



Coordination and Support Action
H2020-LC-SC3-EE-2019

Bottom up methodologies in the scope of streamSAVE Priority Actions

Annex II of Deliverable D2.1 – First PA round

Version N° 3

Authors: Paula Fonseca (ISR), Carlos Patrão (ISR), Pedro Moura (ISR)



@streamsaveh2020



www.streamsave.eu



@stream_save



contact@streamsave.eu



This project has received funding from the Horizon 2020 programme under grant agreement n° 890147.



Disclaimer

The content of this deliverable reflects only the author's view. The European Commission is not responsible for any use that may be made of the information it contains.





Document Information

Grant agreement	890147
Project title	Streamlining Energy Savings Calculations
Project acronym	streamSAVE
Project coordinator	Nele Renders, VITO/EnergyVille
Project duration	1 st September 2020 – 31 st August 2023 (36 months)
Related work package	WP 2 - Knowledge facility: bottom-up calculation methodologies for individual energy saving actions
Related task(s)	Task 2.1 – Status of bottom-up energy saving calculation for priority actions in EU-27 and UK
Lead organisation	ISR
Contributing partner(s)	ADEME, AEA, CIRCE, CRES, ECI, IEECP, JSI, LEA, LGI, SEVEn, VITO
Lead authors	Paula Fonseca (ISR), Carlos Patrão (ISR), Pedro Moura (ISR)
Contributing author(s)	Grégory Chédin (ADEME), Elisabeth Böck (AEA), Gema Millán Ballesteros (CIRCE), Christos Tourkolias (CRES), Tomas Jezdinsky (ECI), Ivana Rogulj (IEECP), Jean-Sébastien Broc (IEECP), Matevž Pušnik (JSI), Aistė Lankininkaitė (LEA), Gabor Szendro (LGI), Jiří Karásek (SEVEn), Nele Renders (VITO), Kelsey van Maris (VITO)
Due date	April 2021 – First PA round
Publication date	10 May 2021 – First PA round
Dissemination level	Public





Table of Contents

Introduction	7
Chapter 1 Heat recovery: district heating and excess heat from industry	8
1.1 Evaluation of energy savings in the secondary recovery of waste heat in compressed air systems - Bulgaria	8
1.2 Evaluation of energy savings of the installation of a suitable burner and waste heat recovery system in industrial furnaces – Bulgaria	9
1.3 Evaluation of energy savings of the installation of heat recovery systems before entering cooling towers - Bulgaria	10
1.4 Introduction of heat recovery systems - Cyprus.....	12
1.5 Evaluation of energy savings in a heat recovery system on the cooling unit - France	13
1.6 Evaluation of energy savings in the installation of a suitable burner and waste heat recovery system in industrial furnaces - France	14
1.7 Evaluation of energy savings in the installation of heat recovery systems before entering cooling towers – France	16
1.8 Heat recovery from a compressed air system - Luxembourg	17
1.9 Industrial boiler with economizer - Luxembourg.....	19
1.10 Industrial boiler with condensing economizer - Luxembourg	20
1.11 Utilization of excess heat in industry and service sector - Slovenia	22
Chapter 2 Building energy management systems & Building automation and control systems	24
2.1 Evaluation of energy savings in the installation of automation and heating control systems in residential buildings - Bulgaria	24
2.2 Evaluation of energy savings in the installation of an energy-efficient management system at a distribution station – Bulgaria.....	29
2.3 Installation of heating system regulation equipment – Croatia	31
2.4 Installation of equipment for automatic regulation of lighting systems – Croatia... ..	33
2.5 Installation of equipment for automatic regulation of electricity consumption – Croatia	34
2.6 Evaluation of energy savings in the installation of automation and heating control systems and hot sanitary water in residential buildings – France.....	36
Chapter 3 Commercial and industrial refrigeration systems	38
3.1 Central compression refrigeration units – Austria	38
3.2 Installation of natural cooling systems – Bulgaria	39
3.3 Installation of a free-cooling by cooling water replacing a cooling unit in a tertiary building – France.....	41
3.4 Installation of free cooling by cooling water replacing a cooling unit in the industry – France	43



3.5 Measures for new installation or replacement of cooling systems in services and industrial sector buildings - Croatia.....	44
3.6 Replacement of electric compression refrigeration units by absorption cooling units – Italy.....	46
3.7 Replacement of electric compression refrigeration units by refrigerating units with indirect absorption – Italy	47
3.8 Replacement or new installation of electric compression refrigeration units - Italy	48
3.9 Increasing the evaporator temperature - Luxembourg	52
3.10 Lowering the condenser temperature - Luxembourg	53
3.11 Central compression cooling system - multEE.....	55
3.12 District cooling - multEE.....	57
Chapter 4 Electric Vehicles: private and public vehicles and infrastructure	60
4.1 Alternative vehicle technologies for passenger cars - Austria	60
4.2 Replacing existing and buying new, more efficient vehicles - Croatia	61
4.3 Promoting electromobility: electric bicycles and scooters – Croatia	63
4.4 Promoting electromobility: mopeds and motorcycles with three or four wheels with electric drive (vehicles of category L2 - L7, except category L3) – Croatia	65
4.5 Promotion of electric vehicles – Cyprus.....	67
4.6 Alternative vehicle technologies for passenger cars – Czechia	68
4.7 Promotion of alternative vehicle technologies – Greece	70
4.8 Eco Fleet in Transport – Electric vehicles - Ireland	72
4.9 Replacing a car by an electric vehicle or a rechargeable hybrid car - Luxembourg.	73
4.10 New electric passenger cars - Slovenia.....	75
4.11 Alternative vehicle technologies for passenger cars – EMEES	76
4.12 Alternative vehicle technologies (passenger cars) – multEE.....	78
Chapter 5 Lighting systems including public lighting.....	82
5.1 Efficient street lighting - Austria.....	82
5.2 Replacement of incandescent lamps at traffic lights with LED lamps – Bulgaria	84
5.3 Installation of light control sensors – Bulgaria	85
5.4 Energy-efficient lighting in buildings of the residential sector – Croatia	87
5.5 Replacement, improvement or installation of new lighting systems and their components in service and industrial sector buildings - Croatia	88
5.6 Replacement of installation of a new public lighting system - Croatia	91
5.7 Replacement of lamps with compact fluorescent lamps - Cyprus.....	93
5.8 Replacement of incandescent lamps with LED lamps – France.....	94
5.9 Replacement of public lighting – France	96
5.10 Energy-efficient lighting in buildings of the residential sector - Greece	97





5.11	Energy-efficient lighting in office buildings of the tertiary sector - Greece.....	99
5.12	Energy-efficient lighting in buildings of the tertiary and industrial sectors - Greece	100
5.13	Energy-efficient street lighting - Greece	101
5.14	Lighting Upgrade Credits Calculation Tool - Ireland.....	103
5.15	Replacement of inefficient lamps - Portugal.....	106
5.16	Energy-efficient lighting in buildings - Slovenia.....	107
5.17	Energy savings when installing a new lighting system – Slovenia	109
5.18	Renovation of outdoor lighting systems - Slovenia.....	111
5.19	Improving street lighting systems - MultEE	114
Chapter 6	Hors category	117
6.1	Energy Management System – Croatia.....	117
6.2	Introduction of energy management systems – Cyprus	118
6.3	Introduction of energy management systems – Greece.....	119
6.4	Intelligent Meters promoting Energy Efficiency and Sustainability – Portugal..	121
6.5	Installation of advanced metering systems and energy billing in households and the service sector - Slovenia	121
6.6	Introduction of energy management systems (EMS) - Slovenia.....	123
6.7	Waste heat recovery systems in buildings - Slovenia	124
6.8	Non-residential space heating improvement in case of heating distribution by a water loop – EMEES	126



Introduction

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

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

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

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

The chapters are organized by the five Priority Actions (PA), such as *“Heat recovery: district heating and excess heat from industry”*, *“Building energy management systems & Building Automation Systems”*, *“Commercial and industrial refrigeration systems”*, *“Electric Vehicles: private and public vehicles and infrastructure”* and *“Lighting systems including public lighting”*. To distinguish between the different methodologies, the heading titles of the chapters and sub-chapters provide information about the methodology and from which Member State it was collected. In the chapter “Hors category”, several collected methodologies are presented that do not fit entirely in the five PAs but can provide useful inputs for future methodologies to be developed.





Chapter 1 Heat recovery: district heating and excess heat from industry

1.1 Evaluation of energy savings in the secondary recovery of waste heat in compressed air systems - Bulgaria

The current method refers to the secondary recovery of waste heat in compressed air systems of the industrial sector.

Application area: The presented method can be used for the case of the industrial units using compressed air systems.

1.1.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = n * [Q_{need} * (CF * P * h_p) * H]$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of compressors with the same technical characteristics
Q_{need}	Degree of absorption of waste heat [%]
CF	Compressor load factor [%]
P	Power of one compressor [kW]
h_p	Percentage utilization of waste heat [%]
H	Average yearly operating hours [h/a]

1.1.2 Standardized calculation values

Lifetime of savings	[a]
All industrial units	20

1.1.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

1.1.4 Description of sources

Calculation methodology

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



Measurement data are used for the estimation of the calculation values. In the absence of data, parameters such as load profile or working hours are collected from interviews with site staff, production levels and reported work programs.

Calculation values

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

1.1.5 Bibliography

Ministry of Energy (2021). Methodology for estimation of energy savings in secondary utilization of waste heat in compressed air systems, Methodology no 25.

<https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijinite-spestqwanic-utwyrdeni-ot-me>

1.2 Evaluation of energy savings of the installation of a suitable burner and waste heat recovery system in industrial furnaces – Bulgaria

The current method refers to the installation of suitable burner and waste heat recovery systems in industrial furnaces.

Application area: The presented method can be used for the case of the industrial units using furnaces.

1.2.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^i n * [(F_{base} - F_{eff}) * H]$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of burners with the same technical parameters for one industrial furnace
i	Different types/capacities of burners for one industrial furnace
F _{base}	Power of the existing burner [kW]
F _{eff}	Power of the energy-efficient burner [kW]
H	Average yearly operating hours of the industrial furnace [h/a]

1.2.2 Standardized calculation values

Lifetime of savings	[a]
All industrial units	20





1.2.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

1.2.4 Description of sources

Calculation methodology

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

It is required to collect data on the energy efficiency of the industrial furnace and the number of working hours annually. Measurements of fuel consumption must be performed to evaluate the efficiency of the industrial furnace. The determination of the energy performance of the energy-efficient burner will be performed by the suppliers in conjunction with the technical specifications.

Calculation values

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

1.2.5 Bibliography

Ministry of Energy (2021). Methodology for estimating energy savings when installing a suitable burner and waste heat recovery system in industrial furnaces, Methodology no 26.

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

1.3 Evaluation of energy savings of the installation of heat recovery systems before entering cooling towers - Bulgaria

The current method refers to the installation of heat recovery systems before entering cooling towers. With this methodology, heat recovery systems installed before the cooling tower can be evaluated as follows:

- Wet cooling tower with closed or open circulation circuit
- Dry cooling tower with closed or open circulation circuit (also called air-cooled condensers and dry coolers)
- Mixed cooling tower (wet/dry) with closed or open circulation circuit

Application area: The presented method can be used for the case of the industrial units using cooling towers.

1.3.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^i n * Q_{rec} * SES$$



Where:

TFES	Total final energy savings [kWh/a]
n	Number of cooling towers
i	Different types of cooling towers
Q_{rec}	Rated heat output of the installed heat exchanger before the cooling tower [kW]
SES	Specific annual energy savings per unit heat output per heat exchanger [kWh/kW]

1.3.2 Standardized calculation values

SES	[kWh/kW]
One working shift	2,100
Two working shifts	4,200
Three working shifts without Saturday and Sunday	6,300
Three working shifts	7,680
Lifetime of savings	[a]
All industrial units	10

1.3.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

1.3.4 Description of sources

Calculation methodology

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

The methodology is based on data analysis in accordance with European standards. The values for the calculation method are determined by a standard and no measurements are required. Moreover, the methodology is applied when installing a heat recovery system before entering the cooling tower (rated power < 7 MW). The information must be given about the nominal heat output of the installed heat exchanger before the cooling towers (Q_{rec}). The nominal heat output of the recovery system must be up to 70% of that of the cooling tower.

Calculation values

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





1.3.5 Bibliography

Ministry of Energy (2021). Methodology for estimating energy savings when installing heat recovery systems before entering cooling towers, Methodology no 29.

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

1.4 Introduction of heat recovery systems - Cyprus

The current method refers to the introduction of heat recovery systems to enterprises.

Application area: The presented method can be used for the case of enterprises in the industrial and tertiary sectors.

1.4.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^n FEC_{before} - FEC_{after}$$

Where:

TFES	Total final energy savings [kWh/a]
FEC_{before}	Final energy consumption before the installation of the heat recovery system [kWh]
FEC_{after}	Final energy consumption after the installation of the heat recovery system [kWh]
n	Number of the installed systems

It should be noted that the calculations are performed taking into account the energy bills issued over a period beginning two years before installation and ending one year after installation.

1.4.2 Standardized calculation values

Lifetime of savings	[a]
Enterprises of the tertiary sector	20
Enterprises of the industrial sector	15

1.4.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

1.4.4 Description of sources

Calculation methodology

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





Calculation values

The required calculation values are collected for each developed system separately.

The lifetime of savings was defined in the notification report for achieving the target of Article 7 of the EED for the period 2014-2020.

It should be noted that typical values for the delivered energy savings per installed system for specific categories of projects are provided also in the notification report.

Energy savings	[toe per system]
Heat recovery system – Tertiary sector	55.00
Heat recovery system – Industrial sector	59.32

1.4.5 Bibliography

MECIT (2017). 4th National Energy Efficiency Action Plan of Cyprus, 235.

MECIT (2014). National Energy Efficiency Program, Notification report for achieving the target of Article 7, 34 and 37.

1.5 Evaluation of energy savings in a heat recovery system on the cooling unit - France

Application area: The current method refers to a heat recovery system on a cooling unit in the industrial sector.

1.5.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = D * P * f$$

Where:

TFES	Total final energy savings [kWh/a]
D	Annual duration of use of recovered heat [hours]
P	Thermal power recovered [kW]
f	Factor of 0,9

1.5.2 Standardized calculation values

Lifetime of savings	[a]
All industrial units	14

1.5.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.





1.5.4 Description of sources

Calculation methodology

This methodology for assessing the delivered energy savings has been approved and has been published by order of the Minister of Ecological Transition.

Calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Ecological Transition.

A preliminary sizing study is used to obtain the data used for the calculation.

1.5.5 Bibliography

Ministry of Energy (2020). Arrêté du 24 juillet 2020 (JO du 2 août 2020) avec rectificatif publié au JO du 8 août 2020.

Standard Operations information sheets: IND UT 117 :

https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie#scroll-nav_7

1.6 Evaluation of energy savings in the installation of a suitable burner and waste heat recovery system in industrial furnaces - France

The current method refers to the installation of suitable burner and waste heat recovery systems in industrial furnaces.

Application area: The presented method can be used for the case of the industrial units using furnaces.

1.6.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = P * ESt * H$$

Where:

TFES	Total final energy savings [kWh/a]
P	powers nominal thermal of new burners [kW]
ESt	Energy savings per kW depending on the temperature [kWh]
H	Average yearly operating hours of the industrial furnace [h/a]



1.6.2 Standardized calculation values

Smoke temperature at the outlet furnace in degree Celsius	Est
$600 \leq T \leq 750$	138
$750 < T \leq 1000$	216
$1000 < T \leq 1250$	355
$1250 < T$	502
Average yearly operating hours of the industrial furnace [h/a]	H
One working shift	1
Two working shifts	2,2
Three working shifts without Saturday and Sunday	3
Three working shifts	4,2

Lifetime of savings	[a]
All industrial units	15

1.6.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

1.6.4 Description of sources

Calculation methodology

This methodology for assessing the delivered energy savings has been approved and has been published by order of the Minister of Ecological Transition.

The power to be used is the one shown on the burner nameplate or indicated on a document from the manufacturer.

Calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Ecological Transition.

1.6.5 Bibliography

Ministry of Ecological Transition (2017). Arrêté du 26 juillet 2017 (JO du 8 août 2017).

Standard Operations information sheets : IND UT 118 :

https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie#scroll-nav_7





1.7 Evaluation of energy savings in the installation of heat recovery systems before entering cooling towers – France

The current method refers to the installation of heat recovery systems before entering cooling towers.

With this methodology, heat recovery systems installed before the cooling tower can be evaluated as follows:

- Wet cooling tower with closed or open circulation circuit
- Dry cooling tower with closed or open circulation circuit (also called air-cooled condensers and dry coolers)
- Mixed cooling tower (wet/dry) with closed or open circulation circuit

Application area: The presented method can be used in the case of the industrial units using cooling towers.

1.7.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = Q_{rec} * ES$$

Where:

TFES	Total final energy savings [kWh/a]
Q_{rec}	Rated heat output of the installed heat exchanger before the cooling tower [kW]
ES	Energy savings per unit heat output per heat exchanger [kWh/kW]

1.7.2 Standardized calculation values

Working shifts	ES [kWh/kW]
One working shift	1,434
Two working shifts	3,165
Three working shifts without Saturday and Sunday	4,315
Three working shifts	6,046
Lifetime of savings	[a]
All industrial units	10

1.7.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.



1.7.4 Description of sources

Calculation methodology

This methodology for assessing the delivered energy savings has been approved and has been published by order of the Minister of Ecological Transition.

The methodology is based on data analysis in accordance with European standards. The values for the calculation method are determined by a standard and no measurements are required. Moreover, the methodology is applied when installing a heat recovery system before entering the cooling tower (rated power < 7 MW). The information must be given about the nominal heat output of the installed heat exchanger before the cooling towers (Q_{rec}). The nominal heat output of the recovery system must be up to 70% of that of the cooling tower.

Calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Ecological Transition.

1.7.5 Bibliography

Ministry of Ecological Transition.(2015). Arrêté du 30 septembre 2015 (JO du 04 octobre 2015)

Standard Operations information sheets: IND BA 112 :
https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie#scroll-nav_7

1.8 Heat recovery from a compressed air system - Luxembourg

The functioning of the compressor entails significant heat losses. In case this heat is recovered and used for other applications, energy savings can be attained. The heat could especially be used to preheat ventilation air or for other purposes in the domain of heating.

Application area: The measure is applicable in the industrial sector.

Boundary conditions: The measure is only applicable if the compressed fluid is ambient air; If the average compressor load significantly differs from 80%, a specific calculation must be performed; If the available heat cannot be fully used because of demand-side limitations, a specific calculation must be performed.

Only the standard values of energy savings as listed in Annex II (section 1.8.5) to the Grand Ducal Regulation, and not the measured energy savings, can be counted for standardized measures.

1.8.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

Annual opening time t_{ouv} is identified according to the table below in section 1.8.2. Then, the nominal electrical power of the compressor P_{nom} is identified. This can be found on the technical fiche of or the registration card of the compressor. Then, the formula below is used to calculate the annual savings.





$$VEEP = \frac{0,8 * P_{nom} * t_{ouv} * k_i * 0,7}{100.000}$$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]
P _{nom}	Nominal electrical power of the compressor [kW]
t _{ouv}	Annual opening time (cf. table 1) [h]
k _i	Ratio of compressor load time to opening time [%]. As a default, k _i = 100% but can be more specified by the type of user, in case needed.

1.8.2 Standardized calculation values

Lifetime of savings	[-]
Lifetime of savings	10
Average load of compressor	[%]
Average load of compressor	80
Annual opening time t_{ouv}	[h/year]
Industry, 1 post, 5days/week	1.920
Industry, 2 posts, 5days/week	3.840
Industry, 2 posts, 6days/week	4.608
Industry, 2 posts, 7days/week	5.376
Industry, 3 posts, 5days/week	5.760
Industry, 3 posts, 6days/week	6.912
Industry, 3 posts, 7days/week	8.064
Industry, 3 posts, continuously	8.760
Ratio of compressor load time to opening time k_i	[%]
Default	100
Energy savings	[%]
Standard value of energy savings as listed in Annex II of the bibliography listed in the below section 1.8.5.	70

1.8.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

1.8.4 Description of sources

Calculation methodology

This methodology was published in the Luxembourg catalogue on standardized measures (Annex II - section 1.8.5), which is annexed to the Grand-Ducal Regulation of August 7,



2015 relating to the functioning of the energy efficiency obligation mechanism. The document is published in French.

Calculation values

No information on the calculation values was provided.

1.8.5 Bibliography

Ministry of the Economy (2015). Grand-Ducal Regulation of August 7, 2015 relating to the operation of the energy efficiency obligation mechanism (JO of 2 September 2015, Mémorial A 170).

Annex II Catalogue of standardized measures: Code AC-040

<http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo>

1.9 Industrial boiler with economizer - Luxembourg

During the operation of a boiler, a substantial part of energy is lost through the escape of smoke via the chimney. The installation of an economizer allows to recover a part of this waste heat, which can then be used to preheat a cold fluid, in particular makeup water. Although modern boilers are already equipped with this technology, existing boilers can be retrofitted with an economizer as an improvement.

