New Methodologies in the Scope of streamSAVE Priority Actions

Annex III of Deliverable D2.1

Version N°1

Authors: Pedro Moura *(ISR-UC)*, Paula Fonseca *(ISR-UC)*, Kelsey van Maris *(VITO)*, Christos Tourkolias *(CRES)*, Vanja Hartman *(EIHP)*, Angelika Melmuka *(AEA)*, Mindaugas Mižutavičius (*LEA*), Hana Gerbelova (*SEVEn*), Matevz Pusnik (*JSI*), Dragomir Tzanev (*EnEffect*)

@streamSAVEplus

www.svn.cz/streamsaveplus

contact@streamsaveplus.eu

Co-funded by the European Union

Co-funded by the
European Union

Disclaimer

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the CINEA. Neither the European Union nor the CINEA can be held responsible for them.

Keywords

Energy Savings Methodologies, Bottom-up Calculations, Deemed Savings, Energy Efficiency Directive (EED), Priority Actions

Co-funded by the
European Union

This project has received funding from the European Union's LIFE programme.
Project No. 101167618 — LIFE23-CET-streamSAVEplus

Project coordinator:

SEVEn, The Energy Efficiency Center z.ú.
Americká 17, 120 00, Praha 2, Czech Republic
+420 224 252 115 https://www.svn.cz/streamsaveplus

Document Information

Grant agreement	101167618
Project title	Streamlining Energy Savings Calculations in the EU Member States +
Project acronym	streamSAVE+
Project coordinator	Jiří Karásek, SEVEn
Project duration	1 July 2024 – 30 June 2027 (36 months)
Related work package	WP 2 – Knowledge Hub: bottom-up calculation methodologies and data collection for individual energy saving actions
Related task(s)	Task 2.1 – Knowledge Hub: bottom-up calculation methodologies and data collection for individual energy saving actions
Lead organisation	ISR-UC
Contributing partner(s)	VITO, IEECP, AEA, CRES, SEVEn, JSI, LEA, EIHP, EnEffect
Lead authors	Pedro Moura *(ISR-UC)* Paula Fonseca *(ISR-UC)*
Contributing author(s)	Kelsey van Maris *(VITO)* Christos Tourkolias *(CRES)* Vanja Hartman *(EIHP)* Angelika Melmuka *(AEA)* Mindaugas Mižutavičius (*LEA*) Hana Gerbelova (*SEVEn*) Matevz Pusnik (*JSI*) Dragomir Tzanev (*EnEffect*)
Reviewer(s)	Nele Renders (VITO), Jiří Karásek (SEVEn)
Due date	31.01.2025
Publication date	01.06.2025
Dissemination level	Public

Energy Savings Methodologies, Bottom-up Calculations, Deemed Savings, Energy Efficiency Directive (EED), Priority Actions

Co-funded by the
European Union

Content

Co-funded by the
European Union

Co-funded by the
European Union

1. Introduction

For the newly identified methodologies covering the 10 PAs developed by streamSAVE project, the existing bottom-up calculation methodologies are summarized in this Annex. A template has been designed to collect the data in a uniform format, including the following elements:

- Description of the action.
- Formula and standardized calculation values for final energy savings
- Formula and standardized calculation values for primary energy savings
- Formula and standardized calculation values for greenhouse gas savings
- Overview of costs related to the action
- Methodological aspects

The information presented in this report is based on a comprehensive review conducted by all partners, covering all identified bottom-up methodology catalogues in Member States and insights from recent project reports. The data was gathered from the following sources:

- Existing catalogues within Member States, serving as the primary source of information.
- Existing methodologies for savings calculation and energy consumption reduction developed by previous projects, such as multEE and EMEEES, as well as other relevant initiatives, scientific literature, grey reports, and guidance materials on bottom-up methodologies for energy savings assessment.

The chapters are organized by the 10 Priority Actions (PA), such as:

- Heat Recovery
- Building Automation and Energy Management Systems
- Commercial and Industrial Refrigeration
- Electric Vehicles
- Lighting Systems and Public Lighting
- Small-Scale Renewable Central Heating
- Energy Poverty
- Motor Replacement
- Behavioural Changes
- Modal Shift in 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.

2. Heat Recovery

2.1. France - Waste heat storage system

Installation of a waste heat storage system to cover a heat requirement on the site. The storage system is fixed and connected to the heat distribution network. Fatal heat is heat generated by an existing installation that is not one of its primary purposes, and that is not recovered. For the purposes of this methodology, a liquid or gaseous effluent that meets the previous definition and has a temperature greater than 25°C is considered to be fatal heat. The waste heat is generated by the industrial site concerned by the operation and the annual fatal heat recovered is less than or equal to 16 GWh/year.

For the purposes of this methodology, a waste heat storage system means one or more thermal batteries, connected in parallel or in series, as well as the associated heat recovery and distribution system(s). The installation of the storage system is the subject of a preliminary sizing study established, dated and signed by the professional or a design office. This study aims to evaluate the expected energy savings via the heat recovered with regard to the fatal heat source and the heat requirements but also to justify the consistency between the heat recovery and the heat requirements by presenting the calculations and calculation hypotheses.

2.1.1 Calculation of Final Energy Savings

Formula

Equation (1) calculates cumulative final energy savings.

$$TFES = 14.134 \times \eta \times C \times N_C \quad (1)$$

The parameters used in the formula for final energy savings are presented in Table 1.

Table 1 – Parameters used in the formula for final energy savings

Parameter	Description
$TFES$	Total final energy savings [kWh]
η	Efficiency of the storage system [%]
C	Maximum heat storage capacity of the system [kWh]
N_C	Annual number of cycles equivalent to 100% of the maximum capacity of the storage system, carried out over a representative year

Standardized Calculation Values

No calculation values are available for this methodology.

2.1.2 Calculation of Primary Energy Savings

Formula

The methodology does not include any formula to calculate primary energy savings.

Standardized Calculation Values

No calculation values are available for this methodology.

2.1.3 Calculation of Greenhouse Gas Savings

Formula

The methodology does not include any formula to calculate Greenhouse Gas Savings.

Standardized Calculation Values

No calculation values are available for this methodology.

Co-funded by the
European Union

2.1.4 Overview of Costs Related to the Action

Cost-Effectiveness

No information on cost-effectiveness is available for this methodology.

Standardized Values

No calculation values are available for this methodology.

2.1.5 Methodological Aspects

The original document is in French, being an official document from the Ministry of Ecological Transition published with the reference IND-UT-139.

In France the energy savings targets, and action are recorded in kWh cumac of final energy, cumac being the contraction of "cumulative and actualized" and given by (2).

$$kWh_{cumac} = TFES \times DC \tag{2}$$

The parameters used in the formula are presented in Table 2 and the indicative values are in Table 3.

Table 2 – Parameters used in the formula for final energy savings

Parameter	Description
kWh_{cumac}	Total final energy savings [kWh]
DC	Discount coefficient

Table 3 – Indicative values for calculation of energy savings certificates

Parameter	Value
Lifetime	20 [years]
$DC(4\%)$	14.134

2.1.6 Bibliography

Opérations standardisées d'économies d'énergie | Ministère du Partenariat avec les territoires et de la Décentralisation Ministère de la Transition écologique, de l'Énergie, du Climat et de la Prévention des risques Ministère du Logement et de la Rénovation urbaine. (n.d.). Ministère Du Partenariat Avec Les Territoires Et De La Décentralisation Ministère De La Transition Écologique, De L'Énergie, Du Climat Et De La Prévention Des Risques Ministère Du Logement Et De La Rénovation Urbaine. https://www.ecologie.gouv.fr/politiques-publiques/operations-standardisees-deconomies-denergie#scroll-nav__7

Co-funded by the
European Union

3. Building Automation and Energy Management Systems

3.1. Croatia - Automatic regulation in buildings

The equipment for regulating the heating system in the building for end-users include elements for regulating heat on heating bodies, as end elements in the central heating system for transferring heat energy to the room for the purpose of regulating the air temperature in the final heated space. Heat emission control devices may be installed in accordance with the regulations in the field of the heat energy market:

– Classic thermostatic radiator set and
– Electronic thermostatic radiator set (programmable controller).

Energy savings can be calculated using all project-specific data. In the case of using project-specific input data, the documentation that must be attached/possessed as evidence of the implementation of the measure and verification of the input data for the calculation of savings is as follows:

- Record of the handover of the equipment for automatic regulation of the heating system in the building and/or invoice for the delivered equipment,
- Energy audit report or project documentation showing data on the efficiency of the subsystem, specific annual heat needs and useful area of the building/part of the building in which the automatic regulation equipment is installed.

In the absence of project-specific data, savings can be calculated using full or partial reference values. One input that must be known is the useful area of the building where the regulation equipment is installed. The documentation that must be attached/possessed as proof of the implementation of the measure and verification of the input data in this case is the record of the handover of the equipment for the automatic regulation of the heating system in the building and/or the invoice for the delivered equipment, with the total area covered by the installed equipment.

3.1.1 Calculation of Final Energy Savings

Formula

The savings resulting from this measure can be determined using method "New installation or replacement of heating systems and systems for the preparation of domestic hot water (DHW) in residential buildings and buildings in the service sector (4.)" which includes all elements of the heating system (production, distribution and delivery of thermal energy) in accordance with regulations in the field of the thermal energy market and uses the estimated energy savings approach:

$$UFES = \left(\frac{1}{\eta_{init}} - \frac{1}{\eta_{new}}\right) \times SHD \times A$$
$$FES = \sum_{i} UFES_i \qquad (3)$$

Table 4 – Parameters used in the formula

Parameter	Description
UFES	Unit annual energy savings [kWh/unit x a]
FES	Total final energy savings [kWh/a]
η_{init}	Heating system efficiency before equipment installation
η_{new}	Heating system efficiency after equipment installation
SHD	Specific annual thermal needs of the building [kWh/m^2 x a]
A	Useful building surface [m^2]

As compared to the above, a more specific formula can be used for the savings calculation due to the installation of heating systems regulation equipment, that includes the whole heating system:

$$UFES = \frac{1}{\eta_{boiler} \times \eta_{dis}} \left(\frac{1}{\eta_{init\_em}} - \frac{1}{\eta_{new\_em}} \right) \times SHD \times A \qquad (4)$$

Table 5 – Parameters used in the formula

Parameter	Description
UFES	Unit annual energy savings [kWh/unit x a]
η_{init_em}	Efficiency of the heat transfer (emission) subsystem before the installation of the equipment
η_{new_em}	Efficiency of the heat transfer (emission) subsystem after installation of the equipment
η_{boiler}	Efficiency of the heat production subsystem
η_{dis}	Efficiency of the heat distribution subsystem
SHD	specific annual thermal needs of the building [kWh/m^2 x a]
A	Useful building surface [m^2]

Standardized Calculation Values

Table 6 – Indicative values for SHD

Condition of the outer envelope of the building	Purpose of building	Continent			Coast		
		until 1970.	1970.-2005.	after 2006.	until 1970.	1970.-2005.	after 2006.
		kWh/m^2					
SHD_{init}	Single-family homes	220	160	80	130	90	60
	Multi-apartment buildings	150	110	80	100	90	50
	Offices	150	110	60	90	70	40
	Educational buildings	140	120	60	80	70	40
	Hotels and restaurants	140	130	75	90	80	50
	Hospitals	180	140	70	100	80	65
	Sports halls	210	180	110	130	110	80
	Shops	150	90	70	80	60	40
	Other buildings	200	140	60	120	80	50
SHD_{new}	Single-family homes	75			58		
	Multi-apartment buildings	75			46		
	Offices	52			38		
	Educational buildings	47			32		
	Hotels and restaurants	70			33		
	Hospitals	54			60		
	Sports halls	90			59		
	Shops	60			36		
	Other buildings	50			46		

Table 7 – Indicative values for efficiency of subsystems

Efficiency of subsystems	Value
η_{init_em}	0,78
η_{new_em}	0,93 (for the classic thermostatic radiator set) 0,97 (for electronic thermostatic radiator set (programmable regulator)*
η_{boiler}	0,84
η_{dis}	0,93

**The values are defined according to the standard HRN EN 15316-2-1 (Heating systems in buildings. Method for calculating system energy requirements and system efficiency. Thermal energy emission systems)*

Table 8 – Lifetime of savings

Lifetime of savings	[a]
Lifetime of savings	5

3.1.2 Calculation of Primary Energy Savings

Formula

No information on primary energy savings available for this methodology.

Standardized Calculation Values

No information on primary energy savings available for this methodology.

3.1.3 Calculation of Greenhouse Gas Savings

Formula

Formula for calculating the annual reduction of greenhouse gas emissions:

$$E_{CO2} = \frac{FES \times e}{1000} \tag{5}$$

Table 9 – Parameters used in the formula

Parameter	Description
E_{CO2}	Greenhouse gas savings [t CO_2/a]
FES	Total Final Energy Savings [kWh/a]
e	Emission factor for emission factor for fuel/thermal energy used [kg/kWh]*

* If it is not known which fuel is used, the factor for natural gas is used

Standardized Calculation Values

Table 10 –Indicative values for calculation of greenhouse gas savings

Energy source		Emission factor[kg CO_2/kWh]
Hard coal		0,349
Brown coal		0,359
Lignite		0,385
Firewood		0,028
Wood briquettes		0,028
Wood pellets		0,027
Wood chips		0,034

Energy source		Emission factor[kg CO_2/kWh]
Charcoal		0,011
Solar energy		0,000
Environmental energy		0,000
Natural gas		0,214
LPG		0,255
Motor gasoline		0,280
Kerosene		0,264
Jet fuel		0,295
Diesel fuel		0,281
Extra-light fuel oil		0,300
Fuel oil		0,307
Electricity		0,159
District heating	Croatia average	0,275
	DHS ZG+OS (cogeneration)	0,333
	KO* – average for HR	0,337
	DHS ZG (cogeneration)	0,326
	DHS OS (cogeneration)	0,306
	DHS SK (cogeneration)	0,308
	KO – average for ZG	0,332
	KO – average for OS	0,291
	KO – average for RI	0,374
	KO – average for Sl.Brod	0,284
	KO – average for KA	0,315
	KO – average for VŽ	0,366
	KO – average for Vinkovci	0,347
	KO – average for Vukovar	0,282
	KO – wood chips	0,053
	KO – natural gas	0,279
	KO – heating oil	0,436
	KO – extra light heating oil	0,427

** KO stands for Boiler Room*

3.1.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

3.1.5 Methodological Aspects

Calculation methodology

This methodology was integrated into the catalogue on bottom-up calculation methodologies. The document is published in Croatian language. Is the part of the Rulebook on the system for monitoring, measurement and verification of energy savings.

Calculation values

The required calculation values must be collected by each developed system separately.

Co-funded by the
European Union

3.1.6 Bibliography

Ministry of Economy and Sustainable Development (2021), *Rulebook on system for monitoring, measurement and verification of energy savings*, NN 98/2021, https://narodne-novine.nn.hr/clanci/sluzbeni/2021_09_98_1772.html

Ministry of Economy and Sustainable Development (2022), *Regulation on Amendments and Supplements to the Rulebook on system for monitoring, measurement and verification of energy savings*, NN 30/2022, https://narodne-novine.nn.hr/clanci/sluzbeni/2022_03_30_370.html

3.2. Latvia - Methodology for Calculating Energy Savings from an Energy Monitoring and Management System Using Specialized Computerized / Mobile Applications

This methodology calculates the energy savings achieved from the implementation of an energy monitoring system for legal entities. It utilizes specialized monitoring devices or management systems, such as mobile applications, to identify consumption patterns and change habits, ensuring a reduction in energy consumption within the legal sector.

3.2.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative savings from system using specialized computerized / mobile applications:

$$TFES = EC \times k \times y \times rb \times so \times fr \tag{6}$$

Table 11 – Parameters used in the formula for calculating energy savings from system using specialized computerized / mobile applications

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
EC	Final energy consumption per year [kWh/year]
k	Savings factor [%]
y	The lifetime of the measure [-]
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 12 – Indicative values for calculation of final energy savings from energy monitoring and management system using specialized computerized / mobile applications

Parameter	Value	Unit
Savings factor for electricity (k)	3	%
Savings factor for heat (k)	5	%
The lifetime of the measure (y)	5	years

3.2.2 Calculation of Primary Energy Savings

No information on calculation of primary energy savings available for this methodology.

Co-funded by the European Union

3.2.3 Calculation of Greenhouse Gas Savings

No information on calculation of greenhouse gas savings available for this methodology.

3.2.4 Overview of Costs Related to the Action

No information on calculation of costs related to the action for this methodology.

3.2.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

3.2.6 Bibliography

Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

3.3. Slovakia - Deployment support and technical improvements systems in buildings

This measure focuses on systemic approach to reducing energy intensity and active monitoring of the results achieved from proposed and implemented internal energy efficiency projects and the formula is specific for public administration buildings and industry. The result should be a continuous reduction of energy demand through the implementation of planned measures. These activities include: Introduction of systems of energy management and environmental management; Introduction of a system for registration and assessment in the field of reducing energy intensity or improving environmental impacts; Support of data collection systems on measured consumption or emissions and internal monitoring (IoT, intelligent measurement systems, software for data collection, etc.) with automation of data transfer; Energy efficiency monitoring system; Integration to data sources on energy consumption or savings; Professional or expert activity related to the calculation of savings.

Formula

Methods for the calculation of energy savings can be ex ante based on projected savings where the original and new condition of a building is determined on the basis of a project evaluation of the energy required for space heating, drawn up by a professionally competent person according to technical standards by reference to the existing and proposed thermal performance of the building or ex post based on savings measured after project implementation, taking into account the extent to which the building is used, plus climate impacts.

Savings are determined on the basis of annual energy consumption data prior to the implementation of the measure and energy consumption planned after the implementation of the measure. An entity that has an established energy or environmental management system shall provide data on the calculated annual savings and the actual savings (achieved) for the period from implementation to the end of the calendar year. Data from each implemented technical measure in a given calendar year will be provided no later than 15.2. the following year.

$$ÚS_{i\_plán} = (P_{pred} - P_{po}) \quad (7)$$

Table 13 – Parameters used in the formula for final energy savings

Parameter	Description
$ÚS_{i\_plán}$	Planned final energy savings in the year of building renovation [kWh/a]
P_{pred}	Energy requirement for the building prior to renovation – average energy requirement for the original condition of the building [kWh/(m^2.a)]
P_{po}	Energy required for the building after renovation – standardised heat requirement for the post-renovation condition of the building [kWh/(m^2.a)]

Standardized Calculation Values

No calculation values available for this methodology

4. Commercial and Industrial Refrigeration

4.1. Croatia - New installation or change of cooling/refrigeration system in commercial and industry buildings

This methodology provides a way to determine the energy savings resulting from a new installation or replacement of a cooling system in services and industrial sector buildings.

Unit annual energy savings in direct consumption are calculated based on annual cooling energy requirements, space area, and European Seasonal Energy Efficiency Ratio (ESEER)[1] difference before and after the application of the measure. Total annual energy savings in direct consumption are determined by summing all unit annual energy savings from each individual project.

To calculate energy savings, information on the cooled surface area of the building is required. It is recommended to provide information on the specific annual cooling demand of the building and basic information on the existing system (type, year of manufacture, seasonal cooling factor) and the new one (type, year of manufacture/installation, seasonal cooling factor).

The documentation that must be attached/possessed as evidence of the implementation of the measure and verification of the input data for the calculation of savings is as follows:

- report on the energy audit of the building (with the building energy certificate) or
- project documentation showing the following data:
    - specific annual energy required for cooling,
    - usable surface area of the cooled part of the building supplied from the cooling source
- cost estimate certified and paid by the client for cooling systems with a nominal power of up to 30 kW, containing information on the efficiency of the new cooling systems, or
- final expert supervision report on the completion of the project for the new installation or replacement of a cooling system with a nominal power above 30 kW, containing information on the efficiency of the new cooling systems.

4.1.1 Calculation of Final Energy Savings

Formula

The formula for calculating energy savings achieved by replacing cooling equipment in buildings in the service and industrial sectors can be determined for next cases:

- new installation of a cooling system (new buildings, installation of equipment that is more efficient than current equipment on the market with average efficiency), which also includes the case of replacing an existing cooling system at the end of its life (replacing equipment at the end of its life with more efficient equipment)
- early replacement of an existing cooling system (forced replacement of equipment before the end of its life with more efficient equipment)

a) New cooling system installation

In the case of new cooling system installations in new buildings and in the case of replacement of cooling systems at the end of the equipment's life, the savings achieved can be determined based on a comparison of an efficient cooling system with the average cooling system on the market.

Formulas for calculating energy savings in service and industrial buildings resulting from the installation of efficient cooling system equipment instead of the average efficiency equipment on the market:

[1] Instead of the ESEER cooling factor, it is possible to use the factor to estimate savings SEER (Seasonal Energy Efficiency Ratio), if this factor is specified in the project documentation for a specific project.

$$UFES = \left(\frac{1}{ESEER_{average}} - \frac{1}{ESEER_{new}}\right) \times SCD \times A$$

$$FES = \sum_{i=1}^{n} UFESi \qquad (8)$$

Table 14 – Parameters used in the formula

Parameter	Description
UFES	Unit annual energy savings [kWh/unit x a]
FES	Total final energy savings [kWh/a]
A	Area of cooled usable floor space of the building [m^2]
$ESEER_{average}$	Average seasonal cooling factor of existing cooling systems
$ESEER_{new}$	Seasonal cooling factor of the new cooling system
SCD	Specific annual needs for cooling buildings [kWh/m^2 x a]

b) Early replacement of the existing cooling system (before the end of the equipment's life)

Energy savings are achieved by replacing the equipment of the existing cooling system before the end of its service life with efficient equipment. Until the end of the service life of the existing equipment, reference values related to the existing situation are used to calculate energy savings, and after the end of the service life, reference values for equipment of average efficiency on the market are used to calculate energy savings.

The formulas for calculating energy savings resulting from the early replacement of cooling system equipment in buildings in the service and industrial sectors before the end of their service life are given below.

Energy savings over the lifetime of the replaced cooling system[2]:

$$UFES = \left(\frac{1}{ESEER_{init}} - \frac{1}{ESEER_{new}}\right) \times SCD \times A \qquad (9)$$

Energy savings after the end of the life of the replaced cooling system:

$$UFES = \left(\frac{1}{ESEER_{average}} - \frac{1}{ESEER_{new}}\right) \times SCD \times A \qquad (10)$$

Total final energy savings:

$$FES = \sum_{i=1}^{n} UFESi \qquad (11)$$

[2] The life expectancy of existing systems is assumed to be 25 years from installation.

Table 15 – Parameters used in the formula

Parameter	Description
UFES	Unit annual energy savings [kWh/unit x a]
FES	Total final energy savings [kWh/a]
A	Area of cooled usable floor space of the building [m^2]
$ESEER_{init}$	Seasonal cooling factor of existing cooling systems
$ESEER_{average}$	Average seasonal cooling factor of existing cooling systems
$ESEER_{new}$	Seasonal cooling factor of the new cooling system
SCD	Specific annual needs for cooling buildings [kWh/m^2 x a]

Standardized Calculation Values

Table 16 – Indicative values for SCD [kWh/m^2]

Purpose of building	Continent			Coast		
	until 1970.	1970.-2005.	after 2006.	until 1970.	1970.-2005.	after 2006.
	kWh/m2					
Single-family homes	15	15	15	30	30	30
Multi-apartment buildings	20	25	20	50	60	40
Offices	30	30	40	50	45	50
Educational buildings	35	25	50	45	60	60
Hotels and restaurants	40	45	50	70	70	75
Hospitals	60	50	50	90	100	90
Sports halls	30	15	15	45	20	25
Shops	60	50	85	90	70	150
Other buildings	30	30	40	50	50	50
Industrial plants	16	68	31	17	73	46

Table 17 – Indicative values for ESEER by type

Air-cooled compressor					
$ESEER_{new}$	5,5				
$ESEER_{average}$	4,0				
$ESEER_{existing}$	3,5				
Water-cooled compressor					
	Cooling power				
	100 kW	500 kW	1000 kW	1500 kW	2000 kW
$ESEER_{new}$	6,0	6,6	7,4	8,2	9,0
$ESEER_{average}$	5,0	5,2	5,5	5,7	6,0
$ESEER_{existing}$	3,5	3,7	4,0	4,2	4,5

Table 18 – Lifetime of savings

Lifetime of savings	[a]
Lifetime of savings	17

4.1.2 Calculation of Primary Energy Savings

Formula

No information on primary energy savings available for this methodology.

Standardized Calculation Values

No information on primary energy savings available for this methodology.

4.1.3 Calculation of Greenhouse Gas Savings

Formula

Formula for calculating the annual reduction of greenhouse gas emissions:

$$E_{CO2} = \frac{FES \times e}{1000} \tag{12}$$

Table 19 – Parameters used in the formula

Parameter	Description
E_{CO2}	Greenhouse gas savings [t CO_2/a]
FES	Total Final Energy Savings [kWh/a]
e	Emission factor for electricity [kg/kWh]

Standardized Calculation Values

Table 20 –Indicative values for calculation of greenhouse gas savings

Factors	[kg CO_2/kWh]
Electricity	0,159

4.1.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

4.1.5 Methodological Aspects

Calculation methodology

This methodology was integrated into the catalogue on bottom-up calculation methodologies. The document is published in Croatian language. Is the part of the Rulebook on the system for monitoring, measurement and verification of energy savings.

Calculation values

The required calculation values must be collected by each developed system separately.

4.1.6 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 98/2021, 30/2022): https://narodne-novine.nn.hr/clanci/sluzbeni/2021_09_98_1772.html, https://narodne-novine.nn.hr/clanci/sluzbeni/2022_03_30_370.html

4.2. Hungary- Replacement of central refrigeration equipment used in commercial units

This energy efficiency measure considers replacement of previously less energy-efficient central refrigeration equipment (condensing unit) by a more energy-efficient central refrigeration equipment.

Its application is for commercial, i.e. non-residential, uses in both service and industrial sectors.

It is based on the Commission Regulation (EU) 2015/1095 of 5 May 2015 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to eco-design requirements for professional refrigerated storage cabinets, blast cabinets, condensing units and process chillers (hereinafter referred to as Commission Regulation (EU) 2015/1095) which defines the following parameter crucial for the measure implementation:

"Condensing unit": a product comprising at least one electrically driven compressor and a condenser (using ambient air as the heat transfer medium) which, based on the principle of the vapour compression cycle, is capable of cooling and maintaining the temperature within a refrigerated appliance or system to low or medium temperatures, when connected to an evaporator and an expansion device.

"Medium temperature"**:** indicates the use in which the condensing unit delivers its rated cooling capacity at a saturated evaporating temperature of -10 °C.

"Low temperature"**:** indicates the use in which the condensing unit delivers its rated cooling capacity at a saturated evaporating temperature of -35 °C.

"Nominal cooling capacity (P_A)"**:** the cooling capacity achieved by the vapour compression cycle, provided by the condensing unit – connected to the evaporator and expansion equipment – at full load and under standard measurement conditions, at an ambient reference temperature of 32 °C, expressed in kW, to two decimal places.

"Nominal electrical power demand (D_A)"**:** the amount of electrical power, in kW, to two decimal places, that the condensing unit (including the compressor, condenser fan(s) and auxiliaries, if any) consumes to achieve the rated cooling capacity.

"Coefficient of performance (COP_A)"**:** the ratio of the rated cooling capacity, expressed in kW, to the rated electrical power consumed, expressed in kW, to two decimal places.

"Seasonal energy performance ratio (SEPR)"**:** the efficiency of a condensing unit to provide cooling under standard measurement conditions, expressed in two decimal places, reflecting the variations in load and ambient temperature during a given year, calculated by establishing the ratio between the annual cooling demand and the annual electricity consumption.

"Efficiency degradation factor": applied if the capacity control of condensing units operating at part load can only provide the cooling capacity required to meet the desired part load in combination with an on-off cycle; the value is set at 0.25.

The nominal technical data and operating characteristics of the central refrigeration system subject to the measure shall be recorded in accordance with Table 21.

Table 21 – Nominal technical data and operating characteristics of the central refrigeration system subject to the measure

A	B	C	D
Row number	**Technical parameter**	**Old**	**New**
1	Manufacturer		
2	Type (Model ID)		
3	The date the equipment was comissioned	in case of early replacement	
4	Nominal cooling capacity of central cooling equipment P_A [kW] (for ambinet temperature of 32 °C)		
5	Cooling evaporation temperature Te [°C] (-10 or -35 °C)		
6	Refrigerant type		

7	Coefficient of performance, COP_A[(1)]		
8	Seasonal energy performance ratio, SEPR[(1)]		
9	Average load of cooling equipment, f_A [%]		
10	Annual operating time, τ [h/year]		

[(1)] *If the COP_A and SEPR data of the old equipment cannot be documented, early replacement cannot be accounted for.*

The documentation needed to record data listed in the table above and to prove eligibility of the measure and calculated savings is as follows:

- Technical data sheet or other document certifying nominal cooling capacity $P_{A,old}$ [kW], coefficient of performance, COP_{old}, or the seasonal energy performance ratio, $SEPR_{old}$ of the old central cooling system (in case of early replacement),
- Proof of the date of commissioning of the old central cooling system (in case of early replacement),
- Technical data sheet or other document certifying nominal cooling capacity $P_{A,new}$ [kW], coefficient of performance, COP_{new}, or the seasonal energy performance ratio, $SEPR_{new}$ of the new central cooling system,
- Document certifying the commissioning of the new central cooling system (in particular the commissioning protocol).

The calculation method applies to central refrigeration equipment (condensing units) with the following cooling capacity (P_A):

a) Central refrigeration equipment with a nominal cooling capacity of 0.2 kW ≤ P_A ≤ 50 kW for medium (-10 °C evaporating and 32 °C ambient) temperatures,
b) Central refrigeration equipment with a nominal cooling capacity of 0.1 kW ≤ P_A ≤ 20 kW for low (-35 °C evaporating and 32 °C ambient) temperatures.

There are two calculation principles.

The **COP_A calculation** principle shall be used:

a) if the cooling capacity valid for the medium operating temperature is between 0.2 kW ≤ P_A ≤ 5 kW,
b) if the cooling capacity valid for the low operating temperature is between 0.1 kW ≤ P_A ≤ 2 kW.

The **SEPR calculation** method shall be used:

a) if the cooling capacity valid for the medium operating temperature is between 5 kW < P_A ≤ 50 kW,
b) if the cooling capacity valid for the low operating temperature is between 2 kW < P_A ≤ 20 kW.

The lifetime of the measure is **15 years**. When applying the measure, annual obsolescence of energy savings does not need to be taken into account.

The calculation of the final energy savings achieved by replacing central refrigeration equipment (condensing units) shall take into account the service life of the old refrigeration equipment:

a) If the old central refrigeration equipment to be replaced has not yet reached the end of its maximum eligible service life, the measure qualifies as **early replacement**.
b) If the old central refrigeration equipment to be replaced has exceeded the end of its maximum allowable lifetime, the energy consumption of the new equipment shall be compared with the minimum requirements laid down in the Commission Regulation on eco-design for the equipment in question. The excess energy saving is the amount by which the energy consumption of the new equipment is lower than the reference consumption that meets the minimum energy efficiency requirements for eco-design. This situation is referred and **replacement after the end of lifetime**.

Co-funded by the
European Union

4.2.1 Calculation of Final Energy Savings

Formula

Early replacement

Annual energy savings are calculated from the difference between the power demand of the old central refrigeration system and the new central refrigeration system.

In case of COP_A calculation method:

$$TFES = [(P_{A,old} \times COP_{new} - P_{A,new} \times COP_{new}) \times f_A \times \tau] \times rb \times so \times fr \tag{13}$$

In case of SEPR calculation method:

$$TFES = [(P_{A,old} \times SEPR_{old} - P_{A,new} \times SEPR_{new}) \times f_A \times \tau] \times rb \times so \times fr \tag{14}$$

Replacement after the end of lifetime of old equipment

In case of COP_A calculation method:

$$TFES = P_{A,new} \times f_A \times (1/COP_{ref} - 1/COP_{new}) \times \tau \tag{15}$$

In case of SEPR calculation method:

$$TFES = P_{A,new} \times f_A \times (1/SEPR_{ref} - 1/SEPR_{new}) \times \tau \tag{16}$$

Table 22 – Parameters used in the formulas for calculation of energy savings before the end of life of old equipment

Parameter	Description
TFES	Total final energy savings [kWh/a]
$P_{A,old}$	nominal cooling capacity of the old central cooling system [kW]
$P_{A,new}$	nominal cooling capacity of the new central cooling system [kW]
f_A	average load of the old and new central cooling systems [%]
COP_{old}	coeficient of performance of the old central cooling system
COP_{new}	coeficient of performance of the new central cooling system
COP_{ref}	reference coeficient of performance of the central cooling system that meets the minimum energy efficiency requirements according to Table 24
$SEPR_{old}$	seasonal energy performance ratio of the old central cooling system
$SEPR_{new}$	seasonal energy performance ratio of the new central refrigeration system
$SEPR_{ref}$	seasonal energy performance ratio of the central cooling system that meets the minimum energy efficiency requirements according to Table 24
τ	8760 [h/year], annual operating time of the central refrigeration system (continuous operation)
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

According to point 1(b) of Annex V to **Commission Regulation (EU) 2015/1095**, from 1 July 2018 the coefficient of performance (COP) and seasonal performance ratio (SEPR) of condensing units shall not be lower than the values given in the table below.

Table 23 –Minimum COP and SEPR values as a function of operating temperature

A	B	C	D	E
Row number	**Operating temperature (evaporative)**	**Nominal cooling capacity, P_A**	**Applicable rate**	**Value**
1	Medium (for -10 °C evaporating and 32 °C ambient temperature)	$0.2\ kW \le P_A \le 1\ kW$	COP	1.40
2		$1\ kW < P_A \le 5\ kW$	COP	1.60
3		$5\ kW < P_A \le 20\ kW$	SEPR	2.55
4		$20\ kW < P_A \le 50\ kW$	SEPR	2.65
5	Low (for -35 °C evaporating and 32 °C ambient temperature)	$0.1\ kW \le P_A \le 0{,}4\ kW$	COP	0.80
6		$0.4\ kW < P_A \le 2\ kW$	COP	0.95
7		$2\ kW < P_A \le 8\ kW$	SEPR	1.60
8		$8\ kW < P_A \le 20\ kW$	SEPR	1.70

The values are used for COP_{ref} and $SEPR_{ref}$, when the calulation fo energy savings is done according to formula (3) or (4). Data for old and new equipment shall be recorded, as per Table 21

4.2.2 Calculation of Primary Energy Savings

Formula

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

$$\mathrm{APES} = TFES \times PEF_{Electricity} \qquad (17)$$

Table 24 – Parameters used in the formula for primary energy savings

Parameter	Description
APES	Annual primary energy savings [kWh/a]
TFES	Total final energy savings [kWh/a]
$\mathrm{PEF}_{Electricity}$	Primary Energy Factor for electricity [dmnl]

Standardized Calculation Values

There are no calculation values available for this in the Decree on data reporting on end-use energy savings.

Table 25 – Indicative values for calculation of primary energy savings

Parameter	Value	Unit
$PEF_{Electricity}$		

In case there are calculation values available, please also explain (in a short and concise manner) how they were defined. What data was used? Where was this data taken from? How often are the values updated? This does not need to be a long explanation but should only be an "inspiration" on how to identify data for calculation values.

4.2.3 Calculation of Greenhouse Gas Savings

Formula

The following formula is used to calculate the annual GHG savings:

$$GHGSAV = TFES \times f_{GHG,electricity} \times 10^{-6} \qquad (18)$$

Table 26 – Parameters used in the formula for greenhouse gas savings

Parameter	Description
GHGSAV	Greenhouse gas savings [t CO_2 p.a.]
TFES	Total final energy savings [kWh/a]
$f_{GHG,electricity}$	Emission factor for electricity [g CO_2/kWh]

Standardized Calculation Values

There are no calculation values available for this in the Decree on data reporting on end-use energy savings.

Table 27 – Indicative values for calculation of greenhouse gas savings

Parameter	Value	Unit
Electricity		

In case there are calculation values available, please also explain (in a short and concise manner) how they were defined. What data was used? Where was this data taken from? How often are the values updated? This does not need to be a long explanation but should only be an "inspiration" on how to identify data for calculation values.

4.2.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

4.2.5 Methodological Aspects

The principle of calculation is based on the difference between the power demand of the old central refrigeration system and the new central refrigeration system.

The Hungarian Energy and Public Utility Regulatory Authority (MEKH) is the regulatory body of the energy and public utility market, supervising the national economy's sectors of strategic importance. The MEKH has established and reviews each year the EEOS catalogue, which lists the types of energy efficiency measures or investments that can be accounted in a simplified way. This Catalogue is published as the Annex of **17/2020.(XII. 21.) MEKH Decree on data reporting on end-use energy savings.**

Each catalogue sheet contains a description of the energy efficiency measure; the method and content of recording the baseline and post-measure status; the eligible lifetime and the level of degradation; a description of the performance factors and the principles for their calculation, the formula for calculating the annual savings; the documents to be submitted and other relevant information to support the accounting. For the time being, the catalogue contains 51 sheets in 5 categories.

