Jožef Stefan Institute, Ljubljana, Slovenia
Centre for Energy Efficiency (CEU)

METHODS FOR CALCULATING ENERGY SAVINGS IN IMPLEMENTING MEASURES TO INCREASE ENERGY EFFICIENCY AND THE USE OF RENEWABLE ENERGY SOURCES

in accordance with the requirements and guidelines deriving from Directive 2006/32/EC on energy end-use efficiency and energy services

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Coordinator for the client:
mag. Boris Selan

Project head:
mag. Evald Kranjčevič

Authors of the report:
mag. Evald Kranjčevič
Dr Fouad Al-Mansour
mag. Stane Merše
mag. Barbara Petelin Visočnik
Marko Peč

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0. INTRODUCTION

0.1 NATIONAL ENERGY EFFICIENCY ACTION PLAN 2008-2016

On 31 January 2008 the Slovenian Government adopted the National Energy Efficiency Action Plan 2008-2016 (NEEAP), which was formulated in accordance with Directive 2006/32/EC on energy end-use efficiency and energy services (hereinafter: Directive 2006/32/EC or the ESD). Under the NEEAP 1, in the 2008-2016 period Slovenia will achieve end-use energy savings of at least 9% or 4,261 GWh, of which 2.5% will be in the first three years. In this document, plans call for a reduction in CO_2 emissions of around 1.1 million tons a year up to 2016. The NEEAP represents the first of a series of planning documents under which, by 2020, Slovenia will gradually achieve the targets from the European Union's energy and climate package.

The NEEAP targets will be achieved through a package of 29 instruments covering financial incentives to promote investment (subsidies, low-interest loans, tax relief), regulatory instruments (regulations on buildings, energy-efficient products etc.), information and awareness-raising (promotional campaigns, energy advice network, energy audits, demonstration projects, informative energy bills etc.), voluntary agreements, the offering of energy services and other instruments.

The NEEAP pays special attention to energy efficiency in the public sector, since that sector is supposed to serve as a model for other sectors. In addition to other instruments, green public procurement will be introduced in the public sector for purchasing energy-efficient equipment and vehicles and for the purchase or rental of energy-efficient buildings. Another important element will be the use of financial instruments for raising energy efficiency, such as contractual assurance of energy savings.

The budget funds required for implementation of the NEEAP amount to around EUR 380 million. A portion of these funds has been provided as part of the Operational Programme of Environmental and Transport Infrastructure Development 2007-2013, the implementation of which will be financed up to 85°% from the Cohesion Fund. The overall value of the NEEAP 1, including investor funds, amounts to around EUR 1.1 billion.

The Government is implementing the action plan through line ministries. The expert, developmental and coordination tasks associated with the action plan are implemented by the Ministry of the Economy. The Ministry also carries out tasks related to providing general monitoring of achieving targets, verifying energy savings and reporting to the Government and European Commission on results achieved.

0.2 THE DIRECTIVE ON ENERGY END-USE EFFICIENCY AND ENERGY SERVICES WITH REGARD TO DETERMINING ENERGY SAVINGS

In accordance with Article 4 of Directive 2006/32/EC, Member States must identify the savings achieved through individual measures to increase energy efficiency, with account being taken of the general framework for measurement and verification of energy savings given in Annex IV to Directive 2006/32/EC. The contribution of individual measures is thus taken into account only if they ensure savings that accord with Annex IV, are clearly measurable and verifiable or estimable, and their effect on energy savings is not already included in other special measures (double counting).

The calculation of energy savings may involve use of the top-down (TD) or the bottom-up (BU) method. The TD method (what is termed the method of "energy efficiency indicators") means that in calculating energy savings the baseline is taken to be national data or data on energy savings combined within sectors. BU means that the energy savings achieved through a specific measure to improve energy efficiency are measured in kilowatt hours (kWh), joules (J) or kilograms of oil equivalent (kgoe), and are added up with energy savings from other special measures to improve energy efficiency. The data used to calculate the savings using the two methods include data and methods based on measurements and data and methods based on estimates.

0.3 "BOTTOM-UP" AND "TOP-DOWN" METHODS FOR CALCULATING SAVINGS

The assessment of energy savings using bottom-up (BU) methods begins with data at the level of the specific measure to raise energy efficiency, mechanism or programme, wherein the data or results of all measures within a specific programme to raise energy efficiency are aggregated.

The key advantage of BU methods (compared to TD methods, which use already existing and officially confirmed data) is that they enable direct monitoring of energy savings with regard to the specific measure. This approach involves greater accuracy and certainty of results, and consequently enables the drawing of appropriate comparisons (i.e. benchmarking) and improvements in monitoring the implementation of certain programmes/mechanisms. The main drawback of BU methods is that they require (additional) collection of data, especially if a high degree of accuracy in the evaluation results is required.

The individual method or evaluation can be implemented on three basic levels (the "3-level approach for monitoring and measurements": the EU level, national level and measure/programme level), Figure 1 below:

Data used	Level of evaluation
Reference values on EU level	LEVEL 1: simple evaluation
Specific values on Member State level	LEVEL 2: medium-complicated evaluation
Specific values on measure level	LEVEL 3: complicated evaluation

The evaluation method can be a combination of various levels and/or various data sources (types of data and methods of collection)

Data collection methods
Available (existing) data
Known methods of data collection
Specific methods of data collection

Figure 1: Three-level approach for BU method

Another extremely important element is the determining/selection of the baseline for determining savings, since this serves to define how we evaluate savings ("all savings", "additional savings"). The assessment of appropriateness/applicability of the individual method is made on the basis of testing the method in practice or partly also on the basis of the experiences to date of the implementer in the specific field of work. Individual BU methods are shown in Chapter 1.

On the other hand, top-down methods relate to harmonised statistical indicators for national averages that are sectoral and/or relate to type of energy consumption, or indicators of energy efficiency developed as part of the ODYSSEE project with the following objectives:

- monitoring a group of targets on the national and international level in respect of energy efficiency and programmes to reduce CO_2 emissions,
- evaluating energy efficiency policies and programmes,
- planning future energy efficiency action programmes and
- international comparison.

Energy efficiency indicators are divided up into three basic groups, depending on the part they play:

- indicators for monitoring energy efficiency trends,
- comparative indicators of energy efficiency for comparing the international "performance" of energy efficiency with other countries,
- diffusion indicators for measuring the introduction of energy technology.

Developed within the first group of indicators is what is called the "ODEX" energy efficiency index, which measures energy efficiency progress on the sectoral level (industry, transport, households) or for all sectors. This indicator is obtained by aggregating all changes in units of end-use energy consumption on the lower level (subsectors) in the observed period. Change in a unit of consumption is an index that allows the use of different units for more detailed indicators (kWh/appliance, toe/m, toe/t etc.).

Diffusion indicators are also useful for measuring the introduction of energy-efficient technology, where we can talk about different types of penetration: market penetration of energy-efficient technology (e.g. % of class A household appliances sold, the transfer of passengers or goods from the roads to rail or ship transportation in %, the extent of using solar collectors or wood biomass boilers for heating etc.).

Top-down methods (TD methods) for calculating end-use energy savings were created on the basis of energy indicators that were developed as part of the ODYSSEE project. As part of this project and the EMEEES, methods were developed to determine net energy savings through the improvement of energy efficiency as a result of the implementation of energy efficiency policies and/or measures (these are measures defined in the National Energy Efficiency Action Plan 2008-2016). Net energy savings do not take into account savings from independent advances, the effect of price changes or structural changes, as can be seen in Figure 2.