Application area: The measure is applicable in the industrial sector.

Boundary conditions: The makeup water should not be preheated by another system before the economizer; Only the standard values of energy savings as listed in Annex II (section 1.8.5) to the Grand Ducal Regulation, and not the measured energy savings, can be counted for standardized measures.

1.9.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

The current industrial boiler (hot water, steam, or thermic oil) is not equipped with an economizer. The measure comprises the retrofitting of an economizer on the boiler.

$$VEEP = 0,05 * E_{chaud,n-1}$$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]
$E_{chaud,n-1}$	Fuel consumption of the boiler for the last full year [MWh]





1.9.2 Standardized calculation values

Lifetime of savings	[-]
Lifetime of savings	10
Energy savings	[%]
Standard value of energy savings as listed in Annex II of the bibliography listed in the below section 1.9.5.	5

1.9.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

1.9.4 Description of sources

Calculation methodology

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

Calculation values

No information on the calculation values was provided.

1.9.5 Bibliography

Ministry of the Economy (2015). Grand-Ducal Regulation of August 7, 2015 relating to the operation of the energy efficiency obligation mechanism (JO of 2 September 2015, Mémorial A 170).

Annex II Catalogue of standardized measures: Code CI-010:
<http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo>

1.10 Industrial boiler with condensing economizer - Luxembourg

During the operation of a boiler, a substantial part of the energy is lost through the escape of smoke via the chimney. The installation of a condensation economizer allows recovering a part of this waste heat (and does so to a larger extent than a non-condensing economizer). The waste heat can then be used to preheat a cold fluid, in particular makeup water.

Application area: The measure is applicable in the industrial sector.

Boundary conditions: The makeup water should not be preheated by another system before the economizer; Only the standard values of energy savings as listed in Annex II (section 1.9.5) to the Grand Ducal Regulation, and not the measured energy savings, can be counted for standardized measures.

1.10.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

Three cases can be distinguished:





1. The current industrial boiler is out of use and cannot be repaired anymore, or even the absence of an industrial boiler. A new industrial boiler with condensation will be installed.
2. The current industrial boiler does not have an economizer. It will be equipped with a condensation economizer.
3. The current industrial boiler has an economizer, however, without condensation. It will be equipped with a condensation economizer.

According to the above-mentioned cases, the following calculation formulas are used:

Case 1	$VEEP = 0,01 * E_{chaud,n-1}$
Case 2	$VEEP = 0,06 * E_{chaud,n-1}$
Case 3	$VEEP = 0,01 * E_{chaud,n-1}$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]
$E_{chaud,n-1}$	Fuel consumption of the boiler for the last full year [MWh] (for case a: Fuel consumption of the boiler for the last full year or projected consumption in case of absence of a boiler in the initial situation [MWh])

1.10.2 Standardized calculation values

Lifetime of savings	[-]
Lifetime of savings	10
Energy savings	[%]
Standard value of energy savings as listed in Annex II of the bibliography listed in the below section 1.10.5.	1 or 6

1.10.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

1.10.4 Description of sources

Calculation methodology

This methodology was published in the Luxembourg catalogue on standardized measures (Annex II - section 1.10.5), which is annexed to the Grand-Ducal Regulation of August 7, 2015 relating to the functioning of the energy efficiency obligation mechanism. The document is published in French.

Calculation values

No information on the calculation values was provided.





1.10.5 Bibliography

Ministry of the Economy (2015). Grand-Ducal Regulation of August 7, 2015 relating to the operation of the energy efficiency obligation mechanism (JO of 2 September 2015, Mémorial A 170).

Annex II Catalogue of standardized measures: Code CI-020:

<http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo>

1.11 Utilization of excess heat in industry and service sector - Slovenia

Excess heat is the residual heat in the operation of various processes and devices, which is discharged as a by-product into the environment (in flue gases, fluids, etc.). The beneficial use of excess heat is the efficient use of available excess heat for economically justifiable heating or cooling which would otherwise have to be satisfied under market conditions with other energy sources. The most common measures for the utilization of excess heat according to the source and technology are:

- high-temperature heat of furnace flue gases (heat exchangers for heating, regeneration and recuperation burners, electricity generation, etc.), flue gas heat of boilers (flue gas heat exchangers/economizer, condenser etc.),
- heat compressors for compressed air and refrigeration systems (heat exchangers, direct use of hot air, etc.), low-temperature heat of various cooling systems (heat exchangers, heat pumps etc.).

The utilization of excess heat in the production of electricity is considered in the method for cogeneration of heat and electricity (CHP). Energy savings due to the use of excess heat are equal to the energy value of used excess heat, which is determined directly by heat efficiency measurements. Where this is not technically feasible or associated with disproportionately high costs, the savings are calculated based on energy audits.

1.11.1 Calculation Formula - First-year savings

Energy savings in the use of excess heat are determined by the equation:

$$PE_{WH} = Q_{uWH}$$

Where:

PE_{WH}	Energy savings [kWh/year] due to the implementation of measures to exploit excess heat,
Q_{uWH}	Useful use of excess heat [kWh/year] - measured or calculated based on an energy audit.

1.11.2 Cost-effectiveness

No information on cost-effectiveness available for this methodology.



1.11.3 Description of sources

To calculate energy savings, measurements of the useful use of excess heat in a sufficiently long period are required reference period to allow a qualitative assessment of the annual useful use of excess heat due to the implementation of the measure and according to the available consumers of this heat. If the performance of measurements is technical impracticable or would require a disproportionately high cost, a detailed estimate of usefulness shall be used use of excess heat produced within an energy view, where they must be detailed analyzed and evaluated:

- available excess heat potential: annual volume according to excess heat temperature levels, time dynamics (daily, weekly and seasonal...), technological limitations and capture requirements, etc.,
- possible useful use of this heat: required temperature levels of potential users, compliance of time dynamics of use with the availability of excess heat (daily, weekly and seasonal...), spatial framework (distances, barriers at the location, etc.) and other factors.

1.11.4 Bibliography

Uradni list RS, št. [67/15](#), [14/17](#) in [158/20](#) – ZURE, Rules on the methods for determining energy savings, p. 58–59:

<http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12451>





Chapter 2 Building energy management systems & Building automation and control systems

2.1 Evaluation of energy savings in the installation of automation and heating control systems in residential buildings - Bulgaria

The current method refers to the implementation of automation and heating control systems in residential buildings.

Application area: The presented method can be used for all types of buildings.

2.1.1 Calculation Formula - First-year savings

Estimation of savings for Article 7

$$TFES = n * [FEC_{before} - FEC_{after}]$$

Where:

TFES	Total final energy savings [kWh/a]
FEC_{before}	Heat consumption of residential buildings before the installation of automation and heating control systems [kWh/m ²]
FEC_{after}	Heat consumption of residential buildings after the installation of automation and heating control systems [kWh/m ²]
n	Total heated area of the residential buildings where the automation and heating control systems will be installed

2.1.2 Standardized calculation values

Lifetime of savings	[a]
All types of buildings	10

2.1.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

2.1.4 Description of sources

Calculation methodology

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

The calculation of the energy savings is performed through the energy class of the building (at least class "F") and the automation class of the technical systems of the building, as specified in the standard CEN EN 15232: 2007 ("Energy performance of buildings. Impact of automation, control and monitoring systems on buildings").



The automation and heating control systems have been classified into four different categories regarding their energy efficiency potential. The energy efficiency ratio of the four categories of automation and heating control systems are presented in the following table.

Category of automation and heating control systems	Energy efficiency ratio
D - Energy inefficient building	1.1
C - Standard (reference)	1.0
B - Energy efficient building	0.88
A - High energy performance	0.81

Moreover, predefined specific TFES (sTFES) estimations have been calculated, which are equal to the difference of heat consumption of residential buildings before and after the installation of automation and heating control systems ($FEC_{\text{before}} - FEC_{\text{after}}$). The sTFES are provided for two categories of the automation and heating control systems (classified as A and B according to the previous table) regarding energy class of the buildings (A+ to F), the S/V ratio (building's surface in m^2 per building's volume in m^3) and climatic zones (A to F in relation to the Heating Degrees (HD) days). In the case that no data are available before the implementation of the measure, an upper energy-saving limit up to 5% is acceptable. The predefined estimations of the expected TFES are displayed in the following table.

Calculation values

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

2.1.5 Bibliography

Ministry of Energy (2021). Methodology for estimating energy savings in the installation of systems for automation and control of heating in residential buildings, Methodology no 28: <https://seea.government.bg/bg/metodiki/2-uncategorised/9912-specializirani-metodiki-za-ocenqwane-na-energijnite-spestqwanig-utwyrdeni-ot-me>





		sTFES Energy class of the building A+ [kWh/m2/a]									
		A	B		C		D		E		F
		HD ≤ 600	HD 601-900		HD 901-1400		HD 1401-2100		HD 2101-3000		HD >3000
Automation class A	S/V ≤ 0.2	0	0.40375	0	0.608	0	1.01175	0	1.615	0	2.223
	S/V ≥ 0.9	0	1.71	0	2.28	0	3.23	0	4.18	0	5.51
Automation class B	S/V ≤ 0.2	0	0.255	0	0.384	0	0.639	0	1.02	0	1.404
	S/V ≥ 0.9	0	1.08	0	1.44	0	2.04	0	2.64	0	3.48
		sTFES Energy class of the building A [kWh/m2/a]									
		A	B		C		D		E		F
		HD ≤ 600	HD 601-900		HD 901-1400		HD 1401-2100		HD 2101-3000		HD >3000
Automation class A	S/V ≤ 0.2	0	0.8075	0	1.216	0	2.0235	0	3.23	0	4.446
	S/V ≥ 0.9	0	3.42	0	4.56	0	6.46	0	8.36	0	11.02
Automation class B	S/V ≤ 0.2	0	0.51	0	0.768	0	1.278	0	2.04	0	2.808
	S/V ≥ 0.9	0	2.16	0	2.88	0	4.08	0	5.28	0	6.96
		sTFES Energy class of the building B [kWh/m2/a]									
		A	B		C		D		E		F
		HD ≤ 600	HD 601-900		HD 901-1400		HD 1401-2100		HD 2101-3000		HD >3000
Automation class A	S/V ≤ 0.2	0	1.21125	0	1.824	0	3.03525	0	4.845	0	6.669
	S/V ≥ 0.9	0	5.13	0	6.84	0	9.69	0	12.54	0	16.53
Automation class B	S/V ≤ 0.2	0	0.765	0	1.152	0	1.917	0	3.06	0	4.212



	S/V ≥ 0.9	0	3.24	0	4.32	0	6.12	0	7.92	0	10.44
		sTFES Energy class of the building C [kWh/m ² /a]									
		A	B	C	D	E	F				
		HD ≤ 600	HD 601-900	HD 901-1400	HD 1401-2100	HD 2101-3000	HD >3000				
Automation class A	S/V ≤ 0.2	0	1.615	0	2.432	0	4.047	0	6.46	0	8.892
	S/V ≥ 0.9	0	6.84	0	9.12	0	12.92	0	16.72	0	22.04
Automation class B	S/V ≤ 0.2	0	1.02	0	1.536	0	2.556	0	4.08	0	5.616
	S/V ≥ 0.9	0	4.32	0	5.76	0	8.16	0	10.56	0	13.92
		sTFES Energy class of the building D [kWh/m ² /a]									
		A	B	C	D	E	F				
		HD ≤ 600	HD 601-900	HD 901-1400	HD 1401-2100	HD 2101-3000	HD >3000				
Automation class A	S/V ≤ 0.2	0	2.01875	0	3.04	0	5.05875	0	8.075	0	11.115
	S/V ≥ 0.9	0	8.55	0	11.4	0	16.15	0	20.9	0	27.55
Automation class B	S/V ≤ 0.2	0	1.275	0	1.92	0	3.195	0	5.1	0	7.02
	S/V ≥ 0.9	0	5.4	0	7.2	0	10.2	0	13.2	0	17.4
		sTFES Energy class of the building E [kWh/m ² /a]									
		A	B	C	D	E	F				
		HD ≤ 600	HD 601-900	HD 901-1400	HD 1401-2100	HD 2101-3000	HD >3000				
Automation class A	S/V ≤ 0.2	0	2.826	0	4.256	0	7.082	0	11.305	0	15.561
	S/V ≥ 0.9	0	11.97	0	15.96	0	22.61	0	29.26	0	38.57





Automation class B	S/V ≤ 0.2	0	1.785	0	2.688	0	4.473	0	7.14	0	9.828
	S/V ≥ 0.9	0	7.56	0	10.08	0	14.28	0	18.48	0	24.36
		sTFES Energy class of the building F [kWh/m2/a]									
		A	B		C		D		E		F
		HD ≤ 600	HD 601-900		HD 901-1400		HD 1401-2100		HD 2101-3000		HD >3000
Automation class A	S/V ≤ 0.2	0	4.0375	0	6.08	0	10.1175	0	16.15	0	0
	S/V ≥ 0.9	0	17.1	0	22.8	0	32.3	0	41.8	0	0
Automation class B	S/V ≤ 0.2	0	2.55	0	3.84	0	6.39	0	10.2	0	0
	S/V ≥ 0.9	0	10.8	0	14.4	0	20.4	0	26.4	0	0



2.2 Evaluation of energy savings in the installation of an energy-efficient management system at a distribution station – Bulgaria

The current method refers to the installation of an energy-efficient management system at a distribution station.

Application area: The presented method can be used for the *case of commercial and residential buildings* connected to the district heating systems with installed control systems.

2.2.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

With:

$$TFES = \left[\left(E_p * \frac{DD_c}{DD_p} - E_c \right) + (E_{DHW,P} - E_{DHW,C}) \right] * [H_{HP} * P_{rated} * SPF]$$

$$E_{DHW,P} = E_{DHW,P,S} + E_{DHW,P,W}$$

$$E_{DHW,P,W} = \frac{E_{DHW,P,S}}{G_{DHW,P,S}} * G_{DHW,P,W} * \frac{Dt_w}{Dt_s}$$

$$E_{DHW,C} = E_{DHW,C,S} + E_{DHW,C,W}$$

$$E_{DHW,C,W} = \frac{E_{DHW,C,S}}{G_{DHW,C,S}} * G_{DHW,C,W} * \frac{Dt_w}{Dt_s}$$

$$\text{if } G_{DHW,C} > G_{DHW,P} \text{ then } E_{DHW,C} = \frac{E_{DHW,C,S}}{G_{DHW,C,S}} * G_{DHW,P,S} + \frac{E_{DHW,C,W}}{G_{DHW,C,W}} * G_{DHW,P,W}$$

Where:

TFES	Total final energy savings [kWh/a]
E_p	Measured consumption of thermal energy for heating in the AC of the building during a period without energy management [kWh/a]
DD_c	Degrees for the period with energy management
DD_p	Degrees for the period without energy management
E_c	Measured consumption of thermal energy for heating in the AC of the building during the period with energy management [kWh/a]
$E_{DHW,P}$	Energy for DHW before the installation of the energy management system in the AC [kWh/a]
$E_{DHW,C}$	Energy for DHW after the installation of the energy management system in the AC [kWh/a]
H_{HP}	The equivalent operating hours at full load of air conditioners for the heating period [h/a]



P_{rated}	Electric power of the installed air conditioners in the building after the installation of the energy-saving system [kW]
SPF	Average seasonal conversion factor
$E_{DHW,P,S}$	DHW energy for the non-heating period during the year [kWh/a]
$E_{DWP,P,W}$	DHW energy for the heating period during the year [kWh/a]
$G_{DHW,P,W}$	The quantity of cold water measured on the water meter installed in front of the DHW heater, for the heating period during the year [m ³]
$G_{DHW,P,S}$	The amount of cold water, measured by the water meter installed in front of the DHW heater, for the non-heating period during the year [m ³]
Dt_w	The difference between the temperatures of the heated water at the outlet and the inlet of the DHW heater, averaged for each month for the heating period, when the service is not applied
Dt_s	The difference between the temperatures of the heated water at the outlet and the inlet of the DHW heater, averaged for the non-heating period when the service is not applied
$E_{DHW,C,S}$	DHW energy for the non-heating period during the year [kWh/a]
$E_{DWP,C,W}$	DHW energy for the heating period during the year [kWh/a]
$G_{DHW,C,W}$	The amount of cold water measured by the water meter installed in front of the DHW heater for the non-heating period during the year [m ³]
$G_{DHW,C,S}$	The amount of cold water measured by the water meter installed in front of the DHW heater for the heating period during the year [m ³]

In cases when the temperature of the cold heating water for the respective month is not measured and there is no data for it from the water supply company, the temperature is assumed 10°C.

The default value of the average seasonal conversion factor can be assumed equal to 2.6 in the case of non-available data. Respectively, the equivalent operating hours at full load of air conditioners for the heating period can be assumed equal to 15% of 710 hours, which is considered as the total operation of air conditioners in heating mode.

2.2.2 Standardized calculation values

Lifetime of savings	[a]
All types of buildings	10

2.2.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

2.2.4 Description of sources

Calculation methodology

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



The method for calculating energy savings takes into account the difference between the thermal energy consumption of the heating system and domestic hot water supply (DHW) before and after the installation of the energy-efficient energy management system in the subscriber station of the building.

Energy savings for heating are calculated by normalizing the consumption by means of the heating degrees before and after the installation of the energy management system in the substation in order to eliminate the strong influence of the outdoor temperature factor.

The energy savings for domestic hot water supply during the non-heating period are determined according to the readings of the heat meter and water meter, and during the heating period - by calculation according to Ordinance № 16-334 of 6.04.2007 for the heat supply.

Calculation values

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

2.2.5 Bibliography

Ministry of Energy (2021). Methodology for estimating the energy savings in energy management in customer-side heat-distribution station, Methodology no 36.

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

2.3 Installation of heating system regulation equipment – Croatia

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).

2.3.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$UFES = \left(\frac{1}{\eta_{init}} - \frac{1}{\eta_{new}} \right) \times SHD \times A$$

$$FES = \sum_i UFES_i$$

Where:

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:

$$UFES = \frac{1}{\eta_{boiler} \times \eta_{dis}} \left(\frac{1}{\eta_{init_em}} - \frac{1}{\eta_{new_em}} \right) \times SHD \times A$$

Where:

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]

2.3.2 Standardized calculation values

Sector	SHD [kWh/m2]
Services	175
Households	160
Efficacy of subsystems	
η_{init_em}	0,82
η_{new_em}	0,93
η_{boiler}	0,78
η_{dis}	0,93 (classic) – 0,97 (programmable)
Lifetime of savings	[a]
Lifetime of savings	10

2.3.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.



2.3.4 Description of sources

Calculation methodology

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

2.3.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

2.4 Installation of equipment for automatic regulation of lighting systems – Croatia

Lighting system control equipment controls the operation of lighting by adapting it to actual needs, taking into account the occupation of space and / or the availability of natural light. This includes:

- Brightness sensors;
- Time management;
- Partial ignition quenching (zoning) and
- Presence sensors.

2.4.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$UFES = \frac{P \times (1 - r) \times n_h}{1000}$$

$$FES = \sum_i UFES_i$$

Where:

UFES	Unit energy savings by installing one set of equipment for automatic system control [kWh/unit x a]
FES	Total final energy savings [kWh/a]
P	installed power of all light sources with associated losses on ballasts controlled by built-in automatic control equipment





r	reduction factor that depends on the newly applied lighting management strategy (built-in equipment for automatic control of the lighting system) according to the table below
n _h	reference annual operating hours of the lighting system according to the table

2.4.2 Standardized calculation values

Lifetime of savings	[a]
Lifetime of savings	10

2.4.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

2.4.4 Description of sources

Calculation methodology

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

2.4.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

2.5 Installation of equipment for automatic regulation of electricity consumption – Croatia

2.5.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$UFES = \frac{P_G \times t_{SB} - P_P \times t_a}{1000}$$

$$FES = \sum_i UFES$$



Where:

UFES	Unit energy savings by installing one set of equipment for automatic system control [kWh/unit x a]
FES	Total final energy savings [kWh/a]
P _G	Power of all devices in standby mode connected to one set of equipment for automatic regulation of electricity consumption [W]
P _P	Power of equipment for automatic regulation of electricity consumption
t _{SB}	annual operating hours when devices are in standby mode [h/a]
t _a	annual operating hours when the equipment for automatic regulation of electricity consumption is in operation [h/a]

2.5.2 Standardized calculation values

Standardized values	
P _G [W]	5,14
P _P [W]	0,50
t _{SB} [h/a]	7.300
t _a [h/a]	8.760
UFES [kWh/unit x a]	3,10
Lifetime of savings	[a]
Lifetime of savings	2

2.5.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

2.5.4 Description of sources

Calculation methodology

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

2.5.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html





2.6 Evaluation of energy savings in the installation of automation and heating control systems and hot sanitary water in residential buildings – France

The current method refers to the implementation of automation and heating control systems in residential buildings.

Application area: The presented method can be used for all types of buildings.