All documents are available in Hungarian language.

4.2.6 Bibliography

The Hungarian Energy and Public Utility Regulatory Authority (2020): *17/2020.(XII. 21.) MEKH Decree on data reporting on end-use energy savings*, https://njt.hu/jogszabaly/2020-17-20-5Z

4.3. Slovakia - Increased energy efficiency in industrial production

In general, this measure focuses on an increase in energy efficiency in both production and consumption and the deployment of progressive technologies in the energy sector and includes, among others, reconstruction and modernization of equipment for the production and distribution of cold.

Formula

The achieved energy savings in individual projects are calculated as the difference between the average energy consumption before the implementation of the energy efficiency measure and the planned energy need after the implementation of the project stated in the energy audit/project documentation. Methods for the calculation of savings can be ex ante based on the projected savings (standard savings for each measure) or ex post based on measured savings (measurement before and after implementation of the measure) or relative savings drawing on technical estimates of savings.

Savings are determined on the basis of annual energy consumption data prior to the implementation of the measure and energy consumption planned after the implementation of the measure.

$$ÚS_{i\_plán} = (S_{pred} - S_{po}) \quad (19)$$

Table 28 – Parameters used in the formula for final energy savings

Parameter	Description
$ÚS_{i\_plán}$	Final energy savings in the year of project implementation [MWh/year]
S_{pred}	Final energy consumption before project implementation [MWh/year]
S_{po}	Final eenergy consumption after project implementation [MWh/year]

Standardized Calculation Values

No calculation values available for this methodology

5. Electric Vehicles

5.1. Austria - Alternative vehicle technologies in passenger cars

Alternatively fuelled vehicles - battery-powered electric vehicles (BEV) and fuel cell electric vehicles (FCEV) - are the focus of this method. The method can be used for both new purchases and the replacement of existing vehicles.

5.1.1 Calculation of Final Energy Savings

Formula

This formula calculates yearly savings.

$$FES = n \times (eev_{Ref} - evv_{Eff}) \times AM \times f_{DC} \times rb \times so \times fr \qquad (20)$$

Rebound (rb), spill-over (so) and free-rider (fr) effects are not taken into account in the formula.

Table 29 – Parameters used in the formula for energy consulting for households

Parameter	Description
FES	Final energy savings [kWh/a]
n	Number of efficient vehicles purchased [-]
eev_{Ref}	mileage-specific energy consumption of the conventional vehicle [kWh/vehicle-km]
eev_{Eff}	mileage-specific energy consumption of the efficient vehicle [kWh/vehicle-km]
AM	Average annual mileage [vehicle kilometres per year]
f_{DC}	Adjustment factor to correct double counting [-]

Standardized Calculation Values

The default values differentiate between the following use cases:

Drive technology:

- Battery-powered electric vehicles (BEV)
- Fuel cell electric vehicles (FCEV)

Vehicle class:

- Passenger cars (cars)
- Light commercial vehicles
- Trucks
- Buses

Utilisation:

- private use
- professional use

Table 30 – Indicative values for calculation of final energy savings for motor vehicles

Parameter	Value	Unit
Lifetime	10	Years
Milage-specific energy consumption reference vehicle (eevRef)		
Privately used cars	0,66	kWh/vehicle-km
Car used for business purposes	0,66	kWh/vehicle-km
Light commercial vehicle	specific	kWh/vehicle-km
Truck	specific	kWh/vehicle-km

Bus	specific	kWh/vehicle-km
AM Driving performance		
Privately used car	12.600	Vehicle km/a
Car used for business purposes	specific	Vehicle km/a
Light commercial vehicle	specific	Vehicle km/a
Truck	specific	Vehicle km/a
Bus	specific	Vehicle km/a
rb	1	-
so	1	-
fr	1	-

Table 31 – Indicative values for calculation of final energy savings for motor vehicles

Parameter	BEV	FCEV	Unit
Adjustment factor for double counting (f_{DC})	0,5	1	-
Milage-specific energy consumption reference vehicle (eev_{Ref})			
Privately used car	0,21	0,267	kWh/vehicle-km
Car used for business purposes	0,21	0,267	kWh/vehicle-km
Light commercial vehicle	specific	specific	kWh/vehicle-km
Truck	specific	specific	kWh/vehicle-km
Bus	specific	specific	kWh/vehicle-km

5.1.2 Calculation of Primary Energy Savings

There is no information regarding primary energy savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

5.1.3 Calculation of Greenhouse Gas Savings

There is no information regarding the greenhouse gas savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology

5.1.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

Cost-Effectiveness

No formula available for this methodology.

Standardized Values

No calculation values available for this methodology

5.1.5 Methodological Aspects

The methodology and formulas have been taken from an officially published legal document – it is a regulation of the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology on specifying the assessment and eligibility of energy efficiency measures. The initial language of the document is German.

The original document is available under:
https://www.ris.bka.gv.at/eli/bgbl/II/2024/28

5.1.6 Bibliography

Verordnung der Bundesministerin für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie: Konkretisierung der Bewertung und Anrechenbarkeit von Energieeffizienzmaßnahmen (Energieeffizienz-Maßnahmenverordnung – EEff-MV), BGBl. II Nr. 28/2024 (2024). https://www.ris.bka.gv.at/eli/bgbl/II/2024/28

5.2. Croatia - Replacement of existing and purchase of new, more efficient vehicles

This methodology provides a way to determine savings when replacing or purchasing new, more efficient vehicles, and two typical cases are distinguished:

- Replacing old vehicles with new, more efficient vehicles. In this case, the calculation is based on the difference in fuel consumption of old and new vehicles, multiplied by the average annual mileage and the number of cars replaced. An example of this case is the replacement of old petrol or diesel vehicles with new vehicles that use petrol, diesel, LPG, SPP, electricity, or hybrid drive. In the case of vehicle conversion, the calculation is the same as in the case of a vehicle replacement.
- Purchase of new efficient vehicles. In this case, the savings are calculated based on the difference between the unit consumption of the reference vehicle and the new vehicle, which is multiplied by the average annual mileage and the number of newly purchased cars. An example of this case is the procurement of new efficient vehicles that use petrol, diesel, LPG, SBA, electricity, or hybrid drive.

Mandatory input data for the calculation of savings in the case of replacing an old vehicle with a new one are the average consumption of the old and new vehicle and the average annual mileage.

In the case of buying a new energy-efficient vehicle, it is necessary to know the fuel and average consumption of the new vehicle.

Savings can be calculated using data specific to each project or using reference values.

In the case of using reference values, the documentation that needs to be attached/possessed as proof of the implementation of the measure and verification of the input data for the calculation of savings is the invoice for the delivered vehicles, which shows the number and type of the vehicle.

In the case of using specific values, along with the invoice for the delivered vehicles, it is necessary to attach/have records of fuel consumption and vehicle mileage.

5.2.1 Calculation of Final Energy Savings

Formula

$$UFES = \left(FC_{init} \times f_{c\_init} - FC_{new} \times f_{c\_new}\right) \times D$$

$$FES = \sum_{i=1}^{N} UFES_i \tag{21}$$

Table 32 – Parameters used in the formula

Parameter	Description
UFES	Unit energy savings in direct consumption [kWh / vehicle / year]
FC_{init}	Fuel consumption of an old vehicle [l / 100 km or kg / 100 km]
FC_{new}	New vehicle fuel consumption [l / 100 km or kg / 100 km]
f_{C_init}	Conversion factor in kWh / 100km for old vehicles [kWh / l or kWh / kg]
f_{C_new}	Conversion factor to kWh / 100km for new vehicles [kWh / l or kWh / kg]
D	Average mileage for a specific vehicle type [km / year]
FES	Total final energy savings [kWh/a]
N	Number of replaced or newly purchased cars covered by the measure

Standardized Calculation Values

Table 33 – Indicative values for fuel consumption, conversion factor and average mileage by type of vehicle

Type of vehicle	Fuel	F_C	f_c	D
		l/100km	kWh/l	km/god
Car	Petrol	7,5	9,35	9.200
Car	Diesel	5,9	10,02	15.500
Car	LPG	8,7	7,16	16.000
Car	CNG	5,3	12,94	15.000
Light delivery vehicle	Petrol	8,1	9,35	20.000
Light delivery vehicle	Diesel	9,1	10,02	20.000
Light delivery vehicle	LPG	8,9	7,16	20.000
Light delivery vehicle	CNG	5,9	12,94	20.000
Bus M2	Diesel	14,9	10,02	34.500
Bus M2	CNG	17,5	12,94	34.500
Bus M3	Diesel	33	10,02	65.000
Bus M3	CNG	52	12,94	65.000
Freight vehicle N2	Diesel	12,2	10,02	21.000
Freight vehicle N2	LPG	15,1	7,16	21.000
Freight vehicle N2	CNG	14,3	12,94	21.000
Freight vehicle N3	Diesel	29,7	10,02	52.000
Freight vehicle N3	CNG	34,8	12,94	52.000
Freight vehicle N3	LNG	55,6	7	52.000
Motorcycle	Petrol	4,3	9,35	3.000

Table 34 – Indicative values for average annual mileage by vehicle type

Type of vehicle	Average annual mileage [km/a]
Car	12.650
Petrol car	9.200
Diesel car	15.500
Light delivery vehicle	20.000
Bus M2	34.500
Bus M3	65.000
Freight vehicle N2	21.000
Freight vehicle N3	52.000

Type of vehicle	Average annual mileage [km/a]
Motorcycle	3.000

Table 35 – Indicative values for fuel conversion factor

Fuel	Base unit	MJ	kWh
Petrol	1 l	33,67	9,35
Diesel	1 l	36,09	10,02
LPG	1 l	25,79	7,16
CNG	1 kg	46,58	12,94
LNG	1 kg	56,3	15,7

When purchasing new electric or hybrid vehicles, the reference data is the energy consumption of a gasoline car. To calculate the savings in this case, the energy consumption in kWh/100km for the new vehicle must also be known, which is equal to the product $FC_{new}xf_{cnew}$. The consumption of a reference new electric vehicle is 19.1 kWh/100km.

If the vehicle is not in one of the above categories, but rather a special purpose vehicle (tourist and special vehicles for national parks), the reference assumption is that an equivalent gasoline vehicle would consume three times more energy than a car.

In case b., when purchasing new energy-efficient vehicles, reference values are taken for $FC_{init}xf_{c\_init}$ depending on the type of vehicle. When purchasing new electric or hybrid vehicles, the reference data is the energy consumption of a gasoline car, i.e.: $FC_{init}xf_{c\_init}$ = 7.5 l/100 km x 9.35 kWh/l =70.125 kWh/100 km.

To calculate the savings in this case, the data on energy consumption in kWh/100km for a new vehicle must be known, which is equal to the product of $FC_{new}xf_{c\_new}$ in the above formula.

Table 36 – Lifetime of savings

Lifetime of savings	[a]
Lifetime of savings	8

5.2.2 Calculation of Primary Energy Savings

Formula

No information on primary energy savings available for this methodology.

Standardized Calculation Values

No information on primary energy savings available for this methodology.

5.2.3 Calculation of Greenhouse Gas Savings

Formula

Formula for calculating the annual reduction of greenhouse gas emissions:

$$E_{CO2} = \frac{e_{init} \times FC_{init} \times f_{c\_init} - e_{new} \times FC_{new} \times f_{c:new}}{1000} \times D \times N \qquad (22)$$

Table 37 – Parameters used in the formula

Parameter	Description
E_{CO2}	Greenhouse gas savings [t CO_2/a]

e_{init}	Emission factor of fuel used before measure[kg/kWh]
e_{new}	Emission factor of fuel used after measure[kg/kWh]
FC_{init}	Fuel consumption of an old vehicle [l / 100 km or kg / 100 km]
FC_{new}	New vehicle fuel consumption [l / 100 km or kg / 100 km]
f_{C_init}	Conversion factor for fuel used before measure [kWh / l or kWh / kg]
f_{C_new}	Conversion factor for fuel used after measure [kWh / l or kWh / kg]
D	Average mileage of vehicle [km / year]

Standardized Calculation Values

Table 38 –Indicative values for calculation of greenhouse gas savings

Factors	[kg CO_2/kWh]
LPG	0,255
Electricity	0,159
Petrol	0,280
Diesel	0,281
Natural gas	0,214

5.2.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

5.2.5 Methodological Aspects

Calculation methodology

This methodology was integrated into the catalogue on bottom-up calculation methodologies. The document is published in Croatian language. Is the part of the Rulebook on the system for monitoring, measurement and verification of energy savings.

Calculation values

The required calculation values must be collected by each developed system separately.

5.2.6 Bibliography

Ministry of Economy and Sustainable Development (2021), *Rulebook on system for monitoring, measurement and verification of energy savings*, NN 98/2021, https://narodne-novine.nn.hr/clanci/sluzbeni/2021_09_98_1772.html

Ministry of Economy and Sustainable Development (2022), *Regulation on Amendments and Supplements to the Rulebook on system for monitoring, measurement and verification of energy savings*, NN 30/2022, https://narodne-novine.nn.hr/clanci/sluzbeni/2022_03_30_370.html

5.3. Hungary- Energy savings by replacing a vehicle with a more energy-efficient one

An energy efficiency measure is considered a measure in which one or more vehicles are replaced with vehicles with lower consumption and lower greenhouse gas emissions. The measure can be implemented in the case of vehicles of categories M1 and N1 according to Decree 5/1990. (IV.12.) on the technical inspection of road vehicles (hereinafter: Decree 5/1990. (IV. 12.)).

The relevant data of both the replaced vehicles (hereinafter: old vehicles) and the new vehicles must be recorded. The average CO_2 emissions (g/km) or the average consumption (litres/100 km) shall be determined for each vehicle, based on the vehicle registration certificate and the manufacturer's type approval (distributor's data). The average annual mileage shall also be determined.

Table 39 –The minimum data to be recorded for each vehicle within the framework of the measure

A	B	C	D
Row number	Technical parameter	Old vehicle	New vehicle
1	Registration number	necessary	necessary
2	Vehicle category	necessary	necessary
3	Fuel	necessary	necessary
4	Date of first registration	necessary	necessary
5	Decomissioning date	necessary	not necessary
6	Specific emissions [g/km]	necessary	necessary
7	Consumption [l/100 km] or [kg/100 km]	necessary	necessary
8	Own weight [kg]	not necessary	necessary
9	Average annual mileage [km/year]	necessary	not necessary

The documentation needed to record data listed in the table above and to prove eligibility of the measure and calculated savings is as follows:

- Registration data and nominal consumption data of old vehicles,
- Proof of final withdrawal of old vehicles from the use,
- Registration data and nominal consumption data of new vehicles.

The measure takes into account Commission Recommendation (EU) 2019/1658 of 25 September 2019 on transposing the energy savings obligations under the Energy Efficiency Directive (hereinafter: Recommendation). The savings may be counted for new vehicles with a specific emission value not higher than the specific emission standard in force at the time of the measure, as set out in Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting carbon dioxide emission performance standards for new passenger cars and new light commercial vehicles and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 (hereinafter: Regulation (EU) 2019/631).

The savings are calculated based on the following principle: in the first step, the eligible specific and annual emission reduction is determined, and then, based on this, in the second step, the energy savings are calculated.

In the first step, the average CO_2 emissions of the existing entire fleet must be determined. This is based on the vehicle's WLTP combined emission value or, in its absence, the vehicle manufacturer's declaration. Depending on the unit of measurement in which the initial data is available, the specific quantities in g/km can be obtained by converting them according to the table below.

Table 40 –Conversion of fuel consumption and specific emissions (per unit of consumption)

A	B	C	D	E	F	G	H	I	J
Row number	Fuel	Calorific value		Consumption Original unit of measure	Energy consumption		Specific emissions		
		[MJ/kg]	[MJ/l]		Original measure unit	[kWh/km]	[g/MJ]	[g/kWh]	[g/km]
1	petrol	-	32.3	l/100 km	1.0	0.090	69.3	249	22.38
2	diesel	-	35.7	l/100 km	1.0	0.099	74.1	267	26.44
3	LPG	46.0		kg/100 km	1.0	0.128	63.1	227	29.01

4	CNG	47.2		kg/100 km	1.0	0.131	56.1	202	26.48

After this, the specific emission reduction is determined for each vehicle, and then the annual reduction for the entire measure.

According to point 1.2 of Annex VII of the Recommendation, no savings are associated with the implementation of the measure after the end of lifetime of old vehicle.

The lifetime of the measure is **15 years**. When applying the measure, annual obsolescence of energy savings does not need to be taken into account.

5.3.1 Calculation of Final Energy Savings

Formula

The total annual energy savings achieved by the measure are:

$$TFES = \Delta E_j \tag{23}$$

ΔE_j is determined using the following formula, if the condition $K_{new,i} \leq K_{ref,kat,i}$ is met:

$$\Delta E_j = \sum_i (K_{old,i} - K_{ref,kat,ij}) \times f_i \times N_i / e_i \ [kWh/year] \tag{24}$$

Table 41 –Parameters used in the formula for calculation of energy savings before the end of life of old equipment

<table>
<tr><th>Parameter</th><th colspan="2">Description</th></tr>
<tr><td>TFES</td><td colspan="2">Total final energy savings [kWh/a]</td></tr>
<tr><td>ΔE_j</td><td colspan="2">total energy savings achieved by the measure in the j-th period in the i-th group [kWh/a]</td></tr>
<tr><td>$K_{ref,kat,ij}$</td><td colspan="2">the reference specific emission in the i-th group</td></tr>
<tr><td></td><td>value in 2021-2024 [g/km]:
- For category M1 95 + (M_m – 1379.88 kg) * 0.0333
- For category N1 147 + (M_m - 1766.4 kg) * 0.096</td><td>value in 2025-2030 [g/km]:
- For category M1, 0.85 times the value for the previous period,
- For category N1, 0.85 times the value for the previous period</td></tr>
<tr><td>M_m</td><td colspan="2">the unladen weight of the new vehicle according to Decree 5/1990. (IV. 12.) [kg]</td></tr>
<tr><td>j</td><td colspan="2">indicates the period of introduction of the measure, in order to separate the period up to 2024 and the period 2025-2030, one period up to 2024, the other starting from 2025</td></tr>
<tr><td>$K_{new,i}$</td><td colspan="2">specific emissions of new vehicles in the i-th group [g/km]</td></tr>
<tr><td>$K_{old,i}$</td><td colspan="2">specific emissions of existing vehicles in the i-th group, according to nominal standards [g/km]</td></tr>
<tr><td>f_i</td><td colspan="2">the average annual mileage in the i-th group, as recorded when determining the initial data [km/year]</td></tr>
<tr><td>N_i</td><td colspan="2">the number of vehicles in the i-th group [pcs]</td></tr>
<tr><td>e_i</td><td colspan="2">specific emissions of vehicles belonging to the i-th group according to specific emission value [g/kWh]</td></tr>
</table>

If the criterion $K_{new,i} \leq K_{ref,kat,i}$ is not met, then there are no savings, i.e. $\Delta E_j = 0$.

In the formula, the groups and categories are always determined based on the category and type of newly purchased vehicles, and the replaced vehicles is based on this.

Standardized Calculation Values

The reference values corresponding to the minimum energy efficiency requirement are taken into account in the calculations in accordance with Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting CO_2 emission performance standards for new passenger cars and for new light commercial vehicles, and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011.

5.3.2 Calculation of Primary Energy Savings

Formula

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

$$\mathrm{APES} = TFES \times PEF_{fuel} \qquad (25)$$

Table 42 –Parameters used in the formula for primary energy savings

Parameter	Description
APES	Annual primary energy savings [kWh/a]
TFES	Total final energy savings [kWh/a]
PEF_{fuel}	Primary Energy Factor for fuel [dmnl]

Standardized Calculation Values

There are no calculation values available for this in the Decree on data reporting on end-use energy savings.

5.3.3 Calculation of Greenhouse Gas Savings

Formula

The following formula is used to calculate the annual GHG savings:

$$GHGSAV = TFES \times e_{GHG,fuel} \times 10^{-6} \qquad (26)$$

Table 43 –Parameters used in the formula for greenhouse gas savings

Parameter	Description
GHGSAV	Greenhouse gas savings [t CO_2 p.a.]
TFES	Total final energy savings [kWh/a]
$f_{GHG,fuel}$	Emission factor for fuel [g CO_2/kWh]

Standardized Calculation Values

Standardised calculation values available are determined in the Decree on data reporting on end-use energy savings.

Table 44 –Indicative values for calculation of greenhouse gas savings

Parameter	Value	Unit

petrol	22.38	g/km
diesel	26.44	g/km
LPG	29.01	g/km
CNG	26.48	g/km

In determination of standardised calculation values the Regulation (EU) 2019/631 of the European Parliament and of the Council of 17 April 2019 setting carbon dioxide emission performance standards for new passenger cars and new light commercial vehicles and repealing Regulations (EC) No 443/2009 and (EU) No 510/2011 was respected. Vehicle's WLTP combined emission value or, in its absence, the vehicle manufacturer's declaration are also important source of data.

5.3.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

5.3.5 Methodological Aspects

The principle of calculation is based on the difference between the specific fuel consumption and GHG emissions of an old and new vehicle. As explained in section 5-1, the savings are calculated based on the following principle: in the first step, the eligible specific and annual emission reduction is determined, and then, based on this, in the second step, the energy savings are calculated. In the first step, the average CO_2 emissions of the existing entire fleet must be determined. This is based on the vehicle's WLTP combined emission value or, in its absence, the vehicle manufacturer's declaration.

The Hungarian Energy and Public Utility Regulatory Authority (MEKH) is the regulatory body of the energy and public utility market, supervising the national economy’s sectors of strategic importance. The MEKH has established and reviews each year the EEOS catalogue, which lists the types of energy efficiency measures or investments that can be accounted in a simplified way. This Catalogue is published as the Annex of 17/2020.(XII. 21.) MEKH Decree on data reporting on end-use energy savings.

Each catalogue sheet contains a description of the energy efficiency measure; the method and content of recording the baseline and post-measure status; the eligible lifetime and the level of degradation; a description of the performance factors and the principles for their calculation, the formula for calculating the annual savings; the documents to be submitted and other relevant information to support the accounting. For the time being, the catalogue contains 51 sheets in 5 categories.

All documents are available in Hungarian language.

5.3.6 Bibliography

The Hungarian Energy and Public Utility Regulatory Authority (2020): *17/2020.(XII. 21.) MEKH Decree on data reporting on end-use energy savings*, https://njt.hu/jogszabaly/2020-17-20-5Z

5.4. Ireland -Electric Vehicles

Application area: This methodology and the provided calculation tool enable users to estimate the annual energy savings associated with electric vehicles.

Boundary conditions: The methodology used targets fuel switching between conventional and electric vehicles.

5.4.1 Calculation of Final Energy Savings

Formula

This formula calculates first-year savings.

$$TFES = (sFEC_{ref} - sFEC_{eef}) \times \frac{DT}{100} \times n \times f_{BEN} \quad (27)$$

Table 45 – Parameters used in the formula for final energy savings

Parameter	Description
TFES	Total final energy savings [kWh/a]
$sFEC_{ref}$	Specific final energy consumption of the reference vehicle [kWh/100 km]
$sFEC_{eef}$	Specific final energy consumption of the efficient vehicle [kWh/100 km]
DT	Average yearly distance travelled with the vehicle [km/a]
n	Number of efficient vehicles purchased
f_{ben}	Factor to consider behaviour effects

Standardized Calculation Values

The methodology provides the following indicative values for calculation of final energy savings.

Table 46 – Indicative values for calculation of final energy savings

Parameter	sFECref [kWh/100 km] 2020 onwards	2025 onwards	2030 onwards	sFECeff [kWh/100 km]	DT [km/a]
Car	36,82	31,26	23,01	12,4	17 074
Van - Diesel	55,11	46,86	38,61	24,6	17 480
Truck	311,53	311,53	311,53	130,2	55 570
Bus	311,53	311,53	311,53	130,2	77 800

5.4.2 Calculation of Primary Energy Savings

Formula

No formula available for this methodology.

Standardized Calculation Values

No information on calculation values available for this methodology.

5.4.3 Calculation of Greenhouse Gas Savings

Formula

No formula available for this methodology.

Standardized Calculation Values

No information on calculation values available for this methodology.

5.4.4 Overview of Costs Related to the Action

Cost-Effectiveness

No formula available for this methodology.

Standardized Values

No information on calculation values available for this methodology.

5.4.5 Methodological Aspects

The above data is based on the calculation tool provided on the website of the Sustainable Energy Authority of Ireland.

5.4.6 Bibliography

Electric vehicle savings calculator [EXCEL Workbook]: https://www.seai.ie/sites/default/files/publications/EEOS-EV-Energy-Credit-Calculator.xlsx

5.5. Italy - White Certificate: Operational Guide: Transport Sector

The method is an operational guide for "White Certificates" (Certificati Bianchi) by GSE (Gestore Servizi Energetici). It focuses on the transport sector and provides guidelines for energy efficiency interventions.

5.5.1 Calculation of Final Energy Savings

Formula

The used formula for calculating additional energy savings are used for interventions for road transport and fleets of road passenger vehicles. The energy consumption indicator is “tep” (km * passenger) or “toe” (km * passenger seat).

The formula calculates yearly savings.

$$AES = (CS_{baseline} - CS_{expost}) \times km_{post} \times passengers_{post} \qquad (28)$$

$$AES = (CS_{baseline} - CS_{expost}) \times km_{post} \times p_{expost} \qquad (29)$$

For fleets of heavy transport vehicles and road freight the following formula should be used:

$$AES = (CS_{baseline} - CS_{expost}) \times km_{post} \times t_{post} \qquad (30)$$

Rebound, spill-over and free-rider effects are not taken into account in the formula.

The measurement must provide the monitoring in the post-intervention situation, and in the case of replacement or efficiency also in the pre-intervention situation, of all the energy vectors involved and the operational variables that influence consumption (e.g. type of route, speed, etc.), in order to normalise the specific consumption with respect to the external conditions that influence them.

Table 47 – Parameters used in the formula for final energy savings

Parameter	Description
AES	Additional Energy Savings [tonnes]
$CS_{baseline}$	Specific consumption in the baseline
CS_{expost}	Specific consumption in the post-intervention situation
km_{post}	Kilometres driven in the post-intervention situation
$passengers_{post}$	Number of passengers transported in the post-intervention situation
p_{expost}	Maximum number of transportable passenger seats (standing and seated)
t_{post}	Tonnes of goods actually transported in the post-intervention situation

Standardized Calculation Values

No calculation values available for this methodology.

Table 48 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
rb	1	-
so	1	-

fr	1	-

5.5.2 Calculation of Primary Energy Savings

There is no information regarding primary energy savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

5.5.3 Calculation of Greenhouse Gas Savings

There is no information regarding the greenhouse gas savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

5.5.4 Overview of Costs Related to the Action

Cost-Effectiveness

No information on cost-effectiveness available for this methodology.

Standardized Values

No calculation values available for this methodology.

5.5.5 Methodological Aspects

The methodology and formulas have been taken from the published document of GSE – Gestore Servizi Energetici. GSE is a state-owned company. GSE has a significant role in promoting sustainable development and managing incentives to support the production of electricity from renewable sources and improve energy efficiency.

The document is a guide on public lighting as part of the "White Certificates" (Certificati Bianchi). These certificates are an incentive mechanism to promote energy efficiency.

The initial language of the document is Italian. The original document is available under: https://www.gse.it/documenti_site/Documenti%20GSE/Servizi%20per%20te/CERTIFICATI%20BIANCHI/GUIDE/All.2.7_Guide%20settoriali_Trasporti.pdf

5.5.6 Bibliography

GSE - Gestore Servizi Energetici: CERTIFICATI BIANCHI - Allegato 2.7 alla Guida Operativa. Guide Settoriali IL SETTORE DEI TRASPORTI. (2022).
https://www.gse.it/documenti_site/Documenti%20GSE/Servizi%20per%20te/CERTIFICATI%20BIANCHI/GUIDE/All.2.7_Guide%20settoriali_Trasporti.pdf

5.6. Lithuania - Methodology for calculating the energy saved by replacing freight transport with more efficient ones

There is no precise methodology for calculating energy savings achieved by shifting road freight transport, primarily trucks, to railway freight transport. However, there are methodologies available for calculating energy savings in freight transport when replacing less efficient trucks with more energy-efficient ones. The greatest energy savings are typically achieved by replacing trucks powered by diesel (or other fuel types) internal combustion engines with more fuel-efficient models or with trucks that utilize alternative primary energy sources.

5.6.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative energy savings for measures with a lifespan exceeding one year. To determine the total energy savings over the entire period, the annual energy savings are multiplied by the number of years the measure remains effective. Specifically, this formula is used to calculate energy savings when replacing a truck with an engine powered by a different fuel type. For this reason, fuel consumption must be converted into energy consumption in kilowatt-hours (kWh) to enable an accurate comparison:

$$\Delta E = (E_{before} - E_{after}) \times y \times rb \times so \times fr$$

$$\Delta E = \left((l_{100before} \times k_{fuel1} - l_{100after} \times k_{fuel2}) \times \frac{d}{100}\right) \times y \times rb \times so \times fr \qquad (31)$$

Table 49 – Parameters used in the formula for calculating replacing freight transport with more efficient ones.

Parameter	Description
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_{after}	Energy consumption of trucks with more efficient engines (after replacement) [kWh]
y	Duration of the measure [year]
$l_{100before}$	Average diesel consumption per 100 km for trucks with internal combustion diesel engines [liters] before replacement
$l_{100after}$	Average diesel consumption per 100 km [liters] of trucks with more efficient engines after replacement
$k_{fuel(1,2)}$	Coefficient expressing the energy content of 1 liter of fuel [kWh/liter]. k_{fuel} – see the following table for vehicle coefficients by fuel type (k_{fuel1} fuel efficiency of the vehicle used before the efficiency measure, k_{fuel2} fuel efficiency of the more efficient vehicle)
d	Total distance travelled by lorries per year [km/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)

In the formula listed above, standardized coefficient values (k) are used to convert fuel quantities from natural units to energy units (kWh). These coefficients vary depending on the type of fuel.

Table 50 – Indicative values for calculation of final energy savings from freight transport replacement

Parameter	Value	Unit
k (diesel)	10,292	kWh/liter
k (petroleum)	9,333	kWh/liter
k (CNG)	10,400	kWh/kg
k (CNG)	7,956	kWh/m^3

5.6.2 Calculation of Primary Energy Savings

No information on calculation of primary energy savings available for this methodology.

5.6.3 Calculation of Greenhouse Gas Savings

Formula

The average annual CO_2 emissions per kilometre (measured in tons per kilometre) are calculated by dividing the total annual amount of CO_2 emitted into the atmosphere by the total annual mileage of the vehicles.

$$CO_{2,year} = C_{fuel,year} \times k_{CO2}$$
$$CO_{2,per\ km} = \frac{CO_{2,year}}{d} \qquad (32)$$

Table 51 – Parameters used in the formula greenhouse gas savings for freight transport replacement

Parameter	Description
$CO_{2,\ year}$	Total annual CO_2 emissions per year [t/year]
$CO_{2,\ per\ km}$	The average CO_2 emissions in tonner per kilometre [t CO_2/km]
$C_{fuel,\ year}$	Fuel energy consumption per year [toe/year]
k_{CO2}	CO_2 emission coefficient (by fuel type) per unit of fuel energy content [t CO_2/toe]
d	Total distance travelled by vehicles per year [km/year]

Standardized Calculation Values

For annual CO_2 emission calculations, the CO_2 emission coefficient per unit of fuel energy for different fuel types is used. In other words, it indicates how many tonnes of CO_2 are emitted per tonne of oil equivalent (toe) of fuel.

Table 52 – Indicative values for calculation of greenhouse gas savings from freight transport replacement

Parameter	Value	Unit
k_{CO2} (diesel)	3,025	t CO_2/toe
k_{CO2} (petroleum)	3,047	t CO_2/toe
k_{CO2} (LPG)	2,764	t CO_2/toe
k_{CO2} (fuel oil)	3,283	t CO_2/toe

5.6.4 Overview of Costs Related to the Action

No information on calculation of costs related to the action for this methodology.

5.6.5 Methodological Aspects

This methodology was taken from officially published legal document "The description of the procedure for setting up energy savings agreements, No.: 1-187": https://www.e-tar.lt/portal/lt/legalAct/cd89c430688011e7827cd63159af616c/asr [in Lithuanian language].

This methodology was taken from officially published legal document "Law of the Republic of Lithuania on Alternative Fuels, No.: XIV-196": https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/0409c522915c11eb998483d0ae31615c/asr [in Lithuanian language].

The greenhouse gas savings methodology was taken from officially methodology for energy consumption in vehicle "Audit methodology for energy consumption in vehicles, No.: 1-291/3-535":

https://www.e-tar.lt/portal/lt/legalAct/255a00b0cdf011e7910a89ac20768b0f [in Lithuanian language].

5.6.6 Bibliography

1. Ministry of Energy of the Republic of Lithuania (2017). The description of the procedure for setting up energy savings agreement, No.: 1-187. Consolidated version 2020-08-19. Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/cd89c430688011e7827cd63159af616c/asr
2. Ministry of Energy of the Republic of Lithuania (2021). Law of the Republic of Lithuania on Alternative Fuels, No.: XIV-196. Consolidated version 2021-04-08 Nr. 2021-07413. Register of legal acts. https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/0409c522915c11eb998483d0ae31615c/asr
3. Ministry of Energy of the Republic of Lithuania (2017). Audit methodology for energy consumption in vehicles, No.: 1-291/3-535. Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/255a00b0cdf011e7910a89ac20768b0f

5.7. Poland - Development of public transport in cities

The aim is to develop and more use of low-emission urban transport to serve the inhabitants of functional urban areas.

Application area:

- Public sector
  - local government units and their associations – regional cities and their functional areas and organisational units and special purpose vehicles acting on their behalf;
  - managers of infrastructure used by urban transport;
  - public transport operators

Types of actions/projects:

- The development of green transport at local level
  (as such, the measure supports a further range of actions from modal shift to infrastructure support to public transport development)

5.7.1 Calculation of Final Energy Savings

Formula

Correction factors for the rebound, spill-over, and free-rider effects are not taken in the account.

This formula calculates first-year savings.

$$O_{FLOTA} = Noeb * esj + NoH2b * esjh2b + other\ savings \quad (33)$$

Table 53 – Parameters used in the formula for final energy savings

Parameter	Description
O_{FLOTA}	annual savings [ktoe/year]
Noeb	number of new electric vehicles [-]
Esj	the final energy savings per unit of the electric vehicle [ktoe/1 bus]
NoH2b	number of new vehicles powered by alternative fuels
Esjh2b	the specific final energy savings of the alternatively fuelled vehicle [ktoe/1 bus]

Standardized Calculation Values

Values for the specific energy consumption of cars and buses have been developed and published in the Regulation of the Minister for Climate and the Environment amending the Regulation on the detailed scope and method of drawing up energy efficiency audits and methods for calculating energy savings (Journal Of Laws 2022, item 956).

5.7.2 Calculation of Primary Energy Savings

Calculation of Primary Energy Savings is not available. The calculation is done in final energy.

5.7.3 Calculation of Greenhouse Gas Savings

No calculation of greenhouse gas savings available for this methodology

5.7.4 Overview of Costs Related to the Action

No Overview of Costs Related available for this methodology

5.7.5 Methodological Aspects

In line with the requirements on methods and rules for calculating energy savings set out in Annex V, point 1, of the Energy Efficiency Directive 2023/EU, a methodology for estimating energy savings (i.e. deemed savings) and scaled savings (i.e. scaled savings) has been adopted.

The language(s) of the original document is English and Polish.

5.7.6 Bibliography

Collective of authors. (2024). Poland - Draft updated NECP 2021-2030 - Annex 3. *Warsaw: Ministerstwo Klimatu i Środowiska*. Retrieved from: https://commission.europa.eu/publications/poland-draft-updated-necp-2021-2030_en

5.8. Slovakia - Support of electromobility

Supported activities mainly focuses on the purchase of vehicles in accordance with the principle of energy efficiency savings and purchase of new components and installations that will demonstrably contribute to the reduction of final and primary energy consumption and to the reduction of emissions.

Formula

Methods for calculating savings are ex ante depending on expected savings.

$$ÚS_{i\_plán} = (S_{pred} - S_{po})\ x\ L\ x\ p \qquad (34)$$

Table 54 – Parameters used in the formula for final energy savings

Parameter	Description
$ÚS_{i\_plán}$	Planned final energy savings in the year of vehicle replacement [kWh/a]
S_{pred}	Average electricity consumption for an old vehicle/original condition [kWh/km]
S_{po}	Average electricity consumption for a new vehicle /new condition [kWh/km]
L	Annual driving performance [km/a]
p	Number of replaced old vehicles with new ones

Standardized Calculation Values

Table 55 – Indicative values for calculation of final energy savings

	Parameter	Value	Unit
Passenger transport	S_{po}	17,5	kWh/100 km
	L	20 000	km
Electric bus	S_{po}	180	kWh/100 km

	L	74 460	km
Fright electric until 3.5t	S_{po}	n.a.	kWh/100 km
	L	20 000	km

6. Lighting Systems and Public Lighting

6.1. Croatia - New installation or change of public lighting system

Mercury bulbs, metal halide or sodium lamps are usually replaced with more efficient LED lighting.