For the requirements of calculating energy savings, within the EMEEES project detailed top-down methods were developed to determine the net savings of measures carried out, where in addition to energy indicators developed as part of the ODYSSEE project, various correction factors were also used, and these served to exclude savings made through independent progress and other factors.

Given the major uncertainty and difficulties in determining correction factors, the final selection of TD methods proposed by the Committee of the Commission for Implementing the ESD was simplified. Through these methods we may thus calculate the entire energy savings, which include savings from independent advances, the effect of price changes, structural changes, the effect of prior measures and the rebound effect.

Entire savings calculated using TD methods
Structural changes
Price effect
Independent advances
Old measures
Rebound effect
Net
energy savings

Figure 2: Structure of energy savings using TD methods

Individual TD methods are shown in Chapter 2.

0.4 TEMPERATURE DEFICIT

The temperature deficit (degree days) for heating is an indicator of the “intensity of winter” and consequently the need for heating, so it is used for climate correction in calculating energy consumption for heating in buildings.

The temperature deficit in Slovenia is calculated or determined as the amount of the daily differences between the reference interior temperature (for Slovenia 20°C) and the exterior average daily temperature of the air, if it is lower than or equal to 12°C. In its calculation of temperature deficit, Eurostat uses the temperatures 18°C/15°C (originally used for Britain, and they conform less to the climate conditions and method of heating in Slovenia).

The calculation of temperature deficit by individual region uses exterior temperature measurements from various meteorological stations around the country. The average temperature deficit in Slovenia is calculated as the arithmetical average temperature deficit by specific region, while there is a more applicable calculation where specific regional temperature deficits are weighted with population numbers. Slovenia publishes data only on the temperature deficit by individual measuring station, while an average for the country has not yet been published.

Eurostat calculates the average temperature deficit for all countries using the temperatures of 18°C/15°C without population weighting. In its latest draft recommendation of methods, the Committee of the Commission for implementing the ESD[1] (ANNEX C) recommends for temperature correction the use of the national temperature deficit, calculated using the weighting of population distribution.

With regard to the more appropriate use of the temperatures 20°C/12°C for Slovenia and the recommended use of a weighted average incorporating population distribution, Eurostat publishes temperature deficit values for Slovenia that are less appropriate for use in methods of calculating energy

[1] European Commission - RECOMMENDATIONS ON MEASUREMENT AND VERIFICATION METHODS IN THE FRAMEWORK OF DIRECTIVE 2006/32/EC ON ENERGY END-USE EFFICIENCY AND ENERGY SERVICES, preliminary draft, October 2010

savings. For this reason the use of national values for the temperature deficit is recommended (for Slovenia as a whole).

In the methods set out below, the climate correction uses the annual temperature deficit and the long-term 25-year national temperature deficit, which represents the reference average winter. Eurostat uses a 25-year average (1980-2004); some countries use later years (owing to milder winters in more recent years) or a sliding average. For Slovenia, the calculations will use the long-term 25-year average temperature deficit for the 1986 - 2010 period[2].

1. METHODS FOR DETERMINING ENERGY SAVINGS USING THE BOTTOM-UP (BU) METHOD

The methods for determining energy savings are formulated on the basis of energy efficiency measures being implemented in Slovenia (NEEAP), taking into account the guidelines and recommendations of the European Commission. As part of the second National Energy Efficiency Action Plan (2011-2016), the individual Member State must provide a selection of methods that it will be or already is using to determine end-use energy savings by individual instrument. Although the individual methods are not harmonised, which in other words means that Member States have free choice in their use, it is true that in the case of using the methods proposed by the European Commission,[3] there is no need to provide any additional explanation or clarification regarding the use of specific methods. The opposite is true in the case of Member States using their own method. In this case, an appropriate explanation of national methods must be given in an Annex to the Second National Energy Efficiency Action Plan.

The fact is that the selection of methods as proposed (in the draft) by the European Commission is not in itself sufficient, since it does not "cover" all the instruments and measures being implemented or due to be implemented in the future in Slovenia. In this respect the development of a specific number of our own methods is unavoidable, including in cases where the method proposed by the Commission gives an overly conservative estimate of energy savings. In such cases it makes sense to develop our own method that allows a more accurate/objective calculation of energy savings. The draft of methods proposed by the Commission is set out in Annex C.

This chapter sets out the individual methods covering instruments and measures being implemented in Slovenia as part of meeting targets under the ESD. For each method there is a separate definition of the level of harmonisation (relative to the European Commission proposals and guidelines).

[2] Since ARSO does not yet currently publish the average weighted temperature deficit for Slovenia, the calculations of savings for 2008 used a weighted temperature deficit calculated at IJS-CEU. Instead of the long-term 25-year average, it used the available 7-year average in the 1992-2008 period (3,033 K*day/year).
[3] Draft set out in Annex C.

Table 1: Review of BU methods

Method (No.)	Name/title of method	Status	Harmonisation with the European Commission proposal[4]
1	Complete renovation of buildings	method formulated	yes (EC: measure 1), detailed treatment
2	Construction of low-energy and passive buildings	method formulated	no EC method[5]
3	Partial renovation of buildings (renovation of individual elements of the exterior shell)	method formulated	partly (EC: measure 2)
4	Regulations on the energy performance of new buildings	method formulated	partly (EC: measure 3)
5	Replacing hot water boilers with new ones	method formulated	partly (EC: measure 4), detailed treatment
6	Replacement of electric heater for heating sanitary water	method formulated	different method of treatment
7	Installation of heat pumps	method formulated	no EC method
8	New installation of solar collectors (SC)	method formulated	partly (EC: measure 7)
9	Optimisation of heating system in multi-dwelling buildings with several separate sections	method formulated	no EC method
10	Performing public chimney maintenance service	method formulated	no EC method
11	Providing energy advice for citizens (ENSVET project)	method formulated	no EC method
12	Energy audits in industry and the service sector	method formulated	no EC method
13	New private vehicles with specific emissions up to 130 gCO2/km	method formulated	no EC method
14	Systems for cogeneration of heat and power (CHP)	method formulated	no EC method
15	Photovoltaic power plants	method formulated	no EC method
16	Small hydroelectric plants	method formulated	no EC method
17	Energy-efficient lighting	method formulated	partly (EC: measures 9 ad 10)
18	Refurbishing public lighting systems	method formulated	no EC method
19	Energy-efficient household appliances	method formulated	partly (EC: measure 8), detailed treatment
20	Energy-efficient office equipment	method formulated	yes (EC: measure 11)
21	Energy-efficient electric motors	method formulated	no EC method
22	Use of frequency converters	method formulated	no EC method
23	Systems for exploiting waste heat	Method formulated	no EC method
24	Implementing voluntary agreements (exemption from payment of environmental tax)	further development of method or new method required[6]	no EC method
25	Introducing energy management systems	further development of method required[7]	no EC method

[4] European Commission - RECOMMENDATIONS ON MEASUREMENT AND VERIFICATION METHODS IN THE FRAMEWORK OF DIRECTIVE 2006/32/EC ON ENERGY END-USE EFFICIENCY AND ENERGY SERVICES, preliminary draft, October 2010
[5] EC - European Commission.
[6] With regard to the provisions that will be set out in the new decree on the CO_2 tax - this should be adopted in 2010.
[7] Based on an analysis of the effects of specific cases in practice.

