
Lifetime of savings			17

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $\eta s,h_{Eff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.26.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.26.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.26.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU21b-ii, http://www.cres.gr/obs/yliko.html.

1.27 Energy up-grading of existing air-heating systems in office buildings of tertiary sector – Greece

This method refers to the replacement of conventional heating systems with new more efficient ones in office buildings of the tertiary sector including the substitution of fossil fuels (e.g., with natural gas biomass, district heating, etc.).

For the baseline, the available heating systems in the market are taken into consideration in compliance with the Regulation 813/2013 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.27.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.27.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * A * SHD * \left(\frac{1}{n_{sh,Ref}} - \frac{1}{n_{sh,Eff}}\right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (offices/tertiary)
SHD	Average energy needed for space heating in office buildings of tertiary sector prior to energy efficiency interventions [kWh/m2]
A	Heated surface area of each renovated building [m2]

$\eta_{s,hRef}$	Lowest seasonal space heating efficiency based on Directive 2009/125/EK
$\eta_{s,hEff}$	Energy efficiency of seasonal space heating efficiency based on Directive 2009/125/EK
n	Number of buildings

Standardized calculation values

Table 37: Indicative values for calculation of final energy savings (Article 7).

SHD			[kWh/m²]
Building type	**Climatic zone**	**Construction year**	**Value**
Offices	A	Before 1980	17.8
	A	1980-2010	9.3
	A	After 2010	3.9
	A	Weighted average	13.4
	B	Before 1980	20.3
	B	1980-2010	7.6
	B	After 2010	4.4
	B	Weighted average	14.1
	C	Before 1980	57.9
	C	1980-2010	27.7
	C	After 2010	18.4
	C	Weighted average	43.4
	D	Before 1980	76.7
	D	1980-2010	38.3
	D	After 2010	25.2
	D	Weighted average	59.5
$\eta_{s,hRef}$			Value
Room space heaters fired by oil having rated thermal input less than 400 kW according to minimum requirements of Regulation 813/2013			86%
Lifetime of savings			[a]
Lifetime of savings			17

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and

verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $\eta s,h_{Eff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.27.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.27.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.27.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU22a, http://www.cres.gr/obs/yliko.html.

1.28 Replacement of heat pumps for water heating for space heating with new more efficient ones in office buildings of tertiary sector – Greece

This particular method refers to the replacement of heat pumps for heating purposes with new more efficient ones in office buildings of tertiary sector. This method does not include the replacement of those heat pumps using air for heating purposes with new ones.

For the baseline, the available heating systems in the market are taken into consideration in compliance with the Regulation 813/2013 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

1.28.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

1.28.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * A * SHD * \frac{1}{2,5} * \left(\frac{1}{n_{sh,Ref} + 3\%} - \frac{1}{n_{sh,Eff} + 3\%} \right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]
i	Building category (offices/tertiary)
SHD	Average energy needed for space heating in office buildings of tertiary sector prior to energy efficiency interventions [kWh/m2]
A	Heated surface area of each renovated building [m2]
$\eta_{s,hRef}$	Lowest seasonal space cooling efficiency based on Directive 2009/125/EK
$\eta_{s,hEff}$	Energy efficiency of seasonal space cooling efficiency based on Directive 2009/125/EK
n	Number of buildings

Standardized calculation values

Table 38: Indicative values for calculation of final energy savings (Article 7).

SHD			[kWh/m²]
Building type	Climatic zone	Construction year	Value
Offices	A	Before 1980	17.8
	A	1980-2010	9.3
	A	After 2010	3.9
	A	Weighted average	13.4
	B	Before 1980	20.3
	B	1980-2010	7.6
	B	After 2010	4.4
	B	Weighted average	14.1
	C	Before 1980	57.9
	C	1980-2010	27.7
	C	After 2010	18.4
	C	Weighted average	43.4
	D	Before 1980	76.7
	D	1980-2010	38.3
	D	After 2010	25.2

	D	Weighted average	59.5
ηs,h$_{Ref}$			Value
Room space heaters with heat pump and room space heaters with combined operation with heat pump (55 ^{0}C) according to minimum requirements of Regulation 813/2013			1.10
Low temperature heat pumps (35 ^{0}C) according to minimum requirements of Regulation 813/2013			1.25
Lifetime of savings			[a]
Lifetime of savings			17

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for ηs,h$_{Eff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

1.28.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

1.28.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

1.28.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU22b, http://www.cres.gr/obs/yliko.html.

1.29 Replacement of gas boiler with heat pump – Hungary

Energy efficiency improvement measure where a heat pump heating system is installed to replace the previous gas-fired heat generation system for heating or for heating and domestic hot water. The type of heat generator replaced can be either a conventional or a condensing gas boiler. For heat pump heating systems, a low-temperature heat dissipation

side shall be provided. The measure can only be implemented in thermally upgraded SFHs and CDs.

A building is considered to be thermally upgraded if the building has been brought into use within 10 years of the start of the measure or at least two of the following three measures have been implemented in the last 10 years before the heating system was replaced:

- Thermal insulation of the end slab
- Insulation of external walls
- Window replacement

Energy calculations must be carried out on the basis of an audit.

1.29.1 Calculation of impact on energy consumption (Article 3)

There is no information on primary energy consumption.

1.29.2 Calculation of final energy savings (Article 7)

The calculation of the final energy savings of the measure should take into account the expected lifetime of the replaced/old gas boiler.

- If the old gas boiler that has been replaced has not yet reached the end of its expected average life, the measure is considered as an early exchange in the following cases:
  - installation of a heat pump to replace a gas boiler not older than 20 years (< 30 kW)
  - installation of a heat pump to replace a gas boiler not older than 25 years (> 30 kW)

  The calculation shall be performed according to the formula below.
- For the period beyond the expected lifetime of the old gas boiler to be replaced, the additional energy savings eligible for calculation are the difference between the energy consumption of the new installation and the reference energy consumption that meets the minimum ecodesign requirements. The calculation shall be performed according to the second formula below

Annual energy savings over the expected lifetime of the replaced equipment

The calculations should be done for the classification type (n) of the building(s) separately, and then summing up the sub-savings.

$$\Delta E_{early/year} = \sum_{i=1}^{n} A_{N,i} \cdot \left(k_{rep} - \frac{SCOP_{ref}}{SCOP_{new}} \cdot k_{ref}\right) \cdot (q_F + q_{DHW}) \cdot \frac{3.6}{1000}, [\frac{GJ}{y}]$$

Where

n = number of building classification types

A_N = heated floor area of building [m2]

k_{rep} = energy efficiency factor of the building before replacement of the heat generating equipment according to Table 2.8.5.4

k_{ref} = energy efficiency factor of the building with the reference (minimum requirement) heat pump

$SCOP_{ref}$ = SCOP value of the reference (minimum requirement) heat pump

$SCOP_{new}$ = SCOP value of the new heat pump installed (seasonal coefficient of performance)

q_F = specific net annual energy demand for heating [kWh/m2 , a]

q_{DHW} = specific net annual energy demand for domestic hot water production [kWh/m2 , a]

Annual additional energy savings beyond the expected lifetime of the replaced equipment

The calculations should be done for the building(s) classification type(s) (n) separately and then summing up the sub-savings.

$$\Delta E_{additional/year} = \sum_{i=1}^{n} A_{N,i} \cdot \left(k_{ref} - \frac{SCOP_{ref}}{SCOP_{new}}\right) \cdot (q_F + q_{DHW}) \cdot \frac{3.6}{1000}, [\frac{GJ}{y}]$$

where

n = number of building classification types according to 2.8.2

A_N = heated floor area of building [m2]

k_{ref} = energy efficiency factor of the building with the reference (minimum requirement) heat pump,

$SCOP_{ref}$ = SCOP of heat pump meeting the minimum requirement

$SCOP_{new}$ = SCOP of new heat pump (seasonal coefficient of performance)

q_F = specific net annual energy demand for heating, [kWh/m2 , a]

q_{DHW} = specific net annual energy demand for domestic hot water production [kWh/m2 , a]

This formula calculates cumulative savings.

Standardized calculation values

The calculation of savings is based on the database of energy certificates registered in Hungary. The energy efficiency factors applied to old/replaced gas boilers (k_{rep}) and to the minimum reference value for new heat pumps (k_{ref}), as well as the specific net annual energy demand that can be statistically taken into account for each building type, are presented in the table below.

Table 39: Energy efficiency factors and specific net annual energy demand used in the calculation methodology

Data for a thermally upgraded building		SFH	CD < 10 dwellings	CD > 10 dwellings
q_F	kWh/m² ,a	51	40	30
q_{DHW}	kWh/m² ,a	27,5		
krep	cond. gas boiler system	1,11	1,22	1,24
krep	old gas boiler system	1,39	1,41	1,43
kref	air-to-air heat pump system reference value	0,32	0,39	0,4
	low temperature (air-to-water) heat pump system reference value	0,352	0,42	0,44

	medium temperature (air-to-water) heat pump system reference value	0,4	0,48	0,49

If only the heating system is affected by the replacement of the boiler heat pump, the value q_{DHW} =0 should be used in the calculation.

Methodological aspects:

The parameters of the gas boiler, heat pump and building subject to the measure shall be recorded according to the following table:

A	B	C	D
Line number	Technical data	Replaced/old gas boiler	New heat pump
1	Manufacturer		
2	Type		
3	Date of commissioning of the replaced gas boiler	only early in case of replacement	-
4	$SCOP_{new}$ = COP of installed new heat pump for seasonal heating	-	
5	Classification category of building		
6	n = number of building types		
7	I = number of housing units		
8	A_N = heated floor area of building$[m^2]$		

Regarding the lifetime of the measure, there are the following indicative values:

- for air-to-air heat pumps: 10 years;
- for air-to-water heat pumps: 15 years;
- for ground source heat or ground source water heat pumps: 25 years.

The life expectancy of the natural gas heating system replaced in the energy efficiency improvement measure, is based on the following recommendation:

- for gas boilers (< 30 kW): 20 years
- for gas boilers (> 30 kW): 25 years

The reduction in the impact of the measure is calculated based on the rate of deterioration per year. The degradation value of heat pumps is set out in point 16 of Annex I to 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 heaters, refrigerating appliances, high-temperature process chillers and fan coil units [hereinafter Commission Regulation (EU) 2016/2281] and in Annex I to Commission Regulation (EU) No 813/2013:

- air-to-air for a new heat pump with integrated heat pump 0,25 [% /year]
- for all other new heat pumps installed 0,9 [% /year]

Reference values for the efficiency are correspondent to the minimum energy performance requirement. When using heat pumps, the seasonal space heating efficiency (ηs,ref) should not be reduced according to Commission Regulation (EU) No 813/2013, as follows:

- below 125% for low temperature heat pumps,
- below 110% for medium temperature heat pumps.

According to Annex I of Commission Regulation (EU) No 813/2013, 'low-temperature use' means a use in which the heat-pumped space heating system provides its rated heating output at an indoor heat exchanger outlet temperature of 35°C. The 'medium temperature use' means a use in which the heat pump space heater or heat pump combination heater provides its rated heating output at an indoor heat exchanger outlet temperature of 55°C.

According to Annex II, point 1(b) of Commission Regulation (EU) 2016/2281, the minimum seasonal space heating efficiency for electrically driven air-to-air heat pumps is 137%.

The methodology follows the EU minimum requirements for the seasonal coefficient of performance ($SCOP_{ref}$) of heat pumps:

- for low temperature heat pumps: SCOPref = ηs,ref • CC = 1,25 • 2,5 = 3,13
- for medium temperature heat pumps: SCOPref = ηs,ref • CC = 1.10 • 2.5 = 2.75
- for electric motor driven air-to-air heat pumps: $SCOP_{ref} = \eta_{s,ref}$ • CC = 1, 37 • 2,5 = 3,43

where

$\eta_{s,ref}$ = reference seasonal space heating efficiency meeting the minimum energy efficiency requirement

CC = 'conversion coefficient', as defined in Annex IV to Directive 2012/27/EU of the European Parliament and of the Council of 25 October 2012 on energy efficiency (1), reflecting an average estimated EU energy production efficiency of 40%, with CC = 2.5

The seasonal heating efficiency of building types are based on the energy performance certificate database, as follows:

- average seasonal heating efficiency of a detached house: η_s =1.1
- apartment building with <10 apartments; average seasonal heating efficiency: η_s =1.32
- condominium >10 apartments; average seasonal heating efficiency: η_s =1.36

Interpretation of the minimum energy efficiency factor (k_{ref}):

$$k_{ref} = \frac{E_{elec}}{q_F + q_{DHW}} = \eta_s / SCOP_{ref}$$

where:

E_{elec} = the actual specific electricity demand of the building for heating and DHW production, (specific annual final electricity consumption) [(kWh/m2/a]

q_F = specific net annual energy demand for heating[(kWh/m2 /a]

q_{DHW} = Specific net annual energy demand for DHW production [kWh/m2/a]

η_s = average seasonal space heating efficiency of the building type

$SCOP_{ref}$ = EU minimum requirement for the seasonal coefficient of performance of the heat pump

These are the documents needed to prove the final eligible energy savings:

- document certifying the manufacturer and type of the replaced/old gas boiler (in case of early replacement),
- the date of installation and year of manufacture of the replaced gas boiler (in case of early replacement),
- a document certifying the manufacturer and type of heat pump installed,
- a document certifying the seasonal coefficient of performance ($SCOP_{new}$) of the installed heat pump,
- documents (e.g. deed of incorporation, joint representative, owner's declaration) certifying the type of building classification (SFH; CD), the number of building classification types (n), the number of dwelling units (l),
- document certifying the heated floor area of the building [m2],
- a document certifying the commissioning of the heat pump (in particular the commissioning report),
- Calculated final energy savings [GJ/year].

The starting date for the eligibility of the measure is the day following the successful trial run or the date of activation of the investment.

Data sources for indicative calculation values

The source for the indicative values is available in the 17/2020. (XII. 21.) MEKH decree on the provision of data on end-use energy savings, available online: https://njt.hu/jogszabaly/2020-17-20-5Z.4

1.29.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.29.4 Calculation of greenhouse gas savings

No information on cost GHG savings available for this methodology

1.29.5 Bibliography

17/2020. (XII. 21.) MEKH decree on the provision of data on end - use energy savings, available online: https://njt.hu/jogszabaly/2020-17-20-5Z.4

1.30 Support for domestic hot water supply with solar collectors – Hungary

The installation of a DHW supply system supported by a solar thermal system can be counted as an energy saving measure. The measure can be applied to office, accommodation, residential, commercial, industrial and educational buildings on the basis of the normative demand for DHW consumption, and for industrial showers and industrial kitchens on the basis of the individually calculated normative demand for DHW consumption.

The theoretical fraction of the DHW heat demand that can be produced by solar collectors is fixed at 70% of the annual calculated DHW heat demand. If a feasible solar collector system cannot provide this proportion due to lack of available space, the calculation of the normative final energy savings presented herein shall not apply.

For conditions other than the above, an individual audit is required to calculate the final energy savings

1.30.1 Calculation of impact on energy consumption (Article 3)

There is no information on primary energy consumption

1.30.2 Calculation of final energy savings (Article 7)

The reference efficiency of the DHW heat generation according to the requirements of the eco-design ($\eta_{DHW,ref}$) should be selected according to the annual heat demand of the DHW (QDEMAND/year).

$$\frac{Q_{DEMAND}}{year} = \frac{Q_{DHW}}{year} /70\% \ /H_{corr} \ [kWh]$$

where:

Q_{DHW}/year = fraction of DHW heat demand that can be produced by solar collectors

70% = theoretical fraction of DHW heat demand that can be produced by solar collectors

H_{corr} = Solar heat recovery correction factor based on the classification type of the building using solar thermal energy *[kWh/year]*

Q_{DHW}/year = fraction of DHW heat demand that can be produced by solar collectors kWh/year]

$$\frac{Q_{DHW}}{year} = (Z_{\frac{person}{year}} \cdot Q_{DHW,shower} + K_{\frac{portion}{year}} \cdot Q_{DHW,kitchen} + A_{bldng} \cdot Q_{DHW,bldng}) \cdot H_{corr}$$

[kWh/year]

The final energy savings (ΔE/year) can be calculated from the difference in efficiency between the solar collector and the CHP plant [GJ / year]

$$\frac{\Delta E}{year} = Q_{DHW}/year \cdot (1 - \eta_{DHW}) \cdot 3.6/1000$$

[GJ/year]

where:

$Z_{person/year}$ = Annual number of people showering *[persons/year]*

$Q_{DHW,shower}$= Share of the annual DHW heat demand of industrial showers that can be produced *[kWh/year]*

$K_{portion}$/year= Annual number of industrial kitchen portions *[portions/year]*

$Q_{DHW,kitchen}$= Annual share of industrial kitchen heat demand for DHW *[kWh/year]*

A_{bldng} = Heated floor area of building utilising DHW *[m²]*

$Q_{DHW,ép}$= The share of the annual heat demand of buildings that can be produced from DHW based on the classification type of the building using DHW *[kWh/year]*

H_{corr} = Solar heat gain correction factor for the building utilizing solar thermal energy by classification type [kWh/year]

H_{DHW} = Efficiency of existing DHW production equipment

Excess final energy savings (ΔEexcess/year) can be calculated from the difference between the reference efficiency of the solar collector and the DHW heat generator according to the environmentally sound design criteria *[GJ/year]*

$$\frac{\Delta E_{plus}}{year} = Q_{DHW}/year \cdot (1 - \eta_{DHW,ref}) \cdot 3.6/1000$$

where:

Q_{DHW}/year = fraction of DHW heat demand that can be produced by solar collectors *[kWh/year]*

$\eta_{DHW,ref}$ = reference efficiency of the DHW generating installation according to the environmental design criteria.

The formulas calculate the cumulative savings.

Standardized calculation values

Reference efficiencies of DHW production according to environmental design requirements, as a function of DHW heat demand ($\eta_{DHW,ref}$)

rated load profile	3XS	XXS	XS	S	M	L	XL	XXL	3XL	4XL
QDEMAND / day *[kWh/m² /day]*	0.345	2.1	2.1	2.1	5.845	11.655	19.07	24.5	46.76	93.52
QDEMAND / day *[kWh/m² /year]*	120	750	750	750	1400	2790	4570	5880	11 200	22400
η_{DHW},ref	32%	32%	32%	32%	36%	37%	38%	60	64%	64%

Methodological aspects

When designing a solar thermal system, solar collectors and heat storage capacity sized for up to 100% of summer heat production should be used to match solar thermal production with the use of DHW heat. The solar energy recovery capacity of solar collector panels, depending on the tilt and azimuth angle of the solar collector panels, should be taken into account in the design.

Conversion efficiency of renewable heat produced locally for own use into heat is 1.

The nominal technical data and the operating characteristics of the system subject to the measure shall be recorded according to the following table:

Recording of nominal technical data and operational characteristics

A	B	
Line number	Tecnical data	
1	HMV heat generator manufacturer	
2	HMV heat generator type	
3	Date of first commissioning of the cogeneration installation	
4	η_{DHW} = Efficiency of a combined heat and power plant *[%]*	
5	P_{Ncoll} = Nominal power of the solar collector system *[kW]*	
6	$Z_{ppl/year}$ = Annual number of people showering *[persons/year]*	

7	$K_{port/year}$ = Annual number of industrial kitchen portions *[portions/year]*	
8	Classification of the type of DHW	
9	A_{bldng} = Heated floor area of building utilising DHW *[m²]*	

Life expectancy based on the recommendation:

- Life expectancy of solar collector system: 15 years
- Expected lifetime of a combined heat and power plant:
  - For high energy efficiency boilers (< 30 kW): 20 years
  - For boilers (> 30 kW): 25 years

Maximum eligible lifetime of the solar collector investment: 15 years.

Data sources for indicative calculation values:

The source for the indicative values is available in the 17/2020. (XII. 21.) MEKH decree on the provision of data on end-use energy savings, available online: https://njt.hu/jogszabaly/2020-17-20-5Z.4

1.30.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.30.4 Calculation of greenhouse gas savings

No information on cost GHG savings available for this methodology

1.30.5 Bibliography

17/2020. (XII. 21.) MEKH decree on the provision of data on end - use energy savings, available online: https://njt.hu/jogszabaly/2020-17-20-5Z.4

1.31 Heating - Ireland

There is no calculation formula neither a detailed methodology publicly available.

Only annual Energy Saving Credits pre-calculated for different technologies as Energy Credits kWh/annum. Following table show the respective values and the boundary conditions for small-scale RES in residential heating:

Measure	Minimum Specification - All measures installed must meet the minimum specification listed below	Energy Credits kWh/annum	
		Appartement	House
Biomass boiler with thermal store and Fully integrated Heating Controls Upgrade	Min gross efficiency of 77% as per HARP. Full zone control on space and water heating, with at least 2 zones for space heating as recommended in TGD L 2008 and 80mm hot water cylinder insulating jacket	5,180	8,145
Biomass boiler with thermal store and Fully	Min gross efficiency of 77% as per HARP. Full zone control on space and water heating, with at least 2 zones	5,385	8,480

integrated Heating Controls Upgrade with remote access	for space heating as recommended in TGD L 2008 and 80mm hot water cylinder insulating jacket Programmer to have capacity to adjust heating schedule remotely via Web or SMS		
Biomass boiler without thermal store and Fully integrated Heating Controls Upgrade	Min gross efficiency of 82% as per HARP. Full zone control on space and water heating, with at least 2 zones for space heating as recommended in TGD L 2008 and 80mm hot water cylinder insulating jacket	4,685	7,370
Biomass boiler without thermal store and Fully integrated Heating Controls Upgrade with remote access	Min gross efficiency of 82% as per HARP. Full zone control on space and water heating, with at least 2 zones for space heating as recommended in TGD L 2008 and 80mm hot water cylinder insulating jacket Programmer to have capacity to adjust heating schedule remotely via Web or SMS	4,895	7,710
Solar Water Heating Installation	Sized and installed in accordance with SR 50-2	955	1,500
Water to Water Heat Pump with Fully integrated Heating controls Upgrade	Water to Water Heat pump, minimum SPF of 485. Listed on the HARP, EHPA, Ecolabel or Eurovent database3 Full zone control on space and water heating, with at least 2 zones for space heating as recommended in TGD L 2008 and 50mm pre insulated hot water cylinder	11,885	18,680
Water to Water Heat Pump with Fully integrated Heating controls Upgrade with remote access	Water to Water Heat pump, minimum SPF of 485. Listed on the HARP, EHPA, Ecolabel or Eurovent database3 Full zone control on space and water heating, with at least 2 zones for space heating as recommended in TGD L 2008 and 50mm pre insulated hot water cylinder Programmer to have capacity to adjust heating schedule remotely via Web or SMS	12,230	19,235
Air to Water Heat Pump with Fully integrated Heating controls Upgrade	Air to Water Heat pump, minimum SPF of 350. Listed on the HARP, EHPA, Ecolabel or Eurovent database3 Full zone control on space and water heating, with at least 2 zones for space heating as	9,905	15,570

	recommended in TGD L 2008 and 50mm pre insulated hot water cylinder		
Air to Water Heat Pump with Fully integrated Heating controls Upgrade with remote access	Air to Water Heat pump, minimum SPF of 350. Listed on the HARP, EHPA, Ecolabel or Eurovent database3 Full zone control on space and water heating, with at least 2 zones for space heating as recommended in TGD L 2008 and 50mm pre insulated hot water cylinder Programmer to have capacity to adjust heating schedule remotely via Web or SMS	10,255	16,125
Brine to Water Heat Pump with Fully integrated Heating controls Upgrade	Brine to Water Heat pump, minimum SPF of 390. Listed on the HARP, EHPA, Ecolabel or Eurovent database3 Full zone control on space and water heating, with at least 2 zones for space heating as recommended in TGD L 2008 and 50mm pre insulated hot water cylinder	10,675	16,775
Brine to Water Heat Pump with Fully integrated Heating controls Upgrade with remote access	Brine to Water Heat pump, minimum SPF of 390. Listed on the HARP, EHPA, Ecolabel or Eurovent database3 Full zone control on space and water heating, with at least 2 zones for space heating as recommended in TGD L 2008 and 50mm pre insulated hot water cylinder Programmer to have capacity to adjust heating schedule remotely via Web or SMS	11,025	17,335
Air to Air Heat Pump with Fully integrated Heating controls Upgrade	Air to Air Heat pump, minimum SPF of 325%. Listed on the HARP, EHPA, Ecolabel or Eurovent database* Full zone control with at least 2 zones for space heating as recommended in TGD L 2008. 50mm pre insulated hot water cylinder	7,320	11,490
Air to Air Heat Pump with Fully integrated Heating controls Upgrade with remote access	Air to Air Heat pump, minimum SPF of 325%. Listed on the HARP, EHPA, Ecolabel or Eurovent database* Full zone control with at least 2 zones for space heating as recommended in TGD L 2008. 50mm pre insulated hot water cylinder. Programmer to have capacity to adjust heating schedule remotely via Web or SMS	7,620	11,975

1.31.1 Calculation of impact on energy consumption (Article 3)

Not available

1.31.2 Calculation of final energy savings (Article 7)

There is no formula available.

1.31.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.31.4 Calculation of greenhouse gas savings

Not available

1.31.5 Bibliography

SEIA Energy Efficiency Obligation Scheme: Guidance on authenticating and claiming energy credits, see: EEOS Guidance to authenticate & claim energy credits (www.seai.ie)

Consultation report: Consultation on the implementation of the Clean Energy Package, last update June 2020. From Department of the Environment, Climate and Communications, Irish Government (www.gov.ie)

Ireland's Energy Efficiency Obligation Scheme Summary of responses to public consultation and policy decisions on scheme design October 2021. From Department of the Environment, Climate and Communications, Irish Government (www.gov.ie)

1.32 Boiler Replacement with more efficient technologies – Lithuania

In order to reduce energy poverty, the National Energy and Climate Action Plan of the Republic of Lithuania 2021-2030 provides for the following measure "**Boiler Replacement with More Efficient Technologies**".

This measure encourages the use of RES for space heating, which can reduce heating costs and reduce energy poverty for the poor. They can also be applied to all groups of the population, which is not necessarily limited to socially vulnerable groups.

1.32.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.32.2 Calculation of final energy savings (Article 7)

Calculation of the final energy savings from the "**Boiler Replacement with More Efficient Technologies**" measure.

This formula calculates **cumulative savings**. Such a measure has a shelf life of more than one year. Therefore, the total overall energy savings over the whole period would be calculated as the product of one year's energy savings times the number of years.

$$\Delta E = (E_{before} - E_{after}) \times y = \left(\frac{P_{before} \times h_{before}}{\eta_{before}} - \frac{P_{after} \times h_{after}}{\eta_{after}}\right) \times y$$

Where:

ΔE	Total final energy savings from replacing old boilers with more efficient ones [kWh]
E_{before}	The amount of energy required by the boiler before replacement [kWh]
E_{before}	Energy required by the boiler after replacement [kWh]
y	Duration of the measure [years]
P_{before}	Boiler power before replacement [kW]
h_{before}	Boiler lifetime before replacement [h]
η_{before}	Boiler efficiency before replacement [-]
P_{after}	Boiler power after replacement [kW]
h_{after}	Boiler lifetime after replacement [h]
η_{after}	Efficiency of the boiler after replacement [-]

Standardized calculation values

No calculation values available for this methodology.

1.32.3 Overview of costs related to the action

No calculation values available for this methodology.

1.32.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.32.5 Bibliography

Description of the procedure for the climate change programme for the compliance benefits for the improvement of the interior heating and hot water systems of multi-apartment houses - https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/4f3893820a0a11eaa727fba41f42a7e9/asr

Description of renewable energy resources for the use of electricity for the electricity needs of non-resident individuals and for the replacement of heating devices https://e-seimas.lrs.lt/portal/legalAct/lt/TAP/268436a0dfac11eb866fe2e083228059?positionInSearchResults=0&searchModelUUID=a9c5c543-4451-48d3-b6eb-32b24bfe881a

Procedural description for the climate change programme for individuals 'use of renewable energy sources for the replacement of electrical energy needs and/or change of heating equipment for non-insident individuals https://www.e-tar.lt/portal/lt/legalAct/2c848570ff4911eb9f09e7df20500045

Use of renewable energy sources (solar) for the electricity needs of natural persons in need and/or for the replacement of fossil fuel-fired heating installations

https://apvis.apva.lt/paskelbti_kvietimai/atsinaujinanciu-energijos-istekliu-saules-panaudojimas-nepasiturinciu-fiziniu-asmenu-elektros-energijos-reikmems-ir-ar-iskastini-kura-naudojanciu-silumos-irenginiu-pakeitimui-2021-09

1.33 Replacing a heating installation - Luxemburg

The energy consumption of heat production is reduced by replacing the existing heat production installation with a higher efficiency installation. In order to calculate the savings the measure is producing, first the insulation class of the building needs to be defined. Then the exact heating demand is calculated together with the demand for domestic hot water, after which the specific energy savings from the intervention can be calculated. These are then used to calculate the annual volume of energy savings produced by the measure. The measure is applicable to existing residential buildings and existing functional buildings.

1.33.1 Calculation of impact on energy consumption (Article 3)

No calculation formula is available.

1.33.2 Calculation of final energy savings (Article 7)

First step is to identify the thermal insulation class of the building. This can be done through the energy performance certificate or, in case not available, through the year of construction of the building, taking into account a possible previous (partial) modernization of the building (see table 1).

Second, the specific heating demand to be taken into account is calculated by the following formula:

$$q_c = a_0 \times A_n^{a1}$$

Where:

q_c	Specific heating demand [kWh/m^2]
a_0	Parameter to extract from table 2
A_n	Energy reference area of the building [m^2]
a_1	Parameter to extract from table 2

Please note that it is not permitted to use the specified heating demand from the energy performance certificate.

The energy reference surface should be taken from the energy performance certificate. In the absence of the energy performance certificate, the energy reference area can be calculated in a simplified way by the following formula (in case of a rectangular building):

$$A_n = 0.85 \times n_{VG} \times L \times B$$

Where:

A_n	Energy reference area of the building [m²]
n_{VG}	Number of entire floors heated (in the case of attics partially heated, the value for the attic can be multiplied by 0.5.)
L	Exterior length of the building [m²]
B	Exterior width of the building [m²]

Then, the specific need for domestic hot water q_{ec} is taken from table 3 (expressed in kWh/m²) and used to calculate the specific energy savings according to the following formula:

$$\Delta q_c = q_c \times (e_{c,e} - e_{c,n}) + q_{ec} \times (e_{ec,e} - e_{ec,n})$$

Where:

Δq_c	Specific energy savings [kWh/m²]
q_c	Specific heating demand [kWh/m²]
q_{ec}	Specific demand for domestic hot water [kWh/m²]
$e_{c,e/n}$	Expenditure factor for the production of heat by the existing/new heating installation Factors to be taken from table 4
$e_{ec,e/n}$	Expenditure factor for the production of domestic hot water by the existing/new installation Factors to be taken from table 4

Finally, after calculating Δq_c, the annual volume of energy savings produced by the measure can be calculated by multiplying the specific energy savings by the energy reference area of the building. This formula calculates **first year savings**.

$$VEEP = \frac{\Delta q_c \times A_n}{1000}$$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]

Δq_c	Specific energy savings [kWh/m²]
A_n	Energy reference area of the building [m²]

Standardized calculation values

Table 40: Simplified identification of the thermal insulation class of the building

Year of construction	Thermal insulation class	Thermal insulation class in case of previous partial modernization
From 2012	C	C
2008-2011	D	D
1995-2007	E	D
1984-1994	F	D
1973-1983	G	E
1962-1972	H	F
Before 1962	I	G

Table 41: Parameters a0 and a1

Thermal insulation class of the building	a_0	a_1
A	78.49	-0.2686
B	103.87	-0.2345
C	112.67	-0.1345
D	137.11	-0.1285
E	221.83	-0.1519
F	292.89	-0.1557
G	431.52	-0.1802
H	613.47	-0.1964
I	898.49	-0.1969

Table 42: specific demand of domestic hot water qec per building type

Building type	q_{ec} [kWh/m²]
Single Family Home (SFH)	19
Multi Family Home (MFH)	29
Buildings with purpose: administration, schools, commercial and industry	11
Centres de manifestation	23

Sports facilities	137
Restaurants	78
Hospitals	39

Table 43: Expenditure factor for the production of heating / domestic hot water ec/ec, in function of the heat production installation.

Type of heat production installation	Factor e_c	Factor e_{ec}
Boiler constant temperature	$1.13 \leq 1.633 \times A_n^{-0.04282} \leq 1.38$	$1.17 \leq 2.732 \times A_n^{-0.09709} \leq 1.82$
Boiler low temperature	$1.08 \leq 1.209 \times A_n^{-0.01283} \leq 1.15$	$1.10 \leq 1.313 \times A_n^{-0.02007} \leq 1.21$
Condensing boiler (radiators)	$1.01 \leq 1.094 \times A_n^{-0.00922} \leq 1.05$	$1.08 \leq 1.251 \times A_n^{-0.01722} \leq 1.17$
Condensing boiler (floor heating)	$0.98 \leq 1.019 \times A_n^{-0.00463} \leq 1.00$	$1.08 \leq 1.251 \times A_n^{-0.01722} \leq 1.17$
Electric heating (direct / accumulation)	1.00	1.00
Ground – Water heat pump (radiators)	0.27	0.27
Ground – Water heat pump (floor heating)	0.23	0.27
Air – Water heat pump (radiators)	0.37	0.37
Air – Water heat pump (floor heating)	0.30	0.37
Boiler wood log	1.75	1.75
Pellet boiler only indirect heat release	1.38	1.38
Pellet boiler direct and indirect heat release	1.48	1.48
District heating	1.01	1.14

Note: A_n is the energy reference area of the building in m².

Methodological aspects

The calculation methodology is only valid for monovalent systems of heat production used for the conditioning of residential buildings and functional buildings. Installation of direct electric heating systems, respectively accumulation, is excluded. The lifetime is set at 20 years, 15 years for heat pumps.

This methodology was published in the Luxemburg catalogue on standardized measures (Annex II), which is annexed to the Grand-Ducal Regulation of August 7, 2015 relating to the functioning of the energy efficiency obligation mechanism. The document is published in French.

Data sources for indicative calculation values

No information on the calculation values was provided.

1.33.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.33.4 Calculation of greenhouse gas savings

Information not available.

1.33.5 Bibliography

Règlement grand-ducal du 7 août 2015 relatif au fonctionnement du mécanisme d'obligations en matière d'efficacité énergétique
http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo

1.34 Installing a solar heating installation with or without additional heating – Luxemburg

The energy consumption of the heat production is reduced by the installation of a solar thermal system with or without heating support. In the situation before, heat is produced without a solar thermal installation. The situation after implies a heat production system that is supplemented by a solar thermal system for the production of domestic hot water, of for the production of domestic hot water with support of the heating system. The measure is applicable to existing residential buildings.

1.34.1 Calculation of impact on energy consumption (Article 3)

No calculation formula available.

1.34.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**.

In the case of a solar thermal installation for the production of domestic hot water, the annual volume of energy savings produced by the measure is calculated by the following formula:

$$VEEP = \frac{q_{sol} \times A_c \times e_{ec}}{1000}$$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]
q_{sol}	Energy efficiency of the solar thermal collector [kWh/m²] surface of the solar collector a to be extracted from table 5 depending on the type of solar thermal system and the type of solar thermal collector
A_c	Aperture surface of the solar thermal collector [m²]

e_{ec}	Expenditure factor for the production of domestic hot water according to the existing heat production installation Factor to be taken from table 6

In the case of a solar thermal installation for the production of domestic hot water with back-up heating, the annual volume of energy savings produced by the measure is calculated by the following formula:

$$VEEP = \frac{q_{sol} \times A_c \times (0.9 \times e_{ec} + 0.1 \times e_c)}{1000}$$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]
q_{sol}	Energy efficiency of the solar thermal collector [kWh/m²] surface of the solar collector a to be extracted from table 1 depending on the type of solar thermal system and the type of solar thermal collector
A_c	Aperture surface of the solar thermal collector [m²]
e_{ec}	Expenditure factor for the production of domestic hot water, depending on the existing heat production installation. Factor to be extracted from table 2
e_c	Expenditure factor for the production of heating, depending on the existing heat production installation. Factor to be extracted from table 2.

Standardized calculation values

Table 44: Energy efficiency of the thermal solar collector qsol in kWh/m2 and in function of the type of solar thermal installation and of the type of solar thermal collector.

Type of solar thermal collector	Production of domestic hot water	Production of domestic hot water with a back-up installation
Flat collector	350	310
Tubular collector	450	430

Table 45: Expenditure factor for the production of heating / domestic hot water ec/ec, in function of the heat production installation.