There are two typical cases:

1. Replacing existing bulbs with new, more efficient ones. This case is characteristic of a situation where the existing lighting meets the requirements of the standard HR EN 13201 and applicable laws in the field of public lighting and only the lighting fixtures are changed. In this case, the savings are calculated based on the difference in the installed power of the lighting fixtures and the reference number of operating hours of public lighting per year.
2. Reconstruction of the public lighting system and installation of new, more efficient lighting fixtures and lamps. This case is typical for the case when the existing public lighting system does not meet the requirements of HR EN 13201 and when co-financing energy efficiency measures require reconstruction of the system to meet the requirements of this standard and other applicable laws and technical regulations. When calculating energy savings in this case, the lighting situation is simulated with existing technologies while meeting the traffic safety indicators prescribed by HRN EN 13201 and the corresponding energy indicators for such a configuration are calculated (installed power in kW and annual energy consumption in kWh / year). The state thus simulated constitutes a reference existing state and is taken into account through the simulation factor. This case also includes the installation of a new public lighting system. When building new public lighting, the simulation is made with sodium light sources of rated power 70, 150 or 250 W as a budget assumption of the existing condition

Mandatory input data for calculating savings in case a.:

- number, type and power of replaced light bulbs and number of hours of operation per year or reduction factor if there was a public lighting management strategy
- number, type and power of new light bulbs, number of hours of operation per year or reduction factor if there is a public lighting management strategy

Given that lighting systems have energy consumption measuring devices, it is recommended to use measured values of electricity consumption before and after the implementation of the EnU measure, which would provide the most accurate assessment of savings, without investing much effort in data collection.

Mandatory input data for calculating savings in case b.:

- number, type and power of replaced light bulbs, a certain simulation factor and number of hours of operation per year or reduction factor if there was a public lighting management strategy
- number, type and power of new light bulbs, number of hours of operation per year or reduction factor if there is a public lighting management strategy.

In this case, the measured energy consumption before and after the measure is not a relevant indicator of energy savings because the reconstruction and improvement of the quality of the public lighting system was carried out.

Savings can be calculated using data specific to each project or using reference values.

In the case of using reference values, the documentation that must be attached/possessed as evidence of the implementation of the measure and verification of the input data for the calculation of savings is the record of the acceptance of lighting fixtures or lamps and/or the invoice for the delivered lighting fixtures/lamps, which shows the number and type of lighting.

In the case of using specific values, in addition to the record of the acceptance and/or invoice for the delivered lighting, it is necessary to attach/possess a report on lighting energy consumption. It is necessary to determine the actual old installed lighting power, the new installed lighting power and the number of operating hours. The number of operating hours is determined for each measuring point separately, or in specific cases for each lamp separately. The report is prepared by an authorized electrical engineer or a person authorized to conduct an energy audit of public lighting.

6.1.1 Calculation of Final Energy Savings

Formula

a) Replacement of lighting

$$UFES = \frac{P_{init} \times n_{hinit} - P_{new} \times n_{hnew}}{1000}$$
$$UFES = \frac{P_{init} - P_{new} \times r}{1000} \times n_h \tag{35}$$
$$FES = UFES \times N$$

Table 56 – Parameters used in the formula

Parameter	Description
FES	Total Final Energy Savings [kWh/a]
UFES	Unit energy savings in direct consumption [kWh / unit / year]
N	Number of old lamps (equal to the number of new lamps)
P_{init}	Installed power before measure [W]
P_{new}	Installed power after measure [W]
n_h	Number of hours of operation lighting system per year [h / year]
n_{hinit}	Number of hours of old lamp operation per year [h / year]
n_{hnew}*	Number of hours of new lamp operation per year [h / year]
r	Reduction factor that depends on the applied public lighting management strategy

**It is common that $n_{hinit} = n_{hnew}$ unless a new lighting control strategy is introduced through the EnU measure. The effect of the new control strategy can be taken into account by the reduction factor r, which depends on the applied lighting control strategy, and the equation $n_{hinit} = n_{hnew} \times r$ is valid*

b) Improvement, reconstruction or installation of new public lighting systems

$$F_S = \frac{N_{initS}}{N_{init}}$$
$$UFES = \frac{P_{init} \times F_S \times N_{init} \times n_{hinit} - P_{new} \times N_{new} \times n_{hnew}}{1000}$$
$$UFES = \frac{P_{init} \times F_S \times N_{init} - P_{new} \times N_{new} \times r}{1000} \times n_h \tag{36}$$
$$FES = \sum_{i=1}^{n} UFESi$$

Table 57 – Parameters used in the formula

Parameter	Description
N_{init}	Number of old lamps
N_{initS}	Simulated number of light bulbs before measures are implemented

Parameter	Description
F_S	Simulation factor: <1 in case the existing system exceeds the requirements of the HR EN 13201 standard 1 in case the existing system meets the requirements of the HR EN 13201 >1 in case the existing system does not meet the requirements of the HR EN 13201 standard, and the simulation shows that the distance between the poles should be reduced or the power of the existing bulbs should be increased
UFES	Unit energy savings in direct consumption [kWh / unit / year]
P_{init}	Installed power before measure [W]
P_{new}	Installed power after measure [W]
n_{hinit}	Number of hours of old lamp operation per year [h / year]
n_{hnew}*	Number of hours of new lamp operation per year [h / year]
r	Reduction factor that depends on the applied public lighting management strategy
n_h	Number of hours of operation lighting system per year [h / year]
FES	Total Final Energy Savings [kWh/a]
N	Number of public lighting subsystems reconstructed in the project

**It is common that n_{hinit} = n_{hnew} unless a new lighting control strategy is introduced through the EnU measure. The effect of the new control strategy can be taken into account by the reduction factor r, which depends on the applied lighting control strategy, and the equation $n_{hinit} = n_{hnew} \times r$ is valid*

In the case of public lighting, the power must be calculated by adding up the power of the bulbs and the losses in the ballast and transformer. In existing public lighting systems, ballast losses are about 15%, transformer and network losses are about 4%, and the power of the bulb itself needs to be increased by 19%.

Standardized Calculation Values

Table 58 – Indicative values

Parameter	Value
n_h [h/god]	4.100 – when the lighting management strategy is known
	3.572 – when the lighting management strategy is unknown
r [-]	1 – without a control strategy
	0,72 – 50% power reduction from 11 PM to 6 AM
	0,65 – 100% power reduction from 1 AM to 5 AM
F_S [-]	1,3
P_{init} [W]	85 – for a sodium lamp with a 70 W bulb (low-intensity traffic areas)
	155 – for a mercury lamp with a 125 W bulb (low-intensity traffic areas)
	180 – for a sodium lamp with a 150 W bulb (medium-intensity traffic areas)
	310 – for a mercury lamp with a 250 W bulb (medium-intensity traffic areas)
	300 – for a sodium lamp with a 250 W bulb (high-intensity traffic areas)
	500 – for a mercury lamp with a 400 W bulb (medium-intensity traffic areas)
	480 – for a sodium lamp with a 400 W bulb (high-intensity traffic areas and floodlights)
P_{new} [W]	30 – for an LED lamp replacing a sodium lamp with a 70 W bulb or a mercury lamp with a 125 W bulb

Parameter	Value
	60 – for an LED lamp replacing a sodium lamp with a 150 W bulb or a mercury lamp with a 250 W bulb
	100 – for an LED lamp replacing a sodium lamp with a 250 W bulb or a mercury lamp with a 400 W bulb
	130 – for an LED lamp replacing a sodium lamp with a 400 W bulb
UFES [kWh/year per newly installed lamp]	336 – If the information about the power is unknown

Table 59 – Lifetime of savings

Lifetime of savings	[a]
Lifetime of savings	13

6.1.2 Calculation of Primary Energy Savings

Formula

No information on primary energy savings available for this methodology.

Standardized Calculation Values

No information on primary energy savings available for this methodology.

6.1.3 Calculation of Greenhouse Gas Savings

Formula

Formula for calculating the annual reduction of greenhouse gas emissions:

$$E_{CO2} = \frac{FES \times e}{1000} \qquad (37)$$

Table 60 – Parameters used in the formula

Parameter	Description
E_{CO2}	Greenhouse gas savings [t CO_2/a]
FES	Total Final Energy Savings [kWh/a]
e	Emission factor for electricity [kg/kWh]

Standardized Calculation Values

Table 61 –Indicative values for calculation of greenhouse gas savings

Factors	[kg CO_2/kWh]
Electricity	0,159

6.1.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

6.1.5 Methodological Aspects

Calculation methodology

This methodology was integrated into the catalogue on bottom-up calculation methodologies. The document is published in Croatian language. Is the part of the Rulebook on the system for monitoring, measurement and verification of energy savings.

Calculation values

The required calculation values must be collected by each developed system separately.

6.1.6 Bibliography

Ministry of Economy and Sustainable Development (2021), *Rulebook on system for monitoring, measurement and verification of energy savings*, NN 98/2021, https://narodne-novine.nn.hr/clanci/sluzbeni/2021_09_98_1772.html

Ministry of Economy and Sustainable Development (2022), *Regulation on Amendments and Supplements to the Rulebook on system for monitoring, measurement and verification of energy savings*, NN 30/2022, https://narodne-novine.nn.hr/clanci/sluzbeni/2022_03_30_370.html

6.2. Hungary - Lighting modernisation

An energy efficiency measure is the replacement of a previously installed lighting system with a lighting system with better light efficiency and lower power requirements. The energy efficiency investment includes the dismantling of old lighting fixtures, the renovation of the electrical network circuit assemblies and the installation of new LED lighting fixtures.

In the case of lighting modernization, it is necessary to check the adequacy of the lighting by preliminary sizing and subsequent light measurement documented in a report.

a) Indoor lighting
- a.1.1. Lighting of industrial halls, warehouses, agricultural buildings
- a.1.2. Lighting of office buildings
- a.1.3. Indoor lighting of institutions, in particular shops, shopping centres, sports facilities which operate according to official weekly opening hours.

b) Outdoor lighting

c) Public lighting

d) Emergency lighting

In Annex 1 to Commission Regulation (EU) 2019/2020 of 1 October 2019 laying down eco-design requirements for light sources and separate control gear pursuant to Directive 2009/125/EC of the European Parliament and of the Council and repealing Commission Regulations (EC) No 244/2009, (EC) No 245/2009 and (EU) No 1194/2012 (hereinafter referred to as 'Commission Regulation (EU) 2019/2020'), the term light source shall mean a luminaire as defined below:

"Mains-operated light source (MLS)" means a light source that can be operated directly from the mains supply. Light sources that can be operated directly or indirectly from the mains supply through a separate control gear shall be considered to be mains-operated light sources.

"***Non-mains light source (NMLS)****":* a light source that requires a separate control unit to operate from the mains.

"***Directional light source (DLS)":*** a light source with at least 80% of its total luminous flux falling within the solid angle π sr (corresponding to a 120° cone).

"***Non-directional light source (NDLS)***": a light source that is not considered to be a directional light source.

"***Luminaire***": A luminaire, including a light source mounted in its socket or built in. Depending on the design, it also includes the electrical control gear.

"***Official weekly opening hours***": The weekly opening hours specified by the end user, which also include the time for preparing for sale. Preparation time is e.g. the time for baking and baking bakery products before opening.

The nominal technical parameters and operating characteristics of the lighting systems subject to the measure shall be recorded.

Table 62 – Nominal technical parameters and operating characteristics

A	B	C	D
Number of rows	**Technical parameter**	**Old**	**New**
In case of early replacement: (old luminaire age < 15 years)			
1.	$Type_{old,k}$ = type of old lighting fixtures		-
2.	Date of commissioning of the old lighting system/luminaire, [year]		-
3.	$Pold_{,nominal,k}$ = nominal electrical power requirement of old lighting fixtures per type, [W/pc]		-
4.	n_k = quantity of old lighting fixtures within the type [pcs]		-
5.	$\eta_{i,ballast}$ = old luminaire type ballast efficiency [%]		-
For all replacements that are not considered early substitutions:			
6.	$Type_{new,I}$ = the type of new LED luminaires	-	
7.	Date of commissioning of the old lighting system/light fixture, [year]	-	
8.	$P_{new,i}$ = electrical power requirement of new LED luminaires by type [W/pc]	-	
9.	Electrical power requirement of new LED luminaires by type [W/pc]	-	
10.	$\eta_{new,i}$ = luminous efficacy of new LED luminaire types [lm/W]	-	
11.	$Ü_k$ = Operational correction factor		
12.	C = correction factor	-	From 01.09.2021
13.	F = efficiency factor	-	From 01.09.2021
14.	$t_{m,j}$ = typical annual operating time [h/year] for lighting group "j".		

Lifetime of the measure is 15 years. If the measure is applied, the annual obsolescence of energy savings does not need to be considered.

6.2.1 Calculation of Final Energy Savings

The calculation shall consider the average expected lifetime of the old lighting system or luminaire.

a) Calculation of energy savings before the end of the expected lifetime of the old equipment.

If the old lighting system or luminaire has not reached the end of its average expected lifespan, the measure shall be considered as early replacement according to Annex 7, point 2.6. of Government Decree 122/2015. (V. 26.) on the implementation of the Energy Efficiency Act (hereinafter: Ehat.vhr.).

The total savings shall be the difference between the energy consumption of the old lighting system and the new lighting system corresponding to the old lighting. The lighting may be of a higher intensity, regardless of the eligible savings, if the requirements so require.

b) Calculation of additional savings after the end of the average expected lifetime of the old equipment.

The requirements for the eco-design of luminaires and separate control gear set out in point 1. a) of Annex II to Commission Regulation (EU) 2019/2020 shall set out the requirements from 1 September 2021.

The accounting in accordance with ***6.2.1 Calculation of Final Energy Savings*** shall apply to measures completed after 1 September 2021.

In the case of investments completed in 2021 but before 1 September 2021, the energy savings shall be determined in the framework of an individual audit, taking into account the provisions of Annex III to Commission Regulation (EU) No 1194/2012 of 12 December 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to eco-design requirements for directional lamps and light-emitting diode lamps and related equipment, containing energy efficiency requirements.

If the lighting system or luminaire was replaced after its average expected lifetime, the eligible energy savings are exclusively the additional energy savings calculated from the difference between the energy requirement calculated from the maximum permitted reference power, depending on the lighting type, in accordance with the eco-design energy efficiency requirement, and the individual energy requirement of the new LED luminaires.

c) In the case of outdoor and public lighting, the total savings shall be determined by considering the energy consumption of new lighting fixtures equal to the number of old lighting fixtures.

The energy consumption of new lighting fixtures resulting from an increase in lighting demand shall not be considered in the calculation of the savings.

d) In the case of emergency lighting, the total savings shall be determined by considering the energy consumption of new lighting fixtures equal to the number of old permanent exit signs and direction lights.

Formula

Calculation of the electrical power requirement of old lighting fixtures by type, considering ballast losses:

$$P_{old} = \frac{P_{old,nominal}}{\eta_{ballast}} [kW] \qquad (38)$$

Table 63 – Parameters used in the formula for calculation of energy savings

Parameter	Description
P_{old}	Calculated power requirement of the old light source [kW]
$P_{old,nominal}$	Nominal power requirement of the old light source [kW]
$\eta_{ballast}$	Efficiency of the ballast

For this measure, it is necessary to record the nominal power of the old luminaires and the efficiency of their ballasts for each luminaire.

The energy efficiency category of the ballasts of the old luminaires must be considered as B1 during the calculation.

Early replacement

Annual energy savings can be calculated from the difference in power requirements of the old lighting system and the new LED lighting system. $TFES$ is calculated using the following formula:

$$TFES = (FEC_{before} - FEC_{after}) \times rb \times so \times fr \times lt \tag{39}$$

$$TFES_i = \frac{\left(P_{old,k} \times n_k \times U_{k,j,old} - P_{new,i} \times n_i \times U_{k,j,new}\right) \times t_{m,j}}{1000} \; [kWh/year] \tag{40}$$

$$\Delta E_{early/year,i} = \frac{\left(P_{old,k} \times n_k \times U_{k,j,old} - P_{new,i} \times n_i \times U_{k,j,new}\right) \times t_{m,j}}{1000} \times \frac{3,6}{1000} \; [GJ/year] \tag{41}$$

Table 64 – Parameters used in the formula for calculation of energy savings

Parameter	Description
$TFES$	Total final energy savings [kWh/year]
$TFES_i$	Energy savings of individual lighting system [kWh/year]
FEC_{before}	Final energy consumption before implementation of the action [kWh/a]
FEC_{after}	Final energy consumption after implementation of the action [kWh/a]
rb	Factor to calculate a rebound effect
so	Factor to calculate a spill-over effect
fr	Factor to calculate a free-rider effect (=1)
lt	Factor for the lifetime of savings
$\Delta E_{early/year}$	Total final energy savings [GJ/year]
$\Delta E_{early/year,i}$	Energy savings of individual lighting system [GJ/year]
$P_{new,i}$	Power requirement of new LED luminaires per type [W/pc]
n_i	Number of new LED luminaires within the type [pcs]
$P_{old,k}$	Power requirement of old luminaires per type, including control gear/ballast, calculated according to the formula *(42)* (2.5.5.1.1.) [W/pc]
n_k	Number of old luminaires within the type
$t_{m,j}$	Typical annual operating time valid for lighting group "j" [h/year].
$U_{k,j,new}$	Typical operational correction factor valid for lighting group "j" considering the classification according to point ***in chapter Operational correction factors***, to point 2.5.5.3.

Total values can be calculated according to variables "i", "k" and "j" using following formula:

$$TFES = \sum TFES_i \; [kWh/year] \tag{43}$$

$$\Delta E_{early/year} = \sum \Delta E_{early/year,i} \; [GJ/year] \tag{44}$$

Pursuant to Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (hereinafter: Directive 2011/65/EU), the production of compact fluorescent lamps and circular fluorescent lamps has ceased as of 1 March 2023. In lighting systems put into service after that, energy savings for luminaires still equipped with standard fluorescent lamps and circular fluorescent lamps cannot be considered due to the withdrawal of the products from the market pursuant according to

Annex 7, point 2.3.2 of Government Decree 122/2015. (V. 26.) on the implementation of the Energy Efficiency Act (hereinafter: Ehat.vhr.).

Pursuant to Directive 2011/65/EU, the production of T5 and T8 fluorescent lamps and high-intensity sodium lamps with a power exceeding 105 W has ceased as of 1 September 2023. In lighting systems put into service subsequently, energy savings for luminaires still equipped with T5 and T8 standard fluorescent lamps and high-intensity sodium lamps with a power greater than 105 W cannot be accounted for due to the withdrawal of the products from the market pursuant according to Annex 7, point 2.3.2 of Government Decree 122/2015. (V. 26.) on the implementation of the Energy Efficiency Act (hereinafter: Ehat.vhr.).

Replacement after the end of lifetime of old equipment

The eligible energy savings are the excess energy savings calculated from the difference between the energy demand calculated with the reference luminance factor corresponding to the minimum energy efficiency requirement specified in ***Calculation of the reference luminous efficiency in accordance with the minimum energy efficiency requirement*** in *(45)* in point 2.5.6.1 and the energy demand calculated with the individual luminance factor of the new LED luminaires. $TFES$ is calculated using the following formula:

$$TFES = (FEC_{before} - FEC_{after}) \times rb \times so \times fr \times lt \qquad (46)$$

$$TFES_i = P_{new,i} \times n_i \times \left(\frac{\eta_{new}}{\eta_{ref} - 1}\right) \times \frac{t_{m,j}}{(U_{k,j}/1000)} [kWh/year] \qquad (47)$$

$$\Delta E_{excess/year,i} = P_{new,i} \times n_i \times \left(\frac{\eta_{new}}{\eta_{ref} - 1}\right) \times \frac{t_{m,j}}{(U_{k,j}/1000)} \times \frac{3,6}{1000} [GJ/year] \qquad (48)$$

Table 65 – Parameters used in the formula for calculation of energy savings

Parameter	Description
$TFES$	Total final energy savings [kWh/year]
$TFES_i$	Energy savings of individual lighting system [kWh/year]
FEC_{before}	Final energy consumption before implementation of the action [kWh/a]
FEC_{after}	Final energy consumption after implementation of the action [kWh/a]
rb	Factor to calculate a rebound effect
so	Factor to calculate a spill-over effect
fr	Factor to calculate a free-rider effect (=1)
lt	Factor for the lifetime of savings
$\Delta E_{excess/year}$	Total final energy savings [GJ/year]
$\Delta E_{excess/year,i}$	Energy savings of individual lightning system [GJ/year]
i	number of new LED luminaire types
j	number of switching groups
$P_{new,i}$	power requirement of new LED luminaire types [W/pc]
n_i	quantity of new luminaires within a type [pc]
η_{new}	luminous efficiency of new LED luminaire types [lm/W]
η_{ref}	reference luminous efficacy factor per LED luminaire type calculated according to *(49)* to point 2.5.6.1. *chapter Calculation of the reference*

	luminous efficiency in accordance with the minimum energy efficiency requirement [lm/W]
$t_{m,j}$	annual operating time valid for lighting group "j" [h/year].
$U_{k,j,new}$	operational correction factor valid for lighting group "j" taking into account the classification according to point 2.5.5.3.

In the case of emergency lighting: In the case of replacing old permanent exit signs and direction lights with more modern ones, $\Delta E_{excess/year}$= 7 W/pc additional energy savings can be accounted for.

Total value can be calculated according to variables "i", "k" and "j" using following formula:

$$TFES = \sum TFES_i \ [kWh/year] \qquad (50)$$

$$\Delta E_{excess/year} = \sum \Delta E_{excess/year,i} \ [GJ/year] \qquad (51)$$

Standardized Calculation Values

Table 66 – Efficiency of non-dimmable fluorescent lamps and their ballasts

A	B	C	D
Number of rows	**Type of light source**	**Nominal power of the old light source** $P_{old,nominal}$ [W]	**Ballast efficiency** $\eta_{ballast}$ [%] *(category B1)*
1	T8	18	71,3
2	T8	36	83,4
3	T8	58	86,1
4	TC-L	18	71,3
5	TC-L	24	76,0
6	TC-L	36	83,4
7	TC-D / DE	10	67,9
8	TC-D / DE	13	72,6
9	TC-D / DE	18	71,3
10	TC-D / DE	26	77,2
11	TC-D / DE	13	72,6
12	TC-D / DE	18	71,3
13	TC -T / TC -TE	26	77,5
14	TC -T / TC -TE	10	68,8
15	TC -T / TC -TE	16	72,4
16	TC	9	60,3
17	TC	11	66,7
18	T5	13	72,6
19	T2	6	58,8
20	T2	8	65,0
21	T2	11	72,0
22	T2	13	76,0
23	T2	21	79,2
24	T2	23	80,7
25	T5 -E	14	72,1

26	T5 -E	21	79,6
27	T5 -E	24	80,4
28	T5 -E	28	81,8
29	T5 -E	35	82,6
30	T5 -E	39	82,6
31	T5 -E	49	84,6
32	T5 -E	54	85,4
33	T5 -E	80	87,0
34	TC-LE	40	83,3
35	TC-LE	55	84,6

Table 67 – Efficiencies of ballasts for high-intensity discharge lamps

A	B	C
Number of rows	**Nominal power of the old light source** ($P_{old,nominal}$)	**Ballast efficiency** $\eta_{ballast}$ [%]
1	P ≤ 30	78
2	30 < P ≤ 75	85
3	75 < P ≤ 105	87
4	105 < P ≤ 405	90
5	P > 405	92

Typical annual lighting system operating times

$t_{m,j}$ = typical annual operating time valid for lighting group "j" [h/year]

a) In industrial halls, warehouses, agricultural buildings:

a.1. in one shift + start and end time of shift: tm,j = 253 days/year · 8 hours/day + 200 hours/year = 2224 [h/year]

a.2. in one shift in a hall building with good sunlight and large windows: $t_{m,j}$ = 1600 [h/year]

a.3. in two shifts: $t_{m,j}$ = 253 days/year · 16 hours/day = 4048 [h/year]

a.4. in two shifts in a hall with good daylight and large windows: $t_{m,j}$ = 2500 [h/year]

a.5. in three shifts: $t_{m,j}$ = 253 days/year · 24 hours/day = 6072 [h/year]

a.6. in three shifts in a hall with good daylight and large windows: tm, j = 4524 [h/year]

a.7. In a hall with poor natural light, in the case of continuous operation: $t_{m,j}$ = 365 · 24 hours = 8760 [h/year]

b) In office buildings:

b.1. 1 shift + cleaning time: $t_{m,j}$ = 253 days/year · 8 hours/day + 200 hours/year = 2224 [h/year]

b.2. one shift in an office building with good sunlight and large windows: $t_{m,j}$ = 2000 [h/year]

b.3. In office rooms smaller than 50 m2, the operating time $t_{m,j}$ can be considered with a correction factor of 0.75

c) Typical operating time of public lighting: $t_{m,j}$ = 4000 [h/year]

d) The typical operating time of outdoor lighting is the same as the typical operating time according to point c) if it is controlled exclusively by a twilight sensor.

e) Indoor lighting of institutions requiring continuous lighting, in particular shops, shopping centres, sports facilities, which operate according to official weekly opening hours or hourly occupancy:

Hours according to official weekly opening hours · 51 weeks (40 weeks in educational institutions) + 180 hours/year cleaning time $t_{m,j} = t_{open}$ opening hours/week · 51 weeks/year + 180 hours/year = t_{open} · 51+180 [h/year]

where:

t_{open} = number of hours according to official weekly opening hours (hourly occupancy) [hours/week]

f) Indoor lighting of institutions (in particular shops, office buildings, medical practices) which also have natural lighting, which operate according to official weekly opening hours or hourly occupancy:

Official weekly opening hours / 2 · 51 weeks (40 weeks in educational institutions) + 180 hours/year of cleaning time.

Operational correction factors

$Ü_k$ = Operational correction factor

a) Dimmable indoor lighting: if the indoor lighting can be automatically controlled depending on the outdoor natural lighting, then the correction factor $Ü_{kij}$ = 0.77
b) Row-switchable indoor lighting: if the indoor lighting can be switched row-by-row depending on the outdoor natural lighting, then the correction factor $Ü_{kij}$ = 0.83
c) Integration into a motion or presence detector system: if the lighting group is equipped with a motion or presence detector, then the correction factor for the group is $Ü_{kij}$ = 0.7
d) Regulated public lighting modernization: if the new LED public lighting is dimmable, then the correction factor: Ükij = 0.8

The correction factor was calculated based on domestic practice for a 50% reduction in lighting from 24:00 to 5:00.

If the classification does not meet any of a) - d): $Ü_k$ = 1.

Reference values corresponding to the minimum energy efficiency requirement

According to point 1(a) of Annex II to Commission Regulation (EU) 2019/2020, from 1 September 2021 the electrical power requirement $P_{on}=P_{new}$ of the luminaire shall not exceed the maximum permitted value P_{onmax} [W], which is defined as a function of the declared useful luminous flux Φ_{use} [lm] and the declared colour rendering index CRI (–), as follows:

$$P_{onmax} = C \times (L + \frac{\Phi_{use}}{(F \times \eta)\ ) \times R} [W] \qquad (52)$$

Table 68 – Parameters used in the formula for calculation of energy savings

Parameter	Description
P_{onmax}	Maximum permitted value [W]
η	Luminous efficiency [lm/W]
L	Power requirement of the control gear/ballast [W] *(Not relevant for calculating the additional energy savings due to the difference calculation.)*
$\eta_{ballast}$	Luminous flux of the luminaire, according to the technical data sheet [lm]
Φ_{use}	Luminous flux of the luminaire, according to the technical data sheet [lm]
C	Power correction factor C=1.08 for non-directional, mains-operated (MLS) luminaire C= 1.23 for directional, mains-operated (MLS) luminaire

F	Efficiency factor F=1 for non-directional luminaire (NDLS, total luminous flux) F= 0.85 for directional luminaire (DLS, cone-shaped luminous flux)
R	Colour rendering index (CRI) R = 1, the colour rendering index correction factor is ignored in the power requirement calculation for simplification

Calculation of the reference luminous efficiency in accordance with the minimum energy efficiency requirement

The luminous efficiency in Table 1 of Annex II to Commission Regulation (EU) 2019/2020 is not the same as the minimum required luminous efficacy. The latter calculation shall consider the luminous efficacy factor of the useful luminous flux (F) of the luminaire.

The reference luminous efficiency (η_{ref}) according to the eco-design requirements shall be determined on the basis of the luminous efficacy (η) of the LED luminaire per type, considering its efficiency factor (F), separately for each type.

η_{ref} is calculated using the following formula:

$$\eta_{ref} = \frac{\eta \times F}{C} [lm/W] \qquad (53)$$

Table 69 – Parameters used in the formula for calculation of energy savings

Parameter	Description
η_{ref}	The reference luminous efficiency [lm/W]
F	Efficiency factor F=1 for non-directional luminaire (NDLS, total luminous flux) F= 0.85 for directional luminaire (DLS, cone-shaped luminous flux)
C	Power correction factor C=1.08 for non-directional, mains-operated (MLS) luminaire C= 1.23 for directional, mains-operated (MLS) luminaire
$\eta_{threshold}$	Luminous efficacy for LED luminaires according to the classification of 'other light sources not specified above falling within the scope of this Regulation' in Annex II, Table 1 of Commission Regulation (EU) 2019/2020.

$\eta_{threshold}$ = 120 luminous efficacy threshold [lm/W]

With the above values, the luminous efficacy per type is:

a) In the case of a directional light fixture:

$$\eta_{ref} = \frac{\eta_{\text{threshold}} \times F}{C} = 120 \times \frac{0,85}{1,23} = 83 [lm/W] \qquad (54)$$

b) In the case of a non-directional light fixture:

$$\eta_{ref} = \frac{\eta_{\text{threshold}} \times F}{C} = 120 \times \frac{1}{1,08} = 111 [lm/W] \qquad (55)$$

The calculation must be performed separately according to the type of LED luminaire.

6.2.2 Calculation of Primary Energy Savings

Formula

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

$$\text{APES} = TFES \times PEF_{Electricity} \tag{56}$$

Table 70 – Parameters used in the formula for primary energy savings

Parameter	Description
APES	Annual primary energy savings [kWh/a]
$TFES$	Total final energy savings [kWh/a]
$PEF_{Electricity}$	Primary Energy Factor for electricity [dmnl]

Standardized Calculation Values

No calculation values available for this methodology.

Table 71 – Indicative values for calculation of primary energy savings

Parameter	Value	Unit
$PEF_{Electricity}$		

6.2.3 Calculation of Greenhouse Gas Savings

Formula

$$GHGSAV = TFES \times f_{GHG,electricity} \times 10^{-6} \tag{57}$$

Standardized Calculation Values

Table 72 – Parameters used in the formula for greenhouse gas savings

Parameter	Description
GHGSAV	Greenhouse gas savings [t CO_2 p.a.]
TFES	Total final energy savings [kWh/a]
$f_{GHG,electricity}$	Emission factor for electricity [g CO_2/kWh]

6.2.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

6.2.5 Methodological Aspects

The principle of calculation is based on the difference in power requirements of the old lighting system and the new LED lighting system.

The Hungarian Energy and Public Utility Regulatory Authority (MEKH) is the regulatory body of the energy and public utility market, supervising the national economy's sectors of strategic importance. The MEKH has established and reviews each year the EEOS catalogue, which lists the types of energy efficiency measures or investments that can be accounted in a simplified way. This Catalogue is published as the Annex of **17/2020.(XII. 21.) MEKH Decree** on data reporting on end-use energy savings.

Each catalogue sheet contains a description of the energy efficiency measure; the method and content of recording the baseline and post-measure status; the eligible lifetime and the level of degradation; a description of the performance factors and the principles for their calculation, the formula for calculating the annual savings; the documents to be submitted and other relevant information to support the accounting. For the time being, the catalogue contains 51 sheets in 5 categories.

All documents are available in Hungarian language.

6.2.6 Bibliography

The Hungarian Energy and Public Utility Regulatory Authority (2020): *17/2020.(XII. 21.) MEKH Decree on data reporting on end-use energy savings*, https://njt.hu/jogszabaly/2020-17-20-5Z

6.3. Italy - White Certificate: Operational Guide: Public lighting

The method is an operational guide for "White Certificates" (Certificati Bianchi) by GSE (Gestore Servizi Energetici). It focuses on public lighting in Italy.

A new public lighting system must guarantee compliance with the minimum performance requirement set out in UNI 13201, for each lighting category defined in UNI 11248.
The lighting system installed must also reach the minimum efficiency after ministerial decree of 27 September 2017 ss.mm.ii. "Minimum environmental criteria for the acquisition of public lighting equipment, the entrusting of the design service public lighting installations".

6.3.1 Calculation of Final Energy Savings

Formula

The definition of the baseline starts from the analysis of the actual state. In particular, a value of power absorbed by the system must be identified starting from the number, type and power of the lamps and lightings installed and the efficiency of any ballasts present in the pre-intervention condition. In the case of the new installation of a lighting system, the baseline value shall refer to the standard technology that can currently be installed, i.e. high-pressure sodium vapor lamps that have a luminous efficiency value (lumens/W) equal to or greater than the value indicated in EC Regulation 245/2009 and subsequent amendments and additions for the specific type of lamp examined.

This formula calculates yearly savings.

$$AES = [(P_{baseline} \times h_{post}) - (E_{post} \times Agg_{lux})] \times Add_{norm} \times 0{,}187 \times 10^{-3}[\,tep] \times rb \times so \times fr \qquad (58)$$

Rebound (rb), spill-over (so) and free-rider (fr) effects are not taken into account in the formula.

For calculating the number of equivalent operating hours, the following formula is used:

$$h_{post} = \frac{E_{post}}{P_{post}} \qquad (59)$$

The calculation of the Additional Energy Savings (AES) must be implemented at the individual meter level. The calculation sheet must therefore contain a summary table containing only the data necessary for calculating the savings.

Table 73 – Parameters used in the formula for final energy savings

Parameter	Description
AES	Additional Energy Savings
$P_{baseline}$	Nominal installed power (from the technical data sheet) of the lamps and/or lightings present in the pre-intervention situation (possibly including the absorptions due to the ballasts), to be compared with the measurements transmitted relative to the pre-intervention situation. In the case new installation, $Pbaseline$ is the power of the reference lamps and/or lightings
h_{post}	Number of equivalent operating hours of the lamps and/or lightings in the postintervention situation
E_{post}	Electrical energy measured in the post-intervention situation
Agg_{lux}	Lighting adjustment coefficient. It must be taken into account in the case of lower luminance/illuminance levels under post-intervention conditions compared to baseline conditions. This coefficient, greater than or equal to the unit value, is determined as the ratio between luminance/illuminance in the baseline and post-intervention situation and is necessary to ensure that savings are alculated for the same illuminance conditions
Add_{norm}	Normative additionality coefficient. It is used when luminance/illuminance requirements are not met under pre-intervention conditions. Therefore, through this parameter quantifies, in terms of the reduction in energy savings achievable through the project, the part of the intervention that is an adaptation to the luminance/illuminance requirements of the standard. This coefficient, less than or equal to the unit value and multiplicative of the total savings calculated, is defined by the ratio between the luminance/illuminance provided in the preintervention conditions and that foreseen by the reference standard.4 In cases where, following the risk analysis, a downgrading of the road category is carried out between the pre-intervention situation and the post-intervention situation, the minimum illuminance level to be considered for the purposes of verifying compliance with the luminance/illuminance requirements foreseen by the standard, is that referring to the new category identified.
P_{post}	Nominal installed power (from the technical data sheet) of the lamps and/or lightings present in the post-intervention situation (possibly including the absorptions due to the ballasts)

Standardized Calculation Values

No calculation values available for this methodology.

Table 74 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
rb	1	-
so	1	-
fr	1	-

6.3.2 Calculation of Primary Energy Savings

There is no information regarding primary energy savings calculations available.

Co-funded by the
European Union

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

6.3.3 Calculation of Greenhouse Gas Savings

There is no information regarding the greenhouse gas savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

6.3.4 Overview of Costs Related to the Action

Cost-Effectiveness

No information on cost-effectiveness available for this methodology.

Standardized Values

No calculation values available for this methodology.

6.3.5 Methodological Aspects

The methodology and formulas have been taken from the published document of GSE – Gestore Servizi Energetici. GSE is a state-owned company. GSE has a significant role in promoting sustainable development and managing incentives to support the production of electricity from renewable sources and improve energy efficiency.

The document is a guide on public lighting as part of the "White Certificates" (Certificati Bianchi). These certificates are an incentive mechanism to promote energy efficiency.

The initial language of the document is Italian. The original document is available under:

https://www.gse.it/servizi-per-te/efficienza-energetica/certificati-bianchi/documenti (included in CERTIFICATI BIANCHI All. 2 Guide settoriali)

6.3.6 Bibliography

GSE - Gestore Servizi Energetici: CERTIFICATI BIANCHI - Allegato 2.8 alla Guida Operativa. Guide Settoriali ILLUMINAZIONE PUBBLICA. (2022). https://www.gse.it/servizi-per-te/efficienza-energetica/certificati-bianchi/documenti (included in CERTIFICATI BIANCHI All. 2 Guide settoriali)

6.4. Italy - White Certificate: Operational Guide: Lighting in private sector

The method is an operational guide for "White Certificates" (Certificati Bianchi) by GSE (Gestore Servizi Energetici). It focuses on lighting in the private sector.