In addition to the methods for determining energy savings from individual measures, this chapter sets out the methods for determining the use of renewable sources and methods for determining the reduction or savings in CO_2 emissions.
Savings of CO_2 emissions are determined on the basis of the calculated energy saving, taking into account the relevant emission factors (ANNEX A). These are based on values determined for the specific calendar year by the Slovenian Environment Agency (ARSO), while in the case of average emission factors, official statistical data serve as the basis (e.g. regarding fuel consumption in the individual sector and so forth)[8].

METHODOLOGICAL EXPLANATIONS

The primary aim of the formulated methods is an objective and methodologically harmonised approach to evaluating the savings of end-use energy achieved, the increased use of RES and reduction of CO_2 emissions in the implementation of measures in Slovenia. Here, owing to the great diversity of measures and the varying levels of evaluation (project, national etc.), as a matter of necessity the degree of generalisation of the approach has been determined, so the formulated methods represent a basis for the minimal starting point for evaluation. In the case of a more precise evaluation of individual measures, the formulated methods may be used in an adapted way (thus for instance the use of more precise values instead of using standardised values) or appropriately supplemented and enhanced, with the aim of more objective evaluation using available more detailed data.

In preparing the methods for individual measures, we attempted to the greatest possible extent to follow the recommendations and guidelines of the European Commission, which proposed a draft[9] of accounting methods for certain measures, where it should be pointed out that some of these methods are suitable for application in Slovenia in their original form, but others only on the basis of appropriate adjustment (e.g. the use of national values for certain calculation parameters). It is generally true that the majority of methods presented in this document are our own, since the selection of European Commission methods is limited, or rather in some cases we are dealing with measures or instruments that are specific to Slovenia.

The energy savings discussed in this chapter are, in accordance with the ESD, “amounts of saved energy determined by measuring and/or estimating consumption before and after implementation of one or more energy efficiency improvement measures, whilst ensuring normalisation for external conditions that affect energy consumption”, where the term energy is understood to mean or denote “all forms of commercially available energy[10]”.

In the BU methods set out below in this document, the energy saving is determined using the following important methodological assumptions:

- all savings deriving from the consumption of fuel and electricity are determined or calculated on the end-use energy level (marked as PKE), except in certain exceptions or special cases (heat pumps, systems for combined heat and power generation), where the savings are determined on the primary energy level (marked as PPE), taking into account the conversion factor of 2.5 for electricity[11].

[8] The methodology or method of determining the individual emission factor is given in ANNEX A.
[9] See ANNEX C (RECOMMENDATIONS ON MEASUREMENT AND VERIFICATION METHODS IN THE FRAMEWORK OF DIRECTIVE 2006/32/EC ON ENERGY END-USE EFFICIENCY AND ENERGY SERVICES, preliminary draft, October 2010).
[10] All forms of fuels, electricity and district heating and cooling sold to final customers.
[11] Conversion to the primary level is necessary for an objective determination of energy savings in the event that electricity replaces the use of other energy sources. The ESD gives the default value of 2.5, while the factor calculated for Slovenia in the period from 2000 to 2009 ranges between 2.5 and 2.74 (taking into account 50% of generation at the NEK nuclear plant, and with 100% from NEK, this value is somewhat higher). Owing to the imperfect method of calculating the factor and the simplification in the calculation, up until the adoption of new rules on the EU level, Slovenia is using the default value of 2.5 for the factor. Using this factor makes it possible, on the basis of the provided calculations of electricity savings, to make a simple calculation of the reduced consumption of primary energy.

- all savings by individual method are also separately presented as "ESD energy savings", with the designation PE(ESD), and these may be claimed as savings in verifying the attainment of the national target in accordance with Directive 2006/32/EC. ESD savings deriving from the consumption of fuel are determined or calculated on the end-use energy level, while in accordance with the provision in the ESD (Annex II), the ESD savings deriving from electricity consumption are determined or calculated on the primary energy level, taking into account the conversion factor of 2.5.

The **reduction in emissions of carbon dioxide (REC)** is determined using previously calculated energy savings, taking into account the relevant emissions factors. Where the initial state is not known (e.g. the type of fuel used), we must make use of sectoral (average) values for emission factors, since emissions can only be determined on the basis of average emission factors (where account is taken of fuel consumption for the entire sector). In specific cases this can mean that the specific calculation as a whole does not reflect the actual reduction in CO2 emissions for the identified individual case or measure, which can mean higher or lower emissions. With regard to the calculation equations provided, the use of actual emission factors is always possible, but is contingent on a precise knowledge of all the circumstances regarding the use and consumption of fuel for the specific case or appliance.

The **increased use of renewable energy sources (POVE)** for measures where renewable sources are used (solar collectors, wood biomass boilers, heat pumps etc.) is determined using special equations (that are extrapolated from existing equations to determine energy savings). For this reason there are (usually) no additional data requirements for the calculation, in other words for the most part the data used in already calculated energy savings suffice.

In general, however, with specific measures and their pertaining methods of calculation various dilemmas or issues arise, and they (might) affect the actual implementation or calculation of energy savings, the reduction of carbon dioxide emissions or increased use of renewable energy sources:

- The biggest obstacle to developing individual methods is the availability of data needed to calculate energy savings. In principle it is true that the better the data we have, the more accurate and credible the final calculation will be. This means in other words that the actual method or its level of development unambiguously determines the specific data requirements, wherein the further development of such a method is contingent on more precise (i.e. better, higher quality) data. In specific cases of measures there is sometimes a need to evaluate objectively what level of preciseness of data is necessary and/or suitable (including in terms of the anticipated effect of the specific instrument/measure). Consequently this means that in certain cases we make use of default standardised values (such as for combustion plants or boilers). There are practically no other options, since it is in fact impossible to determine specific efficiency levels (for instance with old combustion plants).

- In dealing with individual methods we need to take into account that individual methods are developed using the national aspect or approach (i.e. the same method for all, and this is especially important in using emission factors for various fuels and values for efficiency levels), which in some cases can run counter to what is termed the project approach, which in certain cases shows greater savings of energy and greenhouse gas emissions than where average values are used. In such cases individual methods need to be appropriately adapted.

- Some methods are provided as generally applicable (they can be used for a wide range of users), while others derive from specific instruments (e.g. calls/tenders) and require specific data. Nevertheless, with appropriate adaptation (as described above) they can be used more broadly.

1.1 MEASURES TO INCREASE THE ENERGY PERFORMANCE OF BUILDINGS

1.1.1 MEASURE 1: Complete renovation of buildings

Sector

Households and service sector. Description of measure

The complete renovation of buildings is a measure that involves at the same time the replacement or upgrading of several elements of the building's exterior (exterior fixtures, facade, roof insulation, floor insulation etc.) and the heating system (modern boiler or heat pump, both of an appropriate capacity for the heating needs of the renovated building. Implementation of this measure secures a reduction in energy consumption for heating rooms, and there is also a marked reduction in greenhouse gas emissions.

This measure is important since particularly in the area of building renovation, there is great potential in Slovenia for achieving energy savings, while at the same time it has a long lifetime.

Methodological background

This method is based on a calculation of the construction physics for an entire building (under the old-new or before-after principle), which must be calculated in accordance with the Rules on Efficient Use of Energy in Buildings (Official Gazette of the Republic of Slovenia - Off. Gaz. RS - No 52/2010), while at the same time a standardised efficiency for heating systems is used.