Type of heat production installation	Factor e_c	Factor e_{ec}
Boiler constant temperature	$1.13 \leq 1.633 \times A_n^{-0.04282} \leq 1.38$	$1.17 \leq 2.732 \times A_n^{-0.09709} \leq 1.82$

Boiler low temperature	$1.08 \leq 1.209 \times A_n^{-0.01283} \leq 1.15$	$1.10 \leq 1.313 \times A_n^{-0.02007} \leq 1.21$
Condensing boiler (radiators)	$1.01 \leq 1.094 \times A_n^{-0.00922} \leq 1.05$	$1.08 \leq 1.251 \times A_n^{-0.01722} \leq 1.17$
Condensing boiler (floor heating)	$0.98 \leq 1.019 \times A_n^{-0.00463} \leq 1.00$	$1.08 \leq 1.251 \times A_n^{-0.01722} \leq 1.17$
Electric heating (direct / accumulation)	1.00	1.00
Ground – Water heat pump (radiators)	0.27	0.27
Ground – Water heat pump (floor heating)	0.23	0.27
Air – Water heat pump (radiators)	0.37	0.37
Air – Water heat pump (floor heating)	0.30	0.37
Boiler wood log	1.75	1.75
Pellet boiler only indirect heat release	1.38	1.38
Pellet boiler direct and indirect heat release	1.48	1.48
District heating	1.01	1.14

Note: A_n is the energy reference area of the building in m^2.

If the solar thermal installation is integrated into a bivalent system for the production of heat, the heat-generating plant with the lowest expenditure factors must be applied.

Methodological aspects:

The application of the calculation methodology presupposes that the solar thermal installation is correctly sized (surface of the thermal solar collector and volume of the heat accumulator). As an indication, the surface of the collector of a solar thermal installation for domestic hot water production ranges between 1.0 and 1.5 m^2/person for a flat collector and between 0.8 and 1.2 m^2/person for a tubular collector.

This methodology was published in the Luxemburg catalogue on standardized measures (Annex II), which is annexed to the Grand-Ducal Regulation of August 7, 2015 relating to the functioning of the energy efficiency obligation mechanism. The document is published in French.

Data sources for indicative calculation values:

No information on the calculation values was provided.

1.34.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.34.4 Calculation of greenhouse gas savings

Information not available.

1.34.5 Bibliography

Règlement grand-ducal du 7 août 2015 relatif au fonctionnement du mécanisme d'obligations en matière d'efficacité énergétique:
http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo

1.35 Stimulering Duurzame Energieproductie (SDE) +(+) – The Netherlands

The Sustainable Energy Production Incentive Scheme (SDE+) is a policy instrument to stimulate the production of sustainable energy in the Netherlands. Specifically, SDE+ is an operating subsidy that producers receive for the sustainable energy they generate. Because the cost price of sustainable energy is higher than that of energy from fossil fuels, the production of sustainable energy is not always profitable. SDE+ reimburses the difference between the cost price of sustainable energy and the market value of the energy supplied: the unprofitable top. The cost price of sustainable energy techniques is determined annually by PBL.

The subsidy is awarded over a period of 12 or 15 years and the amount of the subsidy depends on the technology and the amount of sustainable energy that is produced. SDE+ is open for the production of renewable electricity, renewable gas and renewable heat or a combination of renewable heat and electricity (CHP) from biomass, geothermal energy, water, wind and sun.

In the autumn of 2020, this scheme will be extended to the Sustainable Energy Transition Incentive Scheme (SDE++). In addition to sustainable energy production, this new scheme will also stimulate other CO2-reducing techniques. For example, electric boilers, heat pumps, the use of residual heat, hydrogen through electrolysis and CO2 capture and storage (CCS). The basic principle of the SDE++ remains to reduce CO2 in a cost-effective way and to subsidize the unprofitable top per technology. However, the amount of the subsidy will no longer be determined on the basis of (renewable energy) production, but on the basis of the amount of CO2 that is reduced with the technology. The former SDE+ and the opening of the SDE++ in 2020 will make an important contribution to achieving the 2030 climate target.

The technical estimates are applied for both the realized (ex-post) and expected (ex-ante) energy savings. This also applies to the SDE+(+). An estimate can be made of the expected energy savings on the basis of data in the subsidy decision, in which the maximum annual production that is eligible for subsidy are stated. The realized energy savings can be determined on the basis of registered production data. The subsidy to be paid out at the SDE(+) is based on certified productions supplied. In this context, the Dutch Enterprise Agency (RVO) receives the certified electricity and heat productions from chain partner CertiQ (in the case of green gas productions, this concerns Vertogas). Measuring companies are technically involved in the measurements of an installation on the basis of a measurement protocol drawn up in advance.

1.35.1 Calculation of impact on energy consumption (Article 3)

Savings on the final heat consumption are calculated as the avoided consumption of natural gas that produces the same amount of heat (based on the sub-value) and is expressed in kWh (final consumption).

Most SDE+(+) subsidized projects have a duration of 15 years (see table 6.3 below). The term corresponds to the economic life. The technical lifespan is often even longer (eg 30 years for solar panels). When calculating energy savings, it is especially important to take into account projects with a duration of less than 10 years. Such projects are not included in the SDE+(+).

Table 46: Principles for calculating energy savings and duration of SDE+(+) techniques

EED relevant SDE+(+) techniques	Principles of energy saving calculation	Duration (years)
Solar panels for own consumption	The self-consumption of the amount of electricity generated by a photovoltaic solar energy system is equal to savings in electricity consumption	15
Solar thermal	The energy saving is equal to the avoided consumption of natural gas that produces the same amount of heat (based on net value) as the heat supplied by solar collectors	15
Heat pump	The energy saving is equal to the avoided consumption of natural gas that (based on net value) produces the same amount of heat as the heat supplied by heat pumps, minus the electricity consumption of the heat pump	15
Industrial heat pump	The energy saving is equal to the avoided consumption of natural gas that (based on net value) produces the same amount of heat as the heat supplied by heat pumps, minus the electricity consumption of the heat pump	12
Electric water heaters	The energy saving is equal to the avoided consumption of natural gas that (based on net value) with an industrial steam boiler (usually 85% efficiency) produces the same amount of heat as an electric boiler (which has a conversion efficiency of 100%), minus the electricity consumption from the e-boiler	15

When determining the energy determination, a decrease in energy savings during the run time is not considered. So far there are no indications that this plays a significant role.

1.35.2 Calculation of final energy savings (Article 7)

When determining the energy determination, a decrease in energy savings during the run time is not taken into account. So far there are no indications that this plays a significant role.

The savings calculation of the SDE+(+) is carried out on the basis of specific techniques in which the consumption of electricity (by solar panels) or natural gas (by solar thermal) is avoided. In the future, techniques in the SDE++ will also be eligible for the savings calculation (heat pumps and electric boilers).

The savings of the techniques described in table 6.3 are calculated based on production data available from RVO. Because the subsidy level of SDE++ is determined based on the amount of energy produced, production data is recorded for the entire subsidy period of 15 years. Energy savings can be calculated on this basis. These savings are by definition additional, ie attributable to national policy (the SDE++), because only techniques are subsidized where there is an unprofitable top.

The energy savings with solar panels for self-consumption is equal to the amount of electricity that is generated (MWh). In the SDE+, different rates apply for grid supply and self-consumption. That is why data on the amount of grid supply and own consumption are in the possession of RVO. Every kWh produced that is not supplied to the grid counts (on an annual basis) as a kWh saving.

The energy saving with solar thermal is calculated on the basis of the avoided consumption of natural gas that produces the same amount of heat (based on net value). This is determined on the basis of certified measured values of the solar thermal installations that RVO receives from chain partner CertiQ. The average annual energy consumption of the installation is then compared with the average annual energy consumption of a new natural gas boiler.

This is relevant for the calculation of energy savings based on multiple data sources and is not relevant for the calculation of energy savings based on data from individual policy measures. See the method documents per climate table for an explanation of the approach to avoid overlap.

The notification states that the Netherlands does not apply methods that consider any climate differences within the Netherlands. The climate differences within the Netherlands are so small that they are not taken into account when determining the effects of policy measures (including the SDE+(+)).

1.35.3 Overview of costs related to the action

The SDE++ is one of the most extensive Dutch interventions and offers a budget of € 13 billion (!) to businesses and consumers in 2022.

The SDE++ offers subsidies for the use of techniques for generating renewable energy and other CO2-reducing techniques and must fall in the categories: Renewable electricity, renewable heat and CHP, renewable gas, low-carbon heat, or low-carbon production. For each category, several sub-categories are defined.

Companies granted SDE++ subsidy receive the awarded support over 12-15 years. The duration depends on which technology is used.

1.35.4 Calculation of greenhouse gas savings

No information found

1.35.5 Bibliography

Rijksdienst Voor Ondernemern Nederland (RVO): EED Methodedocument energiebesparing https://english.rvo.nl/sites/default/files/2020/07/EED-Methodedocument-energiebesparing.pdf

Rijksdienst Voor Ondernemern Nederland (RVO) SDE+(+) website: https://www.rvo.nl/subsidies-financiering/sde

Planburea voor de Leefomgeving (PBL) website: https://www.pbl.nl/kev/modellen

1.36 Residential Solar Thermal and Solar Heating for Services – Portugal

The programme aimed to promote the integration of solar heating systems in existing and future buildings in the domestic and services sectors and consists of two measures.

The first measure, for Residential sector, aimed to create a sustained market for the residential sector of 100 000 m² of solar panels installed per year, which would result in about 800 000 m2 of installed and operational panels by 2016 and around 1.2 million m2 by 2020.

This programme also aimed to revitalise existing infrastructure, creating favourable conditions for substituting and/or specialised repair/maintenance.

The implementation of this measure was the result of the potential identified by means of the Energy Certification of Buildings (new buildings and improvement measures included in the energy certificates of existing buildings), leveraged by means of specific support aimed at the area of energy efficiency, including negotiating lines of credit essentially targeting the domestic sector.

The second measure, for the Service sector, aimed to create a sustained market, with an installation of 40 000 m² of solar panels per year, which would result in around 330 000 m² of panels installed and operational by 2016 and around 500 000 m² by 2020.

This measure was implemented due to the potential identified by means of Energy Certification for Buildings (new buildings and improvement measures included in the energy certification of existing buildings), leveraged by means of specific national and Community support for energy efficiency.

1.36.1 Calculation of impact on energy consumption (Article 3)

No information.

1.36.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**.

$$EE = \frac{USAVE}{\eta} \times A$$

Where:

EE	Energy savings
USAVE	Thermal production (toe/m²)
η	Performance of water heaters (%)
A	Area installed per year (m²)

Standardized calculation values

There are no indicative values for this measure.

Methodological aspects:

Both measures use the same calculation formula, but no information is provided about the methodology.

1.36.3 Overview of costs related to the action

No information available.

1.36.4 Calculation of greenhouse gas savings

No information available.

1.36.5 Bibliography

Council of Ministers Resolution No 20/2013
https://data.dre.pt/eli/resolconsmin/20/2013/04/10/p/dre/pt/html

1.37 Replacing hot water boilers with new boilers – Slovenia

Energy saving represents the difference between energy use in a building with old system and energy use in a building when new boiler is introduced. Energy savings can be determined in two ways, depending on the available data, namely:

- taking into account the normalised average heat needs for heating buildings, knowing the (actual) heated surface of the building;
- taking into account the (actual) rated boiler heating power, taking into account the normal operating hours of the boiler during the heating season.

In the case of the replacement of boilers, the increase in the use of renewable energy sources is determined when the old fossil fuel boiler is replaced by a new wood biomass boiler.

1.37.1 Calculation of impact on energy consumption (Article 3)

Not available.

1.37.2 Calculation of final energy savings (Article 7)

The energy savings for residential buildings are calculated using the formulas below:

$$FE_{boiler} = (\frac{1}{\eta_{old}} - \frac{1}{\eta_{new}}) \cdot S \cdot A$$

or

$$FE_{boiler} = (\frac{1}{\eta_{old}} - \frac{1}{\eta_{new}}) \cdot P \cdot t$$

The energy savings for non-residential buildings are calculated using the formula below:

$$FE_{boiler} = (1 - \frac{\eta_{old}}{\eta_{new}}) \cdot E_a$$

Where:

FE_{boiler}	Energy savings due to the replacement of the boiler [kWh/a]
S	Average heat required [kWh/m2 per a]
A	Conditioned area of the building [m2]
P	Nominal power of the new boiler [kW]
t	Operating time of the boiler operation in the heating season (operating at nominal power) [h]; normalised value for the household sector = 1,500 hours/year (determined according to VDI 2067 guidelines)
Ea	Average annual energy consumption for heating [kWh/year] in the last three years
η_{old}	Annual operating efficiency of the old (replaced) hot water boiler according to DIN 4702-8
η_{new}	Annual operating efficiency of the new hot water boiler according to DIN 4702-8

Standardized calculation values

Table 47: Average heat required to heat a building (S), expressed in kWh/m2 per year.

Type of building	Heating	Heating + HWP[1]
Single family house (SFH)	132	162
Multifamily house (MFH)	94	124

η_{old} - the annual operating efficiency of the old (replaced) heating system shall be based on the condition that it is an old hot water boiler. The efficiency is determined on the basis of DIN 4702-8 by taking into account the average normalised efficiency for old products (boilers), the efficiency of the pipe network and the efficiency of the control system:

$$\eta_{old} = \eta_k \cdot \eta_c \cdot \eta_r = 0.72 \cdot 0.97 \cdot 0.94 = 0{,}66$$

Where:

η_k	Normalised efficiency of the boiler, which takes into account the actual operating characteristics of the boiler (actual load) and is defined as the ratio between the annual energy consumed and the annual heat generated by the boiler at the partial load of the heating system; the normalized value for the old boiler is 0.72 (DIN 4702-8)
η_c	Pipe watering efficiency – the normalized value for the old system is 0.97 (DIN 4702-8)

[1] The average (normalized) need for hot sanitary water in one-dwelling buildings is 3,000 kWh/household per year or 30 kWh/m2 per year, considering the average building size of 100 m2 and a 4-member family with a hot water consumption of 2 kWh/person per day.

η_r	Efficiency of the regulation – the normalized value for the old system is 0.94 (DIN 4702-8)

η_{new} - the annual operating efficiency of the new boiler boiler system according to DIN 4702-8 is calculated using the formula:

$$\eta_{new} = \eta_k \cdot \eta_c \cdot \eta_r$$

using the appropriate values set out in the table below:

Table 48: Efficiency values for new boiler systems.

Boiler type	Type of fuel	η_k	η_c	η_r	η_{new}
Low temperature	Wood biomass	0.90	0.98	0.95	0.84

Increase in the use of renewable energy sources (wood biomass boilers):

When switching to boilers to wood biomass, the increase in the use of renewable energy sources shall also be calculated according to the following formula:

$$SRES_{boiler\_WB} = \frac{P \cdot t}{\eta_{new}} \cdot f$$

Where:

$SRES_{boiler\_WB}$	Energy savings due to the replacement of the boiler [kWh/a]
f	f = 1 - η_{old} installation of a new wood biomass boiler instead of an old fossil fuel boiler
f	f = 0 - η_{old} installation of a new wood biomass boiler instead of an old fossil fuel boiler

Methodological aspects:

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

1.37.3 Overview of costs related to the action

Not available. The lifetime expectancy of this measure is 20 years for the household sector and 25 for industrial sector.

1.37.4 Calculation of greenhouse gas savings

Savings or reductions in CO_2 emissions (CES) when the type of fuel is not changed shall be calculated using the formula:

$$CES_{boiler} = FE_{boiler} \cdot ef_{fuel}$$

When changing the fuel type, use the following equation:

for residential buildings:

$$CES_{boiler} = (\frac{ef_{old}}{\eta_{old}} - \frac{ef_{new}}{\eta_{new}}) \cdot S \cdot A$$

or

$$CES_{boiler} = (\frac{ef_{old}}{\eta_{old}} - \frac{ef_{new}}{\eta_{new}}) \cdot P \cdot t$$

for non-residential buildings, use the following equation:

$$CES_{boiler} = (ef_{old} - \frac{ef_{old} \cdot \eta_{old}}{\eta_{new}}) \cdot E_a$$

Where:

$\boldsymbol{CES_{boiler}}$	CO2 emission savings of a boiler [kg CO2/a],
ef_{fuel}	Emission factor for fuel [kg CO2/kWh]
ef_{old}	Emission factor for fuel or energy source for the old heating system [kg CO2/kWh]
ef_{new}	Emission factor for fuel or energy source for the new heating system [kg CO2/kWh]

Table 49: Emission factors indicative values for calculation of greenhouse gas savings.

ef_{fuel}	Households [kg CO2/kWh]	Services [kg CO2/kWh]	Industry [kg CO2/kWh]
Natural Gas	0.20	0.20	0.20
LFO	0.27	0.27	0.27
Wood biomass	0	0	0
Sectoral average	0.09	0.23	0.21
Electricity	0.49	0.49	0.49
District heating	0.32	0.32	0.32

Data sources for indicative calculation values:

In order to apply the method, data on the heated surface of buildings and the power of new heating devices should be known for residential buildings. In the case of non-residential buildings, it is necessary to know the type of fuel and the average annual consumption of energy for heating in the last three years.

1.37.5 Bibliography

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

1.38 Replacement of an electric heater for the preparation of hot sanitary water with heat pump – Slovenia

1.38.1 Calculation of impact on energy consumption (Article 3)

Not available

1.38.2 Calculation of final energy savings (Article 7)

Energy saving is equal to the reduction of electricity use due to the replacement of an old electric heater for the preparation of hot sanitary water by a heat pump (classic air/water heat pump) for the preparation of hot sanitary water or by the installation of solar energy receivers (thermal or photovoltaic).

Photovoltaic modules not connected to the main grid may be used for direct water heating via resistive electric heaters, whereby the PV system must not be connected to the internal low voltage installation of the building. The system shall comply with the safety requirements as set out in the Regulation on the technical requirements of self-sufficient RES devices and shall at all times enable the system to be switched off within the system.

The savings are calculated on the basis of the normalised values of the average consumption of hot water in the household, the efficiency of the old electric heater, the efficiency of the new system, the energy yield of solar energy receivers and the surface of the thermal receivers of solar energy and in the case of solar energy photovoltaic receivers, according to the total power (kWp) of the installed PV modules.

The energy savings from replacing the electric heater with a heat pump (air/water) is calculated in accordance with the following equations:

$$FE_{sw,HP} = \left(\frac{1}{\eta_{old}} - \frac{1}{\eta_{HP} \cdot SPF}\right) \cdot E_{sw}$$

Where:

$FE_{sw,HP}$	Energy saving [kWh/year] due to replacement of the (old) electric heater with a heat pump for the preparation of hot sanitary water (air/water).
E_{sw}	Average (normalised) hot sanitary water demand [kWh/year] 30 kWh/m2 per year; in one-dwelling buildings is 3000 kWh/household per year, with average building size of 100 m² and a 4-member family with a consumption of warm sanitary water 2 kWh/person per day.
η_{old}	Efficiency of the old system (electric heater) for the preparation of hot sanitary water, the normalized value is 0.8.

η_{HP}	The annual operating efficiency of the heating system using the heat pump, the normalized value is 0.9.
SPF	Annual Seasonal Performance Factor of heat pump.

Calculation of energy savings from the installation of solar energy receivers (Solar thermal energy - STE):

1 where the condition $FE_{sw,STE} \leq \frac{E_{sw}}{\eta_{old}}$ is met, energy saving is calculated according to the following equations:

$$FE_{sw,STE} = \frac{U_{STE}}{\eta} \cdot \eta_{STE} \cdot A$$

$$FE_{sw,PVSTE} = \frac{U_{PVSTE}}{\eta} \cdot \eta_{PVSTE} \cdot P_{PVSTE}$$

2 where the condition $FE_{sw,STE} > \frac{E_{sw}}{\eta_{old}}$ is met, energy saving is calculated according to the following equations:

$$FE_{sw,STE} = \frac{E_{sw}}{\eta_{old}}$$

Where:

$FE_{sw,STE}$	Energy saving [kWh/year] due to replacement of the (old) electric heater with a solar energy receiver (Solar thermal energy - STE).
$FE_{sw,PVSTE}$	Energy saving [kWh/year] due to replacement of the (old) electric heater with a PV solar energy receiver (PVSTE).
U_{STE}	annual contribution [kWh/m2/year] of STE solar energy receivers by type: - Flat panel STE = 500 kWh/m2 per year, - Vacuum STE = 600 kWh/m2 per year
U_{PVSTE}	The normalized annual production of solar power PV receivers (1000 kWh/kWp per year).
η	Efficiency (average) of the conventional hot water preparation system – the normalized value is 0.8.
η_{STE}	Solar system efficiency – normalized value is 0.8.
η_{PVSTE}	Efficiency of the photovoltaic solar thermal system – the normalized value is 0.9. Compared to thermal STE, the utilized solar energy from PV STE is distributed evenly over the year: slightly reduced in the summer heat and

	higher on cold days – energy losses on the way from the receiver to the heating device are significantly lower.
A	Light (apertive) surface [m2] of mounted STE
P_{PVSTE}	Power of photovoltaic modules (kWp)

Standardized calculation values

Table 50: Average annual Seasonal Performance Factor of heat pump.

Type of Heat Pump	Classic HP	Gas HP	Sorption HP	Hybrid HP
Air/Water	2.8	1.5	1.26	3.6
Geo/Water	3.5	-	1.3	-
Water/Water	4	-	1.3	-

Increase in the use of renewable energy sources:

The increase in the use of renewable energy sources shall be calculated according to the following formula:

- when replacing the electric heater with heat pumps:

$$SRES_{sw,HP} = \frac{E_{sw}}{\eta_{HP}} \cdot (1 - \frac{1}{SPF})$$

Where:

$SRES_{sw,HP}$	Energy savings due to the installation of a heat pump [kWh/a]

- when installing solar thermal energy receivers:

$$SRES_{sw,STE} = U_{STE} \cdot \eta_{STE} \cdot A$$

$$SRES_{sw,PVSTE} = U_{PVSTE} \cdot \eta_{PVSTE} \cdot P_{PVSTE}$$

Where:

$SRES_{sw,STE}$	Increase in the use of renewable energy sources [kWh/year] due to the installation of solar thermal energy receivers
$SRES_{sw,PVSTE}$	Increase in the use of renewable energy sources [kWh/year] due to the installation of PV solar thermal energy receivers

Methodological aspects

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

1.38.3 Overview of costs related to the action

Not available. The lifetime expectancy of this measure is 15 years.

1.38.4 Calculation of greenhouse gas savings

The reduction of CO_2 emissions (CES) is calculated according to the formulas bellow according to the type or method of preparation of hot water:

- when replacing the electric heater with a heat pump (air/water):

$$CES_{sw,HP} = \left(\frac{1}{\eta_{old}} - \frac{1}{\eta_{HP} \cdot SPF}\right) \cdot ef_{el} \cdot E_{sw}$$

Where:

$CES_{sw,HP}$	Reduction of CO_2 emissions [kg CO_2/year] when installing a heat pump.
ef_{el}	Emission factor for electricity [kg CO_2/kWh]

- when replacing the electric heater with a solar thermal energy system:

$$CES_{sw,STE} = \frac{U_{STE}}{\eta} \cdot \eta_{STE} \cdot A \cdot ef_{el}$$

$$CES_{sw,PVSTE} = \frac{U_{PVSTE}}{\eta} \cdot \eta_{PVSTE} \cdot P_{PVSTE} \cdot ef_{el}$$

Where:

$CES_{sw,STE}$	Reduction of CO_2 emissions [kg CO_2/year] when installing a solar thermal energy system.
ef_{el}	Emission factor for electricity [kg CO_2/kWh]

Data sources for indicative calculation values

When replacing an old electric heater for the preparation of hot sanitary water with a heat pump, information on the type of heat pump is required to select the appropriate method; for the installation of solar thermal receivers, data on the type and apertive surface are required and for PV solar thermal energy receivers the data on installed net power is required.

1.38.5 Bibliography

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

1.39 Installation of heat pumps for space heating – Slovenia

1.39.1 Calculation of impact on energy consumption (Article 3)

Not available.

1.39.2 Calculation of final energy savings (Article 7)

The measure covers the installation of heat pumps (HP) for space heating in buildings, namely:

- classic heat pumps, i.e. compressor heat pumps driven by an electric motor;
- gas heat pumps, i.e. gas-powered compressor heat pumps;
- sorption heat pumps, i.e. heat pumps with an adsorption or absorption unit and a gas condensation generator as a source of working heat;
- hybrid heat pumps as a combination of a heat pump and a condensation boiler operating as a single heating device.

Energy savings is the difference between the use of energy in a building with an old heating device and the use of energy pump.

Energy savings are calculated in two ways, depending on the available data, namely:

- taking into account the normalised heat needs for heating buildings, knowing the (actual) heated surface of the building, or
- taking into account the actual rated heating power of the heat pump, considering the normal working hours of the heat pump in the heating season.

The energy savings for the heat pump are determined by the following Equations:

Classic Heat Pump:

$$FE_{HP} = (\frac{1}{\eta_{old}} - \frac{K_{el}}{\eta_{HP} \cdot SPF}) \cdot S \cdot A$$

or

$$FE_{HP} = (\frac{1}{\eta_{old}} - \frac{K_{el}}{\eta_{HP} \cdot SPF}) \cdot P \cdot t$$

Gas and Sorption Heat Pump:

$$FE_{HP} = (\frac{1}{\eta_{old}} - \frac{K_{el}}{\eta_{HP} \cdot SPF}) \cdot S \cdot A$$

or

$$FE_{HP} = (\frac{1}{\eta_{old}} - \frac{K_{el}}{\eta_{HP} \cdot SPF}) \cdot P \cdot t$$

Hybrid Heat Pump:

$$FE_{HP} = (\frac{1}{\eta_{old}} - \left(\frac{0.55 \cdot K_{el}}{\eta_{HP} \cdot SPF} + \frac{0.45}{\eta_{new,boiler}}\right)) \cdot S \cdot A$$

or

$$FE_{HP} = (\frac{1}{\eta_{old}} - \left(\frac{0.55 \cdot K_{el}}{\eta_{HP} \cdot SPF} + \frac{0.45}{\eta_{new,boiler}}\right)) \cdot P \cdot t$$

Where:

FE_{HP}	Energy saving [kWh/year] due to replacement of the (old) boiler with a heat pump.
S	Average heat required [kWh/m2 per a]
A	Conditioned area of the building [m2]
t	Operating time of the boiler operation in the heating season (operating at nominal power) [h]; normalised value for the household sector = 1,500 hours/year (determined according to VDI 2067 guidelines)
K_{el}	Electricity conversion factor – the default value is 2, in the case of own electricity generation on site, the value is 1.
η_{old}	Efficiency of the old system (boiler) the normalized value is 0.66.
η_{HP}	The annual operating efficiency of the heating system using the heat pump, the normalized value is 0.93.
SPF	Annual Seasonal Performance Factor of heat pump.
$\eta_{new,boiler}$	Efficiency of the heating system with a condensation boiler as part of a hybrid heat pump – the normalised value is 0.90.

Standardized calculation values

Table 51: Average annual Seasonal Performance Factor of heat pump.

Type of Heat Pump	Classic HP	Gas HP	Sorption HP	Hybrid HP
Air/Water	2.8	1.5	1.26	3.6
Geo/Water	3.5	-	1.3	-
Water/Water	4	-	1.3	-

Increase in the use of renewable energy sources:

The increase in the use of renewable energy sources shall be calculated according to the following formula:

Classic, gas and sorption Heat Pump:

$$SRES_{HP} = \frac{1}{\eta_{HP}} \cdot P \cdot t \cdot (1 - \frac{1}{SPF})$$

Hybrid Heat Pump:

$$SRES_{HP} = \frac{0.55}{\eta_{HP}} \cdot P \cdot t \cdot (1 - \frac{1}{SPF})$$

Where:

$SRES_{HP}$	Energy savings due to the installation of a heat pump [kWh/a]

Methodological aspects

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf

1.39.3 Overview of costs related to the action

Not available. The lifetime expectancy of this measure is 20 years.

1.39.4 Calculation of greenhouse gas savings

The reduction of CO_2 emissions (CES) is calculated according to the formulas bellow:

Classic, gas and sorption Heat Pump:

$$CES_{HP} = (\frac{ef_{f,old}}{\eta_{old}} - \frac{1}{SPF} \cdot \frac{ef_{f,HP}}{\eta_{HP}}) \cdot S \cdot A$$

or

$$CES_{HP} = (\frac{ef_{f,old}}{\eta_{old}} - \frac{1}{SPF} \cdot \frac{ef_{f,HP}}{\eta_{HP}}) \cdot P \cdot t$$

Hybrid Heat Pump:

$$CES_{HP} = (\frac{ef_{f,old}}{\eta_{old}} - \left(\frac{1}{SPF} \cdot \frac{0.55 \cdot ef_{f,HP}}{\eta_{HP}} + \frac{0.45 \cdot ef_{f,new,boiler}}{\eta_{new,boiler}}\right)) \cdot S \cdot A$$

or

$$CES_{HP} = (\frac{ef_{f,old}}{\eta_{old}} - \left(\frac{1}{SPF} \cdot \frac{0.55 \cdot ef_{f,HP}}{\eta_{HP}} + \frac{0.45 \cdot ef_{f,new,boiler}}{\eta_{new,boiler}}\right)) \cdot P \cdot t$$

Where:

CES_{HP}	Reduction of CO_2 emissions [kg CO_2/year] when installing a heat pump.
$ef_{f,HP}$	Emission factor for fuel or electricity for heat pump [kg CO_2/kWh]
$ef_{f,new,boiler}$	Emission factor for fuel or energy source for the new heating system with condensing boiler as part of a hybrid heat pump [kg CO_2/kWh]

Table 52: Emission factors indicative values for calculation of greenhouse gas savings.

ef_{fuel}	Households [kg CO2/kWh]	Services [kg CO2/kWh]	Industry [kg CO2/kWh]
Natural Gas	0.20	0.20	0.20
LFO	0.27	0.27	0.27
Wood biomass	0	0	0
Sectoral average	0.09	0.23	0.21
Electricity	0.49	0.49	0.49
District heating	0.32	0.32	0.32

Data sources for indicative calculation values

Depending on the method of calculation, data on the type of Heat Pump, the heating surface of the building and the heating power of the heat pump is needed for the calculation.

1.39.5 Bibliography

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

1.40 Installation of solar energy receivers – Slovenia

1.40.1 Calculation of impact on energy consumption (Article 3)

Not available

1.40.2 Calculation of final energy savings (Article 7)

Energy savings are equal to the annual energy contribution due to the installation of thermal or photovoltaic solar energy receivers.

The measure refers to the following examples of the transition from the corner to the receivers of solar energy:

a) in existing buildings:

- heating of hot sanitary water,
- heating of hot sanitary water and support for space heating;

(b) in new buildings:

- heating of hot sanitary water – use of solar energy receivers instead of a boiler,
- heating of hot sanitary water and support for space heating – use of solar energy receivers instead of a boiler.

Thermal solar energy receivers

Vacuum receivers of solar energy are more efficient compared to flat ones by about 20% along the same surface area, hence using different normalized values for the annual energy yield of solar energy receivers.

Energy savings from the installation of solar energy receivers for the above examples are calculated using the following equations:

$$FE_{STE} = \frac{U_{STE}}{\eta} \cdot \eta_{STE} \cdot A$$

Photovoltaic solar energy receivers

Photovoltaic modules not connected to the main grid may be used for direct water heating via resistive electric heaters, whereby the PV system must not be connected to the internal low voltage installation of the building. The system shall comply with the safety requirements as set out in the Regulation on the technical requirements of self-sufficient RES devices and shall at all times enable the system to be switched off within the system.

$$FE_{PVSTE} = \frac{U_{PVSTE}}{\eta} \cdot \eta_{PVSTE} \cdot P_{PVSTE}$$

Where:

FE_{STE}	Energy saving [kWh/year] due to implementation of solar energy receiver (Solar thermal energy - STE).
FE_{PVSTE}	Energy saving [kWh/year] due to implementation of PV solar energy receiver (PVSTE).
U_{STE}	annual contribution [kWh/m2/year] of STE solar energy receivers by type: - Flat panel STE = 500 kWh/m2 per year, - Vacuum STE = 600 kWh/m2 per year
U_{PVSTE}	The normalized annual production of solar power PV receivers (1000 kWh/kWp per year).
η	Efficiency (average) of the conventional hot water preparation system – the normalized value is 0.75.
η_{STE}	Solar thermal system efficiency – normalized value is 0.8.
η_{PVSTE}	Efficiency of the photovoltaic solar thermal system – the normalized value is 0.9. Compared to thermal STE, the utilized solar energy from PV STE is distributed evenly over the year: slightly reduced in the summer heat and higher on cold days – energy losses on the way from the receiver to the heating device are significantly lower.
A	Light (apertive) surface [m2] of mounted STE
P_{PVSTE}	Power of photovoltaic modules (kWp)

Standardized calculation values

Standardized calculation values are given under the description of the equations, namely the normalized values for the efficiencies of different technologies.

The increase in the useof renewable energy sources shall be calculated according to the following formula when installing solar thermal energy receivers:

$$\boldsymbol{SRES}_{\boldsymbol{PVSTE}} = \boldsymbol{U}_{\boldsymbol{PVSTE}} \cdot \boldsymbol{\eta}_{\boldsymbol{PVSTE}} \cdot \boldsymbol{P}_{\boldsymbol{PVSTE}}$$

$$\boldsymbol{SRES}_{\boldsymbol{STE}} = \boldsymbol{U}_{\boldsymbol{STE}} \cdot \boldsymbol{\eta}_{\boldsymbol{STE}} \cdot \boldsymbol{A}$$

Where:

$SRES_{STE}$	Increase in the use of renewable energy sources [kWh/year] due to the installation of solar thermal energy receivers
$SRES_{PVSTE}$	Increase in the use of renewable energy sources [kWh/year] due to the installation of PV solar thermal energy receivers

Methodological aspects

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

1.40.3 Overview of costs related to the action

Not available. The lifetime expectancy of this measure is 20 years.

1.40.4 Calculation of greenhouse gas savings

The reduction of CO_2 emissions (CES) is calculated according to the formulas bellow:

Thermal solar energy receivers

$$CES_{STE} = FE_{STE} \cdot ef_f$$

Photovoltaic solar energy receivers

$$CES_{PVSTE} = FE_{PVSTE} \cdot ef_f$$

Where:

CES_{STE}	Reduction of CO_2 emissions [kg CO_2/year] when installing a solar thermal energy system.
CES_{PVSTE}	Reduction of CO_2 emissions [kg CO_2/year] when installing a PV solar thermal energy system.
ef_f	Emission factor for replaced fuel [kg CO_2/kWh]

Table 53: Emission factors indicative values for calculation of greenhouse gas savings.

ef_{fuel}	Households [kg CO2/kWh]	Services [kg CO2/kWh]	Industry [kg CO2/kWh]
Natural Gas	0.20	0.20	0.20
LFO	0.27	0.27	0.27
Wood biomass	0	0	0
Sectoral average	0.09	0.23	0.21

Electricity	0.49	0.49	0.49
District heating	0.32	0.32	0.32

Data sources for indicative calculation values:

In order to use the method, the type of solar energy receivers (flat or vacuum) and their surface area must be known. If the type or type of receiver is not known, the value shall be assumed for the flat performance of the solar energy receiver. For PV solar energy receivers, the installed power of solar energy PV receivers must be known.

1.40.5 Bibliography

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

1.41 PV Microgeneration – United Kingdom

There is no calculation formula neither a detailed methodology publicly available.

Only deemed scores available for substitution of traditional heating systems or upgraded with new installation of solar PV. The base parameters and adjustment factors as described as follows:

Solar PV is an eligible measure under the Home Heating Cost Reduction Obligation (HHCRO) where electric heating is the primary heating source of the premises and the generated heat is used partly or fully for space heating.

The current deemed scores developed for solar PV are based on the following assumptions;

- the installed capacity is 2.5kWp,
- the solar panels are installed in a south facing orientation with an inclination of 30°
- there is modest over shading.

These factors will vary by installation, and they can have a material impact on the saving achieved by the measure.

This methodology will therefore use the Percentage of Property Treated (POPT) to adjust the deemed scores for solar PV measures according to two of the characteristics of the installation.

Approach The POPT of the solar PV deemed score will be adjusted based on two variables;

- Installed capacity
- Orientation and inclination of the installation Installed capacity

The current deemed score is based on an installed capacity of 2.5 kWp. If an installation is greater or less than 2.5 kWp, the POPT should be adjusted on a pro-rata basis up to a maximum of 10 kWp. For example, where an installation has an installed capacity of 5 kWp, POPT should be increased to 200% to reflect that the installation has an installed capacity which is 200% of what the deemed score assumes.

Orientation and inclination

The current deemed score is based on solar panels in a south-facing orientation with an inclination of 30°. If installed outside of these parameters, the power generated by the installation could be significantly different to that assumed in the deemed score. To recognise this, the POPT should be adjusted based on an orientation and inclination factor (OI factor).