The new lighting system must guarantee compliance with the minimum illuminance levels laid down by the UNI EN 12464 standard, for each area subject to intervention.
The lamps to be installed in the postintervention situation must have an efficiency class at least equal class "D", according to the provisions of Regulation (EU) 2019/2015 and subsequent amendments and integrations.

6.4.1 Calculation of Final Energy Savings

Formula

The definition of the baseline, therefore, starts from the analysis of the actual state. In particular, a nominal power value of the system must be identified starting from the number, type and power of the lamps and/or lightings installed, and the efficiency of any ballasts present in the pre-intervention condition. In the case of the new installation of a lighting system, the reference consumption value shall refer to the standard technology currently installed for example:

- *fluorescent lamps* (for offices and other civil interiors)
- *high-pressure sodium vapour lamps* (for outdoor areas)

This formula calculates yearly savings.

$$AES = [(P_{baseline} \times h_{post}) - (E_{post} \times Agg_{lux})] \times Add_{norm} \times 0{,}187 \times 10^{-3}[\,tep] \times rb \times so \times fr \qquad (60)$$

Rebound, spill-over and free-rider effects are not taken into account in the formula.

For calculating the number of equivalent operating hours, the following formula is used:

$$h_{post} = \frac{E_{post}}{P_{post}} \qquad (61)$$

Table 75 – Parameters used in the formula for final energy savings

Parameter	Description
AES	Additional Energy Savings
$P_{baseline}$	Nominal installed power (from the technical data sheet) of the lamps and/or lightings present in the pre-intervention situation (possibly including the absorptions due to the ballasts), to be compared with the measurements transmitted relative to the pre-intervention situation. In the case new installation, $Pbaseline$ is the power of the reference lamps and/or lightings
h_{post}	Number of equivalent operating hours of the lamps and/or luminaires in the postintervention situation
E_{post}	Electrical energy measured in the post-intervention situation
Agg_{lux}	Lighting adjustment coefficient. It must be taken into account in the case of lower luminance/illuminance levels under post-intervention conditions compared to baseline conditions. This coefficient, greater than or equal to the unit value, is determined as the ratio between uminance/illuminance in the baseline and post-intervention situation and is necessary to ensure that savings are calculated for the same illuminance conditions
Add_{norm}	Normative additionality coefficient. It is used when luminance/illuminance requirements are not met under pre-intervention conditions. Therefore, through this parameter quantifies, in terms of the reduction in energy savings achievable through the project, the part of the intervention that is an adaptation to the luminance/illuminance requirements of the standard. This coefficient, less than or equal to the unit value and multiplicative of the total savings calculated, is defined by the ratio between the luminance/illuminance provided in the preintervention conditions and that foreseen by the reference standard.4 In cases where, following the risk analysis, a downgrading of the road

	category is carried out between the pre-intervention situation and the post-intervention situation, the minimum illuminance level to be considered for the purposes of verifying compliance with the luminance/illuminance requirements foreseen by the standard, is that referring to the new category identified.
P_{post}	Nominal installed power (from the technical data sheet) of the lamps and/or lightings present in the post-intervention situation (possibly including the absorptions due to the ballasts)

Standardized Calculation Values

No calculation values available for this methodology.

Table 76 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
rb	1	-
so	1	-
fr	1	-

6.4.2 Calculation of Primary Energy Savings

There is no information regarding primary energy savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

6.4.3 Calculation of Greenhouse Gas Savings

There is no information regarding the greenhouse gas savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

6.4.4 Overview of Costs Related to the Action

Cost-Effectiveness

No information on cost-effectiveness available for this methodology.

Standardized Values

No calculation values available for this methodology.

6.4.5 Methodological Aspects

The methodology and formulas have been taken from the published document of GSE – Gestore Servizi Energetici. GSE is a state-owned company. GSE has a significant role in promoting sustainable development and managing incentives to support the production of electricity from renewable sources and improve energy efficiency.

The document is a guide on public lighting as part of the "White Certificates" (Certificati Bianchi). These certificates are an incentive mechanism to promote energy efficiency.

The initial language of the document is Italian. The original document is available under:

https://www.gse.it/servizi-per-te/efficienza-energetica/certificati-bianchi/documenti (included in CERTIFICATI BIANCHI All. 2 Guide settoriali)

6.4.6 Bibliography

GSE - Gestore Servizi Energetici: CERTIFICATI BIANCHI - Allegato 2.9 alla Guida Operativa. Guide Settoriali ILLUMANZIONE PRIVATA Progetto a Consuntivo. (2022).
https://www.gse.it/servizi-per-te/efficienza-energetica/certificati-bianchi/documenti (included in CERTIFICATI BIANCHI All. 2 Guide settoriali)

6.5. Italy - White Certificate: Operational Guide: Public lighting systems with LED

The method is an operational guide for "White Certificates" (Certificati Bianchi) by GSE (Gestore Servizi Energetici). It focuses on public lighting systems with LED in Italy.

The new public lighting system must guarantee compliance with the minimum performance requirements set out in UNI 13201, for each lighting category defined in UNI 11248.
The lighting system installed must also reach the minimum efficiency after ministerial decree of 27 Spetmber 2017 ss.mm.ii. "Minimum environmental criteria for the acquisition of public lighting equipment, the entrusting of the design service public lighting installations".

6.5.1 Calculation of Final Energy Savings

Formula

The definition of the baseline therefore starts from the analysis of the pre-intervention situation. In particular a value of power absorbed by the plant must be identified from the numerosity, type and power of lamps installed, and the efficiency of any ballasts present in the baseline condition.

Compliance with the UNI 13201 standard, regarding minimum luminance/illuminance levels for the baseline situation, must then be evaluated through transmission of baseline lighting calculations. Should compliance with the minimum illuminance levels not be guaranteed in the pre-intervention conditions, the proposer shall adopt a regulatory additionality coefficient equal to the ratio between the pre-intervention illuminance levels and the minimum illuminance level envisaged by the standard.

This formula calculates yearly savings.

$$AES = [(P_{baseline} \times Add_{tec} \times h_{post}) - (E_{post} \times Agg_{lux})] \times Add_{norm} \times 0{,}187 \times 10^{-3}[\,tep] \times rb \times so \times fr \qquad (62)$$

Rebound, spill-over and free-rider effects are not taken into account in the formula.

For calculating the number of equivalent operating hours, the following formula is used:

$$h_{post} = \frac{E_{post}}{P_{post}} \qquad (63)$$

Table 77 – Parameters used in the formula for final energy savings

Parameter	Description
AES	Additional Energy Savings
$P_{baseline}$	Nominal installed power (from the technical data sheet) of the lamps and/or lightings present in the pre-intervention situation (possibly including the absorptions due to the ballasts), to be compared with the measurements

	transmitted relative to the pre-intervention situation. In the case new installation, $Pbaseline$ is the power of the reference lamps and/or lightings
Add_{tec}	Coefficient of technological additionality. It as to be taken into account if under preintervention conditions the lamps have a lower minimum efficacy (lumens/W) than minimum efficacy required by Regulation (EU) 2019/2020 as amended for vapour lamps high-pressure sodium, which is the standard technology currently installed. coefficient, less than or equal to the unit value, is determined as the ratio between the luminous efficacy of the lamps in the pre-intervention situation and the minimum luminous efficacy required.
h_{post}	Number of equivalent operating hours of the lamps and/or lightings in the postintervention situation
E_{post}	Electrical energy measured in the post-intervention situation
Agg_{lux}	Lighting adjustment coefficient. It must be taken into account in the case of lower luminance/illuminance levels under post-intervention conditions compared to baseline conditions. This coefficient, greater than or equal to the unit value, is determined as the ratio between uminance/illuminance in the baseline and post-intervention situation and is necessary to ensure that savings are calculated for the same illuminance conditions
Add_{norm}	Normative additionality coefficient. It is used when luminance/illuminance requirements are not met under pre-intervention conditions. Therefore, through this parameter quantifies, in terms of the reduction in energy savings achievable through the project, the part of the intervention that is an adaptation to the luminance/illuminance requirements of the standard. This coefficient, less than or equal to the unit value and multiplicative of the total savings calculated, is defined by the ratio between the luminance/illuminance provided in the preintervention conditions and that foreseen by the reference standard.4 In cases where, following the risk analysis, a downgrading of the road category is carried out between the pre-intervention situation and the post-intervention situation, the minimum illuminance level to be considered for the purposes of verifying compliance with the luminance/illuminance requirements foreseen by the standard, is that referring to the new category identified.
P_{post}	Nominal installed power (from the technical data sheet) of the lamps and/or lightings present in the post-intervention situation (possibly including the absorptions due to the ballasts)

It should be noted that the different coefficients in the algorithm are to be calculated as a weighted average over the total power of the lamps subtended by each meter:

- the coefficient Agg_{lux} must be weighted with respect to the nominal post-intervention power output
- the coefficient Add_{norm} must be weighted against the difference between baseline and postintervention power ratings
- the coefficient Add_{tec} must be weighted against the nominal baseline power

It should also be noted that even in the case of a downgrading of road categories between the preintervention and post-intervention situation, the lower luminance/illuminance level in the post-intervention conditions must be taken into account through application of the coefficient Agg_{lux}.

Standardized Calculation Values

No calculation values available for this methodology.

Table 78 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
rb	1	-
so	1	-
fr	1	-

6.5.2 Calculation of Primary Energy Savings

There is no information regarding primary energy savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

6.5.3 Calculation of Greenhouse Gas Savings

There is no information regarding the greenhouse gas savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

6.5.4 Overview of Costs Related to the Action

Cost-Effectiveness

No information on cost-effectiveness available for this methodology.

Standardized Values

No calculation values available for this methodology.

6.5.5 Methodological Aspects

The methodology and formulas have been taken from the published document of GSE – Gestore Servizi Energetici. GSE is a state-owned company. GSE has a significant role in promoting sustainable development and managing incentives to support the production of electricity from renewable sources and improve energy efficiency.

The document is a guide on public lighting as part of the "White Certificates" (Certificati Bianchi). These certificates are an incentive mechanism to promote energy efficiency.

The initial language of the document is Italian. The original document is available under:

https://www.gse.it/servizi-per-te/efficienza-energetica/certificati-bianchi/documenti (included in CERTIFICATI BIANCHI All. 2 Guide settoriali)

6.5.6 Bibliography

GSE - Gestore Servizi Energetici: CERTIFICATI BIANCHI - Allegato 2.10 alla Guida Operativa. Guide SISTEMI DI ILLUMANZIONE PUBBLICA A LED. Progetto Standardizzato. (2022). https://www.gse.it/servizi-per-te/efficienza-energetica/certificati-bianchi/documenti (included in CERTIFICATI BIANCHI All. 2 Guide settoriali)

6.6. Italy - White Certificate: Operational Guide: Lighting in private sector with LED

The method is an operational guide for "White Certificates" (Certificati Bianchi) by GSE (Gestore Servizi Energetici). It focuses in private sector lighting with LED in Italy.

The new lighting system must guarantee compliance with the minimum illuminance levels laid down by the UNI EN 12464 standard, for each area subject to intervention.
For the purposes of access to the White Certificates mechanism, the LED lamps to be installed in the postintervention situation must have an efficiency class at least equal class "D", according to the provisions of Regulation (EU) 2019/2015 and subsequent amendments and integrations. It is specified that, for those lighting products that are excluded from the scope of application of Regulation (EU) 2019/2015 and ss.mm.ii., compliance with this requirement is not required.

6.6.1 Calculation of Final Energy Savings

Formula

The definition of the baseline therefore starts from the analysis of the actual state. In particular, a nominal power value of the system must be identified starting from the number, type and power of the lamps installed and the efficiency of any ballasts present in the pre-intervention condition. In the case of the new installation of a lighting system, the baseline value will be referred to the standard technology currently installed:

- fluorescent lamps (for offices and other civil interiors)
- high-pressure sodium vapour lamps (for outdoor areas)

The reference lamps listed above must comply with Regulation (EU) 2019/2020 and subsequent

amendments, i.e. they must have an efficacy value (lumens/W) equal to or greater than the minimum value required by Regulation (EU) 2019/2020 and subsequent amendments for the specific type of lamp examined.

Compliance with the UNI EN 12464 standard regarding minimum illuminance levels for the pre-intervention or baseline situation must then be assessed. This respect must be demonstrated by providing the lighting engineering calculations of the baseline situation that, in the case of a new installation, must refer to the standard technology that can currently be installed, considering the same points of installation of the luminaires as those of the post-intervention configuration. Should compliance with the minimum illuminance levels not be guaranteed, the proposer shall adopt a regulatory additionality coefficient equal to the ratio between the pre-intervention illuminance levels and the minimum illuminance level envisaged by the regulations.

The formula calculates yearly savings.

$$AES = [(P_{baseline} \times h_{post} \times Add_{tec}) - (E_{post} \times Agg_{lux})] \times Add_{norm} \times 0{,}187 \times 10^{-3}[\,tep] \times rb \times so \times fr \qquad (64)$$

Rebound, spill-over and free-rider effects are not taken into account in the formula.

For calculating the number of equivalent operating hours, the following formula is used:

$$h_{post} = \frac{E_{post}}{P_{post}} \qquad (65)$$

Table 79 – Parameters used in the formula for final energy savings

Parameter	Description
AES	Additional Energy Savings
$P_{baseline}$	Nominal installed power (from the technical data sheet) of the lamps and/or lightings present in the pre-intervention situation (possibly including the absorptions due to the ballasts), to be compared with the measurements transmitted relative to the pre-intervention situation. In the case new installation, $Pbaseline$ is the power of the reference lamps and/or lightings
Add_{tec}	Coefficient of technological additionality. It as to be taken into account if under preintervention conditions the lamps have a lower minimum efficacy (lumens/W) than minimum efficacy required by Regulation (EU) 2019/2020 as amended for vapour lamps high-pressure sodium, which is the standard technology currently installed. coefficient, less than or equal to the unit value, is determined as the ratio between the luminous efficacy of the lamps in the pre-intervention situation and the minimum luminous efficacy required.
h_{post}	Number of equivalent operating hours of the lamps and/or lightings in the postintervention situation
E_{post}	Electrical energy measured in the post-intervention situation
Agg_{lux}	Lighting adjustment coefficient. It must be taken into account in the case of lower luminance/illuminance levels under post-intervention conditions compared to baseline conditions. This coefficient, greater than or equal to the unit value, is determined as the ratio between luminance/illuminance in the baseline and post-intervention situation and is necessary to ensure that savings are calculated for the same illuminance conditions
Add_{norm}	Normative additionality coefficient. It is used when luminance/illuminance requirements are not met under pre-intervention conditions. Therefore, through this parameter quantifies, in terms of the reduction in energy savings achievable through the project, the part of the intervention that is an adaptation to the luminance/illuminance requirements of the standard. This coefficient, less than or equal to the unit value and multiplicative of the total savings calculated, is defined by the ratio between the luminance/illuminance provided in the preintervention conditions and that foreseen by the reference standard.4 In cases where, following the risk analysis, a downgrading of the road category is carried out between the pre-intervention situation and the post-intervention situation, the minimum illuminance level to be considered for the purposes of verifying compliance with the luminance/illuminance requirements foreseen by the standard, is that referring to the new category identified.
P_{post}	Nominal installed power (from the technical data sheet) of the lamps and/or lightings present in the post-intervention situation (possibly including the absorptions due to the ballasts)

the different coefficients in the algorithm are to be calculated as a weighted average over the total power of the lamps subtended by each meter:

- the coefficient Agg_{lux} must be weighted in relation to the nominal post-intervention power output;
- the coefficient Add_{norm} must be weighted against the difference between baseline and postintervention power ratings
- the coefficient Add_{tec} must be weighted against the nominal baseline power.

Standardized Calculation Values

No calculation values available for this methodology.

Table 80 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
rb	1	-
so	1	-
fr	1	-

6.6.2 Calculation of Primary Energy Savings

There is no information regarding primary energy savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

6.6.3 Calculation of Greenhouse Gas Savings

There is no information regarding the greenhouse gas savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

6.6.4 Overview of Costs Related to the Action

Cost-Effectiveness

No information on cost-effectiveness available for this methodology.

Standardized Values

No calculation values available for this methodology.

6.6.5 Methodological Aspects

The methodology and formulas have been taken from the published document of GSE – Gestore Servizi Energetici. GSE is a state-owned company. GSE has a significant role in promoting sustainable development and managing incentives to support the production of electricity from renewable sources and improve energy efficiency.

The document is a guide on public lighting as part of the "White Certificates" (Certificati Bianchi). These certificates are an incentive mechanism to promote energy efficiency.

The initial language of the document is Italian. The original document is available under:

https://www.gse.it/servizi-per-te/efficienza-energetica/certificati-bianchi/documenti (included in CERTIFICATI BIANCHI All. 2 Guide settoriali)

6.6.6 Bibliography

GSE - Gestore Servizi Energetici: CERTIFICATI BIANCHI - Allegato 2.11 alla Guida Operativa. Guide Settoriali SISTEM DI ILLUMANZIONE PRIVATA A LED Progetto Standardizzato. (2022). https://www.gse.it/servizi-per-te/efficienza-energetica/certificati-bianchi/documenti (included in CERTIFICATI BIANCHI All. 2 Guide settoriali)

6.7. Latvia - Methodological Guidelines for Energy Savings Reporting and Calculation

This methodology outlines the calculation of energy savings from replacing inefficient lighting with LED or energy-saving lamps in residential buildings and catering establishments and hotels. In residential buildings, the primary objective is to reduce household electricity consumption and lower energy costs, while in catering establishments and hotels, the focus is on improving operational efficiency, reducing energy expenses, and supporting sustainability efforts.

6.7.1 Calculation of Final Energy Savings

The energy savings are determined based on the difference in power consumption between old and new lamps, the number of lamps replaced, and their annual operating hours. Total energy savings over the lifetime of the lighting upgrade are calculated by multiplying annual savings by the expected lifespan of the new lamps, ensuring a standardized assessment of energy efficiency improvements.

Formula

This formula calculates cumulative savings from using efficient lighting technologies in residential buildings, catering establishments, and hotels:

$$TFES = \frac{(P_{old} - P_{new}) \times n \times h}{1000} \times y \times rb \times so \times fr \qquad (66)$$

Table 81 – Parameters used in the formula for calculating energy savings from lighting replacement in residential buildings or catering establishments and hotels

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
P_{old}	Average power of an existing lamp [W]
P_{new}	Average power of the new (effective) lamp [W]
n	Number of lamps replaced [-]
h	Annual usage [h/year]
y	The lifetime of the measure [-]
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 82 – Indicative values for calculation of final energy savings from lighting replacement in residential buildings or catering establishments and hotels

Parameter	Value	Unit
P_{old}	60	W
P_{new}	15	W
h (annual usage in residential buildings)	1460	h
h (annual usage catering buildings and hotels)	2920	h
y (the lifetime of the measure in residential buildings)	4	years
y (the lifetime of the measure in catering buildings and hotels)	3	years

Co-funded by the
European Union

6.7.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

6.7.3 Calculation of Greenhouse Gas Savings

No information on calculation of greenhouse gas savings for this methodology.

6.7.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

6.7.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

6.7.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

6.8. Latvia - Methodology for Calculating the Energy Saved by Using More Efficient Lighting Technologies in Non-Residential Buildings

This methodology outlines the calculation of final energy savings from the use of efficient lighting technologies in non-residential buildings. It is based on the ex-ante estimation method and standardized parameters provided in the State Construction Control Bureau's Energy Savings Catalogue.

6.8.1 Calculation of Final Energy Savings

Formula

This formula calculates final energy savings from using efficient lighting technologies in non-residential buildings:

$$TFES = \frac{a \times (P_{old} - P_{new} \times k) \times h}{1000} \times y \times rb \times so \times fr \qquad (67)$$

Table 83 – Parameters used in the formula for calculating energy savings from using efficient lighting technologies in non-residential buildings

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
a	Office building area for lighting system modernization [m²]
P_{old}	Installed lighting power per square meter before replacement [W/m2]
P_{new}	Installed lighting power per square meter after replacement [W/m2]
h	Annual usage [h/year]
k	Implemented additional measures coefficient (partial reduction or dimming of lighting; interval timer; motion sensor; automatic adaptation to daylight) [-]

y	The lifetime of the measure [-]
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 from using efficient lighting technologies in non-residential buildings

Parameter	Value	Unit
P_{old}	15	W/m^2
P_{new}	5	W/m^2
h	2400	h
k (if accompanying measures have been implemented: partial reduction or dimming of lighting; interval timer; motion sensor; automatic adaptation to daylight, if not k = 1)	0,8	-
y	15	years

6.8.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

6.8.3 Calculation of Greenhouse Gas Savings

No information on calculation of greenhouse gas savings for this methodology.

6.8.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

6.8.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”: https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

6.8.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”. https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

6.9. Latvia - Methodology for Calculating the Energy Savings from Using More Efficient Street Lighting

This methodology provides a standardized approach to calculating final energy savings from implementing more efficient street lighting systems. It employs the ex-ante estimation method and uses default values provided in the State Construction Control Bureau's Energy Savings Catalogue.

6.9.1 Calculation of Final Energy Savings

Formula

This formula calculates final energy savings from using more efficient street lighting:

$$TFES = \frac{\left((n_{ne} \times P_{ne}) - (n_e \times P_e \times k)\right) \times h}{1000} \times y \times rb \times so \times fr \qquad (68)$$

Table 85 – Parameters used in the formula for calculating energy savings from using more efficient street lighting

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
n_{ne}	Number of light points of an energy-inefficient street lighting system [-]
n_e	Number of light points of an energy-efficient street lighting system [-]
P_e	Power of one light point in an energy-efficient system [W]
P_{ne}	Power of one light point in an energy-inefficient system [W]
h	Annual usage [h/year]
k	Implemented additional measures coefficient (reduction of lighting at night; full shutdown of lighting at night) [-]
y	The lifetime of the measure [-]
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 86 – Indicative values for calculation of final energy savings from using more efficient street lighting

Parameter	Value	Unit
P_e	30	W
P_{ne}	120	W
h	3200	h
k (if accompanying measures have been implemented: reduction of lighting at night; full shutdown of lighting at night, if not k = 1)	0,8	-
y	15	years

6.9.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

6.9.3 Calculation of Greenhouse Gas Savings

No information on calculation of greenhouse gas savings for this methodology.

6.9.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

Co-funded by the
European Union

6.9.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”: https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

6.9.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”. https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

6.10. Latvia - Methodology for Calculating Energy Savings with Efficient Lighting in Industrial Buildings

This methodology describes the calculation of energy savings achieved by replacing lighting systems with more efficient alternatives in industrial buildings. It uses an ex-ante approach based on default values outlined in the State Construction Control Bureau's Energy Savings Catalogue.

6.10.1 Calculation of Final Energy Savings

Formula

This formula calculates final energy savings from using more efficient lighting in industrial buildings:

$$TFES = \frac{(P_{old} - P_{new} \times k) \times n \times h}{1000} \times y \times rb \times so \times fr \tag{69}$$

Table 87 – Parameters used in the formula for calculating energy savings from using more efficient in industrial buildings

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
n	Number of lighting systems replaced [-]
P_{old}	Installed lighting power before replacement [W]
P_{new}	Installed lighting power after replacement [W]
h	Annual usage [h/year]
k	Implemented additional measures coefficient (interval timer; motion sensor; automatic adaptation to daylight) [-]
y	The lifetime of the measure [-]
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 88 – Indicative values for calculation of final energy savings from using more efficient in industrial buildings

Parameter	Value	Unit
P_{old}	80	W
P_{new}	20	W
h	2400	h
k (if accompanying measures have been implemented: interval timer; motion sensor; automatic adaptation to daylight, if not k = 1)	0,8	-
y	10	years

6.10.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

6.10.3 Calculation of Greenhouse Gas Savings

No information on calculation of greenhouse gas savings for this methodology.

6.10.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

6.10.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”: https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

6.10.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”. https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

6.11. Lithuania - Methodology for calculating the energy saved by using more efficient lighting technologies

Lighting energy savings play a crucial role in Lithuania's efforts to improve energy efficiency, reduce greenhouse gas emissions, and promote sustainable development. As lighting accounts for a significant portion of energy use in residential, commercial, and public buildings, modernizing lighting systems offers an accessible and cost-effective way to achieve substantial energy savings. By adopting energy-efficient technologies such as LED lighting and smart control systems, Lithuania can reduce electricity consumption, lower energy costs, and enhance the quality of indoor and outdoor lighting. These measures align with national energy efficiency targets, the EU Green Deal, and climate change mitigation goals, contributing to a cleaner and more sustainable future.

6.11.1 Calculation of Final Energy Savings

Formula

The formula for calculating lighting energy savings in buildings is based on comparing the energy consumption before and after the lighting modernization. This formula calculates first-year savings for replacement of lighting equipment indoors and / or outdoors:

$$TFES = \left(\left(N_{ref} \times P_{ref} \times t\right) - \left(N_{eff} \times P_{eff} \times t\right)\right) \times rb \times so \times fr \qquad (70)$$

Table 89 – Parameters used in the formula for calculating savings from replacement of lighting equipment indoors and / or outdoors

Parameter	Description
TFES	The total final energy saved by replacing indoors and / or outdoors equipment [kWh]
N_{ref}	Number of old (replaceable) / inefficient luminaires [-]
N_{eef}	Number of new / efficient luminaires [-]
P_{ref}	Power of old (replacement) / inefficient luminaire [kW]
P_{eff}	Power of new / efficient luminaire [kW]
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)
t	Annual operating time of the luminaire [h]

Standardized Calculation Values

The formula for the key contributor to electricity consumption in heated spaces in lighting, which varies throughout the year due to seasonal changes in daylight availability. This article presents a detailed analysis of calculated monthly electricity consumption for lighting in heated spaces. By examining consumption patterns across all months, optimization of energy use and enhancing energy efficiency strategies can be performed.

$$QE_{lg,m} = \frac{k_m}{25.89} \times 0.5 \times f_E \times \Psi_E \times \frac{1}{A_p} \times \sum_{x=1}^{n} \left(A_{p,x} \times \frac{15}{\eta_{E,x}}\right) \qquad (71)$$

The calculation of monthly electricity consumption for lighting in heated spaces is determined using multiple key parameters, provided in Table 2.

Table 90 – Parameters used in the formula for calculating monthly electricity consumption for lighting in heated spaces

Parameter	Description
$QE_{lg,m}$	Calculated monthly electricity consumption for lighting in heated spaces for each month [kWh/(m²·month)]
0.5	The portion of electricity from the total electricity consumption in the building's heated spaces used for lighting [-]
k_m	The coefficient that describes the use of electricity for room lighting in the corresponding month of the year (Table 2.19 of the Regulation STR 2.01.02:2016) [-]
25.89	Sum of month related to k_m coefficients [-]
f_E	The portion of electricity used in the building's heated spaces [-]

Parameter	Description
Ψ_E	The annual electricity consumption per unit of building area (Table 2.4 of the Regulation STR 2.01.02:2016) [kWh/(m²·year)]
$A_{p,x}$	The floor area of the building where the corresponding "x" lighting equipment is installed [m²]
$\eta_{E,x}$	The efficiency indicator of the corresponding "x" lighting equipment (this is taken from the technical documentation of the lighting equipment; if no data is available, it is taken from Table 11 of the Regulation STR 2.01.02:2016) [lm/W]

Table 91 – Indicative values for electricity consumption for room lighting (k_m) by different months

Parameter	Month of the year											
	1	2	3	4	5	6	7	8	9	10	11	12
k_m	3,1	2,52	2,06	1,73	1,51	1,41	1,45	1,63	1,92	2,33	2,9	3,33

Values of various indicators for buildings of different purposes.

Table 92 – Indicative values for consumption per unit of building area (Ψ_E) by purpose of buildings

Parameter (Ψ_E) – purpose of the building	Value	Unit
Residential buildings for single-family and two-family homes (houses)	20	kWh/(m²·year)
Other residential buildings (houses)	30	kWh/(m²·year)
Administrative buildings	20	kWh/(m²·year)
Educational buildings	10	kWh/(m²·year)
Healthcare buildings	30	kWh/(m²·year)
Catering buildings	30	kWh/(m²·year)
Commercial buildings	30	kWh/(m²·year)
Sports buildings, excluding swimming pools	10	kWh/(m²·year)
Swimming pools	60	kWh/(m²·year)
Cultural buildings	20	kWh/(m²·year)
Garage, manufacturing, and industrial buildings	20	kWh/(m²·year)
Warehousing buildings	6	kWh/(m²·year)
Hotel buildings	30	kWh/(m²·year)
Service buildings	20	kWh/(m²·year)
Transportation buildings	20	kWh/(m²·year)
Recreational buildings	10	kWh/(m²·year)
Special-purpose buildings	30	kWh/(m²·year)

Table 93 – Indicative values for efficiency indicator ($\eta_{E,x}$) by luminaire type

Parameter ($\eta_{E,x}$)	Value	Unit
Luminaires with incandescent lamps	15	lm/W
Luminaires with halogen or fluorescent lamps (including "energy-saving" lamps)	50	lm/W
Luminaires with light-emitting diode (LED) lamps	150	lm/W

6.11.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

6.11.3 Calculation of Greenhouse Gas Savings

No information on calculation of greenhouse gas savings for this methodology.

6.11.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

6.11.5 Methodological Aspects

The lighting energy-saving formula is recommended by the Lithuanian Energy Agency for calculating electricity savings from lighting when declaring energy savings under energy-saving agreements. This simplified formula is not mandatory and is only recommended for use when reporting savings.

The monthly electricity consumption for lighting in heated spaces is based on the official Construction Technical Regulations. Building modernization, including lighting systems, is primarily regulated by the document STR 2.01.02:2016 "Energy Performance of Buildings: Design and Certification": https://www.e-tar.lt/portal/lt/legalAct/2c182f10b6bf11e6aae49c0b9525cbbb/asr [in Lithuanian language]

6.11.6 Bibliography

1. Ministry of Environment of the Republic of Lithuania (2016). STR 2.01.02:2016 Energy Performance of Buildings: Design and Certification, No.: D1-754. Consolidated version 2024-05-01. Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/2c182f10b6bf11e6aae49c0b9525cbbb/asr

6.12. Poland - Green Investment Scheme – GIS. Part 6 – SOWA – Energy efficient street lighting

Reducing emission of carbon dioxide through co-financing projects improving energy efficiency of street lighting systems. The program supported projects until 2017.

6.12.1 Calculation of Final Energy Savings

Formula

Correction factors for the rebound, spill-over, and free-rider effects are not taken in the account.

This formula calculates first-year savings.

$$O_{GIS6} = \varepsilon * \sigma_{GIS6} \qquad (72)$$

Table 94 – Parameters used in the formula for final energy savings

Parameter	Description
O_{GIS6}	annual value for final energy savings [ktoe/year]
ε	emission benchmarks for electricity production (average for years 2008- 2010)
σ_{GIS6}	CO_2 emissions avoided under GIS 6, as declared by beneficiaries [toe/CO_2]

Standardized Calculation Values

No calculation values available for this methodology

6.12.2 Calculation of Primary Energy Savings

Calculation of Primary Energy Savings is not available. The calculation is done in final energy, but primary energy factors, which are set by legislation, can be used.

6.12.3 Calculation of Greenhouse Gas Savings

No calculation of greenhouse gas savings available for this methodology

6.12.4 Overview of Costs Related to the Action

No Overview of Costs Related available for this methodology

DGC (Dynamic Generation Cost) - Dynamic Generation Cost equals the price that allows for the achievement of discounted revenues equalling the discounted costs. In other words, the DGC indicator shows the technical cost of obtaining the ecological effect unit. The cost is expressed in PLN per ecological effect unit. The lower the indicator value, the more efficient the project is.

Formula

$$DGC = P_{EE} = \frac{\sum_{t=0}^{t=n} \frac{KI_t - \Delta KE_t}{(1+i)^t}}{\sum_{t=0}^{t=n} \frac{EE_t}{(1+i)^t}} \qquad (73)$$

Table 95 – Parameters used in the formula for final energy savings

Parameter	Description
KIt	Eligible investment costs incurred in a given year – t
ΔKEt	difference in operating costs incurred prior to modernisation and costs incurred in a given year – t; The operating costs before modernisation concern the year preceding the commencement of modernisation works bringing savings
i	discount rate (in decimal fraction)
t	year, values from 0 to n, where 0 is the year when first costs are incurred and n is the last year of running the installation
EEt	measure of ecological effect obtained in individual years in physical units. Ecological effect which is assigned the price pEE per physical unit (with the assumption that the price is fixed in the whole period of analysis)
pEE	price for physical unit of the ecological effect

Note: EE – ecological effect should be understood as reduction of CO_2 emission.

6.12.5 Methodological Aspects

No details provided.

6.12.6 Bibliography

Collective of authors. (2017). National Energy Efficiecny Action Plan for Poland. *Warsaw: Ministerstwo Klimatu i Środowiska*. Retrieved from: https://commission.europa.eu/publications/poland-draft-updated-necp-2021-2030_en

Collective of authors. (-). Green Investment Scheme (GIS). Retrieved from: https://www.gov.pl/attachment/f9fe17eb-d1b2-45a6-b944-9b8f78bc20c2

6.13. Slovakia - Highly efficient lighting

6.13.1 Calculation of Final Energy Savings

This measure is intended to make energy savings of electricity and scaling down the lighting system maintenance requirements. It focuses on reducing the energy consumption of the original lamps by replacing them with new ones. The activities includes: Replacement of original lamps, or light sources of the existing public lighting system for new, technically superior, less energy intensive lights or light sources; Addition of new technically advanced, less energy-demanding lamps; Light points of the public lighting system and supporting structures; Replacement or installation of new electrical switchboards;

Adjustment and installation of the controller, or public lighting monitoring system; Replacement and addition of cabling (not underground); Development of project documentation in the scope of lighting engineering study or lighting and technical measurement of the properties of the lighting system.

Formula

The calculation of energy savings is based on the cover sheet of the lighting-technical study. The method for calculating savings can be ex ante based on the expected savings (standard values of savings for each measure) or ex post based on measured savings (measurement before and after).

$$ÚS_{i\_plán} = \left(P_{pred} - P_{po}\right) \text{ x } N_s \, x \, h \qquad (74)$$

Table 96 – Parameters used in the formula for primary energy savings

Parameter	Description
$ÚS_{i\_plán}$	Planned final energy savings in the year of r of public lighting modernization [kWh/year]
P_{pred}	Electricity demand for lighting before modernization [kW/(lamp)]
P_{po}	Electricity demand for lighting after modernization [kW/(lamp)]
N_S	Number of lights
h	Hours of public lighting illumination per year

Standardized Calculation Values

Table 97 – Indicative values for calculation of primary energy savings

Parameter	Value	Unit
P_{pred}	0.291	kW/lamp
P_{po}	0.100	kW/lamp
h	3900	Number of hours

6.13.2 Methodological Aspects

All methods above refer to the Methodological tables for energy efficiency measures by sector for 2021-2030 (version 2023). The Slovak Methodological tables are very detailed and contain a detailed description of the policy measure in accordance with the requirements of Annex V of the EED (points 4 and 5 of Annex III of the Governance Regulation 2018/1999). The new Methodological tables contains in total 111 measures under a given financial mechanism.

The weblink for the document (in Slovak language):

https://www.economy.gov.sk/uploads/files/EirowzB0.pdf

7. Small-Scale Renewable Central Heating

7.1. Austria - Central heating in existing non-residential buildings (heat pumps, biomass boilers, district heating)

The methodology calculates the replacement of an existing system for the provision of space heating and hot water in a residential building. In the course of modernising the heating system, all technical precautions are taken to ensure optimum operation of the installed technologies (adjustment of radiators, hydraulic balancing, insulation of pipes).

The method is not applicable for:

- Heating systems without connection to the central heating distribution system (e.g. individual room heaters).
- Heat supply in newly constructed residential buildings.
- Heat generators that do not comply with the ecodesign requirements set out in Annex II of Regulation (EU) No. 813/2013 implementing Directive 2009/125/EG with regard to ecodesign requirements for space heaters and combination heaters, No. L 239 06.09.2013 p. 136 as amended.
- Heat generators that are operated with fossil fuels.

To apply the standard values for unrenovated buildings, the area-specific heating demand must be at least 40.7 kWh/m²a.

The installed heating systems must fulfil the following requirements for the application of this method, depending on the technology:

- Biomass boilers (logs, wood chips, pellets, etc.) must at least fulfil the boiler efficiencies at rated output in accordance with Ecolabel Guideline UZ 37.
- Heat pumps must at least fulfil the seasonal coefficients of performance (SCOP) in accordance with the EHPA quality criteria.

The application area of this method is private households Austria.

7.1.1 Calculation of Final Energy Savings

Formula

This formula calculates first year savings.

$$FES = n \times GFA \times (HD + HWHD) \times \left(EC_{Ref} - EC_{Eff}\right) \times rb \times so \times fr \qquad (75)$$

Rebound (rb), spill-over (so) and free-rider effects (fr) are not taken into account in the formula.