In specific cases the use of individual values for the useful efficiency of old heating systems makes no sense, since it is hard to ensure the appropriate credibility and integrity of baseline data (especially in the case of old, replaced combustion plants).

For the useful efficiency of new heating systems we use standardised efficiency levels depending on the type of fuel (natural gas, extra light heating oil/ELHO, wood, electricity etc.) and the type of heating appliance (e.g. condensing systems). Specific efficiency levels are determined on the basis of DIN 4702-8, which has turned out in practice to be the most appropriate system.

CO_2 emissions and savings thereof resulting from improved energy efficiency are determined on the basis of the calculated value of the energy saving, taking into account the relevant emission factor. In cases where we do not have data on the type of fuel for old or new combustion plants and heating systems, we use the average emission factor for heating in households.

Energy savings

Energy savings are determined in respect of the type of new heating appliance (boiler or heat pump) as follows:

- where a boiler is used:

$$PKE_{celovita\ obnova,kotel} = \left(\frac{PTE_{stari}}{\eta_{stari}} - \frac{PTE_{novi}}{\eta_{novi,kotel}} \right) \cdot A \qquad \text{[kWh/year]} \quad [1]$$

or:

$$\boxed{PKE_{celovita\ obnova,kotel} = \left(1{,}515 \cdot PTE_{stari} - \frac{PTE_{novi}}{\eta_{novi,kotel}} \right) \cdot A} \qquad \text{[kWh/year]} \quad [2]$$

$$\boxed{PE(ESD)_{celovita\ obnova,kotel} = PKE_{celovita\ obnova,kotel}} \qquad \text{[kWh/year]} \quad [3]$$

- where a heat pump (HP) is used[12]:

$$PPE_{celovita\ obnova,TČ} = \left(\frac{PTE_{stari}}{\eta_{stari}} - \frac{PTE_{novi}}{\eta_{novi,TČ}} \cdot \frac{2{,}5}{SPF} \right) \cdot A \qquad \text{[kWh/year]} \quad [4]$$

or:

$$\boxed{PPE_{celovita\ obnova,TČ} = \left(1{,}515 \cdot PTE_{stari} - 2{,}688 \cdot \frac{PTE_{novi}}{SPF} \right) \cdot A} \qquad \text{[kWh/year]} \quad [5]$$

$$\boxed{PE(ESD)_{celovita obnova,TČ} = PPE_{celovita obnova,TČ}} \qquad \text{[kWh/year]} \quad [6]$$

[12] In the case of heat pumps (HP), for the purpose of objective determination of energy savings in cases where electricity replaces the use of other energy sources, savings are not evaluated on the end-use energy level but on the primary energy level, using a factor of 2.5.

where:

$PKE_{celovita\ obnova,kotel}$	: end-use energy savings [kWh/year] owing to complete renovation of building in cases where a hot water boiler is used for the heating system
$PE(ESD)_{cel.obn.,kotel}$:	ESD energy savings [kWh/year] owing to complete renovation of building in cases where a hot water boiler is used for the heating system
$PPE_{celovita\ obnova,TČ}$:	primary energy saving[13] [kWh/year] owing to complete renovation of building in cases where a heat pump is used for the heating system
$PE(ESD)_{cel.\ obn.,TČ}$:	ESD energy savings [kWh/year] owing to complete renovation of building in cases where a heat pump is used for the heating system
PTE_{stari} :	the heat required [kWh/m^{2}year] to heat the building prior to renovation (construction physics of the building, which must be calculated in accordance with the Rules on Efficient Use of Energy in Buildings, Off. Gaz. RS, No 52/2010)
PTE_{novi} :	the heat required [kWh/m^{2}year] to heat the building after renovation (construction physics of the building, which must be calculated in accordance with the Rules on Efficient Use of Energy in Buildings, Off. Gaz. RS, No 52/2010)
n_{stari} :	the annual operating efficiency of the old (replaced) heating system is based on the assumption that it is an old hot water boiler. This is determined no the basis of DIN 4702-8, whereby in addition to the average standardised efficiency for old boilers, we also take into account the efficiency of the piping (distribution) and efficiency of the regulation system: $n_{old} = n_k \cdot n_c \cdot n_r = 0.72 \cdot 0.97 \cdot 0.94 = 0.66$ [7]
n_k :	the standardised boiler efficiency that takes into account the actual operating characteristics of the boiler (actual load) and is determined as the relationship between annual energy consumed (Q_H) and the annual heat obtained from the boiler (Q_P) in the partial loading of the heating system. n_k for an old boiler amounts to 72% (DIN 4702-8)
n_c :	efficiency of the piping distribution - old system; (DIN 4702-8: 97%)
n_r :	efficiency of regulation - old system; (DIN 4702-8: 94%)
$n_{novi,kotel}$:	the annual operating efficiency of a new boiler-powered heating system according to DIN 47028 is determined using the following equation[14]: (it is determined in the same way or on the basis of the same calculation as for the old system): $n_{new,\ boiler} = n_k \cdot n_c \cdot n_r$ [8]

where we take the relevant value from Table 2;

Table 2: Values of efficiency levels for boiler heating systems

Type of boiler	Type of fuel	n_k	n_c	n_r	$n_{new,\ boiler}$
Low-temperature	ELHO, NG, biomass	0.95	0.98	0.95	88%
Condensing	ELHO	0.99	0.98	0.95	92%
Condensing	NG	1.04	0.98	0.95	97%

[13] In the case of heat pumps (HP), for the purpose of objective determination of energy savings in cases where electricity replaces the use of other energy sources, savings are not evaluated on the end-use energy level but on the primary energy level, using a factor of 2.5.

[14] It is determined in the same way or on the basis of the same calculation as for the old boiler system.

$\eta_{novi.TČ}$: the annual operating efficiency of a heating system using a heat pump is determined as follows:

$\eta_{new\ HP} = \eta_c \cdot \eta_r = 0.98 \cdot 0.95 = 0.93$ [9]

SPF : annual heating figure of heat pump (SPF - Seasonal Performance Factor). Standardised values for the SPF are given in Table 3:

Table 3: SPF values (annual heating figure of heat pump)

Type of heat pump	Average (standardised) annual heating figure (SPF)
Air/water	2.8
Ground/water	3.5
Water/water	4

A : heated surface area [m^2] of building

Reduction of CO_2 emissions

Savings or reductions of CO_2 emissions (ZEC in the equations) are determined using the following equations:

- use of a boiler in a (new) heating system:

$$ZEC_{kotel} = \left(\frac{PTE_{stari}}{\eta_{stari}} \cdot ef_{stari} - \frac{PTE_{novi}}{\eta_{novi,kotel}} \cdot ef_{novi} \right) \cdot A \quad [kgCO_2/year] \quad [10]$$

or

$$\boxed{ZEC_{kotel} = \left(1{,}515 \cdot PTE_{stari} \cdot ef_{stari} - \frac{PTE_{novi}}{\eta_{novi,kotel}} \cdot ef_{novi} \right) \cdot A} \quad [kgCO_2/year] \quad [11]$$