2.6.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = S * ES * G$$

TFES	Total final energy savings [kWh/a]
S	Surface [m ²]
ES	Energy savings by sector by end use and energy [kWh/m ²]
G	Geographical area

2.6.2 Standardized calculation values

Energy savings by sector by end used and energy type [kWh/m ²]				
Sector	Heating only		Hot water and heating	
	Fossil energy	Electricity	Fossil energy	Electricity
Office	28	16	29	16
Education	10	6	12	8
Retail	29	16	31	18
Hotel and restaurants	27	9	31	13
Health	11	7	15	11
Other	10	6	12	8

Geographical area	G
H1	1,1
H2	0,9
H3	0,6
Lifetime of savings	[a]
All types of buildings	15

2.6.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.



2.6.4 Description of sources

Calculation methodology

This methodology for assessing the delivered energy savings has been approved and has been published by order of the Minister of Ecological Transition.

Calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Ecological Transition.

2.6.5 Bibliography

Ministry of Ecological Transition (2018). Arrêté du 31 décembre 2018 (JO du 10 janvier 2019)

Standard Operations information sheets: BAT TH 116:

https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie#scroll-nav_5





Chapter 3 Commercial and industrial refrigeration systems

3.1 Central compression refrigeration units – Austria

This methodology is valid for new installations and replacement of air- or water-chilled central compression refrigeration units. It is based on the European Seasonal Energy Efficiency Ratio (ESEER), a voluntary classification standard prepared by Eurovent¹. This standard is based on standard testing conditions and therefore offers the possibility to compare the efficiency of refrigeration units at different operation points regardless of their implementation area, both from a technical as well as a climatic point of view.

To use this calculation methodology, the following criteria have to be met:

- the compressors must be powered by electrical energy;
- cooling systems using free cooling or heat recovery are not covered.

ESEER values for reference- and efficient cases are available for water-chilled systems with installed cooling power of up to 1.500 kW and air-chilled systems with the installed cooling power of up to 600 kW. Cooling power and full-load hours have to be provided project-specific.

3.1.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = n \times P_c \times h_{FL} \times \left(\frac{1}{ESEER_{Ref}} - \frac{1}{ESEER_{Eff}} \right) \times rb \times so \times fr$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of cooling systems installed at a specific cooling power
P _c	Installed cooling power of the cooling system [kW]
h _{FL}	Full-load hours related to the maximum installed cooling power [h]
ESEER _{Ref}	European Seasonal Energy Efficiency Ratio of the reference compression refrigeration system [-]
ESEER _{Eff}	European Seasonal Energy Efficiency Ratio of the more efficient compression refrigeration system [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)

¹ <https://www.eurovent-certification.com/en/third-party-certification/certification-programs/lcp-hp-liquid-chilling-packages-and-heat-pumps>



3.1.2 Standardized calculation values

For air-chilled coolers	[-]
ESEER _{Ref}	4
ESEER _{Eff}	5.5
For water-chilled coolers	[-]
ESEER _{Ref}	5.6
ESEER _{Eff}	7.5
Lifetime of savings	[a]
Lifetime of savings	15

3.1.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

3.1.4 Description of sources

Calculation methodology

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

Calculation values

The identification of calculation values is based on averages of units available on the market in 2015. For the reference case ESEER value, the market average of all units with a Eurovent certification was used. For the efficient case ESEER values, all certified units with an ESEER exceeding the reference value were averaged once again.

The lifetime of the measure is taken from the Austrian Standards definition (Austrian Standards, 2013).

For cooling power and full-load hours, no standardized calculation values are available.

3.1.5 Bibliography

Anlage 1 BGB1. II, Nr. 172 (2016). Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen, 100–103.

https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2016_II_172/C00_2026_100_2_1241958.pdf

Austrian Standards (2013). ÖNORM M 7140:2013 für Kompressionskältemaschinen.

3.2 Installation of natural cooling systems – Bulgaria

The current method refers to the installation of *natural cooling systems to refrigeration machines with air and water-cooling for industrial applications*. This methodology applies only to natural cooling heat exchangers mounted on electricity-powered refrigeration machines. The measure is applied either for indirect use of natural cooling (ambient temperature must be below the temperature of the refrigerant to the chiller) or for direct





use of natural cooling (outdoor temperature must be below or equal to the desired temperature).

Application area: The presented method can be used for the case of the industrial units using refrigeration machines.

3.2.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^i \left(\frac{1}{EER_{ref}} - \frac{1}{EER} \right) * E_{chill}$$

Where:

TFES	Total final energy savings [kWh/a]
i	Different types/capacities of the refrigeration machines
EER _{ref}	Existing energy efficiency ratio of the refrigeration machines in relation to their power
EER	Measured refrigeration energy efficiency ratio (calculation through the equation E _{chill} /E _{el})
E _{el}	Electricity consumed by the compressor of the refrigeration machine [kWh/a]
E _{chill}	Produced cooling energy after the installation of the natural cooling heat exchanger [kWh]

3.2.2 Standardized calculation values

EER _{ref}	
Air type of cooling - Power range: 20-50 kW _{chill}	2.8
Air type of cooling - Power range: 51-250 kW _{chill}	2.7
Air type of cooling - Power range: 251-500 kW _{chill}	2.9
Air type of cooling - Power range: 501-1000 kW _{chill}	3.0
Air type of cooling - Power range: >1000 kW _{chill}	3.2
Water type of cooling - Power range: 20-50 kW _{chill}	3.6
Water type of cooling - Power range: 51-250 kW _{chill}	4.0
Water type of cooling - Power range: 251-500 kW _{chill}	4.1
Water type of cooling - Power range: 501-1000 kW _{chill}	4.3
Water type of cooling - Power range: >1000 kW _{chill}	4.4
Lifetime of savings	[a]
All industrial units	20



3.2.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

3.2.4 Description of sources

Calculation methodology

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

The methodology is based on data analysis in accordance with European standards. The calculation method combines standard (EER_{Ref}) and measured data (EER and E_{chill}).

Calculation values

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

3.2.5 Bibliography

Ministry of Energy (2021). Methodology for estimating energy savings when installing cooling systems with natural source, Methodology no 3.

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

3.3 Installation of a free-cooling by cooling water replacing a cooling unit in a tertiary building – France

The current method refers to the installation or integration into an existing or new cooling unit installation of free cooling by cooling water, replacing the cooling unit, allowing to cool a hydraulic system using outside air.

Application area: The presented method can be used for the case of the replacement of an air conditioner in a tertiary building.

3.3.1 Calculation Formula – First year savings

Estimation of savings for Article 7

$$TFES = ESt * P * f$$

Where:

TFES	Total final energy savings [kWh/a]
ESt	Energy savings per kW depending on the set temperature [kWh]
P	Power electric nominal of cooling unit [kW]
F	Factor depending on the sector





3.3.2 Standardized calculation values

Geographical area (in France)	Temperature set	ESt
H1	[15 °C ; 18 °C[464
H2	[15 °C ; 18 °C[382
H3	[15 °C ; 18 °C[273
H1	[18 °C ; 20 °C]	583
H2	[18 °C ; 20 °C]	537
H3	[18 °C ; 20 °C]	428
Air conditioner	F	
Air conditioner excluded Data Center	1	
Air conditioner for Data Center	4,5	
Lifetime of savings	[a]	
All units	14	

3.3.3 Cost-effectiveness

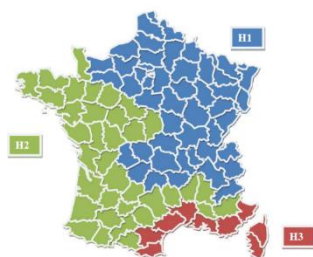
No information on cost-effectiveness available for this methodology.

3.3.4 Description of sources

Calculation methodology

This methodology for assessing the delivered energy savings has been approved and has been published by order of the Minister of Ecological Transition.

The geographical area is defined due to harsh climate and is described on the map below.



Calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Ecological Transition.

3.3.5 Bibliography

Ministry of Ecological Transition (2017). Arrêté du 26 juillet 2017 (JO du 8 août 2017).

Standard Operations information sheets : IND UT 135 :

https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie#scroll-nav_7



3.4 Installation of free cooling by cooling water replacing a cooling unit in the industry – France

The current method refers to the installation or integration into an existing or new cooling unit installation of free cooling by cooling water, replacing the cooling unit, allowing to cool a hydraulic system using outside air.

Application area: The presented method can be used for the case of the replacement cooling unit in the industry.

3.4.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = Est * P * H$$

Where:

TFES	Total final energy savings [kWh/a]
Est	Energy savings per kW depending on the set temperature [kWh]
P	Power electric nominal of cooling unit [kW]
H	Average yearly operating hours of the industrial furnace [h/a]

3.4.2 Standardized calculation values

Average yearly operating hours of the industrial furnace [h/a]		H
One working shift		1
Two working shifts		2,2
Three working shifts without Saturday and Sunday		3
Three working shifts		4,2
Geographical area (in France)	Temperature set	Est
H1	[12 °C; 15 °C[674
H2	[12 °C; 15 °C[446
H3	[12 °C; 15 °C[300
H1	[15 °C ; 18 °C[901
H2	[15 °C ; 18 °C[746
H3	[15 °C ; 18 °C[528
H1	[18 °C ; 21 °C]	1120
H2	[18 °C ; 21 °C]	1047





H3	[18°C ; 21°C]	819
Lifetime of savings	[a]	
All industrial units	14	

3.4.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

3.4.4 Description of sources

Calculation methodology

This methodology for assessing the delivered energy savings has been approved and has been published by order of the Minister of Ecological Transition.

Calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Ecological Transition.

3.4.5 Bibliography

Ministry of Ecological Transition. (2020). Arrêté du 10 janvier 2020 (JO du 30 janvier 2020)

Standard Operations information sheets: IND UT 135 :
https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie#scroll-nav_7

3.5 Measures for new installation or replacement of cooling systems in services and industrial sector buildings - Croatia

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)² 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.

² 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.



3.5.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

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

$$FES = \sum_i UFES_i$$

Where:

UFES	Unit annual energy savings [kWh/unit x a]
FES	Total final energy savings [kWh/a]
ESEER _{average}	Average seasonal cooling factor of existing cooling systems
ESEER _{new}	Seasonal cooling factor of the new cooling system
SCD	Specific annual cooling needs [kWh/m ² x a]

3.5.2 Standardized calculation values

Calculation values	
SCD [kWh/m ²]	86 for commercial non-residential buildings, of which: 72 for the continental Republic of Croatia 115 for the coastal Republic of Croatia
Water- cooled	
ESEER _{new}	7,5
ESEER _{average}	5,5
ESEER _{existing}	4,0
Air- cooled	
ESEER _{new}	5,5
ESEER _{average}	4,0
ESEER _{existing}	3,5
ESEER _{new}	7,5
Lifetime of savings	[a]
Lifetime of savings	25

3.5.3 Cost effectiveness

No information on cost effectiveness available for this methodology.





3.5.4 Description of sources

Calculation methodology

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

3.5.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

3.6 Replacement of electric compression refrigeration units by absorption cooling units – Italy

This methodology is valid for the replacement of *air- or water-chilled electric compression refrigeration units by absorption cooling systems*.

As there are no standardized parameters, the formula is applicable in various sectors and climate conditions. However, the conversion factor used in case of withdrawal of electricity from the national electricity grid has to be adapted accordingly when the formula is applied in other countries.

3.6.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \frac{1}{EER_{baseline}} * E_{chilled} * f_e - E_{th} * f_t - E_{aux} * f_e * rb * so * fr * lt$$

Where:

TFES	Total final energy savings [MWh/a]
EER _{baseline}	Energy Efficiency Ratio of the compression refrigeration system in the baseline scenario [-]
E _{chilled}	Refrigeration energy sold [MWh]
f _e	Conversion factor equal to 0.187 toe / MWh, in case of withdrawal of electricity from the national electricity grid
E _{th}	measured hourly value of the thermal energy associated with the fuel used [MWh]
f _t	conversion factor equal to 0.086 toe / MWh _t



E _{aux}	electrical self-consumption [MWh]
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)
lt	Factor for the lifetime of savings (=1)

3.6.2 Standardized calculation values

No calculation values are available for this methodology.

3.6.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

3.6.4 Description of sources

Calculation methodology

This methodology was published by GSE as part of an [operation guide for the White Certificates scheme](https://www.gse.it/documenti_site/Documenti%20GSE/Servizi%20per%20te/CERTIFICATI%20BIANCHI/MANUALI/Allegato%201%20del%20Decreto%20Direttoriale%2030%20aprile%202019%20-%20Guida%20operativa.pdf). The document is published in Italian language.

Calculation values

No calculation values have been defined.

3.6.5 Bibliography

GSE (2019). Certificati Bianchi – Guida operativa, 100-122.

https://www.gse.it/documenti_site/Documenti%20GSE/Servizi%20per%20te/CERTIFICATI%20BIANCHI/MANUALI/Allegato%201%20del%20Decreto%20Direttoriale%2030%20aprile%202019%20-%20Guida%20operativa.pdf

3.7 Replacement of electric compression refrigeration units by refrigerating units with indirect absorption – Italy

This methodology is valid for the replacement of air- or water-chilled electric compression refrigeration units by refrigerating units with indirect absorption.

As there are no standardized parameters, the formula is applicable in various sectors and climate conditions. However, the conversion factor used in case of withdrawal of electricity from the national electricity grid has to be adapted accordingly when the formula is applied in other countries.

3.7.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \frac{1}{EER_{baseline}} * E_{chilled} * f_e - E_{aux} * f_e * rb * so * fr * lt$$





Where:

TFES	Total final energy savings [MWh/a]
EER _{baseline}	Energy Efficiency Ratio of the compression refrigeration system in the baseline scenario [-]
E _{chilled}	Refrigeration energy sold [MWh]
f _e	Conversion factor equal to 0.187 toe / MWh, in case of withdrawal of electricity from the national electricity grid
E _{aux}	electrical self-consumption [MWh]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)
It	Factor for the lifetime of savings (=1)

3.7.2 Standardized calculation values

No calculation values are available for this methodology.

3.7.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

3.7.4 Description of sources

Calculation methodology

This methodology was published by GSE as part of an [operation guide for the White Certificates scheme](#). The document is published in Italian language.

Calculation values

No calculation values have been defined.

3.7.5 Bibliography

GSE (2019). Certificati Bianchi – Guida operativa, 100-122.

https://www.gse.it/documenti_site/Documenti%20GSE/Servizi%20per%20te/CERTIFICATI%20BIANCHI/MANUALI/Allegato%201%20del%20Decreto%20Direttoriale%2030%20aprile%202019%20-%20Guida%20operativa.pdf

3.8 Replacement or new installation of electric compression refrigeration units - Italy

This methodology is valid *for new installations and replacement of air- or water-chilled electric compression refrigeration units*. The methodology contains a formula for the calculation of savings as well as a guideline for the identification of calculation parameters. As there are no standardized parameters, the formula is applicable in various sectors and climate conditions. However, the conversion factor used in case of withdrawal of electricity



from the national electricity grid has to be adapted accordingly when the formula is applied in other countries.

3.8.1 Calculation Formula – First year savings

Estimation of savings for Article 7

$$TFES = \left(\frac{1}{EER_{baseline}} - \frac{1}{EER_{expost}} \right) * E_{chilled} * f_e * rb * so * fr * lt$$

Where:

TFES	Total final energy savings [MWh/a]
$EER_{baseline}$	Energy Efficiency Ratio of the compression refrigeration system in the baseline scenario [-]
EER_{expost}	Energy Efficiency Ratio of the compression refrigeration system of the realized project [-]
$E_{chilled}$	Refrigeration energy sold [MWh]
f_e	Conversion factor equal to 0.187 toe / MWh, in case of withdrawal of electricity from the national electricity grid
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)
lt	Factor for the lifetime of savings (=1)

3.8.2 Standardized calculation values

There are reference values for $EER_{standard}$, which is used to calculate the $EER_{baseline}$:

Environment		Compression refrigeration units						
External	Intern	External environment (° C)	internal environment (° C)	EER				
				Power ranges (kW _{cooling})				
				20-50	51-250	251-500	501-1000	>1000
Air	Air	dry bulb at the entrance: 35 wet bulb at the entrance: 24	dry bulb at the entrance: 27 wet bulb at the entrance: 19	3,4				
	Water		Entrance temperature: 12 Outlet temperature: 7	2,8	2,9	2,9	3,0	3,2
Water	Air	dry bulb at the entrance: 30 wet bulb at the entrance: 35	dry bulb at the entrance: 27 wet bulb at the entrance: 19	4,4				





	Water		Entrance temperature: 12 Outlet temperature: 7	3,9	4,0	4,4	4,8	4,9
Brine	Air	dry bulb at the entrance: 30 wet bulb at the entrance: 35	dry bulb at the entrance: 27 wet bulb at the entrance: 19	4,4				
	Water		Entrance temperature: 23 Outlet temperature: 18	4,4				

The $EER_{baseline}$ value has to be calculated using the following formula:

$$EER_{baseline} = EER * K_{Carnot} * K_{load}$$

In the case of a *new installation*, $EER_{standard}$ is used for the “EER”-factor of the formula. The other values are calculated as followed:

$$K_{Carnot} = \frac{EER_{carnot,ex-post project}}{EER_{carnot standard}}$$

With:

$$EER_{carnot standard} = \frac{T_{e,standard}}{T_{c,standard} - T_{e,standard}}$$

$$EER_{carnot,ex-post project} = \frac{T_{e,ex-post project}}{T_{c,ex-post project} - T_{e,ex-post project}}$$

With:

$T_{e,standard}$	average temperature (expressed in Kelvin) at the evaporator (internal ambient column of Table above). For the air, on the other hand, the dry bulb temperature at the inlet is considered
$T_{c,standard}$	average temperature (expressed in Kelvin) at the condenser (external ambient column of Table above). In the case of air, the dry bulb temperature at the inlet is considered
$T_{e,ex-post project}$	average temperature (expressed in Kelvin) at the design evaporator of the refrigeration unit used in the ex-post situation. For the air, on the other hand, the dry bulb temperature at the inlet is considered
$T_{c,ex-post project}$	average temperature (expressed in Kelvin) at the design condenser of the refrigeration unit used in the ex-post situation. In the case of air, the dry bulb temperature at the inlet is considered.

The correction coefficient K_{load} , on the other hand, takes into account the correlation that exists between the load factor (F) and the EER value. This coefficient must be obtained hourly according to the following formula:



$$K_{load} = -0.4 * F + 1.4 \quad \text{if } F \geq 50\%$$

$$K_{load} = 0.1822 * \ln(F) + 1.329 \quad \text{if } F < 50\%$$

With:

F	Load factor, $F = (P_{cooling, ex-post}) / (P_{cooling, nominal})$
$P_{cooling, ex-post}$	the hourly cooling capacity produced by the machine in the ex-post situation
$P_{cooling, nominal}$	the nominal cooling capacity indicated in the technical data sheet of the refrigeration unit installed in the ex-post situation

In the case of a *replacement*, the actual EER value of the replaced equipment is used to calculate the $EER_{baseline}$ value. The other values are calculated as followed:

$$K_{Carnot} = \frac{EER_{carnot, ex-post project}}{EER_{carnot, ex ante project}}$$

With:

$$EER_{carnot, ex-ante project} = \frac{T_{e, ex-ante project}}{T_{c, ex-ante project} - T_{e, ex-ante project}}$$

$$EER_{carnot, ex-post project} = \frac{T_{e, ex-post project}}{T_{c, ex-post project} - T_{e, ex-post project}}$$

With:

$T_{e, ex-ante project}$	average temperature (expressed in Kelvin) at the evaporator as indicated by the ex-ante sheet of the refrigerator unit replaced. For the air, on the other hand, the dry bulb temperature at the inlet is considered
$T_{c, ex-ante project}$	average temperature (expressed in Kelvin) at the condenser as indicated by the ex-ante card of the replaced refrigeration unit. In the case of air, the dry bulb temperature at the inlet is considered
$T_{e, ex-post project}$	average temperature (expressed in Kelvin) at the design evaporator of the refrigeration unit used in the ex-post situation. For the air, on the other hand, the dry bulb temperature at the inlet is considered
$T_{c, ex-post project}$	average temperature (expressed in Kelvin) at the design condenser of the refrigeration unit used in the ex-post situation. In the case of air, the dry bulb temperature at the inlet is considered.

The coefficient K_{load} must be obtained from the ex-ante measurements and from the technical sheets of the ex-ante refrigeration units.

3.8.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.





3.8.4 Description of sources

Calculation methodology

This methodology was published by GSE as part of an [operation guide for the White Certificates scheme](#). The document is published in Italian language.

Calculation values

The values for the $EER_{standard}$ were taken from elaborations of Eurovent data prepared by GSE and the D.Lgs. 28/2011, which is the “Implementation of Directive 2009/28/EC on the promotion of the use of energy from renewable sources, amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC”.

3.8.5 Bibliography

GSE (2019). Certificati Bianchi – Guida operativa, 100-122.

https://www.gse.it/documenti_site/Documenti%20GSE/Servizi%20per%20te/CERTIFICATI%20BIANCHI/MANUALI/Allegato%201%20del%20Decreto%20Direttoriale%2030%20aprile%202019%20-%20Guida%20operativa.pdf

3.9 Increasing the evaporator temperature - Luxembourg

By increasing the *temperature at the evaporator*, i.e. on the cold side of a refrigeration system, the electricity consumption of the system is reduced.