The calculation of final energy savings from energy efficiency measures in heating technologies and hot water preparation is based on the heating energy requirement. The conversion from useful energy (heating demand) to final energy (heating energy demand) is carried out using the so-called effort coefficient (EC).

The calculation for the effort coefficient is:

$$EC = \frac{HED}{HD + HWHD} \tag{76}$$

Table 98 – Parameters used in the formulas for final energy savings

Parameter	Description
FES	Final energy savings [kWh/a]
n	Number of detached houses or residential units [-]
GFA	Heated gross floor area per utilisation unit [m²]
HD	Area-specific heating demand [kWh/m²a]
HWHD	Area-specific hot water heat demand [kWh/m²a]
EC_{Ref}	Effort coefficient of the existing heating system [-]
EC_{Eff}	Effort coefficient of the efficient heating system [-]
EC	Effort coefficient of a heating system [-]
HED	Area-specific heating energy demand [kWh/m²a]

Standardized Calculation Values

In the following standard values, a distinction is made between the following use cases:

Building type:

- SFH: single-family
- MFH: multi-family house, large-volume residential building and other buildings for residential purposes (e.g. retirement homes, boarding schools)

Building standard:

- unrenovated
- renovated
- Assumed distribution between unrenovated and renovated

Technology:

- Air source heat pump
- Ground source heat pump (including direct vaporisation)
- Groundwater heat pump
- Biomass boilers (logs, wood chips, pellets)
- District heating connections.

Table 99 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
Lifetime per technology		
Air source heat pump	18	Years
Ground source heat pump	20	Years
Groundwater heat pump	20	Years
Biomass boiler	20	Years
District heating connections	30	Years
rb	1	-
so	1	-
fr	1	-

Table 100 – Heat supply in existing residential buildings - building and heating system parameters of unrenovated residential single-family (SFH) and multifamily houses (MFH)

Parameter	SFH	MFH	Unit
GFA	175	89	m^2
HD	158,9	98,7	kWh/m^2a
HWHD	7,7	10,2	kWh/m^2a
EC_{Ref}	1,66	1,70	-
EC_{Eff}			
Air source heat pump	-	-	-
Ground source heat pump	-	-	-
Groundwater heat pump	-	-	-
Biomass boiler	1,30	1,34	-
District heating connections	1,11	1,16	-

Table 101 – Heat supply in existing residential buildings - building and heating system parameters of renovated residential single-family (SFH) and multifamily houses (MFH)

Parameter	SFH	MFH	Unit
GFA	175	89	m^2
HD	56,0	40,7	kWh/m^2a
HWHD	7,7	10,2	kWh/m^2a
EC_{Ref}	2,11	2,42	-
EC_{Eff}			
Air source heat pump	0,32	0,42	-
Ground source heat pump	0,27	0,37	-
Groundwater heat pump	0,24	0,34	-
Biomass boiler	1,50	1,56	-
District heating connections	1,25	1,35	-

7.1.2 Calculation of Primary Energy Savings

There is no information regarding primary energy savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

7.1.3 Calculation of Greenhouse Gas Savings

There is no information regarding the greenhouse gas savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

7.1.4 Overview of Costs Related to the Action

Cost-Effectiveness

No information on cost-effectiveness available for this methodology.

Standardized Values

No calculation values available for this methodology.

7.1.5 Methodological Aspects

The methodology and formulas have been taken from an officially published legal document – it is a regulation of the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology on specifying the assessment and eligibility of energy efficiency measures. The initial language of the document is German.

The original document is available under:
https://www.ris.bka.gv.at/eli/bgbl/II/2024/28

7.1.6 Bibliography

Verordnung der Bundesministerin für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie: Konkretisierung der Bewertung und Anrechenbarkeit von Energieeffizienzmaßnahmen (Energieeffizienz-Maßnahmenverordnung – EEff-MV), BGBl. II Nr. 28/2024 (2024). https://www.ris.bka.gv.at/eli/bgbl/II/2024/28

7.2. Austria - Central heating in existing residential buildings (heat pumps, biomass boilers, district heating)

The methodology calculates the replacement of an existing system for the provision of space heating and hot water in a non-residential building. The building envelope remains unchanged.

While modernising the heating system, all technical precautions are taken to ensure optimum operation of the installed technologies (adjustment of radiators, hydraulic balancing, insulation of pipes). The application area of this method is non-residential buildings in Austria.

In addition to the basic requirements, the following verifications are required for the application of this method:

- Gross floor area and heating requirement of the utilisation units.
- Brand and model name of the installed heat generators.

The method is not applicable for:

- Heating systems without connection to the central heating distribution system (e.g. individual room heaters).
- Heat supply in newly constructed non-residential buildings.
- Heat generators that do not fulfil the ecodesign requirements in accordance with Annex II of Regulation (EU) No. 813/2013 as amended.
- Heat generators that are operated with fossil fuels.

7.2.1 Calculation of Final Energy Savings

Formula

This formula calculates yearly savings.

$$FES = n \times GFA \times (HD + HWHD) \times (EC_{Ref} - EC_{Eff}) \times rb \times so \times fr \quad (77)$$

Rebound (rb), spill-over (so) and free-rider (fr) effects are not taken into account in the formula.

The calculation of final energy savings from energy efficiency measures in heating technologies and hot water preparation is based on the heating energy requirement. The conversion from useful energy (heating demand) to final energy (heating energy demand) is carried out using the so-called effort coefficient (EC).

The calculation for the effort coefficient is:

$$EC = \frac{HED}{HD + HWHD} \tag{78}$$

Table 102 – Parameters used in the formulas for final energy savings

Parameter	Description
FES	Final energy savings [kWh/a]
n	Number of utilisation units in non-residential buildings [-]
GFA	Heated gross floor area per utilisation unit [m²]
HD	Area-specific heating demand [kWh/m²a]
HWHD	Area-specific hot water heat demand [kWh/m²a]
EC_{Ref}	Effort coefficient of the existing heating system [-]
EC_{Eff}	Effort coefficient of the efficient heating system [-]
EC	Effort coefficient of a heating system [-]
HED	Area-specific heating energy demand [kWh/m²a]

Standardized Calculation Values

In the following standard values, a distinction is made between the following use cases / technology:

- Air source heat pump
- Ground source heat pump
- Groundwater heat pump.
- Biomass boilers (logs, wood chips, pellets).
- District heating connections.

Table 103 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
Lifetime per technology		
Air source heat pump	18	Years
Ground source heat pump	20	Years
Groundwater heat pump	20	Years
Biomass boiler	20	Years
District heating connections	30	Years
GFA	Real value	m²
HD	Real value	kWh/m²a
HWHD	Real value	kWh/m²a
EC_{Ref}	Real value	-
Air source heat pump	Real value	-
Ground source heat pump	Real value	-
Groundwater heat pump	Real value	-
Biomass boiler	Real value	-
District heating connections	Real value	-
rb	1	-
so	1	-
fr	1	-

7.2.2 Calculation of Primary Energy Savings

There is no information regarding primary energy savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

7.2.3 Calculation of Greenhouse Gas Savings

There is no information regarding the greenhouse gas savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

7.2.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

Cost-Effectiveness

No formula available for this methodology.

Standardized Values

No calculation values available for this methodology.

7.2.5 Methodological Aspects

The methodology and formulas have been taken from an officially published legal document – it is a regulation of the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology on specifying the assessment and eligibility of energy efficiency measures. The initial language of the document is German.

The original document is available under:
https://www.ris.bka.gv.at/eli/bgbl/II/2024/28

7.2.6 Bibliography

Verordnung der Bundesministerin für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie: Konkretisierung der Bewertung und Anrechenbarkeit von Energieeffizienzmaßnahmen (Energieeffizienz-Maßnahmenverordnung – EEff-MV), BGBl. II Nr. 28/2024 (2024). https://www.ris.bka.gv.at/eli/bgbl/II/2024/28

7.3. Croatia - Heat pumps

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.

To calculate the savings, it is necessary to know the data on the heat pump performance (air-to-water, water-to-water, ground-to-water) and, if known, the seasonal efficiency factor. If the seasonal efficiency factor is not known, a certain reference value of the seasonal efficiency factor is selected based on the heat pump performance.

For the specific annual heat needs of the building and the energy needs for the preparation of DHW, reference values in residential buildings and service sector buildings can be used.

It is necessary to know the data on the useful area of the building and the amount of energy provided from other sources in the building (e.g. solar collectors, biomass boilers, fossil fuel boilers). If the amount is not known, $\Delta E_{other} = 0$ is entered.

The documentation that must be attached/possessed as evidence of the implementation of the measure and verification of the input data for the calculation of savings is as follows:

- report on the energy audit of the building (with the building energy certificate) or
- report on the regular inspection of the space heating system (if the nominal thermal power is > 70 kW) or
- project documentation showing the following data:
    - specific annual thermal energy required for heating,
    - specific annual thermal energy required for the preparation of domestic hot water (DHW),
    - useful surface area of the heated part of the building, which is supplied with thermal energy from the heat pump,
    - technical data of the selected heat pump and possibly other sources of thermal energy
- a bill of quantities certified and paid by the client for heat pumps with a nominal thermal power of up to 30 kW, which contains information on the efficiency of the heat pump, or
- final expert supervision report on the completion of the project for a new installation of a heat pump with a nominal power above 30 kW or replacement of the existing heating system and domestic hot water system with a heat pump with a nominal power of over 30 kW, which contains information on the efficiency of the heat pump.

7.3.1 Calculation of Final Energy Savings

Formula

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:**

$$UFES = \left(\frac{1}{\eta_{average}} - \frac{1}{SPF}\right) \times (SHD + SWD - \Delta E_{other}) \times A \qquad (79)$$

$$FES = \sum_{i=1}^{n} UFESi \tag{80}$$

Table 104 – Parameters used in the formula

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

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:

All energy savings:

$$UFES = (\frac{1}{\eta_{init}} - \frac{1}{SPF}) \times (SHD + SWD - \Delta E_{other}) \times A \tag{81}$$

Extra energy savings:

$$UFES = (\frac{1}{\eta_{average}} - \frac{1}{SPF}) \times (SHD + SWD - \Delta E_{other}) \times A \tag{82}$$

Total energy savings:

$$FES = \sum_{i=1}^{n} UFESi \tag{83}$$

Table 105 – Parameters used in the formula

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

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)

Energy savings are achieved by replacing the equipment of the existing heating system and DHW preparation system before the end of its service life with a heat pump. Until the end of the service life of the existing equipment, the efficiency values that refer to the current state (before the implementation of the EnU measure) are used to calculate energy savings, and after the end of its service life, the efficiency values of the equipment with average efficiency on the market are used to calculate energy savings.

Formulas for calculating energy savings resulting from early replacement of heating system equipment and DHW preparation systems in residential and service sector buildings before the end of their service life with a heat pump:

All energy savings:

$$UFES = \left(\frac{1}{\eta_{average}} - \frac{1}{SPF}\right) \times (SHD + SWD - \Delta E_{other}) \times A \tag{84}$$

Extra energy savings – **during** lifetime of equipment:

$$UFES = \left(\frac{1}{\eta_{init}} - \frac{1}{SPF}\right) \times (SHD + SWD - \Delta E_{other}) \times A \tag{85}$$

Extra energy savings – **after** lifetime of equipment:

$$UFES = \left(\frac{1}{\eta_{average}} - \frac{1}{SPF}\right) \times (SHD + SWD - \Delta E_{other}) \times A \tag{86}$$

Total energy savings:

$$FES = \sum_{i=1}^{n} UFESi \tag{87}$$

Table 106 – Parameters used in the formula

Parameter	Description
UFES	Unit final energy savings [kWh/ (unit x a)]
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	Specific annual thermal needs of the building [kWh/(m²×a)]

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

Standardized Calculation Values

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

Table 107 – Indicative values for SPF

Heat pump design	SPF [-]
Heat pump air/air – Continental part of Croatia*	3,5
Heat pump air/air – Coastal part of Croatia**	3,2
Heat pump air/water – Continental part of Croatia*	3,0
Heat pump air/water – Coastal part of Croatia**	3,3
Heat pump ground/water	3,8
Heat pump water/water	4,4

**Continental Croatia – the average monthly temperature of the outside air in the coldest month at the location of the building, according to the data from the Meteorological Data for the nearest climatically relevant meteorological station, is $\theta_{mm} \leq 3$ °*

***Coastal Croatia – the average monthly temperature of the outside air in the coldest month at the location of the building, according to the data from the Meteorological Data for the nearest climatically relevant meteorological station, is $\theta_{mm} > 3$ °C*

Table 108 – Indicative values for SHD

Condition of the outer envelope of the building	Purpose of building	Continent			Coast		
		until 1970.	1970.-2005.	after 2006.	until 1970.	1970.-2005.	after 2006.
		kWh/m^2					
SHD_{init}	Single-family homes	220	160	80	130	90	60
	Multi-apartment buildings	150	110	80	100	90	50
	Offices	150	110	60	90	70	40
	Educational buildings	140	120	60	80	70	40
	Hotels and restaurants	140	130	75	90	80	50
	Hospitals	180	140	70	100	80	65
	Sports halls	210	180	110	130	110	80
	Shops	150	90	70	80	60	40
	Other buildings	200	140	60	120	80	50
SHD_{new}	Single-family homes	75			58		
	Multi-apartment buildings	75			46		
	Offices	52			38		
	Educational buildings	47			32		
	Hotels and restaurants	70			33		
	Hospitals	54			60		
	Sports halls	90			59		

Condition of the outer envelope of the building	Purpose of building	Continent			Coast		
		until 1970.	1970.-2005.	after 2006.	until 1970.	1970.-2005.	after 2006.
		kWh/m²					
	Shops	60			36		
	Other buildings	50			46		

Table 109 – Indicative values for SWD

Type of building		SWD [kWh/m2a]
Residential buildings	≤ three residential units	12,5
	> three residential units	16,0
Service Sector Buildings	public and commercial buildings (hospitals, penitentiaries, barracks, dormitories, hotels, sports facilities, etc.)	3,5
	Other buildings of the service sector	0,5

Table 110 – Indicative values for η

Efficiency	η [-]
η_{init}	0,84
$\eta_{average}$	0,9

Table 111 – Lifetime of savings

Lifetime of savings	[a]
Lifetime of saving - heat pump air-air	10
Lifetime of saving - heat pump air-water	15
Lifetime of saving - heat pump ground-water and water-water	25

If the amount of energy provided from other sources in the building (e.g. solar collectors, biomass boilers, fossil fuel boilers) is not known, $\Delta E_{other} = 0$ is entered.

7.3.2 Calculation of Primary Energy Savings

Formula

No information on primary energy savings available for this methodology.

Standardized Calculation Values

No information on primary energy savings available for this methodology.

7.3.3 Calculation of Greenhouse Gas Savings

Formula

Formulas for calculating the annual reduction of greenhouse gas emissions:

New installation of heat pump for heating and DHW preparation:

Co-funded by the European Union

$$E_{CO2} = \sum_{i=1}^{n} [(\frac{e_{gas}}{\eta_{average}} - \frac{e_{el\_energy}}{SPF}) \times \frac{(SHD + SWD - \Delta E_{other}) \times A}{1000}]i \quad (88)$$

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):

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

$$E_{CO2} = \sum_{i=1}^{n} [(\frac{ep_{gas}}{\eta_{average}} - \frac{e_{el\_energy}}{SPF}) \times \frac{(SHD + SWD - \Delta E_{other}) \times A}{1000}]i \quad (89)$$

Table 112 – Parameters used in the formula

Parameter	Description
E_{CO2}	Greenhouse gas savings [t CO_2/a]
e_{gas}	Emission factor of alternative energy source - natural gas [kg CO_2/kWh]
e_{el_energy}	Emission factor for electricity [kg CO_2/kWh]

Standardized Calculation Values

Table 113 –Indicative values for calculation of greenhouse gas savings

Factors	[kg CO_2/kWh]
Electricity	0,159
Gas	0,214

7.3.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

7.3.5 Methodological Aspects

Calculation methodology

This methodology was integrated into the catalogue on bottom-up calculation methodologies. The document is published in Croatian language. Is the part of the Rulebook on the system for monitoring, measurement and verification of energy savings.

Calculation values

The required calculation values must be collected by each developed system separately.

7.3.6 Bibliography

Ministry of Economy and Sustainable Development (2021), *Rulebook on system for monitoring, measurement and verification of energy savings*, NN 98/2021, https://narodne-novine.nn.hr/clanci/sluzbeni/2021_09_98_1772.html

Ministry of Economy and Sustainable Development (2022), *Regulation on Amendments and Supplements to the Rulebook on system for monitoring, measurement and verification of energy savings*, NN 30/2022, https://narodne-novine.nn.hr/clanci/sluzbeni/2022_03_30_370.html

7.4. France - Solar thermal device

Installation of an individual solar thermal system intended for heating and the production of domestic hot water or for the production of domestic hot water only. The installation is carried out by a professional. The solar thermal device is delivered without additional equipment and includes solar thermal collectors (hybrid collectors producing both electricity and heat are excluded), a storage tank and a temperature regulator. Solar collectors have a productivity greater than or equal to 600 W/m² of collector input surface, calculated by multiplying the optical efficiency of the collector measured in ΔT=0 condition by a radiation (G) of 1000 W/m².

7.4.1 Calculation of Final Energy Savings

Formula

Equation(58) calculates cumulative final energy savings.

$$TFES = S_A \times C_A \qquad (90)$$

The parameters used in the formula for final energy savings are presented in Table 114.

Table 114 – Parameters used in the formula for final energy savings

Parameter	Description
$TFES$	Total final energy savings [kWh]
S_A	Savings per area (m^2) of collectors [kWh]
C_A	Area of the installed collectors [m^2]

Standardized Calculation Values

Table 115 presents the indicative values for the calculation of final energy savings for domestic hot water and
Table 116 for domestic hot water and heating.

Table 115 – Indicative values for calculation of final energy savings for domestic hot water

Parameter	Value		Unit
S_A		H	kWh
	7100	H1	
	8200	H2	
	10400	H3	

Table 116 – Indicative values for calculation of final energy savings for domestic hot water and heating

Parameter	Value		Unit
S_A		H	kWh
	14300	H1	
	12800	H2	
	11000	H3	

7.4.2 Calculation of Primary Energy Savings

Formula

The methodology does not include any formula to calculate primary energy savings.

Standardized Calculation Values

No calculation values are available for this methodology.

7.4.3 Calculation of Greenhouse Gas Savings

Formula

The methodology does not include any formula to calculate Greenhouse Gas Savings.

Standardized Calculation Values

No calculation values are available for this methodology.

7.4.4 Overview of Costs Related to the Action

Cost-Effectiveness

No information on cost-effectiveness is available for this methodology.

Standardized Values

No calculation values are available for this methodology.

7.4.5 Methodological Aspects

The original document is in French, being an official document from the Ministry of Ecological Transition published with the reference BAR-TH-168.

In France the energy savings targets, and action are recorded in kWh cumac of final energy, cumac being the contraction of "cumulative and actualized" and given by (59).

$$kWh_{cumac} = TFES \times DC \tag{91}$$

The parameters used in the formula are presented in Table 117 and the indicative values in Table 118.

Table 117 – Parameters used in the formula for final energy savings

Parameter	Description
kWh_{cumac}	Total final energy savings [kWh]
DC	Discount coefficient

Table 118 – Indicative values for calculation of energy savings certificates

Parameter	Value
Lifetime	25 [years]
DC(4%)	16.247

7.4.6 Bibliography

Opérations standardisées d'économies d'énergie | Ministère du Partenariat avec les territoires et de la Décentralisation Ministère de la Transition écologique, de l'Énergie, du Climat et de la Prévention des risques Ministère du Logement et de la Rénovation urbaine. (n.d.). Ministère Du Partenariat Avec Les Territoires Et De La Décentralisation Ministère De La Transition Écologique, De L'Énergie, Du Climat Et De La Prévention Des Risques Ministère Du Logement Et De La Rénovation Urbaine. https://www.ecologie.gouv.fr/politiques-publiques/operations-standardisees-deconomies-denergie#scroll-nav__7

7.5. Latvia - Methodology for Calculating the Energy Savings from Heat Pump Installations

This methodology calculates final energy savings from replacing heat pumps in newly built or existing individual houses and multi-apartment buildings. It uses a formula incorporating specific energy consumption for heating and hot water, heating system efficiency. The method also considers the lifetime of heat pumps and assumes no adjustments for rebound, spill-over, or free-rider effects. Applicable to the residential sector, the methodology is designed for heat pump replacements (air-to-air, water, and ground) in Latvia. Calculation of Final Energy Savings.

7.5.1 Calculation of Final Energy Savings

Formula

This formula calculates the cumulative savings for replacing a heat pump in newly built or existing individual houses:

$$TFES = a \times \left(\frac{EC_{heating} + EC_{hotwater}}{TE} - \frac{EC_{heating} + EC_{hotwater}}{EE} \right) \times y \times rb \times so \times fr \qquad (92)$$

Table 119 – Parameters used in the formula for calculating final energy savings from heat pump replacement in newly built or existing individual houses

Parameter	Description
TFES	The total savings [kWh]
a	Total conditioned area of an individual house [m^2]
$EC_{heating}$	Specific energy consumption for space heating [$kWh/m^2/year$]
$EC_{hotwater}$	Specific energy consumption to produce domestic hot water [$kWh/m^2/year$]
TE	The efficiency of a typical heating system [-]
EE	Efficiency of an efficient heating system [-]
y	The lifetime of the measure [-]
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)

This formula calculates the cumulative savings for replacing a heat pump in newly built or existing multi-apartment buildings:

$$TFES = \bar{a} \times n \times \left(\frac{EC_{heating} + EC_{hotwater}}{TE} - \frac{EC_{heating} + EC_{hotwater}}{EE} \right) \times y \times rb \times so \times fr \qquad (93)$$

Table 120 – Parameters used in the formula for calculating final energy savings from heat pump replacement in newly built or existing multi-apartment buildings

Parameter	Description
TFES	The total savings [kWh]
ā	Average conditioned area of one apartment (dwelling) [m^2]
n	Number of apartments (dwellings) in the building [-]
$EC_{heating}$	Specific energy consumption for space heating [$kWh/m^2/year$]
$EC_{hotwater}$	Specific energy consumption to produce domestic hot water [$kWh/m^2/year$]
TE	The efficiency of a typical heating system [-]
EE	Efficiency of an efficient heating system [-]
y	The lifetime of the measure [-]
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 121 – Indicative values for calculation of greenhouse gas savings from heat pump replacement in newly built or existing multi-apartment buildings

Parameter	Value	Unit
TE	0.8	-
EE	0.9	-

Co-funded by the
European Union

Parameter	Value	Unit
$EC_{heating}$ (for ground, water and air heat pumps in a newly built house or multi-apartment buildings)	50	[kWh/m²/year]
$EC_{heating}$ (for ground, water and air heat pumps in an existing built house or multi-apartment buildings)	150	[kWh/m²/year]
$EC_{hotwater}$ (for ground, water and air heat pumps in a newly built house)	20	[kWh/m²/year]
$EC_{hotwater}$ (for ground, water and air heat pumps in a newly built multi-apartment building)	40	[kWh/m²/year]
$EC_{hotwater}$ (for ground, water and air heat pumps in an existing house)	40	[kWh/m²/year]
$EC_{hotwater}$ (for ground, water and air heat pumps in an existing multi-apartment building)	60	[kWh/m²/year]
y (air-to-air heat pump)	10	years
y (water heat pump)	15	years
y (ground heat pump)	25	years

7.5.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

7.5.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

7.5.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

7.5.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

7.5.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

7.6. Latvia - Methodology for Calculating Energy Savings from the Installation of Solar Collectors

This methodology estimates the energy savings achieved by installing solar collectors as a supplementary energy source for heating and hot water production. Solar collectors can be integrated into both new and existing buildings, complementing conventional energy sources such as petroleum products, gas, and biomass. The methodology follows an ex-ante approach and uses standardized parameters from the Energy Savings Catalogue of the State Construction Control Bureau.

7.6.1 Calculation of Final Energy Savings

Formula

This formula calculates the cumulative savings resulting from installing solar collectors:

$$TFES = a \times Q \times \frac{1}{\eta} \times y \times rb \times so \times fr \qquad (94)$$

Table 122 – Parameters used in the formula for calculating final energy savings resulting from installing solar collectors

Parameter	Description
TFES	The total savings [kWh]
a	Surface area of the installed solar collector, [m^2]
Q	Average annual heat output per 1 m^2 of installed collector surface area [kWh/m^2/year]
η	Efficiency of the existing heating system [-]
y	The lifetime of the measure [-]
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 123 – Indicative values for calculation of greenhouse gas savings from final energy savings resulting from installing solar collectors

Parameter	Value	Unit
Q	500	[kWh/m^2/year]
η	0.8	-
y	20	years

7.6.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

7.6.3 Calculation of Greenhouse Gas Savings

No information on of greenhouse gas savings available for this methodology.

7.6.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

7.6.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

7.6.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

7.7. Latvia - Methodology for Calculating Energy Savings from the Installation of Biomass Boilers

This methodology calculates the energy savings achieved by installing biomass boilers as an additional heating source in apartments, single-family homes, and public buildings. It employs an ex-ante approach, using standardized parameters from the Energy Savings Catalogue of the State Construction Control Bureau. The formula estimates total final energy savings (TFES) over the measure's lifetime, considering heat demand, system efficiency improvements, and biomass boiler contributions.

7.7.1 Calculation of Final Energy Savings

Formula

This formula calculates the cumulative savings resulting from installation of biomass boilers:

$$TFES = n \times a \times P \times Q \times \left(\frac{Q_h + Q_w}{\eta_{old}} - \frac{Q_h + Q_w}{\eta_{new}}\right) \times y \times rb \times so \times fr \qquad (95)$$

Table 124 – Parameters used in the formula for calculating final energy savings resulting from installation of biomass boilers

Parameter	Description
TFES	The total savings [kWh]
n	Number of biomass boilers installed [-]
P	The percentage value of heat energy consumption provided by the biomass boiler [%]
Q_h	Energy consumption for space heating [kWh/m²/year]
Q_w	Energy consumption to produce domestic hot water [kWh/m²/year]
η_{new}	Efficiency of a new heating system [-]
η_{old}	Efficiency of the existing heating system [-]
y	The lifetime of the measure [-]
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 125 – Indicative values for calculation of greenhouse gas savings from final energy savings resulting from installing solar collectors

Parameter	Value	Unit
Q_h (apartment buildings)	150	[kWh/m²/year]
Q_h (single-family buildings)	150	[kWh/m²/year]
Q_h (public buildings)	124	[kWh/m²/year]
Q_w (apartment buildings)	60	[kWh/m²/year]
Q_w (single-family buildings)	30	[kWh/m²/year]
Q_w (public buildings)	70	[kWh/m²/year]

Co-funded by the European Union

Parameter	Value	Unit
η_{old}	0.8	-
η_{new}	0.9	-
y	15	years

7.7.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

7.7.3 Calculation of Greenhouse Gas Savings

No information on of greenhouse gas savings available for this methodology.

7.7.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

7.7.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”: https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

7.7.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”. https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

7.8. Lithuania - Small scale renewable central heating

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.

Next measure - 2021–2030 Development Programme progress Measure No. 03-001-06-03-02 "Increase the share of renewable energy sources by ensuring the integration of renewable resources into electricity grids", Investment support for installation of solar power plants in households and purchase of solar power plants/their parts from remote solar power parks for household needs. The final energy savings are not calculated during the implementation of this measure, but the total GHG emissions of the entities or processes to which support is provided are assessed before the implementation of the projects corresponding to the activities/effects of the Progress Measure and after the implementation of the projects.

7.8.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative energy savings, as the measure has a lifespan exceeding one year. Therefore, the total energy savings over the entire period are determined by multiplying the annual energy savings by the number of years the measure remains effective:

$$\Delta E = (E_{before} - E_{after}) \times y = \left(\frac{P_{before} \times h_{before}}{\eta_{before}} - \frac{P_{after} \times h_{after}}{\eta_{after}}\right) \times y \times rb \times so \times fr \qquad (96)$$

Table 126 – Parameters used in the formula for calculating final energy savings from replacement of space heating unit

Parameter	Description
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 [-]
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

Standardized calculation values are not used in this methodology.

7.8.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

7.8.3 Calculation of Greenhouse Gas Savings

Formula for measure "Boiler Replacement with More Efficient Technologies".

The initial value of the indicator is the expected annual greenhouse gas emissions before the intervention, and the achieved value is the calculated expected greenhouse gas emissions based on the achieved energy efficiency after the intervention.

When assessing the reduction of greenhouse gas (hereinafter referred to as GHG) emissions after the implementation of an activity partially financed by the programme, the GHG emissions after the implementation of the activity (project scenario) are compared with the GHG emissions without the implementation of this activity (baseline scenario) during the assessment period.

The GHG emissions reduction is the difference between the GHG emissions under the baseline scenario and the project scenario.

The GHG emissions and reduction of emitted GHG quantity are calculated according to the formulas:

$$GHG\ emissions = energy\ or\ fuel\ consumption \frac{MWh}{year} \times pollution\ factor$$

$$C = A - B \qquad (97)$$

$$I = C \times G$$

Table 127 – Parameters used in the formula for calculating greenhouse gas savings from replacement of space heating unit

Parameter	Description
A	Annual GHG emissions under the baseline scenario [t CO_2e/year]
B	Annual GHG emissions under the project scenario [t CO_2e/year]
C	Annual reduction of emitted GHG quantity [t CO_2e/year]
G	Evaluation period [years]
I	Total reduction of emitted GHG quantity, [t CO_2e]
GHG emissions	greenhouse gases – carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF6) and nitrogen trifluoride (NF3) [t]
pollution factor, t CO2e/MWh	1. When assessing direct GHG emissions, the amount of CO2 emissions caused by the fuel burned and the GHGs released during other processes are assessed: 1.1. When assessing direct CO2 emissions caused by the fuel burned, the amount of fuel burned during the assessment period is multiplied by the pollution factor. Typical pollution factors are applied for each type of fuel burned: 1.1.1. When applying typical pollution factors to projects implemented in Lithuania, the values used for each type of fuel burned are specified in the Construction Technical Regulation STR 2.01.02:2016 “Design and Certification of Energy Performance of Buildings”, approved by Order No. 11 of the Minister of the Environment of the Republic of Lithuania of 2016. November. D1-754 “On the approval of the technical construction regulation STR 2.01.02:2016 “Design and certification of energy performance of buildings” in Annex 2, Table 2.18. If the table does not contain a pollution factor for the relevant fuel type, then the pollution factors specified in the latest National Greenhouse Gas Inventory Report shall be used. 1.1.2. the applicant may propose specific relative energy pollution factors, oxidation coefficients and fuel calorific values, and pollution factors calculated from them, if it can be proven that the specific applied values are more accurate in the case of a specific activity; 1.2. For projects carried out outside Lithuania, typical pollution factors for each type of fuel burned are found in: 1.2.1. if it is a Party included in Annex I to the United Nations Framework Convention on Climate Change (hereinafter referred to as the UNFCCC), in the most recent National Inventory Report of the relevant Party, published on the website of the UNFCCC Secretariat https://unfccc.int/ghg-inventories-annex-i-parties/2020 1.2.2. if it is not a Party included in Annex I to the UNFCCC, in the most recent National Communication of the relevant Party, published on the website of the UNFCCC Secretariat https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/national-communications-and-biennial-update-reports-non-annex-i-parties/national-communication-submissions-from-non-annex-i-parties. 1.2.3. if the latest National Communication of the relevant country published on the UNFCCC Secretariat website indicates that default emission factors are used for the relevant fuel type, they can be found in

Parameter	Description
	Part 2 of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Table 2.2. "Energy" https://www.ipcc-nggip.iges.or.jp/public/2006gl/. 2. When assessing the indirect CO2 emissions (in tonnes) in other power plants not controlled by the applicant, resulting from the amount of electricity purchased from the grid by the applicant or the amount of electricity produced by the applicant and supplied to the grid by the applicant, which replaces electricity production in other power plants not controlled by the applicant, the amount of electricity purchased from the grid during the assessment period or the amount of electricity supplied to the grid during the assessment period is multiplied by: 2.1. For projects implemented in Lithuania, by the electricity pollution factor equal to 0.42 t CO2e/MWh; 2.2. for electricity produced in power plants from renewable energy sources, if the applicant can provide a declaration from the electricity supplier, by the electricity pollution factor equal to 0.00 t CO2e/MWh; 2.3. For projects implemented outside Lithuania, by the electricity pollution factor equal to 0.707 t CO2e/MWh. 3. When assessing the indirect CO2 emissions (in tonnes) in heat generating installations not controlled by the applicant of a district heating system, caused by the amount of thermal energy purchased by the applicant from the network or the amount of thermal energy produced by the applicant to the network, replacing heat production in other heat generating installations not controlled by the applicant, the amount of thermal energy purchased from the network during the assessment period or the amount of thermal energy supplied to the network during the assessment period is multiplied by the pollution factor of district heating, which is equal to: 3.1. For projects implemented in Lithuania – 0.10 t CO2e/MWh; 3.2. For projects implemented outside Lithuania, where natural gas accounts for more than 50 percent of the fuel balance – 0.28 t CO2e/MWh; 3.3. For projects implemented outside Lithuania, where biofuel accounts for more than 50 percent of the fuel balance fuel balance – 0.10 t CO2e/MWh; 3.4. for the specific value of the pollution factor for district heating, if it can be demonstrated that the specific value is more accurate in a particular case. 4. When assessing the amount of indirect GHG emissions in installations not controlled by the applicant, the amount of GHG during the assessment period caused by the combustion of fossil fuels and greenhouse gases emitted during other processes may also be assessed.

Formula for measure "Installation of solar power plants in households and acquisition of solar power plants/their parts from remote solar power parks for household needs".

Definitions:

Greenhouse gases (GHG) - Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6) and nitrogen trifluoride (NF_3).

The total GHG emissions of the entities or processes receiving support are assessed before and after the implementation of the projects corresponding to the activities/outcomes of the progress measure. The baseline level represents the estimated annual GHG emissions from electricity consumers before the intervention, and the achieved value is calculated as the annual GHG reduction based on the replacement of electricity consumption from the grid with 100% electricity generated from renewable energy sources in the year after the intervention.

Formula for calculating the indicator value

In the case of **solar power plants**, the indicator value is calculated according to the formula:

$$GHG = MW \times 1000 \times 0.42 \tag{98}$$

Table 128 – Parameters used in the formula for calculating greenhouse gas savings in the case of solar power plants installation

Parameter	Description
GHG	Reduction in annual greenhouse gas emissions, expressed in tons of CO2 equivalent [t]
1000	A number defining how many MWh of electricity is generated on average by a 1 MW solar power plant (based on research results) [-]
0.42	A number defining how many tons of CO2 equivalent reduces GHG emissions due to the fact that 1 MWh of electricity from renewable energy sources replaces 1 MWh of electricity that a household receiving support would consume from the electricity distribution network [-]
MW	solar power plant power [MW]

In the case of **wind power plants**, the indicator value is calculated according to the formula:

$$GHG = MW \times 1280 \times 0.42 \tag{99}$$

Table 129 – Parameters used in the formula for calculating greenhouse gas savings in the case of wind power plants installation

Parameter	Description
GHG	annual reduction in greenhouse gas emissions, expressed in tons of CO2 equivalent [t]
1280	a number defining how many MWh of electricity a 1 MW wind power plant generates on average per year (based on research results) [-]
0.42	a number defining how many tons of CO2 equivalent reduces GHG emissions due to the fact that 1 MWh of electricity from renewable energy sources replaces 1 MWh of electricity that a household receiving support would consume from the electricity distribution network [-]
MW	wind power plant power [MW]

7.8.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

7.8.5 Methodological Aspects

No information on methodological aspects for this methodology.

7.8.6 Bibliography

1. Ministry of Energy of the Republic of Lithuania (2023). "Implementation of measures to increase energy consumption efficiency in public central government buildings, individual residential houses and enterprises" Description of the terms and conditions for project financing of activities related to the replacement of boilers to more efficient, heat production technologies using renewable energy resources in individual houses not connected to a centralized heat supply system, No.: 1-244. Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/3a65d6602aaf11ee9de9e7e0fd363afc
2. Ministry of Environment of the Republic of Lithuania (2010). Order on the approval of the description of the procedure for the use of funds from the Climate Change Programme, No.: D1-275. Consolidated version 2023-03-20: Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/TAR.A2E8B0079BC9/asr
3. Ministry of Energy of the Republic of Lithuania (2022). Description of the Energy Development Programme Progress Measure No. 03-001-06-03-02 "Increasing the share of renewable energy sources, ensuring the integration of renewable resources into electricity grids" of the Ministry of Energy of the Republic of Lithuania, which manages the 2021–2030 development programme, No: 1-265. Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/637bf8e02f3311edb4cae1b158f98ea5/asr
4. Ministry of Energy of the Republic of Lithuania (2024). Installation of solar power plants in households and acquisition of solar power plants/their parts from remote solar power parks for household needs. Website of the Ministry of Energy. https://enmin.lrv.lt/lt/veiklos-sritys-3/europos-sajungos-parama/europos-sajungos-investicijos-ir-strukturine-parama/2021-2027-m-europos-sajungos-parama/saules-elektriniu-irengimas-namu-ukiuose-ir-saules-elektriniu-ju-daliu-isigijimas-is-nutolusiu-saules-elektriniu-parku-namu-ukiu-reikmems/

8. Energy Poverty

8.1. Latvia - Methodology for Calculating Energy Savings from Buildings' Thermal Properties Improvement

This methodology estimates the energy savings achieved through building envelope improvements, specifically wall insulation, roof insulation, and window replacement. It follows an ex-ante approach and utilizes standardized values for heat transfer coefficients (U-values) in energy-efficient and non-efficient building elements. Due to variations in climate conditions and building energy efficiency, these values are not included in the methodology. For heating degree days calculation, it is recommended to use the Latvian building standard *LBN 003-19 "Būvklimatoloģija"* (applicable only to the Latvian region).