The OI factor represents the expected energy yield when considering the orientation and inclination values of a particular installation. Suppliers should select the appropriate OI factor based on the orientation and inclination of a specific installation using table 1. The orientation of a system should be selected on the horizontal axis and the inclination on the vertical axis. Where these points meet will identify the correct band. The key should then be used to identify the OI factor for that band.

Table 54: OI factors for solar PV installations of different orientation and inclinations

	Orientation																								
	North		North West			West			South West			South			South East			East			North East			North	
Inclination	-185°	-165°	-150°	-135°	-120°	-105°	-90°	-75°	-60°	-45°	-30°	-15°	0°	15°	30°	45°	60°	75°	90°	105°	120°	135°	150°	165°	180°
90°																									
80°																									
70°																									
60°																									
50																									
45																									
40																									
35																									
30																									
20																									
10																									
0																									

Key:	
Band colour	**OI factor (%)**
	35
	55
	74
	86
	93
	100

1.41.1 Calculation of impact on energy consumption (Article 3)

Not available

1.41.2 Calculation of final energy savings (Article 7)

There is no formula available.

1.41.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.41.4 Calculation of greenhouse gas savings

Not available

1.41.5 Bibliography

ECO2t Solar PV scoring methodology, V1 – June 2018, issued on Ofgem website

1.42 Installation of a soil-, water or air-source heat pump in new buildings – multEE

The methods described hereunder refer to the installation of soil-, water and air-source heat pumps in new residential buildings. They apply to single-family homes, multi-family homes and big housing blocks.

Attention has to be paid to the fact that the methods described below target exclusively the installation of heat pumps in buildings. The improvement of the building shell, be it through applying higher energy efficiency standards than requested to newly constructed buildings or refurbishing existing buildings thermally, at the same time as installing heat pumps is not covered by the methods in this section.

The method provides for evaluating the energy savings derived from the installation of soil, water- or air-source heat pumps in newly constructed residential buildings. An average heating system for producing heat and hot water serves as reference system.

When applying the formula, the following conditions have to be met:

- The criteria for the minimum Seasonal Performance Factor (SPF) according to Annex VII of the Renewable Energy Directive 2009/28/EC must be taken into account.
- When installing the heat pump, all technical prerequisites for the optimal functioning of the heat pump have to be met.

1.42.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.42.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

Option 1

$$TFES = A \times \left((SHD + HWD) \times EF_{Ref} - (SHD + HWD) \times EF_{Eff}\right)$$

Option 2

$$TFES = A \times \left(\frac{SHD + HWD}{\eta_{Ref}} - \frac{SHD + HWD}{\eta_{Eff}}\right)$$

Where:

TFES	Total final energy savings [kWh/a]
A	Heated gross floor area of the newly constructed building [m2]
SHD	Area-related Space Heating Demand [kWh/m²/a]
HWD	Area-related Domestic Hot Water Demand [kWh/m²/a]

EF_{Ref}	Expenditure Factor of the reference heating system
EF_{Eff}	Expenditure Factor of the efficient heating system
η_{Ref}	Annual use efficiency of the reference heating system
η_{Eff}	Annual use efficiency of the efficient heating system

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects:

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

When applying the methods for calculating energy savings from energy efficiency measures related to buildings and heating systems, a model building needs to be defined, specifying an average value of the (heated) floor area per building type, an average space heating demand per building type (reference and energy efficient building), an average hot water demand per dwelling unit and the efficiency of the heating system based on assumptions made related to the heating structure of the country.

However, if available, project specific values may also be used for the savings calculation, but attention needs to be paid to the fact that project specific values and default values may not mixed in one and the same savings calculation.

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 85. Alternatively, the lifetime may be determined based on national empirical values.

Heated gross floor area of newly constructed residential building (average value): values for determining the heated gross floor area are to be defined in the model building. The average gross floor area may be calculated based on national statistics on newly constructed residential buildings or may be available from analyses of energy certificates, buildings databases etc.

Area-related Space Heating Demand (average value): values for determining the area-related space heating demand are to be defined in the model building.

The average specific space heating demand may be taken from the national building code or may be determined by considering more ambitious regulations on the heating demand of new buildings for example as set in subsidy guidelines.

Average values for the specific space heating demand may also be available from national empirical studies, analyses of energy certificates, buildings databases etc.

Area-related Domestic Hot Water Demand (average value): values for determining the area-related domestic hot water demand are to be defined in the model building. It is calculated based on the building's gross floor area and the efficiency of the heating system providing

not only space heating but also hot water. The efficiency of the heating system is determined by the efficiency of the heating system, the distribution losses and energy demand of auxiliary systems.

Expenditure Factor of the heating system: It is determined by the ratio of heating energy demand (fuel consumption of the heating system) to space heating demand plus domestic hot water demand (ratio of final energy demand to useful energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and
- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

Annual use efficiency of the heating system: It is determined by the ratio of space heating demand plus domestic hot water demand to heating energy demand (ratio of useful energy demand to final energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and
- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

The efficiency of the heating system shall be determined in the model building for the reference and/or efficient heating system. EU Member States may have set default values for the efficiency of the heating system when implementing the Energy Performance Building Directive and consequently the energy performance certificate.

Heating Degree Days: figures may be available either at the national meteorological institute or at the national statistical office.

1.42.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.42.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.42.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

1.43 Installation of a soil-, water or air-source heat pump in existing buildings – multEE

The methods described hereunder refer to the installation of soil-, water and air-source heat pumps in existing residential buildings. They apply to single-family homes, multi-family homes and big housing blocks.

Attention has to be paid to the fact that the methods described below target exclusively the installation of heat pumps in buildings. The improvement of the building shell, be it through applying higher energy efficiency standards than requested to newly constructed buildings

or refurbishing existing buildings thermally, at the same time as installing heat pumps is not covered by the methods in this section.

The method provides for evaluating the energy savings derived from the installation of soil, water- or air-source heat pumps in existing refurbished residential buildings. An average heating system for producing heat and hot water serves as reference system.

When applying the formula, the following conditions have to be met:

- The criteria for the minimum Seasonal Performance Factor (SPF) according to Annex VII of the Renewable Energy Directive 2009/28/EC must be taken into account.
- When installing the heat pump, all technical prerequisites for the optimal functioning of the heat pump have to be met.

1.43.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.43.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

Option 1

$$TFES = A \times \left((SHD + HWD) \times EF_{Ref} - (SHD + HWD) \times EF_{Eff}\right)$$

Option 2

$$TFES = A \times \left(\frac{SHD + HWD}{\eta_{Ref}} - \frac{SHD + HWD}{\eta_{Eff}}\right)$$

Where:

TFES	Total final energy savings [kWh/a]
A	Heated gross floor area of the newly constructed building [m2]
SHD	Area-related Space Heating Demand [kWh/m²/a]
HWD	Area-related Domestic Hot Water Demand [kWh/m²/a]
EF_{Ref}	Expenditure Factor of the reference heating system
EF_{Eff}	Expenditure Factor of the efficient heating system
η_{Ref}	Annual use efficiency of the reference heating system
η_{Eff}	Annual use efficiency of the efficient heating system

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects:

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

When applying the methods for calculating energy savings from energy efficiency measures related to buildings and heating systems, a model building needs to be defined, specifying an average value of the (heated) floor area per building type, an average space heating demand per building type (reference and energy efficient building), an average hot water demand per dwelling unit and the efficiency of the heating system based on assumptions made related to the heating structure of the country.

However, if available, project specific values may also be used for the savings calculation, but attention needs to be paid to the fact that project specific values and default values may not mixed in one and the same savings calculation.

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 85. Alternatively, the lifetime may be determined based on national empirical values.

Heated gross floor area of the thermally refurbished residential building (average value): values for determining the heated gross floor area are to be defined in the model building. The average gross floor area may be calculated based on national statistics on newly constructed residential buildings or may be available from analyses of energy certificates, buildings databases etc.

Area-related Space Heating Demand (average value): values for determining the area-related space heating demand are to be defined in the model building.

The average specific space heating demand may be taken from the national building code or may be determined by considering more ambitious regulations on the heating demand of new buildings for example as set in subsidy guidelines.

Average values for the specific space heating demand may also be available from national empirical studies, analyses of energy certificates, buildings databases etc.

Area-related Domestic Hot Water Demand (average value): values for determining the area-related domestic hot water demand are to be defined in the model building. It is calculated based on the building's gross floor area and the efficiency of the heating system providing not only space heating but also hot water. The efficiency of the heating system is determined by the efficiency of the heating system, the distribution losses and energy demand of auxiliary systems.

Expenditure Factor of the heating system: It is determined by the ratio of heating energy demand (fuel consumption of the heating system) to space heating demand plus domestic hot water demand (ratio of final energy demand to useful energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and
- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

Annual use efficiency of the heating system: It is determined by the ratio of space heating demand plus domestic hot water demand to heating energy demand (ratio of useful energy demand to final energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and

- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

The efficiency of the heating system shall be determined in the model building for the reference and/or efficient heating system. EU Member States may have set default values for the efficiency of the heating system when implementing the Energy Performance Building Directive and consequently the energy performance certificate.

Heating Degree Days: figures may be available either at the national meteorological institute or at the national statistical office.

1.43.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.43.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.43.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

1.44 Replacement of an old boiler with an efficient biomass boiler – multEE

The formula provides for calculating the energy savings resulting from the replacement of old inefficient boilers used for heating and hot water (oil, gas or biomass) with energy efficient biomass boilers. It can be used for single- and multi-family homes as well as for big housing blocks.

1.44.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.44.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

Option 1

$$TFES = n \times A \times \left((SHD + HWD) \times EF_{Ref} - (SHD + HWD) \times EF_{Eff}\right)$$

Option 2

$$TFES = n \times A \times (SHD + HWD)\left(\frac{1}{\eta_{Ref}} - \frac{1}{\eta_{Eff}}\right)$$

Where:

TFES	Total final energy savings [kWh/a]

n	Number of boilers replaced
A	Heated gross floor area of the building [m2]
SHD	Area-related Space Heating Demand [kWh/m²/a]
HWD	Area-related Domestic Hot Water Demand [kWh/m²/a]
EF_{Ref}	Expenditure Factor of the existing heating system
EF_{Eff}	Expenditure Factor of the new heating system
η_{Ref}	Annual use efficiency of the existing heating system
η_{Eff}	Annual use efficiency of the new heating system

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects:

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

When applying the methods for calculating energy savings from energy efficiency measures related to buildings and heating systems, a model building needs to be defined, specifying an average value of the (heated) floor area per building type, an average space heating demand per building type (reference and energy efficient building), an average hot water demand per dwelling unit and the efficiency of the heating system based on assumptions made related to the heating structure of the country.

However, if available, project specific values may also be used for the savings calculation, but attention needs to be paid to the fact that project specific values and default values may not mixed in one and the same savings calculation.

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 85. Alternatively, the lifetime may be determined based on national empirical values.

Area-related Space Heating Demand (reference and energy efficient building): values for determining the area-related space heating demand are to be defined in the model building.

The average specific space heating demand of the reference building may be calculated based on national statistics such as energy balance, useful energy balance and statistics on buildings.

Alternatively, average values for a specific space heating demand for different building types – whether they are thermally refurbished or not – may be available from national empirical studies, analyses of energy certificates, buildings databases etc. For selected European countries (mostly EU Member States), reference can also be made to the EU-

funded projects TABULA and EPISCOPE (http://episcope.eu/welcome/) where national building typologies representing the residential building stock have been developed.

For thermally refurbished buildings, the space heating demand may also be determined by subsidy guidelines, specifying a certain thermal quality to be reached when applying for subsidies for thermal refurbishment.

Area-related Domestic Hot Water Demand (average value): values for determining the area-related domestic hot water demand are to be defined in the model building. It is calculated based on the building's gross floor area and the efficiency of the heating system providing not only space heating but also hot water. The efficiency of the heating system is determined by the efficiency of the heating system, the distribution losses and energy demand of auxiliary systems.

Expenditure Factor of the heating system: It is determined by the ratio of heating energy demand (fuel consumption of the heating system) to space heating demand plus domestic hot water demand (ratio of final energy demand to useful energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and
- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

Annual use efficiency of the heating system: It is determined by the ratio of space heating demand plus domestic hot water demand to heating energy demand (ratio of useful energy demand to final energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and
- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

Reference may be made to the document "EMEEES bottom-up case application 4: Residential condensing boilers in space heating", page 14: http://www.evaluate-energy-savings.eu/emeees/downloads/EMEEES_WP42_Method_4_resboilers_080609.pdf. Alternatively, the national empirical values can be used.

Supplementary information may be sought under:

- Domestic heating and hot water – Choice of fuel and system type, Good Practice Guide, GPG 301: Domestic heating and hot water – Choice of fuel and system type, Good Practice Guide, GPG 301: http://www.perfectheatingandplumbing.com/Docs/gpg301_Dom_Htg_and_HW.pdf
- Domestic Central Heating and Hot Water: Systems with Gas and Oil-fired Boilers, GPG 284: http://regulations.completepicture.co.uk/pdf/Energy%20Conservation/Heating%20Systems%20-%20Boilers/Domestic%20central%20heating%20and%20hot%20water-%20systems%20with%20gas%20and%20oil-fired%20boilers%20-.pdf
- Controls for domestic Central Heating and Hot Water, GPG 302: http://www.draytoncontrols.co.uk/uploadedFiles/Drayton/Industry_Regulation/Good_Practise_Guide_302_ENG.pdf

Heating Degree Days: figures may be available either at the national meteorological institute or at the national statistical office.

1.44.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.44.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.44.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

1.45 Biomass boilers (escorted with old existing ones as additional energy source) – multEE

The measure is about replacing conventional fossil fuel fired boilers with biomass boilers. The biomass boiler can represent:

- the only heating system in the building or
- an additional heating system in the building.

The existing fossil fuel boiler (FFB) is supplemented by a biomass boiler (BMB). The annual heat consumption (Q) is divided into two parts, according to the ratio of heat production (usually: BMB = base load; FFB = peak load/backup). The default values refer to the heat demand (useful heat) by biomass (QBiomass, e.g. QBiomass = 90% of total heat demand) and by fossil fuels (QFossil, e.g. QFossil = 10% of total heat demand).

1.45.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.45.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

Existing fossil fuel boiler escorted with an energy efficient biomass boiler:

Option 1:

$$TFES = n * A * \Big((SHD + HWD) * EF_{Ref} - \big(Q_{Fossil} * (SHD + HWD) * EF_{Ref} + Q_{Biomass} * (SHD + HWD) * EF_{Eff}\big) \Big)$$

Option 2:

$$TFES = n * A * \left(\frac{1 * (SHD + HWD)}{\eta_{Ref}} - \left(\frac{Q_{Fossil} * (SHD + HWD)}{\eta_{Ref}} + \frac{Q_{Biomass} * (SHD + HWD)}{\eta_{Eff}} \right) \right)$$

Or:

$$TFES = n * A * Q_{Biomass} * \left(\frac{(SHD + HWD)}{\eta_{Ref}} - \frac{(SHD + HWD)}{\eta_{Eff}}\right)$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of biomass boilers installed/replaced
A	Heated gross floor area of the building [m2]
SHD	Area-related Space Heating Demand [kWh/m²/a]
HWD	Area-related Domestic Hot Water Demand [kWh/m²/a]
EF_{Ref}	Expenditure Factor of the existing heating system (fossil fuel boiler)
EF_{Eff}	Expenditure Factor of the new heating system (biomass boiler)
η_{Ref}	Annual use efficiency of the existing heating system (fossil fuel boiler)
η_{Eff}	Annual use efficiency of the new heating system (biomass boiler)

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

When applying the methods for calculating energy savings from energy efficiency measures related to buildings and heating systems, a model building needs to be defined, specifying an average value of the (heated) floor area per building type, an average space heating demand per building type (reference and energy efficient building), an average hot water demand per dwelling unit and the efficiency of the heating system based on assumptions made related to the heating structure of the country.

However, if available, project specific values may also be used for the savings calculation, but attention needs to be paid to the fact that project specific values and default values may not mixed in one and the same savings calculation.

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 85. Alternatively, the lifetime may be determined based on national empirical values.

Area-related Space Heating Demand (reference and energy efficient building): values for determining the area-related space heating demand are to be defined in the model building.

The average specific space heating demand of the reference building may be calculated based on national statistics such as energy balance, useful energy balance and statistics on buildings.

Alternatively, average values for a specific space heating demand for different building types – whether they are thermally refurbished or not – may be available from national empirical studies, analyses of energy certificates, buildings databases etc. For selected European countries (mostly EU Member States), reference can also be made to the EU-funded projects TABULA and EPISCOPE (http://episcope.eu/welcome/) where national building typologies representing the residential building stock have been developed.

For thermally refurbished buildings, the space heating demand may also be determined by subsidy guidelines, specifying a certain thermal quality to be reached when applying for subsidies for thermal refurbishment.

Area-related Domestic Hot Water Demand (average value): values for determining the area-related domestic hot water demand are to be defined in the model building. It is calculated based on the building's gross floor area and the efficiency of the heating system providing not only space heating but also hot water. The efficiency of the heating system is determined by the efficiency of the heating system, the distribution losses and energy demand of auxiliary systems.

Expenditure Factor of the heating system: It is determined by the ratio of heating energy demand (fuel consumption of the heating system) to space heating demand plus domestic hot water demand (ratio of final energy demand to useful energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and
- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

Annual use efficiency of the heating system: It is determined by the ratio of space heating demand plus domestic hot water demand to heating energy demand (ratio of useful energy demand to final energy demand). Input parameters for the calculation are:

Space heating demand (plus domestic hot water demand) and

Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

In addition, reference can be made to the European standard EN 303-5:2012. "Heating boilers for solid fuels, manually and automatically stoked, nominal heat output of up to 500 kW. Terminology, requirements, testing and marking".

Heating Degree Days: figures may be available either at the national meteorological institute or at the national statistical office.

1.45.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.45.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.45.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35,

https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

1.46 Solar assisted space heating – multEE

The measure refers to the installation of solar thermal plants for hot water and auxiliary heating purposes in existing and newly constructed buildings. The heat generated with solar panels reduces the amount of heat to be generated with an existing heating system.

The method applies to flat plate collectors and evacuated tube collectors which differ from their heat output.

1.46.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.46.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

Option 1:

$$TFES = A * Q_{ave_{yield}} * EF_{Ref}$$

Option 2:

$$TFES = A * Q_{ave\_yield} * \frac{1}{\eta_{Ref}}$$

Where:

TFES	Total final energy savings [kWh/a]
A	Installed collector surface [m²]
Q_{ave_yield}	Average yearly heat output per m² installed collector surface [kWh/m2/a]
EF_{Ref}	Expenditure Factor of the existing heating system
η_{Ref}	Annual use efficiency of the existing heating system

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

When applying the methods for calculating energy savings from energy efficiency measures related to buildings and heating systems, a model building needs to be defined, specifying

an average value of the (heated) floor area per building type, an average space heating demand per building type (reference and energy efficient building), an average hot water demand per dwelling unit and the efficiency of the heating system based on assumptions made related to the heating structure of the country.

However, if available, project specific values may also be used for the savings calculation, but attention needs to be paid to the fact that project specific values and default values may not mixed in one and the same savings calculation.

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 85. Alternatively, the lifetime may be determined based on national empirical values.

Average yearly heat output per m² installed collector surface for flat plate collectors and evacuated tube collectors: in order to define the average yearly heat output of a solar thermal plant, an average plant has to be defined (size, alignment, angle of inclination, shading, etc.).

In case no national data is available on the average yearly heat output of an average solar thermal plant, reference can be made to the following software: T*Sol: http://valentin.de/calculation/thermal/start/en - an Online Solar Calculation and Simulation of Solar Thermal Systems.

Expenditure Factor of the heating system: It is determined by the ratio of heating energy demand (fuel consumption of the heating system) to space heating demand plus domestic hot water demand (ratio of final energy demand to useful energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and
- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

Annual use efficiency of the heating system: It is determined by the ratio of space heating demand plus domestic hot water demand to heating energy demand (ratio of useful energy demand to final energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and
- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

The efficiency of the heating system shall be determined in the model building for the reference and/or efficient heating system. EU Member States may have set default values for the efficiency of the heating system when implementing the Energy Performance Building Directive and consequently the energy performance certificate.

1.46.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.46.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.46.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35,

https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

1.47 Water heating with solar energy – multEE

The measure refers to the installation of solar thermal plants for hot water and auxiliary heating purposes in existing and newly constructed buildings. The heat generated with solar panels reduces the amount of heat to be generated with an existing heating system.

The method applies to flat plate collectors and evacuated tube collectors which differ from their heat output.

1.47.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

1.47.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

Option 1:

$$TFES = A * Q_{ave_{yield}} * EF_{Ref}$$

Option 2:

$$TFES = A * Q_{ave\_yield} * \frac{1}{\eta_{Ref}}$$

Where:

TFES	Total final energy savings [kWh/a]
A	Installed collector surface [m²]
Q_{ave_yield}	Average yearly heat output per m² installed collector surface [kWh/m2/a]
EF_{Ref}	Expenditure Factor of the existing heating system
η_{Ref}	Annual use efficiency of the existing heating system

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

When applying the methods for calculating energy savings from energy efficiency measures related to buildings and heating systems, a model building needs to be defined, specifying an average value of the (heated) floor area per building type, an average space heating demand per building type (reference and energy efficient building), an average hot water demand per dwelling unit and the efficiency of the heating system based on assumptions made related to the heating structure of the country.

However, if available, project specific values may also be used for the savings calculation, but attention needs to be paid to the fact that project specific values and default values may not mixed in one and the same savings calculation.

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 85. Alternatively, the lifetime may be determined based on national empirical values.

Average yearly heat output per m² installed collector surface for flat plate collectors and evacuated tube collectors: in order to define the average yearly heat output of a solar thermal plant, an average plant has to be defined (size, alignment, angle of inclination, shading, etc.).

In case no national data is available on the average yearly heat output of an average solar thermal plant, reference can be made to the following software: T*Sol: http://valentin.de/calculation/thermal/start/en - an Online Solar Calculation and Simulation of Solar Thermal Systems.

Expenditure Factor of the heating system: It is determined by the ratio of heating energy demand (fuel consumption of the heating system) to space heating demand plus domestic hot water demand (ratio of final energy demand to useful energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and
- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

Annual use efficiency of the heating system: It is determined by the ratio of space heating demand plus domestic hot water demand to heating energy demand (ratio of useful energy demand to final energy demand). Input parameters for the calculation are:

- Space heating demand (plus domestic hot water demand) and
- Heating energy (fuel) demand determined by the boiler's efficiency, distribution losses and energy demand of auxiliary systems.

The efficiency of the heating system shall be determined in the model building for the reference and/or efficient heating system. EU Member States may have set default values for the efficiency of the heating system when implementing the Energy Performance Building Directive and consequently the energy performance certificate.

1.47.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

1.47.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

1.47.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

Chapter 2 Measures alleviating (also) Energy Poverty

No methodology could be found in any country where the savings are estimated specifically for the target group, energy poor households.

2.1 Related information from Austria

There are no methodologies specifically directed towards savings in energy poor households in Austria.

In the 2014 – 2020 reporting period of the Austrian Energy Efficiency Obligation Scheme, an incentive was provided for obligated parties to implement actions in this area:

The savings of actions implemented in an energy poor household are multiplied with a factor of 1.5. This factor can be applied to all methodologies mentioned in the Austrian catalogue of standardized calculation methodologies targeting households. Additionally, the factor can also be applied for actions implemented in energy poor households where the calculation of savings did not follow a standardized methodology, but was conducted by an authorized person, e.g., an energy auditor ("Individual Evaluation").

Parties reporting such actions have to provide certain information to confirm that the households are considered energy poor. If the action is directly coordinated with energy poor households, certificates stating that the household is exempted from certain tax payments are the most common form of documentation. In case an action is coordinated with a NGO working in this area and targets a large number of households, confirmation by the NGO that only energy poor households have been included is sufficient.

However, even though 27 % of savings reported in the 2014 – 2020 reporting period were implemented in households, only 0.55 % of the total savings reported were implemented in energy poor households. This is most likely due to the high efforts in documentation needed in order to apply the 1.5 factor.

Actions most commonly reported for energy poor households include the replacement of heating systems, energy advice and replacement of household equipment (replacement of old lamps with LED, white goods, etc.).

It should be noted that the factor of 1.5 was only used as an incentive to implement actions in energy poor households within the Energy Efficiency Obligation Scheme. It does not represent actual higher savings achieved, but implementing actions in this area will contribute more towards reaching the savings target of the obligated party. For the reporting of savings archived under Article 7 EED to the European Commission, the factor was therefore not included.

2.2 Related information from Croatia

Croatia is one of the countries using administrative uplifts (adding calculating savings) in case energy poor household is where the measure is implemented. The financing programmes for energy poor households are increasing in number and in the overall sum. These energy poverty alleviation programmes need to be reported, monitored, and verified within the national System for Monitoring and Verifying Energy Savings (SMiV). **The EEOS**

include a 1.1 to 1.3 uplift, depending on whether the energy poor households are targeted in developing areas or are defined as vulnerable consumers. It is expected in the future there will be a combination of alternative measures and EEOS to combat energy poverty, with an implemented monitoring programme aimed specifically at energy poor households.

Translation of Art. 21 of Energy Savings Obligation Regulation:

Achieving a social goal (Article 21)

(1) With the aim of reducing energy poverty, energy efficiency shall be encouraged in households of beneficiaries of the vulnerable consumers in accordance with the regulation on social welfare and in households in areas with developmental challenges, according to the provisions of the law governing regional development.

(2) The calculation of savings resulting from measures taken in final consumption in areas with developmental peculiarities to the savings holder shall be increased by 10%.

(3) The calculation of savings resulting from measures taken in the residential premises of the beneficiary of the fee for a vulnerable energy consumer shall be increased by 20%.

(4) The obligated party shall set out its request for the increase referred to in paragraph 1 of this Article in the savings report.

Actions included are mostly energy renovation of buildings, partial or total.

2.2.1 Bibliography

Rules on the Energy Efficiency Obligation System, NN 41/2019

https://narodne-novine.nn.hr/clanci/sluzbeni/2019_04_41_847.html

2.3 Related information from France

In France, there is no particular measure alleviating energy poverty.

In the energy savings certificates scheme (ESCS), there are two kinds of obligation. A classic obligation to carry out energy saving operations from the catalog of standardized sheets or from filing a claim for energy savings certificates for a special operation. An obligation on energy poverty. Operations whose beneficiary is a household in a situation of energy poverty make it possible to obtain “poverty ESC”. These ESC will make it possible to fulfill the energy poverty obligation for the period.

The “poverty ESC have a higher price on the market, which encourages those obliged to direct their actions in priority to households in a situation of energy poverty.

2.4 Related information from Ireland

In the new EEOS scheme, at least 5% of the EEOS Target must be achieved through measures delivered in energy poor homes (the Energy Poverty Delivery Sub-target). In achieving this sub-target, which will be set at 5% for all obligated parties, obligated parties will be required to meet new delivery requirements.

In defining an 'eligible energy poor home' for the purpose of the EEOS, the Irish Government sets on prioritising and targeting support towards those energy poor households who are living in the worst performing homes, i.e. homes with the lowest energy ratings (BER).

The Irish Goverment has decided that savings from measures will be eligible under the Energy Poverty Delivery Sub-target where

1. the measures have been delivered in an 'eligible energy poor home', which is a property:

- with a pre-works BER of an D2 rating or worse (i.e. > 250 kWh/m2/yr); and
- which is occupied by a person in receipt of a Warmer Homes-eligible welfare payment or is owned by a Local Authority/Housing Association

AND

2. the post-works BER reaches a B2 rating or better (i.e. < 125 kWh/m2/yr).

In meeting the above requirements:

- A published pre and post BER will be required in relation to all residential measures installed from 1 January 2022.
- Any measure that can deliver eligible final energy savings, and which can be modelled in DEAP, will be eligible, subject to meeting all other relevant requirements.

2.4.1 Bibliography

Ireland's Energy Efficiency Obligation Scheme Summary of responses to public consultation and policy decisions on scheme design October 2021. From Department of the Environment, Climate and Communications, Irish Government (www.gov.ie)

2.5 Related information from Lithuania

Energy efficiency (EE) measures reduce household costs for energy services by reducing energy consumption. Effects of current EE measures on cost reduction in 2017-2020*:

- **EE2.** Renovation/modernisation of multi-apartment buildings. Upgrading an apartment building to class C and save 40% of energy. By the end of 2030 Around 5,000 apartment buildings should be renovated or nearly 500 renovations each year Multi-apartment buildings.
- **EE6.** Agreements with energy suppliers on consumer education and energy advice. Energy suppliers will provide consumer education and the scope and means of consumer education and advice that provided for in agreements between them or through agreements between themselves and others, implementation.
- **EE7.** Replacement of boilers with more efficient technologies. 10 000 households will have replaced their homes by 2030 boilers and other heat-using appliances will be replaced energy efficiency improvements measures.
- **EE8.** Modernisation of internal heating and hot water systems in multi-apartment buildings (n.a.). A financial instrument that will boost the performance of buildings building owners to refurbish old elevator-type heat points to a newer single-loop type type heat station. Planned reimbursement of up to 30% of investment costs and Upgrade around 250 heat points each year.

- **EE11.** Renovation of individual houses. Energy provider price comparison tool and the development of an energy information update of energy poverty information by providing information on solutions for energy advisors and consumers.

Educational and advisory measures:

Communication to reduce energy consumption of end-users is carried out in accordance with agreements between the Ministry of Energy and energy suppliers:

- Websites
- In the press
- Television and radio programmes
- Telephone advice
- Supplementing bills with information content
- At publicity events

Energy suppliers:

- Draw consumers' attention to high energy consumption
- Provide opportunities to compare consumption with each other
- Provide practical energy saving advice
- Advise on support options

A cornerstone of a sustainable internal market is the availability of energy services to all citizens, to ensure that consumers' basic needs and health are met. However, Lithuania faces the problem of energy poverty (sometimes referred to as energy poverty), where it is difficult or impossible for people to heat their homes adequately or to access essential energy services.

Energy poverty is caused by four main problems:

- Inefficient energy use,
- high energy prices,
- low household incomes
- lack of consumer awareness.

Energy poverty is also reflected in the energy poverty indicators. EU data also indicates hidden energy poverty, where households may be under-spending and under-servicing. Energy poverty primarily affects vulnerable groups: the elderly, children, people with chronic illnesses, single parents and the unemployed. Tackling this urgent social problem requires a comprehensive policy approach combining social and environmental policies.

To tackle energy poverty, the objective is "Reducing energy poverty", with national indicators and targets.

To achieve these targets, Lithuania is taking a comprehensive approach, covering energy efficiency, household income, energy prices and consumer information. In Lithuania, as in 8 other EU countries, the EU-funded Horizon 2020 project STEP - Solutions to Tackle Energy Poverty was launched in 2019. STEP's main objective is to alleviate energy poverty by promoting changes in consumer behaviour. The project and national measures to tackle energy poverty take into account financial support (reimbursement of a share of the heating and water costs of housing for people in need, public support for the renovation/modernisation of multi-apartment buildings through credit and interest payments), improve the energy efficiency of buildings and equipment and raise consumer awareness.

2.5.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

2.5.2 Calculation of final energy savings (Article 7)

In order to reduce energy poverty, the National Energy and Climate Action Plan of the Republic of Lithuania 2021-2030 provides for the following measures:

- Renovation (modernisation) of multi-apartment buildings;
- Agreements with energy suppliers on consumer education and energy advice;
- Replacement of boilers with more efficient technologies;
- Upgrading of internal heating and hot water systems in multi-apartment buildings;
- Renovation of individual houses.

Each of these measures can be used not only to reduce energy poverty but also to improve energy efficiency. They can also be applied to all groups of the population, which is not necessarily limited to socially vulnerable groups.

The calculation of final energy savings is usually based on the difference between the energy consumed before the measure and the energy consumed after the measure.

2.5.3 Bibliography

Description of the procedure for the climate change programme for the compliance benefits for the improvement of the interior heating and hot water systems of multi-apartment houses - https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/4f3893820a0a11eaa727fba41f42a7e9/asr

Description of renewable energy resources for the use of electricity for the electricity needs of non-resident individuals and for the replacement of heating devices https://e-seimas.lrs.lt/portal/legalAct/lt/TAP/268436a0dfac11eb866fe2e083228059?positionInSearchResults=0&searchModelUUID=a9c5c543-4451-48d3-b6eb-32b24bfe881a

Procedural description for the climate change programme for individuals 'use of renewable energy sources for the replacement of electrical energy needs and/or change of heating equipment for non-insident individuals https://www.e-tar.lt/portal/lt/legalAct/2c848570ff4911eb9f09e7df20500045

Use of renewable energy sources (solar) for the electricity needs of natural persons in need and/or for the replacement of fossil fuel-fired heating installations https://apvis.apva.lt/paskelbti_kvietimai/atsinaujinanciu-energijos-istekliu-saules-panaudojimas-nepasiturinciu-fiziniu-asmenu-elektros-energijos-reikmems-ir-ar-iskastini-kura-naudojanciu-silumos-irenginiu-pakeitimui-2021-09

2.6 Related information from Slovenia

Energy poverty occurs in low-income households, which, due to social distress, are unable to provide adequate energy services. Energy poverty most often affects the most vulnerable groups, such as the unemployed, pensioners and low-paid employees.

The Eco Fund (Slovenian alternative measures authority) offers a number of measures to reduce energy poverty and improve the quality of life:

- 100 % of the subsidy for certain investments in the renovation of residential buildings;
- a visit from an energy consultant with a free package of appliances and advice on energy use.

2.6.1 The ZERO500 programme

The ZERO500 program is aimed at low-income households facing energy poverty. The Eco-Fund will, on the basis of a public call, grant eligible investors a non-refundable financial incentive of 100% of the eligible investment costs to make investments in energy efficiency measures.

A financial incentive may be granted for investments in actions which, prior to the signing of a Tripartite contract between the investor, the contractor of each measure and the Eco Fund for the following measures:

- thermal insulation of the roof and/or ceiling;
- thermal insulation of the facade;
- installation of energy-efficient windows and/or front doors;
- replacing the hot water preparation system with a water heater with solar energy receivers;
- replacing an inefficient hot water preparation system with a heat pump water heater;
- installation of local ventilation by returning heat from waste air.

2.6.2 Energy poverty reduction measures for citizens (ZERO program)

Within the ENSVET counselling network managed by the Eco Fund, consultants also carry out the Energy Poverty Reduction (ZERO) activity.

Citizens who are recipients of regular financial social assistance apply for a professional consultant at their Social Work Centre with a completed ZERO leaflet for a free visit from an energy consultant at home.

When visiting their home, the energy consultant performs required measurements and calculations to advise on how to reduce energy and water use and corresponding costs. In addition to the advice, councils also receive a package of simple devices to reduce energy and water use (energy and water efficiency lamps, electric extension cords with off switch, energy tap and shower attachments, window seals, etc.).

Following the advice of the consultant and by installing energy saving devices, the cost of energy and water consumed on an annual basis can be reduced by around EUR 100. In the following, the consultant also presents options for various more complex measures for which (perhaps in the future) the Eco Fund could provide support in the form of a grants or credit.

Furthermore, Eco Fund also provides the 100 % subsidy for the replacement of heating boilers and furnaces for the recipients of monthly financial social aid for replacing the old furnace. A 100 % subsidy is also envisaged for the renovation of multi-dwelling buildings for the recipients of monthly financial social aid for the investments in increased energy efficiency of buildings with three or more parts and the renovation of common boiler rooms.

2.6.3 Data sources for indicative calculation values:

All the savings of implemented measures are calculated and reported in accordance with the national catalogue methodology where also the indicative calculation values are reported per measure.

2.6.4 Bibliography

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

The information on measures elevating Energy Poverty were summarised from Eco Fund webpage: https://www.ekosklad.si/prebivalstvo/zmanjsevanje-energetske-revscine.

2.7 Investeringssubsidie Duurzame Energie (ISDE) – The Netherlands

The Sustainable Energy Investment Grant (ISDE) is a financial contribution for the purchase of solar boilers, heat pumps and from 2021 also for insulation measures. This scheme is for both individuals and business users.

With the ISDE, the national government encourages Dutch households and companies to use less natural gas and more sustainable heat. This saves energy and reduces CO2 emissions.

2.7.1 Calculation of impact on energy consumption (Article 3)

The technical estimates are used for both the realized (ex-post) and expected (ex-ante) energy savings. This also applies to the ISDE. The energy savings will be determined based on data in the subsidy application about the type of technology, using key figures.

2.7.2 Calculation of final energy savings (Article 7)

No method is used for the conversion from primary to final energy consumption, because the energy savings will be determined in terms of final energy savings.

All measures supported by the ISDE (i.e. heat pumps, solar boilers and from 2021 also insulation measures) have a lifespan of more than 10 years. When determining the energy savings, a decrease in energy savings over the lifetime is not considered. As so far there are no indications that this plays a significant role.