Application area: The measure is applicable in tertiary and industrial sectors.

Boundary conditions: The measure is only applicable for refrigeration systems that operate under permanence (8760 hours/year) and on a single temperature level. This is often the case for cold rooms, furniture refrigerators, or large refrigerators and freezers; The measure does not apply to air conditioning installations. The measure is not applicable to household refrigeration appliances; If the average compressor load significantly differs from 80%, a specific calculation must be performed.

Only the standard values of energy savings as listed in Annex II to the Grand Ducal Regulation, and not the measured energy savings, can be counted for standardized measures.

3.9.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

The refrigeration system works at a lower temperature level than necessary on the evaporator’s side. The measure consists of increasing the temperature at the evaporator.

$$VEEP = \frac{0.025 * (T_{\text{évap},ap} - T_{\text{évap},av}) * 0.8 * P_{nom} * 8760}{1000}$$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]
$T_{\text{évap},av}$	Evaporator temperature before the measurement [°C]



T _{évap,ap}	Evaporator temperature after the measurement [°C]
P _{nom}	Nominal electrical power of the compressor (indicated on the technical fiche or the compressor's nameplate) [kW]

3.9.2 Standardized calculation values

Lifetime of savings	[-]
Lifetime of savings	1
Average compressor load	[%]
Average compressor load	80
Permanent operation	[h/year]
Permanent operation	8760
Energy savings	[%]
Standard value of energy savings as listed in Annex II of the bibliography listed in the below section 3.9.5.	2.5

3.9.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

3.9.4 Description of sources

Calculation methodology

This methodology was published in the Luxembourg catalogue on standardized measures (Annex II - section 3.9.5), which is annexed to the Grand-Ducal Regulation of August 7, 2015 relating to the functioning of the energy efficiency obligation mechanism. The document is published in French.

Calculation values

No information on the calculation values was provided.

3.9.5 Bibliography

Ministry of the Economy (2015). Grand-Ducal Regulation of August 7, 2015 relating to the operation of the energy efficiency obligation mechanism (JO of 2 September 2015, Mémorial A 170).

Annex II Catalogue of standardized measures: Code SR-010:

<http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo>

3.10 Lowering the condenser temperature - Luxembourg

By lowering the *temperature at the condenser*, i.e. on the hot side of a refrigeration system, the electricity consumption of the system is reduced.

Application area: The measure is applicable in tertiary and industrial sectors.





Boundary conditions: The measure is only applicable for refrigeration systems that operate under permanence (8,760 hours/year). This is often the case for cold rooms, furniture refrigerators or large refrigerators and freezers; The measure does not apply to air conditioning installations. The measure is not applicable to household refrigeration appliances; If the average compressor load significantly differs from 80%, a specific calculation must be performed.

Only the standard values of energy savings as listed in Annex II to the Grand Ducal Regulation, and not the measured energy savings, can be counted for standardized measures.

3.10.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

The refrigeration system works at a higher temperature than necessary on the condenser's side. The measure consists of lowering the temperature level of the condenser.

$$VEEP = \frac{0.025 * (T_{cond,av} - T_{cond,ap}) * 0.8 * P_{nom} * 8760}{1000}$$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]
T _{cond,av}	Condenser temperature before the measurement [°C]
T _{cond,ap}	Condenser temperature after the measurement [°C]
P _{nom}	Nominal electrical power of the compressor (indicated on the technical fiche or on the compressor's nameplate) [kW]

3.10.2 Standardized calculation values

Lifetime of savings	[-]
Lifetime of savings	1
Average compressor load	[%]
Average compressor load	80
Permanent operation	[h/year]
Permanent operation	8760
Energy savings	[%]
Standard value of energy savings as listed in Annex II of the bibliography listed in the below section 3.10.5.	2.5

3.10.3 Cost effectiveness

No information on cost effectiveness available for this methodology.



3.10.4 Description of sources

Calculation methodology

This methodology was published in the Luxembourg catalogue on standardized measures (Annex II - section 3.10.5), which is annexed to the Grand-Ducal Regulation of August 7, 2015 relating to the functioning of the energy efficiency obligation mechanism. The document is published in French.

Calculation values

No information on the calculation values was provided.

3.10.5 Bibliography

Ministry of the Economy (2015). Grand-Ducal Regulation of August 7, 2015 relating to the operation of the energy efficiency obligation mechanism (JO of 2 September 2015, Mémorial A 170).

Annex II Catalogue of standardized measures: Code SR-020

<http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo>

3.11 Central compression cooling system - multEE

When applying the method “central compression refrigeration system”, the following requirements have to be fulfilled:

- The compressors must be powered by electrical energy.
- Cooling systems with free cooling or heat recovery are not covered.

The method is valid for new installation and replacement of central compression cooling systems. It can be used for residential and non-residential buildings. Below, two calculation formulae are provided. The first option applies to cases where the cooling demand of the building stays constant, only a more efficient cooling system is put in place. The second option applies to cases where not only the efficiency of the cooling system, but also the cooling demand of the building improves.

3.11.1 Calculation Formula – First-year savings

Estimation of savings for Article 7 for non-refurbished buildings

$$TFES = n * (P_C * h_{FL}) * \left(\frac{1}{ESEER_{Ref}} - \frac{1}{ESEER_{Eff}} \right) * rb * so * fr * lt$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of cooling systems installed at a specific cooling power [-]
P _C	Installed cooling power of the cooling system [kW]
h _{FL}	Full-load hours related to the maximum installed cooling power [h]





ESEER _{Ref}	European Seasonal Energy Efficiency Ratio of the reference compression cooling system [-]
ESEER _{Eff}	European Seasonal Energy Efficiency Ratio of the more efficient compression cooling system [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)
lt	Factor for the lifetime of savings (=1)

Estimation of savings for Article 7 for refurbished buildings lowering the cooling demand

$$TFES = A * \left(SCD_{Ref} * \frac{1}{ESEER_{Ref}} - SCD_{Eff} * \frac{1}{ESEER_{Eff}} \right) * rb * so * fr * lt$$

Where:

TFES	Total final energy savings [kWh/a]
A	Conditioned floor area of the building [m ²]
SCD _{Ref}	Specific Cooling Demand of the reference building [kWh/(m ² *a)]
SCD _{Eff}	Specific Cooling Demand of the energy-efficient building [kWh/(m ² *a)]
ESEER _{Ref}	European Seasonal Energy Efficiency Ratio of the reference compression cooling system [-]
ESEER _{Eff}	European Seasonal Energy Efficiency Ratio of the more efficient compression cooling system [-]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)
lt	Factor for the lifetime of savings (=1)

3.11.2 Standardized calculation values

No calculation values are available for this methodology.

3.11.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

3.11.4 Description of sources

Calculation methodology

This methodology was published in the multEE project's deliverable "[Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures](#)". The document is published in English language. The document is available on the [multEE website](#).



Calculation values

While the document does not *state-defined calculation values*, it offers suggestions on possible data sources for the definition of values:

Lifetime of the measure: reference can be made to the document “Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services”, page 85-8725. Alternatively, the lifetime of air conditioning devices may be defined in national standards, or project-specific values may be available.

ESEER values: represent the average efficiency of the air conditioning system at different operation levels. For determining default ESEER values, average values of Eurovent certified air conditioning systems of different energy efficiency standards may be calculated based on the Eurovent database:

http://www.euroventcertification.com/en/Certified_products/Search_Engine.php?rub=04&srub=04&ssrub=&lg=en

Conditioned floor area of the building: values for determining the cooled floor area are to be defined in the model building. The average floor area may be calculated based on national statistics or may be available from analyses of energy certificates, buildings databases etc.

Specific Cooling Demand (reference and energy efficient building): values for determining the area-related space cooling demand are to be defined in the model building. For newly constructed buildings, the average specific space cooling demand of the reference building may be taken from the national building code.

The average specific space cooling demand of the energy efficient building may be determined by considering more ambitious regulations on the cooling demand of new buildings for example as set in subsidy guidelines.

3.11.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 33 – 35,
https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf

3.12 District cooling - multEE

District cooling represents an alternative to conventional air conditioning systems, delivering chilled water to buildings needing cooling. District cooling systems are more efficient, as larger systems are considerably more energy-efficient than small, individual units. The method provides to replace several existing decentralized cooling systems with a central cooling system (district cooling system).





3.12.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \left(\frac{Q_b}{COP_{S_d}} * t_d \right) * n_b - \left[\left(\frac{Q_b * n_b * f_{sf} + q_l * l}{COP_{S_c}} \right) * t_c \right] - P_p * t_c * rb * so * fr * lt$$

Where:

TFES	Total final energy savings [kWh/a]
Q_b	Average cooling load per building [kW]
COP_{S_d}	Average System Coefficient of Performance (decentralized systems) [-]
t_d	Average yearly operating hours (decentralized systems) [h/a]
n_b	Number of buildings [-]
f_{sf}	Simultaneity Factor [-]
q_l	Specific distribution losses [kW/m]
l	Length of distribution grid [m]
COP_{S_c}	System Coefficient of Performance (centralized system) [-]
t_c	Average yearly operating hours (centralized system) [h/a]
P_p	Power of distribution pump [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)
lt	Factor for the lifetime of savings (=1)

3.12.2 Standardized calculation values

No calculation values are available for this methodology.

3.12.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

3.12.4 Description of sources

Calculation methodology

This methodology was published in the multEE project's deliverable "[Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures](#)". The document is published in English language. The document is available on the [multEE website](#).

Calculation values

While the document does not state defined calculation values, it offers suggestions on possible data sources for the definition of values:



Lifetime of the measure: reference can be made to the document “Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services”, page 85.

Average cooling load per building: values for determining the cooling load per building are to be defined in the model building or can be project specific. The value can be calculated based on national standards (e.g. Austria: ÖNORM H 6040 or VDI 2078).

Average System Coefficient of Performance: a system specific value. The value can be found in national guidelines (e.g. Austria: VDMA-24247-5) or studies. The following international database may also be recommended for determining this coefficient: <http://www.eurovent-certification.com/>

Average yearly operating hours: project specific value dependent on the climatic conditions in the different countries. Default values may be found in relevant national publications.

Simultaneity Factor: Simultaneity is a concept that is used to describe that separate customer's peak load doesn't occur at the same time due to (1) demand occurring at different times of the day, (2) a variation of demand that occurs randomly over time and is influenced by individual temperature regulation in both district cooling and district heating systems, (3) different buildings are not exposed to the maximum temperature at the same time due to shading etc. and (4) different ways of operating the technical installations. It is suggested to use a project-specific value as a simultaneity factor. It depends on the number of buildings supplied with district cooling. Default values may be found in national publications.

Specific distribution losses: project specific values. Default values can be found in datasheets of distribution pipe manufacturers or national publications.

Length of distribution grid: project specific value. The value can be determined from plans.

Power of distribution pump: project specific value. The value can be calculated based on the mass flow and pressure losses.

3.12.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 39 – 40, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf





Chapter 4 Electric Vehicles: private and public vehicles and infrastructure

4.1 Alternative vehicle technologies for passenger cars - Austria

A vehicle with alternative technology is purchased. This methodology can be used both for newly purchased vehicles as well as the replacement for another, “conventional” vehicle.

Even though the purchase of a new vehicle leads to increased energy consumption, it is assumed that otherwise, a “conventional” vehicle with even higher energy consumption would have been purchased.

4.1.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = n * (FEC_{ref} - FEC_{eff}) * m * rb * so * fr * lt$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of purchased vehicles [-]
FEC_{ref}	Final energy consumption of the reference passenger car [kWh/100 km]
FEC_{eff}	Final energy consumption of the efficient passenger car [kWh/100 km]
m	Average yearly mileage [100 km/a]
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)
lt	Factor for the lifetime of savings (=1)

4.1.2 Standardized calculation values

Parameter	Value	Unit
<i>FEC_{eff} - Final energy consumption of the efficient passenger car</i>		
Natural gas or liquid gas vehicle	49.0	kWh/100 km
<i>FEC_{ref} - Final energy consumption of the efficient passenger car</i>		
Newly purchased	54.7	kWh/100 km
Replacement of other vehicle	66.0	kWh/100 km
<i>m – Average yearly mileage</i>		
Privately used passenger car	14,000	100 km/a
Fleet vehicles	no standardized value	100 km/a
Lifetime of savings	10	a



4.1.3 Cost effectiveness

No information on cost-effectiveness available for this methodology.

4.1.4 Description of sources

Calculation methodology

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

Calculation values

The final energy consumption of a newly purchased reference vehicle was determined using statistical data on the average consumption of newly registered vehicles. The same approach is used for the consumption of the reference vehicle in case of replacement using statistical data on the Austrian vehicle fleet.

The final energy consumption of natural- and liquid gas vehicles was defined using the average consumption of such vehicles available on the market at the time.

The lifetime of savings was defined in accordance with a study on ecological assessment of different e-vehicles performed by the Austrian Umweltbundesamt (Umweltbundesamt, 2014).

4.1.5 Bibliography

Anlage 1 BGB1. II, Nr. 172 (2016). Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen, 120–125.
https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2016_II_172/COO_2026_100_2_1241958.pdf

Umweltbundesamt. (2014a). Ökobilanz alternativer Antriebe – Elektrofahrzeuge im Vergleich. Wien.
<https://www.umweltbundesamt.at/fileadmin/site/publikationen/rep0572.pdf>

4.2 Replacing existing and buying new, more efficient vehicles - Croatia

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

- A) 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.
- B) 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.

4.2.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$UFES = (FC_{init} \times f_{c_{init}} - FC_{new} \times f_{c_{new}}) \times D$$

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

Where:

UFES	Unit energy savings in direct consumption [kWh / vehicle / year]
F _{Cinit}	Fuel consumption of an old vehicle [l / 100 km or kg / 100 km]
F _{Cnew}	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]

4.2.2 Standardized calculation values

Standardized values for fuel consumption and factors					
Fuel	Fuel consumption				
	Car	Van	Bus	Truck	Motorcycle
Gas [l/100 km]	7,1	15,1	-	-	4,0
Diesel [l/100 km]	6,4	13,6	27,2	42,8	-
LNG [l/100 km]	8,9	18,9	37,8	59,5	-
CNG [kg/100 km]	5,4	11,5	25,4	39,9	-
Fuel	Factors				
	Unit	MJ**		kWh	
Gas	1 l	34,42		9,56	
Diesel	1 l	36,09		10,03	
LNG	1 l	25,98		7,22	
CNG	1 kg	47,88		13,30	

Vehicle type	D - Average mileage [km/year]
Passenger car	12.000
Gasoline car	10.000
Diesel car	16.500



Van	18.000
Bus	54.500
Truck	34.500
Motorcycle	6.000
Lifetime of savings	[a]
All categories of vehicles	8 (or 100,000 km for passenger cars)
Coefficients for unit conversions	
Den _{gasoline} [kg/lt]	0.745
Den _{diesel} [kg/lt]	0.832
HV _{gasoline} [kWh/kg]	12.222
HV _{diesel} [kWh/kg]	11.833

4.2.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.2.4 Description of sources

Calculation methodology

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

4.2.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

4.3 Promoting electromobility: electric bicycles and scooters – Croatia

This methodology provides a way to determine the energy savings when buying electric bicycles or scooters, which are achieved due to the transition from other modes of transport, primarily users of L and M1 category vehicles. At the same time, the assumption is accepted that some users will switch from using public transport or walking to using electric bicycles or scooters.





The introduction of electric bicycles or scooters changes the distribution of modes of transport, so the budget introduced a "transition factor" that determines the shares of each mode of transport that is replaced by electric bicycles and scooters.

In addition, a "relation factor" has been introduced, which determines the ratio of the distance to be traveled by a vehicle M or L to the distance covered by an electric bicycle or scooter. Namely, a bicycle or a scooter can be used to reach a certain destination on a road that is not allowed to be used by vehicles of category M or L, so the total distance traveled is reduced.

4.3.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$UFES = (E_{M1} \times F_{PM1} + E_{L1} \times F_{PL1}) \times F_{rML} - E_{ebic} \times F_{Pebic} \times PR_{ebic}$$

$$FES = UFES \times N_{ebic}$$

Where:

UFES	Unit energy savings in direct consumption [kWh / vehicle / year]
FES	Total annual energy savings in direct consumption using electric bicycles / scooters
E _{M1}	Average specific energy consumption of a passenger car (M1 category) with internal combustion engine [kWh / km]
E _{L1}	Average specific energy consumption of L-category vehicles with internal combustion engines [kWh / km]
E _{ebic}	Average specific energy consumption of an electric bicycle or scooter [kWh / km]
F _p	Transition factor indicating the ratio of users who have switched from the previous mode of transport to transport by electric bicycle or scooter [%]
F _{rML}	Route factor that determines the ratio of the distance to be covered by a vehicle of category M or L in relation to the distance covered by an electric bicycle or scooter
PR _{ebic}	Average annual mileage of an electric bicycle or scooter [km / vehicle]
N _{ebic}	Number of purchased electric bicycles or scooters [number of vehicles]

4.3.2 Standardized calculation values

Parameter	Unit	Standardized values
E _{M1}	[kWh / km]	0,80
E _{L1}	[kWh / km]	0,26
E _{ebic}	[kWh / km]	0,01
PR _{ebic}	[km / vehicle]	1100
F _{rML}	ratio	1,17



e _{co2,M1}	[kgCO ₂ / km]	0,20
e _{co2,L1}	[kgCO ₂ / km]	0,07
e _{EL}	[kgCO ₂ / kWh]	0,330
Lifetime of savings	[a]	
All categories of vehicles	5 years	

4.3.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.3.4 Description of sources

Calculation methodology

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

4.3.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

4.4 Promoting electromobility: mopeds and motorcycles with three or four wheels with electric drive (vehicles of category L2 - L7, except category L3) – Croatia

The measure includes the introduction of electric vehicles of categories L2 (three-wheeled moped), L4 (motorcycle with side trailer), L5 (motor tricycle), L6 (light quadricycle) and L7 (heavy quadricycle) as a partial replacement in passenger car traffic (categories M1) with an internal combustion engine.

4.4.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$UFES = (E_{M1} - E_{L2,L4,L5,L6,L7e}) \times PR_{L2,L4,L5,L6,L7e}$$

$$FES = UFES \times N_{L2,L4,L5,L6,L7e}$$





Where:

UFES	Unit energy savings in direct consumption [kWh / vehicle / year]
FES	Total annual energy savings in direct consumption using vehicle
E_{M1}	Average specific energy consumption of a passenger car (M1 category) with internal combustion engine [kWh / km]
E_L	Average specific energy consumption of L-category vehicles with internal combustion engines [kWh / km]
E_e	Average specific energy consumption of a vehicle [kWh / km]
PR	Average annual mileage of an electric vehicle [km / vehicle]
N	Number of purchased electric vehicles [number of vehicles]

4.4.2 Standardized calculation values

Parameter	Unit	Standardized values
EM1	[kWh / km]	0,80
$E_{L2,L4,L5,L6,L7e}$	[kWh / km]	0,03
$PR_{L2,L4,L5,L6,L7e}$	[km / vehicle]	3500
E_{M1CO2}	[kgCO ₂ / km]	0,20
$E_{L2,L4,L5,L6,L7eCO2}$	[kgCO ₂ / km]	0,01
Lifetime of savings	[a]	
All categories of vehicles	8 years	

4.4.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.4.4 Description of sources

Calculation methodology

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

4.4.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html



4.5 Promotion of electric vehicles – Cyprus

The current method refers to the estimation of the delivered energy savings from the purchase of electric vehicles within the framework of a grant scheme. The application of the proposed method was based on the assumption that the promoted electric vehicles would replace the purchase of an average gasoline-fuelled urban vehicle.

Application area: The presented method can be used for the promotion of electric vehicles in the transport sector.

4.5.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^i n * (sFEC_{Ref} * d_{Ref} * HV_{Ref} - sFEE_{Eff}) * Mil$$

Where:

TFES	Total Final Energy Savings [kWh/a]
n	Number of efficient cars replaced/purchased
sFEC _{Ref}	Specific final energy consumption of the reference vehicle [lt/100 km]
d _{Ref}	Density of the fuel that is consumed in the reference vehicle [kg/lt]
HV _{Ref}	Heating value of the fuel that is consumed in the reference vehicle [kWh/kg]
sFEE _{Eff}	Specific final energy consumption of the energy-efficient vehicle [kWh/100 km]
Mil	Average yearly mileage [km/a]

4.5.2 Standardized calculation values

sFEC _{Ref}	[lt/100 km]
Reference vehicles	7
d _{Ref}	[kg/lt]
Gasoline	0.750
HV _{Ref}	[kWh/kg]
Gasoline	12.222
sFEE _{Eff}	[kWh/100 km]
Electric vehicles	10
Mil	[km/a]
Passenger vehicles	20,000
Lifetime of savings	[a]
All types of vehicles	15





4.5.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.5.4 Description of sources

Calculation methodology

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

Calculation values

The calculation values and the lifetime were presented in the 4th National Energy Efficiency Action Plan of Cyprus, which was submitted in 2017.

4.5.5 Bibliography

MECIT (2017). 4th National Energy Efficiency Action Plan of Cyprus, 239.