8.1.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative final energy savings resulting from buildings thermal properties improvement:

$$TFES = \left(U - U_{eff}\right) \times a \times HDD \times 0.024 \times \frac{1}{\eta} \times y \times rb \times so \times fr \qquad (100)$$

Table 130 – Parameters used in the formula for calculating energy savings from buildings thermal properties improvement

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
a	Area of the renovated building element [m^2]
HDD	The number of days of heating degrees in average climatic conditions [-]
U	Typical building element U-value: heat transfer coefficient [W/m^{2}K]
U_{eff}	U-value of energy efficient building element: heat transfer coefficient [W/m^{2}K]
η	The efficiency of the heating system in a typical building [-]
y	The lifetime of the measure [-]
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 131 – Indicative values for calculation of final energy savings resulting from buildings thermal properties improvement

Parameter	Value	Unit
η	0.8	-
y (wall / roof insulation)	20	years
Y (windows replacement)	30	years

8.1.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

8.1.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

8.1.4 Overview of Costs Related to the Action

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

8.1.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

8.1.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali
2. Ministru kabinets (2019). Legislative act Regulations on Latvian Building Code LBN 003-19 "Būvklimatoloģija". https://likumi.lv/ta/id/309453-noteikumi-par-latvijas-buvnormativu-lbn-003-19-buvklimatologija

8.2. Latvia - Methodology for Calculating Energy Savings from Thermal Insulation of Water Heaters

The methodology for calculating energy savings from thermal insulation of water heaters. The methodology relies on standardized values provided by the State Construction Control Bureau's Catalogue of Energy Savings, which is part of Latvia's energy efficiency monitoring system.

8.2.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative final energy savings resulting from thermal insulation of water heaters:

$$TFES = n \times \frac{Q_{non} - Q_{in}}{\eta} \times y \times rb \times so \times fr \qquad (101)$$

Table 132 – Parameters used in the formula for calculating energy savings from thermal insulation of water heaters

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
n	Number of insulated warm water tanks [-]
η	The efficiency of the heating system [-]
Q_{non}	Heat loss per year from poorly insulated (non-insulated) tank [kWh/year]
Q_{in}	Heat loss per year from a well-insulated tank [kWh/year]
y	The lifetime of the measure [-]
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 133 – Indicative values for calculation of final energy savings resulting from thermal insulation of water heaters

Parameter	Value	Unit
η	0.8	-
Q_{non}	8750	kWh/year
Q_{in}	4375	kWh/year
y	15	years

8.2.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

8.2.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

8.2.4 Overview of Costs Related to the Action

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

8.2.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

8.2.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

8.3. Latvia - Methodology for Calculating Energy Savings from Thermal Insulation of Heating System Pipeline

This methodology provides a systematic approach to calculate the cumulative final energy savings achieved by insulating pipelines in heating systems. The methodology relies on standardized values and factors to ensure accurate and consistent calculations, as outlined in the State Construction Control Bureau's Catalogue of Energy Savings.

8.3.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative final energy savings resulting from thermal insulation of heating system pipelines:

$$TFES = (Q_{non} - Q_{in}) \times l \times HD \times 24 \times \frac{k}{1000} \times y \times rb \times so \times fr \qquad (102)$$

Table 134 – Parameters used in the formula for calculating energy savings thermal insulation of heating system pipelines

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
l	Length of insulated pipelines [m]
k	Inequality coefficient that characterizes the continuous operation of the heating system [-]
HD	Number of heating days [days]
Q_{non}	Initial heat loss from pipelines [W/m]
Q_{in}	Heat loss from pipelines after the application of thermal insulation [W/m]
y	The lifetime of the measure [-]
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 135 – Indicative values for calculation of final energy savings resulting from thermal insulation of heating system pipelines

Parameter	Value	Unit
η	0.8	-
Q_{non}	130	W/m
Q_{in}	13	W/m
K	0,52	-
y	20	years

8.3.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

8.3.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

8.3.4 Overview of Costs Related to the Action

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

8.3.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

8.3.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

8.4. Latvia - Methodology for Calculating Energy Savings from Installation of Thermostatic Valves for Radiators

This methodology outlines the process for calculating the cumulative final energy savings achieved by installing thermostatic valves on radiators (where they did not exist before). The formula can be used for both residential and non-residential buildings. This approach is part of the energy efficiency monitoring system and is detailed in the State Construction Control Bureau's Catalogue of Energy Savings.

8.4.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative final energy savings resulting from installation of thermostatic valves for radiators:

$$TFES = a \times Q \times \frac{1}{\eta_{prod} \times \eta_{dist}} \times \left(\frac{1}{\eta_{r\_old}} - \frac{1}{\eta_{r\_new}}\right) \times y \times rb \times so \times fr \qquad (103)$$

Table 136 – Parameters used in the formula for calculating energy savings from installation of thermostatic valves for radiators

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
Q	Specific energy consumption for space heating [kWh/m^2/year]
η_{prod}	Efficiency of the heat production system (boiler) [-]
η_{dist}	Efficiency of the heat distribution system [-]
η_{r_old}	Efficiency of the previous heat system (radiators without thermostatic valves)
η_{r_new}	Efficiency of a new heat system (radiators with thermostatic valves)
a	Total air-conditioned area of the building [m^2]
y	The lifetime of the measure [-]
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 137 – Indicative values for calculation of final energy savings resulting from installation of thermostatic valves for radiators

Parameter	Value	Unit
Q	150	kWh/m^2/year

Parameter	Value	Unit
η_{prod}	0.8	-
η_{dist}	0.85	-
η_{r_old}	0.85	-
η_{r_new}	0.93	-
y	10	years

8.4.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

8.4.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

8.4.4 Overview of Costs Related to the Action

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

8.4.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”: https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

8.4.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”. https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

8.5. Latvia - Methodology for Calculating Energy Savings from Adjustment of Hydraulic Systems

This methodology focuses on improving the heat supply system by introducing a new control system or modernizing the existing one. It calculates the cumulative final energy savings resulting from the adjustment of hydraulic systems using a specific formula. This approach is part of the energy efficiency monitoring system and is detailed in the State Construction Control Bureau's Catalogue of Energy Savings.

8.5.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative final energy savings resulting from adjustment of hydraulic systems:

$$TFES = a \times Q \times \left(\frac{1}{\eta} - \frac{1}{\eta_{adjusted}}\right) \times y \times rb \times so \times fr \qquad (104)$$

Table 138 – Parameters used in the formula for calculating energy savings resulting from adjustment of hydraulic systems

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
Q	Specific energy consumption for space heating [kWh/m²/year]
η	Efficiency of the heating system [-]
$\eta_{adjusted}$	Efficiency of the heating system with hydraulic adjustment [-]
a	Total air-conditioned area of the building [m²]
y	The lifetime of the measure [-]
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 139 – Indicative values for calculation of final energy savings resulting from adjustment of hydraulic systems

Parameter	Value	Unit
Q	150	kWh/m²/year
η	0.8	-
$\eta_{adjusted}$	0.9	-
y	15	years

8.5.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

8.5.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

8.5.4 Overview of Costs Related to the Action

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

8.5.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

8.5.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

Co-funded by the European Union

8.6. Latvia - Methodology for Calculating Energy Savings from Connection to the District Heating Network

This methodology calculates the cumulative final energy savings achieved by connecting unrenovated single-family and multi-family residential buildings to the district heating network. It replaces existing heating systems to prevent heat loss and provides heat for both space heating and hot water. The formula considers specific energy consumption for space heating and hot water production, the efficiencies of the heating systems before and after connection, and other relevant factors. This approach is part of the energy efficiency monitoring system and is detailed in the State Construction Control Bureau's Catalogue of Energy Savings.

8.6.1 Calculation of Final Energy Savings

Formula

This formula calculates the cumulative final energy savings resulting from connecting unrenovated single-family houses to the district heating network:

$$TFES = a \times \left(\frac{Q_h + Q_w}{\eta} - \frac{Q_h + Q_w}{\eta_{eff}} \right) \times y \times rb \times so \times fr \qquad (105)$$

Table 140 – Parameters used in the formula for calculating energy savings connecting unrenovated single-family houses to the district heating network

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
Q_h	Specific energy consumption for space heating in a building [kWh/m^2/year]
Q_w	Specific energy consumption for hot water production [kWh/m^2/year]
η	Efficiency of the typical heating system [-]
η_{eff}	Efficiency of the efficient heating system [-]
a	Total conditioned area of the building [m^2]
y	The lifetime of the measure [-]
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)

This formula calculates the cumulative final energy savings resulting from connecting unrenovated multi-family houses and apartment buildings to the district heating network:

$$TFES = n \times \bar{a} \times \left(\frac{Q_h + Q_w}{\eta} - \frac{Q_h + Q_w}{\eta_{eff}} \right) \times y \times rb \times so \times fr \qquad (106)$$

Table 141 – Parameters used in the formula for calculating energy savings connecting unrenovated multi-family houses and apartment buildings to the district heating network

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
Q_h	Specific energy consumption for space heating in a building [kWh/m^2/year]
Q_w	Specific energy consumption for hot water production [kWh/m^2/year]
η	Efficiency of the typical heating system [-]
η_{eff}	Efficiency of the efficient heating system [-]

a	Total conditioned area of the building [m^2]
ā	Average conditioned area of the building [m^2]
n	Number of apartments in the building [-]
y	The lifetime of the measure [-]
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 142 – Indicative values for calculation of final energy savings resulting from connecting unrenovated multi-family houses and apartment buildings to the district heating network

Parameter	Value	Unit
Q_h	150	kWh/m^2/year
Q_w (for single-family houses)	30	kWh/m^2/year
Q_w (for multi-family houses and apartment buildings)	60	kWh/m^2/year
η	0.6	-
η_{eff}	0.9	-
y	30	years

8.6.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

8.6.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

8.6.4 Overview of Costs Related to the Action

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

8.6.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

8.6.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

Co-funded by the
European Union

8.7. Latvia - Methodology for Calculating Energy Savings from Installation of Thermostats

This methodology calculates the cumulative final energy savings achieved by equipping residential buildings with thermostats where they did not exist before. The formula considers specific energy consumption for space heating, the efficiencies of the heat production and distribution systems, and the thermostat's temperature reduction impact. This approach is part of the energy efficiency monitoring system and is detailed in the State Construction Control Bureau's Catalogue of Energy Savings.

8.7.1 Calculation of Final Energy Savings

Formula

This formula calculates the cumulative final energy savings resulting from installation of thermos stats for heating systems:

$$TFES = Q \times a \times \left(\frac{1}{\eta_{prod} \times \eta_{dist}}\right) \times \left(T \times \frac{k}{100} \times \frac{HD \times (h_n + h_d)}{HD \times 24}\right) \times y \times rb \times so \times fr \qquad (107)$$

Table 143 – Parameters used in the formula for calculating energy savings from installation of thermostats for heating systems

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
Q	Specific energy consumption for space heating in a building [kWh/m^2/year]
η_{prod}	Efficiency of the heat production system [-]
η_{dist}	Efficiency of the heat distribution system [-]
T	Thermostat temperature reduction in residential premises at certain hours of the day [°C]
k	Reduction of energy for heating by reducing the temperature by 1 °C [%]
HD	Duration of the heating period [days]
h_d	Number of day hours to which the thermostat reduction is applied [h]
h_n	Number of night hours to which the thermostat reduction is applied [h]
a	Total conditioned area of the building [m^2]
y	The lifetime of the measure [-]
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 144 – Indicative values for calculation of final energy savings resulting from installation of thermostats for heating systems

Parameter	Value	Unit
Q	150	kWh/m^2/year
η_{prod}	0.8	-
η_{dist}	0.85	-
k	1.8	%

Co-funded by the
European Union

Parameter	Value	Unit
y	10	years

8.7.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

8.7.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

8.7.4 Overview of Costs Related to the Action

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

8.7.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”: https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

8.7.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document “Energy savings catalogue developed by the Ministry of Economics” / “Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs”. https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali
2. Ministru kabinets (2019). Legislative act Regulations on Latvian Building Code LBN 003-19 "Būvklimatoloģija". https://likumi.lv/ta/id/309453-noteikumi-par-latvijas-buvnormativu-lbn-003-19-buvklimatologija

8.8. Lithuania - Methodology for calculating energy savings from renovation / modernisation of multi-apartment buildings

The multi-apartment building renovation project is aimed at enhancing energy efficiency by modernizing building systems and structures. Key measures include upgrading insulation, replacing outdated heating systems with sustainable alternatives, and installing energy-efficient windows and doors. The project aims to reach energy efficiency class B, reduce energy consumption by not less than 40 %, lower utility costs, and improve overall living comfort. Supported by government incentives, these efforts contribute significantly to sustainability goals, reducing the building's carbon footprint while increasing its value and longevity.

8.8.1 Calculation of Final Energy Savings

Formula

This formula calculates first-year savings. The calculation of final energy savings during the modernization of multi-apartment buildings is based on comparing the energy consumption before and after modernization, considering factors such as improved energy efficiency and reduced energy losses. The achieved energy performance class of the building is determined in the building's energy performance certificate. The reduction in calculated thermal energy consumption (for heating and hot water preparation) is determined based on the difference in total thermal energy consumption (for heating and hot water preparation) specified in the energy performance certificates issued before and after the implementation of multi-apartment building renovation (modernization) measures.

$$\Delta E = (E_{before} - E_{after}) \times rb \times so \times fr \tag{108}$$

Table 145 – Parameters used in the formula for calculating final energy savings from multi-apartment building modernisation/renovation

Parameter	Description
ΔE	Total final energy savings [MWh/year]
E_{before}	Annual final energy consumption of the building before modernization [MWh/year]
E_{after}	Annual final energy consumption of the building after modernization [MWh/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 calculation values available for this methodology.

8.8.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

8.8.3 Calculation of Greenhouse Gas Savings

Formula

Determine the energy source used for heating and hot water (e.g., natural gas, electricity, biomass, district heating).

$$\Delta CO_2 = \Delta E \times EF$$

In case of multiple energy sources used, emissions are calculated separately for each source and the results summed:

$$\Delta CO_2 = \sum_{i=1}^{n} (\Delta E_i \times EF_i) \tag{109}$$

Table 146 – Parameters used in the formula for greenhouse gas savings

Parameter	Description
ΔCO_2	Annual CO_2 emissions reduction [t CO_2/year]
ΔE	Total final energy savings [MWh/year]
EF	Emission factor of the energy source [t CO_2/MWh]
n	Number of different energy sources [-]
i	i-th energy source [-]

Standardized Calculation Values

Table 147 – Indicative values for calculation of greenhouse gas emission factor (EF) by fuel type

Parameter (Emission Factor EF)	Value	Unit
Coal	0,9 to 1,0	kg CO_2/kWh
Natural gas	0,3 to 0,4	kg CO_2/kWh
Biomass	0,05 to 0,1	kg CO_2/kWh
Hydropower	0	kg CO_2/kWh
Wind Power	0	kg CO_2/kWh
Solar Power	0	kg CO_2/kWh
Peat	0,7 to 1,0	kg CO_2/kWh
Oil	0,7 to 0,9	kg CO_2/kWh

8.8.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

8.8.5 Methodological Aspects

In Lithuania, the calculation of energy savings for building modernization is primarily regulated by the following document: STR 2.01.02:2016 "Energy Performance of Buildings: Design and Certification". https://www.e-tar.lt/portal/lt/legalAct/2c182f10b6bf11e6aae49c0b9525cbbb/asr [in Lithuanian language]

8.8.6 Bibliography

1. Ministry of Environment of the Republic of Lithuania (2016). STR 2.01.02:2016 Energy Performance of Buildings: Design and Certification, No.: D1-754. Consolidated version 2024-05-01. Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/2c182f10b6bf11e6aae49c0b9525cbbb/asr

8.9. Lithuania - Methodology for calculating energy savings from modernisation of domestic heating and hot water systems in multi-apartment buildings ("small renovation")

A modernisation of domestic heating and hot water systems in multi-apartment buildings or a "small renovation" involves upgrading and balancing the heating and hot water systems in an apartment building to ensure efficient use of heat. This includes replacing old elevator-type heat points with new automated ones and optimizing heating systems by installing automatic balancing valves.

State support is available for upgrading heating systems, such as replacing radiators, installing thermostatic valves, and replacing pipelines. It also covers installing individual heat metering devices, heat dividers, or smart meters for apartments, enabling remote readings of heat and water usage. Costs for remodelling hot water systems, including replacing towel dryers and pipelines, are also eligible for financing.

The final energy savings methodology is specifically applied to this policy measure, and savings are calculated only for measures eligible for financial support (see below).

8.9.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative savings from each implemented measure.

$$S_{total} = \sum_{i=1}^{n}(Q_{norm} \times k_i \times t_i) \times rb \times so \times fr \quad (110)$$

Table 148 – Parameters used in the formula for calculating final energy savings from modernisation of domestic heating and hot water systems

Parameter	Description
S_{total}	Total accumulated heat energy savings [MWh]
Q_{norm}	Normalized heat consumption over the heating season [MWh]
k_i	The energy efficiency coefficient for measure [%]
t_i	Lifetime for measure [year]
n	Number of implemented measures [-]
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

In the table below, percentages (coefficients k_i) for different implemented measures are presented. These percentages are used to calculate the final heat consumption. A maximum of 30 % reduction in final heat consumption is allowed from all implemented measures.

Table 149 – Indicative values for calculation of final energy savings from modernisation of domestic heating and hot water systems

Parameter (k_i) – measure	Value	Unit
Replacement of elevator heat points with a new automated heat point or refurbishment of old, worn-out automated heat points or installation of a separate heat point in an apartment building	8	%
Installation of thermostatic valves, dividers or individual metering devices	10	%
Balancing heating systems	5	%
Balancing hot water systems	5	%
Pipeline insulation	2	%
Replacement of heating devices and/or pipelines	0	%

The lifetime of the measure [t_i] is based on the *Commission Recommendation (EU) 2019/1658 of 25 September 2019* on transposing the energy savings obligations under the *Energy Efficiency Directive*.

8.9.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

8.9.3 Calculation of Greenhouse Gas Savings

Formula

This formula calculates greenhouse gas savings.

$$CO_{2e,total} = S_{total} \times CO_{2e} \quad (111)$$

Co-funded by the
European Union

Table 150 – Parameters used in the formula for greenhouse gas savings from modernisation of domestic heating and hot water systems

Parameter	Description
$CO_{2e,total}$	Total greenhouse gas savings [t CO_{2e}]
S_{total}	Total accumulated heat energy savings (see formula above for final energy consumption) [MWh]
CO_{2e}	CO_2 equivalent coefficient for heat consumption [t CO_{2e}/MWh]

Standardized Calculation Values

The indirect CO_2 emissions (in tons) are calculated by multiplying the amount of heat energy (purchased or supplied during the evaluation period) by the emission factor. In Lithuania implemented projects, this emission factor is 0,10 t CO_{2e}/MWh. In cases where fuel-specific consumption is known, CO_2 emissions should be calculated based on the type of fuel used (factor for each fuel type).

8.9.4 Overview of Costs Related to the Action

No information on costs calculation for this methodology.

8.9.5 Methodological Aspects

This methodology was taken from officially published legal document "Description of the procedure for compensatory payments under the climate change programme for the modernisation of domestic heating and hot water systems in multi-apartment buildings, No.: D1-238": https://www.e-tar.lt/portal/lt/legalAct/08450d50404c11efbdaea558de59136c [in Lithuanian language]

8.9.6 Bibliography

1. Ministry of Energy of the Republic of Lithuania (2024). Description of the procedure for compensatory payments under the climate change programme for the modernisation of domestic heating and hot water systems in multi-apartment buildings, No.: D1-238: Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/08450d50404c11efbdaea558de59136c
2. Ministry of Environment of the Republic of Lithuania (2010). Order on the approval of the description of the procedure for the use of funds from the Climate Change Programme, No.: D1-275. Consolidated version 2023-03-20. Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/TAR.A2E8B0079BC9/asr
3. European Union (2019). Commission Recommendation (EU) 2019/1658 of 25 September 2019 on transposing the energy savings obligations under the Energy Efficiency Directive (CELEX No. 32019H1658). EUR-Lex. https://eur-lex.europa.eu/legal-content/LT/TXT/?uri=CELEX:32019H1658

8.10. Poland - Thermomodernisation and Renovation Fund (TERMO programme)

The aim is to calculate savings from thermo-modernisation and renovation projects. This is a general measure that can also cover vulnerable customers.

Application area:

- residential buildings,
- multi-apartment units;
- public utility buildings owned by local government units for the performance of their public tasks,
- district heating networks,

- local heat sources

Types of actions/projects:

- reducing energy consumption for heating and heating of useful water,
- reducing the cost of obtaining heat supplied to the above-mentioned buildings,
- reducing primary energy losses in local heating grids and local heat sources;
- a complete or partial change of energy sources to renewable sources, or using high-efficiency cogeneration

8.10.1 Calculation of Final Energy Savings

Formula

Correction factors for the rebound, spill-over, and free-rider effects are not taken in the account.

This formula calculates first-year savings.

$$O_{FTiR} = \sum_{i=1}^{N} o_i \qquad (112)$$

Table 151 – Parameters used in the formula for final energy savings

Parameter	Description
O_{FTiR}	Annual average final energy savings [ktoe/year]
o_i	Energy savings resulting from the energy audit for each of thermo-modernisation projects carried out [toe/year]
N	Number of investments

Standardized Calculation Values

No calculation values available for this methodology

8.10.2 Calculation of Primary Energy Savings

Calculation of Primary Energy Savings is not available. The calculation is done in final energy, but primary energy factors, which are set by legislation, can be used.

8.10.3 Calculation of Greenhouse Gas Savings

No calculation of greenhouse gas savings available for this methodology

8.10.4 Overview of Costs Related to the Action

No Overview of Costs Related available for this methodology.

8.10.5 Methodological Aspects

The amount of energy consumption is determined on the basis of an energy audit of the building, which sets out the basic parameters of the energy efficiency improvement project, including the average annual final energy savings expressed in toe per year.

The final energy savings of each thermomodernisation project are determined by an ex-ante method (estimated savings), calculated and reported in the mandatory energy audit.

The detailed methodology for the implementation of the energy audit is set out in the Regulation of the Minister for Infrastructure of 17 March 2009 on the detailed scope and forms of energy audit and part of the renovation audit, model audit sheets and the algorithm for assessing the cost-effectiveness of thermomodernisation project (Journal of Laws 2022, item 2816).

The language(s) of the original document is English and Poland.

8.10.6 Bibliography

Collective of authors. (2024). Poland - Draft updated NECP 2021-2030 - Annex 3. *Warsaw: Ministerstwo Klimatu i Środowiska*. Retrieved from: https://commission.europa.eu/publications/poland-draft-updated-necp-2021-2030_en

8.11. Poland - Tax credit for expenditure on thermomodernisation of single-family dwellings, the so-called 'thermomodernisation relief'

The policy measure in question consists of the introduction of a tax credit, known as the 'thermomodernisation relief', the objective of which is to create an incentive in personal income tax for thermomodernisation of single-family residential buildings. This is a general measure that can also cover vulnerable customers.

Application area:

- residential buildings – single-family houses

Types of actions/projects:

- window and door joinery,
- building materials included in the heating installation, domestic hot water preparation, electric heating system,
- heat pump, solar collector or photovoltaic cell with accessories,
- installation of the above-mentioned materials and equipment,
- activation and adjustment of the heat source and analysis of flue-gas, hydraulic adjustment and balancing of the installation, dismantling of the heat generator into solid fuel.

8.11.1 Calculation of Final Energy Savings

Formula

Correction factors for the rebound, spill-over, and free-rider effects are not taken in the account.

This formula calculates first-year savings.

$$O_{tax-relief} = volume * w_{FTiR} * w_{ekspert} * p \qquad (113)$$

Table 152 – Parameters used in the formula for final energy savings

Parameter	Description
$O_{tax\text{-}relief}$	final energy savings [ktoe/year]
Volume	the amount of deductions in a given year [PLN/year]
w_{FTiR}	indicator, which is the ratio of final energy savings to capital expenditure [kWh/PLN],determined on the basis of the database of energy audits carried out under the Thermomodernisation Fund;
$w_{ekspert}$	a ratio of Capex to the amount of co-financing determined on the basis of data obtained under the Clean Air Priority Programme
p	unit conversion factor [ktoe/kWh]

Standardized Calculation Values

No calculation values available for this methodology

8.11.2 Calculation of Primary Energy Savings

Calculation of Primary Energy Savings is not available. The calculation is done in final energy.

8.11.3 Calculation of Greenhouse Gas Savings

No calculation of greenhouse gas savings available for this methodology

8.11.4 Overview of Costs Related to the Action

No Overview of Costs Related available for this methodology

8.11.5 Methodological Aspects

Given the broad scope of the measure and the fact that it is characterised by a simple tax deduction for the beneficiary of the costs incurred in connection with an energy efficiency improvement project, the savings will be calculated on the basis of expert estimates, a scaled method (i.e. scaled savings).

The language(s) of the original document is English and Poland.

8.11.6 Bibliography

Collective of authors. (2024). Poland - Draft updated NECP 2021-2030 - Annex 3. *Warsaw: Ministerstwo Klimatu i Środowiska*. Retrieved from: https://commission.europa.eu/publications/poland-draft-updated-necp-2021-2030_en

8.12. Poland - Improving the Energy Efficiency of Housing Buildings

The aim is at improving energy efficiency by renovating existing buildings, improving energy efficiency by increasing heat generation from low-carbon heat sources; reduce emissions of dust and other pollutants into the atmosphere

Application area:

- residential buildings
    - Natural person, housing cooperatives, housing community

Types of actions/projects:

- Replacement/purchase of a heat generator, investment in the connection of ca.o. and c.w. (including, but not limited to: connection to the district heating network and connection, purchase of a heat pump, purchase of a condensing gas boiler).
- Insulation of building envelopes, replacement of window and door joinery.
- Purchase and installation of windows, doors separating rooms from unheated spaces.
- Purchase and installation of mechanical ventilation with heat recovery.
- The installation of hybrid systems, i.e. a photovoltaic or a wind power plant with a heat pump, coupled to a single system

8.12.1 Calculation of Final Energy Savings

Formula

Correction factors for the rebound, spill-over, and free-rider effects are not taken in the account.

This formula calculates first-year savings.

$$R_F = A * \omega \qquad (114)$$

Table 153 – Parameters used in the formula for final energy savings

Parameter	Description
R_F	reference value for final energy savings [ktoe/year]
A	a controlled air temperature area [m²]
ω	final energy saving factor for the replacement of a heat source in a residential buildings [toe/m²]

Taking into account that the programme also assumes the possibility of implementing the project on the basis of an energy audit, which estimates... the final energy savings for the Housing Buildings Energy Efficiency Programme are calculated using the formula:

$$O_{PEEBM} = R_f + other\ savings \qquad (115)$$

Table 154 – Parameters used in the formula for final energy savings

Parameter	Description
O_{PEEBM}	final energy savings [ktoe/year]
Other savings	other final energy savings resulting from the estimated method, i.e. energy audits or energy efficiency carried out as part of the implementation of the project.

The estimates determined on the basis of the Methodology for estimating the effect provided by the NFOŚiGW are updated on an ongoing basis as part of selective checks on the durability of the project. The scheme rules provide that the installation financed under the project should be operated at a minimum of 3 to 5 years, depending on the type of investment. During this period, the NFOŚiGW carries out selective checks to update the estimated values of environmental impact indicators, including final energy savings.

8.12.2 Standardized Calculation Values

No calculation values available for this methodology

8.12.3 Calculation of Primary Energy Savings

Calculation of Primary Energy Savings is not available. The calculation is done in final energy, but primary energy factors, which are set by legislation, can be used.

8.12.4 Calculation of Greenhouse Gas Savings

No calculation of greenhouse gas savings available for this methodology

8.12.5 Overview of Costs Related to the Action

No Overview of Costs Related available for this methodology

8.12.6 Methodological Aspects

As regards the implementation of contracts under the Programme for the Improvement of Energy Efficiency in Housing Buildings, data on energy savings achieved at final customers are collected by the WFOŚiGW and by the JST. In view of the fact that the programme provides for the implementation of different projects, two possible methods of calculating energy savings are used: estimated and scaled savings.

Estimated savings:

> As part of the energy audit, a study is being drawn up specifying the scope and technical and economic parameters of thermomodernisation project, indicating the optimal solution, in particular from the point of view of the cost of implementing the project and energy savings. The audit is the basis for the construction project for the project being carried out. Furthermore, the audit determines the technical (energy savings) and economic effect of the thermomodernisation projects, energy losses (heat transmission and ventilation), energy needs for heating, cooling, lighting and domestic hot water, and solar and domestic profits are taken into account.

Scaled savings

> As the programme is implemented on a massive scale, potentially affecting millions of beneficiaries, the methodology for determining the effects is estimated on the basis of the average values for the reference building.

The amount of energy consumption is determined on the basis of an energy audit of the building or, where justified, a simplified energy audit of the building, i.e. the ecological effect indicator is calculated. On the basis of the above, the basic parameters of the energy efficiency improvement project shall be determined, including the average annual final energy savings.

Final energy savings calculated on the basis of a simplified methodology for estimating the ecological effect, which is prepared each time for a given priority and on the basis of the Regulation of the Minister for Climate and the Environment of 22 November 2021 on reference values for final energy savings for energy efficiency improvement projects and on the method of calculating these values (Journal Of Laws 2021, item 2172). The relevant methodology has been developed taking into account the seasonal efficiency of heat generators and the non-renewable primary energy input factor.

The language(s) of the original document is English and Poland.

8.12.7 Bibliography

Collective of authors. (2024). Poland - Draft updated NECP 2021-2030 - Annex 3. *Warsaw: Ministerstwo Klimatu i Środowiska*. Retrieved from: https://commission.europa.eu/publications/poland-draft-updated-necp-2021-2030_en

8.13. Slovakia - Energy efficiency actions alleviating energy poverty

Savings from this measure are considers a significant renovation, which the owners would not have implemented without the intervention of the state and would only deal with emergency situations and energy saving measures with a reasonable payback period. For individual projects in family houses, the minimum requirements for the energy efficiency of the building should be achieved, if it is technically, functionally and economically feasible.

The measure takes into account total energy savings representing the difference between the original and new state of the building. Any savings obtained by replacing existing light sources are not included in the energy savings. According to the experts evaluating the measures, the highest energy savings are achieved through insulation of the building envelope.

8.13.1 Calculation of Final Energy Savings

Formula

Savings are determined as the difference between the energy demand in the original condition of the building and the energy demand after the renovation of the building according to the energy certificate of the building. The saving is calculated on the basis of the same specific energy savings per 1 m^2 of the family house according to the sample project.

$$ÚS_{i\_plán} = (P_{pred} - P_{po}) \bullet CPP \qquad (116)$$

Table 155 – Parameters used in the formula for final energy savings

Parameter	Description
$ÚS_{i\_plán}$	Planned final energy savings in the year of building renovation [kWh/a]
P_{pred}	Energy requirement for the building prior to renovation – average energy requirement for the original condition of the building [kWh/(m^2.a)]
P_{po}	Energy requirement for the building after renovation, by reference to energy performance certificate data [kWh/(m^2.a)]
CPP	Total floor area of the building, as per the energy performance certificate [m^2]

Standardized Calculation Values

No calculation values available for this methodology.

9. Motor Replacement

9.1. Croatia - Electromotors in industry

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.

The application of the measure is intended for use in the industrial sector, but there are no restrictions. Additionally, the application of the measure does not depend on geographical and climatic coverage.

Savings can be calculated using data specific to each project or in certain cases using reference values.

In the case of using reference values, the documentation that needs to be attached/possessed as proof of the implementation of the measure and verification of the input data for the calculation of savings is the record of the handover of the electric motor and/or the invoice for the delivered electric motors, which shows the number, type and mechanical power of the electric motor.

In the case of using specific values, along with the record of handover and/or the invoice for the supplied electric motors or energy converters, it is necessary to attach/have a report on the energy consumption of the electric motor. It is necessary to determine the actual old installed power of the electric motor, the new installed power of the electric motor and the number of working hours. In addition, it is necessary to specify the efficiency of the electric motor and the load factors. In the case of installation of only energy converters, it is necessary to specify the savings factor. The report is drawn up by an authorized electrical engineering designer or a person authorized to carry out an energy inspection in the electrical engineering department for complex systems and/or industry.

9.1.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative savings:

$$TFES = \left(\sum_{i=1}^{N} UFES_i\right) \times rb \times so \times fr \times lt \qquad (117)$$

Table 156 – Parameters used in the formula for final energy savings

11	Description
TFES	Total final energy savings [kWh]
UFES	Unit annual energy savings of one electric motor [kWh/motor/a]
N	Number of motors replaced
rb	Factor to calculate a rebound effect
so	Factor to calculate a spill-over effect
fr	Factor to calculate a free-rider effect (=1)
lt	Factor for the lifetime of savings [a]

For savings in the event of a change in the power of the installed electric motor, unit energy savings are calculated using the following formula:

$$UFES = \left(\frac{P_{init} \times LF_{init}}{\eta_{init}} - \frac{P_{new} \times LF_{new}}{\eta_{new}}\right) \times h \tag{118}$$

If the power of the old engine is equal to the power of the efficient engine, the savings are determined according to the formula:

$$UFES = \left(\frac{1}{\eta_{init}} - \frac{1}{\eta_{new}}\right) \times P_{new} \times LF_{new} \times h \tag{119}$$

Table 157 – Parameters used in the formula for unit annual energy savings

Parameter	Description
UFES	Unit annual energy savings of one electric motor [kWh/motor/a]
P_{init}	Mechanical power of old motor [kW]
P_{new}	Mechanical power of new motor [kW]
LF_{init}	Load factor of old motor [%]
LF_{new}	Load factor of new motor [%]
η_{init}	Efficiency of old motor [%]
η_{new}	Efficiency of new motor [%]
h	Number of working hours per year [h/a]

In the case of installing power converters on an existing electric motor, the following formula must be used:

$$UFES = P \times h \times f_{VSD} \times \frac{1}{\eta} \tag{120}$$

Table 158 – Parameters used in the formula for unit annual energy savings

Parameter	Description
UFES	Unit annual energy savings of one electric motor [kWh/motor/a]
P	Mechanical power of motor [kW]
h	Number of working hours per year [h/a]
f_{VSD}	Energy saving factor by installing an energy converter [%]
η	Efficiency of motor [%]

Standardized Calculation Values

In the absence of project-specific data, indicative values should be used for η, h and LF. Reference values can be used in cases of installing new efficient electric motors or when changing the size of electric motors.