The thermal capacity of the subsidized heat pumps is known per application. This concerns both heat pumps that use ambient heat from the air and the shallow soil. The expected heat production and the required electricity consumption are determined using key figures. The difference between them (the consumption of ambient heat) is counted as a saving on the final consumption of natural gas.

For the subsidized solar boilers, the thermal capacity is also known per application. The heat production per solar boiler is an assumed average, production that varies according to the aperture area. This assumed production for systems up to 10 m2 is corrected for the annual share of heat not obtained from solar energy according to the product card and the supplementary electricity consumption according to the product card. For systems larger than 10 m2, the heat production depends on the total collector surface, the collector

efficiency, the irradiation angle modifier, and the loss factor of the hot water tank. The heat production is counted as a saving on the final consumption of natural gas.

The climate differences within the Netherlands are so small that they are not taken into account when determining the effects of policy measures.

2.7.3 Overview of costs related to the action

In 2022, a €228 million budget is available for solar boilers, (hybrid) heat pumps, insulation measures and connections to a heat network. A budget of €30 million is available in 2022 for small-scale wind turbines and solar panels. A new budget is made available every year. The ISDE subsidy will continue until 2030.

The amount of the subsidy per device or measure depends on the type of solar boiler, heat pump or insulation. And its energy performance. The indicative amounts can be found on the appliance lists. A fixed amount of €3,325 applies for the connection to a heat network.

The available subsidy budget for investments in heat pumps, solar boilers, insulation and heat networks by business users and/or private individuals will be €228 million in 2022. In January 2022, 4,172 applications were submitted for 9,017 devices and/or measures.

The partially estimated claim of these applications is €15.4 million. The estimated budget claim 2022 includes private applications.

On the left the overview of citizens. In total 40M€ of the budget is claimed, of which 26,1M€ went to insulation measures, the other major claim is for heat pumps 12,7M€.

2.7.4 Bibliography

RVO ISDE website: https://www.rvo.nl/subsidies-financiering/isde

TNO report - De feiten over energiearmoede in Nederland Inzicht op nationaal en lokaal niveau: https://publications.tno.nl/publication/34638644/4OIuwM/TNO-2021-P11678.pdf

2.8 Related information from United Kingdom

This new ECO4 policy will be entirely formed from one obligation, the Home Heating Cost Reduction Obligation (HHCRO). Under HHCRO, obligated suppliers must mainly promote

measures which improve the ability of low income, fuel poor and vulnerable households to heat their homes. This includes actions that result in heating savings, such as the installation of insulation or the upgrade of an inefficient heating system. The target is divided between suppliers based on each supplier's relative share of the domestic gas and electricity market.

HHCRO is now the only funding channel in the Government's ECO scheme. It is designed to reduce the cost of heating and insulation improvements for residents that are struggling to keep on top of their fuel bills.

Previously, funding was available through the CERO channel (Carbon Emissions Reduction Obligation) which covered all householders, but this was axed in October 2018. This change means that the ECO scheme is now 100% means tested and focused on supporting the most vulnerable residents.

This policy is intended to drive uptake of energy efficiency measures among low income and vulnerable households in or at risk of fuel poverty, that would not have occurred in the absence of intervention.

The intended effects are to:

- make progress against Government's statutory fuel poverty and climate change commitments
- reduce energy demand in the residential sector
- thereby lowering energy bills and improving energy security
- improve thermal comfort and subsequent health outcomes
- support jobs and growth.

The British Government focus here is on:

- To support on owner occupied EPC D-G homes, but with support to both private rented properties and social housing for certain measures
- Set minimum requirements to improve EPC D and E homes to at least EPC C and EPC F and G homes to at least EPC D
- Increase the proportion of the scheme that suppliers can deliver with Local Authorities (Flexible Eligibility), or Scottish and Welsh Governments, to 50% of obligation
- Overall target of £224.3 million in notional annual bill savings to be achieved by March 2026
- Band E, F and G sub obligation of £155.9 million in notional annual bill savings between April 2022 to March 2026, this is broadly equivalent to 150,000 private tenure homes.
- Set a solid wall minimum at 90,000 solid walls being insulated over the April 2022 to March 2026 period.
- Limit the repair and replacement of broken efficient heating systems to 5,000 per year each (up to 40,000 measures in total over the four years)

2.8.1 Bibliography

Energy Company Obligation ECO4: 2022 – 2026 Government Response, issued on website of BEIS (Department for Business, Energy and Industrial Strategy).

Chapter 3 Anticipated motor replacement

3.1 Replacement of electrically operated stationary motors - Austria

An electrically operated stationary motor is replaced by a more efficient electric motor. Other system components and all general conditions remain unchanged. Default values are available for electric motors used in industry with nominal output powers of at least 0.75 kW. The rated output power of the motor must be defined project-specifically.

A prerequisite for the measure to be eligible is that the new electric motor achieves the efficiency level IE3 defined in Regulation No. 640/2009 of the European Commission (Ecodesign Regulation).

3.1.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

3.1.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = n \times P \times h_o \times f_L \times \left(\frac{1}{\eta_{baseline}} - \frac{1}{\eta_{action}}\right) \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of replaced motors [-]
P	Nominal power output of the electric motor [kW]
h_o	Annual operating hours [h/a]
f_L	Average load of the electric motor [-]
$\eta_{baseline}$	Efficiency of the electric motor in the baseline situation [-]
η_{action}	Efficiency of the electric motor after replacement [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

Standardized calculation values

Table 55: Indicative values for calculation of final energy savings (Article 7).

Parameter	0,75 < P ≤ 7,5 kW	7,5 < P ≤ 75 kW	P > 75 kW	Unit
h_o	2,600	3,300	6,000	[h/a]
f_L	0.6	0.6	0.6	[-]
$\eta_{baseline}$	0.824	0.912	0.941	[-]
η_{action}	0.869	0.934	0.941	[-]
Lifetime of savings	12	15	20	[a]

Methodological aspects

This methodology is a suggestion for new methodologies to be added to the Austrian catalogue of bottom up methodologies. It has not been officially published, but is available on the website of the Austrian Energy Efficiency Monitoring Agency in German language.

The energy consumption of an electric motor results from its nominal output power, the operating hours, the average load and its efficiency. The final energy savings in terms of this method result from the improvement in efficiency with the same nominal output power. Operating conditions such as the operating hours and the average utilization of the engine remain unchanged.

The indicative calculation values distinguish between three performance categories that represent small, medium-sized and large motors. This categorization is based on the product classes for multi-phase AC motors of the Eurostat production statistics Prodcom.

Data sources for indicative calculation values

Annual operating hours of the electric motor h_o:

The annual operating hours of the electrically operated motors were determined using data on electric motors installed in industry in the EU-15. The average operating hours quoted by SAVE (2000) are distinguished by power class and industry. In order to obtain average values for each performance category, weighted mean values were formed across all branches of industry according to the installed number.

Average utilization f_u:

The average utilization of electric motors corresponds to the average utilization of 60% stated in a preliminary study for the EuP Directive for electric motors (Almeida et al., 2008)(European Commission 2005). It is the same for all performance categories.

Efficiency of the existing electric motor $\eta_{baseline}$:

The efficiency of the existing electric motors corresponds to average values of the minimum efficiency for the efficiency levels IE1 and IE2 according to the IEC 60034-30 standard or Annex I of Regulation No. 640/2009 of the European Commission (Ecodesign Regulation). The minimum efficiency for 4-pole motors was used because this group clearly has the largest market share (Almeida et al., 2008). For both efficiency levels IE1 and IE2, the minimum efficiency of the individual nominal output powers was combined to mean minimum efficiency of the power classes as defined in this method. The mean minimum efficiency for the efficiency levels IE1 and IE2 were then weighted and averaged. Sales data from 1998 to 2009 was used for this, broken down into percentages according to efficiency

levels, which were extrapolated to follow the trend (Almeida et al., 2014). Depending on the service life of the performance category, the last 12, 15 or 20 years were considered and defined as stock. Assuming that as of June 2011, due to the requirements of Regulation No. 640/2009 of the European Commission, no motors with a poorer efficiency level than IE2 were sold, the weighting of the efficiency levels shows the following results:

Table 56: Shares of efficiency levels in the electric motor stock.

Parameter	0,75 < P ≤ 7,5 kW	7,5 < P ≤ 75 kW	P > 75 kW
Lifetime	12 years	15 years	20 years
Share of IE2	53 %	44 %	33 %
Share of IE1	47 %	56 %	67 %

Efficiency of the efficient electric motor η_{action}:

The efficiency of the efficient electric motors corresponds to the minimum efficiency for the efficiency level IE3 (50 Hz) of Annex I of Regulation No. 640/2009 of the European Commission (Ecodesign Regulation). The minimum efficiency for 4-pole motors was used, as this group clearly has the largest market share (Almeida et al., 2008). For the efficiency level IE3, the minimum efficiency of the individual nominal output powers were combined to a mean minimum efficiency of the power classes defined in this method.

3.1.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

3.1.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

3.1.5 Bibliography

Austrian Energy Efficiency Monitoring Agency (2021). Bewertung von Energieeffizienzmaßnahmen, https://www.monitoringstelle.at/monitoring/energielieferanten/bewertung-von-energieeffizienzmassnahmen

SAVE (2000). Improving the Penetration of Energy-Efficient Motors and Drives.

Almeida et al. (2008). EUP Lot 11 Motors Final. Coimbra: ISR – University of Coimbra.

European Commission (2005). Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council

Almeida et al. (2014): EuP Lot 30: Electric Motors and Drives. Task 1: Produkt Definition, Standards and Legislation ENER/C3/413-2010 Final April 2014

3.2 Replacement of electrically operated stationary motors with variable speed drives - Austria

An electrically operated stationary motor is replaced by a more efficient electric motor. This includes a power adjustment and the equipment with a variable speed drive. Indicative calculation values are available for electric motors used in industry with nominal output powers from 0.75 kW. The nominal output power and the average loads before and after replacing the motor must be specified project-specifically.

A prerequisite for the measure to be eligible is that the new electric motor achieves the efficiency level IE3 defined in Regulation No. 640/2009 of the European Commission (Ecodesign Regulation).

3.2.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

3.2.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = n \times h_o \times \left(\frac{P_{baseline} \times f_{baseline}}{\eta_{baseline}} - \frac{P_{action} \times f_{action}}{\eta_{action}} \right) \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of replaced motors [-]
h_o	Annual operating hours [h/a]
$P_{baseline}$	Nominal power output of the electric motor to be replaced [kW]
$f_{baseline}$	Average load of the electric motor to be replaced [-]
P_{action}	Nominal power output of the electric motor after replacement [kW]
f_{action}	Average load of the electric motor after replacement [-]
$\eta_{baseline}$	Efficiency of the electric motor to be replaced [-]
η_{action}	Efficiency of the electric motor after replacement [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

Standardized calculation values

Table 57: Indicative values for calculation of final energy savings (Article 7).

Parameter	0,75 < P ≤ 7,5 kW	7,5 < P ≤ 75 kW	P > 75 kW	Unit
h_o	2,600	3,300	6,000	[h/a]
$\eta_{baseline}$	0.824	0.912	0.941	[-]
η_{action}	0.869	0.934	0.958	[-]
Lifetime of savings	12	15	20	[a]

Methodological aspects

This methodology is a suggestion for new methodologies to be added to the Austrian catalogue of bottom up methodologies. It has not been officially published, but is available on the website of the Austrian Energy Efficiency Monitoring Agency in German language.

The energy consumption of an electric motor results from its nominal output power, the operating hours, the average load and its efficiency. The final energy savings in terms of this method result from the improvement in efficiency, an increase in utilization and/or a reduced nominal output power. The engine operating hours remain unchanged.

The indicativevalues distinguish between three performance categories that represent small, medium and large motors. This categorization is based on the product classes for multi-phase AC motors of the Eurostat production statistics Prodcom.

Data sources for indicative calculation values

Annual operating hours of the electric motor h_o:

The annual operating hours of the electric motors were determined using data on electric motors installed in industry in the EU-15. The average operating hours quoted by SAVE (2000) are broken down by power class and branch of industry. In order to obtain average values for each performance category, weighted mean values were formed across all branches of industry according to the installed number.

Efficiency of the existing electric motor $\eta_{baseline}$:

The efficiency of the existing electric motors corresponds to average values of the minimum efficiency for the efficiency levels IE1 and IE2 according to the IEC 60034-30 standard or Annex I of Regulation No. 640/2009 of the European Commission (Ecodesign Regulation). The minimum efficiency for 4-pole motors was used, as this group clearly has the largest market share (Almeida et al., 2008). For both efficiency levels IE1 and IE2, the minimum efficiency of the individual nominal output power was combined to mean minimum efficiency of the power classes defined in this method. The mean minimum efficiency for the efficiency levels IE1 and IE2 were then weighted and averaged. Sales data from 1998 to 2009 was used for this, broken down into percentages according to efficiency levels, which were extrapolated to follow the trend (Almeida et al., 2014)). Depending on the service life of the performance category, the last 12, 15 or 20 years were considered and defined as stock. Assuming that as of June 2011, due to the requirements of Regulation No. 640/2009 of the European Commission, no motors with an efficiency level lower than IE2 were sold, the following weighting of the efficiency levels is used:

Table 58: Shares of efficiency levels in the electric motor stock.

Parameter	0,75 < P ≤ 7,5 kW	7,5 < P ≤ 75 kW	P > 75 kW
Lifetime	12 years	15 years	20 years
Share of IE2	53 %	44 %	33 %
Share of IE1	47 %	56 %	67 %

Efficiency of the electric motor after replacement η_{action}:

The efficiency of the efficient electric motors corresponds to the minimum efficiency for the efficiency level IE3 (50 Hz) of Annex I of Regulation No. 640/2009 of the European Commission (Ecodesign Regulation). The minimum efficiency for 4-pole motors was used, as this group clearly has the largest market share (Almeida et al., 2008). For the efficiency level IE3, the minimum efficiency of the individual nominal output powers were combined to a mean minimum efficiency of the power classes defined in this method.

3.2.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

3.2.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

3.2.5 Bibliography

Austrian Energy Efficiency Monitoring Agency (2021). Bewertung von Energieeffizienzmaßnahmen, https://www.monitoringstelle.at/monitoring/energielieferanten/bewertung-von-energieeffizienzmassnahmen

SAVE (2000). Improving the Penetration of Energy-Efficient Motors and Drives.

Almeida et al. (2008). EUP Lot 11 Motors Final. Coimbra: ISR – University of Coimbra.

European Commission (2005). Directive 2005/32/EC of the European Parliament and of the Council of 6 July 2005 establishing a framework for the setting of ecodesign requirements for energy-using products and amending Council Directive 92/42/EEC and Directives 96/57/EC and 2000/55/EC of the European Parliament and of the Council

Almeida et al. (2014): EuP Lot 30: Electric Motors and Drives. Task 1: Produkt Definition, Standards and Legislation ENER/C3/413-2010 Final April 2014

3.3 Installing a frequency converter (inverter) for regulating the speed of an induction motor – Bulgaria

This methodology sets out the conditions, specifies the practical procedures, regulates the calculation of energy savings and indicates the form of outgoing energy saving documents for implementing the installation of frequency converter (inverter) for regulating the speed of an induction motor.

This methodology can be used to assess the energy-saving effect of an implemented energy saving measure and/or of an expected energy-saving effect of a measure whose implementation is yet to be implemented. It is applicable to tertiary sector buildings (public buildings).

Some of the specificities of this methodology include:

- The implementation of this measure must be carried out by the persons under Art. 43, par. 1 and 2 and Art. 59, par. 1 of the SEE;
- A document is required to demonstrate that the installed frequency converter (inverter) for adjusting the speed of an asynchronous engine is newly installed;
- The methodology applies to a group of electric motors of the same power under the following applications: circulation pumps for heating, ventilation (supply of fresh refrigeration equipment and air-conditioning pumps;
- No measuring instruments are necessary;
- The methodology does not apply to IE2 and IE3 engines as defined by Regulation (EC) 240/2009 adopted by the Commission on July 22nd, 2009 as amended by Regulation (EC) No 4/2014 adopted on January 6th, 2014 produced after 01.01.2015 with rated power between 0,75 kW and 375 kW;
- The data are based on one of the two modes of operation – S1 (prolonged operation mode or S3 (periodic interruption mode);
- The activities implemented must comply with the following standards:
  a) IEC 61800-2: Electric-powered speed control systems - Part 2: General requirements. Declared technical characteristics for electric-powered systems powered by variable low voltage with frequency adjustment;
  b) IEC 61800-4: Electric-powered speed control systems - Part 4: General requirements. Declared technical characteristics for power supply systems powered by an alternating voltage above 1000 V and not exceeding 35 kV
  c) IEC 60034-1: Rotating electric machines. Part 1: Data announced and performance;
  d) IEC 60359: Electrical and electronic measuring instruments. Presentation of characteristics.

3.3.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the impact on energy consumption within the framework of Article 3 is provided.

3.3.2 Calculation of final energy savings (Article 7)

The calculation method takes into account the difference between the energy efficiency consumed by the engine before and after installing a frequency converter (inverter) for adjusting the speed of the engine in end-user's equipment. The savings are determined according to the area of application and the corresponding power.

$$\mathrm{FES}_{\mathrm{kwh}} = p * \Delta R$$

Where:

FES_{kWh}	Final energy savings in end-user entity for one rated device [kWh/yr]
$(\rho c)_w$	rated engine power [kW]
V_w	saving factor [kWh/Kw]

Standardized calculation values

Table 59: Indicative values for calculation of final energy savings (Article 3).

Application	Saving factor δR = kWh/kW
Heat pump	1,084
Ventilation pump	869
Cooling pump	350

The calculation of the primary energy savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = FES_{kWh} * e_p$$

Where:

PES_{kWh}	Primary energy savings in end-user's equipment [kWh]
e_p	Factor taking into account losses for energy extraction/production and transmission for the used fuels

Standardized calculation values

Table 60: Indicative values for calculation of primary energy savings (Article 3).

Type of used fuel	e_p
Industrial gas oil, diesel	1.10
Oil	1.10
Natural gas	1.10
LPG	1.10
Black coal	1.20
Lignite/Brown coal	1.20
Brown coal	1.20
Anthracite coal	1.20
Coal briquettes	1.25
Firewood, pellets	1.05
Heat from central heat supply system	1.30
Electricity	3.00

Lifetime of savings	[a]
Lifetime of savings	15

Methodological aspects

This methodology for assessing the delivered energy savings has been approved by order of the Minister of Energy and has been published by SEDA, which is a legal entity at state budget support and has the status of an executive agency within the Ministry of Energy.

Data sources for indicative calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Energy (2022).

3.3.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

3.3.4 Calculation of CO_2 emission savings

The calculation of the CO_2 emission savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = {FES_{kWh} * f_r}/{10^6}$$

Where:

CO_2	CO_2 emission savings in end-user's equipment [tCO_2/yr]
f_r	CO_2 emission factor for the used fuels

Standardized calculation values

Table 61: Indicative values for calculation of CO_2 emission savings.

Type of used fuel	f_i (tCO_2/GWh)
Industrial gas oil, diesel	267
Oil	279
Natural gas	202
LPG	227
Black coal	341
Lignite/Brown coal	364
Anthracite coal	354
Coal briquettes	351
Firewood, pellets	43
Heat from central heat supply system	290
Electricity	819

3.3.5 Bibliography

Ministry of Energy (2022). Methodology for estimating energy savings when installing a frequency converter (inverter) for regulating the speed of an induction motor, Methodology no 13.

https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwaniq-utwyrdeni-ot-me

3.4 Installation of electric motors with higher efficiency – Bulgaria

This methodology sets out the conditions, specifies the practical procedures, regulates the calculation of energy savings and indicates the form of outgoing energy saving documents for implementing the installation of electric motors with higher efficiency.

This methodology can be used to assess the energy-saving effect of an implemented energy saving measure and/or of an expected energy-saving effect of a measure whose implementation is yet to be implemented. It is applicable to the industrial sector (effective systems for automation and measures for rational use of energy).

The calculation method is analytical, applied to engines with an output power between 0.75 kW and 375 kW. Furthermore, it is based on an analysis of the efficiency of electricity classes according to BDS EN 60034-30.

Some of the specificities of this methodology include:

- The implementation of this measure must be carried out by the persons under Art. 43, par. 1 and 2 and Art. 59, par. 1 of the SEE;
- A document from the manufacturer is required to demonstrate that the installed frequency converter (inverter) for adjusting the speed of an electric motor is new;
- The methodology does not apply to IE2 and IE3 engines as defined by Regulation (EC) 240/2009 adopted by the Commission on July 22nd, 2009 as amended by Regulation (EC) No 4/2014 adopted on January 6th, 2014 produced after 01.01.2015 with rated power between 0,75 kW and 375 kW;
- The data are based on one of the two modes of operation – S1 (prolonged operation mode or S3 (periodic interruption mode);
- The activities implemented must comply with the following standards:

  IEC 61800-2: Electric-powered speed control systems - Part 2: General requirements. Declared technical characteristics for electric-powered systems powered by variable low voltage with frequency adjustment;

  IEC 61800-4: Electric-powered speed control systems - Part 4: General requirements. Declared technical characteristics for power supply systems powered by an alternating voltage above 1000 V and not exceeding 35 kV

  IEC 60034-1: Rotating electric machines. Part 1: Data announced and performance;

  IEC 60359: Electrical and electronic measuring instruments. Presentation of characteristics.

3.4.1 Calculation of impact on energy consumption (Article 3)

The calculation method takes into account the difference between the energy efficiency of electric motors having Class IE2 and IE3 according to BDS EN 60034-30. The efficiency of electric motors is indicated in the standard and the difference in values is indicated in the standardized values as a function of the rated power and the number of poles. Furthermore, parameters, such as operating engine hours and a pair of coefficients (e.g. load factor and coefficient of use) should also be taken into account when determining the calculation algorithm.

$$\mathrm{FES_{kwh}} = P * C_i * H * C_u * \left(\frac{1}{\eta_{IE2}} - \frac{1}{\eta_{IE3}}\right)$$

Where:

FES_{kWh}	Final energy savings in end-user entity for one rated device [kWh/yr]
P	Rated engine power when applying the measure [kW]
H	Efficient operation per year from average data, depending on the area of application and rated engine power [h]
C_i	Engine load factor, percentage of the full load of the engine running equipment where the engine operates [e.g., 0.75]
η_{IE2}	Efficiency of existing engine [%]
η_{IE3}	Efficiency of new engine [%]
C_u	Engine util ratio percentage of the operating hours of the equipment in which the engine operates [e.g., 1]

Standardized calculation values

Table 62: Indicative values for calculation of final energy savings (Article 3).

P (kW)	Savings factor = ($1/\eta_{IE2}$ - $1/\eta_{IE3}$)		
	2 poles	4 poles	6 poles
0.75	0.0528	0.0442	0.0501
1.1	0.0471	0.0394	0.0458
1.5	0.0424	0.0354	0.0410
2.2	0.0378	0.0328	0.0363
3	0.0339	0.0293	0.0323
4	0.0304	0.0261	0.0300
5.5	0.0283	0.0242	0.0264
7.5	0.0252	0.0212	0.0245
11	0.0221	0.0195	0.0200
15	0.01963	0.0180	0.0183
18.5	0.0179	0.0166	0.0157

22	0.0165	0.0164	0.0155
30	0.0151	0.0150	0.0141
37	0.0138	0.0138	0.0128
45	0.0126	0.0125	0.0115
55	0.0125	0.0124	0.0114
75	0.0101	0.0112	0.0102
90	0.0101	0.0112	0.0101
110	0.0100	0.0100	0.0089
132	0.0089	0.0099	0.0089
160	0.0088	0.0099	0.0088
200	0.0088	0.0099	0.0088
250	0.0088	0.0099	0.0088
315	0.0088	0.0099	0.0088
355	0.0088	0.0099	0.0088
375	0.0088	0.0099	0.0088

The calculation of the primary energy savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = FES_{kWh} * e_p$$

Where:

PES_{kWh}	Primary energy savings in end-user's equipment [kWh]
e_p	Factor taking into account losses for energy extraction/production and transmission for the used fuels

Standardized calculation values

Table 63: Indicative values for calculation of primary energy savings (Article 3).

Type of used fuel	e_p
Industrial gas oil, diesel	1.10
Oil	1.10
Natural gas	1.10
LPG	1.10
Black coal	1.20
Lignite/Brown coal	1.20
Brown coal	1.20
Anthracite coal	1.20

Coal briquettes	1.25
Firewood, pellets	1.05
Heat from central heat supply system	1.30
Electricity	3.00
Lifetime of savings	[a]
Lifetime of savings	15

Methodological aspects

This methodology for assessing the delivered energy savings has been approved by order of the Minister of Energy and has been published by SEDA, which is a legal entity at state budget support and has the status of an executive agency within the Ministry of Energy.

Data sources for indicative calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Energy.

3.4.2 Calculation of final energy savings (Article 7)

No information for the calculation of the final energy savings within the framework of Article 7 is provided.

3.4.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

3.4.4 Calculation of CO_2 emission savings

The calculation of the CO_2 emission savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = {FES_{kWh} * f_r}/{10^6}$$

Where:

CO_2	CO_2 emission savings in end-user's equipment [tCO_2/yr]
f_r	CO_2 emission factor for the used fuels

Standardized calculation values

Table 64: Indicative values for calculation of CO_2 emission savings.

Type of used fuel	f_i (tCO_2/GWh)
Industrial gas oil, diesel	267
Oil	279
Natural gas	202
LPG	227
Black coal	341

Lignite/Brown coal	364
Anthracite coal	354
Coal briquettes	351
Firewood, pellets	43
Heat from central heat supply system	290
Electricity	819

3.4.5 Bibliography

Ministry of Energy (2022). Methodology for estimating energy savings when installing electric motors with higher efficiency, Methodology no 14.

https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwaniq-utwyrdeni-ot-me

3.5 Converter (inverter) for the adjustment of the speed of air compressors' electric motors having power equal to or greater than 11 kW – Bulgaria

This methodology sets out the conditions, specifies the practical procedures, regulates the calculation of energy savings and indicates the form of outgoing energy saving documents for implementing the installation of frequency converter (inverter) for the adjustment of speed of electric motors of air compressors with power equal to greater than 11 kW.

This methodology can be used to assess the energy-saving effect of an implemented energy saving measure and/or of an expected energy-saving effect of a measure whose implementation is yet to be implemented. It is applicable to the industrial sector (effective systems for automation and measures for rational use of energy).

The calculation method was developed for screw compressors, taking into account a type load diagram of this type of compressor compressors; compressors operating mainly in industrial processes with variable compressed air consumption, depending on the need for the technological process.

Some of the specificities of this methodology include:

- The implementation of this measure must be carried out by the persons under Art. 43, par. 1 and 2 and Art. 59, par. 1 of the SEE;
- The measuring instruments must be in accordance with BDS EN 60359;
- The activities implemented must comply with the following standards:

  IEC 61800-2: Speed control power supply systems - Part 2: General requirements. Declared technical characteristics for electric-powered systems powered by variable low voltage with adjustment of the frequency;

  IEC 61800-4: Speed control power supply systems - Part 4: General requirements. Declared technical characteristics for electric-powered systems powered by an alternating voltage exceeding 1000 V and not exceeding 35 kV

IEC 60034-1: Rotating electric machines. Part 1: Data announced and performance;

IEC 60359: Electrical and electronic measuring instruments. Presentation of characteristics.

- This methodology must be applied in the absence of data on the efficient operation of compressors, 1500h/yr work, minimum flow rate of 0.75, engine efficiency at minimum flow rate of 0.54 (≈ 65% of the rated efficiency) at 25% operation with a minimum flow rate, engine efficiency at maximum flow rate at 0.90 (at 60% operation with maximum flow rate).

3.5.1 Calculation of impact on energy consumption (Article 3)

The calculation method takes into account the difference between the energy consumed by the engine before and after installing a frequency converter (inverter) in order to adjust the speed of the engine.

The algorithm was developed based on the assumption that working conditions are:

- 60% of the time is worked with full load;
- 25 % of the time is running with minimal load and 15% of the time is downtime.

$$\mathrm{FES_{kwh}} = \left(P_n * \frac{FC_c}{n_c} * 0.60 * h + P_n * \frac{FC_v}{n_v} * 0.25 * h\right) - E_p$$

Where:

FES_{kWh}	Final energy savings in an end-user entity for one rated device [kWh/yr]
P_n	Rated compressor power [kW]
H_i	Work annually before the measure is applied [h]
Hme_s	Measurement period with full operational cycle [h]
h	Hours of work per year [h]
FC_c	Load factor at a maximum flow rate = 0,75
η_c	Engine efficiency at maximum flow rate = 0,9
FC_v	Load factor at minimum flow rate = 0,25
η_v	Engine efficiency at a minimum flow rate = 0.54 (or 65% of η_c)
E_p	Energy consumption after measure [kWh/yr]

The parameters for measurement and calculation are:

- hours (h) and
- energy consumption after the measure C_p

The following activities must be carried out:

- Determination of a measurement period covering full normal operating cycle from maximum to minimum load;

- Measurement of energy consumption after the introduction of the measure for the definitions of period;
- Calculation of annual energy consumption E_p by measured consumption for normal operational cycle and bringing it to the active hours of work before the implementation of the measure, in accordance with: $E_p = E_i * H_i / H_{mes}$.

The calculation of the primary energy savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = FES_{kWh} * e_p$$

Where:

PES_{kWh}	Primary energy savings in end-user's equipment [kWh]
e_p	Factor taking into account losses for energy extraction/production and transmission for the used fuels

Standardized calculation values

Table 65: Indicative values for calculation of primary energy savings (Article 3).

Type of used fuel	e_p
Industrial gas oil, diesel	1.10
Oil	1.10
Natural gas	1.10
LPG	1.10
Black coal	1.20
Lignite/Brown coal	1.20
Brown coal	1.20
Anthracite coal	1.20
Coal briquettes	1.25
Firewood, pellets	1.05
Heat from central heat supply system	1.30
Electricity	3.00
Lifetime of savings	[a]
Lifetime of savings	15

Methodological aspects

This methodology for assessing the delivered energy savings has been approved by order of the Minister of Energy and has been published by SEDA, which is a legal entity at state budget support and has the status of an executive agency within the Ministry of Energy.

Data sources for indicative calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Energy.

3.5.2 Calculation of final energy savings (Article 7)

No information for the calculation of the final energy savings within the framework of Article 7 is provided.

3.5.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

3.5.4 Calculation of CO_2 emission savings

The calculation of the CO_2 emission savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = {FES_{kWh} * f_r}/{10^6}$$

Where:

CO_2	CO_2 emission savings in end-user's equipment [tCO_2/yr]
f_r	CO_2 emission factor for the used fuels

Standardized calculation values

Table 66: Indicative values for calculation of CO_2 emission savings.

Type of used fuel	f_i (tCO_2/GWh)
Industrial gas oil, diesel	267
Oil	279
Natural gas	202
LPG	227
Black coal	341
Lignite/Brown coal	364
Anthracite coal	354
Coal briquettes	351
Firewood, pellets	43
Heat from central heat supply system	290
Electricity	819

3.5.5 Bibliography

Ministry of Energy (2022). Methodology for estimating energy savings when installing a frequency converter (inverter) for regulating the speed of electric motors of air compressors with power equal to or higher than 11 kW, Methodology no 15.

https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwaniq-utwyrdeni-ot-me

3.6 Installation of a frequency converter (inverter) of an electric motor in ventilation systems – Bulgaria

This methodology sets out the conditions, specifies the practical procedures, regulates the calculation of energy savings and indicates the form of outgoing energy saving documents for implementing the installation of frequency converter (inverter) of electric motor in ventilation systems.

This methodology can be used to assess the energy-saving effect of an implemented energy saving measure and/or of an expected energy-saving effect of a measure whose implementation is yet to be implemented. It is applicable to the industrial sector (effective systems for automation and measures for rational use of energy).

The calculation method is analytical, and based on data analysis in accordance with the European and National standards and measurements.

Some of the specificities of this methodology include:

- The implementation of this measure must be carried out by the persons under Art. 43, par. 1 and 2 and Art. 59, par. 1 of the SEE;
- A document from the manufacturer is required to demonstrate that the installed frequency converter (inverter) for adjusting the speed of an electric motor in the ventilation system is new;
- The methodology applies to a group of electric motors of ventilation systems with uniform performance characteristics;
- The measuring instruments are:

  Ventilation system flow meter (anemometer);

  A power meter or

  Voltage and current meter

3.6.1 Calculation of impact on energy consumption (Article 3)

The calculation method takes into account the difference between the energy consumed by the engine before and after the installation of a frequency converter (inverter) in order to adjust the speed of the engine in end-user's equipment.

$$\mathrm{FES_{kwh}} = \sum_{n} P_{a,i} * h_i - \sum_{n} P_{p,i} * h_i$$

Where:

FES_{kWh}	Final energy savings in end-user entity for one rated device [kWh/yr]
$P_{a,i}$	Rated fan engine power at set air flow rate before the measure is applied [kW]
$P_{p,i}$	Rated fan engine power at set air flow rate after the application of the measure [kW]
H_i	Engine operating hours with the same air flow rate for a specific period of time [h]

n_i =4	Load modes from the nominal flow rate of the ventilation system – 100%, 75%, 50% and 25%
η_{IE3}	Efficiency of new engine [%]
C_u	Engine util ratio percentage of the operating hours of the equipment in which the engine operates [e.g., 1]

The following activities must be carried out sequentially:

- The measurement period H_i shall be determined in order to cover a complete normal operating cycle from maximum to minimum load;
- Measure (calculate) the electrical power $P_{a,i}$ before realizing the measure, depending on the air flow rate Q_i;
- Measure (calculate) the electrical power $P_{p,i}$ after the measure by adjusting the air flow rate Qi with the use of frequency converter;
- Determination of operating hours H_i at different flow /load per year;
- Calculation of energy consumption during the specified synchronised time periods before and after installation of the frequency converter in order to achieve energy savings.

The value of the electrical power $P_{a,i}$ prior to the application of the measure may be defined in the following two ways:

- According to the manufacturer's data, it is used when there is no mechanical regulator of the flow rate (valve). If the manufacturer's data are for the power of the fan, the engine power must be determined by taking into account its Performance Ratio.
- Direct measurement – used in the presence of a mechanical airflow regulator

The measurement shall take into account the electrical power of the engine at different four modes – 100%, 75%, 50% and 25% of the nominal flow rate of the ventilation system. In the case where the assessment is being carried out when frequency converter is already being installed, then:

- Set the inverter frequency corresponding to the maximum load of the ventilation system;
- Activate the mechanical regulator until the desired air flow rate is reached in four modes – 100%, 75%, 50% and 25% of the nominal flow rate of the ventilation system;
- Measure the engine power before inverter at the desired airflow rate;
- Multiply the value of power measured before the inverter by the inverter efficiency according to its Performance Ratio.

Table 67: Indicative values for calculation of final energy savings (Article 3).

P (kW)	Number of poles		
	2 poles	4 poles	6 poles
0.8	77.4	79.6	75.9
1.1	79.6	81.4	78.1
1.5	81.3	82.8	79.8
2.2	83.2	84.3	81.8

3.0	84.6	85.5	83.3
4.0	85.8	86.6	84.6
5.5	87.0	87.7	86.0
7.5	88.1	88.7	87.2
11.0	89.4	89.8	88.7
15.0	90.3	90.6	89.7
18.5	90.9	91.2	90.4
22.0	91.3	91.6	90.9
30.0	92.0	92.3	91.7
37.0	92.5	92.7	92.2
45.0	92.9	93.1	92.7
55.0	93.2	93.5	93.1
75.0	93.8	94.0	93.7
90.0	94.1	94.2	94.0
110.0	94.3	94.5	94.3
132.0	94.6	94.7	94.6
160.0	94.8	94.9	94.8
200.0	95.0	95.1	95.0
375.0	95.0	95.1	95.0

Frequency	Inverter Performance Ratio			
	Inverter power (kW)			
	< 1	1 - 9	10 - 99	100 - 999
50 Hz	89.00%	92.50%	97.00%	98.00%

The calculation of the primary energy savings is performed by the following equation:

$$\mathrm{PES}_{\mathrm{kwh}} = FES_{kWh} * e_p$$

Where:

PES_{kWh}	Primary energy savings in end-user's equipment [kWh]
e_p	Factor taking into account losses for energy extraction/production and transmission for the used fuels

Standardized calculation values

Table 68: Indicative values for calculation of primary energy savings (Article 3).

Type of used fuel	e_p
Industrial gas oil, diesel	1.10
Oil	1.10
Natural gas	1.10
LPG	1.10
Black coal	1.20
Lignite/Brown coal	1.20
Brown coal	1.20

Anthracite coal	1.20
Coal briquettes	1.25
Firewood, pellets	1.05
Heat from central heat supply system	1.30
Electricity	3.00
Lifetime of savings	[a]
Lifetime of savings	15

Methodological aspects

This methodology for assessing the delivered energy savings has been approved by order of the Minister of Energy and has been published by SEDA, which is a legal entity at state budget support and has the status of an executive agency within the Ministry of Energy.