- use of a heat pump in a (new) heating system:

$$ZEC_{TČ} = \left(\frac{PTE_{stari}}{\eta_{stari}} \cdot ef_{stari} - \frac{PTE_{novi}}{\eta_{novi,TČ}} \cdot \frac{1}{SPF} \cdot ef_{EL} \right) \cdot A \quad [kgCO_2/year] \quad [12]$$

or

$$ZEC_{TČ} = \left(1{,}515 \cdot PTE_{stari} \cdot ef_{stari} - 1{,}075 \cdot \frac{PTE_{novi}}{SPF} \cdot ef_{EL}\right) \cdot A$$ [kg CO2/year] [13]

where:

ef_{stari} :	the emission factor [kgCO2/kWh] for fuel or energy source for an old heating system - values for the individual sector or type of fuel are given in ANNEX A
ef_{novi} :	the emission factor [kgCO_2/kWh] for fuel or energy source for a new heating system - values for the individual sector or type of fuel are given in ANNEX A
ef_{EL} :	the average emission factor [kgCO_2/kWh] in electricity generation at power plants in Slovenia - values are given in ANNEX A

Increased use of renewable energy sources

Where a new biomass boiler or heat pump are used, we also determine the increased use of renewable energy sources (POVE) as follows:

- use of biomass boiler instead of a fossil fuel boiler[15]:

$$POVE_{celovita\ obnova,kotel-biomasa} = \frac{PTE_{novi}}{\eta_{novi,kotel}} \cdot A$$ [kWh/year] [14]

or

$$POVE_{celovita\ obnova,kotel-biomasa} = 1{,}136 \cdot PTE_{novi} \cdot A$$ [kWh/year] [15]

- use of heat pumps:

$$POVE_{celovita\ obnova,TČ} = \frac{PTE_{novi}}{\eta_{novi,TČ}} \cdot \left(1 - \frac{1}{SPF}\right) \cdot A$$ [kWh/year] [16]

[15] Where an old biomass boiler is replaced with a new one, owing to the improved efficiency of the new boiler, the use of renewable energy sources is lower.

or:

$$POVE_{celovita\ obnova,TČ} = 1{,}075 \cdot PTE_{novi} \cdot \left(1 - \frac{1}{SPF}\right) \cdot A$$ [kWh/year] [17]

Data requirements

Use of this method requires comprehensive data on the state of the building before and after renovation, i.e. an accurate and full account of the construction physics. Since the measure of complete building renovation used to be carried out as part of Eco Fund calls for applications, which precisely defined all the data requirements, there will be no difficulties in providing relevant calculation data, at least for measures carried out in the past.

It is recommended that in holding calls for applications and otherwise where possible, data collection on heating systems (old and new) is ensured, as follows:

- type of energy source of old and new system (natural gas, wood, electricity etc.),
- type of new heating system (condensing system, type of heating appliance etc.),
- age of replaced heating appliances (boilers).

On the basis of more precise data, it will be possible to further differentiate the calculation of CO_2 emission savings in terms of the type of energy source and type of heating appliance.

Other notes and features

Development of this method has been contingent on the holding of Eco Fund calls for applications in the area of complete renovation of buildings.

1.1.2 MEASURE 2: Construction of low-energy and passive buildings

Sector

Households and service sector (new constructions).

Description of measure

This measure is the construction of low-energy and passive buildings, where the energy consumption for heating is lower than the value prescribed by the regulation on new buildings.

Methodological background

The method is based on a calculation of the construction physics, taking into account the efficiency of combustion plants (with regard to type of fuel and type of combustion plant). The energy saving is the difference between energy consumption for heating a new low-energy or passive building and energy consumption for heating as prescribed by the regulation for new buildings (on the assumption that an average new boiler is in use).

The reduction of CO_2 emissions is determined on the basis of the calculated energy saving, taking into account the relevant emission factor (with regard to energy source and type of appliance in heating the building).

Energy savings

Energy savings are determined in respect of the type of heating appliance as follows:

- use of boiler:

$$PKE_{NH-PH,\,kotel} = \left(\frac{PTE}{\eta} - \frac{PTE_{NH-PH}}{\eta_{novi,\,kotel}} \right) \cdot A = \left(\frac{PTE}{0{,}9} - \frac{PTE_{NH-PH}}{\eta_{novi,\,kotel}} \right) \cdot A \qquad \text{[kWh/year]} \qquad [18]$$

$$\boxed{PKE_{NH-PH,\,kotel} = \left(77{,}78 - \frac{PTE_{NH-PH}}{\eta_{novi,\,kotel}} \right) \cdot A} \qquad \text{[kWh/year]} \qquad [19]$$

$$\boxed{PE(ESD)_{NH-PH,\,kotel} = PKE_{NH-PH,kotel}} \qquad \text{[kWh/year]} \qquad [20]$$

- use of heat pump[16]:

$$PPE_{NH-PH,TČ} = \left(\frac{PTE}{\eta} - \frac{PTE_{NH-PH}}{\eta_{novi,TČ}} \cdot \frac{2{,}5}{SPF} \right) \cdot A =$$

[kWh/year] [21]

$$= \left(\frac{PTE}{0{,}9} - \frac{PTE_{NH-PH}}{\eta_{novi,TČ}} \cdot \frac{2{,}5}{SPF} \right) \cdot A$$

$$\boxed{PPE_{NH-PH,TČ} = \left(77{,}78 - \frac{PTE_{NH-PH}}{\eta_{novi,TČ}} \cdot \frac{2{,}5}{SPF} \right) \cdot A}$$

[kWh/year] [22]

$$\boxed{PE(ESD)_{NH-PH,TČ} = PPE_{NH-PH,TČ}}$$

[kWh/year] [23]

where:

$PKE_{NH-PH,\ kotel}$:	the end-use energy savings [kWh/year] from construction of low-energy or passive buildings (use of boiler as heating source)
$PE(ESD)_{Nh-PH,\ kotel}$	: the ESD energy saving [kWh/year] from construction of low-energy or passive buildings (use of boiler as heating source)
$PPE_{NH-PH,\ TČ}$:	the primary energy saving [kWh/year] from construction of low-energy or passive buildings (use of heat pump as heating source)
$PE(ESD)_{NH-PH,\ TČ}$:	the ESD energy saving [kWh/year] from construction of low-energy or passive buildings (use of heat pump as heating source)
PTE_{NH-PH} :	the heat required [kWh/m year] for heating rooms in a low-energy or passive building deriving from the construction physics (calculation PHPP'07[17] for houses with specific heat losses below 15 kWh/m^{2}year or calculation using what is called the Eco Fund methods[18] for houses with specific heat losses of between 15 and 35 kWh/m^{2}year).
PTE :	the highest permitted requirement of heat [kWh/m^{2}year] to heat rooms in accordance with the Rules on Efficient Use of Energy in Buildings, Off. Gaz. RS, No 52/2010), i.e. 35 kWh/m^{2}year for single-dwelling and 30 kWh/m^{2}year for multi-dwelling buildings. For buildings that should be planned in compliance with the Rules on the Thermal Insulation and Efficient Use of Energy in Buildings (Off. Gaz. RS, 42/2002), 70 kWh/m^{2}year is taken as the PE.
n :	annual operating efficiency for equivalent new boiler - standardised value 0.9[19]
$n_{novi,kotel}$:	the annual operating efficiency of a new boiler-powered heating system according to DIN 4702-8 (see MEASURE 1)
$n_{novi,TČ}$:	the annual operating efficiency of a heating system with heat pump (see MEASURE 1)

[16] In the case of heat pumps (HP), for the purpose of objective determination of energy savings in cases where electricity replaces the use of other energy sources, savings are not evaluated on the end-use energy level but on the primary energy level, using a factor of 2.5.