4.6 Alternative vehicle technologies for passenger cars – Czechia

A vehicle with alternative technology is purchased. This methodology can be used for replacement for another, “conventional” vehicle.

Even though the purchase of a new vehicle leads to increased energy consumption, it is assumed that otherwise, a “conventional” vehicle with even higher energy consumption would have been purchased.

Calculation values are available for vehicles powered by petrol, diesel and electricity. However, the calculation formula is fit for calculation the savings of other technologies.

4.6.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = (FEC_{rep} - FEC_{el})$$

Final energy consumption of the replaced car

$$FEC_{rep} = ECO2_{rep} / Ek_{rep}$$

CO₂ emissions of the replaced car

$$ECO2_{rep} = (C_{rep} * Ek_{rep} * CV_{rep} * d * m) / (1 \times 10^8)$$

Final energy consumption of the electric car

$$FEC_{el} = ECO2_{el} * m * 0,000036$$

CO₂ emissions of the electric car

$$ECO2_{el} = (C_{el} * Ek_{el} * m) / (1 \times 10^2)$$

Where:

TFES	Total final energy savings [kWh/a]
------	------------------------------------



FEC_{rep}	Final energy consumption of the replaced car [kWh/100 km]
FEC_{el}	Final (electric) energy consumption of the electric car [kWh/100 km]
$ECO2_{rep}$	CO ₂ emissions of the replaced car [kg]
$ECO2_{el}$	CO ₂ emissions of the electric car [kg]
Ek_{rep}	Emission coefficient of petrol or diesel [kg/GJ]
Ek_{el}	Emission coefficient of electricity [kg/GJ]
C_{rep}	Consumption of petrol or diesel [l/100 km]
C_{el}	Consumption of electricity [kWh/100 km]
CV_{rep}	Calorific value of petrol or diesel [GJ/kg]
d	Density of petrol or diesel [kg/m ³]
m	Average yearly mileage [km/a]

4.6.2 Standardized calculation values

Calculation values can be obtained based on the Decree No. 480/2012 Coll. on energy audit and energy assessment by two means – the general carbon dioxide emission factors or based on site-specific calculation. It should be mentioned that the general CO₂ emission factors in the Decree were last updated in 2016, therefore they may not reflect the current state.

In table below general CO₂ emission factors from 2016 and recalculated CO₂ emission factors from the most recent years are provided.

Ek - Emission coefficient(factor) for CO ₂			
Fuel type	Value		Unit
	General	Recalculated	
Petrol	76.60	69.72	kg/GJ
Diesel	69.20	66.39	kg/GJ
Electric power	281.00	118.89 / 179.72	kg/GJ

4.6.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.6.4 Description of sources

Calculation methodology

This methodology was published in the Methodology for reporting energy savings from alternative policy measures pursuant to Article 7 (9) of the Energy Efficiency Directive (2012/27 / EU). The document is published in Czech language.

Calculation values

The general CO₂ emission factors are provided by Decree No. 480/2012 Coll. on energy audit and energy assessment.





The recalculated emission coefficient for electric power is provided by two sources – the first one is the Czech Ministry of the Industry and Trade (value for 2019) and the second one is Enviro - consulting company in the field of energy, environment and management. Value from Enviro (for 2018) is based on their expert calculation using official statistical data from Eurostat and Czech Statistical Office.

The recalculated emission coefficients for petrol and diesel are based on data from the Transport Research Centre for 2015.

4.6.5 Bibliography

Ministry of the Industry and Trade (2020). Methodology for reporting energy savings from alternative policy measures pursuant to Article 7 (9) of the Energy Efficiency Directive (2012/27 / EU). Prague, CZR: Ministry of the Industry and Trade. Retrieved from <https://www.mpo.cz/cz/energetika/energeticka-ucinnost/strategicke-dokumenty/metodika-vykazovani-uspor-energie-z-alternativnich-politickych-opatreni-176331/>

Decree No. 480/2012 Coll. on energy audit and energy assessment. (2012) Retrieved from <https://www.zakonyprolidi.cz/cs/2012-480>

Ministry of the Industry and Trade. (2020). *The value of the CO2 emission factor from electricity production for the years 2010–2019*. MPO. Retrieved from <https://www.mpo.cz/cz/energetika/statistika/elektrina-a-teplo/hodnota-emisniho-faktoru-co2-z-vyroby-elektriny-za-leta-2010-2019-258830/>

ENVIROS, s. r. o. (2018). *Sustainable Energy and Climate Action Plan (2030) - the statutory city of Liberec*. Retrieved from <https://www.liberec.cz/files/dokumenty/odbory/odbor-strategickeho-rozvoje-dotaci/dotacni%20projekty/akcni-plan-cz.pdf>

4.7 Promotion of alternative vehicle technologies – Greece

The current method refers to the replacement of an old conventional vehicle (either passenger car or truck) with a new high efficient one.

Application area: The presented method can be used for specific categories of vehicles (passenger cars, LDVs, HDVs, buses, taxis) in the transport sector.

4.7.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^i n * (sFEC_{Ref} - sFEF_{Eff}) * Mil$$

Where:

TFES	Total Final Energy Savings [kWh/a]
n	Number of efficient cars replaced/purchased
i	Category of vehicles (passenger cars, LDVs, HDVs, buses, taxis)
sFEC _{Ref}	Specific final energy consumption of the reference vehicle [kWh/100 km]



sFEC _{Eff}	Specific final energy consumption of the energy-efficient vehicle [kWh/100 km]
Mil	Average yearly mileage [km/a]

4.7.2 Standardized calculation values

sFEC _{Ref}	[kWh/km]
Passenger cars	0.49
LDVs	0.67
HDVs	2.95
Buses	3.77
Mil	[km]
Passenger cars	10,222
LDVs	16,491
HDVs	58,693
Buses	68,412
Taxis	77,871
Lifetime of savings	[a]
All categories of vehicles	100,000 km
Coefficients for unit conversions	
Den _{gasoline} [kg/lt]	0.745
Den _{diesel} [kg/lt]	0.832
HV _{gasoline} [kWh/kg]	12.222
HV _{diesel} [kWh/kg]	11.833

4.7.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.7.4 Description of sources

Calculation methodology

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

Calculation values

The required calculation values were estimated combining the findings of the survey, which was conducted by CRES for studying the final energy consumption of the various end-uses (CRES, 2015) for the case of the annual mileage and the requirements the EU regulations





443/2009 and 510/2011 for the case of specific final energy consumption of the reference vehicles in order to address the criterion of additionality.

The determination of the specific final energy consumption of the energy efficient vehicles must be done in accordance to the actual data for each vehicle separately.

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

4.7.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, 18, <http://www.cres.gr/obs/yliko.html>.

CRES (2015). Deliverable 13: Application of criteria for quant control of all survey data.

4.8 Eco Fleet in Transport – Electric vehicles - Ireland

The Irish methodology for ECOfleet vehicle fleet consumption savings is following the principles of International Performance Measurement & Verification Protocol (IPMVP) Option C where 'whole facility' is the "whole fleet". This baseline protocol and guidelines are available only after registration at EVO's website at: [Home \(evo-world.org\)](http://Home (evo-world.org)).

These savings calculations are used for commercial and municipal/ public vehicle fleets managed by a centralized fleet operator – no individual vehicles.

These vehicle fleet savings are applicable to all fuel types incl also hybrids & battery electric vehicles. In Ireland until today, there is only a simple comparison of fuel consumption (in liter or kWh) per km, not yet related to tons of goods transported.

4.8.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

Expected fuel consumption as Liter/100km x actual distance travelled in km (/100) – reported fuel consumption (pump protocol) = total fuel savings in reporting period (*in ECOFleet this is quarterly*). Savings of liters fossil fuel can be put into equivalent energy value (Joule or kWh, according to Euro5 diesel e.g. about 34,7 MJ/l or 9,7 kWh/l)

The same method applies to kWh/100km electrical consumption of EVs.

$$TFFS = \left(\frac{Fa * d}{100} \right) - Rf$$

Where:

TFFS	Total fleet fuel savings (in reporting period = quarterly) [Liter]
Fa	Old fleet average fuel consumption [liter per 100km]
Rf	Reported total fuel consumption (pump protocol) [Liter]



d	Actual distance for entire fleet traveled in the period [km]
---	--------------------------------------------------------------

4.8.2 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.8.3 Description of sources

Calculation methodology

This methodology is not officially published but was only mentioned by Irish authorities' representatives.

4.8.4 Bibliography

EVO (Efficiency Valuation Organization) "Core Concepts"; International Performance Measurement and Verification Protocol™; October 2016; EVO 10000 – 1:2016.

4.9 Replacing a car by an electric vehicle or a rechargeable hybrid car - Luxembourg

The consumption of fuel is reduced when replacing an existing car with a new pure-electric or a rechargeable hybrid one.

Application area: the measure is applicable to vehicles from the M1 category, which is specified in the amended Directive 2007/46/CE. In Annex II, Part A, category M₁ is defined as: "Vehicles of category M, comprising not more than eight seating positions in addition to the driver's seating position. Vehicles belonging to category M1 shall have no space for standing passengers. The number of seating positions may be restricted to one (i.e. the driver's seating position)".

Boundary conditions: the measure is applicable to vehicles from the M1 category and provided that the existing car is permanently deregistered by the owner.

The volume of energy savings is counted on the condition that the new car is not transferred or exported – within 6 months of the date of first registration in the Grand Duchy of Luxembourg – by the first owner or, in the case of leasing, by the first holder registered on the registration certificate or identified in the leasing contract. The duration of the leasing contract must be longer than 6 months. For rental cars without a driver, the deadline is extended to 12 months. The measure is only possible once every 5 years for the same owner or holder.

Only the standard values of energy savings as listed in Annex II to the Grand Ducal Regulation, and not the measured energy savings, can be counted for standardized measures.

4.9.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

First, the reference consumption C_{ref} of the vehicle is determined according to table 1. Then, the annual volume of annual savings is calculated according to the following formula:





$$VEEP = \left(c_{ref} - (c_{ap,elec} + c_{ap,carb} * p_{c_{carb}}) \right) * 0,1$$

Where:

VEEP	Annual volume of energy savings produced by the measure [MWh]
C _{ref}	Reference consumption, according to table 1 [kWh/100 km]
C _{ap,elec}	Electricity consumption in standardized test cycle combined/mixed ³ of the new car [kWh/100 km]
C _{ap,carb}	Fuel consumption in standardized test cycle combined/mixed ⁴ of the new car [l/100 km] (for pure-electric vehicles C _{ap,carb} = 0)
p _{Ccarb}	Calorific value of fuel [gasoline 9,23 kWh/l and diesel 9,93 kWh/l]

4.9.2 Standardized calculation values

Reference consumption C _{ref}	[kWh/100km]					
Year	2015	2016	2017	2018	2019	2020
Car on gasoline	51,7	49,4	47,1	44,8	42,5	40,2
Car on diesel	48,7	46,5	44,4	42,2	40,1	37,9
p _{Ccarb}	[kWh/l]					
Gasoline	9,23					
Diesel	9,93					
Lifetime of savings	[-]					
Lifetime of savings	5					
Standard value of energy savings as listed in Annex II	[%]					
Standard value of energy savings as listed in Annex II	10					

4.9.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.9.4 Description of sources

Calculation methodology

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

³ In accordance with the 'certificate of conformity' as defined in the amended directive 2007/46/EC.

⁴ In accordance with the 'certificate of conformity' as defined in the amended directive 2007/46/EC.



Calculation values

No information on the calculation values was provided.

4.9.5 Bibliography

<http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo>

Règlement grand-ducal modifié du 7 août 2015 relatif au fonctionnement du mécanisme d'obligations en matière d'efficacité énergétique:

<http://data.legilux.public.lu/eli/etat/leg/rgd/2015/08/07/n1/jo>

4.10 New electric passenger cars - Slovenia

Energy savings are calculated as the difference between the energy consumed by passenger motor vehicles with an internal combustion engine (IC) in Slovenia, and the energy consumed by the new electricity passenger cars (EV) in a given calendar year. The calculation of energy savings is made on the basis of differences in the average projected specific energy consumption of the new ICs for new passenger cars at 130 gCO₂/km in 2015 and 95 gCO₂/km by the end of 2020 and the average specific electricity consumption of the new electric passenger car. The specific energy use of EV, when the value is not declared by the manufacturer, is determined by the declared battery capacity and declared vehicle range. In EV with extended range operation, only the range provided by the built-in battery is considered when calculating the specific energy use. The average specific energy use of EV is calculated from the average of the specific energy use of EV sold on a Slovenian market with a guaranteed service network.

4.10.1 Calculation formula – First-year savings

Estimation of savings for Article 7

Calculation of energy savings based on the difference between the estimated specific energy use determined by the mandatory specific CO₂ emissions for the new IC and the average specific electricity consumption energy of the new EOVS is determined by the equation:

$$PE_{EV} = (e_{CO_2all} \cdot 0.00385 - E_{EV}) \cdot PR \cdot N_{EV}$$

Where:

PE_{EV}	Energy savings [kWh/year] due to the purchase of new EV
e_{CO_2all}	Average projected specific emissions of CO ₂ [g CO ₂ /km] for the new IC determined by binding emission targets for new passenger cars (table below in 4.10.2)
E_{EV}	Average specific energy use EV, which is 0.128 [kWh/km]
PR	Average number of annual kilometers [km/vehicle] for passenger cars in the calendar year
N_{EV}	Number of purchased new EV in a calendar year





0.00385	Factor for conversion from CO ₂ emission savings to energy savings (1/(260 g CO ₂ /kWh)) taking into account the average specific fuel emissions.
---------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------

4.10.2 Standardized calculation values

Year	<i>e_{CO2all}</i> – average projected specific emissions of CO ₂ [g CO ₂ /km]
2015	130
2016	123
2017	116
2018	109
2019	102
2020	95

4.10.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.10.4 Description of sources

For the calculation, the data on average specific energy consumption of EV for all EV in the Slovenian market is required.

4.10.5 Bibliography

Uradni list RS, št. [67/15](#), [14/17](#) in [158/20](#) – ZURE, Rules on the methods for determining energy savings, p. 32–33.

<http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12451>

4.11 Alternative vehicle technologies for passenger cars – EMEES

This method/case application applies for fiscal measures and other financial incentives, national labelling of tyres/lubricants, information/motivation campaigns, research/development as well as for car scrapping rebates. Every measure covered aims at supporting one single end-use action: The usage of energy efficient vehicle technologies.

Theoretically, the method may be applied for EU-level measures such as reduction commitments, aiming at reducing the average fuel consumption of a manufacturer's car fleet as well as for vehicle labelling, a measure that has already been adopted for passenger cars (Directive 1999/94/EC). In general, such EU-level facilitating measures shall be evaluated top-down with the help of specific energy consumption indicators. But if one out of these measures is a selected promotion of efficient vehicles on the national or local level and thus the number of participants can be derived bottom-up, e.g. through monitoring of the number of participants, this method does apply and is recommended to be chosen.



4.11.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

For this method, the unit is one vehicle, which may be equipped with fuel-saving motor oil and tyres. The formula for unitary gross annual energy savings is:

$$ES_{uga} = En_{bas} \times \left(1 - \frac{En_{eff}}{En_{bas}} \times EV_{lub} \times EV_{tyr}\right) \times ADT - (En_{eff} \times RE)$$

Where:

ES _{uga}	Unitary gross annual energy savings [kWh]
En _{bas}	Fuel consumption in the baseline case [kWh/km]
En _{eff}	Average fuel consumption of efficient vehicle [kWh/km]
EV _{lub}	Efficiency value for fuel-saving lubricants [0;1]
EV _{tyr}	Efficiency value for fuel-saving tyres [0;1]
ADT	Annual distance travelled [km]
RE	Direct rebound effect [km]; <i>inclusion of this effect subject to decision by ESD Committee</i>

The total gross annual energy savings are derived by multiplying the number of efficient passenger cars/commercial vehicles that are purchased or affected in the context of the EEI measure under evaluation with the average unitary gross annual energy savings.

$$ES_{tga} = N \times \overline{ES_{uga}}$$

Where:

ES _{tga}	Total gross annual energy savings
ES _{uga}	Unitary gross annual energy savings (derived from equation 1)
N	Number of participating/equipped passenger cars/commercial vehicles

The adjusted gross savings consider free rider, multiplier and double counting effects. Hence, the formula for the total ESD annual energy savings is as follows:

$$ES_{tna} = ES_{tga} \times (1 - \text{free rider coefficient} + \text{multiplier coefficient}) \times \text{double counting factor}$$

Where:

ES _{tna}	Total net annual energy savings
ES _{tga}	Total gross annual energy savings (derived from equation 2)





Free-rider coefficient	[0;1], <i>inclusion is subject to decision by ESD Committee</i>
Multiplier coefficient	≥ 0
Double counting factor	[0;1]

4.11.2 Standardized calculation values

According to Schallaböck et al., there are numerous options to improve vehicle energy efficiency, and a combination of efficient technologies offers a technical saving potential beyond 50 %.

By contrast, the determination of the saving potential of certain facilitating measures proves to be difficult. According to Irrek/Jarczinsky, for passenger transport, the net impact achieved by existing policies and measures was not known.

Hence, there is no level 1 default value for Eneff/Enbas. Enuga depends on the fuel consumption values measured and is country-specific. The level 1 default efficiency values of fuel-saving tyres and lubricants are listed in the table below.

lubricants	lubricants	tyres	tyres
<i>passenger car</i>	<i>com. vehicle</i>	<i>passenger car</i>	<i>com. vehicle</i>
0.973	0.973	0.971	0.950

The next table shows the indicative values of lifetimes for the calculation of energy savings.

(EU-) default savings lifetime	efficient vehicles	100,000 km (CEN WS 27 Agreement)
	low resistance tyres for cars	50,000 km (CEN WS 27 Agreement)
	low resistance tyres for trucks	100,000 km (CEN WS 27 Agreement)
	fuel-saving lubricants	15,000 km (own estimate)

4.11.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.11.4 Bibliography

Susanne Böhler, Frederic Rudolph Task 4.2: harmonised bottom-up evaluation methods; Method No 15: Vehicle Energy Efficiency, EMEES, 2008

Schallaböck, K.O.; Fishedick, M.; Brouns, B.; Luhmann, H.-J.; Merten, F.; Ott, H.E.; Pastowski, A.; Venjakob, J.: Klimawirksame Emissionen des Pkw-Verkehrs und Bewertung von Minderungsstrategien. Wuppertal 2006, p. 77

Irrek, Wolfgang; Jarczinsky, Lutz: Overall Impact Assessment of current energy Efficiency Policies and Potential 'Good Practise' Policies, Wuppertal 2007, p. XI

4.12 Alternative vehicle technologies (passenger cars) – multEE

The method refers to the purchase of an alternative fuel car, both with and without replacing an old conventionally fuelled car.



When a more efficient car is purchased without an old car being replaced, this leads to additional energy consumption. However, the additional energy consumption is lower if an alternative fuel car is purchased instead of a conventional car.

On the other hand, energy can actually be saved if an old car is replaced by a new car.

4.12.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = n * (sFEC_{Ref} - sFEC_{Eff}) * \frac{Mil}{100} * rb * so * fr * lt$$

Where:

TFES	Total final energy savings [kWh/a]
n	Number of efficient cars purchased
sFEC _{Ref}	Specific Final energy consumption of the reference passenger car [kWh/100 km]
sFEC _{Eff}	Specific Final energy consumption of the efficient passenger car [kWh/100 km]
Mil	Average yearly mileage [km/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

4.12.2 Standardized calculation values

No calculation values are available for this methodology.

4.12.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

4.12.4 Description of sources

Calculation methodology

This methodology was published in the multEE project's deliverable "[Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures](#)". The document is published in English language. The document is available on the [multEE website](#).

Calculation values

While the document does not state-defined calculation values, it offers suggestions on possible data sources for the definition of values:

Lifetime of the measure: Reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 86. Lifetime determined in





kilometres. Alternatively, the lifetime may be determined based on national standard values or other national data available.

Specific Final energy consumption of the reference passenger car: Baseline cars in stock: the average specific final energy consumption of the reference passenger car may be calculated based on the national energy balance or be obtained from the national statistical office, the national Ministry of Transport or other institutions dealing with national transport data (e.g. national environmental office, transport associations).

Baseline new conventional fuel car (no replacement of an old car): figures for the average specific energy consumption of new conventional fuel cars may be available at the national statistical office, the national Ministry of Transport or other institutions dealing with national transport data (e.g. national environmental office, transport associations).

Alternatively, figures are available in the Odyssee database that shows the average specific final energy consumption of cars (in stock and new cars) in litres: <http://www.indicators.odyssee-mure.eu/online-indicators.html>). In this case, a conversion factor (litre to kWh) needs to be applied. The conversion factor may be available at the national Ministry of Transport or other institutions dealing with national transport data (e.g. national environmental office, transport associations). Alternatively, conversion factors are published in the EU Directive 2009/33/EC “Promotion of clean and energy-efficient road transport vehicles” (<http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:120:0005:0012:EN:P> DF, Annex Table 1: Energy content of motor fuels, p.8)

Specific Final energy consumption of the efficient passenger car

Electric passenger cars: To calculate the average specific energy consumption for pure electric cars, electric cars with a range extender, as well as plug-in hybrid drives, the standard specific consumption of a selection of available electric vehicles can be used constituting an average over this. Figures for the available electric vehicles may be available at the national statistical office, the national Ministry of Transport or other institutions dealing with national transport data (e.g. national environmental office, transport associations) or it can be sought from the Clean Vehicle Portal that provides an overview of the electric and plug-in hybrid car models available on the market www.cleanvehicle.eu/.