Data sources for indicative calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Energy.

3.6.2 Calculation of final energy savings (Article 7)

No information for the calculation of the final energy savings within the framework of Article 7 is provided.

3.6.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

3.6.4 Calculation of CO_2 emission savings

The calculation of the CO_2 emission savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = {FES_{kWh} * f_r}/{10^6}$$

Where:

CO_2	CO_2 emission savings in end-user's equipment [tCO_2/yr]
f_r	CO_2 emission factor for the used fuels

Standardized calculation values

Table 69: Indicative values for calculation of CO_2 emission savings.

Type of used fuel	f_i (tCO_2/GWh)
Industrial gas oil, diesel	267
Oil	279
Natural gas	202
LPG	227

Black coal	341
Lignite/Brown coal	364
Anthracite coal	354
Coal briquettes	351
Firewood, pellets	43
Heat from central heat supply system	290
Electricity	819

3.6.5 Bibliography

Ministry of Energy (2022). Methodology for estimating energy savings when installing a frequency converter (inverter) of an electric motor in ventilation systems, Methodology no 16.

https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwaniq-utwyrdeni-ot-me

3.7 Installation of a frequency converter (inverter) of an electric motor for flow control in pump systems with power over 20 kW – Bulgaria

This methodology sets out the conditions, specifies the practical procedures, regulates the calculation of energy savings and indicates the form of outgoing energy saving documents for implementing the installation of frequency converter (inverter) of an electrical flow control motor in pumping systems with a power of more than 20 kW.

This methodology can be used to assess the energy-saving effect of an implemented energy saving measure and/or of an expected energy-saving effect of a measure whose implementation is yet to be implemented. It is applicable to the industrial sector (effective systems for automation and measures for rational use of energy).

The calculation method is analytical, and based on data analysis in accordance with the European and National standards and measurements.

Some of the specificities of this methodology include:

- The implementation of this measure must be carried out by the persons under Art.43, par.1 and 2 and Art. 59, par. 1 of the SEE;
- A document from the manufacturer is required to demonstrate that the installed frequency converter (inverter) for adjusting the speed of an electric motor for the flow control in pumping systems with a power of more than 20 kW is newly installed;
- The methodology applies to a group of electric motors to pump systems with the same performance;
- The methodology does noy apply to IE2 and IE3 engines as defined by Regulation (EC) 240/2009 adopted by the Commission on July 22nd 2009, as amended by Regulation (EC) No 4/2014 adopted on 6 January 2014 produced after 01.01.2015 with rated power between 20 kW and 375 kW;

- The measuring instruments are:

  Fluid flow meter;

  A power meter or

  Voltage and current meter

3.7.1 Calculation of impact on energy consumption (Article 3)

The calculation method takes into account the difference between the energy consumed by the engine before and after the installation of a frequency converter (inverter) in order to adjust the speed of the engine in end-user's equipment.

$$\mathrm{FES_{kwh}} = \sum_{n} P_{a,i} * h_i - \sum_{n} P_{p,i} * h_i$$

Where:

FES_{kWh}	Final energy savings in end-user entity for one rated device [kWh/yr]
$P_{a,i}$	Rated power of pump engine at set fluid flow rate prior to the implementation of measure [kW]
$P_{p,i}$	Rated power of the pump engine at set air flow rate of the fluid after the application of the measure [kW]
H_i	Engine running hours with the same fluid flow rate for a specific period of time [h]
n_i =4	Load modes from the nominal flow rate of the pump system – 100%, 75%, 50% and 25%

The measurement parameters are:

- Working hours H_i
- Electrical power P_i
- Fluid flow rate Q_i

The following activities must be carried out sequentially:

- The Hi measurement period shall be determined to cover a complete normal operating cycle from maximum to minimum load;
- Measure (calculate) the electrical power $P_{a,i}$ before realizing the measure, depending on the air flow rate Q_i;
- Measure (calculate) the electrical power $P_{p,i}$ after the measure by adjusting the air flow rate Qi fluid with the use of frequency converter;
- Determination of operating hours H_i at different flow/load per year;
- Calculation of energy consumption during the specified synchronised time periods before and after installation of the frequency converter in order to achieve energy savings.

The value of the electrical power $P_{a,i}$ prior to the application of the measure may be defined in the following two ways:

- According to the manufacturer's data, it is used when there is no mechanical flow regulator (control valve). If the manufacturer's data are for the pump system power then the engine power must be determined by taking into account its Performance Ratio
- Direct measurement – used in the presence of a mechanical fluid flow regulator (control valve)

The measurement shall take into account the electrical power of the engine at different flow rates in four modes – 100%, 75%, 50% and 25% of the nominal flow rate of the ventilation system. In the case where the assessment is being carried out after the frequency converter is already being installed, then:

- Set the inverter frequency corresponding to the maximum load of the pumping system;
- Activate the mechanical regulator until the desired fluid flow rate is reached in four modes – 100%, 75%, 50% and 25% of the nominal pump flow rate system;
- Measure the engine power before inverter at the desired fluid flow rate;
- Multiply the value of power measured before the inverter by the inverter efficiency according to its Performance Ratio.

Table 70: Indicative values for calculation of final energy savings (Article 3).

P (kW)	Number of poles		
	2 poles	4 poles	6 poles
0.8	77.4	79.6	75.9
1.1	79.6	81.4	78.1
1.5	81.3	82.8	79.8
2.2	83.2	84.3	81.8
3.0	84.6	85.5	83.3
4.0	85.8	86.6	84.6
5.5	87.0	87.7	86.0
7.5	88.1	88.7	87.2
11.0	89.4	89.8	88.7
15.0	90.3	90.6	89.7
18.5	90.9	91.2	90.4
22.0	91.3	91.6	90.9
30.0	92.0	92.3	91.7
37.0	92.5	92.7	92.2
45.0	92.9	93.1	92.7
55.0	93.2	93.5	93.1
75.0	93.8	94.0	93.7

90.0	94.1	94.2	94.0
110.0	94.3	94.5	94.3
132.0	94.6	94.7	94.6
160.0	94.8	94.9	94.8
200.0	95.0	95.1	95.0
375.0	95.0	95.1	95.0

Frequency	Inverter Performance Ratio			
	Inverter power (kW)			
	< 1	1 - 9	10 - 99	100 - 999
50 Hz	89.00%	92.50%	97.00%	98.00%

The calculation of the primary energy savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = FES_{kWh} * e_p$$

Where:

PES_{kWh}	Primary energy savings in end-user's equipment [kWh]
e_p	Factor taking into account losses for energy extraction/production and transmission for the used fuels

Standardized calculation values

Table 71: Indicative values for calculation of primary energy savings (Article 3).

Type of used fuel	e_p
Industrial gas oil, diesel	1.10
Oil	1.10
Natural gas	1.10
LPG	1.10
Black coal	1.20
Lignite/Brown coal	1.20
Brown coal	1.20
Anthracite coal	1.20
Coal briquettes	1.25
Firewood, pellets	1.05
Heat from central heat supply system	1.30
Electricity	3.00

Lifetime of savings	[a]
Lifetime of savings	15

Methodological aspects

This methodology for assessing the delivered energy savings has been approved by order of the Minister of Energy and has been published by SEDA, which is a legal entity at state budget support and has the status of an executive agency within the Ministry of Energy.

Data sources for indicative calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Energy.

3.7.2 Calculation of final energy savings (Article 7)

No information for the calculation of the final energy savings within the framework of Article 7 is provided.

3.7.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

3.7.4 Calculation of CO_2 emission savings

The calculation of the CO_2 emission savings is performed by the following equation:

$$\mathrm{PES_{kwh}} = {FES_{kWh} * f_r}/{10^6}$$

Where:

CO_2	CO_2 emission savings in end-user's equipment [tCO_2/yr]
f_r	CO_2 emission factor for the used fuels

Standardized calculation values

Table 72: Indicative values for calculation of CO_2 emission savings.

Type of used fuel	f_i (tCO_2/GWh)
Industrial gas oil, diesel	267
Oil	279
Natural gas	202
LPG	227
Black coal	341
Lignite/Brown coal	364
Anthracite coal	354
Coal briquettes	351

Firewood, pellets	43
Heat from central heat supply system	290
Electricity	819

3.7.5 Bibliography

Ministry of Energy (2022). Methodology for estimating energy savings when installing a frequency converter (inverter) on an electric motor for flow control in pump systems with power over 20 kW, Methodology no 17.

https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwaniq-utwyrdeni-ot-me

3.8 Efficient electric motors in industry– Croatia

This methodology for calculating savings refers to measures to replace existing electric motors with new and more efficient ones. The calculation of savings is based on the difference between the efficiency of the electric motor before and after the measure.

If there is a change in the power and load factor of the electric motor in order to increase efficiency, they also affect the overall energy savings.

Lifetime of measure is 12 years.

3.8.1 Calculation of impact on energy consumption (Article 3)

Not available.

3.8.2 Calculation of final energy savings (Article 7)

For savings in the event of a change in the power of the installed electric motor, unit energy savings are calculated according to the following formula:

$$UFES = \left(\frac{P_{init} \times LF_{init}}{\eta_{init}} - \frac{P_{new} \times LF_{new}}{\eta_{new}}\right) \times h$$

If the power of the old engine is equal to the power of the efficient engine, the savings are determined according to the formula:

$$UFES = \left(\frac{1}{\eta_{init}} - \frac{1}{\eta_{new}}\right) \times P_{new} \times LF_{new} \times h$$

Total energy savings are:

$$ES = \sum_{i=1}^{n} UFESi$$

Where:

UFES [kWh/ motor/a]	Unit final energy savings
P_{init} [kW]	Mechanical power of old motor
P_{new} [kW]	Mechanical power of efficient motor
LF_{init} [%]	Load factor of old motor
LF_{new} [%]	Load factor of efficient motor
η_{init} [%]	Efficiency of old motor
η_{new} [%]	Efficiency of efficient motor
h [h/a]	Working hours/year

Standardized calculation values

In the absence of project-specific data, indicative values should be used for η, h and LF

Methodological aspects

No other information is available in the catalogue.

Data sources for indicative calculation values:

All sources are available in the national catalogue referred in the bibliography.

3.8.3 Overview of costs related to the action

Not availble

3.8.4 Calculation of greenhouse gas savings

Formula for calculating the annual reduction of greenhouse gas emissions:

$$E_{CO2} = FES \times e/1000$$

Where:

ECO2 [t CO_2/a]	Greenhouse gas savings
FES [kWh/a]	Total final energy savings
e [kg CO2/kWh]	Emission factor

Table 73: Indicative values for calculation of greenhouse gas savings.

Factors	[kg CO_2/kWh]
Electricity	0.330

Data sources for indicative calculation values:

All data sources are available on the methodology catalogue referred on th bellow bibliography.

3.8.5 Bibliography

Ministry of Environmental Protection and Energy, Rulebook on system for monitoring, measurement and verification of energy savings, NN 33/2020, 20.3.2020, https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

3.9 Replacement of electric motors – Hungary

A measure to increase energy efficiency is considered to be a measure where a previously installed electric motor is replaced by a more efficient and speed-controlled motor, or the operating power demand of the electric drive is less than the rated power of the installed motor, so that the motor to be replaced/old motor is oversized.

3.9.1 Calculation of impact on energy consumption (Article 3)

There is no information on primary energy consumption.

3.9.2 Calculation of final energy savings (Article 7)

Annual energy savings over the expected lifetime of the replaced equipment [GJ/year]

$$\frac{\Delta E}{year} = \frac{P_{N,rep} \cdot f_{A,rep}}{\eta_{m,rep}} - \frac{P_{N,new} \cdot f_{A,new}}{\eta_{m,new}} \cdot \tau \cdot 3600/1000$$

Where

$P_{N,rep}$: nominal electric power of the replaced/old electric motor [kW]

$P_{N,new}$: rated electrical power of the new electric motor[kW]

$\eta_{m,rep}$: efficiency of the replaced/old electric motor[%]

$\eta_{m,new}$: efficiency of the new electric motor[%]

$f_{A,rep}$: average load of the replaced/old electric motor[%]

$f_{A,new}$: average load of the new electric motor [%]

τ: annual operating time of the engine [h/year]

This formula calculates cumulative savings.

Additional annual energy savings calculated over the expected lifetime of the replaced equipment [GJ/year]:

$$\frac{\Delta E_{plus}}{year} = P_{N,new} \cdot f_{A,new} \cdot \left(\frac{1}{\eta_{m,ref}} \cdot \frac{1}{\eta_{m,new}}\right) \cdot \tau \cdot 3600/1000$$

Where

$P_{N,new}$: the rated electric power of the new electric motor

$f_{A,new}$: average load of the new electric motor

$\eta_{m,new}$: the efficiency of the new electric motor

$\eta_{m,ref}$: reference efficiency

τ: annual operating time of the engine [h/year]

Standardized calculation values

Reference values corresponding to the minimum energy performance requirement

The reference efficiency values corresponding to the minimum energy efficiency requirement shall be established in accordance with Annex I to Commission Regulation (EU) 2019/1781 laying down ecodesign requirements for electric motors and inverters pursuant to Directive 2009/125/EC of the European Parliament and of the Council amending Regulation (EC) No 641/2009 with regard to ecodesign requirements for glandless standalone circulators and glandless in-built circulators and repealing Commission Regulation (EC) No 640/2009:

1. As from 1 July 2021, the energy efficiency of three-phase motors other than enhanced safety motors with a rated power output of 0,12 kW or more but less than 0,75 kW, with 2, 4, 6 or 8 poles, shall comply at least with the IE2 efficiency category
2. As from 1 July 2021, the energy efficiency of three-phase motors other than enhanced safety motors with a rated power output of 0,75 kW or more and up to 1 000 kW, with 2, 4, 6 or 8 poles, shall comply with at least the IE3 efficiency category
3. From 1 July 2023, the energy efficiency of enhanced safety motors with a rated power output of 0,12 kW or more and up to 1 000 kW, with 2, 4, 6 or 8 poles, and single-phase motors with a rated power output of 0,12 kW or more shall comply with at least the IE2 efficiency category
4. From 1 July 2023, three-phase motors with a rated power output of 75 kW or more and up to 200 kW, with 2, 4 or 6 poles, other than brake motors or other explosion-proof motors shall have an energy efficiency of at least IE4

The energy efficiency of motors expressed in terms of International Energy Efficiency (IE) categories for different rated motor power values (P_N).

The IE categories are determined on the basis of rated power (P_N), rated voltage (U_N), based on 50 Hz operation and an ambient base temperature of 25 °C

Methodological aspects:

The calculation of the final energy savings achieved by replacing electric motors should take into account the lifetime of the replaced/old electric motor.

- If the old electric motor to be replaced has not yet reached the end of its expected average lifetime, the measure is considered an early replacement.
- If the lifetime of the old electric motor to be replaced exceeds 8 years, the energy consumption of the new equipment shall be compared with the minimum requirements of the Commission's ecodesign regulation for that equipment. The additional energy saving is the amount by which the energy consumption of the new equipment is less than the reference consumption meeting the minimum ecodesign requirements.

Data sources for indicative calculation values:

The source for the indicative values is available in the 17/2020. (XII. 21.) MEKH decree on the provision of data on end-use energy savings, available online: https://njt.hu/jogszabaly/2020-17-20-5Z.4

3.9.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

3.9.4 Calculation of greenhouse gas savings

No information on cost GHG savings available for this methodology

3.9.5 Bibliography

17/2020. (XII. 21.) MEKH decree on the provision of data on end - use energy savings, available online: https://njt.hu/jogszabaly/2020-17-20-5Z.4

3.10 Motor replacement - Ireland

There is no calculation formula neither a detailed methodology available.

If anticipated electric motor replacement a/o upgrade an existing motor with a Variable Speed Drive (VSD) is claimed as eligible measure, the Irish SEAI will always ask for a detailed engineering report with the proper M&V savings on the entire project.

The tool "Electric Motors and Variable Speed Drives Evaluation Tool" on the SEAI website, see: Tools & Calculators | SEAI is used by companies mostly to help them work out pay back times. They do not report back to SEAI for EEOS with these calculations.

This excel tool developed by SEAI is designed to assist organisations evaluate the benefits of retrofitting a range of high efficiency motors and/or VSDs. The methodologies used in the calculation engine are based on the EMEEES1 approach. The EMEEES project funded by the EU whose objective was to develop harmonised evaluation methods to evaluate measures implemented to archive targets set out in the energy end-use and energy services directive is the key component of this tool.

Two calculation outputs are possible:

- Energy Savings Calculator - to provide an estimate of energy savings,
- Payback Calculator - to provide a simple payback and average payback of all measures included in the retrofit project.

Three retrofit options can be evaluated:

- VSDs installed on existing standard motors
- Motor replacement with either a High Efficiency (IE2) motor or Premium Efficiency (IE3) motor
- Motor replacement (with higher efficiency class) and incorporating VSD

Unfortunately, as this tool has been developed >10 years ago, the references and sources for their few indicative, „default" values are obsolete or highly questionable for current industry processes.

For instance:

- Motor efficiency only covers IE2 and IE3, but not IE4
- Operating hours depending on industry vs tertiary vary from 2.200 to max 5.000 hrs/a
- Motor load factors vary depending on application – where only a limited choice between pumps, fans, air compressors, conveyors and refrigeration is possible – from 0,42 to 0,70

Data sources for these indicative calculation values:

Evaluation and Monitoring for the EU Directive on Energy End-Use Efficiency and Energy Services. EEMEEES bottom-up case applications; 12: Energy Efficient Motors, 13 Variable Speed Drives, eERG Politecnico di Milano, Dipartimento di Energetica, Italy, 2009. http://www.evaluate-energy-savings.eu/emeees/en/evaluation_tools/bottom-up.php

Default: Stefan Thomas (Wuppertal Institute), 2009: Overview of default values proposed in bottom-up case application, http://www.evaluate-energy-savings.eu/emeees/en/evaluation_tools/bottom-up.php

3.11 Installation of more efficient electric motors – Italy

This methodology applies to energy efficiency projects that involve the installation of IE4 (or higher) class electric motors or the simultaneous installation of IE3 (or higher) class electric inverters and motors with a rated power between 0.75 and 375 kW, at one or more plants or sites, in the industrial sector or energy networks and services sector.

The reporting party must provide documentation to prove that the proposed interventions are homogeneous in terms of the type of electric motor installed (type, size, number of poles, etc ...), application and load conditions. A representative sample (in regard to measurements aimed at determining additional energy savings) must be identified for the project. Based on these findings and information on the engines not subject to measurement, the results achieved on the representative sample will be extended to the entire project.

3.11.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

3.11.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**.

$$TFES = P \times h \times \left(\frac{1}{\eta_{Baseline}} - \frac{1}{\eta_{ex-post}}\right) \times c_c \times 0.187 \times 10^{-3} \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [toe/a]
P	rated motor power [kW]

h	hours of operation of the electric motor measured in the ex post situation
$\eta_{Baseline}$	efficiency of a motor with minimum level of efficiency IE2 in the case of simultaneous installation of motor and inverter or IE3 in the case of installation of an electric motor without inverter
$\eta_{ex\text{-}post}$	ex post motor efficiency with minimum level of efficiency IE3 in the case of simultaneous installation of motor and inverter or IE4 in case of installation of electric motor without inverter
c_c	load coefficient of the electric motor defined as $E_h/(h*P)$
E_h	electricity consumption measured by the electric motor in the time interval h
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

It is specified that for the calculation of the savings achieved by the motors not subject to direct measurement, the values of h and cc must be established based on the measurements made on the representative sample.

Standardized calculation values

No indicative calculation values available for this methodology.

Methodological aspects

This methodology was published in the Italian Gazetta Ufficiale della republica italiana Anno 159° - Numero 158. The document contains elaborations on the savings calculation of various energy efficiency actions. It is published in Italian language.

The standard methodology on high efficiency electric motors envisages, for the purpose of determining the achievable primary energy savings, the comparison between the ex post electricity consumption and the " reference "of the standard technological solution that is installed. It is determined based on EC regulation No. 640/2009 and subsequent amendments.

Therefore, in order to determine the reference consumption, it will be sufficient to identify the correct efficiency based on the characteristics of the electric motor that will be installed, in terms of installed power and number of poles.

The yield value to be used as the baseline of the project, for each representative sample, will be that corresponding to the value expressed in EC Regulation No. 640/2009, i.e. equal to the value of:

- IE2 efficiency class in the case of simultaneous installation of electric motor and inverter, or equal to the higher value between the efficiency of class IE2 as expressed by Regulation EC No. 640/2009 and the efficiency of the electric motor installed in the ex-ante condition, in the case of replacement of an electric motor;
- Efficiency class IE3 in the case of new installation of an electric motor or equal to the higher value between the efficiency of class IE3 as expressed by Regulation EC No. 640/2009 and the efficiency of the electric motor installed in the ex-ante condition, in the case of replacement of an existing electric motor.

Data sources for indicative calculation values:

No indicative calculation values available for this methodology.

3.11.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

3.11.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

3.11.5 Bibliography

Republica Italiana (2018). Gazetta Ufficiale della republica italiana – Serie generale Anno 159° - Numero 158.

3.12 High efficiency electric motor – Luxemburg

The action consists of two possible scenarios: electricity consumption is reduced either by a) the purchase of a new motor or the replacement of an inoperable motor by a motor exceeding the minimum energy performance requirements of the European Union (EU), or b) the forced replacement of a functioning motor by an engine whose energy performance equals or exceeds minimum EU requirements.

The measure is applicable for the industrial and tertiary sectors, from 1/1/2015 until (and including) 31/12/2016. In the event of situations not respecting the conditions of applicability described below, including solutions with speed variation, a specific calculation must be carried out. The lifetime of the measure is set at 10 years.

3.12.1 Calculation of impact on energy consumption (Article 3)

No calculation values available.

3.12.2 Calculation of final energy savings (Article 7)

Case a)

First step is to verify the terms of applicability, which consist of:

- 0.75 kW ≤ nominal power of the motor ≤ 7.5 kW
- The electrical efficiency class of the new motor must be IE3
- In the case of motor replacement, the nominal power and the number of poles of the new engine must be identical to those of the replaced engine

If all the conditions under point 1 (case a) are met, the difference in power absorbed ΔP is identified using table 7. For intermediary nominal power values, the difference in power absorbed is determined by interpolation. As a third step, the annual functioning time t is identified, using table 8. Finally, the annual volume of energy savings produced by the measure is calculated by the following formula, which calculates **first year savings**.

$$VEEP = \frac{\Delta P \times t}{1000}$$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]
ΔP	Difference in power input [kW] According to table
t	Annual functioning time [h] According to table

Case b)

First step is to verify the terms of applicability, which consist of:

- The nominal power and the number of poles of the new motor must be identical to those of the engine replaced
- If the motor's nominal power is greater than or equal to 0.75 kW and less than 7.5 kW, the electrical efficiency class of the new motor must be IE2 or IE3
- If the motor's nominal power is greater than or equal to 7.5 kW and less than or equal to 375 kW, the electrical efficiency class of the new motor must be IE3.

If all the conditions under point 1 (case a) are met, the difference in power absorbed ΔP is calculated used the following formula:

$$\Delta P = 100 \times \left(\frac{P_{nom}}{\eta_{av}} - \frac{P_{nom}}{\eta_{ap}} \right)$$

Where:

ΔP	Difference in power input [kW]
P_{nom}	Nominal power of the motor [kW]
η_{av}	Efficiency of the replaced motor (according to the nameplate or the data sheet of the motor replaced) [%]
η_{ap}	Efficiency of the new motor [%] According to table

As a third step, the annual functioning time t is identified, using table 8. Finally, the annual volume of energy savings produced by the measure is calculated by the following formula, which calculates **first year savings**.

$$VEEP = \frac{\Delta P \times t}{1000}$$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]
ΔP	Difference in power input [kW] According to table
t	Annual functioning time [h] According to table

Standardized calculation values

Table 74: Difference in power absorbed ΔP in function of nominal power and number of poles

Nominal Power [kW]	Number of poles		
	2	4	6
0.75	0.04	0.03	0.04
1.1	4500.05	0.04	0.05
1.5	0.06	0.05	0.06
2.2	0.08	0.07	0.08
3.0	0.10	0.09	0.10
4.0	0.12	0.10	0.12
5.5	0.16	0.13	0.15
7.5	0.19	0.16	0.18

Table 75: Annual standardised functioning time t

Type of activity	[h / a]
Industry, 1 shift, 5 days/week	1920
Industry, 2 shifts, 5 days/week	3840
Industry, 2 shifts, 6 days/week	4608
Industry, 2 shifts, 7 days/week	5376
Industry, 3 shifts, 5 days/week	5760
Industry, 3 shifts, 6 days/week	6912
Industry, 3 shifts, 7 days/week	8064
Industry, 3 shift, continuously	8760
Offices	2000
Commercial	3000

Schools	1440
Hotels	5840
Restaurants	2400
Hospitals and care facilities	8760

Table 76: Difference in power absorbed ΔP in function of nominal power and number of poles

Nominal Power [kW]	IE2			IE3		
	Number of poles			Number of poles		
	2	4	6	2	4	6
0.75	77.4	79.6	75.9	80.7	82.5	78.9
1.1	79.6	81.4	78.1	82.7	84.1	81.0
1.5	81.3	82.8	79.8	84.2	85.3	82.5
2.2	83.2	84.3	81.8	85.9	86.7	84.3
3.0	84.6	85.5	8.33	87.1	87.7	85.6
4.0	85.8	86.6	84.6	88.1	88.6	86.8
5.5	87.0	87.7	86.0	98.2	89.6	88.0
7.5	88.1	88.7	87.2	90.1	90.4	89.1
11	89.4	89.8	88.7	91.2	91.4	90.3
15	90.3	90.6	89.7	91.9	92.1	91.2
18.5	90.9	91.2	90.4	92.4	92.6	91.7
22	91.3	91.6	90.9	92.7	93.0	92.2
30	92.0	92.3	91.7	93.3	93.6	92.9
37	92.5	92.7	92.2	93.7	93.9	93.3
45	92.9	93.1	92.7	94.0	94.2	93.7
55	93.2	93.5	93.1	94.3	94.6	94.1
75	93.8	94.0	93.7	94.7	95.0	94.6
90	94.1	94.2	94.0	95.0	95.2	94.9
110	94.3	94.5	94.3	95.2	95.4	95.1
132	94.6	94.7	94.6	95.4	95.6	95.4
160	94.8	94.9	94.8	95.6	95.8	95.6
185	95.0	95.1	95.0	95.8	96.0	95.8
225	95.0	95.1	95.0	95.8	96.0	95.8
260	95.0	95.1	95.0	95.8	96.0	95.8

300	95.0	95.1	95.0	95.8	96.0	95.8
335	95.0	95.1	95.0	95.8	96.0	95.8
375	95.0	95.1	95.0	95.8	96.0	95.8

Note: For intermediary nominal power values, the difference in power absorbed is determined by interpolation.

Methodological aspects

The application of the calculation methodology presupposes that the solar thermal installation is correctly sized (surface of the thermal solar collector and volume of the heat accumulator). As an indication, the surface of the collector of a solar thermal installation for domestic hot water production ranges between 1.0 and 1.5 m^2/person for a flat collector and between 0.8 and 1.2 m^2/person for a tubular collector.

This methodology was published in the Luxemburg catalogue on standardized measures (Annex II), which is annexed to the Grand-Ducal Regulation of August 7, 2015 relating to the functioning of the energy efficiency obligation mechanism. The document is published in French.

Data sources for indicative calculation values:

No information on the calculation values was provided.

3.12.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

3.12.4 Calculation of greenhouse gas savings

Information not available.

3.12.5 Bibliography

Règlement grand-ducal du 7 août 2015 relatif au fonctionnement du mécanisme d'obligations en matière d'efficacité énergétique:
http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo

3.13 Electric motor optimization – Portugal

The methodology is used for the calculation of energy savings achieved by replacing old electric motors with high-efficiency motors in the industrial sectors. (Note: the formula can be applied to any electric motor).

3.13.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

3.13.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**.

$$EE = P_n \times N \times \left(\frac{1}{\eta_c} - \frac{1}{\eta_{he}}\right) \times LF \times 100$$

Where:

EE	Energy savings (kWh)
P_n	Nominal power as indicated in the nameplate (kW)
N	Annual working hours
η_c	Efficiency of conventional motor (%)
η_{he}	Efficiency of high-efficiency motor (%)
LF	Load factor (%) (if real LF is unknown 75% can be used)

Standardized calculation values

No calculation values available for this methodology.

Methodological aspects

The methodology is used to calculate the savings obtained by rationalization plans under the *"Sistema de Gestão dos Consumos Intensivos de Energia (SGCIE)"* and information gathered from energy audits. The methodology itself is taken from the "Manual de Auditorias Energéticas na Indústria" published by the Portuguese energy agency, ADENE

(https://sgcie.pt/manual-de-auditorias-energeticas).

This measure was transposed to Portugal in the format of energy audits in the scope of Article 8 of the EED.

3.13.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

3.13.4 Calculation of greenhouse gas savings

No information available.

3.13.5 Bibliography

"Manual de Auditorias Energéticas na Indústria" published by the Portuguese energy agency, ADENE, https://sgcie.pt/manual-de-auditorias-energeticas

3.14 Installation of electric motors – Slovenia

3.14.1 Calculation of impact on energy consumption (Article 3)

Not available

3.14.2 Calculation of final energy savings (Article 7)

Energy saving is the difference between the use of electricity of old motor and the installation of an energy-efficient electric motor, calculated on the basis of information on power, number of operating hours, load factor and condition, or any improvements to the drive systems. The load factor can be calculated on a case by case basis and, exceptionally, normalised values may be used for lower power systems.

Energy savings from the installation of the new efficient electric motor are calculated using the following equations:

$$FE_{motor} = (\frac{1}{\eta_{old} - 0.02} - \frac{1}{\eta_{ef}}) \cdot P_M \cdot t_M \cdot LF$$

Note: Ageing and the impact of rewinding the old electric motor are also taken into account by reducing the efficiency by 2 %.

Where:

FE_{motor}	Energy saving [kWh/year] due to implementation of new motor.
η_{old}	Efficiency of the conventional old motor (the one being replaced).
η_{ef}	Efficiency of the new efficient motor (one being installed).
P_M	Installed nominal electric power [kW] of the new electric motor.
t_M	Number of yearly operating hours [h].
LF	Load factor to be determined on the basis of an analysis of the performance of a specific motor system.

Standardized calculation values

Table below presents the normalised efficiencies used for the savings calculation when replacing the old electric motor with new more efficient one.

Table 77: Standardised efficiencies of the motors.

Installed nominal electric power [kW]	η_{old} [standard IE1]	η_{ef} [standard IE3]
0.75	0.721	0.840
1.1	0.750	0.853
1.5	0.772	0.863
2.2	0.797	0.875
3	0.815	0.884
4	0.831	0.892
5.5	0.847	0.900
7.5	0.860	0.908
11	0.876	0.917
15	0.887	0.923
18.5	0.893	0.927
22	0.899	0.931
30	0.907	0.936
37	0.912	0.940
45	0.917	0.943

55	0.921	0.945
75	0.927	0.950
90	0.930	0.952
110	0.933	0.954
132	0.935	0.956
160	0.938	0.958
From 200 up to 370	0.940	0.960

Table 78: Load factors for different types of motors.

Installed nominal electric power [kW]	Apliance	Industry	Services
0.75-4	Motor pumps	0.55	0.55
4-10		0.58	0.60
10-22		0.59	0.60
0.75-4	Ventilators	0.53	0.60
4-10		0.56	0.65
10-22		0.59	0.65
0.75-4	Air compressors	0.63	0.40
4-10		0.60	0.45
10-22		0.68	0.45
0.75-4	Transport systems	0.42	0.61
4-10		0.41	0.53
10-22		0.51	0.49
0.75-4	Cooling compressors	0.60	
4-10		0.65	
10-22		0.70	
0.75-4	Freezing		0.70
4-10			0.70
10-22			0.75
0.75-4	Other	0.34	0.30
4-10		0.39	0.30
10-22		0.45	0.30

Methodological aspects

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

3.14.3 Overview of costs related to the action

Not available. The lifetime expectancy of this measure is 12 years.

3.14.4 Calculation of greenhouse gas savings

The reduction of CO_2 emissions (CES) is calculated according to the formulas bellow:

$$CES_{STE} = FE_{motors} \cdot ef_{el}$$

where:

CES_{STE}	Reduction of CO_2 emissions [kg CO_2/year] when installing a new electric motor.
ef_{el}	Emission factor for electricity [kg CO_2/kWh]

Table 79: Emission factors indicative values for calculation of greenhouse gas savings.

ef_{el}	Services [kg CO2/kWh]	Industry [kg CO2/kWh]
Electricity	0.49	0.49

Data sources for indicative calculation values

Data on the operating characteristics of the electric motor system should be known on the basis of an energy inspection of electric motor systems or a pre-investment study of systems. The use of normalized values is only allowed for low power motors.

3.14.5 Bibliography

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

3.15 Installation of Variable Speed Drives (VSD) – Slovenia

3.15.1 Calculation of impact on energy consumption (Article 3)

Not available.

3.15.2 Calculation of final energy savings (Article 7)

The energy saving is calculated on the basis of the energy savings factor due to the installation of the frequency converter, which is determined on the basis of an analysis of the operation of a specific propulsion system. Normalized savings can be used for simple appliances.

Energy savings from the installation of the new efficient electric motor are calculated using the following equation:

$$FE_{VSD} = \frac{P_M}{\eta} \cdot t_M \cdot LF \cdot f$$

Where:

FE_{VSD}	Energy saving [kWh/year] due to implementation of the VSD.
η	Efficiency of the motor.
P_M	Installed nominal electric power [kW] of the new electric motor.
t_M	Number of yearly operating hours [h].
LF	Load factor to be determined on the basis of an analysis of the performance of a specific motor system.
f	Energy savings factor due to the installation of the frequency converter – the savings must be determined on the basis of an analysis of the operation of a specific propulsion system; for simple devices, the normalized savings set out in table bellow.

Standardized calculation values

Tables below present the standardised efficiencies of the motors along with energy savings due to the installation of frequency converters for some typical motor appliances.

Table 80: Standardised efficiencies of the motors.

Installed nominal electric power [kW]	η_{old} [standard IE1]	η_{ef} [standard IE3]
0.75	0.721	0.840
1.1	0.750	0.853
1.5	0.772	0.863
2.2	0.797	0.875
3	0.815	0.884
4	0.831	0.892
5.5	0.847	0.900
7.5	0.860	0.908
11	0.876	0.917
15	0.887	0.923

18.5	0.893	0.927
22	0.899	0.931
30	0.907	0.936
37	0.912	0.940
45	0.917	0.943
55	0.921	0.945
75	0.927	0.950
90	0.930	0.952
110	0.933	0.954
132	0.935	0.956
160	0.938	0.958
From 200 up to 370	0.940	0.960

Table 81: Energy savings due to the installation of frequency converters for some typical appliances.

Appliance	Industry
Motor pumps	0.28
Ventilators	0.28
Air compressors	0.12
Transport systems	0.12
Cooling compressors	0.12
Freezing	0.12
Other	0.12

Methodological aspects

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

3.15.3 Overview of costs related to the action

Not available. The lifetime expectancy of this measure is 12 years.

3.15.4 Calculation of greenhouse gas savings

The reduction of CO_2 emissions (CES) is calculated according to the formulas bellow:

$$CES_{STE} = FE_{motors} \cdot ef_{el}$$

Where:

CES_{STE}	Reduction of CO_2 emissions [kg CO_2/year] when installing a new electric motor.
ef_{el}	Emission factor for electricity [kg CO_2/kWh]

Table 82: Emission factors indicative values for calculation of greenhouse gas savings.

ef_{el}	Services [kg CO2/kWh]	Industry [kg CO2/kWh]
Electricity	0.49	0.49

Data sources for indicative calculation values

Data on the operating characteristics of the electric motor system should be known on the basis of an energy inspection of electric motor systems or a pre-investment study of systems. The use of normalized values is only allowed for low power motors.

3.15.5 Bibliography

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

3.16 Energy-efficient motors (EEMs) - EMEEES

The methodology is used for the calculation of energy savings achieved by replacing old electric motors with high-efficiency motors.

3.16.1 Calculation of impact on energy consumption (Article 3)

$$\text{unitary gross annual energy savings} = \left(\frac{1}{\eta_{standard}} - \frac{1}{\eta_{efficient}}\right) * P_N * h * LF$$

Where,

Where:

$\eta_{standard}$ - Efficiency of the standard motor;

$\eta_{efficient}$ - Efficiency of the energy efficient motor;

P_N - Mechanical power of the motor;

h - Number of operating hours;

LF - Load Factor.

Standardized calculation values

The baseline efficiency is considered to be IE1.

For number of operating hours and load factor, the values are given in **Table 83**.