[17] The precise calculation of construction physics developed especially for passive houses (Passivhaus Institut, Darmstadt, Germany). For more information go to www.passiv.de

[18] Eco Fund method - a simple arithmetical model for calculating the construction physics of a building (in the form of a MS Excel application) - this method is part of the documentation involved in the Eco Fund public call for applications. For more information go to www.ekosklad.si

[19] Average value for equivalent low-temperature and condensing boiler.

A : heated surface area [m^2] of building

Reduction of CO_2 emissions

The reduction or saving of CO2 emissions (ZEC in the equations) is determined using the following equation:

- use of boiler:

$$ZEC_{NH-PH,kotel} = PKE_{NH-PH,kotel} \cdot ef \qquad [kgCO_2/year] \qquad [24]$$

or

$$\boxed{ZEC_{NH-PH,kotel} = \left(77{,}78 - \frac{PTE_{NH-PH}}{\eta_{novi,kotel}}\right) \cdot A \cdot ef} \qquad [kg\ CO2/year] \qquad [25]$$

- use of heat pumps:

$$ZEC_{NH-PH,TČ} = \left(\frac{PTE}{\eta} \cdot ef - \frac{PTE_{NH-PH}}{\eta_{novi,TČ}} \cdot \frac{1}{SPF} \cdot ef_{EL}\right) \cdot A \qquad [kg\ CO2/year] \qquad [26]$$

or

$$\boxed{ZEC_{NH-PH,TČ} = \left(\frac{PTE}{0{,}9} \cdot ef - \frac{PTE_{NH-PH}}{\eta_{novi,TČ}} \cdot \frac{1}{SPF} \cdot ef_{EL}\right) \cdot A} \qquad [kg\ CO2/year] \qquad [27]$$

where:

ef : the average emission factor for fuel (for heating) - values for the individual sector are given in ANNEX A

ef_{EL} : the average emission factor in electricity generation at power plants in Slovenia - values are given in ANNEX A

Increased use of renewable energy sources

Where a new biomass boiler or heat pump are used instead of a fossil fuel boiler, we also determine the increased use of renewable energy sources (POVE) as follows:

- use of biomass boiler:

$$\boxed{POVE_{NH-PH,kotel-biomasa} = \frac{PTE_{NH-PH}}{\eta_{novi,kotel}} \cdot A} \qquad [kWh/year] \qquad [28]$$

- use of heat pumps:

$$\boxed{POVE_{NH-PH,TČ} = \frac{PTE_{NH-PH}}{\eta_{novi,TČ}} \cdot \left(1 - \frac{1}{SPF}\right) \cdot A} \qquad [kWh/year] \qquad [29]$$

Data requirements

Use of this method requires comprehensive data on the state of the building after construction - i.e. the calculation PHPP'07 for what are termed passive buildings (specific heat losses below 15 kWh/m^2year) or the Eco Fund method for buildings with specific heat losses of between 15 and 35 kWh/m^2year.

Standardised values provided with this method are used to determine the useful efficiency of heating appliances.

Other notes and features

Development of this method has been contingent on the implementation of Eco Fund calls for applications in the area of constructing low-energy and passive buildings.

1.1.3 MEASURE 3: Partial renovation of buildings (renovation of individual elements of the exterior shell)

Sector

Households and service sector.

Description of measure

This measure relates to the renovation of the building shell, i.e. facades, exterior fixtures, roofs, floor facing the land etc. Given the long lifetime and relatively big potential in the area of building renovation in Slovenia, this measure is extremely important.

Methodological background

This method is based on a comparison of the thermal conductivity of individual construction elements in a building before and after renovation, where the values for new materials are determined on the basis of known technical properties, and the values for old materials are determined as a whole on the basis of old technical rules and set empirical values.

The reduction of CO_2 emissions is determined on the basis of the calculated energy saving, taking into account the relevant emission factor (depending on the sector to which the building belongs).

Energy savings

Energy savings are determined on the basis of the universal formula:

$$PKE_{delna\ obnova} = \frac{(U_{staro} - U_{novo}) \cdot SD \cdot 24\,ur}{\eta} \cdot \frac{1}{1000} \cdot A \cdot f_1 \cdot f_2 \quad \text{[kWh/year]} \quad [30]$$

$$PE(ESD)_{delna\ obnova} = PKE_{delna\ obnova} \quad \text{h/year]} \quad [31]$$

where:

$PKE_{delna\ obnova}$:	end-use energy savings [kWh/year] owing to partial (component) renovation of building shell
$PE(ESD)_{delna\ obn.}$	: ESD energy savings [kWh/year] owing to partial (component) renovation of building shell
U_{staro} :	thermal conductivity [W/m^{2}K] of old element of building shell (exterior wall, building fixtures etc.)
U_{novo} :	thermal conductivity [W/m K] of new element of building shell (exterior wall, building fixtures etc.)

SD :	degree days (18-year weighted average in the period 1992-2008[20]) - 3,033 K*day/year
n :	annual operating efficiency for heating system - standardised value 0.75[21]
A :	surface area [m²] of the improved element of the building shell
f1 :	the correction factor that takes into account or evaluates temporary shutdowns of the heating system (night reduction) and the reduced temperature level in part of the building - standardised value for residential buildings: 0.89[22]
f2 :	correction factor of degree days, which is: • for an element abutting the outside air: 1.00 • for a ceiling abutting an unheated loft: 0.75 • for floors directly above unheated basements: 0.50

<u>Determining the thermal conductivity of individual elements</u>

For the thermal conductivity of construction elements before renovation (old state; U_{old}) we use standardised values representing the average values for individual construction elements defined in the Manual for Energy Advisers (ZRMK, published 1990), which also derive from the old regulations governing thermal insulation of buildings (Rules on the Rational Use of Energy in Heating and Ventilating Buildings and in Preparing Hot Water (Off. Gaz. SRS, No 31/1984); Rules on the Technical Standards for Designing and Executing Concluding Works in Construction, (Off. Gaz. SFRJ, No 21/1990); Rules on the Technical Measures and Conditions for Thermal Energy in Buildings (Off. Gaz. SFRJ, No 28/1970)).

Table 4: Values for thermal conductivity for old construction elements of buildings[23]

Construction element	Old (W/m²K)
Exterior wall facing the surrounding area	1.2
Ground base on site	1.5
Basement wall (abutting the ground)	3.0
Floor directly above unheated basements	1.5
Ceiling abutting an unheated loft	1.0
Pitched roof (not insulated)	2.5
Flat roof	1.0
Windows, doors	3.0

[20] A value for the 1986-2010 period is not (yet) available.

[21] The average median value for old and new boilers - baseline data used for new and old boilers given in chapter 1.1.1. (MEASURE 1).

[22] Background data:

- 10-hour shutdown of heating,
- 2 K average temperature reduction during shutdown (range from 1 to 3K, depending on type of construction and insulation of building),
- 17 K average difference between the average outside temperature in the heating season (4°C) and the average temperature in rooms that are heated (21°C),
- 6 K reduced temperature on 20% of the surface area of rooms (e.g. those not in use),

$$f_1 = 0{,}8 \cdot \frac{10ur \cdot (1-\frac{2K}{17K}) + 14ur \cdot 1}{24ur} + 0{,}2 \cdot \frac{24ur\left(1-\frac{6K}{17K}\right)}{24ur} = 0{,}89 \cdot$$

[23] Applies also to non-residential buildings.