Table 159 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
rb	1	-
so	1	-
fr	1	-
lt	7,002	a

Table 160 – Indicative values for efficiency (%) depending on motor power and class

Power P [kW]	IE1				IE2				IE3				IE4			
	Pole number				Pole number				Pole number				Pole number			
	2	4	6	8	2	4	6	8	2	4	6	8	2	4	6	8
0,12	45,0	50,0	38,3	31,0	53,8	59,1	50,6	39,8	60,8	64,8	57,7	50,7	66,5	69,8	64,9	62,3
0,18	52,8	57,0	45,5	38,0	60,4	64,7	56,6	45,9	65,9	69,9	63,9	58,7	70,8	74,7	70,1	67,2
0,20	54,6	58,5	47,6	39,7	61,9	65,9	58,2	47,4	67,2	71,1	65,4	60,6	71,9	75,8	71,4	68,4
0,25	58,2	61,5	52,1	43,4	64,8	68,5	61,6	50,6	69,7	73,5	68,6	64,1	74,3	77,9	74,1	70,8
0,37	63,9	66,0	59,7	49,7	69,5	72,7	67,6	56,1	73,8	77,3	73,5	69,3	78,1	81,1	78,0	74,3
0,40	64,9	66,8	61,1	50,9	70,4	73,5	68,8	57,2	74,6	78,0	74,4	70,1	78,9	81,7	78,7	74,9
0,55	69,0	70,0	65,8	56,1	74,1	77,1	73,1	61,7	77,8	80,8	77,2	73,0	81,5	83,9	80,9	77,0
0,75	72,1	72,1	70,0	61,2	77,4	79,6	75,9	66,2	80,7	82,5	78,9	75,0	83,5	85,7	82,7	78,4
1,10	75,0	75,0	72,9	66,5	79,6	81,4	78,1	70,8	82,7	84,1	81,0	77,7	85,2	87,2	84,5	80,8
1,50	77,2	77,2	75,2	70,2	81,3	82,8	79,8	74,1	84,2	85,3	82,5	79,7	86,5	88,2	85,9	82,6
2,20	79,7	79,7	77,7	74,2	83,2	84,3	81,8	77,6	85,9	86,7	84,3	81,9	88,0	89,5	87,4	84,5
3,00	81,5	81,5	79,7	77,0	84,6	85,5	83,3	80,0	87,1	87,7	85,6	83,5	89,1	90,4	88,6	85,9
4,00	83,1	83,1	81,4	79,2	85,8	86,6	84,6	81,9	88,1	88,6	86,8	84,8	90,0	91,1	89,5	87,1
5,50	84,7	84,7	93,1	81,4	87,0	87,7	86,0	83,8	89,2	89,6	88,0	86,2	90,9	91,9	90,5	88,3
7,50	86,0	86,0	84,7	83,1	88,1	88,7	87,2	85,3	90,1	90,4	89,1	87,3	91,7	92,6	91,3	89,3
11,00	87,6	87,6	86,4	85,0	89,4	89,8	88,7	86,9	91,2	91,4	90,3	88,6	92,6	93,3	92,3	90,4
15,00	88,7	88,7	87,7	86,2	90,3	90,6	89,7	88,0	91,9	92,1	91,2	89,6	93,3	93,9	92,9	91,2
18,50	89,3	89,3	88,6	86,9	90,9	91,2	90,4	88,6	82,4	92,6	91,7	90,1	93,7	94,2	93,4	91,7
22,00	89,9	89,9	89,2	87,4	91,3	91,6	90,9	89,1	92,7	93,0	92,2	90,6	94,0	94,5	93,7	92,1
30,00	90,7	90,7	90,2	88,3	92,0	92,3	91,7	89,8	93,3	93,6	92,9	91,3	94,5	94,9	94,2	92,7
37,00	91,2	91,2	90,8	88,8	92,5	92,7	92,2	90,3	93,7	93,9	93,3	91,8	94,8	95,2	94,5	93,1
45,00	91,7	91,7	91,4	89,2	92,9	93,1	92,7	90,7	94,0	94,2	93,7	92,2	95,0	95,4	94,8	93,4
55,00	92,1	92,1	91,9	89,7	93,2	93,5	93,1	91,0	94,3	94,6	94,1	92,5	95,3	95,7	95,1	93,7
75,00	92,7	92,7	92,6	90,3	93,8	94,0	93,7	91,6	94,7	95,0	94,6	93,1	95,6	96,0	95,4	94,2
90,00	93,0	93,0	92,9	90,7	94,1	94,2	94,0	91,9	95,0	95,2	94,9	93,4	95,8	96,1	95,6	94,4
110,00	93,3	93,3	93,3	91,1	94,3	94,5	94,3	92,3	95,2	95,4	95,1	93,7	96,0	96,3	95,8	94,7
132,00	93,5	93,5	93,5	91,5	94,6	94,7	94,6	92,6	95,4	95,6	95,4	94,0	96,2	96,4	96,0	49,9
160,00	93,8	93,8	93,8	91,9	94,8	94,9	94,8	93,0	95,6	95,8	95,6	94,3	96,3	96,6	96,2	95,1
200,00	94,0	94,0	94,0	92,5	95,0	95,1	95,0	93,5	95,8	96,0	95,8	94,6	96,5	96,7	96,3	95,4
250,00	94,0	94,0	94,0	92,5	95,0	95,1	95,0	93,5	95,8	96,0	95,8	94,6	96,5	96,7	96,5	95,4
315,00	94,0	94,0	94,0	92,5	95,0	95,1	95,0	93,5	95,8	96,0	95,8	94,6	96,5	96,7	96,6	95,4
355,00	94,0	94,0	94,0	92,5	95,0	95,1	95,0	93,5	95,8	96,0	95,8	94,6	96,5	96,7	96,6	95,4
400,00	94,0	94,0	94,0	92,5	95,0	95,1	95,0	93,5	95,8	96,0	95,8	94,6	96,5	96,7	96,6	95,4
450,00	94,0	94,0	94,0	92,5	95,0	95,1	95,0	93,5	95,8	96,0	95,8	94,6	96,5	96,7	96,6	95,4
Over 500,00	94,0	94,0	94,0	92,5	95,0	95,1	95,0	93,5	95,8	96,0	95,8	94,6	96,5	96,7	96,6	95,4

Table 161 – Indicative values for working hours and load factor by device type and power range

Power range	Device type	Industry		Services	
		Working hours [h]	Load factor [%]	Working hours [h]	Load factor [%]
[0,75;4>	Pumps	3.861,00	0,55	3.800,00	0,55
[4;10>		4.501,90	0,58	3.050,00	0,60
[10;22>		5.040,50	0,59	3.000,00	0,60

[0,75;4>	Fans	4.910,50	0,53	2.250,00	0,60
[4;10>		4.137,80	0,56	2.500,00	0,65
[10;22>		5.210,60	0,59	2.500,00	0,65
[0,75;4>	Air compressors	2.178,00	0,63	1.030,00	0,40
[4;10>		4.057,70	0,60	1.000,00	0,45
[10;22>		4.626,00	0,68	980,00	0,45
[0,75;4>	Transporters	3.060,80	0,42	621,00	0,61
[4;10>		2.787,90	0,41	916,00	0,53
[10;22>		3.908,60	0,51	725,00	0,49
[0,75;4>	Refrigeration compressors	5.051,90	0,60		
[4;10>		1.890,60	0,65		
[10;22>		5.066,60	0,70		
[0,75;4>	Refrigerators			4.200,00	0,70
[4;10>				4.170,00	0,70
[10;22>				4.050,00	0,75
[0,75;4>	Other	3.086,60	0,34	500,00	0,30
[4;10>		2.859,50	0,39	530,00	0,30
[10;22>		2.299,40	0,45	570,00	0,30

The sources for all standardized values are listed in the Rulebook on the System for Monitoring, Measurement, and Verification of Energy Savings:

- values for factors of lifetime savings depend on the lifetime of the measure and all of them are listed in Annex D

values in

- Table 160 are taken from *European standard IEC 60034-30-1 Rotating electrical machines - Efficiency classes of constant speed alternating current electrical machines and European standard IEC 60034-30-2 Rotating electrical machines - Efficiency classes of variable speed alternating current electrical machines*.

values in

- Table 161 are taken from EMEEES project, Metod 12.

The indicative values presented in the *Rulebook on the System for Monitoring, Measurement, and Verification of Energy Savings* are intended to be used until they are officially revised or amended. Any changes or updates to these values will take effect at the time of the official publication of the amendments to the Rulebook. Essentially, these indicative values remain valid and in use until formal revisions are made and published in the official documents governing the rulebook.

9.1.2 Calculation of Primary Energy Savings

Formula

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

$$APES = \frac{TFES}{lt} \times PEF_{Electricity} \tag{121}$$

Table 162 – Parameters used in the formula for primary energy savings

Parameter	Description
APES	Annual primary energy savings [kWh/a]
TFES	Total final energy savings [kWh]

$PEF_{electricity}$	Primary Energy Factor for electricity [dmnl]
lt	Factor for the lifetime of savings [a]

Standardized Calculation Values

Table 163 – Indicative values for calculation of primary energy savings

Parameter	Value	Unit
$PEF_{Electricity}$	1,498	-

Data is taken from Annex I Table I-2 *of Rulebook on system for monitoring, measurement and verification of energy savings (NN 98/2021)*. Below the table as data source is listed "Energy in Croatia". Additionally, a note related to the factors given for electricity is added "Electricity production in the Republic of Croatia is mostly based on renewable energy sources, with large hydroelectric plants accounting for 51% and other renewable sources accounting for 15% of total electricity production in the Republic of Croatia. It is also important to note that most district heating plants are cogeneration plants".

The factors are published as part of the *Rulebook on the System for Monitoring, Measurement, and Verification of Energy Savings*, which is an officially published legal document in Croatia. The use of these published factors is considered common practice in the country. This means that the factors, once published, are widely accepted and applied in relevant energy saving programs, ensuring consistency and adherence to the established legal framework for monitoring and verifying energy savings.

9.1.3 Calculation of Greenhouse Gas Savings

Formula

The following formula is used to calculate the annual greenhouse gas savings:

$$GHGSAV = \frac{TFES}{lt} \times f_{GHG,electricity} \times 10^{-6} \quad (122)$$

Table 164 – Parameters used in the formula for greenhouse gas savings

Parameter	Description
GHGSAV	Greenhouse gas savings [t CO_2 p.a.]
TFES	Total final energy savings [kWh]
$f_{GHG,electricity}$	Emission factor for electricity [g CO_2/kWh]
lt	Factor for the lifetime of savings [a]

Standardized Calculation Values

Table 165 – Indicative values for calculation of greenhouse gas savings

Parameter	Value	Unit
$f_{GHG,electricity}$	0,159	kg CO_2/kWh

The data source is the same as for the primary energy factor for electricity as described in the chapter 0

Standardized Calculation Values .

9.1.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

9.1.5 Methodological Aspects

The calculation of savings is based on the difference in installed power before and after the implementation of the measure, while maintaining the same time of motor use, taking into account the load factor and engine utilization before and after the implementation of the measure.

The methodology for calculating savings is published as part of the *Rulebook on system for monitoring, measurement and verification of energy savings* and it is officially published legal document. Using of this published methodology is common practice in Croatia.

The language of the methodology is Croatian.

9.1.6 Bibliography

Ministry of Economy and Sustainable Development (2021), *Rulebook on system for monitoring, measurement and verification of energy savings*, NN 98/2021, https://narodne-novine.nn.hr/clanci/sluzbeni/2021_09_98_1772.html

Ministry of Economy and Sustainable Development (2022), *Regulation on Amendments and Supplements to the Rulebook on system for monitoring, measurement and verification of energy savings*, NN 30/2022, https://narodne-novine.nn.hr/clanci/sluzbeni/2022_03_30_370.html

9.2. Hungary - Replacement of electric motors

An energy efficiency measure can be considered a measure in which a previously installed electric motor is replaced with a motor with better efficiency and controlled speed, or the operating power requirement of the electric drive is lower than the nominal power of the installed motor, so the old motor is oversized and the new motor must be adjusted to a working point with lower power requirements.

For the measure, the nominal power of the electric motor and the average load before and after the motor replacement must be determined project-specifically, in accordance with the need. The nominal technical data and operating characteristics of the electric motors subject to the measure must be recorded.

The lifetime of the measure is 8 years, or the equivalent of 70,000 hours of operation, if recorded by an operating time counter.

When applying this measure, annual depreciation of energy savings does not have to be considered.

Table 166 – Nominal technical data and operating characteristics of the electric motors subject to the measure

A	B	C	D
Number of rows	**Technical parameter**	**Old**	**New**
1	Manufacturer		
2	Type		
3	Date the motor was first put into service	in case of early replacement	
4	Motor efficiency category (IE1, IE2, IE3 or IE4)		
5	Motor pole number (2, 4, 6 or 8)		
6	Engine speed control (constant, regulated)		

7	Rated motor power, P_N [kW]		
8	Motor efficiency, η_m [%]		
9	Average load, f_A [%]		
10	Annual operating time, ÿ [h/year]		

- Old — technical parameters before implementation of the measure
- New — technical parameters after implementation of the measure

9.2.1 Calculation of Final Energy Savings

When calculating the final energy savings achieved by replacing electric motors, the lifespan of the old electric motor must be considered.

a) If the old electric motor has not yet reached the end of its expected average service life, the measure is considered an early replacement according to Annex 7, point 2.6. of Government Decree 122/2015. (V. 26.) on the implementation of the Energy Efficiency Act (hereinafter: Ehat.vhr.).

b) If the old electric motor has a lifespan of more than 8 years, the energy consumption of the new equipment must be compared with the minimum requirements set out in the Commission Regulation on eco-design for the equipment in question. The excess energy saving is the amount by which the energy consumption of the new equipment is lower than the reference consumption that meets the minimum eco-design requirements.

Formula

Annual energy savings calculated from the difference in energy demand between the old and new motor. These formulas calculate first-year savings.

Early replacement

Calculated electricity savings after motor replacement:

$$TFES = (FEC_{before} - FEC_{after}) \times rb \times so \times fr \times lt \tag{123}$$

$$TFES = \left(P_{N,old} \times f_{A,old}/\eta_{m,old} - P_{N,new} \times f_{A,new}/\eta_{m,new}\right) \times \tau \; [kWh/year] \tag{124}$$

$$\Delta E_{early/year} = \left(P_{N,old} \times f_{A,old}/\eta_{m,old} - P_{N,new} \times f_{A,new}/\eta_{m,new}\right) \times \tau \times \frac{3,6}{1000} [GJ/year] \tag{125}$$

Table 167 – Parameters used in the formula for unit annual energy savings

Parameter	Description
$TFES$	Total final energy savings [kWh/year]
FEC_{before}	Final energy consumption before implementation of the action [kWh/a]
FEC_{after}	Final energy consumption after implementation of the action [kWh/a]
rb	Factor to calculate a rebound effect
so	Factor to calculate a spill-over effect
fr	Factor to calculate a free-rider effect (=1)
lt	Factor for the lifetime of savings
$\Delta E_{early/year}$	Total final energy savings [GJ/year]
$P_{N,old}$	Nominal electric power of the old electric motor [kW]
$P_{N,new}$	Nominal electric power of the new electric motor [kW]

$\eta_{m,old}$	Efficiency of the old electric motor [%]
$\eta_{m,new}$	Efficiency of the new electric motor [%]
$f_{A,old}$	Average load of the old electric motor [%]
$f_{A,new}$	Average load of the new electric motor [%]
τ	Annual operating time of the engine [h/ year]

Replacement after the end of lifetime of old equipment

$$TFES = (FEC_{before} - FEC_{after}) \times rb \times so \times fr \times lt \quad (126)$$

$$TFES = P_{N,new} \times f_{A,new} \times \left(1/\eta_{m,ref} - 1/\eta_{m,new}\right) \times \tau \; [kWh/year] \quad (127)$$

$$\Delta E_{excess/year} = P_{N,new} \times f_{A,new} \times \left(1/\eta_{m,ref} - 1/\eta_{m,new}\right) \times \tau \times \frac{3,6}{1000} [GJ/year] \quad (128)$$

Table 168 – Parameters used in the formula for unit additional annual energy savings

Parameter	Description
$TFES$	Total final energy savings [kWh/year]
FEC_{before}	Final energy consumption before implementation of the action [kWh/a]
FEC_{after}	Final energy consumption after implementation of the action [kWh/a]
rb	Factor to calculate a rebound effect
so	Factor to calculate a spill-over effect
fr	Factor to calculate a free-rider effect (=1)
lt	Factor for the lifetime of savings
$\Delta E_{excess/year}$	Additional final energy savings [GJ/year]
$P_{N,new}$	Nominal electric power of the new electric motor [kW]
$f_{A,new}$	Average load of the new electric motor [%]
$\eta_{m,new}$	Efficiency of the new electric motor [%]
$\eta_{m,ref}$	Reference efficiency [%]
τ	Annual operating time of the engine [h/ year]

Standardized Calculation Values

The reference efficiency values corresponding to the minimum energy efficiency requirement shall be set in accordance with Annex I to Commission Regulation (EU) 2019/1781 of 1 October 2019 laying down eco-design requirements for electric motors and frequency converters pursuant to Directive 2009/125/EC of the European Parliament and of the Council, amending Regulation (EC) No 641/2009 as regards eco-design requirements for glandless stand-alone circulators and glandless circulators integrated into products and repealing Commission Regulation (EC) No 640/2009:

a) From 1 July 2021, the energy efficiency of three-phase motors other than motors with increased safety 'Ex-eb' with a rated output of 0.12 kW or more but less than 0.75 kW, with 2, 4, 6 or 8 poles, shall at least comply with the IE2 efficiency category
b) From 1 July 2021, the energy efficiency of three-phase motors other than motors with increased safety 'Ex-eb' with a rated output of 0.75 kW or more but less than 1 000 kW, with 2, 4, 6 or 8 poles, shall at least comply with the IE3 efficiency category.

c) From 1 July 2023, the energy efficiency of motors with an increased safety rating of ‘Ex-eb’ with a rated output of 0.12 kW or more and up to 1 000 kW, with 2, 4, 6 or 8 poles, and of single-phase motors with a rated output of 0.12 kW or more shall comply with at least the efficiency category IE2.

d) From 1 July 2023, the energy efficiency of three-phase motors with a rated output of 75 kW or more and up to 200 kW, with 2, 4 or 6 poles, other than brake motors, increased safety motors with an increased safety rating of ‘Ex-eb’ or other explosion-proof motors shall comply with at least the efficiency category IE4.

The energy efficiency of motors, expressed in international energy efficiency categories (IE), is given in the Table for different nominal motor power values P_N. The IE categories are determined according to the nominal power output (P_N) and nominal voltage (U_N) based on 50 Hz operation and a basic ambient temperature of 25 °C.

Table 169 – Reference efficiencies $\eta_{m,ref}$ for efficiency categories IE2, IE3, IE4 at 50 Hz (%)

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Number of rows	Rated output power P_N [kW]	IE2				IE3J				IE4			
		Pole number				Pole number				Pole number			
		2	4	6	8	2	4	6	8	2	4	6	8
1	0,12	53,6	59,1	50,6	39,8	60,8	64,8	57,7	50,7	66,5	69,8	64,9	62,3
2	0,18	60,4	64,7	56,6	45,9	65,9	69,9	63,9	58,7	70,8	74,7	70,1	67,2
3	0,20	61,9	65,9	58,2	47,4	67,2	71,1	65,4	60,6	71,9	75,8	71,4	68,4
4	0,25	64,8	68,5	61,6	50,6	69,7	73,5	68,6	64,1	74,3	77,9	74,1	70,8
5	0,37	69,5	72,7	67,6	56,1	73,8	77,3	73,5	69,3	78,1	81,1	78	74,3
6	0,40	70,4	73,5	68,8	57,2	74,6	78,0	74,4	70,1	78,9	81,7	78,7	74,9
7	0,55	74,1	77,1	73,1	61,7	77,8	80,8	77,2	73,0	81,5	83,9	80,9	77,0
8	0,75	77,4	79,6	75,9	66,2	80,7	82,5	78,9	75,0	83,5	85,7	82,7	78,4
9	1,1	79,6	81,4	78,1	70,8	82,7	84,1	81,0	77,7	85,2	87,2	84,5	80,8
10	1,5	81,3	82,8	79,8	74,1	84,2	85,3	82,5	79,7	86,5	88,2	85,9	82,6
11	2,2	83,2	84,3	81,8	77,6	85,9	86,7	84,3	81,9	88,0	89,5	87,4	84,5
12	3	84,6	85,5	83,3	80,0	87,1	87,7	85,6	83,5	89,1	90,4	88,6	85,9
13	4	85,8	86,6	84,6	81,9	88,1	88,6	86,8	84,8	90,0	91,1	89,5	87,1
14	5,5	87,0	87,7	86,0	83,8	89,2	89,6	88,0	86,2	90,9	91,9	90,5	88,3
15	7,5	88,1	88,7	87,2	85,3	90,1	90,4	89,1	87,3	91,7	92,6	91,3	89,3
16	11	89,4	89,8	88,7	86,9	91,2	91,4	90,3	88,6	92,6	93,3	92,3	90,4
17	15	90,3	90,6	89,7	88,0	91,9	92,1	91,2	89,6	93,3	93,9	92,9	91,2
18	18,5	90,9	91,2	90,4	88,6	92,4	92,6	91,7	90,1	93,7	94,2	93,4	91,7
19	22	91,3	91,6	90,9	89,1	92,7	93,0	92,2	90,6	94,0	94,5	93,7	92,1
20	30	92,0	92,3	91,7	89,8	93,3	93,6	92,9	91,3	94,5	94,9	94,2	92,7
21	37	92,5	92,7	92,2	90,3	93,7	93,9	93,3	91,8	94,8	95,2	94,5	93,1
22	45	92,9	93,1	92,7	90,7	94,0	94,2	93,7	92,2	95,0	95,4	94,8	93,4
23	55	93,2	93,5	93,1	91,0	94,3	94,6	94,1	92,5	95,3	95,7	95,1	93,7
24	75	93,8	94,0	93,7	91,6	94,7	95,0	94,6	93,1	95,6	96,0	95,4	94,2
25	90	94,1	94,2	94,0	91,9	95,0	95,2	94,9	93,4	95,8	96,1	95,6	94,4
26	110	94,3	94,5	94,3	92,3	95,2	95,4	95,1	93,7	96,0	96,3	95,8	94,7
27	132	94,6	94,7	94,6	92,6	95,4	95,6	95,4	94,0	96,2	96,4	96,0	94,9
28	160	94,8	94,9	94,8	93,0	95,6	95,8	95,6	94,3	96,3	96,6	96,2	95,1
29	200 - 249									96,5	96,7	96,3	95,4
30	250 - 314	95,0	95,1	95,0	93,5	95,8	96,0	95,8	94,6	96,5	96,7	96,5	95,4
31	315 - 1000									96,5	96,7	96,6	95,4

Co-funded by the European Union

Average load of the old motor, $f_{A,old}$ [%]

a) In the case of a motor not matched to the operating point (the power of the old motor is higher than that of the new motor)
   - a.1 in the case of a constant speed electric drive: $f_{A,old}$ = 45%,
   - a.2. in the case of a controlled speed electric drive: $f_{A,old}$ = 30%

b) In the case of a motor matched to the operating point (the power of the old and new motors is almost the same)
   - b.1. in the case of a constant speed electric drive: $f_{A,old}$ = 90%,
   - b.2. in the case of a controlled speed electric drive: $f_{A,old}$ = 60%

c) If the average load of the old motor, $f_{A,old}$, can be derived in a unique way, different from the above values, in that case an individual audit is required.

Average load of the new motor, $f_{A,new}$ [%]

a) in the case of a constant speed electric drive: $f_{A,new}$ = 90%
b) in the case of a variable speed electric drive: $f_{A,new}$ = 60%

9.2.2 Calculation of Primary Energy Savings

Formula

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

$$\mathrm{APES} = TFES \times PEF_{Electricity} \qquad (129)$$

Table 170 – Parameters used in the formula for primary energy savings

Parameter	Description
APES	Annual primary energy savings [kWh/a]
TFES	Total final energy savings [kWh/a]
$PEF_{Electricity}$	Primary Energy Factor for electricity [dmnl]

Standardized Calculation Values

Table 171 – Indicative values for calculation of primary energy savings

Parameter	Value	Unit
$PEF_{Electricity}$		-

9.2.3 Calculation of Greenhouse Gas Savings

Formula

$$GHGSAV = TFES \times f_{GHG,electricity} \times 10^{-6} \qquad (130)$$

Table 172 – Parameters used in the formula for greenhouse gas savings

Parameter	Description
GHGSAV	Greenhouse gas savings [t CO_2 p.a.]
TFES	Total final energy savings [kWh/a]
$f_{GHG,electricity}$	Emission factor for electricity [g CO_2/kWh]

Standardized Calculation Values

Table 173 – Indicative values for calculation of greenhouse gas savings

Parameter	Value	Unit
$f_{GHG,electricity}$		kg CO_2/kWh

The data source is the same as for the primary energy factor for electricity as described in the chapter of Standardized Calculation Values .

9.2.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

9.2.5 Methodological Aspects

The principle of calculation is based on the difference in energy demand between the old and new motor.

The Hungarian Energy and Public Utility Regulatory Authority (MEKH) is the regulatory body of the energy and public utility market, supervising the national economy's sectors of strategic importance. The MEKH has established and reviews each year the EEOS catalogue, which lists the types of energy efficiency measures or investments that can be accounted in a simplified way. This Catalogue is published as the Annex of **17/2020.(XII. 21.) MEKH Decree** on data reporting on end-use energy savings.

Each catalogue sheet contains a description of the energy efficiency measure; the method and content of recording the baseline and post-measure status; the eligible lifetime and the level of degradation; a description of the performance factors and the principles for their calculation, the formula for calculating the annual savings; the documents to be submitted and other relevant information to support the accounting. For the time being, the catalogue contains 51 sheets in 5 categories.

All documents are available in Hungarian language.

9.2.6 Bibliography

The Hungarian Energy and Public Utility Regulatory Authority (2020): *17/2020.(XII. 21.) MEKH Decree on data reporting on end-use energy savings*, https://njt.hu/jogszabaly/2020-17-20-5Z.

9.3. Latvia - Calculating Energy Savings from Replacing Industrial Motors

This methodology outlines the calculation of energy savings from replacing electric motors in industrial enterprises. It employs standardized formulas for different replacement scenarios, such as replacing motors with more efficient alternatives, lower-power motors, or motors with variable frequency drives (VFD). The methodology follows the ex-ante estimation approach and uses parameters from the Energy Savings Catalogue provided by the State Construction Control Bureau.

9.3.1 Calculation of Final Energy Savings

Formula

This formula calculates the cumulative savings for replacing electric motors at industrial enterprises:

$$TFES = P \times h \times LF \times \left(\frac{1}{EF_{prev}} - \frac{1}{EF_{new}}\right) \times n \times y \times rb \times so \times fr \qquad (131)$$

Table 174 – Parameters used in the formula for replacing electric motors at industrial enterprises

Parameter	Description
TFES	The total final energy savings [kWh]
P	Electric power of the newly installed electric motor [kW]
h	Average annual working hours [h/year]
LF	Average load factor [%]
EF_{prev}	Efficiency of the replaced (previous) engine [%]
EF_{new}	Efficiency of the new engine [%]
n	Number of identical electric motors replaced [-]
y	The lifetime of the measure [-]
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)

This formula calculates the cumulative savings for replacing rotary motors with lower power motors:

$$TFES = \left(\frac{P_{prev} \times LF_{prev}}{EF_{prev}} - \frac{P_{new} \times LF_{new}}{EF_{new}}\right) \times h \times n \times y \times rb \times so \times fr \qquad (132)$$

Table 175 – Parameters used in the formula for replacing rotary motors with lower power motors

Parameter	Description
TFES	The total final energy savings [kWh]
P_{prev}	Mechanical power of the replaced (previous) motor [kW]
P_{new}	Mechanical power of the new installed motor [kW]
LF_{prev}	Average load factor of the replaced (previous) motor [%]
LF_{new}	Average load factor of the new installed motor [%]
h	Average annual working hours [h/year]
EF_{prev}	Efficiency of the replaced (previous) motor [%]
EF_{new}	Efficiency of the new lower power motor [%]
n	Number of identical rotary electric motors replaced by the lower-power motors [-]
y	The lifetime of the measure [-]
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)

This formula calculates the cumulative savings achieved by replacing electric motors with variable frequency drives:

$$TFES = Pe \times h \times f \times \frac{1}{EF} \times n \times y \times rb \times so \times fr \qquad (133)$$

Table 176 – Parameters used in the formula for replacing electric motors with variable frequency drives

Parameter	Description
TFES	The total final energy savings [kWh]
Pe	Electric power of electric motor [kW]

Parameter	Description
f	Energy savings from installing a variable-speed drive motor [%]
h	Average annual working hours [h/year]
EF	Efficiency of the electric motor [%]
n	Number of installed electric motors with variable frequency drives [-]
y	The lifetime of the measure [-]
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 177 – Indicative values for calculation of final energy savings from industrial motors replacement

Parameter	Value	Unit
P, Pe	300	kW
P_{new}	250	kW
h	2000	h
f	20	%
LF, LF_{prev}, LF_{new}	60	%
EF_{prev}	60	%
EF, EF_{new}	85	%
y	10	years

9.3.2 Calculation of Primary Energy Savings

No information on calculation of primary energy savings available for this methodology.

9.3.3 Calculation of Greenhouse Gas Savings

No information on calculation of greenhouse gas savings for this methodology.

9.3.4 Overview of Costs Related to the Action

No information on calculation of costs related to the action for this methodology.

9.3.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

9.3.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

10. Behavioural Changes

10.1. Austria - Energy consulting for households

A household is informed individually, personally and in detail about the causes of its energy consumption by qualified persons in the form of an energy consulting. Energy consulting sometimes lead to investments in energy-efficient equipment and sometimes to changes in usage behaviour (e.g. reducing the room temperature).

During this method, the effect on usage behaviour is evaluated. Investments in technical upgrades must be evaluated using other generalised methods or individually. The energy consulting must take place either directly in the household's home or at an advice centre. The duration of the energy consulting should be at least 60 minutes. An energy concept in the form of a consulting report must be drawn up during the consulting and handed over to the household. The application area of this method is private households Austria.

10.1.1 Calculation of Final Energy Savings

Formula

This formula calculates yearly savings.

$$FES = n \times FEV_{Ref} \times f_{fe} \times rb \times so \times fr \qquad (134)$$

Rebound (rb), spill-over (so) and free-rider (fr) effects are not taken into account in the formula.

Table 178 – Parameters used in the formula for energy consulting for households

Parameter	Description
FES	Final energy savings [kWh/a]
n	Number of energy consultings carried out [-]
FEV_{Ref}	Final energy consumption of an average household before implementation of energy counselling [kWh/a]
f_{fe}	Savings factor due to the energy consulting carried out [%]

Standardized Calculation Values

In the following standard values, a distinction is made between the following use cases:

- Electricity advice: Energy advice focussing on electricity consumption
- Heat consulting: An energy consulting focussing on heat (space heating and hot water)
- Household counselling: Comprehensive energy counselling for electricity and heating

Table 179 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
Lifetime of an energy consulting	2	years
Savings factor	3	%
Final energy consumption per household (FEV_{Ref})		
Electricity consulting	3.800	kWh/a
Heat counselling	15.200	kWh/a
Budget consulting	19.000	kWh/a
Household savings factor (f_{fe})	1	-
rb	1	-
so	1	-
fr	1	-

Co-funded by the European Union

10.1.2 Calculation of Primary Energy Savings

There is no information regarding primary energy savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

10.1.3 Calculation of Greenhouse Gas Savings

There is no information regarding the greenhouse gas savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

10.1.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

Cost-Effectiveness

No formula available for this methodology.

Standardized Values

No calculation values available for this methodology

10.1.5 Methodological Aspects

The methodology and formulas have been taken from an officially published legal document – it is a regulation of the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology on specifying the assessment and eligibility of energy efficiency measures. The initial language of the document is German.

The original document is available under:
https://www.ris.bka.gv.at/eli/bgbl/II/2024/28

10.1.6 Bibliography

Verordnung der Bundesministerin für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie: Konkretisierung der Bewertung und Anrechenbarkeit von Energieeffizienzmaßnahmen (Energieeffizienz-Maßnahmenverordnung – EEff-MV), BGBl. II Nr. 28/2024 (2024). https://www.ris.bka.gv.at/eli/bgbl/II/2024/28

10.2. Austria - Energy consulting for SMEs

A small company or a medium-sized company receives a detailed and individualised information on the causes of energy consumption in the form of energy consulting. Energy consulting sometimes lead to investments in energy-efficient equipment and sometimes to changes in usage behaviour (e.g. reducing the room temperature). During this method, the effect on usage behaviour is evaluated. Investments in technical upgrades must be evaluated using other generalised methods or individually.

Energy consulting in small and medium-sized companies should primarily aim to analyse the overall energy flows in the company or parts of the company and identify the main energy-consuming processes and applications. In addition to organisational measures to reduce energy consumption, investment measures must also be proposed.

This method can be used to assess energy management systems and energy consumption monitoring systems in addition to energy consulting. The energy consulting must be customised to the company. At least one on-site appointment must be held as part of the consulting.

The application area of this method is SMEs in Austria.

10.2.1 Calculation of Final Energy Savings

Formula

This formula calculates yearly savings.

$$FES = n \times FEV_{Ref} \times f_{fe} \times rb \times so \times fr \qquad (135)$$

Rebound (rb), spill-over (so) and free-rider (fr) effects are not taken into account in the formula.

Table 180 – Parameters used in the formula for energy consulting for SMEs

Parameter	Description
FES	Final energy savings [kWh/a]
n	Number of energy consultings carried out in small and medium-sized enterprises [-]
FEV_{Ref}	Average final energy consumption in the advised companies [kWh/a]
f_{fe}	Savings factor due to the energy consulting carried out [%]

Standardized Calculation Values

Table 181 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
Lifetime of an energy consulting	2	Years
Final energy consumption per company advised (FEV_{Ref})	Real value	kWh/a
Savings factor(f_{fe})	2	%
rb	1	-
so	1	-
fr	1	-

10.2.2 Calculation of Primary Energy Savings

There is no information regarding primary energy savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

10.2.3 Calculation of Greenhouse Gas Savings

There is no information regarding the greenhouse gas savings calculations available.

Formula

No formula available for this methodology.

Standardized Calculation Values

No calculation values available for this methodology.

10.2.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

Cost-Effectiveness

No formula available for this methodology.

Standardized Values

No calculation values available for this methodology.

10.2.5 Methodological Aspects

The methodology and formulas have been taken from an officially published legal document – it is a regulation of the Federal Minister for Climate Action, Environment, Energy, Mobility, Innovation and Technology on specifying the assessment and eligibility of energy efficiency measures. The initial language of the document is German.

The original document is available under:
https://www.ris.bka.gv.at/eli/bgbl/II/2024/28

10.2.6 Bibliography

Verordnung der Bundesministerin für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie: Konkretisierung der Bewertung und Anrechenbarkeit von Energieeffizienzmaßnahmen (Energieeffizienz-Maßnahmenverordnung – EEff-MV), BGBl. II Nr. 28/2024 (2024). https://www.ris.bka.gv.at/eli/bgbl/II/2024/28

10.3. Bulgaria - Energy savings resulting from household energy consultations – Bulgaria

This methodology establishes the conditions, application, and scope of energy consultations for households. It defines the requirements for documenting consultations and reporting results.

Application area: Households.

Boundary conditions: Savings are based on the total number of effectively conducted individual consultations, their quality level, consultation format, and the average statistical annual energy consumption of households in the country.

10.3.1 Calculation of Final Energy Savings

Formula

This formula calculates first-year savings.

$$FES_{tot\text{общо}} = Q_{\text{ср.общо}} \times (n_{Q1} \times e_{Q1} + n_{Q2} \times e_{Q2} + n_{Q3} \times e_{Q3}) \quad (136)$$

$$FES_{tot\text{Ел.Е}} = Q_{\text{ср.Ел.Е}} \times (n_{Q1} \times e_{Q1} + n_{Q2} \times e_{Q2} + n_{Q3} \times e_{Q3}) \quad (137)$$

Co-funded by the
European Union

$$FES_{totTE} = Q_{\text{cp.TE}} \times (n_{Q1} \times e_{Q1} + n_{Q2} \times e_{Q2} + n_{Q3} \times e_{Q3}) \qquad (138)$$

Table 182 – Parameters used in the formula for final energy savings

Parameter	Description
FEStotобщо	Energy savings at an end customer's site [kWh/a]
FEStotЕл.Е	Electricity savings at an end customer's site [kWh/a]
FEStotTE	Heat energy savings at an end customer's site [kWh/a]
Qср.общо	Average final energy consumption per household [kWh/a]
Qср.Ел.Е	Average final electricity consumption per household [kWh/a]
Qср.TE	Average final heat energy consumption per household [kWh/a]
nQn	Number of consultations conducted at quality level, n = 1÷3 [-]
eQn	Post-consultation quality savings factor, n = 1÷3 [%]

Three levels of consultation are specified:

Level 1: Consultations conducted by trained energy efficiency consultants (not registered with the Sustainable Energy Development Agency), based on user-provided data.

Level 2: Consultations conducted by trained consultants (not registered with the Sustainable Energy Development Agency) using additional technical tools like infrared cameras and energy meters.

Level 3: Consultations conducted by consultants registered with the Sustainable Energy Development Agency or certified European energy managers using user data and/or technical tools.

Standardized Calculation Values

The methodology provides the following indicative values for calculation of final energy savings.

Table 183 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
Qср.общо	8650	[kWh/a]
Qср.Ел.Е	3460	[kWh/a]
Qср.TE	5190	[kWh/a]
eQ1	1	%
eQ2	2	%
eQ3	3	%

The indicative values of Qср.общо, Qср.Ел.Е, and Qср.TE are based on statistical data from the National Statistical Institute.