CNG passenger cars: To calculate the average specific energy consumption for compressed natural gas (CNG) powered vehicles the norm consumption of a chosen selection of available CNG-cars can be used constituting an average over this. For the CNG powered vehicles the average specific fuel consumption can be determined by taking the manufacturer’s information concerning the norm specific consumption. The manufacturer’s information on the vehicle specific fuel consumption is in kg/100km. To generate the specific consumption in kWh/100km, a conversion factor has to be applied: There might be a recommended conversion factor available at the national Ministry of Transport or other institutions dealing with national transport data (e.g. national environmental office, transport associations). The conversion factors may also be sought from the EU Directive 2009/33/EC “Promotion of clean and energy-efficient road transport vehicles” (<http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:120:0005:0012:EN:P> DF, Annex Table 1: Energy content of motor fuels, p.8)

Average yearly mileage: this value (km/a) may be obtained from the national statistical office, the national Ministry of Transport or other institutions dealing with national transport



data. Furthermore, the average mileage could also be available from household or transport surveys. It should be based on observed annual data and should not be extrapolated, as it can fluctuate a lot from one year to the other depending on the economic situation and fuel prices.

4.12.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 39 – 40, https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf





Chapter 5 Lighting systems including public lighting

5.1 Efficient street lighting - Austria

The street lighting of an area is upgraded to a more efficient technology (light sources and ballast units). Additionally, night setback is implemented.

As requirements for street lighting systems vary depending on the type of route and different technologies available for this purpose, the values for the number and power of light points have to be defined project-specific. Harmonized calculation values are prepared for the annual burning time and the impact of the night setback. It has to be noted that the values are defined for Austria, so middle-European lighting conditions. When applying this methodology in countries on differing latitudes, the value should be adapted in accordance to necessary operating hours.

5.1.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \frac{((L_{Ref} * P_{Ref}) - (L_{Eff} * P_{Eff} * f_{ns})) * h}{1000} * rb * so * fr * lt$$

Where:

TFES	Total final energy savings [kWh/a]
L _{Ref}	Number of light points in the inefficient system [-]
L _{Eff}	Number of light points in the efficient system [-]
P _{Ref}	Power of a single light point in the inefficient system [W]
P _{Eff}	Power of a single light point in the efficient system [W]
f _{ns}	Factor for the consumption reduction due to night setback [-]
h	Annual burning time [h]
rb	Factor to calculate a rebound effect (=1)
so	Factor to calculate a spill-over effect (=1)
fr	Factor to calculate a free-rider effect (=1)
lt	Factor for the lifetime of savings (=1)

5.1.2 Standardized calculation values

Factor night setback	[-]
No night setback	1
Setback to 50 % from 23:00 to 6:00	0.72
100 % setback from 1:00 – 5:00	0.65



Annual burning time	[h]
h	4,100
Lifetime of savings	[a]
Lifetime of savings	15

5.1.3 Cost effectiveness

No information on cost effectiveness available for this methodology.

5.1.4 Description of sources

Calculation methodology

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

Calculation values

The value for the annual burning time of street lighting in Austria was taken from a brochure on energy-efficient street lighting prepared by one of the federal provinces' energy agencies ("Oberösterreichischer Energiesparverband").

Values for the effect of night setbacks were taken from a brochure on energy-efficient street lighting prepared by the Federation of Electricity Generators Zurich.

The lifetime of the measure was defined according to the preliminary draft of the European Commission's Recommendations on measurement and verification methods in the framework of directive 2006/32/EC on energy end-use and energy services.

5.1.5 Bibliography

Anlage 1 BGB1. II, Nr. 172 (2016). Verallgemeinerte Methoden zur Bewertung von Energieeffizienzmaßnahmen, 107–109.

https://www.ris.bka.gv.at/Dokumente/BgblAuth/BGBLA_2016_II_172/C00_2026_100_2_1241958.pdf

OÖ Energiesparverband. (2015). Straßenbeleuchtung mit LED. Linz.

https://www.energiesparverband.at/fileadmin/esv/Broschueren/Strassenbeleuchtung_d t.pdf

Federation of Electricity Generators Zurich. (2007). Sicherheit und Effizienz - Straßenbeleuchtung. Empfehlungen für Gemeindebehörden und Beleuchtungsbetreiber. Zürich. https://www.topstreetlight.ch/uploads/ratgeber/SB_Flyer_2007_d.pdf

European Commission. C.E.E. (2010). Recommendations on measurement and verification methods in the framework of directive 2006/32/EC on energy end-use and energy services - preliminary draft.





5.2 Replacement of incandescent lamps at traffic lights with LED lamps – Bulgaria

The current method refers to the replacement of incandescent lamps at traffic lights with led lamps. The methodology is based on standard analytical method for assessing the delivered energy savings and no measurements are required. The energy savings are determined taking into account the difference in the power of incandescent lamps and that of LED lamps, under the same operating conditions - working hours per year and the same lighting requirements.

Application area: The presented method can be used for traffic lighting projects.

5.2.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \frac{n_{inc} * (P_{inc} - P_{led}) * t}{1000}$$

Where:

TFES	Total Final Energy Savings [kWh/a]
n_{inc}	Number of incandescent lamps replaced by led lamps
P_{inc}	Power of incandescent lamp [W]
P_{led}	Power of led lamp [W]
t	Average yearly operating hours [h/a] (see table below)

5.2.2 Standardized calculation values

t – Average yearly operating hours	[h/a]
Red (full circle, directional arrow), diameter 300 mm	2,680
Red/Green/Yellow, (full circle, tram signal, directional arrow, pedestrian signaling), diameter 200-210 mm	2,680
Blinking, diameter 300 mm	4,380
Blinking, diameter 200-210 mm	4,380
P_{inc} – Power of incandescent lamp	[W]
Red (full circle, directional arrow), diameter 300 mm	100
Red/Green/Yellow, (full circle, tram signal, directional arrow, pedestrian signaling), diameter 200-210 mm	60
Blinking, diameter 300 mm	100
Blinking, diameter 200-210 mm	60
Lifetime of savings	[a]
All types of lamps	10



5.2.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.2.4 Description of sources

Calculation methodology

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

Standard data are used by the calculation methodology (P_{inc} and t), while information about the power of the led lamps must be provided additionally (P_{led}).

Calculation values

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

5.2.5 Bibliography

Ministry of Energy (2021). Methodology for estimating energy savings when replacing incandescent lamps at traffic lights with LED lamps, Methodology no 22.

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

5.3 Installation of light control sensors – Bulgaria

The current method refers to the replacement of incandescent lamps at traffic lights with led lamps. The methodology is based on the analysis of the effect of reducing the working hours of electric luminaires without dismantling lamps or changing lighting fixtures. It takes into account the difference between the efficient operation of the luminaires per year before and after the installation of lighting control sensors, which has a direct impact on the annual energy consumption.

Application area: The presented method can be used for the case of residential and service buildings.

5.3.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \frac{n * P * (h_{base} - h_{ee})}{1000}$$

Where:

TFES	Total Final Energy Savings [kWh/a]
n	Number of the luminaires in which the sensors for lighting control will be installed





P	Power of the luminaire when applying the measure [W]
h_{base}	Average yearly operating hours without installed sensors for lighting control depending on the building (area) [h/a]
h_{ee}	Average yearly operating hours with installed sensors for lighting control depending on the building (area) [h/a]

5.3.2 Standardized calculation values

h_{base}	[h/a]
Residential buildings	1,000
Offices and public buildings	2,500
Commercial buildings	4,000
Hospitals	5,000
h_{ee}	[h/a]
Residential buildings	600
Offices and public buildings	1,500
Commercial buildings	2,400
Hospitals	3,000
Lifetime of savings	[a]
All types of buildings	10

5.3.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.3.4 Description of sources

Calculation methodology

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

Standard data are used by the calculation methodology (h_{base} and h_{ee}), while information about the power of the luminaires must be provided additionally (P).

Calculation values

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

5.3.5 Bibliography

Ministry of Energy (2021). Methodology for estimating energy savings when installing sensors for lighting control, Methodology no 20.

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



5.4 Energy-efficient lighting in buildings of the residential sector – Croatia

It is usually a matter of replacing incandescent bulbs with compact fluorescent lamps (CFLs) or light-emitting diodes (LEDs).

The calculation of unit savings is based on the lower installed power of lamps with efficient technology compared to inefficient ones. Total annual savings are determined by multiplying the difference in installed power by the average number of hours of lighting operation.

5.4.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$UFES = \frac{P_{init} - P_{new}}{1000} \times n_h$$

$$UFES = \frac{(R - 1)P_{new}}{1000} \times n_h$$

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

Where:

FES	Total Final Energy Savings [kWh/a]
UFES	Unit energy savings in direct consumption [kWh / unit / year]
N	Number of big lamps replaced/sold
P _{init}	Installed power before measurement [W]
P _{new}	Installed power after measure [W]
n _h	Number of hours of lamp operation per year [h / year]
R	Average electrical power ratio before and after lamp replacement.

5.4.2 Standardized calculation values

Standardized calculation values	
n _h	800[h/a]
P _{init}	60 for classical bulb [W] 15 CFL
P _{new}	15 CFL * 8 LED [W]
R	4 classic/ CFL, 7,5 classic/LED





	1,875 CFL/LED
UFES	36,0 41,6 [kWh/bulb/a] 5,6
Lifetime of savings	[a]
All types of lamps	7

5.4.3 Cost effectiveness

No information on cost effectiveness available for this methodology.

5.4.4 Description of sources

Calculation methodology

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

5.4.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

5.5 Replacement, improvement or installation of new lighting systems and their components in service and industrial sector buildings - Croatia

It is usually a matter of replacing obsolete incandescent bulbs, fluorescent tubes and mercury bulbs with CFL bulbs, more efficient fluorescent tubes, or LED lighting.

There are two typical cases:

- Bulb replacement. The calculation of unit savings is based on the lower installed power of light bulbs with efficient technology compared to inefficient ones. Total annual savings are determined based on the difference in installed power and based on the average number of hours of lighting operation.
- Reconstruction of the lighting system. In this case, not only the light bulbs are changed, but also the lighting systems and subsystems in the service and industrial sector buildings. The number of bulbs after the measure should not correspond to the number of installed bulbs before the measure.



5.5.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$UFES = \frac{P_{init} \times n_{hinit} - P_{new} \times n_{hnew}}{1000}$$

$$UFES = \frac{P_{init} - P_{new} \times r}{1000} \times n_h$$

$$FES = \sum_{i=1}^{N_{limit}} UFES_i$$

Where:

FES	Total Final Energy Savings [kWh/a]
UFES	Unit energy savings indirect consumption [kWh / unit / year]
N	Number of big lamps replaced/sold
P _{init}	Installed power before measurement [W]
P _{new}	Installed power after measure [W]
n _h	Number of hours of lamp operation per year [h / year] (init.- old, new)
r	Reduction factor that depends on the applied lighting management strategy

5.5.2 Standardized calculation values

Standardized calculation values	
n _h	1600[h/a]
r	1 - no management strategy 0.9 - partial extinguishing-ignition (room zoning) 0.9 - time management 0.8 - presence sensors 0.8 - adjustment to daylight intensity





UFES	72.0 - 60 W incandescent bulb replacement with 15 W CFL bulb
	83.2 - 60 W incandescent bulb replacement with 8 W LED bulb
	11.2 - replacement of 15 W CFL bulb with 8 W LED bulb
	22.5 - replacement of T8 fluorescent tube with T5 fluorescent tube
	16 - replacement of electromagnetic ballast with an electronic one
	305.6 - replacement of 400 W mercury bulb 250 W metal halogen bulb **
	536.9 - replacement of 400 W mercury bulb with 135 W LED bulb
	231.4 - replacement of 250 W metal halogen bulb with 135 W LED bulb
	202.4 - replacement of 250 W mercury bulb 150 W metal halogen bulb
	334.6 - replacement of a 250 W mercury bulb with an 85 W LED bulb
	132.2 - replacement of 150 W metal halogen bulb with 85 W LED bulb
Lifetime of savings	[a]
All types of lamps	12

5.5.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.5.4 Description of sources

Calculation methodology

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

5.5.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html



5.6 Replacement of installation of a new public lighting system - Croatia

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

There are two typical cases:

- 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.
- 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.

5.6.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$UFES = \frac{P_{init} \times n_{hinit} - P_{new} \times n_{hnew}}{1000}$$

$$UFES = \frac{P_{init} - P_{new} \times r}{1000} \times n_h$$

$$FES = \sum_{i=1}^{N_{init}} UFES_i$$

Where:

FES	Total Final Energy Savings [kWh/a]
UFES	Unit energy savings in direct consumption [kWh / unit / year]
N	Number of big lamps replaced/sold





P_{init}	Installed power before measurement [W]
P_{new}	Installed power after measure [W]
n_h	Number of hours of lamp operation per year [h / year]
R	Average electrical power ratio before and after lamp replacement.

5.6.2 Standardized calculation values

Standardized calculation values	
n_h	4100[h/a]
r	1 - without control strategy 0.72 - 50% power reduction from 23 to 6 hours 0.65 - 100% power reduction from 1 to 5 hours
UFES	830 - in case of replacement of 400 W mercury lamp with 250 W metal halogen or high-pressure sodium lamp 474.474 - in case of replacement of 400 W mercury lamp with 135 W LED lamp and bulb 644 - in case of replacement of 250 W metal halogen bulb or high-pressure sodium bulb with 135 W LED lamp and bulb 549 - in case of replacement of 250 W mercury lamp with 150 W metal halogen or high-pressure sodium lamp 919 - in case of replacement of 250 W mercury lamp with 85 W LED lamp and bulb 369 - in case of replacement of 150 W metal halogen or high-pressure sodium bulbs with 85 W LED lamp and bulb
F_s	1.3
Lifetime of savings	[a]
All types of lamps	15

5.6.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.



5.6.4 Description of sources

Calculation methodology

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

5.6.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

5.7 Replacement of lamps with compact fluorescent lamps - Cyprus

The current method refers to the replacement of existing lamps with compact fluorescent lamps. Due to the fact that no data on the average power of the lamps being replaced were available, the estimation was performed through the proposed methodology of the document 'Recommendations on measurement and verification methods in the framework of Directive 2006/32/EC on energy end-use and energy services.

Application area: The presented method can be used for the case of buildings in the public and residential sectors.

5.7.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^i n * sFES$$

Where:

TFES	Total Final Energy Savings [kWh/a]
n	Number of replaced lamps
sFES	Specific final energy savings per lamp [kWh]

5.7.2 Standardized calculation values

sFES	[kWh]
Public buildings	118
Residential buildings	47





Lifetime of savings	[a]
Public buildings	6,000 hours (2,500 hours annually average operating hours in public buildings)
Residential buildings	6,000-10,000 hours (1,000 hours annually average operating hours in public buildings)

5.7.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.7.4 Description of sources

Calculation methodology

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

Calculation values

The calculation values and the lifetime were presented in the 4th National Energy Efficiency Action Plan of Cyprus, which was submitted in 2017.

Regarding the replacement of lamps in the tertiary sector, the delivered energy savings can be estimated through the total electric power before and after the energy upgrade and the operating hours.

It should be noted that typical values for the delivered energy savings per installed system for specific categories of projects are provided also in the notification report for the tertiary sector.

Energy savings	[toe per system]
LED	16.36
Replacement of lamps	1.12-11.85

5.7.5 Bibliography

MECIT (2017). 4th National Energy Efficiency Action Plan of Cyprus, 236 and 240.

MECIT (2014). National Energy Efficiency Program, Notification report for achieving the target of Article 7, 34 and 37.

5.8 Replacement of incandescent lamps with LED lamps – France

The current method refers to the replacement of incandescent lamps with led lamps. The methodology is based on a standard analytical method for assessing the delivered energy savings and no measurements are required. The energy savings are determined taking into account the differences in the power of incandescent lamps and that of LED lamps, under the same operating conditions - working hours per year and the same lighting requirements.



Application area: The presented method can be used in the tertiary sector.

5.8.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$TFES = P_{led} * ES$

Where:

TFES	Total Final Energy Savings [kWh/a]
P _{led}	Power of led lamp [W]
ES	Energy savings by sector [kWh/a]

5.8.2 Standardized calculation values

Sector	Energy Savings (ES-kWh/a)
Hotel and restaurants	2,98
Retail	3,95
Office	2,15
Health	3,66
Education	1,48
Other	1,48
Lifetime of savings	[a]
Hotel and restaurants	13
Retail	11
Office, education and other	25

5.8.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.8.4 Description of sources

Calculation methodology

This methodology for assessing the delivered energy savings has been approved and has been published by order of the Minister of Ecological Transition.

Calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Ecological Transition.





5.8.5 Bibliography

Ministry of Ecological Transition (2020). Arrêté du 24 juillet 2020 (JO du 2 août 2020) avec rectificatif publié au JO du 8 août 2020 Standard Operations information sheets : BAT EQ 127

https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie#scroll-nav_5

5.9 Replacement of public lighting – France

The current method refers to the replacement of public lighting (highway, road, urban). The methodology is based on standard analytical method for assessing the delivered energy savings and no measurements are required. The energy savings are calculated from the luminous efficiency of the new lighting system.

Application area: The presented method can be used in public lighting.

5.9.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum n * ES$$

Where:

TFES	Total Final Energy Savings [kWh/a]
n	Number of lamps
ES	Energy savings depending on light efficiency [kWh/a]

5.9.2 Standardized calculation values

Energy savings depending on the light efficiency	Energy Savings (ES – kWh/a)
Light efficiency ≥ 90 lumens/Watt and ULOR $\leq 1\%$ (or, for LED, ULR $\leq 3\%$)	517
Light efficiency ≥ 70 lumens/Watt and ULOR $\leq 10\%$ (or, for LED, ULR $\leq 15\%$)	400
Lifetime of savings	[a]
Lifetime in years	30

5.9.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.



5.9.4 Description of sources

Calculation methodology

This methodology for assessing the delivered energy savings has been approved and has been published by order of the Minister of Ecological Transition.

Calculation values

The calculation values and the lifetime are defined within the officially adopted methodology for assessing the delivered energy savings by the Ministry of Ecological Transition.

5.9.5 Bibliography

Ministry of Ecological Transition (2015). Arrêté du 20 mars 2015 (JO du 29 mars 2015) avec rectificatif publié au JO du 18 avril 2015

Standard Operations information sheets: RES EC 104

https://www.ecologie.gouv.fr/operations-standardisees-deconomies-denergie#scroll-nav_8

5.10 Energy-efficient lighting in buildings of the residential sector - Greece

The current method refers to the replacement of energy-inefficient lamps (conventional light bulbs until their total phase-out, halogen lamps) with energy-efficient ones (CFL, LED).

Application area: The presented method can be used for the case of residential buildings.

5.10.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \frac{[n_s * (P_{Stock_{AvS}} - P_{Best_{MarkS}}) + n_b * (P_{Stock_{AvB}} - P_{Best_{MarkB}})] * t}{1000}$$

Where:

TFES	Total Final Energy Savings [kWh/a]
n_s	Number of small lamps replaced/sold
n_b	Number of big lamps replaced/sold
$P_{Stock_{AvS}}$	Power average of the existing small lamp [W]
$P_{Stock_{AvB}}$	Power average of the existing big lamp [W]
$P_{Best_{MarkS}}$	Power of the market promoted small efficient lamp [W]
$P_{Best_{MarkB}}$	Power of the market promoted big efficient lamp [W]
t	Average yearly operating hours [h/a]





5.10.2 Standardized calculation values

P_{Stock_AvS}	[W]
Existing small lamp	40
P_{Stock_AvB}	[W]
Existing big lamp	60
P_{Best_MarkS}	[W]
CFL	16
LED	7
P_{Best_MarkB}	[W]
CFL	24
LED	11
t	[h/a]
All types of lamps	1,642.5
Lifetime of savings	[a]
All types of lamps	6,000 hours (approximately 4 years)

5.10.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.10.4 Description of sources

Calculation methodology

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

Calculation values

The required calculation values were estimated in accordance with the outcomes of the conducted cost-optimal study for the buildings of the residential sector within the framework of the EPBD.

The value of the average yearly operating hours was derived by a survey, which was conducted by CRES for studying the final energy consumption of the various end-uses (CRES, 2015).

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

5.10.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του



Καθεστώς Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, 13,
<http://www.cres.gr/obs/yliko.html>.

CRES (2015). Deliverable 13: Application of criteria for quant control of all survey data.

5.11 Energy-efficient lighting in office buildings of the tertiary sector - Greece

The current method refers to the replacement of energy-inefficient lamps (conventional light bulbs until their total phase-out, halogen lamps) with energy-efficient ones (CFL, LED).

Application area: The presented method can be used for the case of office buildings.