For thermal conductivity of construction elements (exterior wall, roof and floor) after renovation (new state; U_{novo}) the following equation is used:

$$U_{novo} = \left(\frac{1}{U_{staro}} + \frac{d_{izolacija}}{\lambda_{izolacija}} \right)^{-1} \qquad [W/m^2K] \qquad [32]$$

For new building fixtures (windows, doors) we use standardised values given in each call for applications or programme.

Reduction of $CO_{2\ emissions}$

Reductions or savings of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$ZEC_{de\ln a\ obnova} = PKE_{de\ln a\ obnova} \cdot ef \qquad [kgCO_2/year] \qquad [33]$$

ef : average emission factor for heating (for sector) - ANNEX A

Data requirements

Using this method requires precise data on the properties of newly built construction elements of the exterior shell of the building, and in particular data on the thermal conductivity and size (surface area) of individual elements.

1.1.4 MEASURE 4: Regulations on the energy performance of new buildings

Sector

Households, service sector and industry[24]. Description of measure

This measure is the adoption of the Rules on Efficient Use of Energy in Buildings (Off. Gaz. RS, No 52/2010), which replaced the Rules on Thermal Insulation and Efficient Use of Energy in Buildings (Off. Gaz. RS, No 42/2002). The entry into force of the new rules will mean in the long term the construction of more energy-saving buildings, which is important at a time when the state of technology and knowledge in the field of buildings construction significantly outstrips the current conditions and requirements set by the existing (valid) rules.

Methodological background

Energy savings are determined as the difference between permissible energy consumption for heating buildings under the old and new regulations. It assumes the use of a heating system with a single efficiency of 90%.

The reduction of CO_2 emissions is determined on the basis of the identified energy saving, taking into account the average emission factor for heating for the specific sector.

Energy savings

Energy savings are determined as follows:

$$PKE_{predpis\ URE} = \frac{1}{\eta} \cdot \left(PTE_{stari\ predpis} - PTE_{novi\ predpis}\right) \cdot A \quad [kWh/year] \quad [34]$$

or

$$\boxed{PKE_{predpis\ URE} = 1{,}111 \cdot \left(PTE_{stari\ predpis} - PTE_{novi\ predpis}\right) \cdot A} \quad [kWh/year] \quad [35]$$

$$\boxed{PE(ESD)_{predpis\ URE} = PKE_{predpis\ URE}} \quad [kWh/year] \quad [36]$$

where:

$PKE_{predpis\ URE}$: end-use energy savings [kWh/year] through the introduction of a new (stricter) regulation governing energy efficiency in the construction of new buildings in a specific year

[24] Only buildings whose design must adhere to the Rules on Efficient Use of Energy in Buildings (Off. Gaz. RS, No 52/2010).

$PE(ESD)_{pr.\ URE}$:	ESD energy savings [kWh/year] through the introduction of a new (stricter) regulation governing energy efficiency in the construction of new buildings in a specific year
n :	annual operating efficiency for heating system - standardised value 0.9
$PTE_{stari\ predpis}$:	the highest permitted requirement of heat [kWh/m year] for heating rooms in compliance with the previous rules on the thermal insulation of buildings, i.e. the Rules on the Thermal Insulation and Efficient Use of Energy in Buildings (Off. Gaz. RS, No 42/2002), - standardised value of 70 kWh/m^2year for single-dwelling and 58 kWh/m^2year for multi-dwelling buildings.
$PTE_{novi\ predpis}$:	the highest permitted requirement of heat [kWh/m2year] to heat rooms in accordance with the Rules on Efficient Use of Energy in Buildings, Off. Gaz. RS, No 52/2010) - standardised value of 35 kWh/m^2year for single-dwelling and 30 kWh/m^2year for multi-dwelling buildings.
A :	surface area [m^2] of newly constructed buildings in Slovenia in a specific year (data source: Geodetic Administration of the Republic of Slovenia).

Reduction of $CO_{2\ emissions}$

Reductions or savings of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$ZEC_{predpis\ URE} = PKE_{predpisi\ URE} \cdot ef$$ [$kgCO_2$/year] [37]

ef : average emission factor for heating for sector - ANNEX A

Data requirements

Using this method requires information on the number of newly constructed buildings or their total useful surface area.

Other notes and features

It will be possible to start using this method upon the entry into force of the Rules on Efficient Use of Energy in Buildings (Off. Gaz. RS, No 52/2010).

1.1.5 MEASURE 5: Replacing hot water boilers with new ones

Sector

Households and service sector.

Description of measure

This measure is the replacement of old combustion plants (boilers) with new ones. This results not just in a significant improvement of energy efficiency, but also in improved reliability of the heating system operation. Since the replacement of boilers usually coincides with improvements or renovations to other elements of the building (facade, building fixtures etc.), special attention should be devoted to determining the appropriate capacity of the new combustion plant (excessive capacity means lower efficiency).

Methodological background

This method covers the range of all combustion plants and boilers (by fuel and type), and in determining the energy efficiency and energy savings in the replacement, we use the standardised values for efficiency and the average (standardised) number of operating hours in the heating season.

The reduction of CO_2 emissions is determined on the basis of the identified energy saving in replacing the boiler, taking into account the relevant emission factor, depending on the type of fuel used by the old and new combustion plants.

In replacing boilers we also determine the increased use of renewable energy sources, specifically in cases where an old fossil fuel boiler is replaced with a new wood biomass one.

Energy savings

Energy savings are determined on the basis of the following equations:

$$\boxed{PKE_{kotel} = \left(\frac{1}{\eta_{stari}} - \frac{1}{\eta_{novi}} \right) \cdot S \cdot A}$$ [kWh/year] [38]

or $$\boxed{PKE_{kotel} = \left(\frac{1}{\eta_{stari}} - \frac{1}{\eta_{novi}} \right) \cdot P \cdot t}$$ [kWh/year] [39]

$$\boxed{PE(ESD)_{kotel} = PKE_{kotel}}$$ [kWh/year] [40]

PKE_{kotel} :	end-use energy savings [kWh/year] owing to replacement of boiler
$PE(ESD)_{kotel}$:	ESD energy savings [kWh/year] owing to replacement of boiler

S : average energy figure [kWh/m^{2}leto] in buildings[25], Table 5:

Table 5: Average energy figure for buildings[26]

Type of building	heating	Heating + sanitary water[27]
Single-dwelling	132 kWh/m^{2}year	162 kWh/m^{2}year[28]
Multi-dwelling (blocks of flats)	94 kWh/m^{2}year	124 kWh/m^{2}year

A : heated surface area [m] of building served by boiler

P : rated power [kW] of boiler

t : operating time [h] of the boiler in the heating season (conversion to operation at rated power); standardised value for the household sector = 1,500 hours/year (determined using guidelines VDI 2067; VDI - Verein Deutscher Ingenieure)

n_{stari} : the annual operating efficiency of an old (replaced) hot water boiler according to DIN 4702-8 (see MEASURE 1)

n_{novi} : the annual operating efficiency of a new boiler-powered heating system according to DIN 4702-8 (see MEASURE 1)

Reduction of $CO_{2\ \text{emissions}}$

Savings or reductions of CO_2 emissions (ZEC in the equations) for cases where there is no switching of fuel are determined using the following equation:

$$\boxed{ZEC_{kotel} = PKE_{kotel} \cdot ef} \qquad [\text{kgCO}_2/\text{year}] \qquad [41]$$

ef : emission factor for fuel - ANNEX A

In the case of switching fuel, the following equation applies:

$$\boxed{ZEC_{kotel} = \left(\frac{ef_{stari}}{\eta_{stari}} - \frac{ef_{novi}}{\eta_{novi}} \right) \cdot S \cdot A} \qquad [\text{kgCO}_2/\text{year}] \qquad [42]$$

or

[25] Efficiency of combustion plants not taken into account.