10.3.2 Calculation of Primary Energy Savings

Formula

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

$$PES_{tot} = FES_{totобщо} \times e_P \qquad (139)$$

$$PES_{tot} = FES_{totЕл.Е} \times e_P \qquad (140)$$

$$PES_{tot} = FES_{totТЕ} \times e_P \qquad (141)$$

Table 184 – Parameters used in the formula for primary energy savings

Parameter	Description
PEStot	Primary energy savings at an end customer’s site [kWh/a]
FEStotобщо	Energy savings at an end customer's site [kWh/a]
FEStotЕл.Е	Electricity savings at an end customer's site [kWh/a]
FEStotTE	Heat energy savings at an end customer's site [kWh/a]
eP	Factor of total primary energy (Table 1 of Annex 1 to the Regulation No RD-02-20-3 of 9 November 2022 on technical requirements for the energy performance of buildings [-]

Standardized Calculation Values

Table 185 – Primary energy factors

Energy source	Value
Industrial gas oil, diesel	1,1
Natural gas	1,1
Propane-butane	1,1
Black coal	1,1
Lignite/brown coal	1,1
Anthracite coal	1,1
Coal briquettes	1,1
Firewood, pellets	1,2
Heat from district heating	1,3
Electricity	2,5
Heavy fuel oil	1,1

10.3.3 Calculation of Greenhouse Gas Savings

Formula

$$CO_2 = \frac{FES_{totобщо} \times f_i}{10^3} \qquad (142)$$

$$CO_2 = \frac{FES_{totЕл.Е} \times f_i}{10^3} \qquad (143)$$

$$CO_2 = \frac{FES_{tot\text{TE}} \times f_i}{10^3} \quad (144)$$

Table 186 – Parameters used in the formula for greenhouse gas savings

Parameter	Description
CO2	Greenhouse gas savings [t CO_2/a]
FEStotобщо	Energy savings at an end customer's site [kWh/a]
FEStotЕл.E	Electricity savings at an end customer's site [kWh/a]
FEStotTE	Heat energy savings at an end customer's site [kWh/a]
fi	Emission factor - Table 1 of Annex 1 to the Regulation No. RD-02-20-3 of 9 November 2022 on technical requirements for the energy performance of buildings [gCO2/kWh]

Standardized Calculation Values

Table 187 – Indicative values for calculation of greenhouse gas savings

Energy source	Value	Unit
Industrial gas oil, diesel	290	[gCO2/kWh]
Natural gas	220	[gCO2/kWh]
Propane-butane	220	[gCO2/kWh]
Black coal	360	[gCO2/kWh]
Lignite/brown coal	360	[gCO2/kWh]
Anthracite coal	360	[gCO2/kWh]
Coal briquettes	360	[gCO2/kWh]
Firewood, pellets	40	[gCO2/kWh]
Heat from district heating	290	[gCO2/kWh]
Electricity	486	[gCO2/kWh]
Heavy fuel oil	290	[gCO2/kWh]

10.3.4 Overview of Costs Related to the Action

Cost-Effectiveness

N/A

Standardized Values

N/A

10.3.5 Methodological Aspects

The presented methodology is published on the website of the Sustainable Energy Development Agency in Bulgarian.

10.3.6 Bibliography

Methodology for estimation of energy savings as a result of energy consultations of households, approved by Order No. E-RD-16-99/16.02.2022 of the Minister of Energy [PDF and EXCEL Workbook]

https://www.seea.government.bg/documents/Metodika_1.rar

10.4. Bulgaria - Methodology for estimating energy savings as a result of installing smart metering and control systems for households

The methodology sets out the conditions, implementation and method for reporting energy savings when installing smart metering and control systems for households that reflect the actual energy consumption of the end customer as well as the actual time of use of the energy. The methodology defines the requirements for documenting and reporting the results.

Application area: Households.

Boundary conditions: The calculation method takes into account the number of installed smart meters for households and the reference statistical amount of energy consumed by these households. It takes into account the effect of a reduction in energy consumption compared to households without smart meters.

10.4.1 Calculation of Final Energy Savings

Formula

$$FES_{tot\text{общо}} = n \times Q_{\text{ср.общо}} \times e_{SMART} \qquad (145)$$

$$FES_{tot\text{Ел.Е}} = n \times Q_{\text{ср.Ел.Е}} \times e_{SMART} \qquad (146)$$

$$FES_{tot\text{ТЕ}} = n \times Q_{\text{ср.ТЕ}} \times e_{SMART} \qquad (147)$$

Table 188 – Parameters used in the formula for final energy savings

Parameter	Description
FEStotобщо	Energy savings at an end customer's site [kWh/a]
FEStotЕл.Е	Electricity savings at an end customer's site [kWh/a]
FEStotTE	Heat energy savings at an end customer's site [kWh/a]
Qср.общо	Average final energy consumption per household [kWh/a]
Qср.Ел.Е	Average final electricity consumption per household [kWh/a]
Qср.TE	Average final heat energy consumption per household [kWh/a]
n	Number of installed smart metering and control systems in households [-]
eSMART	Savings factor by introducing smart metering in the household (%);

Standardized Calculation Values

The methodology provides the following indicative values for calculation of final energy savings.

Table 189 – Indicative values for calculation of final energy savings

Parameter	Value	Unit
Qср.общо	8650	[kWh/a]
Qср.Ел.Е	3460	[kWh/a]
Qср.TE	5190	[kWh/a]
eSMART	3	%

The indicative values of Qср.общо, Qср.Ел.Е, and Qср.TE are based on statistical data from the National Statistical Institute.

Co-funded by the
European Union

Studies (cited in the methodology bibliography) show that installing smart meters for households results in a 3% reduction in total household consumption.

10.4.2 Calculation of Primary Energy Savings

Formula

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

$$PES_{tot} = FES_{tot\text{общо}} \times e_P \quad (148)$$

$$PES_{tot} = FES_{tot\text{Ел.Е}} \times e_P \quad (149)$$

$$PES_{tot} = FES_{tot\text{TE}} \times e_P \quad (150)$$

Table 190 – Parameters used in the formula for primary energy savings

Parameter	Description
PEStot	Primary energy savings at an end customer’s site [kWh/a]
FEStotобщо	Energy savings at an end customer's site [kWh/a]
FEStotЕл.Е	Electricity savings at an end customer's site [kWh/a]
FEStotTE	Heat energy savings at an end customer's site [kWh/a]
eP	Factor of total primary energy (Table 1 of Annex 1 to the Regulation No RD-02-20-3 of 9 November 2022 on technical requirements for the energy performance of buildings [-]

Standardized Calculation Values

Table 191 – Primary energy factors

Energy source	Value
Industrial gas oil, diesel	1,1
Natural gas	1,1
Propane-butane	1,1
Black coal	1,1
Lignite/brown coal	1,1
Anthracite coal	1,1
Coal briquettes	1,1
Firewood, pellets	1,2
Heat from district heating	1,3
Electricity	2,5
Heavy fuel oil	1,1

10.4.3 Calculation of Greenhouse Gas Savings

Formula

$$CO_2 = \frac{FES_{totoбщо} \times f_i}{10^3} \quad (151)$$

$$CO_2 = \frac{FES_{totЕл.Е} \times f_i}{10^3} \quad (152)$$

$$CO_2 = \frac{FES_{totТЕ} \times f_i}{10^3} \quad (153)$$

Table 192 – Parameters used in the formula for greenhouse gas savings

Parameter	Description
CO2	Greenhouse gas savings [t CO_2/a]
FEStotoбщо	Energy savings at an end customer's site [kWh/a]
FEStotЕл.Е	Electricity savings at an end customer's site [kWh/a]
FEStotTE	Heat energy savings at an end customer's site [kWh/a]
fi	Emission factor - Table 1 of Annex 1 to the Regulation No. RD-02-20-3 of 9 November 2022 on technical requirements for the energy performance of buildings [gCO2/kWh]

Standardized Calculation Values

Table 193 – Indicative values for calculation of greenhouse gas savings

Energy source	Value	Unit
Industrial gas oil, diesel	290	[gCO2/kWh]
Natural gas	220	[gCO2/kWh]
Propane-butane	220	[gCO2/kWh]
Black coal	360	[gCO2/kWh]
Lignite/brown coal	360	[gCO2/kWh]
Anthracite coal	360	[gCO2/kWh]
Coal briquettes	360	[gCO2/kWh]
Firewood, pellets	40	[gCO2/kWh]
Heat from district heating	290	[gCO2/kWh]
Electricity	486	[gCO2/kWh]
Heavy fuel oil	290	[gCO2/kWh]

10.4.4 Overview of Costs Related to the Action

Cost-Effectiveness

N/A

Standardized Values

N/A

10.4.5 Methodological Aspects

The presented methodology is published on the website of the Sustainable Energy Development Agency in Bulgarian.

10.4.6 Bibliography

Methodology for estimating energy savings as a result of installing smart metering and control systems for households, approved by Order No. E-RD-16-100/16.02.2022 of the Minister of Energy [PDF and EXCEL Workbook]

https://www.seea.government.bg/documents/Metodika_2.rar

10.5. France - Device for displaying and interpreting consumption for a home heated by electricity

Acquisition or rental of a device for displaying and interpreting consumption connected to an electrical energy measurement system without such a device for a dwelling heated by electricity. The function of this device is: to use the measurement of energy consumption to interpret it; to communicate to the user the results obtained and appropriate advice in order to encourage them to reduce their energy consumption; to alert the user if a reference consumption threshold is exceeded.

The device allows the collection and processing of data on the electrical energy consumption of the home. The information and statistics produced by the device and brought to the user's attention include at least the following elements: display of energy consumption over the time interval between two delivery steps; the step is less than or equal to 1 hour; display of consumption in kWh and valued in euros; possibility of user access to different accumulations (hour/day/week/month/year); history of all accumulations, available over 3 months; history of accumulations, for a duration greater than or equal to the day, available for 2 rolling years.

The device allows the consumption achieved to be compared with reference consumption and thresholds. At a minimum, the comparison must be carried out in relation to consumption statistics extracted from the available history.

10.5.1 Calculation of Final Energy Savings

Formula

Equation (117) calculates cumulative final energy savings.

$$TFES = S_F \times S_{CZ} \times f_{LA} \tag{154}$$

The parameters used in the formula for final energy savings are presented in Table 194.

Table 194 – Parameters used in the formula for final energy savings

Parameter	Description
$TFES$	Total final energy savings [kWh]
S_F	Fixed part of the savings [kWh]
S_{CZ}	Savings for the climate zone [kWh]
f_{LA}	Factor to the living area

Standardized Calculation Values

Table 195 presents the indicative values for the calculation of final energy savings for a single-family home and
Table 196 for an apartment.

Table 195 – Indicative values for calculation of final energy savings for a single-family home

Parameter	Value		Unit
S_F	680		kWh
S_{CZ}	f_{CZ}	H	kWh
	2800	H1	
	2400	H2	
	1700	H3	
f_{LA}	f_{LA}	Area S (m^2)	%
	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	S≥130	

Table 196 – Indicative values for calculation of final energy savings for an apartment

Parameter	Value		Unit
S_F	460		kWh
S_{CZ}	f_{CZ}	H	kWh
	1300	H1	
	1100	H2	
	800	H3	
f_{LA}	f_{LA}	Area S (m^2)	%
	0.5	S < 35	
	0.7	35≤S≤60	
	1.0	60≤S≤70	
	1.2	70≤S≤90	
	1.5	90≤S≤110	
	1.9	110≤S≤130	
	2.5	S≥130	

10.5.2 Calculation of Primary Energy Savings

Formula

The methodology does not include any formula to calculate primary energy savings.

Standardized Calculation Values

No calculation values are available for this methodology.

10.5.3 Calculation of Greenhouse Gas Savings

Formula

The methodology does not include any formula to calculate Greenhouse Gas Savings.

Standardized Calculation Values

No calculation values are available for this methodology.

10.5.4 Overview of Costs Related to the Action

Cost-Effectiveness

No information on cost-effectiveness is available for this methodology.

Standardized Values

No calculation values are available for this methodology.

10.5.5 Methodological Aspects

The original document is in French, being an official document from the Ministry of Ecological Transition published with the reference BAR-EQ-113.

In France the energy savings targets, and action are recorded in kWh cumac of final energy, cumac being the contraction of "cumulative and actualized" and given by Equation (118).

$$kWh_{cumac} = TFES \times DC \tag{155}$$

The parameters used in the formula are presented in Table 197 and the indicative values are in Table 198.

Table 197 – Parameters used in the formula for final energy savings

Parameter	Description
kWh_{cumac}	Total final energy savings [kWh]
DC	Discount coefficient

Table 198 – Indicative values for calculation of energy savings certificates

Parameter	Value
Lifetime	4 [years]
DC(4%)	3.7751

10.5.6 Bibliography

Opérations standardisées d'économies d'énergie | Ministère du Partenariat avec les territoires et de la Décentralisation Ministère de la Transition écologique, de l'Énergie, du Climat et de la Prévention des risques Ministère du Logement et de la Rénovation urbaine. (n.d.). Ministère Du Partenariat Avec Les Territoires Et De La Décentralisation Ministère De La Transition Écologique, De L'Énergie, Du Climat Et De La Prévention Des Risques Ministère Du Logement Et De La Rénovation Urbaine. https://www.ecologie.gouv.fr/politiques-publiques/operations-standardisees-deconomies-denergie#scroll-nav__7

10.6. France - Device for displaying and interpreting energy consumption for a fuel-heated dwelling

Acquisition or rental of a device for displaying and interpreting consumption connected to a combustible energy measurement system and to an electrical energy measurement system, without such a device for a dwelling heated by a fuel. The function of this device is: to use the measurement of energy consumption to interpret it; to communicate to the user the results obtained and appropriate advice in order to encourage them to reduce their energy consumption; to alert the user if a reference consumption threshold is exceeded.

The device allows the collection and processing of data on the electrical energy and fuel consumption of the home. The information and statistics produced by the device and brought to the user's attention include at least the following elements: display of energy consumption over the time interval between two delivery steps; the step is less than or equal to 1 hour; display of consumption in m3 and/or kWh and valued in euros; possibility of user access to different accumulations (hour/day/week/ month/year); - history of all accumulations, available over 3 months; - history of accumulations, for a duration greater than or equal to one day, available over 2 rolling years.

The device allows the consumption achieved to be compared with reference consumption and thresholds. At a minimum, the comparison must be carried out in relation to consumption statistics extracted from the available history.

10.6.1 Calculation of Final Energy Savings

Formula

Equation (119) calculates cumulative final energy savings.

$$TFES = S_F \times S_{CZ} \times f_{LA} \tag{156}$$

The parameters used in the formula for final energy savings are presented in Table 199.

Table 199 – Parameters used in the formula for final energy savings

Parameter	Description
$TFES$	Total final energy savings [kWh]
S_F	Fixed part of the savings [kWh]
S_{CZ}	Savings for the climate zone [kWh]
f_{LA}	Factor to the living area

Standardized Calculation Values

Table 200 presents the indicative values for the calculation of final energy savings for a single-family home,
Table 201 for an apartment with individual heating, and
Table 202 for an apartment with collective heating.

Table 200 – Indicative values for calculation of final energy savings for a single-family home

Parameter	Value		Unit
S_F	680		kWh
S_{CZ}	f_{CZ}	H	kWh
	4200	H1	
	3600	H2	
	2600	H3	
f_{LA}	f_{LA}	Area S (m^2)	%
	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	S≥130	

Table 201 – Indicative values for calculation of final energy savings for an apartment with individual heating

Parameter	Value		Unit
S_F	460		kWh
S_{CZ}	f_{CZ}	H	kWh
	2200	H1	
	1900	H2	
	1500	H3	
f_{LA}	f_{LA}	Area S (m^2)	%
	0.5	S < 35	
	0.7	35≤S≤60	
	1.0	60≤S≤70	
	1.2	70≤S≤90	
	1.5	90≤S≤110	
	1.9	110≤S≤130	
	2.5	S≥130	

Table 202 – Indicative values for calculation of final energy savings for an apartment with collective heating

Parameter	Value		Unit
S_F	460		kWh
S_{CZ}	f_{CZ}	H	kWh
	3200	H1	
	2800	H2	
	2100	H3	
f_{LA}	f_{LA}	Area S (m^2)	%
	0.5	S < 35	
	0.7	35≤S≤60	
	1.0	60≤S≤70	
	1.2	70≤S≤90	
	1.5	90≤S≤110	
	1.9	110≤S≤130	
	2.5	S≥130	

10.6.2 Calculation of Primary Energy Savings

Formula

The methodology does not include any formula to calculate primary energy savings.

Standardized Calculation Values

No calculation values are available for this methodology.

10.6.3 Calculation of Greenhouse Gas Savings

Formula

The methodology does not include any formula to calculate Greenhouse Gas Savings.

Standardized Calculation Values

No calculation values are available for this methodology.

10.6.4 Overview of Costs Related to the Action

Cost-Effectiveness

No information on cost-effectiveness is available for this methodology.

Standardized Values

No calculation values are available for this methodology.

10.6.5 Methodological Aspects

The original document is in French, being an official document from the Ministry of Ecological Transition published with the reference BAR-EQ-114.

In France the energy savings targets, and action are recorded in kWh cumac of final energy, cumac being the contraction of "cumulative and actualized" and given by (120).

$$kWh_{cumac} = TFES \times DC \tag{157}$$

The parameters used in the formula are presented in Table 203 and the indicative values are in Table 204.

Table 203 – Parameters used in the formula for final energy savings

Parameter	Description
kWh_{cumac}	Total final energy savings [kWh]
DC	Discount coefficient

Table 204 – Indicative values for calculation of energy savings certificates

Parameter	Value
Lifetime	4 [years]
DC(4%)	3.7751

10.6.6 Bibliography

Opérations standardisées d'économies d'énergie | Ministère du Partenariat avec les territoires et de la Décentralisation Ministère de la Transition écologique, de l'Énergie, du Climat et de la Prévention des risques Ministère du Logement et de la Rénovation urbaine. (n.d.). Ministère Du Partenariat Avec Les Territoires Et De La Décentralisation Ministère De La Transition Écologique, De L'Énergie, Du Climat Et De La Prévention Des Risques Ministère Du Logement Et De La Rénovation Urbaine. https://www.ecologie.gouv.fr/politiques-publiques/operations-standardisees-deconomies-denergie#scroll-nav__7

10.7. Latvia - Methodological Guidelines for Assessing Energy Savings from Information and Education Measures

This calculation methodology evaluates energy savings from information and education campaigns by estimating the behavioural impact on the target audience. It uses standardized values, surveys, or engagement data to assess the proportion of individuals influenced by the campaigns and their subsequent energy consumption reduction. Separate formulas are applied for 1st-level campaigns (broad awareness campaigns) and 2nd-level campaigns (in-depth, actionable initiatives) to capture their respective impacts. The purpose of these agreements is to educate and advise consumers (energy end-users) on energy saving measures and solutions that change consumer behaviour and habits towards energy efficiency. Target sectors: residential, commercial, and public sectors where behaviour-driven energy savings are relevant. Generally, assumes short-term effects (1 year).

10.7.1 Calculation of Final Energy Savings

Formula

This formula calculates first-year savings for 1st-level campaigns (broad awareness campaigns) (measures lifetime equals to one year). 1st-level campaigns require identifying the target group size by a survey.

$$TFES = FEC_{TG} \times S_Q \times S_{iet} \times rb \times so \times fr$$
$$FEC_{TG} = n \times FEC_{person} \tag{158}$$

Table 205 – Parameters used in the formula for calculating final energy savings from 1st-level behavioural measures

Parameter	Description
TFES	The total savings [kWh]
FEC_{TG}	Final energy consumption of a specific target group [kWh]
FEC_{person}	Final energy consumption per household (calculated from statistical data or a specific target group available data) [kWh]
S_Q	Information and education campaign factor [%]
S_{iet}	Share of households affected by information and education campaigns [%]
n	The number of inhabitants or households in the specified target group (determined by the survey) [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (not explicitly included. However, it can be incorporated as a correction factor if reliable data or estimates about the spill-over effect are available such as data from surveys) [%]
fr	Factor to calculate a free-rider effect (=1)

This formula calculates first-year savings for 2nd-level campaigns (in-depth, actionable initiatives) (measures lifetime equals to one year):

$$TFES = FEC_{TG} \times S_Q \times rb \times so \times fr$$
$$FEC_{TG} = n \times FEC_{person} \tag{159}$$

Table 206 – Parameters used in the formula for calculating final energy savings from 2nd-level behavioural measures

Parameter	Description
TFES	The total savings [kWh]
FEC_{TG}	Final energy consumption of a specific target group [kWh]
FEC_{person}	Final energy consumption per household [kWh]
S_Q	Information and education campaign factor [%]
n	The number of inhabitants or households in the specified target group [-]
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)

Co-funded by the
European Union

Standardized Calculation Values

Standardized values for energy-saving factors are supported by different countries empirical data on energy savings.

Table 207 – Indicative values for calculation of greenhouse gas savings from freight transport replacement

Parameter (S_Q)	Value	Unit
Awareness campaign savings factor (1st-level)	2	%
Non-individual advice on the company's website (2nd-level)	3	%
Non-individualised advice at EE centres or at the EE centre stand exhibitions and public events (2nd-level)	3	%
Long-term public awareness program (2nd-level)	3	%
Personalized additional information on EE issues included in energy bills (2nd-level)	8	%
Individual consultations in EE centres, agencies, customer centres (2nd-level)	16	%

10.7.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

10.7.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

10.7.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

10.7.5 Methodological Aspects

The methodology for calculating energy savings from informational campaigns in Latvia follows a structured approach outlined in official government documents and practical guidelines. It integrates survey-based assessments and standardized values to ensure consistency and transparency in evaluating the impact of energy-saving interventions.

This methodology was taken from officially published document "Methodological guidelines for assessing energy savings of information and educational measures" / "Metodiskie norādījumi informēšanas un izglītošanas pasākumu enerģijas ietaupījumu novērtēšanai": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

The methodology aligns with the Latvian Cabinet of Ministers Regulations No. 668 (2016) on energy efficiency monitoring and applicable energy management standards.

10.7.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Methodological guidelines for assessing energy savings of information and educational measures" / "Metodiskie norādījumi informēšanas un izglītošanas pasākumu enerģijas ietaupījumu novērtēšanai". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

10.8. Latvia - Methodology for Calculating Energy Savings from the Installation of Smart Meters –

This methodology calculates the energy savings achieved from the installation of smart meters in the household sector, with and without real-time energy consumption feedback and advice. The methodology varies based on the type of smart meter installed and has a lifetime of two years.

10.8.1 Calculation of Final Energy Savings

Formula

This formula calculates cumulative savings from smart meter installations:

$$TFES = n \times EC \times k \times y \times rb \times so \times fr \quad (160)$$

Table 208 – Parameters used in the formula for calculating energy savings from smart meter installation

Parameter	Description
TFES	The total final energy savings over the lifetime [kWh]
n	Number of installed smart meters [-]
EC	Final energy consumption in the household [kWh/year]
k	Savings factor [%]
y	The lifetime of the measure [-]
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 209 – Indicative values for calculation of final energy savings from smart meters installation

Parameter	Value	Unit
Basic smart meter (k)	2	%
Basic smart meter and guidance for user on information analysis (k)	4	%
A smart meter with real-time feedback (display) (k)	5	%
A smart meter with real-time feedback and advice to the user on information analysis (k)	7	%
A smart meter accompanied by multiple specialized accessories for monitoring the cumulative consumption and cost of specific household electrical appliances (k)	12	%
The lifetime of the measure (y)	2	years

10.8.2 Calculation of Primary Energy Savings

No information on calculation of primary energy savings available for this methodology.

10.8.3 Calculation of Greenhouse Gas Savings

No information on calculation of greenhouse gas savings available for this methodology.

10.8.4 Overview of Costs Related to the Action

No information on calculation of costs related to the action for this methodology.

10.8.5 Methodological Aspects

The methodology uses the expected savings (ex-ante) method, as outlined in Sub-paragraph 2.4 of Regulation No. 660 (18 October 2022), and relies on default values from the State Construction Control

Co-funded by the
European Union

Bureau's Catalogue of Energy Savings. This catalogue is part of the energy efficiency monitoring system and provides standardized energy-saving measures with achievable savings values.

This methodology was taken from the Catalogue "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs": https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali [in Latvian language]

10.8.6 Bibliography

1. Būvniecības valsts kontroles birojs (2022). Document "Energy savings catalogue developed by the Ministry of Economics" / "Ekonomikas ministrijas izstrādātais enerģijas ietaupījumu katalogs". https://www.bvkb.gov.lv/lv/zinojumi-un-metodiskie-materiali

10.9. Lithuania - Methodology for calculating energy savings through education and consulting measures for energy end-users

The Law on Energy Efficiency Improvement of the Republic of Lithuania establishes that education and consulting, aimed at promoting energy efficiency measures and reducing final energy consumption, are key components of the energy efficiency improvement policy. Furthermore, the law mandates that energy suppliers enter into publicly disclosed agreements with the Ministry of Energy to provide consumer education and advice. Energy suppliers are obligated to achieve at least 1 % energy savings from the total energy supplied to final consumers through education and consulting actions.

The purpose of these agreements is to educate and advise consumers (energy end-users) on energy saving measures and solutions that change consumer behaviour and habits towards energy efficiency.

10.9.1 Calculation of Final Energy Savings

Formula

This formula calculates first-year savings (measures lifetime equals to one year). 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:

$$S_1 = Gv \times d \times k \times rb \times so \times fr \qquad (161)$$

The total savings generated by the education and consulting measure are calculated as the sum of the individual education and consulting measure:

$$S = S_1 + \ldots + S_n \qquad (162)$$

Table 210 – Parameters used in the formula for calculating final energy savings from behavioural measures

Parameter	Description
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	The energy savings coefficient of the education and consulting measure [-]
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

The energy-saving coefficients are used to standardize and estimate the impact of various educational and advisory measures on reducing energy consumption. These coefficients represent the expected energy savings resulting from specific interventions and allow for consistent evaluation across different activities. The energy-saving coefficients are determined by the Ministry of Energy based on empirical studies, surveys, and analyses of similar energy-saving initiatives conducted either locally or in other European Union countries.

Table 211 – Indicative values (k) for calculation of final energy savings from behavioural 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

Type of education and advisory measure	Energy saving coefficient
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

10.9.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

10.9.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

10.9.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

10.9.5 Methodological Aspects

This methodology was taken from officially published legal document "The approval of the description of the procedure for calculating and monitoring energy savings from energy efficiency improvement measures, No.: 1-320": https://www.e-tar.lt/portal/lt/legalAct/c3eb4b20bbb911e688d0ed775a2e782a/asr [in Lithuanian language]

10.9.6 Bibliography

1. Ministry of Energy of the Republic of Lithuania (2016). The description of the procedure for calculating and monitoring energy savings from energy efficiency improvement measures, No.: 1-320. Consolidated version 2020-08-28. Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/c3eb4b20bbb911e688d0ed775a2e782a/asr
2. Ministry of Energy of the Republic of Lithuania (2017). The description of procedure for the establishment of energy consumer education and consultation agreements, No.: 1-221. Consolidated version 2020-09-05. Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/95f761a09c4a11e78bd78a8ea3cd0744/asr

10.10. Lithuania - Methodology for calculating overall energy savings through energy saving agreements

Energy saving agreements are concluded between the Ministry of Energy and electricity and gas transmission and distribution network operators. These agreements involve companies in which the state, either directly or through its controlled entities, owns at least half of the shares granting voting rights at the company's general meeting of shareholders. The agreements are established in accordance with the Law of the Republic of Lithuania on *Increasing Energy Efficiency* (No. XII-2702) and the *Description of the Procedure for Concluding Energy Saving Agreements*.

The following methodology calculates the total energy savings achieved through measures implemented under energy saving agreements.

10.10.1 Calculation of Final Energy Savings

Energy savings from energy-saving agreements are calculated using a simple formula that determines the difference in energy consumption before and after the implementation of a measure.

Formula

This formula calculates cumulative savings of the implemented measure:

$$\Delta Q = (Q_{before} - Q_{after}) \times y \times rb \times so \times fr \tag{163}$$

Table 212 – Parameters used in the formula for calculating final energy savings from energy saving agreements

Parameter	Description
ΔQ	Total final heat energy savings [MWh]
Q_{before}	Final heat energy consumption before implementation of the measure [MWh]
Q_{after}	Final heat energy consumption after implementation of the measure [MWh]
y	Duration of the measure [years]
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

The lifetime of the measure [y] is based on the *Commission Recommendation (EU) 2019/1658 of 25 September 2019* on transposing the energy savings obligations under the *Energy Efficiency Directive*.

10.10.2 Calculation of Primary Energy Savings

No information on primary energy savings available for this methodology.

10.10.3 Calculation of Greenhouse Gas Savings

No information on greenhouse gas savings available for this methodology.

10.10.4 Overview of Costs Related to the Action

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

10.10.5 Methodological Aspects

This methodology was taken from officially published legal document "The description of the procedure for setting up energy savings agreements No.: 1-187": https://www.e-tar.lt/portal/lt/legalAct/cd89c430688011e7827cd63159af616c/asr [in Lithuanian language]

10.10.6 Bibliography

1. Ministry of Energy of the Republic of Lithuania (2017). The description of the procedure for setting up energy savings agreement, No.: 1-187. Consolidated version 2020-08-19. Register of legal acts. https://www.e-tar.lt/portal/lt/legalAct/cd89c430688011e7827cd63159af616c/asr
2. European Union (2019). Commission Recommendation (EU) 2019/1658 of 25 September 2019 on transposing the energy savings obligations under the Energy Efficiency Directive (CELEX No. 32019H1658). EUR-Lex. https://eur-lex.europa.eu/legal-content/LT/TXT/?uri=CELEX:32019H1658

10.11. Poland - Nationwide information and educational campaigns

10.11.1 Calculation of Final Energy Savings

Formula

Correction factors for the rebound, spill-over, and free-rider effects are not taken in the account.

This formula calculates first-year savings.

$$O_{kamp} = \frac{L_{odb} * Ods_{skt} * Ods_{dz} * Z_{energ-mieszkanie} * Ods_{zm-beh}}{L_{mieszk}} \qquad (164)$$

Table 213 – Parameters used in the formula for final energy savings

Parameter	Description
L_{odb}	audience of the most popular campaign in a given year
Ods_{skt}	percentage of people willing to save energy
Ods_{dz}	percentage of persons whose declared willingness to save energy translates into concrete actions reducing energy consumption
$Z_{mieszkanie}$	final energy consumption per 1 dwelling
Ods_{zm-beh}	percentage of energy consumption by a dwelling which can be reduced through behavioural changes
L_{mieszk}	average number of occupants of 1 dwelling in Poland

Standardized Calculation Values

No calculation values available for this methodology

10.11.2 Calculation of Primary Energy Savings

Calculation of Primary Energy Savings is not available. The calculation is done in final energy, but primary energy factors, which are set by legislation, can be used.

10.11.3 Calculation of Greenhouse Gas Savings

No calculation of greenhouse gas savings available for this methodology

10.11.4 Overview of Costs Related to the Action

No Overview of Costs Related available for this methodology

10.11.5 Methodological Aspects

No details provided.

10.11.6 Bibliography

Collective of authors. (2017). National Energy Efficiecny Action Plan for Poland. *Warsaw: Ministerstwo Klimatu i Środowiska*. Retrieved from: https://commission.europa.eu/publications/poland-draft-updated-necp-2021-2030_en

11. Modal Shift in Freight Transport

11.1. Hungary - Use of intermodal transport

The measure applies to vehicles of categories N2 and N3 as defined in Decree 5/1990 (IV. 12.) of the Ministry of Transport and Communications, and trailers of categories O3 and O4. The measure may be implemented by companies established in Hungary operating a vehicle park or fleet for business purposes, which partially use freight rail transport instead of road transport in their freight transport activities, with the performance of any business entity providing freight rail transport services. Freight rail is a more energy-efficient intermodal transport type than road freight transport, with the help of which final energy savings in transport can be achieved.

The basic data required for calculating energy savings are given in Table 214. The data in the table must be determined for each shipment, each time. The lifetime of the measure is 1 year.

If the measure is applied, the annual obsolescence of energy savings does not need to be considered. There is no minimum energy efficiency requirement associated with the measure.

Table 214 – Basic data on initial and post-action status for each consignment

A	B	C	D
Number of rows	**Technical parameter**	**Old mode of transport**	**New mode of transport**
1	Trailer registration number (1)	necessary*	
2	Net weight of trailer [tons] (1)	necessary*	
3	Transported payload [tons]	necessary	
4	Pure road transport route length [km]	necessary	not necessary
5	Road route length of intermodal transport [km]	not necessary	necessary
6	Intermodal transport rail route length [km]	not necessary	necessary
7	The share of fuel refuelled in Hungary in the previous year within the transport fuel consumption for all trucks used by the company applying the measure in the relevant transport area	necessary	

(1) Where goods are transported by rail together with the trailer.

11.1.1 Calculation of Final Energy Savings

The principle of calculation is based on the difference between the specific fuel consumption of the two modes of transport.

Formula

The annual final energy savings are calculated using the following formula:

$$TFES = (FEC_{before} - FEC_{after}) \times rb \times so \times fr \times lt \quad (165)$$

$$TFES = \frac{\sum_{i=1}^{n}\left(F_{old} \times u_{old,i} \times m_{sz,i} - F_{old} \times u_{new,i} \times m_{sz,i} - F_{new} \times v_{new,i} \times (m_{sz,i} + m_{fp,i})\right)}{1000} \times a \times 277{,}78\ [kWh/year] \quad (166)$$

$$\Delta E_{total/year} = \frac{\sum_{i=1}^{n}\left(F_{old} \times u_{old,i} \times m_{sz,i} - F_{old} \times u_{new,i} \times m_{sz,i} - F_{new} \times v_{new,i} \times (m_{sz,i} + m_{fp,i})\right)}{1000} \times a\ [GJ/year] \quad (167)$$

Table 215 – Parameters used in the formula for calculation of energy savings

Parameter	Description
$TFES$	Total final energy savings [kWh/year]
FEC_{before}	Final energy consumption before implementation of the action [kWh/a]
FEC_{after}	Final energy consumption after implementation of the action [kWh/a]
rb	Factor to calculate a rebound effect
so	Factor to calculate a spill-over effect
fr	Factor to calculate a free-rider effect (=1)
lt	Factor for the lifetime of savings
$\Delta E_{total/year}$	Total final energy savings [GJ/year]
n	Number of consignments recorded in a given year [-]
$u_{old,i}$	Calculated distance of the first consignment accounted for purely by road [km]
$u_{new,i}$	Actual road journey length of the first consignment accounted for [km]
$v_{new,i}$	Actual rail journey length of the first consignment accounted for [km]
F_{old}	Specific fuel consumption of road transport according to **0** [MJ/tkm]
F_{new}	Specific fuel consumption of rail transport according to **0** [MJ/tkm]
$m_{sz,i}$	Mass of consignment recorded (i) [t]
$m_{fp,i}$	Mass of the trailer of the i^{th} consignment, 0 if the trailer is not to be railed, [t]
a	Share of fuel refuelled in the previous year in the transport fuel consumption of all trucks used by the company applying the measure in the transport area concerned in the Hungary area

Standardized Calculation Values

Specific fuel consumption values to be used for calculation:

- Road transport: F_{old} = 1,79 MJ/tkm
- Rail transport: F_{new} = 0,19 MJ/tkm

For the old mode of transport, the distance to be considered is the distance of transport by road over the entire route length. The new mode of transport shall consider the journeys of the transport actually carried out by road and rail.

11.1.2 Calculation of Primary Energy Savings

Formula

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

$$\text{APES} = TFES \times PEF_{Electricity} \qquad (168)$$

Table 216 – Parameters used in the formula for primary energy savings

Parameter	Description
APES	Annual primary energy savings [kWh/a]
TFES	Total final energy savings [kWh/a]
$PEF_{Electricity}$	Primary Energy Factor for electricity [dmnl]

Standardized Calculation Values

No calculation values available for this methodology.

11.1.3 Calculation of Greenhouse Gas Savings

Formula

$$GHGSAV = TFES \times f_{GHG,electricity} \times 10^{-6} \quad (169)$$

Table 217 – Parameters used in the formula for greenhouse gas savings

Parameter	Description
GHGSAV	Greenhouse gas savings [t CO_2 p.a.]
TFES	Total final energy savings [kWh/a]
fGHG,electricity	Emission factor for electricity [g CO_2/kWh]

Standardized Calculation Values

No calculation values available for this methodology.

11.1.4 Overview of Costs Related to the Action

No information on cost-effectiveness available for this methodology.

11.1.5 Methodological Aspects

The principle of calculation is based on the difference between the specific fuel consumption of the two modes of transport.

The Hungarian Energy and Public Utility Regulatory Authority (MEKH) is the regulatory body of the energy and public utility market, supervising the national economy's sectors of strategic importance. The MEKH has established and reviews each year the EEOS catalogue, which lists the types of energy efficiency measures or investments that can be accounted in a simplified way. This Catalogue is published as the Annex of **17/2020.(XII. 21.) MEKH Decree on data reporting on end-use energy savings.**

Each catalogue sheet contains a description of the energy efficiency measure; the method and content of recording the baseline and post-measure status; the eligible lifetime and the level of degradation; a description of the performance factors and the principles for their calculation, the formula for calculating the annual savings; the documents to be submitted and other relevant information to support the accounting. For the time being, the catalogue contains 51 sheets in 5 categories.

All documents are available in Hungarian language.

11.1.6 Bibliography

The Hungarian Energy and Public Utility Regulatory Authority (2020): *17/2020.(XII. 21.) MEKH Decree on data reporting on end-use energy savings*, https://njt.hu/jogszabaly/2020-17-20-5Z.

List of tables

Co-funded by the
European Union

Co-funded by the
European Union

CONTACT THE PROJECT

@streamSAVEplus

svn.cz/streamsaveplus

contact@streamsaveplus.eu

Co-funded by the
European Union