Table 83 – Estimated values from previous studies (SAVE, 2000)

Power ranges	Type of Applications	Industry			Tertiary		
		Hours (h)	Load factor	LFH (Load Factor*Hours)	Hours (h)	Load factor	LFH(Load Factor*Hours)
[0,75;4[	Pumps	3.861,03	0,55	2.123,57	3.800,00	0,55	2.090,00
[4;10[		4.501,94	0,58	2.611,13	3.050,00	0,60	1.830,00
[10;22[		5.040,47	0,59	2.973,88	3.000,00	0,60	1.800,00
[0,75;4[	Fans	4.910,47	0,53	2.602,55	2.250,00	0,60	1.350,00
[4;10[		4.137,76	0,56	2.317,15	2.500,00	0,65	1.625,00
[10;22[		5.210,64	0,59	3.074,28	2.500,00	0,65	1.625,00
[0,75;4[	Air Compressor	2.177,99	0,63	1.372,13	1.030,00	0,40	412,00
[4;10[		4.057,72	0,60	2.434,63	1.000,00	0,45	450,00
[10;22[		4.625,99	0,68	3.145,67	980,00	0,45	441,00
[0,75;4[	Conveyors	3.060,75	0,42	1.285,52	621,00	0,61	378,81
[4;10[		2.787,90	0,41	1.143,04	916,00	0,53	485,48
[10;22[		3.908,61	0,51	1.993,39	725,00	0,49	355,25
[0,75;4[	Cooling Compressors	5.051,90	0,60	3.031,14			-
[4;10[		1.890,63	0,65	1.228,91			-
[10;22[		5.066,59	0,70	3.546,61			-
[0,75;4[	Refrigeration				4.200,00	0,70	2.940,00
[4;10[					4.170,00	0,70	2.919,00
[10;22[					4.050,00	0,75	3.037,50
[0,75;4[	Others	3.086,64	0,34	1.049,46	500,00	0,30	150,00
[4;10[		2.859,49	0,39	1.115,20	530,00	0,30	159,00
[10;22[		2.299,44	0,45	1.034,75	570,00	0,30	171,00

3.16.2 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

3.16.3 Bibliography

Andrew Pindar, Nicola Labanca, Daniele Palma, Task 4.2: harmonised bottom-up evaluation methods; Method 10, Non residential space heating improvement in case of heating distribution by a water loop, EMEEES, 2008

3.17 Replacement of electric motor drives in industry – multEE

Measures related to industrial motors comprise the replacement of electric motor drives, the use of rotational electrical motors and the installation of variable speed drives (VSDs).

In order to decrease the energy consumption of electric motor drives in industry, an existing electric motor drive is replaced with a more efficient one. The other system components (control, load) remain the same.

The formula below can only be applied for calculating the savings of exactly identical motor drives and identical use patterns. If the technical data or the field of use varies between the motor drives, the bottom-up formula cannot be applied and the energy savings have to be calculated separately.

3.17.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

3.17.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = P \times t \times f_L \times \left(\frac{1}{\eta_{Ref}} - \frac{1}{\eta_{Eff}}\right) \times n_m$$

Where:

TFES	Total final energy savings [kWh/a]
P	Electrical power of the installed motor drive [kW]
t	Average yearly operating hours [h/a]
f_L	Average load factor [%]
η_{Ref}	Efficiency of the replaced motor drive [%]
η_{Eff}	Efficiency of the new motor drive [%]
n_m	Number of identical electric motors replaced

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 87.

Electrical power of the installed motor drive: a project specific value; the value can be found in the datasheet of the motor drive.

Average yearly operating hours: project specific value; the number of operating hours varies between the different areas of application. However, default values can be found in the EUP Lot 11: http://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Lots/Final_Documents/Lot11_Motors_FinalReport.pdf.

Average load factor: a project specific value; default values can be found in the EUP Lot 11: http://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Lots/Final_Documents/Lot11_Motors_FinalReport.pdf.

Efficiency of the replaced motor drive: project specific value; the value can be found in the datasheet of the replaced motor drive.

Efficiency of the new motor drive: project specific value; the value can be found in the datasheet of the new motor drive.

Minimum requirements for the efficiency of motor drives can be found in the EU Regulation 640/2009 with regard to eco-design requirements for electric motors: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0640&from=EN.

Number of identical electric motors replaced: project specific value.

3.17.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

3.17.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

3.17.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

3.18 Resizing of rotational electrical motors – multEE

Motors that run many hours per year at light loading, e.g. below 20%, should be replaced by smaller energy efficient motors. Therefore, savings achieved result from the resizing of the motor. In order to account for energy savings from this measure, a minimum level of energy performance of the motor has to be met: it is suggested that the motor runs above 20% of its rated power most of the time.

3.18.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

3.18.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \left(\frac{P_{Ref} \times f_{Ref}}{\eta_{Ref}} - \frac{P_{Eff} \times f_{Eff}}{\eta_{Eff}}\right) \times t \times n_m$$

Where:

TFES	Total final energy savings [kWh/a]
P_{Ref}	Mechanical power of the existing motor [kW]
P_{Eff}	Mechanical power of the resized motor [kW]
t	Average yearly operating hours [h/a]
f_{Ref}	Average load factor of existing motor [%]
f_{Eff}	Average load factor of resized motor [%]
η_{Ref}	Efficiency of the standard motor [%]
η_{Eff}	Efficiency of the energy efficient, resized motor [%]
n_m	Number of equal rotational electrical motors replaced by equal energy efficient, resized motors

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects:

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 87.

Mechanical power of the installed motor: project specific value; the value can be found in the datasheet of the motor.

Average yearly operating hours: project specific value; the number of operating hours varies between the different areas of application. However, default values can be found in the EUP Lot 11: http://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Lots/Final_Documents/Lot11_Motors_FinalReport.pdf

Average load factor: a project specific value; default values can be found in the EUP Lot 11: http://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Lots/Final_Documents/Lot11_Motors_FinalReport.pdf

Efficiency of the standard motor: project specific value; the value can be found in the datasheet of the standard motor.

Efficiency of the energy efficient motor: project specific value; the value can be found in the datasheet of the new motor.

Minimum requirements for the efficiency of motor drives can be found in the EU Regulation 640/2009 with regard to eco-design requirements for electric motors: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009R0640&from=EN.

Energy efficiency standards are also set in the international standard IEC 60034-30.

Number of identical electric motors replaced: project specific value.

3.18.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

3.18.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

3.18.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

3.19 Variable Speed Drives – multEE

In order to decrease the energy consumption of electric motor drives in industry, existing motor drives are equipped with variable speed drives. The motor drive and the load remain the same. Only the control unit is replaced. The formula is valid for pump and ventilation systems.

The formula below can only be applied for calculating the savings of exactly identical VSDs and identical use patterns. If the technical data or the field of use varies between the VSDs, the bottom-up formula cannot be applied and the energy savings have to be calculated separately.

3.19.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

3.19.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = P \times t \times f_{VSD} \times \frac{1}{\eta} \times n_{VSD}$$

Where:

TFES	Total final energy savings [kWh/a]
P	Electrical power of the installed motor drive [kW]
t	Average yearly operating hours [h/a]
f_{VSD}	Energy saving factor due to installation of a VSD [%]
η	Efficiency of the installed motor drive [%]
n_{VSD}	Number of variable speed drives installed

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 87.

Electrical power of the installed motor drive: project specific value; the value can be found in the datasheet of the motor drive.

Average yearly operating hours: project specific value; the number of operating hours varies between the different areas of application. However, default values can be found in the EUP Lot 11: http://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Lots/Final_Documents/Lot11_Motors_FinalReport.pdf

Energy saving factor due to installation of a VSD: project specific value; default values can be found in the EUP Lot 11: http://www.eup-network.de/fileadmin/user_upload/Produktgruppen/Lots/Final_Documents/Lot11_Motors_FinalReport.pdf

Efficiency of the installed motor drive: project specific value; the value can be found in the datasheet of the motor drive.

Number of VSDs installed project specific value.

3.19.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

3.19.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

3.19.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

Chapter 4 Providing feedback about energy use and tailored advice toward households: behavioural changes

4.1 Energy advice for households – Austria

A household gets individual energy advice from a certified energy consultant or via individualised internet services. This advice should tackle energy savings in the area of electricity and heating.

Such counselling usually leads to both investment (e.g. replacement of the heating system, insulation of the building, etc.) as well as non-investment measures (e.g. behavioural changes like eliminating stand-by energy use, lowering room temperature etc.). To avoid double counting for investment measures, this methodology only accounts for savings generated by non-investment measures.

Indicative calculation values are available for different levels of energy advice, depending on the depth and duration of the counselling session. However, the session has to take account of the individual energy consumption and situation of the household. Campaigns with general tips for energy savings cannot be calculated using this methodology.

4.1.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

4.1.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = n \times FEC \times f_{EA} \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of performed energy counsellings in the relevant quality level [-]
FEC	Final energy consumption examined – either electricity, energy used for heating or both [kWh/a]
f_{EA}	Savings factor for energy counselling of the relevant quality level [%]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

Standardized calculation values

Table 84: Indicative values for calculation of final energy savings (Article 7).

FEC	[kWh/a]
Electricity consumption	3,700
Heating energy consumption	17,300
Total household consumption	21,000
f_{EA}	[%]
for quality level 1	0.25
for quality level 2	1
for quality level 3	3
Lifetime of savings	[a]
Lifetime of savings	2

Methodological aspects

This methodology was published in the Austrian catalogue on bottom-up calculation methodologies (Anlage 1 BGB1. II, Nr. 172, 2016), which is Annex to the Directive 172 on Energy Efficiency. The document is published in German language.

The formula multiplies the relevant final energy consumption (electricity, heating or both) of a household with the energy savings rate that can be achieved depending of the quality level of the energy counselling session and the number of counselling sessions conducted.

The following specifications have to be met by the energy counselling session to be considered accountable:

For quality level 1: the energy counselling has to be conducted directly with the household (personally or via telephone) or via personalized internet services, should analyse the household's energy consumption and needs to last for at least 15 minutes

For quality level 2: the energy counselling has to be conducted directly with the household (personally or via telephone), should analyse the household's energy consumption and needs to last for at least 30 minutes

For quality level 3: the energy counselling has to be conducted directly with the household, either as a stationary counselling or at the household's premises and needs to last for at least 60 minutes. As documentation, a report on possible savings, customized to the household's consumption, has to be prepared.

Data sources for indicative calculation values

Reliable data on the effect of energy advice for households is hard to find, as studies on this topic use different approaches for the identification of savings, resulting in a high range of values for the savings to be achieved. Additionally, most energy advice programmes combine investment and non-investment measures, but only the latter are relevant for this methodology. Therefore, various studies have been examined:

The Institute for Energy and Environmental Research (ifeu, 2007) conducted an evaluation of the on-site Electricity saving counselling conducted by the climate protection and energy-consulting agency Heidelberg and Neighboring communities (KliBA). The counselling

consisted of an approximately one-hour session including apartment inspection and an inventory of the most important electricity consumers in the household (lamps, refrigerators and freezers, stand-by consumers, etc.). Participating households received a report with suggestions for power saving measures and information on efficiency of the measures. The electricity savings in the examined households, which the effect of the on-site consultation could be attributed (compared to a control group), was 8% p.a. (n=27). However, the study did not examine whether the savings were triggered by changes in purchasing decisions, small investments or user behaviour.

Ifeu (2005) also evaluated stationary energy advice from the consumer advice centres, the German Housewives Association in Lower Saxony and the Consumer Service in Bavaria. Here, the proportion of measures implemented was determined relative to the measures recommended during the consultations. For homeowners, the highest savings were achieved in the areas of wall and roof insulation. In the same study (ifeu, 2005), the largest annual savings in electricity savings could be assigned to the areas of lighting and stand-by, with the savings for owners being slightly higher than for tenants and the savings between 0.3 % and 0.8 % pa of the average electricity consumption.

In an energy advice program for residents of Danish single-family homes, savings by energy advice of 4 % p.a of heating energy were determined. However, Larsen and Jensen (1999) argue that some of Danish energy consultations should be terminated for rational reasons, because the costs are very high and the external benefits (greenhouse gas and energy savings) could be achieved through other, lower-cost measures.

Holanek (2007) examined the extent of the implementation of proposed measures as part of the Austrian klimaaktiv energy advice programme "wohnmodern" in the federal states of Vienna, Styria and Salzburg, with "wohnmodern" offering modernization advice only for property developers and property managers of large-volume residential buildings. The most frequently proposed modernization variant is the renovation of the facade with thermal insulation, followed by the insulation of the top floor ceiling and the window replacement. The average implementation rate of the recommended measures across all federal states is around 38%.

In an early study in Wisconsin, Hirst and Gray (1982-1983) determined energy savings in natural gas consumption of 1 – 2 % p.a. compared with a control group one year after an on-site energy counselling in households.

The lifetime of savings is defined according to recommendations of the European Commission on the measurement and verification methods in the framework of directive 2006/32/EC (European Commission. C.E.E., 2010).

4.1.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

4.1.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

4.1.5 Bibliography

Anlage 1 BGB1. II, Nr. 172 (2016). Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen, 100–103. https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2016_II_172/COO_2026_100_2_1241958.pdfsig

ifeu. (2007). Effiziente Beratungsbausteine zur Verminderung des Stromverbrauchs in privaten Haushalten. Institut für Energie- und Umweltforschung. Heidelberg.

ifeu. (2005). Evaluation der stationären Energieberatung der Verbraucherzentralen, des Deutschen HausfrauenbundesNiedersachsen und des Verbraucherservice Bayern. Endbericht im Auftrag des Verbraucherzentrale Bundesverbandes e.V. Heidelberg.

Larsen, A., & Jensen, M. (1999). Evaluations of energy audits and the regulator. In: Energy Policy Vol. 27, S. 557-564.

Holanek, N. (2007). Evaluierung der wohnmodern-Beratungen unter energetischen, ökologischen und ökonomischen Aspekten. Diplomarbeit Fachhochschule Wels.

Hirst, E., & Grady, S. (1982-1983). Evaluation of a Wisconsin utility home energy audit program. Journal of Environmental Systems, 12(4), 303-320.

European Commission. C.E.E. (2010). Recommendations on measurement and verification methods in the framework of directive 2006/32/EC on energy end-use and energy services - preliminary draft.

4.2 Installation of smart meters and informative energy billing for households – Austria

This methodology deals with the installation of smart meters in private households. In addition to this installation, billing has to be organized in a way that both energy consumption and load profiles are easy to understand by final customers in order to enable change in energy consumption. The billing period cannot exceed monthly billing, which is plausible in an international comparison. As an alternative to regular billing, customers can receive information on their energy consumption via a portal. In this case, customers have to be reminded to check their consumption on a regular basis. In order for this methodology to be eligible, the installation must be accompanied by a one-time energy consultation, which provides sufficient information to final energy customers on how their energy consumption can be influenced.

Smart meters that are installed due to a legal obligation are not eligible for reporting.

4.2.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

4.2.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = n \times FEC \times f_{SM} \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of smart meters with informative billing concepts installed [-]

FEC	Final energy consumption measured by the installed smart meter – either electricity, energy used for heating or both [kWh/a]
f_{EA}	Savings factor for the introduction of smart meters and informative billing concepts [%]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

Standardized calculation values

Table 85: Indicative values for calculation of final energy savings (Article 7).

FEC	[kWh/a]
Electricity consumption	4,800
Heating energy consumption	16,200
Total household consumption	21,000
f_{SM}	[%]
Savings factor for the introduction of smart meters and informative billing concepts	3
Lifetime of savings	[a]
Lifetime of savings	2

Methodological aspects:

This methodology was published in the Austrian catalogue on bottom-up calculation methodologies (Anlage 1 BGB1. II, Nr. 172, 2016), which is Annex to the Directive 172 on Energy Efficiency. The document is published in German language.

Both internationally and in Austria, there are only a few studies on the subject of the effects of smart metering and informative billing on energy consumption (Darby, 2006). Against the background of the available studies, the saving value in the present methodology is defined rather conservatively. The available studies evaluate pilot projects, which include mostly, according to Benders et al. (2006), volunteer participants. In the case of a large-scale rollout, on the other hand, not only interested and committed households are taken into account. This is expected to lead to lower savings. The available studies also have a number of methodological problems (the results are not statistically significant, the dropout rate is very high, etc.) and different approaches, which only allow a limited comparison.

In Europe, the Scandinavian countries in particular, as well as Holland and Italy, have initial experience with intelligent metering and billing systems. There are also studies from the USA and Canada on the savings potential. In Austria, individual pilot projects are being carried out in the electricity sector.

Data sources for indicative calculation values

<u>Savings triggered by smart meters (prompt and direct feedback):</u>

A two-and-a-half-year study by Mountain (2006) of electricity consumption in 505 Canadian households found an average savings of 6.5% p.a. compared to the baseline through the

use of portable monitors, which displayed energy consumption in kWh, US$ and COB2B in a timely manner.

Benders et al. (2006) achieved savings of up to 8.5 % p.a. compared to the control group in a study of 137 Dutch households using an internet-based personalized tool. However, the result is not statistically significant. The participating households were recruited via newspaper advertisements. The study shows a high dropout rate. In addition, a number of problems arose due to the use of the internet.

In a three-year Danish study, Nielsen (1993) determined the effect of direct consumption feedback via meters and indirect feedback via additional information in around 1,500 apartments and houses. Savings of around 10 % p.a. could be achieved in single-family houses, but only 1 % p.a. in apartments. Savings in low-income groups in particular were comparatively low.

In Austria, a first estimate of a pilot project by Linz AG indicates a savings potential of 7 % p.a. in heating energy consumption by intelligent energy management (Breitschopf, 2008).

Savings triggered by informative billing (indict feedback):

Wilhite and Ling (1995) were able to prove in several studies (n=190-210) in Oslo that through frequent and informative billing, savings of 8 – 12 % p.a. could be achieved and in the third year, behavioural changes became routine: "Our impression from interviews is that after 3 years, the changes people made had become so routine that they had trouble identifying them." Younger participants in the study were more likely to change their behaviour than older participants.

Henryson et al. (2000) report a series of large-scale studies (n = 600 - 1,500) in several Scandinavian countries. In six out of seven studies, simple, frequent and informative billing led to permanent savings in electricity consumption of 2 - 12% p.a. In one study, no change in behaviour and no electricity savings were demonstrated.

Dutch studies and field tests (source: KEMA Consulting) from 2003 have shown that monthly billing can achieve 3.9 to 4.3% p.a. of energy savings.

The lifetime of savings is defined according to recommendations of the European Commission on the measurement and verification methods in the framework of directive 2006/32/EC (European Commission. C.E.E., 2010).

4.2.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

4.2.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

4.2.5 Bibliography

Anlage 1 BGB1. II, Nr. 172 (2016). Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen, 100–103. https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2016_II_172/COO_2026_100_2_1241958.pdfsig

European Commission. C.E.E. (2010). Recommendations on measurement and verification methods in the framework of directive 2006/32/EC on energy end-use and energy services - preliminary draft.

Darby, S. (2006). The Effectiveness of Feedback on Energy Consumption. A Review for DEFRA of the Literature on Metering, Billing and Direct Displays. Environmental Change Institute: University of Oxford.

Benders et al. (2006). New Approaches for Household Energy Conservation. In Search of Personal Household Energy Budgets and Energy Reduction Options. Energy Policy Vol. 34, S. 3612-3622.

Mountain, D. (2006). The Impact of Real-Time Feedback on Residential Electricity Consumption: the Hydro One Pilot. Ontario: Mountain Economic Consulting and Associates Inc.

Nielsen, L. (1993). How to get the Birds in the Bush into your Hand: Results from a Danish Research Project on Electricity Savings. Energy Policy Vol. 21(11), S. 1133-1144.

Breitschopf, N. (2008). Energiepark Plesching. Präsentation beim 10. Symposium Energieinnovation, 13.-15. Februar 2008. TU Graz.

Wilhite, H., & Ling, R. (1995). Measured Energy Savings from a more Informative Energy Bill. Energy and Buildings Vol. 22, S. 145-155.

Henryson et al. (2000). Energy efficiency in buildings through information - Swedish perspective. Energy Policy Vol. 28, S. 169-180.

4.3 Implementation of programs for optimization of final energy consumption by users of tourist sites with accommodation by raising their awareness of energy efficiency – Bulgaria

This calculation methodology will assess the energy saving effect of the implemented program of changing the behavior of both employees and guests towards optimizing energy consumption (electricity for heating, ventilation and water) in the EU tourist sites by taking into account the social factors associated with the day-to-day operations.

This methodology can be used in public sector as well as in services (hotels) and households.

Some of the specificities of the applied methodology applied include:

- Monthly measurements of the consumed electricity
- Use of a coefficient [$C_{\text{heat norm coefficient}}$] for the impact of climatic conditions.

The activities of this program include the collection and monitoring of the energy consumption, the identification of specific energy saving measures, the training of the staff especially those of service sector, preparation of information brochures (e.g., general info on energy efficiency) for visitors as well as periodic assessment of the achieved results based on consumption for the previous periods.

4.3.1 Calculation of impact on energy consumption (Article 3)

The calculation of the primary energy savings is performed by the following equation:

$$\mathrm{PES}_{\mathrm{kwh}} = FES_{kWh} * e_p$$

Where:

PES_{kWh}	Primary energy savings in end-user's equipment [kWh]
e_p	Factor taking into account losses for energy extraction/production and transmission for the used fuels

Standardized calculation values

Table 86: Indicative values for calculation of primary energy savings (Article 3).

Type of used fuel	e_p
Industrial gas oil, diesel	1.10
Oil	1.10
Natural gas	1.10
LPG	1.10
Black coal	1.20
Lignite/Brown coal	1.20
Brown coal	1.20
Anthracite coal	1.20
Coal briquettes	1.25
Firewood, pellets	1.05
Heat from central heat supply system	1.30
Electricity	3.00
Lifetime of savings	[a]
Lifetime of savings	2

Methodological aspects

This methodology for assessing the delivered energy savings has been approved by order of the Minister of Energy and has been published by SEDA, which is a legal entity at state budget support and has the status of an executive agency within the Ministry of Energy.

Data sources for indicative calculation values:

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Energy.

4.3.2 Calculation of final energy savings (Article 7)

The energy savings are defined as the difference between the specific final consumption – before and after the information campaign, multiplied by the number of nights for the year after the introduction of the measure normalized (aligned) to the climatic conditions of the heating energy for the year before the implementation of the program.

$$FES_{kwh} = FES_e * N_y$$

$$\mathrm{FES}_e = \frac{Ee_{y-1}}{N_{y-1}} - \frac{Ee_{y-norm}}{N_y}$$

Where:

FES_{kWh}	Total final energy savings per year [kWh/yr]
FES_e	Final electricity savings per night [kWh/per night]
N	Number of nights
y	Current year, to take into account the savings, after the implementation of the program
y-1	The year before the implementation of the program
Ee	Annual electricity consumption [kWh]

4.3.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

4.3.4 Calculation of CO_2 emission savings

The calculation of the CO_2 emission savings is performed by the following equation:

$$\mathrm{PES}_{\mathrm{kwh}} = {FES_{kWh} * f_r}/{10^6}$$

Where:

CO_2	CO_2 emission savings in end-user's equipment [tCO_2/yr]
f_r	CO_2 emission factor for the used fuels

Standardized calculation values

Table 87: Indicative values for calculation of CO_2 emission savings.

Type of used fuel	f_i (tCO_2/GWh)
Industrial gas oil, diesel	267
Oil	279
Natural gas	202
LPG	227
Black coal	341
Lignite/Brown coal	364
Anthracite coal	354
Coal briquettes	351
Firewood, pellets	43

Heat from central heat supply system	290
Electricity	819

4.3.5 Bibliography

Ministry of Energy (2022). Methodology for assessment of energy savings in the implementation of programs for optimization of final energy consumption by users of tourist sites with accommodation by raising their awareness of energy efficiency, Methodology no 33.

https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwaniq-utwyrdeni-ot-me

4.4 Implementation of educational and information campaigns on energy efficiency, renewable sources and energy efficient household and office appliances - Croatia

Education and information seek to raise the awareness of energy consumers about the need and benefits related to more conscientious energy consumption and the use of renewable energy sources. Education and information are prerequisites for creating habits of energy efficient behaviour and rational use of all available resources. Also, they are prerequisites for the development and implementation of new projects, which will reduce energy consumption and environmental pollution, while avoiding unnecessary costs related to energy consumption.

The modalities of conducting such campaigns can be different:

a) sending information materials on the possibilities of reducing energy consumption for specific purposes (electricity, heating, etc.)

b) sending information materials on the benefits of purchasing higher energy class devices and

c) creating a website with tips for conscientious use of energy and calculating energy savings.

In addition to such activities, other measures can be initiated to change the behaviour of energy customers.

4.4.1 Calculation of impact on energy consumption (Article 3)

Not available

4.4.2 Calculation of final energy savings (Article 7)

The European Commission (EC) has made recommendations for calculating savings by implementing behavioral change measures (COMMISSION RECOMMENDATION (EU) 2019/1658 of 25 September 2019 on the transposition of energy saving commitments under the Energy Efficiency Directive).

To determine the energy savings resulting from measures that influence the change in the behavior of end customers (consumers) of energy, it is recommended to use the 'deemed

savings' approach, if these savings are used for the same type of intervention and similar targets. groups. The general formula for determining savings is:

$$FES = \sum_{N} UFEC \times S \times dc$$

Where:

UFEC [kWh/a]	energy consumption per participant in the activity (per household, per employee, etc.)
S [%]	Energy saving factor
N	number of participants in the program / behavior change activities
FES [kWh/a]	total annual energy savings in final consumption
dc [%]	Double- counting factor

The number of participants N is determined in one of the following two ways:

- directly through the monitoring system (in cases when participants apply for participation themselves); or
- surveys (in the case of information campaigns aimed at the general population - then surveys must determine the number of participants, provided that the survey must be conducted on a representative sample and it is necessary to explain how this representative sample is determined).

Unit energy consumption per participant in a UFEC activity can be determined in the following ways:

- directly from the data provided by the participants or available to the supplier (eg energy bills, metering); or
- an estimate of the average energy consumption per participant from the target group (eg based on national statistics or previous studies), in which case it is necessary to explain how to ensure that the average energy consumption is representative of the target group's energy consumption.

Energy saving factor S represents the percentage of energy savings resulting from the considered activity, which was determined on the basis of previous estimates (surveys, control groups, pre- and post-measurement). It is necessary to explain how to ensure that the conditions of the intervention for which this factor is used are similar to those for which this information was obtained. Determining this factor is the biggest challenge in determining the methods for estimating savings. Namely, no such research has been conducted in Croatia, so there are no relevant national benchmarks for most of the measures discussed in this document. Therefore, in order to develop this methodology, available examples from other EU Member States were analyzed and reference values were recommended based on already established and applied practices. Where it was not possible to identify relevant EU practice, it was recommended to conduct one's own research.

The methodology also includes the correction of savings for the double counting factor, but the application of this factor is not standard in the existing national methodology of the Republic of Croatia. In addition, this factor does not have to be taken into account in the

case of targeted activities (clearly defined target group) and in the case of repetitive activities and there is no danger that the measure will cover the same participants.

For all measures related to changing the behavior of energy consumers, the starting point in determining the method for assessing energy savings was the above EC recommendation, with the basic formula adapted to each measure, and in the absence of national benchmarks used values set in EU member states' methodologies.

Bond parties invest their resources in such activities and provide them to users free of charge. In addition, the bond parties promote such activities and, therefore, it can be established that such activities would not be carried out with end customers without the involvement of the bond party.

Informing consumers about the possibilities of improving energy efficiency through information materials

Sending information materials with advice on how to achieve energy savings in the household can be considered an information campaign, or a form of low-quality energy consulting, because consulting is not individualized (more on consulting quality levels see Chapter 1.3. However, information on flyers, if presented It is important to emphasize that the content of information materials should always be focused on a specific segment of energy consumption, and not on very general advice on overall energy consumption in the household. Behaviour changes can be expected by providing strictly targeted information, while generalized information will not have such an effect nor is it likely to lead to energy savings.

Calculation of final energy savings (Article 7)

As this is an information campaign, the general method for calculating savings resulting from behavioral change activities recommended by the EC can be used to calculate savings. Energy Efficiency in the study "Document with general formulas of bottom-up methods to assess the impact of energy efficiency measures", measured by "Awareness Raising campaigns".

The formulas for calculating the energy savings achieved by the information campaign through information materials for end customers from the category of households are:

$$UFES = FEC_{HHS} \times S$$

$$FES = N \times UFES$$

Where:

UFES [kWh/a]	Unit final energy savings
FEC_{HHS}	energy consumption in the segment processed by the leaflet per campaign participant (household)
S [%]	Energy saving factor
N	number of households in the program
FES [kWh/a]	total annual energy savings in final consumption

Educating consumers about the benefits of buying a higher energy class device

Educating customers about the benefits of buying a higher energy class device would be achieved by sending it to the addresses of customers in the household category. With such materials, customers would be informed in a clear, understandable and affirmative way about the difference between the consumption of an old household appliance and a new appliance of the highest energy class (A +++).

Statistically speaking, a certain percentage of customers will react to information from information materials and, due to the information obtained in the leaflet, will decide to replace the existing device with a new one of the highest energy class, thus achieving energy savings.

Lifetime of measure: 15yrs for refrigerator, 12 for other appliances.

Calculation of final energy savings (Article 7)

Energy savings can be determined using the formula given in previous chaper taking into account the fact that such a leaflet addresses only the electricity consumption for household appliances, so it is necessary to use the UFES value defined for household appliances.

However, for more precise determination of energy savings, and since no relevant research has been found on the basis of which a savings factor S could be determined, related to this measure, it is recommended to conduct such research and adjust the general formula. Namely, the leaflets will be sent to customers from the household category. It is necessary to conduct a survey on the reference number of these customers, which will be determined in relation to the total number of customers to whom the leaflet was sent. The survey should determine the percentage of customers who have replaced or will replace an existing device with a new energy-efficient device. The survey can also determine the percentage of replacement by type of device. The stated percentage will then be used to calculate the total savings, while the amounts of unit savings for each type of household appliance (estimated savings) will be taken from Annex B.

Website for calculation of electricity savings

One of the ways to educate and inform consumers is through the suppliers' web pages where they can offer advice on energy savings in the household in combination with tools for calculating energy savings. The tool would determine the energy savings and cost benefits that result from buying a more efficient home appliance.

Therefore, this measure will be considered as an energy consulting measure, aimed at the segment of electricity consumption in households for household appliances. The projected savings approach will be based on the basic formula for calculating savings from behaviour change measures recommended by the EC, using the savings factor S as values from existing EU practice and UFEC values at based on national statistics.

Calculation of final energy savings (Article 7)

Formulas for calculating energy savings achieved through energy consulting via the Internet and focused on electricity consumption for household appliances:

$$UFES = FEC_{HHapp} \times S$$

$$FES = N \times UFES$$

Where:

UFES [kWh/a]	Unit final energy savings
FEC_{HHapp}	Electricity consumption of the appliance
S [%]	Energy saving factor
N	number of advises
FES [kWh/a]	Total annual energy savings in final consumption

Standardized calculation values

Informing consumers about the possibilities of improving energy efficiency through information materials

Table 88: Indicative values for calculation of final energy savings (Article 7).

		[kWh/(HH x a)]
FEC_{HH}	Energy consumption per household	15900
FEC_{HHel}	Of that electricity	2850
$FEC_{HHlight}$	Of that for lighting	304
FEC_{HHapp}	Of that for appliancies	1724
FEC_{HHheat}	Of that for heating	12400
S (%)		0.25

All values for FEC are determined on the basis of available energy statistics (Source: Odyssee database: https://odyssee.enerdata.net/database/ (access date: 30.10.2019)). certain benchmarks are given in Annex D.).

The reference value for the energy saving factor S is taken from EU practice [29] [The proposed method and reference values are based on the recommendations of the EU H2020 project MultEE - Facilitating Multi-level governance for Energy Efficiency given in the study »Document with general formulas of bottom-up methods to assess the impact of energy efficiency measures, measured by "Energy audits for households." The method is also elaborated in detail in the Austrian methodology given in the document "Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen (29. 6. 2016.)"

Using the values given in the table above, the following benchmarks for unit energy savings (UFES) are determined:

Household energy consumption	UFES [kWh/ (flyer x a)]
Total	39.75
Of that electricity	8.75
Of that for lighting	0.76
Of that for appliancies	0.86
Of that for heating	31.00

Educating consumers about the benefits of buying a higher energy class appliances

The necessary input data for the calculation of savings are:

- share of respondents who have replaced or plan to replace a household appliance by groups of household appliances - this data is obtained by surveying
- total number of sent information materials - this information is recorded by the sender (official data on output documents)

The documentation that needs to be attached / possessed as proof of the implementation of the measure and verification of the input data Si and N for the calculation of savings is as follows:

- a report on the conducted survey with a clear presentation of the results for the share of respondents who have replaced or plan to replace a household appliance;
- example of information materials;
- purchase order / invoice / contract for the production and printing of information materials with a visible number of pieces or record of handover between the Client of the service for the production of information materials and the Service Provider and
- official data / records on output documents.

The unit energy savings for each type of UFES device are determined according to the reference values given as it is considered that collecting data on consumption of existing and new devices would be too administrative burden, without real impact on the accuracy of calculated savings.

The indicative vales for unit energy savings (UFES) are as follows:

Table 89: Indicative values for calculation of final energy savings (Article 7).

	[kWh/(unit x years)]
Refrigerator	67
Freezer	71
Combined refrigerator + freezer	69
Washing machine	13

Dishwasher	44
Dryer	94

Website for calculation of electricity savings

	kWh/ year
UFES	0.86

Methodological aspects:

No other information is available in the catalogue.

Data sources for indicative calculation values:

All sources are available in the national catalogue referred in the bibliography.

4.4.3 Overview of costs related to the action

Not available.

4.4.4 Calculation of greenhouse gas savings

Formula for calculating the annual reduction of greenhouse gas emissions:

$$E_{CO2} = FES \times e/1000$$

Where:

ECO2 [t CO_2/a]	Greenhouse gas savings
FES [kWh/a]	Total final energy savings
e [kg CO2/kWh]	Emission factor

The emission factor is applied depending on the energy consumption covered by the consultation: total household energy consumption - e factor, electricity consumption - eEL factor or heat consumption - eTE factors, epp depending on the way (fuel) with which the heat needs are met.

Data sources for indicative calculation values

If energy consumption cannot be decomposed into electricity and heat (fuel), then it is necessary to use the emission factor for households, which was obtained on the basis of data on energy balance of households [Source: Annual Energy Review "Energy in Croatia 2017". , Ministry of Environmental Protection and Energy, December 2018). It should be

noted that the calculated emission factor for households depends on the structure of energy consumption in this sector and should be determined annually.

Also, due to the large share of biomass in energy consumption in households (about 46%), this average emission factor is lower than the factor for any other fuel or form of energy.

4.4.5 Bibliography

Ministry of Environmental Protection and Energy, Rulebook on system for monitoring, measurement and verification of energy savings, NN 33/2020, 20.3.2020, https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

4.5 Motivational workshops & courses - Croatia

Energy costs in the public and business sectors are often seen as an unavoidable cost rather than part of a business that can be managed effectively like any other process. The reason for this is the lack of education and motivation of employees to contribute to changes in their behaviour to more efficient use of energy in the work environment. Motivational workshops and courses can be considered a form of energy consulting, but they must be tailored to the company or institution in which they are conducted.

a) Motivational workshops for employees in a company or institution, which raise employee awareness of the importance of rational energy use in regular business activities and

b) Courses for persons responsible for energy in a company or institution, which empower responsible persons to implement specific energy efficiency measures in their own company or institution.

4.5.1 Calculation of impact on energy consumption (Article 3)

Not available

4.5.2 Calculation of final energy savings (Article 7)

a) Motivational workshops

The goal of motivational workshops is to make employees aware of how small behavioral changes at the individual level can make big changes at the organizational level. The workshop gives specific instructions on the rational treatment of energy in the workplace, but the workshops do not analyze in detail the energy consumption in a particular company or institution. The duration of the workshop is about 60 minutes.

Motivational workshops are a form of group energy counselling. The workshops do not analyse the energy consumption in the company or institution, and in that sense the approach to consulting is not individualized but general. In this sense, this activity can be considered as an information campaign to raise awareness among employees, so the general method for calculating savings resulting from behaviour change activities recommended by the EC can be used to calculate savings.

This formula calculates yearly savings:

$$TFES = FEC_{person} \times S$$

$$FES = N \times TFES$$

Where:

UFES	Unit final energy savings [kWh/(unit x a)]
FES	Total final yearly energy savings [kWh/a]
S [%]	Energy saving factor
N	number of included employees
FEC_{person}	Final energy consumption per employee [kWh/(unit x a)]

Standardized calculation values

Energy consumption per employee FEC_{person} can be determined from data for the company or institution for whose employees it is carried out, by dividing the annual energy consumption by the total number of employees. The documentation that needs to be attached / possessed to verify the FEC_{person} input for calculating savings is a signed statement of the responsible person of the company / institution on total energy consumption or energy consumption in the segment covered by the consultation and the total number of employees of the company / institution. Data are given for the first full year preceding the year in which the consultation is conducted or as an average for the last three years.