5.11.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^n \frac{A * (P_{Basic} - P_{New}) * t}{1000}$$

Where:

TFES	Total Final Energy Savings [kWh/a]
A	Area of office building [m ²]
P _{Basic}	Specific installed power average of existing lighting systems per area of building [W/m ²]
P _{New}	Specific installed power average of energy-efficient lighting systems per area of building [W/m ²]
n	Number of office buildings
t	Average yearly operating hours [h/a]

5.11.2 Standardized calculation values

P_{Basic}	[W/m²]
Construction age 1980-2000	20.6
Construction age 2000-2010	14.4
Construction age 2011-2016	12.8
P_{New}	[W/m²]
CFL	24
LED	11
t	[h/a]
All types of lamps	2,500
Lifetime of savings	[a]





All types of lamps	12
--------------------	----

5.11.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.11.4 Description of sources

Calculation methodology

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

Calculation values

The required calculation values were estimated in accordance with the outcomes of the conducted cost-optimal study for the buildings of the residential sector within the framework of the EPBD.

The value of the average yearly operating hours was derived by prEN 15193.

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

5.11.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, 15, <http://www.cres.gr/obs/yliko.html>.

5.12 Energy-efficient lighting in buildings of the tertiary and industrial sectors - Greece

The current method refers to the replacement of energy-inefficient lamps (conventional light bulbs until their total phase-out, halogen lamps) with energy-efficient ones (CFL, LED).

Application area: The presented method can be used for the case of buildings of the tertiary and industrial sectors with the exemption of office buildings.

5.12.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^n (P_{ref} - P_{after}) * t$$

Where:

TFES	Total Final Energy Savings [kWh/a]
------	------------------------------------



P_{ref}	Installed lighting power of the building before the energy upgrade based on a study according to the standard EN 12464 and according to the minimum limits of Directive 2009/125/EC [kW]
P_{after}	Installed lighting power of the building after the energy upgrade based on a study according to the standard EN 12464 and according to the minimum limits of Directive 2009/125/EC [kW]
n	Number of buildings
t	Average yearly operating hours [h/a]

5.12.2 Standardized calculation values

Lifetime of savings	[a]
All types of lamps	12

5.12.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.12.4 Description of sources

Calculation methodology

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

Calculation values

The required calculation values must be collected by the conducted studies before and after the energy upgrade for each building separately.

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

5.12.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, 14, <http://www.cres.gr/obs/yliko.html>.

5.13 Energy-efficient street lighting - Greece

The current method refers to the replacement of energy-inefficient lamps (conventional light bulbs until their total phase-out, halogen lamps) with energy-efficient ones (CFL, LED).

Application area: The presented method can be used for the case of street lighting projects.





5.13.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^n (P_{ref} - P_{after}) * t$$

Where:

TFES	Total Final Energy Savings [kWh/a]
P _{ref}	Installed lighting power of the project before the energy upgrade based on a study according to the standard EN 13201 and according to the minimum limits of Directive 2009/125/EC [kW]
P _{after}	Installed lighting power of the project after the energy upgrade based on a study according to the standard EN 13201 and according to the minimum limits of Directive 2009/125/EC [kW]
n	Number of energy upgrade projects
t	Average yearly operating hours [h/a]

5.13.2 Standardized calculation values

Lifetime of savings	[a]
All types of lamps	15

5.13.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.13.4 Description of sources

Calculation methodology

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

Calculation values

The required calculation values must be collected by the conducted studies before and after the energy upgrade for each project separately.

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

5.13.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, 17, <http://www.cres.gr/obs/yliko.html>.



5.14 Lighting Upgrade Credits Calculation Tool - Ireland

This lighting tool has been developed for use on all SEAI-supported non-domestic lighting projects and the Energy Efficiency Obligation Scheme (EEOS). It enables users to calculate energy credits and cost savings achieved by lighting upgrade projects.

5.14.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

The exact formulas are “hidden” in the excel tool, but based primarily on users input for “original luminaires” (i.e. lighting bulbs that have been replaced) vs “new luminaires” (i.e. lighting bulbs new installed), for following table parameters, which have to be chosen in the excel file before starting the automated calculation.

Original Luminaire	
Lighting type	(selection from e.g. fluorescent / high pressure sodium / low pressure sodium / induction / LED / PL / Tungsten /...etc)
Lamp Watts (ex control gear)	[W]
No. of luminaires	[units]
No. of lamps	[units]
Daylight control fitted?	[YES/NO] – correction factor
Occupancy control fitted?	[YES/NO] – correction factor
New Luminaire:	
Lighting type	(selection from e.g. fluorescent / high pressure sodium / low pressure sodium / induction / LED / PL / Tungsten /...etc)
Lamp Watts (ex control gear)	[W]
No. of luminaires	[units]
No. of lamps	[units]
Daylight control fitted?	[YES/NO] – correction factor
Occupancy control fitted?	[YES/NO] – correction factor

Then the excel shows energy savings estimated as:

$$TFES = (FEC_{\text{before}} - FEC_{\text{after}}) =$$

$$= \frac{Lw * CGf * U1 * Df * Of * Ltf * t}{1.000} - \frac{Rw * U2 * Df * Of * Ltf * t}{1.000}$$





Where:

TFES	Total final energy savings [kWh/a]
FEC _{before}	Final energy consumption before implementation of the action [kWh/a]
FEC _{after}	Final energy consumption after implementation of the action [kWh/a]
Lw	Original Lamp Watts (ex control gear) [W]
Rw	Rated new Lamp Watts [W]
U1	Unit of original lamps
U2	Unit of new lamps
CGf	Control gear factor
Df	Daylight control factor
Of	Occupancy control factor
Ltf	Lighting type correction factor
t	Time of use [h]

5.14.2 Standardized calculation values

The next tables show the multiplication factors that are used in the calculations within the lighting tool (excel file).

The table below shows the default values for control gear losses.

Lamp type:	Control gear multiplication factor	
	< 400 W	>= 400 W
Fluorescent 2D EB	1.00	1.00
Fluorescent 2D MB	1.25	1.25
Fluorescent Compact	1.00	1.00
Fluorescent T12	1.15	1.15
Fluorescent T5	1.00	1.00
Fluorescent T8 EB	1.00	1.00
Fluorescent T8 MB	1.15	1.15
High pressure Sodium	1.10	1.05
Induction	1.00	1.00
LED	1.00	1.00
Low pressure Sodium EB	1.00	1.00
Low pressure Sodium MB	1.20	1.20
Mercury	1.05	1.05
Metal halide	1.10	1.05
PL EB	1.00	1.00



PL MB	1.25	1.25
Tungsten	1.00	1.00
Tungsten halogen	1.00	1.00

This is based on the values in Appendix C of the Energy Efficiency Obligation Scheme: Guidance on authenticating and claiming energy credits, see: [EEOS Guidance to authenticate & claim energy credits \(seai.ie\)](https://www.seai.ie/EEOS/Guidance%20to%20authenticate%20and%20claim%20energy%20credits).

The next table shows conversion factors used within the tool.

From	To	Factor
kWh	kg CO ₂	0.409
kWh	kWh (Primary Energy)	2.5

The CO₂ conversion factor is based on the Dwelling Energy Assessment Procedure (DEAP) and will be updated periodically. The primary energy conversion factor used in this tool is that required under the Energy Efficiency Obligation Scheme until the end of 2020. It will be updated periodically to align with the requirements of the Energy Efficiency Directive.

The below table shows the multiplication factors to account for daylight and occupancy controls.

Type of control	Factor
Daylight	0.9
Occupancy	0.9

Next table shows the multiplication factors to take account of savings available from different lighting types.

Lighting type	Multiplication factor
New fitting (Triple E or equivalent)	1.0
Emergency lighting: Standalone system – unmaintained fitting	0.0
Emergency lighting: Integrated fitting	1.02
Emergency lighting: Signage - maintained	1.02
Fitting (NOT Triple E or equivalent)	1.0
Bulb (NOT Triple E or equivalent)	1.0
No new fitting installed	1.0
Existing lighting unchanged	1.0

5.14.3 Cost-effectiveness

“No information on cost-effectiveness available for this methodology.”





5.14.4 Description of sources

Calculation methodology

This methodology was taken from the excel calculation tool “Lighting Upgrade Credits Calculation Tool” available for free download at the SEIA website (see: [Tools & Calculators | SEAI](#)), to explain the parameters to be set first. Then the main underlying formula (which is hidden in the calculation tool itself) has been explained in the published SEIA guidance document “SEAI Lighting Upgrade Credits Calculation Tool; Guidance for Use; Date: 05/04/2019; Version 1.2”, as well available on the same website.

Calculation values

The main calculation values have been taken from the SEIA guidance document “SEAI Lighting Upgrade Credits Calculation Tool; Guidance for Use; Date: 05/04/2019; Version 1.2” - see section 2.3 various tables. Some of the here shown values are furthermore referred to other SEIA documents and will be constantly updated in the excel calculation tool:

- Copy of the latest version of the web-based Triple E Register (see: [SEAI - Triple E](#)). The register is updated at least once every six months. The lighting tool will be updated as required to contain the full list of Triple E Luminaires.
- Default values for control gear losses refer to values in Appendix C of the Energy Efficiency Obligation Scheme: Guidance on authenticating and claiming energy credits (see the below bibliography).
- CO₂ conversion factor is based on the Dwelling Energy Assessment Procedure (DEAP) and will be updated periodically.

5.14.5 Bibliography

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

SEAI Lighting Upgrade Credits Calculation Tool; Guidance for Use; Date: 05/04/2019; Version 1.2

5.15 Replacement of inefficient lamps - Portugal

Estimation of savings (for Article 7)

This methodology is used to calculate the savings from phasing-out of inefficient lamps through legislation, labelling, and taxation of bulbs with a low level of energy efficiency (Decree-Law No 108/2007 of 12 April 2007).

5.15.1 Calculation Formula – First-year savings

$$EE = (P_{conventional} - P_{with incentive}) \times nh \times \left(\frac{F_{rep}}{1000} \right) \times (N1 + N2) \times F_{ce}$$

Where:

EE	Energy saved
----	--------------



$P_{\text{conventional}}$	Average power of light bulbs in use
$P_{\text{with incentive}}$	Average power of energy saving light bulbs
nh	No. of hours functioning of light bulbs in use
F_{rep}	Correction factor which takes into account the No. of light bulbs sold that did not replace existing light bulbs
N1	No. of light bulbs acquired voluntarily
N2	No. of light bulbs distributed through incentive
F_{ce}	Conversion factor for electrical energy to final energy
F_{ce2}	Conversion factor for electrical energy to primary energy

5.15.2 Standardized calculation values

No calculation values are given for this methodology.

5.15.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology

5.15.4 Description of sources

This methodology was published in the Portuguese catalogue on bottom-up calculation methodologies (Council of Ministers Resolution No 20/2013), which is Annex to the Directive 172 on Energy Efficiency.

5.15.5 Bibliography

Council of Ministers Resolution No 20/2013

<https://data.dre.pt/eli/resolconsmin/20/2013/04/10/p/dre/pt/html>

5.16 Energy-efficient lighting in buildings - Slovenia

Energy savings can be calculated based on:

- standardized energy savings when replacing or improving lighting systems,
- project data, as the difference between the electricity consumption of the installed new lighting system and replaced lighting system (including supporting devices),
- standardized savings of various measures for the new built-in modern lighting system.

5.16.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

Savings can be determined based on project data, considering the actual power and number of operating hours of the new and replaced lighting system, using the following equation:





$$PE_{Lighting} = \sum_i (P_{i,old} \cdot n_{i,old} \cdot t_{i,old}) - \sum_j (P_{j,new} \cdot n_{j,new} \cdot t_{j,new})$$

Where:

$PE_{Lighting}$	Energy savings [kWh/year] due to the use of energy-efficient or improved lighting system
$P_{i,old}$	Electric power [kW/unit] of the old or replaced lighting system (lamps), including auxiliary devices (ballasts, sensors, etc.)
$P_{j,new}$	Electric power [kW/unit] of the new or improved lighting system (lamps), including auxiliary devices (ballasts, sensors, etc.)
$n_{i,old}$	Number of lamps or lighting systems replaced
$n_{j,new}$	Number of new lamps or lighting systems
$t_{i,old}$	Operating time [h] of the old lighting system
$t_{i,new}$	Operating time [h] of the new lighting system

The savings can also be calculated using standardized energy savings using the following equation:

$$PE_{Lighting} = \sum_i NP_i \cdot n_i$$

Where:

$PE_{Lighting}$	Energy savings [kWh/year] due to the use of energy-efficient or improved lighting system
n_i	Number of lighting systems or improvements installed or sold
NP_i	Standardized energy savings [kWh/year per system] when replacing or improving various lighting systems as set out in the table below



5.16.2 Standardized calculation values

The next table shows the annual standardized energy savings for various lighting systems or planned improvements [kWh/year].

Type of lighting system	Commercial sector	Households
	NP standardized annual savings (2500 hours)	NP standardized annual savings (1000 hours)
Installation of LED bulbs instead of ordinary light bulbs	180	80
Installation of CFL instead of ordinary light bulbs	118	47
Replacement of T8 fluorescent lamps with T5	22.5	9
Installation of an electronic ballast (instead of magnetic choke)	15	6
Installation of presence sensors	40	16

5.16.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology

5.16.4 Description of sources

To use this method, it is necessary to know the type and number of new lamps installed or sold, or lighting systems in the calculation based on project data; information on the type and number of new lamps and the number of operating hours for a new or refurbished and for old or replaced system lighting.

When replacing or improving electric lighting in buildings, everything must be considered under the technology design conditions (level of illumination, method of installation, etc.) and standards and recommendations for each device or intended use.

5.16.5 Bibliography

Uradni list RS, št. [67/15](#), [14/17](#) in [158/20](#) – ZURE, Rules on the methods for determining energy savings, p. 42–43, available at: <http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12451>

5.17 Energy savings when installing a new lighting system – Slovenia

Energy savings for this measure can be calculated based on:

- project data, as the difference between the electricity consumption of the replaced system lighting (including ancillary devices) and a new or improved lighting system (including ancillary devices);
- standardized energy savings when replacing or improving lighting systems and/or applying various measures in newly installed modern lighting systems.





5.17.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

Savings are calculated based on the average of the project data, for the newly installed technologies as new lighting shall comply with the values specified in the Technical Guidelines for Energy Efficiency (Ministry of Environment and Spatial Planning, 2010).

$$PE_{Lighting} = 0.001 \cdot \left[\sum_i (p_{i,old} \cdot A_{i,old} \cdot t_{i,old}) - \sum_j (p_{j,new} \cdot A_{j,new} \cdot t_{j,new}) \right]$$

Where:

$PE_{Lighting}$	Energy savings [kWh/year] due to the use of energy efficient or improved lighting system
$P_{i,old}$	Lamp power density [W/m ²], electrical power [W] of the old lighting system (lamps), including auxiliary devices (ballasts, sensors, etc.) - from Technical guidelines for energy efficiency - divided by area space [m ²] to which the renovation of the electric lighting system relates, as set out in the table on section 5.17.2.
$p_{j,new}$	Lamp power density [W/m ²], electrical power [W] of the new lighting system (lamps), including ancillary devices (ballasts, sensors, etc.), divided by the area of the space [m ²] to which the renovation of the electrical system relates as set out in the table above
$A_{i,old}$	The area of the space [m ²] to which the renovation of the electrical system refers lighting, existing condition
$A_{j,new}$	The area of the space [m ²] to which the renovation of the electrical lighting system refers, new condition
$t_{i,old}$	The operating time [h] of the old lighting system. With new electrical systems $t_{i,old} = t_{j,new}$
$t_{j,new}$	Operating time [h] of the new lighting system

5.17.2 Standardized calculation values

Label CC-SI	Description	$P_{i,old}$ [W/m ²]
111, 112	single- and multi-apartment buildings	8
113, 12111, 1212, part 12201, 1241, 1274	special purpose residential buildings, hotel and similar buildings, other catering buildings for short-term accommodation, administrative and office buildings, stations, terminals, correctional facilities, prisons, fire stations	47
12112	inns, restaurants, pubs	15
1251, part 1262, 12721	industrial buildings, libraries, religious buildings	14



del 12201, part 12203, part 1261, 1264	courts, congress and conference buildings, cinemas, pavilions and buildings for animals and plants in animal and botanical gardens, educational buildings and scientific research work, healthcare buildings	13
part 12201, part 12610, del 1262, 1265	post offices, halls for social events, casinos, dances halls, discos, music pavilions, museums, galleries, sports halls	12
part 12301	stand-alone shops and boutiques, pharmacies, eyewear stores, sales galleries	16
part 12301, 12302	shopping malls, shopping malls, department stores, covered markets, fair halls, exhibition halls	9
1242	garage buildings	3
part 1261	theaters, concert halls, opera houses	17

5.17.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.17.4 Description of sources

To use this method, it is necessary to know the type and number of new lamps installed or sold, or lighting systems in the calculation based on project data; information on the type and number of new lamps and the number of operating hours for a new or refurbished and for old or replaced system lighting.

When replacing or improving electric lighting in buildings, everything must be considered under the technology design conditions (level of illumination, method of installation, etc.) and standards and recommendations for each device or intended use.

5.17.5 Bibliography

Uradni list RS, št. [67/15](#), [14/17](#) in [158/20](#) – ZURE, Rules on the methods for determining energy savings, p. 43–45.

<http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12451>

Ministry of Environment and Spatial Planning, (2010). Technical Guidelines for Energy Efficiency.

https://www.ozs.si/datoteke/ozs/sekcije/Janko%20Rozman/Sekcija%20instalaterjev-energetikov/TSG-01-004_2010_U%C4%8Dinkovita%20raba%20energije.pdf

5.18 Renovation of outdoor lighting systems - Slovenia

The calculation of energy savings for this measure is based on the difference between the electricity consumption of the old system and the new more efficient outdoor lighting system. Two calculations are possible, based on “project data” or “using normalized values”.





5.18.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

The energy savings from renovating an existing outdoor lighting system are calculated by the equation:

$$PE_{OutLighting} = \sum_i (P_{i,old} \cdot t_{i,old} \cdot f_{p,old}) - \sum_j (P_{j,new} \cdot t_{j,new} \cdot f_{p,new})$$

Where:

$PE_{OutLighting}$	Energy savings [kWh/year] due to the renovation of the outdoor lighting system
$P_{i,old}$	Connected electrical power [kW] of the old road electric lighting system section on which electric lighting is being renovated, including auxiliary lighting devices (ballasts, sensors, etc.)
$P_{j,new}$	Connected electrical power [kW] of the new electric road lighting system section on which electric lighting is being renovated, including auxiliary lighting devices (ballasts, sensors, etc.)
$t_{i,old}$	Operating time [h] of the old outdoor lighting system
$t_{j,new}$	Operating time [h] of the new outdoor lighting system
f_p	Night light level adjustment factor: a value of 0,8 for lighting systems using night-time adjustment, value 1 for lighting systems without night adjustment.

When replacing or improving street or road lighting, all design conditions, standards and recommendations for each device or purpose of use have to be considered (level of lighting, installation method, etc.). Any replacement or improvement that provides at least 30% of electricity savings compared to the existing condition shall be considered technically appropriate.

To calculate the energy savings for a new road section on which outdoor lighting has not yet been installed, the following equation shall be used:

$$PE_{OutLighting} = \sum_j L_{j,new} \cdot (8 - q_{j,new} \cdot f_{p,new})$$

Where:

$PE_{OutLighting}$	Energy savings [kWh/year] due to the installation of an outdoor lighting system on a new road section on which outdoor lighting has not yet been installed
$L_{j,new}$	The length of the road section on which the exterior system is newly installed lighting [m]



$q_{j,new}$	Average annual energy consumption of the newly installed outdoor lighting system (for 4000 hours per year operation) per meter of road section [kWh/m], energy efficiency limit on the new section is set to the average annual energy consumption at length meter maximum 8 kWh/m per year
$f_{p,new}$	Night light level adjustment factor for the new outdoor lighting system: a value of 0.8 for lighting systems using night-time adjustment, value 1 for lighting systems without night adjustment

In the case of a new section where the lighting has not yet been installed, the starting point shall be the average annual use per meter of length, which is 8 kWh/m per year.

Energy savings in relation to the renovation of the outdoor lighting system can also be determined with the use of normalized savings attributed to the most commonly used systems or technologies. For assessing the energy savings for this measure, the following equation is used:

$$PE_{OutLighting} = \sum_j NP_i \cdot n_i$$

Where:

$PE_{OutLighting}$	energy savings [kWh/year] due to the renovation of the outdoor lighting system
n_i	Number of external lighting systems or improvements installed
NP_i	Annual normalized energy savings [kWh/year] when replacing or improving various outdoor lighting systems as defined in the table below

5.18.2 Standardized calculation values

Annual normalized energy savings for some of the most common systems of outdoor lighting (calculation of the standardized savings considers the power of ballasts and 4000 hours of annual operation at full power) are presented in the table below.