A reference value can also be used for FEC_{person}, which is recommended to reduce the administrative burden. The reference data is used for the energy saving factor S. The number of employees participating in the motivational workshop is a parameter of N. The documentation that needs to be attached / possessed as proof of the implementation of the measure and for the verification of the input data N for the calculation of savings is as follows:

- motivational workshop program and
- signature list of those present.

Table 90: Indicative values for calculation of final energy savings (Article 7).

Parameter	Value
FECperson [kWh/employees x a]	9,125
S (%)	0.25

Methodological aspects & data sources for indicative calculation values

The reference value for the FEC_{person} parameter is the value for annual energy consumption per employee in the services sector (Source: Odyssee database: https://odyssee.enerdata.net/database/ (date of access to the website: 30.10. 2019.) The data on the basis of which the reference values were determined are given in Annex D.). Given that motivational workshops are also conducted in companies from the industrial sector, this value of consumption per employee can be considered relevant for this sector as well.

Namely, a large part of energy consumption in industrial processes does not depend on employee behaviour and cannot be influenced by such motivational activities. Therefore, it would be wrong to calculate the value of energy consumption per employee in the industrial sector. In addition, due to the increasing degree of automation, the number of employees in the industrial sector is continuously declining, which results in high energy consumption per employee and the estimated savings would be overestimated many times over.

The reference value for the energy saving factor S is taken from EU practice [The proposed method and reference values are based on the recommendations of the EU H2020 project MultEE - Facilitating Multi-level governance for Energy Efficiency given in the study "Document with general formula of bottom-up The method is also elaborated in the Austrian methodology given in the document "Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen (June 29, 2016)", measure for households (German: Energieberatung für private Haushalte).), where the lowest value of this factor is taken, because it is a group consultation, which is considered to be the lowest level of consulting.

b) Courses for the implementation of energy efficiency measures

The courses introduce participants (persons responsible for energy management in a company or institution) to the possibilities of energy saving and build their capacity to make decisions on the implementation of energy efficiency measures.

The aim of the course is to develop new professional competencies in the field of operational energy efficiency and training for systematic energy management. The course lasts 2 working days or 16 hours.

Such courses can be considered as a form of energy consulting. It is important that the course analyses the energy consumption in the company or a specific part of that consumption and that the course (consultation) results in a report that will contain an analysis of energy consumption from energy sources to consumers, proposals for organizational and behavioral changes, proposals for investment measures to improve energy efficiency and assess potential energy and money savings, possible interactions between measures and refer to incentive programs for proposed measures.

The method of determining savings is then based on the general method for calculating savings resulting from behavior change activities recommended by the EC and on existing European practice using the projected savings approach. (The method of determining energy savings is based on the Austrian methodology given in *"Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen (June 29, 2016)" - a measure of energy consulting for small and medium-sized enterprises ("Energieberatung für KMU"). , ie in the business sector in general, while in the public sector such courses are conducted by the Agency for Legal Transactions and Real Estate Brokerage (APN).)*

This formula calculates yearly savings:

$$FES = FEC_{entp} \times S$$

Where:

S [%]	Energy saving factor

FEC_{entp}	Final energy consumption of the company [kWh/ a]

The input data in the calculation of energy savings is the energy consumption of the company which is analyzed at the FECentp exchange rate. It is not necessary for the course (consulting) to cover the entire energy consumption in the company, but it is possible to cover only a part of the consumption (e.g., electricity consumption for lighting). Documentation to be attached / possessed as proof of implementation of the measure and to verify the input data FECentp for calculating savings is a report on the consultation signed by the participants with a description of the content of individual consultation and data on total energy consumption of the company or part of consumption analysed in the course . Data are given for the first full year preceding the year in which the consultation is conducted or as an average for the last three years.

A reference value is used for the energy saving factor S.

Standardized calculation values

Table 91: Indicative values for calculation of final energy savings (Article 7).

Parameter	Value
S (%)	2.8

4.5.3 Overview of costs related to the action

Not available.

4.5.4 Calculation of greenhouse gas savings

$$GHGSAV = TFES \times f_{NG}/1000$$

Where:

TFES	Total final energy savings [kWh/a]
$f_{GHG,electricity}$	Emission factor for natural gas [kg CO_2/kWh]

Table 92: Indicative values for calculation of greenhouse gas savings.

$f_{GHG,electricity}$	[kg CO_2/kWh]
Natural gas	0.214

Data sources for indicative calculation values:

Given that the consultation is focused on all aspects of energy consumption, and emission factors are related to a specific fuel or form of energy, it is proposed to use the emission factor for natural gas for this measure. Namely, in the energy balance of the service sector, electricity participates with about 62% and natural gas with about 24%, while other energy sources have a much smaller share (Source: Annual Energy Review "Energy in Croatia

2017", Ministry of Environmental Protection and Energy, December 2018). By selecting the emission factor for natural gas, the reduction of CO2 emissions is determined in a conservative manner and eliminates the need for annual calculation of the emission factor for the services sector or industry, which depends on the annual energy balance.

4.5.5 Bibliography

Ministry of Environmental Protection and Energy, Rulebook on system for monitoring, measurement and verification of energy savings, NN 33/2020, 20.3.2020, https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

MultEE project - Facilitating Multi-level governance for Energy Efficiency given in the study "Document with general formulas of bottom-up methods to assess the impact of energy efficiency measures", measured by "Awareness Raising campaigns"

Annual Energy Review "Energy in Croatia 2017", Ministry of Environmental Protection and Energy, December 2018

"Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen (June 29, 2016)", Measures for households (German: Energieberatung für private Haushalte)

4.6 Consulting of final consumers – Croatia

Consulting of final energy consumers is a measure that seeks to encourage changes in customer behavior related to patterns of energy use and empower them to make informed decisions about investing in measures to improve energy efficiency. Energy consulting is usually carried out in a systematic way, by establishing networks of advisors (e.g., the ENSVET network in Slovenia] (More information is available at: https://ekosklad.si/prebivalstvo/ensvet (access date to the website: 22.10. 2019.)), ie the network of info offices and centers (eg EE info offices and EE info centers established within the project "Promoting energy efficiency in Croatia" [More information is available at: http: //www.enu.fzoeu .hr / info-edu / gdje-po-savjet-ee-savjeti (access date to the website: October 22, 2019)

Such a measure could be established by opening info points (telephone line, website, info centers) where all interested customers could come for advice on improving energy efficiency. It is important to point out that energy consulting involves providing sufficient data on the existing energy consumption profile of the individual consumer (customer) to identify and quantify the potential for energy savings. In this sense, counseling, and in order to lead to behavioral changes that can be quantified in terms of energy savings, must be individualized.

Therefore, the method for estimating savings is determined only for individual counseling, ie counseling that takes into account the energy consumption profile of the individual consumer. In this case, the method for estimating savings refers only to savings that are the result of behavior change. Namely, energy consulting can lead to the implementation of technical energy efficiency measures, for which it is then necessary to apply other methods of calculating energy savings.

Forms of consultation (Source: EU H2020 project MultEE - Facilitating Multi-level governance for Energy Efficiency, study "Document with general formula of bottom-up methods to assess the impact of energy efficiency measures", 2016):

- On-site energy counseling: The most intensive form of counseling is on-site counseling in households. The potential for energy savings can be determined directly, without abstract explanations in the areas of application, concrete recommendations can be made, and in some cases measures can be implemented directly with the help of advisors.
- Energy consulting in info centers: Energy consulting in info centers is the most common way of consulting used by energy suppliers. Interested energy consumers (customers) turn to suppliers with inquiries related to energy consumption and the possibility of achieving energy savings. Such advice is often combined with information brochures / leaflets with tips for achieving energy savings. Participation in conferences and seminars can be accepted as this type of counseling, if counseling is individualized and documented at such events.
- Telephone counseling: Telephone counseling is an alternative to counseling in info centers and is often offered in combination with online counseling.
- Online counseling: online counseling services with individual feedback on energy saving opportunities in the household provide an alternative to counseling on site or in info centers. The advantages of online consulting are low implementation costs and the possibility of wide coverage. In addition, the advice is available anytime and anywhere with Internet access. In order to treat online consulting as an energy efficiency measure, such consulting must include a detailed questionnaire on individual consumption, provide equal access for all users (regardless of whether the user is also a customer of the provider offering this service), personalized tips for energy savings and final report. Publishing advice on ways to achieve savings, without an individualized (personalized) approach is not considered energy consulting in the context of meeting energy efficiency obligations.

This measure applies only to final customers from the category of households, while the envisaged forms of advice for the business sector (industry and services) are discussed in previous measures.

Lifetime: 2yrs.

4.6.1 Calculation of impact on energy consumption (Article 3)

Not available

4.6.2 Calculation of final energy savings (Article 7)

To determine the energy savings that result from measures that change the behavior of end customers (consumers) of energy, it is possible to use the determined savings, using a general formula for measures that affect behavior change, as proposed by the EC.

In doing so, it is crucial to determine the energy saving factor S, which is the biggest challenge in defining the method. Namely, no research has yet been conducted in Croatia on the basis of which this factor could be determined, so there are no relevant national reference values.

For this reason, a study of available examples in other EU Member States was made and the benchmarks were recommended based on already established and applied practices [(The proposed method and benchmarks are based on the EU H2020 recommendations The efficiency given in the study “Document with general formulas of bottom-up methods to assess the impact of energy efficiency measures” is measured by “Energy audits for households.” The method is further elaborated in the Austrian methodology given in the document 29.06.2016) ».

The possibility of applying the method applied to the network of energy advisors in Slovenia ENSVET (according to the Ordinance on amendments to the Ordinance on methods for determining energy savings, Official Gazette of the RS, No. 14/2017) was also considered, but given that this measure has been implemented for many years in Slovenia and that data have been established very specifically related to it, it was assessed that the method and the given reference values are not appropriate for the activities carried out by the parties to the bonds of the energy efficiency obligation system in Croatia.).

Formulas for calculating energy savings achieved by energy consulting:

$$UFES = FEC_{HH} \times S_{Qi}$$

$$FES = \sum_{i=1}^{3} N_{Qi} x UFES_{Qi} = N_{Q1} \times FEC_{HH} \times S_{Q1} + N_{Q2} \times FEC_{HH} \times S_{Q2} + N_{Q3} \times FEC_{HH} \times S_{Q3}$$

Where:

UFES	Unit final energy savings [kWh/(unit x a)]
FES	Total final yearly energy savings [kWh/a]
S_{Qi}	Energy saving factor for the advises of different levels
N_{Qi}	number of advises of the quality 1,2,3
Qi	Advise quality (1-3)
FEC_{HH}	Final energy consumption per household [kWh/a]

Standardized calculation values

Table 93: Indicative values for calculation of final energy savings (Article 7).

Parameter	Unit	Ref. value
FEC_{HH}	[kWh/a]	15,900
FEC_{HHel}	[kWh/a]	3,500
FEC_{HHte}	[kWh/a]	14,400
S_{Q1}	%	0.25
S_{Q2}	%	1
S_{Q3}	%	3

Methodological aspects:

The calculation is based on the quality levels of the consultation, which are defined as follows:

- Level of consultation quality 1: if the consultation is conducted directly (by phone, on site) with the client or through personalized online offers with individual consumption analysis and lasts at least 15 minutes.

- Level of consultation quality 2: if the consultation is conducted directly (by phone, in the info center, on the spot) with the client, it includes an individual analysis of consumption and lasts at least 30 minutes.
- Quality of consultation 3: if the consultation is carried out on the spot, if the consultation lasts more than 60 minutes, the consultation is conducted by a person authorized for energy audit and a report with a proposal of energy efficiency measures is generated.

The energy saving factor SQi depending on the type and level of quality of Qi consulting is determined according to the table:

Type of consultations	Q1	Q2	Q3
Directly		1 %	3 %
Info centers	0.25 %	1 %	3 %
Phone	0.25 %	1 %	
Internet	0.25 %		

Counseling can only refer to electricity, only to heat or to total energy consumption (electricity and heat), which calculate to total.

Each consultation needs to be documented to determine energy savings. Reports must include the date, time, duration, type and level of quality of the consultation. Quality level 2 and 3 consultations must include information on the areas considered for energy efficiency improvement, the proposed energy saving measures and the estimated savings potential. The report on counseling on the spot or in the info centers must be signed by the user. All counseling reports must be signed by the counselor.

The number of consultation reports of a particular type and level of quality represents the NQi parameter. For FEC_{HH} (FEC_{HHel}, FEC_{HHte}) it is possible to use actual data, but they must be documented and verified by the client (by signing the consultation report). In order to reduce the administrative burden, but also errors, it is recommended that the actual data be used only exceptionally, in the case of the level of quality of consultation 3.

Data sources for indicative calculation values:

All values for the FEC are determined on the basis of available energy statistics

Using the values given in the table above, the following benchmarks for unit energy savings (UFES) are determined:

UFES [kWh/(unit x a)]	Q1	Q2	Q3
Total energy savings	39.75	159	477
Electricity	8.75	35	105
Heat	36	144	432

4.6.3 Overview of costs related to the action

Not available

4.6.4 Calculation of greenhouse gas savings

$$GHGSAV = TFES \times f_{GHG}/1000$$

Where:

TFES	Total final energy savings [kWh/a]
f_{GHG}	Emission factor for electricity [kg CO_2/kWh] (depends on the energy used)

Data sources for indicative calculation values:

The emission factor is applied depending on the energy consumption covered by the consultation: total household energy consumption. If the heat needs are met by biomass (usually firewood), the emission factor is zero. If energy consumption cannot be decomposed into electricity and heat (fuel), then it is necessary to use the household emission factor, which is obtained on the basis of data on household energy balance [Source: Annual Energy Review "Energy in Croatia 2017". Ministry of Environmental Protection and Energy, December 2018). It should be noted that the calculated emission factor for households depends on the structure of energy consumption in this sector and should be determined annually. Also, due to the large share of biomass in energy consumption in households (about 46%), this average emission factor is lower than the factor for any other fuel or form of energy.

4.6.5 Bibliography

Ministry of Environmental Protection and Energy, Rulebook on system for monitoring, measurement and verification of energy savings, NN 33/2020, 20.3.2020, https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

EU H2020 project MultEE - Facilitating Multi-level governance for Energy Efficiency, study "Document with general formula of bottom-up methods to assess the impact of energy efficiency measures", 2016

Odyssee database: https://odyssee.enerdata.net/database/ (access date: 30 October 2019)). whose reference values are given are given in Annex 1.).

4.7 Horizontal measures towards attainment of the target referred to in article 7 EED – Cyprus

The current method refers to the implementation of horizontal measures (implementing energy savings information campaigns, carrying out advertising actions, organising workshops, conducting pupils' competitions, etc. A) to attain the target referred to in Article 7 of the EED.

4.7.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

4.7.2 Calculation of final energy savings (Article 7)

This formula calculates first year savings.

$$TFES = n * FEC_{person} * p_{affected} * S_Q$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of involved persons of a specific target group
FEC_{person}	Final energy consumption of a person (either for electricity or for electricity and heat) [kWh/a]
$p_{affected}$	Percentage of affected persons of a specific target group [%]
S_Q	Savings factor of the awareness raising campaign [%]

Standardized calculation values

Table 94: Indicative values for calculation of final energy savings (Article 7).

Parameter	Value
FEC_{person} [kWh/a]	4679
$p_{affected}$ [%]	40%
S_Q [%]	2%

Methodological aspects

This methodology was presented in the 4th National Energy Efficiency Action Plan of Cyprus, which was submitted in 2017.

Data sources for indicative calculation values

The specification of the FEC_{person} parameter was performed taking into account the national data by the energy balance, while the report "Changing Energy Behaviour Guidelines for Behavioural Change Programmes" (IDAE, 2009) was used for determining the S_Q parameter.

4.7.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

4.7.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

4.7.5 Bibliography

MECIT (2017). 4th National Energy Efficiency Action Plan of Cyprus, page 241.

4.8 Energy consumption display and interpretation device– France

Acquisition or rental of a device for displaying and interpreting electrical energy consumption and fuel coupled to a system for measuring the energy supplied to the dwelling.

This device has the following functions:

- use energy consumption measurements to interpret them;
- communicate to the user the results obtained and appropriate advice so as to encourage him to reduce his energy consumption ;
- alert the user if the reference consumption thresholds are exceeded.

4.8.1 Calculation of impact on energy consumption (Article 3)

For article 3, national statistics are used in France to report energy consumption and no method is available for this specific subject.

4.8.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**.

$$TFES = FEC \times A \times C \times S$$

Where:

TFES	Total final energy savings [kWh/a]
FEC	Final energy consumption per dwelling [kWh/a]
A	Factor of energy savings [%]
C	Factor according to “Comfort monitoring” option
S	Factor according to the surface

Standardized calculation values

In France, the A factor is estimated at 5%.

C is 1 if there is a “comfort monitoring option” if not 0,8

The table below shows the S values:

Table 95: Value of S factor

S factor	Surface [M²]
0,3	S < 35
0,5	35 ≤ S < 60
0,6	60 ≤ S < 70
0,7	70 ≤ S < 90
1	90 ≤ S < 110
1,1	110 ≤ S ≤ 130
1,6	>130

Methodological aspects

The final energy consumption per dwelling (FEC) is the average of final energy consumption for all the end-use (heating, hot water, cooking, specific electric consumption).

In France the energy savings targets and action are recorded in kWh cumac of final energy, cumac being the contraction of "cumulative and actualized": KWc cumac= TFES X Dc

Table 96: Indicative values for calculation of energy savings certificates.

Lifetime of savings	[a]
Lifetime of savings	4
Dc: Discount coefficient (4%)	3,7751

Data sources for indicative calculation values

The factor of energy savings A provided from different studies. It's not the average but a conservative value given by experts.

4.8.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

4.8.4 Calculation of greenhouse gas savings

No information for the calculation of greenhouse gas savings available.

4.8.5 Bibliography

« Opérations standardisées d'économies d'énergie ». *Ministère de la Transition écologique*, https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie. Accessed April 11, 2022.

BAR-EQ-115 : Dispositif d'affichage et d'interprétation des consommations d'énergie (PDF - 124.29 Ko)

4.9 Energy consumption monitoring service – France

This follow-up service allows the household:

- to monitor its energy consumption in kWh and valued in euros;
- to visualize its evolutions at a minimum step of 30 minutes for electricity and a day for gas;
- to break down consumption (personalized analysis by use);
- access to different accumulations (hour for electricity only / day / month / year);
- to compare its consumption with that of similar households;
- to alert it if reference consumption thresholds are exceeded;
- to access a history of all accumulations over at least 3 months and those higher or equal to the day for 2 rolling years.

4.9.1 Calculation of impact on energy consumption (Article 3)

For article 3, national statistics are used in France to report energy consumption and no method is available for this specific subject.

4.9.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**.

$$TFES = FEC \times A$$

Where:

TFES	Total final energy savings [kWh/a]
FEC	Final energy consumption per dwelling [kWh/a]
A	Factor of energy savings [%]

Standardized calculation values

In France, the A factor is estimated at 3%.

The display of consumption can be made available either for all consumption electricity ("electric heating" amount + "specific electricity" amount) or on the consumption of specific gas and electricity ("gas heating" amount + "specific electricity" amount) or on the specific consumptions only according to the energies covered by the beneficiary of the operation.

In France the energy savings targets and action are recorded in kWh cumac of final energy, cumac being the contraction of "cumulative and actualized": KWc cumac= TFES X Dc

Table 97 : Values for individual house in kWhcumac

	End-use		
Climatic area	electric heating	gas heating	specific electricity
H1	400	620	90

H2	340	510	90
H3	250	380	90

Methodological aspects

The final energy consumption per dwelling (FEC) is the average of final energy consumption. It's calculated for electric heating, gas heating, and specific electricity.

Table 98: Indicative values for calculation of energy savings certificates.

Lifetime of savings	[a]
Lifetime of savings	1
Dc: Discount coefficient (4%)	1

Data sources for indicative calculation values:

The factor of energy savings A provided from different studies. It's not the average but a conservative value set by the ministry.

4.9.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

4.9.4 Calculation of greenhouse gas savings

No information for the calculation of greenhouse gas savings available.

4.9.5 Bibliography

« Opérations standardisées d'économies d'énergie ». Ministère de la Transition écologique, https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie. Accessed April 13, 2022.

BAR-SE-106 : Service de suivi des consommations d'énergie (PDF - 170.89 Ko)

4.10 Awareness raising campaigns in residential and tertiary sectors – Greece

This method seeks refers to the quantification of the energy savings delivered by the conduction of information and awareness raising measures in residential and tertiary sectors.

For the baseline, it is assumed that no information and awareness raising measures are implemented.

4.10.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

4.10.2 Calculation of final energy savings (Article 7)

This formula calculates first year savings.

Measures for existing consumers/customers:

$$TFES_{yr} = \sum_{1}^{i} n * FEC_{unit} * S_Q * S_{affected} * (1 - S_{reduction}) * (1 - S_{affected\_prev\_year})$$

Measures for non-existing consumers/customers:

$$TFES_{yr} = \sum_{1}^{i} n * FEC_{unit} * S_Q * S_{affected} * (1 - S_{reduction})^2 * (1 - S_{affected\_prev\_year})$$

Where:

TFES	Total final energy savings [kWh]
FEC_{unit}	Average final energy consumption of the target group (either of the residence in residential sector or of the employee in the tertiary sector) [kWh]
S_Q	Energy savings factor [%]
$S_{affected}$	Percentage of affected consumers/customers [%]
$S_{reduction}$	Impairment percentage due to the involvement of more than one obligation parties in existing consumers/customers [%]
$S_{affected\_prev\_year}$	Impairment percentage due to the influence of a target group (either of the residence in residential sector or of the employee in the tertiary sector) from measures taken in the previous reference year [%]
n	Number of involved residences in the case of residential sector and of employees in the case of tertiary sector.
i	Number of energy savings measures

Standardized calculation values

Table 99: Indicative values for calculation of final energy savings (Article 7).

FEC_{unit}	Value
Residential sector [kWh/residence]	7,955
Tertiary sector [kWh/employee]	7,406
Other parameters	[%]
$S_{affected}$	32%
$S_{reduction}$	20%
$S_{affected\_prev\_year}$ – Residential sector	30%
$S_{affected\_prev\_year}$ – Tertiary sector	31%
S_Q	[%]

Information	2%
Specialized information	3%
Financial incentives + information	5%
Information on weekly basis	10%
Issuing of Energy Performance Certificate (EPC)	10%
Energy Audit	15%
Lifetime of savings	[a]
Lifetime of savings	2

Methodological aspects

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

The default values about the final energy consumption were estimated according to the available data in Eurostat, while the $S_{affected}$ was resulted by a ex-post survey, which was conducted after the first year of operation of the Energy Efficiency Obligation Scheme.

Each Obligation Party must provide only the number (n) of involved residences or of employees separately for existing and non-existing consumers/customers. Additionally, in the case of implementing measures using social media then the value of $S_{affected}$ parameter will be considered to be equal to 100%.

Furthermore, in case where the number of employees cannot be verified then the number of employees (n parameter) for each enterprise is considered to be equal to 3.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

4.10.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

4.10.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

4.10.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU1, http://www.cres.gr/obs/yliko.html.

4.11 Home Energy Reports for Behavioural Energy Efficiency - Ireland

There is no calculation formula neither a detailed methodology publicly available.

Only annual Energy Saving Credits pre-calculated for different measures as Energy Credits kWh/annum. Following table show the respective values and the boundary conditions for behavioural changes and their monitoring:

Measure	Minimum Specification - All measures installed must meet the minimum specification listed below	Energy Credits kWh/annum	
		Appartement	House
Electricity Home Energy Reports for Behavioural Energy Efficiency	· Reports must include personalised comparison, comparing a consumer's energy use (based on electrical consumption as dictated on the dwellings bi-monthly energy bill) against a group of no more than 200 similar households (e.g. by location, size, etc.) · A minimum of six energy reports shall be issued per year to the occupants of the dwelling. The energy reports should follow the issuing of an energy bill and reference the energy usage during that period. · Reports include advice for saving energy · Advice for saving energy is personalised to the recipient · Contact information for final customers' organisations, energy agencies or similar bodies, including website addresses, from which information may be obtained on available energy efficiency improvement measures e.g. SEAI's 'Power of One' campaign, comparative end-user profiles and objective technical specifications for energy using equipment.	15	15
Natural Gas Home Energy Reports for Behavioural Energy Efficiency	· Reports must include personalised comparison, comparing a consumer's energy use (based on natural gas consumption as dictated on the dwellings bi-monthly energy bill) against a group of no more than 200 similar households (e.g. by location, size, etc.) · A minimum of six energy reports shall be issued per year to the occupants of the dwelling. The energy reports should	17	17

	follow the issuing of an energy bill and reference the energy usage during that period. · Reports include advice for saving energy · Advice for saving energy is personalised to the recipient · Contact information for final customers' organisations, energy agencies or similar bodies, including website addresses, from which information may be obtained on available energy efficiency improvement measures e.g. SEAI's 'Power of One' campaign, comparative end-user profiles and objective technical specifications for energy using equipment.		

4.12 Implementation of smart bills – Italy

This methodology applies to the adoption of a behavioral efficiency program that takes advantage of the implementation of a Smart bill in the residential sector by inducing the consumer to achieve electricity savings through the disclosure of information that allows them to acquire an accurate perception of the comparison between their own consumption and those of similar users. The project will exploit the adoption of personalized energy reports for each user with the aim of raising consumer awareness of behavioral change.

4.12.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

4.12.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**

$$TFES = \left(\sum_{i=1}^{n} \frac{\left(Consumption_{gdt}\right)_i}{n} - \sum_{i=1}^{n} \frac{\left(Consumption_{gbdc}\right)_i}{n} \right) \times ft \times p \times rb \times so \times fr$$

with:

$$Consumption = ANTE_{gdt/gbc} - POST_{gdt/gbc}$$

Where:

TFES	Total final energy savings [toe/a]
n	Number of users in the relevant group
i	control variable – single user

gdt	users receiving smart bills
gbc	users in the control group
ft	electrical conversion factor from MWh_e to toe equal to (=0.187 toe / MWh)
p	population to which the calculation of the savings calculated on the representative sample is extended
ANTE	energy consumption relating to at least 12 months prior to the start of the first ex post period. In both groups the ex ante measures will lack the implementation of the behavioral efficiency program [kWh/year]
POST	energy consumption relating to the monitoring period subject to reporting with (gdt) or without (gbc) the implementation of the behavioral efficiency program [kWh/year]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

Standardized calculation values

No indicative calculation values available for this methodology.

Methodological aspects:

This methodology was published in the Italian Gazetta Ufficiale della republica italiana Anno 159° - Numero 158. The document contains elaborations on the savings calculation of various energy efficiency actions. It is published in Italian language.

The methodology requires reporting parties to monitor the energy consumption of users receiving smart bills to users in a control group. Both groups have to fullfill the following criteria:

- the gdc (control group) is used as a sample to purify those savings that would have occurred in any case even without the application of the behavioural efficiency program due to the evolution of the market and / or particular contexts not attributable to the behavioural program. The control group must guarantee similar characteristics to the treatment group;
- the gdt (sample group) has the purpose of monitoring the savings related to the effect of the implemented behavioural efficiency program

The 2 * n users divided equally between the gdc and the gdt have similar characteristics to each other and with respect to the population p to which the savings will be extended. In particular, they have:

- housing units with the same intended use and the same conditions of occupation (eg number of users, age group, etc.). This constraint must be respected if the gdc and gdt are not large enough to exclude the variability due to the above;
- same boundary conditions (climatic zone, location and territorial context);

Data sources for indicative calculation values:

No indicative calculation values available for this methodology.

4.12.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

4.12.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

4.12.5 Bibliography

Republica Italiana (2018). Gazetta Ufficiale della republica italiana – Serie generale Anno 159° - Numero 158.

4.13 Education and counselling measures for energy end-users - Lithuania

The Law on Energy Efficiency Improvement of the Republic of Lithuania provides that education and counselling, which encourage the introduction of energy efficiency improvement measures and which have the effect of reducing final energy consumption, shall be one of the measures of the energy efficiency improvement policy. It also provides that energy suppliers shall enter into publicly disclosed agreements with the Ministry of Energy on consumer education and advice.

The purpose of the agreements is to educate and advise consumers on energy saving measures and solutions that **change consumer behaviour and habits towards energy efficiency.**

4.13.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

4.13.2 Calculation of final energy savings (Article 7)

The impact of agreements between energy suppliers and the Ministry of Energy on consumer education and counselling on the reduction of energy consumption shall be evaluated in the light of the consumer education and counselling measures taken by energy suppliers, which may include publishing information to end-users on the benefits of efficiency measures on the internet, in the press, and other publications, the organisation of publicity events for energy saving projects, telephone or on-site counselling, training in the operation of heating or ventilation systems and other measures, but not limited to, and where the impact of the measures on the reduction of energy consumption is calculated on the basis of the reported values of the coefficients of the energy savings of the education and counselling measures (see Table xx). This method can only be used to calculate **energy savings due to changes in consumer behaviour**. It cannot be used to calculate the energy savings resulting from the installation of physical efficiency measures.

The energy savings of an education and consulting measure implemented shall be calculated by multiplying the value of the energy savings coefficient of the education and consulting measure by the average annual energy consumption of the consumers covered by the measure in one calendar year. There is no limit to the number of education and advice measures per consumer.

Principle for calculating energy savings

The percentage of savings shall be calculated as the ratio of the energy supplier's total savings effect generated by the education and consulting measure to the amount of energy

supplied (sold) to its customers during the reference year (this formula calculates **[savings for one year]**:

$$a = S/Gv$$

The total savings generated by the education and consulting measure are calculated as the sum of the individual education and consulting measure:

$$S = S_1 + \ldots + S_n$$

The savings effect of an individual education and consulting measure is calculated as the product of the consumption of the target group of consumers (covered by the individual education and consulting measure) for the reference year and the value of the education and consulting measure's energy savings rate:

$$S_1 = Gv \times d \times k$$

Where:

a	the percentage of savings on the amount of energy supplied (sold) by the energy supplier [%]
S	the total savings generated by the education and consulting measure [MWh]
Gv	the total amount of energy supplied (sold) by the energy supplier to its customers during the reference year [MWh]
$S_{1...n}$	Saving effect of an individual education and consulting measure [MWh]
d	Percentage of consumption of the consumer target group as a percentage of Gv [%]
k	energy savings coefficient of the education and consulting measure [-]. These coefficients are presented in Table 2.

Table 100: Energy saving coefficient values (k) for education and advisory measures

Type of education and advisory measure	Energy saving coefficient
Information on measures to improve electricity efficiency	
Publication of information on the website	0,0025
Publication of information in the press or in printed publications, or on television or radio broadcasts	0,0025
Provision of benchmarking within the consumer group together with energy saving tips in print or electronically/digitally	0,005
Publicity event covering energy efficiency improvement	0,0025
Consultation by e-mail, directly online or by telephone on request of the consumer	0,004
Consultation at the customer's premises	0,02
Lending of electricity meters or other measuring equipment	0,04
Training in the efficient operation of ventilation systems	0,05
Information on thermal energy efficiency measures	
Publication of information on the website	0,0025
Publication of information in the press or printed media or on television or radio	0,002
Provision of a comparative analysis in a consumer group together with energy saving tips in print or electronically/digitally	0,005
Publicity event covering energy efficiency improvement	0,0025
Consultation by e-mail, directly online or by telephone on request of the consumer	0,004
Consultation at the customer's premises	0,05
Lending of heat energy meters or other measuring equipment	0,03
Training in the efficient operation of heating systems	0,05
Training on the efficient operation of heating points	0,07
Information on gas energy efficiency measures	
Publication of information on the website	0,0025
Publication of information in the press or printed media or on television or radio	0,002
Provision of a comparative analysis within the consumer group together with energy saving tips in print or electronically/digitally	0,005
Consultation by e-mail, directly online or by telephone upon request of the consumer	0,0025
Consultation at the customer's premises	0,004
Training on the efficient operation of gas-fired systems	0,05

The above list of types of education and counselling measures is not exhaustive and is subject to change on the basis of reasoned suggestions from the parties involved.

4.13.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

4.13.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

4.13.5 Bibliography

Description of procedures for calculating and maintaining the energy saved by energy use efficiency improvement measurements https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/9281dea0bd8a11e6a3e9de0fc8d85cd8/asr

Description of procedures for the establishment of energy consumer education and consultation agreements https://www.e-tar.lt/portal/lt/legalAct/95f761a09c4a11e78bd78a8ea3cd0744/asr

Description of procedures for calculating and maintaining the energy saved by energy use efficiency improvement measurements https://www.e-tar.lt/portal/lt/legalAct/c3eb4b20bbb911e688d0ed775a2e782a/asr

Description of procedures for setting up energy savings agreements https://www.e-tar.lt/portal/lt/legalAct/cd89c430688011e7827cd63159af616c/asr

Description of the procedure for the climate change programme for the compliance benefits for the improvement of the interior heating and hot water systems of multi-apartment houses https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/4f3893820a0a11eaa727fba41f42a7e9/asr

4.14 Energy advice for citizens ENSVET program – Slovenia

4.14.1 Calculation of impact on energy consumption (Article 3)

Not available.

4.14.2 Calculation of final energy savings (Article 7)

The energy savings calculation in a given year is based on data obtained from the survey of citizens, recipients of advice, two years before the year of evaluation carried out by the ENSVET network. This determines how many households have implemented energy efficiency investments and what is the amount of energy savings.

Corrective factors are used to determine the energy savings from the sample to the total number of households involved in the consultancy. Among other things, the evaluation of the implementation of the measures should take into account the so-called double counting that may result from subsidizing the measures already implemented by alternative measures authority Eco Fund.

Energy savings from the implementation of energy advice to the citizens under the ENSVET program are calculated using the following equation:

$$FE_{Advice} = M \cdot (f_1 \cdot f_2 \cdot f_3 \cdot f_4 \cdot f_5 \cdot f_6) \cdot S$$

Where:

FE_{Advice}	Energy saving [kWh/year] due to the implementation of energy advice to the citizens.
M	Number of advices under the ENSVET program in the preceding calendar year.
f_1	Factor related to the share of surveys for which data have been obtained.
f_2	Factor related to savings in existing building stock, including the share of savings of new buildings.
f_3	Factor for returnees (for updated advice, re- advice).
f_4	Factor addressing the redundancy with the Eco-Fund incentive scheme.
f_5	Factor of other incentives other than state systemic incentives, such as financial incentives from local communities.
f_6	Control group factor that eliminates energy savings achieved per average household rregardless of the energy advice to citizens program.
S	Average annual energy savings. Identified in the analysis of the actions carried out based on a specific survey (for the period 2012-2013 is 8240 kWh/consultancy).

Table 101: Factor values based on 2013 analysis data.

Factor	f_1	f_2	f_3	f_4	f_5	f_6
Value	0.95	0.92	0.61	0.80	0.90	1.00

In general, the average annual energy savings are determined by the change in the energy number of the average area of buildings where savings have been achieved, namely:

$$S = (EN_1 - EN_2) \cdot A$$

Where:

S	the average annual energy savings [kWh/advice per year]
EN_1	Energy number representing the specific energy use in relation to the structure of final energy in the building stock prior to the renovations.
EN_2	Energy number representing the specific energy use in relation to the structure of final energy in the building stock after the renovations.
A	The average heated floor area (inside the heat envelope) of the building [m2].

Standardized calculation values

Table 102: Factor values based on 2013 analysis data.

Parameter	S	EN_1	EN_1	ef_1	ef_2
unit	[kWh/advice per year]	[kWh/m2 per year]	[kWh/m2 per year]	[kg CO2/kWh]	[kg CO2/kWh]
Value	8240	158	122	0.176	0.151

Taking into account the above standardised calculation values based on the 2013 analysis data, the energy savings achieved by the ENSVET advice can be calculated empirically as follows (M represents the number of counselling/advices):

$$FE_{Advice} = 3160 \cdot [\frac{\text{kWh}}{\text{advice}} \text{per year}] \cdot M$$

Methodological aspects

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

4.14.3 Overview of costs related to the action

Not available. The lifetime expectancy of this measure is 5 years.

4.14.4 Calculation of greenhouse gas savings

The reduction of CO_2 emissions (CES) is calculated according to the formulas bellow:

$$CES_{Advice} = FE_{Advice} \cdot \frac{(EN_1 \cdot ef_1) - (EN_2 \cdot ef_2)}{(EN_1 - EN_2)}$$

Where:

CES_{Advice}	Reduction of CO2 emissions [kg CO2/year] when implementing a measure.
ef_1	specific emission discharges related to the specific energy use in relation to the structure of final energy in the building stock prior to the renovations [kg CO2/kWh]. See the table above.
ef_2	specific emission discharges related to the specific energy use in relation to the structure of final energy in the building stock after the renovations [kg CO2/kWh]. See the table above.

Data sources for indicative calculation values

All necessary data on the values of factors and parameters are obtained from the analysis based on the survey on the implementation of measures and energy savings for which consulting/advice has been given, except for f4, which is determined according to the Eco Fund data.

4.14.5 Bibliography

The methodology has been translated from the Slovenian national catalogue for calculating energy savings in line with Article 7, available at: http://www.pisrs.si/Pis.web/npb/2017-01-0676-2015-01-2730-npb1-p1.pdf.

4.15 Awareness Raising campaigns – multEE

Campaigns may vary a lot from each other. They differ in content, target groups, scale, media use, etc. Such campaigns may be information and motivation campaigns; awareness raising programs or the provision of non-individualized energy efficiency "tips" or counselling. Furthermore the message may be spread via different channels (news, TV, brochures, etc.).

Awareness-raising and information campaigns should be supported by social marketing. Social marketing seeks to develop and integrate marketing concepts with other approaches to influence behaviours that benefit individuals and communities for the greater social good. It seeks to integrate research, best practice, theory, audience and partnership insight, to inform the delivery of competition sensitive and segmented social change programs that are effective, efficient, equitable and sustainable.

In order to achieve any effects, it is imperative that the campaign is tailor-made for the target group that should be reached. To address them, the most suitable communication instruments should be used.

At this point it should be mentioned that the potential savings might be increased when combined with so called enabling factors such as financial resources or new skills for example and reinforcing factors such as feedback. Nevertheless when it comes to individual behaviour social interaction, lifestyles, norms and values as well as technologies and policies should be kept in mind as they are all enabling or constraining behavioural change as well.

4.15.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

4.15.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = FEC_{TG} \times S_Q$$

$$FEC_{TG} = n \times FEC_{person}$$

Where:

TFES	Total final energy savings [kWh/a]
FEC_{TG}	Final energy consumption of specific target group (either for electricity or for electricity and heat) [kWh/a]
FEC_{person}	Final energy consumption of a person (either for electricity or for electricity and heat) [kWh/a]

S_Q	Savings factor of the awareness raising campaign [%]
n	Number of persons of a specific target group

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects:

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", behavioural measures or programmes, page 86. A project specific value may be used if results from empirical studies are available.

Average final energy consumption of specific target groups or a person: the final energy consumption of the specific target group or a person for electricity and heat can be calculated based on the national energy balance. Alternatively, this information may also be sought from energy suppliers or regulators, the national statistical office or from empirical studies.

Savings factor of information campaigns: If no empirical values are at hand from recent studies or national surveys on the impacts of awareness raising campaigns, findings from the following study may be considered: http://ec.europa.eu/energy/intelligent/projects/sites/iee-projects/files/projects/documents/behave_guidelines_for_behavioural_change_programmes_en.pdf, page 20.

The maximum savings reported amount up to 1-2%. This is an approximation, which is quite high. It needs to be noted that the savings achieved very much depend on the quality of the information campaign and can therefore not be generalized.

4.15.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

4.15.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

4.15.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

4.16 Energy audits for households – multEE

According to the Energy Efficiency Directive Article 8(3) „Member States shall also develop programmes to raise awareness among households about the benefits of such audits through appropriate advice services."

Energy audits for households lead to awareness raising and may result in more rational energy consumption behaviour patterns. In some cases, energy audits may also induce investments in energy efficient technologies in households. In this chapter, only the impacts of energy savings resulting from behavioural change are analysed.

Energy audits for households may take different forms:

- On-site audits in households: an energy auditor visiting the respective household can directly identify energy saving potentials and discuss possible interventions, be it behavioural or investment-driven with the household.
- On-site audits at information centres: provided at dedicated information and advisory centres for individuals who seek information on how to reduce their energy consumption, decrease energy cost etc. In contrast to on-site audits in households, mostly information material is provided to the individuals; an on-site inspection of the household does not take place.
- Telephone consulting: individuals seek information about specific issues related to energy consumption and saving energy over the phone when calling information centres, specific hotlines of regulators, energy suppliers etc.
- Internet-based consulting: specified internet masks developed by e.g. energy suppliers or regulators allow to analyse a household's energy consumption patterns once specific information about the household's energy situation is provided (e.g. number and age of electrical appliances in place, thermal quality of the building). Based on the information provided, tailored advice on how to improve the household's energy efficiency can be generated through the internet mask.

Energy savings resulting from energy audits for households may be assessed by looking at the quality level of the energy audit. The quality level is determined as follows :

- Quality level 1: the final consumer receives personal advice either through an energy auditor or through internet-based consulting (internet mask). The consumer's energy consuming patterns are analysed individually and tailor-made suggestions for improving the energy efficiency of the household are given. The audit takes no longer than 15 minutes.
- Quality level 2: the final consumer receives personal advice through an energy auditor. The consumers energy consuming patterns are analysed individually and tailor-made suggestions for improving the energy efficiency of the household are given. The audit takes no longer than 30 minutes.
- Quality level 3: the final consumer receives advice through an energy auditor either at an information centre or at home. In addition, an individual energy concept for his/her household is developed (report). The audit takes more than 60 minutes (e.g. thermography). The energy audit has to be carried out by a qualified auditor who does not represent any sort of specific technology or energy carrier.

The following formula applies to audits targeting either electricity consumption only or heat and electricity consumption altogether.

4.16.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

4.16.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = n_{Q1} \times FEC_{HH} \times S_{Q1} + n_{Q2} \times FEC_{HH} \times S_{Q2} + n_{Q3} \times FEC_{HH} \times S_{Q3}$$

Where:

TFES	Total final energy savings [kWh/a]
n_Q	Number of energy audits at a specific quality level
FEC_{HH}	(Average) Final Energy Consumption of household(s) (either for electricity or for electricity and heat) [kWh/a]
$S_{Q1,2,3}$	Savings factor of an energy audit at a specific quality level [%]

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects:

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", behavioural measures or programmes, page 86. A project specific value may be used if results from empirical studies are available.

(Average) Final Energy Consumption of household(s): the final energy consumption of households for electricity and heat can be calculated based on the national energy balance. Alternatively, this information may be sought from energy suppliers or regulators, the national statistical office or from empirical studies. Also project specific values may be used if the household's energy consumption for electricity and heat is known.

Savings factor of an energy audit at a specific quality level: if no empirical values are at hand from recent studies on the impacts of energy audits in households, findings from different studies may be considered:

- Achieving energy efficiency through behaviour change, page 43: http://www.eea.europa.eu/publications/achieving-energy-efficiency-through-behaviour.

- A review of intervention studies aimed at household energy conservation, chapter 3.3.3: http://www.rug.nl/staff/e.m.steg/abrahamsestegvlekrothengatterreview.pdf.

The maximum savings reported in literature amount up to 20%. However, it needs to be noted that the savings achieved very much depend on how the intervention in the households was designed and they can therefore not be generalized.

4.16.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

4.16.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

4.16.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

4.17 Smart Meters and informative billing – multEE

The EU aims to replace at least 80% of electricity meters with smart meters by 2020 wherever it is cost-effective to do so. In EU Member States, many pilot studies have been conducted in order to identify the energy savings potential of smart meters. While the short-term effects have shown reductions in energy consumption in households, the long-term effects of smart meters are still to be examined. Smart meters have proven the most efficient when the installation of the digital meter is combined with feedback systems (e.g. displays in the households showing real-time consumption, billing at short intervals).

The formula below applies to smart meters installed for measuring the consumption of electricity, gas or district heating in households. In order to maximise the benefits of smart meters, the household shall receive real-time feedback about its daily or monthly energy consumption e.g. through home displays showing the actual consumption or short billing cycles.

4.17.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

4.17.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = n \times FEC_{HH} \times S_{smart}$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of smart meters installed in households
FEC_{HH}	(Average) Final Energy Consumption of household(s) (either for electricity or for electricity and heat) [kWh/a]
S_{smart}	Savings factor resulting from the installation of a smart meter incl. feedback mechanisms in households [%]

Standardized calculation values

No standardized calculation values are available for this methodology.

Methodological aspects:

This methodology was published in the multEE project's deliverable "Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures". The document is published in English language. The document is available on the multEE website.

Data sources for indicative calculation values:

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 86. A project specific value may be used if results from empirical studies are available.

(Average) Final Energy Consumption of household(s) (either for electricity or for electricity and heat): the final energy consumption of households for electricity and heat can be calculated based on the national energy balance. Alternatively, this information may be sought from energy suppliers or regulators, the national statistical office or from empirical studies. Also project specific values may be used if the household's energy consumption for electricity and heat is known.

Savings factor:

- Data may be available from empirical (pilot) studies carried out in the different EU Member States.
- Results from the cost-benefit analyses of EU Member States on smart meters: Commission Staff Working Document publishing savings factors for the different EU Member States: Cost-benefit analyses & state of play of smart metering deployment in the EU-27: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014SC0189&from=EN
- Report from the Commission (COM2014) 356 final: Benchmarking smart metering deployment in the EU-27 with a focus on electricity: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52014DC0356&from=EN

4.17.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

4.17.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

4.17.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

Chapter 5 Modal shift for freight transport

5.1 Intermodal transport unit for combined rail-road transport – France

The methodology is about the energy savings due to rail freight transport instead of freight road. The measure is about an acquisition (purchase or rental) of a new intermodal transport unit (UTI) dedicated to combined rail-road transport.

5.1.1 Calculation of impact on energy consumption (Article 3)

For Article 3, national statistics are used in France to report energy consumption and no method is available for this specific subject.

5.1.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**.

$$TFES = [(FEC_{road} - FEC_{rail}) \times A] \times G \times N$$

TFES	Total final energy savings [kWh/a]
FEC_{road}	Final energy consumption for road transport [kWh/a]
FEC_{rail}	Final energy consumption for rail transport [kWh/a]
A	Factor depends on the perimeter of the action
G	Abatement coefficient for traffic made outside the area
N	Number of trips completed over a year

Standardized calculation values

N: corresponds to the number of trips of the traffic report(s) (on 6 months), multiplied by two (to have a year).

Values are national averages.

The method considers two cases depending on the type of the ITU (intermodal transport unit) : ITU >= 9m and ITU <9 m. The next table shows the values for intermodal transport unit >= 9m.

Table 103: Indicative values for intermodal transport unit >= 9m.

	Combined rail-road transport		Road transport
Intermodal transport unit >= 9 m	Before and after by road	Rail	
Mileage	110	700	755
Tonnage	20	20	16

t.km	2200	14000	12080
Unit consumption [goe/t.km]	22,7	4,5	27,90
Total consumption [toe]	0,0499	0,0630	0,3370
Total consumption [toe]	(FECrail) 0,1129		(FECroad) 0,3370
Coef A: market eligible for the operation (-14%)	0,097		0,289

Methodological aspects:

In France the energy savings targets and action are recorded in kWh cumac of final energy, cumac being the contraction of "cumulative and actualized": KWc cumac= TFES X Dc

Table 104: Indicative values for calculation of energy savings certificates.

Lifetime of savings	[a]
Lifetime of savings	12
Dc: Discount coefficient (4%)	9,7605

Data sources for indicative calculation values

The number of trips provided of the traffic report(s).

5.1.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

5.1.4 Calculation of greenhouse gas savings

No information for the calculation of greenhouse gas savings available.

5.1.5 Bibliography

« Opérations standardisées d'économies d'énergie ». Ministère de la Transition écologique, https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie. Accessed April 14, 2022.

TRA-EQ-101 : Unité de transport intermodal pour le transport combiné rail-route (PDF - 21.54 Ko)

5.2 Intermodal transport unit for combined river-road transport – France

The methodology is about the energy savings due to river freight transport instead of freight road. The measure is about an acquisition (purchase or rental) of a new intermodal transport unit (UTI) dedicated to combined river-road transport.

5.2.1 Calculation of impact on energy consumption (Article 3)

For Article 3, national statistics are used in France to report energy consumption and no method is available for this specific subject.

5.2.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**.

$$TFES = [(FEC_{road} - FEC_{river})] \times N$$

Where:

TFES	Total final energy savings [kWh/a]
FECroad	Final energy consumption for road transport [kWh/a]
FECriver	Final energy consumption for river transport [kWh/a]
N	Number of trips completed over a year

Standardized calculation values

The reference situation is all-road transport, which is compared to bimodal river-road transport.

N: corresponds to the number of trips of the traffic report(s) (on 6 months), multiplied by two (to have a year).

Values are national averages.

Table 105 : Final energy consumption for road transport (FECroad) is obtained using the table below

	Per road trip
Mileage	234
Tonnage	25
t.km	5848
Energy unit consumption (goe/tkm[2])	20,40
Energy consumption per trip [toe]	0,11930
Energy consumption per trip [kWh]	1387,17

Table 106: Final energy consumption for river transport (FECriver) is obtained using the values below

	combined river-road transport	
	Before and after river	River transport
Mileage	10	269
Tonnage	25	25

[2] goe (gram oil equivalent) per tonne-killometer (tkm)

t.km	250	6725
Energy unit consumption (goe/tkm)	20,40	A

The energy unit consumption by river freight transport depends on the river and the boat.

In France, the values of A are:

Final energy (goe/tkm) *Value of A*	Seine	Rhône	Nord Pas-de-Calais	Rhin/Moselle	Interbasin
Boat DEK (1000 t)	12,0	12,8	12,7	15,4	13,2
Boat RHK (1350 t)	6,6	7,1	11,7	13,6	9,8
Boat Grand Rhénan (2500 t)	5,9	6,7	10,8	11,6	8,8
Boat Convoy (4400 t)	5,2	5,9	6,1	8,5	6,4

Methodological aspects

In France the energy savings targets and action are recorded in kWh cumac of final energy, cumac being the contraction of "cumulative and actualized": KWc cumac= TFES X Dc

Table 3: Indicative values for calculation of energy savings certificates.

Lifetime of savings	[a]
Lifetime of savings	12
Dc: Discount coefficient (4%)	9,7605

5.2.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

5.2.4 Calculation of greenhouse gas savings

No information for the calculation of greenhouse gas savings available.

5.2.5 Bibliography

« Opérations standardisées d'économies d'énergie ». Ministère de la Transition écologique, https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie. Accessed April 14, 2022.

TRA-EQ-107 : Unité de transport intermodal pour le transport combiné fluvial-route (PDF - 21.33 Ko)

5.3 Rail highway wagon - France

The methodology estimated the energy savings between freight transport by road compared freight transport by rail.

Rail transport of semi-trailers (or "railway motorway") intended for the transport of goods between two transhipment terminals, at least one of which is located in France.

5.3.1 Calculation of impact on energy consumption (Article 3)

For Article 3, national statistics are used in France to report energy consumption and no method is available for this specific subject.

5.3.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**.

$$TFES = \sum_{i=1}^{i=n} (145 \times Dri - 72 \times Drai) \times 2 \times Vi$$

Where:

TFES	Total final energy savings [kWh/a]
Drai	Rail distance travelled in France by the rail motorway wagon linking the departure and arrival points of line i.
Dri	Average road distance traveled in France by a semi-trailer linking the departure multimodal transhipment terminal and the arrival multimodal transhipment terminal
Vi	Number of trips made on a line i during the traffic report (6 months)
n	Total number of lines used by the same wagon during the traffic report

Standardized calculation values

The values 145 and 72 provided from hypothesis and the calculation of unit energy consumption for road and rail.

Methodological aspects

In France the energy savings targets and action are recorded in kWh cumac of final energy, cumac being the contraction of “cumulative and actualized”: KWc cumac= TFES X Dc

Table 107: Indicative values for calculation of energy savings certificates.

Lifetime of savings	[a]
Lifetime of savings	30
Dc : Discount coefficient (4%)	17,984

5.3.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

5.3.4 Calculation of greenhouse gas savings

No information for the calculation of greenhouse gas savings available.

5.3.5 Bibliography

« Opérations standardisées d'économies d'énergie ». Ministère de la Transition écologique, https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie. Accessed April 19, 2022.

TRA-EQ-108 : Wagon d'autoroute ferroviaire (PDF - 263.14 Ko)

Chapter 6 Hors category

This chapter presents methodologies that were collected but do not match the five Priority Actions, but can provide useful inputs for future methodologies to be developed.

6.1 Remotorization in electric propulsion of a sailing boat in inland waters -France

Remotorization in 100% electric or hybrid propulsion of a boat sailing in inland waters, in replacement of thermal or diesel-electric propulsion (using off-road diesel or gasoline).

Application area: Transport, in inland waters, of goods or passengers, operation-maintenance, and yachting.

The method does not apply on remotorization of new boats, cruise liners fluvial and boats whose initial motorization is electric or hybrid with battery banks or with energy bricks running on hydrogen, or with generators at the gas (CNG, CNG, LNG) is not

6.1.1 Calculation of impact on energy consumption (Article 3)

For article 3, national statistics are used in France to report energy consumption and no method is available for this specific subject.

6.1.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings**:

$$\mathrm{AFES} = 12{,}652 * 2\mathrm{R} * \left[\frac{\mathrm{Wi}}{Rmi} - Wf * \left(\frac{Th}{RCe * RMe} + \frac{1 - Th}{RGe * RMe}\right)\right]$$

Where:

AFES	Annual final energy savings [kWh/a]
Wi	Power of the initial engine [kW]
Wf	Power of the electric motor installed [kW]
R	Total number of hours recorded over the period of use (6 months) of the boat [Hours]
RCe	Efficiency of a power plant [%]
RMe	Efficiency of the boat's electric or hybrid motors [%]
RMi	Efficiency of the initial motorization [%]
RGe	Efficiency of the on-board generator [%]
Th	Hybridization rate [%]

Standardized calculation values

Table 108: Indicative values for calculation of final energy savings (Article 7).

Case of a remotorization in electric or hybrid propulsion of an initially thermal boat:	
Type of boat	[kWh/a]
Reception boat intended for use mainly private and work boat	147,567 x R x Wi
Small passenger boat	103,285 x R x Wi
Restaurant boat, sightseeing boat, self-propelled boat, pleasure boat and hotel barge	71,655 x R x Wi
Case of re-engining in electric or hybrid propulsion of an initially diesel-electric boat	
Type of boat	[kWh/a]
Reception boat intended for use mainly private and work boat	54,024 x R x Wi
Small passenger boat	40,809 x R x Wi
Restaurant boat, sightseeing boat, self-propelled boat, pleasure boat and hotel barge	29,212 x R x Wi

Methodological aspects:

R is the total number of hours recorded over the period of use of the boat, expressed in hours.

Wi is the power of the initial engine replaced, expressed in kW

Lifetime of savings	[a]
Lifetime of savings	17
4% discount coefficient	12,6523

6.1.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

However, an estimate of the ESC financial aid is made from the cost of the initial investment.

The average costs of electric remotorization of river units are below:

Pleasure boats	Houseboats Hotels boats	Small passenger boats	Private boats	Restaurants boats	Sightseeing boats	Work boats
40 000 €	50 000 €	145 000 €	974 000 €	1324 000 €	1 660 000 €	1 352 000 €

With regard to the average ESC aid (hypothesis €5.5/MWhcumac), we assess the coverage rates

Pleasure boats	Houseboats Hotels boats	Small passenger boats	Private boats	Restaurants boats	Sightseeing boats	Work boats
4%	3%	8%	7%	9%	12%	9%

6.1.4 Calculation of greenhouse gas savings

No information for the calculation of greenhouse gas savings available.

6.1.5 Bibliography

«Opérations standardisées d'économies d'énergie ». *Ministère de la Transition écologique*, https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie. Accessed April 11, 2022.

TRA-EQ-126 : Remotorisation en propulsion électrique ou hybride d'un bateau naviguant en eaux intérieures (PDF - 280.62 Ko)

6.2 Replacement of conventional space heating systems with new more efficient ones in buildings of residential sector - Greece

This method refers to the replacement of conventional heating systems with new more efficient ones in residential buildings including the substitution of fossil fuels (e.g., natural gas biomass, etc.). Furthermore, this method does not include the replacement of heat pumps for heating purposes with new more efficient ones.

For the baseline, the available heating systems in the market are taken into consideration in compliance with the Regulation 813/2013 of Directive 2009/125/EK.

The BU equation has been developed so as to cover both the four different climate zones and the national level totally.

6.2.1 Calculation of impact on energy consumption (Article 3)

No information for the calculation of the primary energy savings within the framework of Article 3 is provided.

6.2.2 Calculation of final energy savings (Article 7)

This formula calculates **first year savings.**

$$TFES = \sum_{1}^{i} n * (SHD + HWD) * \left(\frac{1}{n_{sh,Ref}} - \frac{1}{n_{sh,Eff}}\right)$$

Where:

TFES	Total final energy savings on a yearly basis [kWh]

i	Building category (tertiary/residential)
SHD	Average energy needed for space heating in a residential building prior to energy efficiency interventions [kWh]
HWD	Average energy needed for domestic hot water (DHW) in a residential building prior to energy efficiency interventions [kWh]
$n_{sh,Ref}$	Lowest energy efficiency for seasonal space heating based on Directive 2009/125/EK
$n_{sh,Eff}$	Energy efficiency of seasonal space heating as indicated on the energy label based on Energy labelling Directive
n	Number of buildings

Standardized calculation values

Table 109: Indicative values for calculation of final energy savings (Article 7).

SHD			[kWh]
Building type	Climatic zone	Construction year	Value
Detached dwellings	A	Before 1980	13,624
	A	1980-2010	7,384
	A	After 2010	5,970
	A	Weighted average	10,943
	B	Before 1980	15,836
	B	1980-2010	9,914
	B	After 2010	6,217
	B	Weighted average	13,228
	C	Before 1980	28,114
	C	1980-2010	18,658
	C	After 2010	13,163
	C	Weighted average	23,962
	D	Before 1980	31,008
	D	1980-2010	18,800
	D	After 2010	14,597
	D	Weighted average	25,679
Multifamily building	A	Before 1980	60,148
	A	1980-2010	33,754
	A	After 2010	26,999
	A	Weighted average	48,796
	B	Before 1980	91,308

	B	1980-2010	48,378
	B	After 2010	39,983
	B	Weighted average	72,681
	C	Before 1980	188,036
	C	1980-2010	100,025
	C	After 2010	85,225
	C	Weighted average	149,866
	D	Before 1980	166,106
	D	1980-2010	89,901
	D	After 2010	70,634
	D	Weighted average	132,948
HWD			[kWh]
Building type	Climatic zone	Construction year	Value
Detached dwellings	A	Before 1980	1,632
	A	1980-2010	1,632
	A	After 2010	358
	A	Weighted average	1,610
	B	Before 1980	1,741
	B	1980-2010	2,175
	B	After 2010	482
	B	Weighted average	1,902
	C	Before 1980	1,873
	C	1980-2010	2,339
	C	After 2010	581
	C	Weighted average	2,051
	D	Before 1980	2,000
	D	1980-2010	2,000
	D	After 2010	655
	D	Weighted average	1,980
Multifamily building	A	Before 1980	12,187
	A	1980-2010	12,187
	A	After 2010	3,712
	A	Weighted average	12,040

	B	Before 1980	17,042
	B	1980-2010	17,042
	B	After 2010	5,903
	B	Weighted average	16,874
	C	Before 1980	18,356
	C	1980-2010	18,356
	C	After 2010	7,657
	C	Weighted average	18,216
	D	Before 1980	14,919
	D	1980-2010	14,919
	D	After 2010	6,023
	D	Weighted average	14,785
$n_{sh,Ref}$			Value
Room space heaters fired by oil having rated thermal input less than 400 kW according to minimum requirements of Regulation 813/2013			86%
Lifetime of savings			[a]
Lifetime of savings			20

Note: The division of the Greek territory into climatic zones by prefectures is referd on previous Table 28 and their schematic illustration on Figure 1.

Methodological aspects:

This methodology was integrated in the catalogue on bottom-up calculation methodologies, which was published by the administrator for measuring, monitoring, controlling and verifying the achieved energy savings within the Energy Efficiency Obligation Scheme in the period 2017-2020. The document is published in Greek language.

Data sources for indicative calculation values:

All default values have been specified in compliance with Directive 2009/125/EK and the Cost Optimal Study.

Actual data of systems based on performance label of the product should be used for $n_{sh,Eff}$ parameter.

The lifetime of savings was defined in accordance according to the national legislation (Ministerial Decision Δ6/7094/Β'/918/2011).

6.2.3 Overview of costs related to the action

No information for the required costs is provided including the calculation of the cost-effectiveness ratio.

6.2.4 Calculation of greenhouse gas savings

No information for the calculation of the greenhouse gas savings is provided.

6.2.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, BU19a, http://www.cres.gr/obs/yliko.html.

6.3 Power of One campaign - Ireland

Power Of One is an energy saving advice website from Irish SEAI aiming to show residential energy users best tips and saving methods through available grants.

See: Power Of One (www.powerofone.ie)

Some examples of SEAI grants mentioned on this website:

Heat Pump System Grants:

- Grant values begin at €650 for air to air systems, all the way up to €3,500 for the other types of upgrade available, including air to water

Insulation grants

- Cavity wall insulation grants
- Attic insulation grants
- External wall insulation
- Internal wall insulation

Insulation grant values begin at just €400 for attic insulation and cavity wall insulation, all the way up to €6000 for external wall insulation for a detached property.

Heating controls grants: Heating controls upgrade is worth €700

6.4 Use of renewable energy sources (solar) for the electricity needs of natural persons and for the replacement of fossil fuel-fired heating installations – Lithuania

The description of the procedure for the Climate Change Programme measure for natural persons 'Use of renewable energy sources for electricity purposes and for the replacement of fossil-fuel-fired heating installations by natural persons in need' sets out the procedures and conditions for the submission of project registration forms, the assessment, the submission of payment applications, the award of payments, and the monitoring of the implementation of commitments. It sets out the general requirements for eligible costs.

Financing shall be granted to natural persons in accordance with the estimates of the use of the Climate Change Programme funds approved by a resolution of the Government of the Republic of Lithuania and the plan detailing the use of the Programme funds in the annual estimates (hereinafter referred to as the 'plan detailing the annual estimates'), approved by an order of the Minister of Environment, the planned measure 'Use of renewable energy sources for electricity needs of needy natural persons and for the replacement of fossil-fuel-fired heating installations', approved by the Minister for

Agriculture and Rural Development in accordance with the Annual Programme of the Ministry of Agriculture and Rural Development, with a view to reducing greenhouse gas emissions and energy poverty by increasing the capacity and use of domestic electricity production from renewable sources.

6.4.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

6.4.2 Calculation of final energy savings (Article 7)

No information on the final energy savings available for this methodology.

6.4.3 Overview of costs related to the action

The amount of funding is 85% of the fixed price for 1 kW of equipment and is calculated as follows:

For the installation of a solar power plant, it is calculated on the basis of the fixed rate (EUR/kW) for 1 kW of equipment (EUR 1 467.78 incl. VAT) as determined by the European Social Fund in its "Study on the Fixed Cost of Installing Solar Power Plants in Households" (hereinafter referred to as the "Study") of 17 January 2019, multiplied by 0.85, and by the capacity (kW) of the planned installation or purchase of the installation from the solar park, but not exceeding a maximum capacity (kW) of 10 (10 kW), as indicated on the registration form. According to the survey, the fees are calculated for the installation of a solar power plant on the basis of the equipment to be installed or the part of the equipment to be acquired from the solar park as indicated by the applicant in the registration form. The contractor undertakes in the contract to maintain the solar plant for 5 years after the project implementation;

Where part of the solar plant is purchased from the developer's solar farm, the fixed price per kW of equipment shall be calculated on the basis of the European Social Fund's "Study on the Fixed Costs for the Acquisition of Solar Power Plants on Third Parties' Land Geographically Distant from the Place of Consumption of Electricity" of 20 November 2019. The fixed price (EUR/kW) of 1 kW of equipment (EUR 885,10 incl. VAT) determined in the study was multiplied by 0,85, and by the capacity (kW) of the solar park equipment to be acquired from the solar park indicated in the registration form, up to a maximum of 10 (kW). According to the survey data, the fees are calculated for the acquisition of a solar power plant depending on the share of the equipment to be acquired from the solar park indicated by the applicant in the registration form. The contractor undertakes in the contract to pay the management and maintenance fees for the solar plant from the solar park for a period of 5 years after the project implementation;

For a heat production installation shall be calculated by multiplying the fixed fee per 1 kW (Eur/kW) set out in Annex 1 to this Schedule by the coefficient of 0.85 of the rated power (Prated) of the heat pump (kW) specified in accordance with the European Commission Regulation (EC) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to the eco-design requirements for space heaters and combined heaters or with the rated (nominal) heating power (kW) of the biofuel boiler (kW). The contractor undertakes in the contract to maintain the heating installation for a period of 5 years after the completion of the project.

Requirements for the replacement of a fossil-fuelled heat generation plant with a plant using renewable energy sources:

The project must be implemented in a single-family house or apartment (in the case of a semi-detached or multi-apartment building) owned in the Republic of Lithuania, which have been formed as separate immovable property objects in a residential building and assigned unique numbers in accordance with the procedure laid down in the Law on Cadastre of Real Estate, the construction of which has been completed in accordance with the procedure laid down in legislation, and which has been registered with the State Enterprise Centre of Registers in the Register of Immovable Assets for at least five years (i.e. i.e. the percentage of completion of the building is at least 100 % and the year of completion of the building, as indicated in the extract from the data bank of the Real Estate Register of the State Enterprise Centre of Registers, is not less than 5 years before the year in which the call for project registration forms is published;

The single-family house or apartment (in the case of duplexes and apartment buildings) in which the project is being implemented may not be subject to seizure (compulsory temporary restriction of a natural person's ownership of property or of the possession, enjoyment or disposal of its separate components, in accordance with the procedure and conditions laid down by law, in order to secure the production of evidence, civil action, possible confiscation of property, recovery of fines and unpaid contributions, or the satisfaction of creditors' claims or the fulfilment of the person's other obligations);

No economic-commercial activity must be carried out in the single-family house or apartment (in the case of semi-detached and multi-family buildings) where the project is located. If the applicant is found to be carrying out economic-commercial activities, no funding will be granted unless the applicant can provide documentation proving that no economic-commercial activities are taking place in the building;

The applicant must implement the project, i.e. replace the fossil-fuel-fired (natural gas, diesel, coal, peat briquettes and other fuels not included in Article 2(2) of the Law on Renewable Energy of the Republic of Lithuania) heat production installation with the equipment referred to in point 9.4 of the Schedule, no later than 12 months after the end of the call for project registration forms, and submit a duly completed payment application to the Agency, together with the documents required to be submitted. The old fossil fuel-fired heat generation plant must be dismantled and handed over to waste managers in accordance with the conditions laid down in the contract;

If the house is registered in an area which, according to the Order of the Minister of the Environment of the Republic of Lithuania of 9 January 2018 No. D1-12 "On the Preparation and Application of the Maps of Ambient Air Pollution with Particulate Matter PM10 Levels Exceeding the Daily Limit Value for Ambient Air Pollution of this Pollutant in the Major Cities of Lithuania (Vilnius, Kaunas, Klaipėda, Šiauliai, Panevėžys) and the Description of their Use", which falls into the zone of elevated ambient air pollution, the fossil-fuel-fired heating installation may only be replaced by a locally non-emitting installation that uses energy from renewable sources for the production of heat;

If the house is registered in an area which, according to the Order of the Minister of the Environment No D1-12 of 9 January 2018, referred to in point 11.5, does not fall within a zone of increased ambient air pollution, the fossil-fuel-fired heating installation may be replaced by a more efficient renewable energy heating installation, irrespective of the primary fuel or energy type;

Funding for the replacement of a heating installation is not reserved and is not available if the house or apartment in a two-apartment or multi-apartment building (according to the data of the Real Estate Register of the State Enterprise Centre of Registers) is connected

to a district heating system. The funding is not reserved and is not granted when the co-owner of a residential building, i.e. a single-family house or apartment (in a duplex or apartment building), is a legal entity (e.g. municipality, state).

Table 110: Expenditure fixes.

No.	Type of device	Power, kW	Fixed rate *, 1kW price, Eur
1.	Biofuel boiler	≤ 15	245,84
		> 15 ≤ 25	150,00
		> 25	97,50
2.	Air-to-water heat pump (without integrated boiler)	≤ 7	815,41
		> 7 ≤ 13	533,72
		> 13	427,01
3.	Air-to-water heat pump (with integrated boiler)	≤ 7	1103,75
		> 7 ≤ 13	661,79
		> 13	509,58
4.	Ground-to-water/water-to-water heat pump (without integrated boiler)	≤ 7	1072,13
		> 7 ≤ 13	653,82
		> 13	405,80
5.	Ground-to-water/water-to-water heat pump (with integrated boiler)	≤ 7	1453,50
		> 7	966,29
6.	Air-to-air heat pump	-	300

* Rates include VAT. VAT rate of 21% has been applied.

6.4.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

6.5 Replacing freight transport with more efficient ones - Lithuania

Introducing incentives for combined freight transport. Encourage intermodal unit carriers to use combined transport instead of land transport of intermodal units. By 2030 5 % of freight will be shifted to combined transport by 2030. This reduces GHG emissions by 19 19% compared to road transport alone.

6.5.1 Calculation of impact on energy consumption (Article 3)

No information on the impact on energy consumption available for this methodology.

6.5.2 Calculation of final energy savings (Article 7)

There are several options for calculating the energy savings of freight transport when replacing trucks with more efficient ones. However, the largest energy savings are achieved by replacing trucks with diesel internal combustion engines with more fuel-efficient trucks (or by replacing them with trucks that may have a different primary energy source).

This formula calculates cumulative savings. Such a measure has a shelf life of more than one year. Therefore, the total overall energy savings over the whole period would be calculated as the multiplication of one year's energy savings times the number of years.

$$\Delta E = (E_{before} - E_{after}) \times y = \left((l_{100before} - l_{100after}) \times k_{diesel} \times \frac{d}{100}\right) \times y$$

Where:

ΔE	Total final energy savings from replacing trucks with diesel internal combustion engines with trucks powered by more efficient engines [kWh]
E_{before}	Energy consumption of trucks with diesel internal combustion engines (before replacement) [kWh]
E_{before}	Energy consumption of trucks with more efficient engines (after replacement) [kWh]
y	Duration of the measure [metai]
$l_{100before}$	Average diesel consumption per 100 km for trucks with internal combustion diesel engines [litres] before replacement
$l_{100after}$	Average diesel consumption per 100 km [litres] of trucks with more efficient engines after replacement
k_{diesel}	Coefficient expressing the energy content of 1 litre of diesel fuel [kWh/litre] (applicable coefficient kdiesel=10,2196 kWh/litre)
d	Total distance travelled by lorries per year [km/year]

6.5.3 Overview of costs related to the action

No information on costs related to this action available for this methodology.

6.5.4 Calculation of greenhouse gas savings

No information on greenhouse gas savings available for this methodology.

6.5.5 Bibliography

Methodology for auditing energy consumption in vehicles https://www.e-tar.lt/portal/lt/legalAct/255a00b0cdf011e7910a89ac20768b0f
Description of procedures for setting up energy savings agreements https://www.e-tar.lt/portal/lt/legalAct/cd89c430688011e7827cd63159af616c/asr

6.6 Installing a "sleep switch" type of power switch – Luxemburg

The use of a "sleep switch" type of power switch saves electricity by automatically switching off non-priority devices such as electrical office appliances, audiovisual, etc., when the appliance is switched off. This avoids consumption in standby mode.

The measure is applicable in the residential, tertiary and industrial sectors. This measure does not apply to manually operated power strips. The lifetime is set at 5 years.

6.6.1 Calculation of impact on energy consumption (Article 3)

No calculation values available.

6.6.2 Calculation of final energy savings (Article 7)

Two cases are described:

- Case a) The devices powered by the power strip are office equipment (computers, screens, printers, scanners, etc.). The savings amount to 90 kWh.
- Case b) The devices powered by the power strip are audiovisual equipment (televisions, hi-fi systems, game consoles, etc.). The savings amount to 61 kWh.

Note that the annual volumes of energy savings are expressed in kWh.

6.6.3 Overview of costs related to the action

No information on cost effectiveness available for this methodology.

6.6.4 Calculation of greenhouse gas savings

Information not available.

6.6.5 Bibliography

Règlement grand-ducal du 7 août 2015 relatif au fonctionnement du mécanisme d'obligations en matière d'efficacité énergétique:
http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo

6.7 Related information from United Kingdom

Simple Energy Advice is an energy saving advice website from Ofgem to explore ways to save on energy such as through:

- home insulation
- boiler upgrades
- using more green energy, like solar power.

See: Simple Energy Advice

Some examples of simple saving tips mentioned on this website incl:

- use of lower energy lighting bulbs
- take showers instead of baths
- reduce tumble dryer use
- turn down thermostats

UK residential energy users can also use the Energy Efficiency Calculator for personalised energy saving advice for their building in a certain region.

See: Reduce your energy bills — Simple Energy Advice

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