Old lamp (type and power of lamp)	New lamp (type and power of lamp)	Normalized energy savings [kWh/year]
Mercury (400 W)	Modular LED (225 W)	680 kWh/year
Mercury (400 W)	High-pressure sodium (250 W)	608 kWh/year
Mercury (400 W)	Metal-Halide (250 W)	608 kWh/year
Mercury (250 W)	High-pressure sodium (150 W)	420 kWh/year
Mercury (250 W)	Metal-Halide (150 W)	420 kWh/year
Mercury (150 W)	Fluorescent (2 x 36 W)	360 kWh/year
Mercury (125 W)	High-pressure sodium (70 W)	216 kWh/year
Mercury (50 W)	Compact fluorescent (26 W)	100 kWh/year





5.18.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.18.4 Description of sources

When using standardized values, the data on the number and type, power and operating hours of new systems are required to calculate the corresponding savings.

5.18.5 Bibliography

Uradni list RS, št. [67/15](#), [14/17](#) in [158/20](#) – ZURE, Rules on the methods for determining energy savings, p. 43-45, available at:

<http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12451>

Ministry of Environment and Spatial Planning, (2010). Technical Guidelines for Energy Efficiency, available at:

https://www.ozs.si/datoteka/ozs/sekcije/Janko%20Rozman/Sekcija%20instalaterjev-energetikov/TSG-01-004_2010_U%C4%8Dinkovita%20raba%20energije.pdf

5.19 Improving street lighting systems - MultEE

For improving the energy efficiency of street lighting systems, old inefficient technologies are being replaced with efficient ones. In addition, the measure provides for energy consumption for street lighting being further reduced by implementing provisions for night setback of 50% and 100% of luminance intensity.

5.19.1 Calculation Formula - – First-year savings

Estimation of savings for Article 7

$$TFES = t * \left((L_{Ref} * P_{Ref}) - (L_{Eff} * P_{Eff} * F_{red}) \right) * rb * so * fr * lt$$

Where:

TFES	Total final energy savings [kWh/a]
t	Average yearly operating hours [h/a]
L _{Ref}	Number of light points of the energy inefficient street lighting system [-]
L _{Eff}	Number of light points of the energy-efficient street lighting system [-]
P _{Ref}	Power output per light point of the energy inefficient system [W]
P _{Eff}	Power output per light point of the energy-efficient system [W]
F _{red}	Reduction factor for additional measures (e.g. dimming) [-]
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)
lt	Factor for the lifetime of savings (=1)



5.19.2 Standardized calculation values

No calculation values are available for this methodology.

5.19.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

5.19.4 Description of sources

Calculation methodology

This methodology was published in the multEE project's deliverable "[Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures](#)". The document is published in English language. The document is available on the [multEE website](#).

Calculation values

While the document does not state-defined calculation values, it offers suggestions on possible data sources for the definition of values:

Lifetime of the measure: reference can be made to the document "Recommendations on Measurement and Verification Methods in the framework of Directive 2006/32/EC on Energy End-Use Efficiency and Energy Services", page 86. Alternatively, the lifetime may be determined based on the lighting system's average yearly operating hours and/or in consultation with the respective guild.

Power output per light point of the lighting system (inefficient and efficient): the respective lighting system and its average power output have to be determined. Either project specific values may be applied or default values for a specific power output per light point are determined (either through desk research or in consultation with the lighting industry).

Reduction factor for additional measures: for determining the reduction factor, the total daily operational time of the street lighting system (the average number for the whole year) has to be defined as well as the time period during which the street lights are being dimmed on a daily basis.

Average yearly operating hours: is to be determined based on the total daily operational time of the street lighting system (the average number for the whole year).

Supplementary information may be sought under:

Regulation (EC) No 245/2009: eco-design requirements for fluorescent lamps without integrated ballast, for high-intensity discharge lamps, and for ballasts and luminaires able to operate such lamps:

<http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:076:0017:0044:en:PDF>

An overview of the Eco-design regulations of the EU can be found under:

https://ec.europa.eu/energy/sites/ener/files/documents/list_of_ecodesign_measures.pdf

An overview of the Eco-labelling regulations of the EU can be found under:

https://ec.europa.eu/energy/sites/ener/files/documents/list_of_energylabelling_measures.pdf





5.19.5 Bibliography

Jamek, A., et. al. (2016). Document with general formulae of bottom-up methods to assess the impact of energy efficiency measures, p. 102 – 104,
https://multee.eu/system/files/D2.1_Document%20with%20general%20formulae%20of%20bottom-up%20methods.pdf



Chapter 6 Hors category

This chapter presents methodologies that were collected but do not match the five Priority Actions, but can provide useful inputs for future methodologies to be developed.

6.1 Energy Management System – Croatia

Given that energy is crucial for the business and functioning of most types of organizations and represents an increasing cost during business, there is a need to create a standardized model for efficient energy management. The introduction of an energy management system (eg ISO 50001) sets out requirements and provides guidance for the application of such energy management that would be suitable for application in all types of organizations and to all types of energy used. With the energy management system, it is desirable to install equipment, ie CO₂ and CO control systems in the room, without exception in the room where an open flame is used. The main purpose of the system is to achieve better energy performance, which includes energy use, energy efficiency, employee safety and energy consumption by applying a series of administrative and organizational procedures, appointing responsible persons and setting specific goals for improving or adopting a comprehensive energy policy.

6.1.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$FES = E \times r_{EL} + (G_L + G_{MU} + G_{KU} + G_{TLU} + G_B + G_{BM} + G_{PP} + G_{ELLU} + G_{UNP} + G_{TE}) \times r_G$$

Where:

FES	Total annual energy savings in direct consumption by introducing an energy management system, separately for the service sector, micro and small enterprises of the industrial sector and medium and large enterprises of the industrial sector [kWh/a]
E	Annual electricity consumption of all end customers measured in the year before the introduction of the energy management system [kWh/a]
r _{EL}	Electricity saving factor due to the introduction of energy management systems according to the table of reference values
G _x	Different fuels' consumptions
r _G	Fuel saving factor due to the introduction of an energy management system according to the table of reference values below

6.1.2 Standardized calculation values

Lifetime of savings	[a]
Lifetime of savings	5





6.1.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

6.1.4 Description of sources

Calculation methodology

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

6.1.5 Bibliography

Ordinance on the system for monitoring, measuring and verifying energy savings (OG 33/2020): https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_33_723.html

6.2 Introduction of energy management systems – Cyprus

The current method refers to the introduction of the different types of energy management systems to buildings.

Application area: The presented method can be used for buildings of the industrial and tertiary sectors.

6.2.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^n FEC_{before} - FEC_{after}$$

Where:

TFES	Total final energy savings [kWh/a]
FEC_{before}	Final energy consumption before the installation of the energy management system [kWh]
FEC_{after}	Final energy consumption after the installation of the energy management system [kWh]
n	Number of the installed systems

It should be noted that the calculations are performed taking into account the energy bills issued over a period beginning two years before installation and ending one year after installation.



6.2.2 Standardized calculation values

Lifetime of savings	[a]
EMS – Tertiary sector	5
BMS – Tertiary sector	15
BEMS – Tertiary sector	6 and 15 (two different categories)
EMS – Industrial sector	5
BMS – Industrial sector	10

6.2.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

6.2.4 Description of sources

Calculation methodology

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

Calculation values

The required calculation values are collected for each developed system separately.

The lifetime of savings was defined in the notification report for achieving the target of Article 7 of the EED for the period 2014-2020.

It should be noted that typical values for the delivered energy savings per installed system for specific categories of projects are provided also in the notification report.

Energy savings	[toe per system]
EMS – Tertiary sector	8.76
BMS – Tertiary sector	6.50
BEMS – Tertiary sector	34.31 and 53.79 (two different categories)
EMS – Industrial sector	2.93
BMS – Industrial sector	7.53

6.2.5 Bibliography

MECIT (2017). 4th National Energy Efficiency Action Plan of Cyprus, 235.

MECIT (2014). National Energy Efficiency Program, Notification report for achieving the target of Article 7, 34 and 37.

6.3 Introduction of energy management systems – Greece

The current method refers to the introduction of the energy management system (either ISO 50001 standard or other standards).





Application area: The presented method can be used for all types of buildings.

6.3.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$TFES = \sum_1^n FEC_{before} * S_Q$$

Where:

TFES	Total final energy savings [kWh/a]
FEC_{before}	Final energy consumption before the implementation of the interventions as measured by the developed system [kWh]
S_Q	Final energy savings coefficient as determined in a specific scenario of the developed system [%]
n	Number of the developed systems

6.3.2 Standardized calculation values

Lifetime of savings	[a]
Lifetime of savings	5

6.3.3 Cost effectiveness

No information on cost effectiveness available for this methodology.

6.3.4 Description of sources

Calculation methodology

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

Calculation values

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

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

6.3.5 Bibliography

CRES (2020). Εξισώσεις «Από τη βάση στην κορυφή» για τον προσδιορισμό της εξοικονόμησης ενέργειας από μέτρα βελτίωσης της ενεργειακής απόδοσης στο πλαίσιο του Καθεστώτος Επιβολής της Υποχρέωσης Ενεργειακής Απόδοσης, 12, <http://www.cres.gr/obs/yliko.html>.



6.4 Intelligent Meters promoting Energy Efficiency and Sustainability – Portugal

Methodology for calculating the effect of expanding remote management and measuring to cover all energy end-users, with a view to monitoring and potentially reducing consumption and the respective costs of using energy, promoting energy efficiency and environmental sustainability. These tools enable a detailed analysis of consumption, resulting in effective behavioral changes with regard to energy efficiency.

6.4.1 Calculation Formula – First-year savings

Estimation of savings for Article 7

$$EE = N \times (C_{e1} \times P1) \times F_{ce}$$

Where:

EE	Total final energy savings [toe]
N	Nº of Intelligent Meters installed [units]
C _{e1}	Reduction in consumption of energy due to meter [%]
P	Average consumption per consumer [kWh/a]
F _{ce}	Conversion factor for electrical energy to final energy [toe/kWh]

6.4.2 Standardized calculation values

No calculation values are given for this methodology.

6.4.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology

6.4.4 Description of sources

This methodology was published on the National Energy Efficiency Action Plan (NEEAP) and the National Renewable Energy Action Plan (NREAP) for the period 2013-2016.

6.4.5 Bibliography

“Council of Ministers Resolution No 20/2013.” Ministers Resolution, April 10, 2013.
<https://dre.pt/home/-/dre/260463/details/maximized>.

6.5 Installation of advanced metering systems and energy billing in households and the service sector - Slovenia

An advanced metering system is an electronic system that can measure energy consumption while transmitting more information in comparison to a conventional meter and can send and receive data using electronic communication, thus enabling more advanced monitoring and billing of actual energy consumption. The advanced metering system must





be adequately supported by the provider's set of advanced services equipment (monitoring application, daily insight, comparison, etc.). Energy savings due to the installation of advanced metering systems are calculated based on annual consumption (separately for electricity and heat or fuel measured with such system) prior to the installation of the system.

6.5.1 Calculation formula – First-year savings

Estimation of savings for Article 7

Energy savings due to the installation of advanced metering systems are calculated by the equation:

$$PE_{AMS} = E \cdot r_{EL} + G \cdot r_G$$

Where:

PE_{AMS}	Energy savings [kWh/year] due to the introduction of an advanced metering system in the lifetime of the measure (five years)
E	Electricity consumption [kWh/year], measured with the built-in advanced metering system, in the last year before installation
r_{EL}	Electricity saving factor due to the installation of an advanced metering device system as set out in the table below
G	Fuel consumption [kWh/year], measured with the built-in advanced metering system, in the last year before installation
r_G	Fuel and heat saving factor due to the installation of advanced system measurements as set out in the table below

6.5.2 Standardized calculation values

sector	electricity saving factor r_{EL}	fuel and heat saving factor r_G
Buildings – commercial	0.01	0.02
Buildings – households	0.02	0.03

6.5.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

6.5.4 Description of sources

Energy consumption data (separately for electricity, heat and other fuels) are required to calculate energy savings in enterprises, institutions or buildings, measured by built-in advanced metering systems.

6.5.5 Bibliography

Uradni list RS, št. [67/15](#), [14/17](#) in [158/20](#) – ZURE, Rules on the methods for determining energy savings, p. 51.

<http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12451>



6.6 Introduction of energy management systems (EMS) - Slovenia

Energy savings due to the introduction of a computerized energy management system or the introduction of the EN ISO 50001 standard in the organization is calculated according to the annual energy consumption (separately for electricity, heat or other fuels) prior to the introduction of the energy management system. This system's software and hardware enable measurement, control, monitoring and energy management. Its establishment should be supported by the following actions:

- designation of a person responsible for efficient energy management in the organization;
- adoption of an organization energy policy covering the objectives and set of the company's own measures to increasing energy efficiency and the use of renewable energy sources, dynamics of the implementation and responsibilities and activities of employees in the field of energy management;
- preparation of an annual report on the implementation and achievement of energy management effects - determine the number and arrangement of metering points used within the energy management system.

6.6.1 Calculation formula – First-year savings

Estimation of savings for Article 7

Energy savings due to the installation of advanced metering systems are calculated by the equation:

$$PE_{EMS} = E \cdot r_{EL} + G \cdot r_G$$

Where:

PE_{EMS}	Energy savings [kWh/year] due to the introduction of an advanced metering system in the lifetime of the measure (five years)
E	Electricity consumption [kWh/year], measured with the built-in advanced metering system, in the last year before installation
r_{EL}	Electricity saving factor due to the installation of an advanced metering device system as set out in the table below
G	Fuel consumption [kWh/year], measured with the built-in advanced metering system, in the last year before installation
r_G	Fuel and heat saving factor due to the installation of advanced system measurements as set out in the table below

6.6.2 Standardized calculation values

Sector	electricity saving factor r_{EL}	fuel and heat saving factor r_G
Buildings – commercial	0.03	0.05
Industry		





micro and small companies	0.02	0.03
medium and large companies	0.01	0.01

6.6.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

6.6.4 Description of sources

Energy consumption data (separately for electricity, heat and other fuels) are required to calculate energy savings in organizations that have implemented an appropriate energy management system or standard SIST EN ISO 50001.

6.6.5 Bibliography

Uradni list RS, št. [67/15](#), [14/17](#) in [158/20](#) – ZURE, Rules on the methods for determining energy savings, p. 52–53:

<http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12451>

6.7 Waste heat recovery systems in buildings - Slovenia

The calculation of energy savings is based on the amount of heat transferred to the supply air from the warm air that leaves the building. The savings are determined by the area of the building in which the ventilation system works. For the savings calculation standardized values of the air exchange rate, the operating time of the system, room height, temperature differences between the air leaving the room and the outside air, recuperation rate and air density are used.

6.7.1 Calculation formula – First-year savings

Estimation of savings for Article 7

Energy savings due to the installation of a ventilation system with waste heat recovery are calculated according to the equation:

$$PE_i = A \cdot h \cdot \beta \cdot t \cdot c \cdot \rho \cdot \Delta T \cdot \eta \cdot N$$

Where:

PE_i	Energy savings [kWh/year] due to the utilization of waste heat in ventilation systems (recuperation)
A	Area of the building [m ²] to which the central ventilation system applies, or building area, if local ventilation units are installed
h	Height [m] of rooms (from floor to ceiling)
β	Air exchange rate [h ⁻¹]
t	Operating time [h] of the ventilation system during the heating season
c	Specific heat of the air (1 kJ / kg K)



ρ	Air density (1.2 kg / m ³)
ΔT	Difference between indoor air temperature and average outdoor temperature of the air during the heating season
η	Recovery rate
N	Number of ventilation units (central system $N = 1$, system with up to 4 local units)

Considering the above normalized values, the energy savings are calculated according to the equation:

$$PE_i = 13,125 \cdot A \cdot N$$

6.7.2 Standardized calculation values

Area of the building [m ²]	A
Standardized value is 103 m ² for a dwelling in single-family buildings and 60 m ² for dwelling in multi-apartment buildings	
Height [m] of rooms (from floor to ceiling)	h
Standard value is 2.5 m	
Air exchange rate [h ⁻¹]	β
Standard value is 0.5 h ⁻¹	
Operating time [h]	t
Standardized value is 3000 hours	
Difference between indoor air temperature and average outdoor temperature of air during the heating season	ΔT
Standard value (22–4) K = 18 K	
Recovery rate	η
Normalized value is 0.7	

6.7.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

6.7.4 Description of sources

To use this method, it is necessary to know the data on the number of ventilation units and the area of buildings (subject to certain conditions and standard values).

6.7.5 Bibliography

Uradni list RS, št. [67/15](#), [14/17](#) in [158/20](#) – ZURE, Rules on the methods for determining energy savings, p. 28.

<http://www.pisrs.si/Pis.web/pregledPredpisa?id=PRAV12451>





6.8 Non-residential space heating improvement in case of heating distribution by a water loop – EMEES

The EMEES project defined a methodology for the BU calculation of energy savings in heating systems in non-residential buildings. Although this method does not strictly fit in this category it is included because it addresses improved control strategies as well as the use of efficient heat generators, emitters and distribution systems.

Control Strategies are defined as: room temperature controls systems are defined as the aggregate of sensors, actuators and software algorithms on the basis of which a certain room temperature is achieved. They control the on- and off switching of the boiler and often also the boiler feed temperature for the purpose of achieving a predefined temperature in a heated room.

6.8.1 Calculation Formula – First year savings

Estimation of savings for Article 7

The following formula is used to calculate the total gross final savings:

$$\Delta E = \left(\frac{1}{\eta_{p,st} \cdot \eta_{e,st} \cdot \eta_{c,st} \cdot \eta_{d,st}} - \frac{1}{\eta_{p,eff} \cdot \eta_{e,eff} \cdot \eta_{c,eff} \cdot \eta_{d,eff}} \right) \cdot E \cdot S$$

Where:

ΔE	Total gross final energy savings from the EEI Action
E	Useful heat demand for the specific tertiary building and climatic zone (kWh/m ² /year): average for level 1 or 2 calculations, building-specific for level 3 calculations
S	Heated surface area interested by Action (m ²)
$\eta_{p,eff}$	Efficiency of the efficient heat generator
$\eta_{e,eff}$	Efficiency of the efficient emitter system
$\eta_{c,eff}$	Efficiency of the efficient control system
$\eta_{d,eff}$	Efficiency of the efficient distribution system
$\eta_{p,st}$	Efficiency of the standard heat generator
$\eta_{e,st}$	Efficiency of the standard emitter system
$\eta_{c,st}$	Efficiency of the standard control system
$\eta_{d,st}$	Efficiency of the standard distribution system



6.8.2 Standardized calculation values

The next table shows the standardized values for the average energy savings from the replacement of standard heating systems.

	Variables in relation to Equation (1)	Values
<i>Stock Baseline</i>		
Average efficiency of the standard heat generator	$\eta_{p, st}$	82.0%
Average efficiency of the standard emitter system	$\eta_{e, st}$	92.5%
Average efficiency of the standard control system	$\eta_{c, st}$	84.8%
Average efficiency of the standard distribution system	$\eta_{d, st}$	93.0%
<i>Market Efficient Baseline</i>		
Average efficiency of the efficient heat generator	$\eta_{p, eff}$	90.0%
Average efficiency of the heat pump	$\eta_{p, eff}$	120%
Average efficiency of the efficient emitter system	$\eta_{e, eff}$	97.0%
Average efficiency of the efficient control system	$\eta_{c, eff}$	96.7%
Average efficiency of the efficient distribution system	$\eta_{d, eff}$	97.0%

Heating operating hours are normalized via a correction factor that takes both the different degree days and the different average building envelope characteristics into account (Normalisation Factor NH).

The table below shows the standardized values for the normalization factor NH to take account of the different climates proposed for five EU micro-climatic zones.

Climate Zone	Country	Assumed Normalization Factor (NH)
A	Malta Portugal Cyprus	0.5
B	Lithuania Italy Ireland Sweden Hungary Estonia France Belgium Spain Latvia	1
C	Czech Republic	1.1





	Finland Austria Slovakia Denmark Poland Netherlands	
D	Greece Germany United Kingdom Luxembourg Slovenia	1.4

Energy savings (E) as determined by the calculation formula are adjusted by multiplying by the normalization factor NH.

6.8.3 Cost-effectiveness

No information on cost-effectiveness available for this methodology.

6.8.4 Description of sources

The data is mainly based on the results of the following study: VHK: Preparatory Study on Eco-Design of Boilers (2007) (<http://www.ecoboiler.org>), providing specific data of thermal energy consumption in Europe, in the context of the Ecodesign of Energy-Using Products Directive 2005/32/EC.

It gives an overview of different product categorisation options as background information. The largest part of the report is dedicated to an overview of existing legislation and voluntary measures regarding boilers at the level of the EU, the Member States and Third Countries outside the EU.

6.8.5 Bibliography

Andrew Pindar, Nicola Labanca, Daniele Palma, Task 4.2: harmonised bottom-up evaluation methods; Method 10, Non residential space heating improvement in case of heating distribution by a water loop, EMEEES, 2008

VHK Preparatory Study on Eco-Design of Boilers (2007) (<http://www.ecoboiler.org>).

CONTACT THE PROJECT



@stream_save



@streamsaveh2020



contact@streamsave.eu



www.streamsave.eu



This project has received funding from the Horizon 2020 programme under grant agreement n° 890147.