[26] Source: IJS, ZRMK: Prognosis of energy consumption in buildings based on statistical surveys. Values for 2008 are used.

[27] The average (standardised) requirement for hot sanitary water in single-dwelling buildings amounts to 3,000 kWh/household/year or 30 kWh/m^{2}year, which takes the average size of building to be 100 m^2 housing a 4-member family using hot sanitary water in the amount of 2 kWh/person/day; source: Recknagel/Sprenger, 2002).

[28]

$$ZEC_{kotel} = \left(\frac{ef_{stari}}{\eta_{stari}} - \frac{ef_{novi}}{\eta_{novi}} \right) \cdot P \cdot t$$

[$kgCO_2$/year] [43]

ef_{stari} :	the emission factor [$kgCO_2$/kWh] for fuel or energy source for an old heating system - values for the individual sector or type of fuel are given in ANNEX A
ef_{novi} :	the emission factor [$kgCO_2$/kWh] for fuel or energy source for a new heating system - values for the individual sector or type of fuel are given in ANNEX A

Increased use of renewable energy sources biomass boilers

Where there is a switch to using biomass boilers, we also determine the increased use of renewable energy sources (POVE) as follows:

$$POVE_{kotel\ (biomasa)} = \frac{P \cdot t}{\eta_{novi}} \cdot f$$

[kWh/year] [44]

POVE :	increased use of renewable energy sources [kWh/year]
f -1 :	installation of a new biomass boiler to replace a fossil fuel boiler in newly constructed buildings
f - 0 :	installation of a new biomass boiler to replace an old biomass boiler

Data requirements

In view of the way the method is used, we need data on the heated surface area of the building and data on the power of new combustion plants. Both methods of calculating energy savings are equal, while the choice is contingent on the availability of data.

1.1.6 MEASURE 6: Replacement of electric heater for heating sanitary water

Sector

Households.

Description of measure

This measure is the replacement of an electric heater (boiler) for sanitary hot water with an instant gas heater, a new electric heater (boiler), heat pump (air/water) for sanitary hot water or solar collectors.

Methodological background

The calculation of energy savings is based on certain assumptions, such as the average consumption of sanitary hot water in households, the efficiency of the old heater, surface are of solar collectors etc.

The CO_2 emissions and their reduction depend on the energy savings, the efficiency of the individual system and the values of the emission factors.

Energy savings

Replacement of an electric heater with a new electric heater or instant gas heater:

$$PKE_{SV,EL-GR} = \left(\frac{1}{\eta_{stari}} - \frac{1}{\eta_{novi}} \right) \cdot E_{SV} = 0{,}139 \cdot E_{SV} \quad \text{[kWh/year]} \qquad [45]$$

or

$$\boxed{PKE_{SV,EL-GR} = 0{,}139 \cdot E_{SV}} \quad \text{[kWh/year]} \qquad [46]$$

$$\boxed{PE(ESD)_{SV,EL-GR} = 2{,}5 \cdot PKE_{SV,EL-GR} = 0{,}347 \cdot E_{SV}} \quad \text{[kWh/year]} \qquad [47]$$

Replacement of an electric heater with an instant gas heater:

$$PPE_{SV,PL-GR} = \left(\frac{2{,}5}{\eta_{stari}} - \frac{1}{\eta_{novi}} \right) \cdot E_{SV} = 2{,}014 \cdot E_{SV}$$ [kWh/year] [48]

or

$$\boxed{PPE_{SV,PL-GR} = 2{,}014 \cdot E_{SV}}$$ [kWh/year] [49]

$$\boxed{PE(ESD)_{SV,PL-GR} = PPE_{SV,PL-GR}}$$ [kWh/year] [50]

Replacement of an electric heater with a heat pump (air/water):

$$PKE_{SV,TČ} = \left(\frac{1}{\eta_{stari}} - \frac{1}{\eta_{novi,TČ}} \cdot \frac{1}{SPF} \right) \cdot E_{SV}$$ [kWh/year] [51]

or

$$\boxed{PKE_{SV,TČ} = \left(1{,}250 - 1{,}075 \cdot \frac{1}{SPF} \right) \cdot E_{SV}}$$ [kWh/year] [52]

$$\boxed{\mathrm{PE(ESD)}_{\mathrm{SV,TČ}} = 2{,}5 \cdot \mathrm{PKE}_{\mathrm{SV,TČ}}}$$ [kWh/year] [53]

$PKE_{SV,EL-GR}$: end-use energy savings [kWh/year] owing to installation of a new electric heater for sanitary hot water to replace an (old) electric heater

$PE(ESD)_{SV,EL-GR}$: :ESD energy savings [kWh/year] owing to installation of a new electric heater for sanitary hot water to replace an (old) electric heater

$PPE_{SV,PL-GR}$: primary energy savings [kWh/year] owing to installation of a new instant gas heater for sanitary hot water to replace an (old) electric heater

$PE(ESD)_{SV,PL-GR}$: : ESD energy savings [kWh/year] owing to installation of a new instant gas heater for sanitary hot water to replace an (old) electric heater

$PKE_{SV,TČ}$:	end-use energy savings [kWh/year] owing replacement of an (old) electric heater by a heat pump for hot sanitary water (air/water)
$PE(ESD)_{SV,TČ}$:	ESD energy savings [kWh/year] owing replacement of an (old) electric heater with a heat pump for hot sanitary water (air/water)
ESV :	average (standardised) requirement for hot sanitary water [kWh/year], Table 6:

Table 6: Requirement for hot sanitary water in households

Type of building	Sanitary water requirement
Single-dwelling[29]	30 $kWh/m^2 year$
Mluti-dwelling (blocks of flats)	30 $kWh/m^2 year$

N_{stari} :	efficiency of old system (electric heater) for heating sanitary water - standardised value 0.8
N_{novi} :	efficiency of new system (new electric boiler, instant gas heater etc.) for heating sanitary water - standardised value 0.9
$N_{novi,TČ}$:	the annual operating efficiency of a heating system using a heat pump, see MEASURE 1, equation [9],
SPF :	annual heating figure of heat pump (SPF - Seasonal Performance Factor)[30]

Replacement of electric heater with solar collectors (SC):

$$\boxed{PKE_{SV,SSE} = \frac{U_{SSE}}{\eta} \cdot \eta_{SS} \cdot A} \qquad [kWh/year] \qquad [54]$$

Where the following condition must be taken into account: $PKE_{SV,SSE} \leq \frac{E_{SV}}{\eta_{stari}}$

$$\boxed{PE(ESD)_{SV,SSE} = 2{,}5 \cdot \frac{U_{SSE}}{\eta} \cdot \eta_{SS} \cdot A} \qquad [kWh/year] \qquad [55]$$

$PKE_{SV,SSE}$:	end-use energy savings [kWh/year] from the installation of solar collectors (SC) to replace an electric heater
$PE(ESD)_{SV,SSE}$:	ESD energy savings [kWh/year] from the installation of solar collectors (SC) to replace an electric heater

[29] The average (standardised) requirement for hot sanitary water in single-dwelling buildings amounts to 3,000 kWh/household/year or 30 $kWh/m^2 year$, which takes the average size of building to be 100 m^2 housing a 4-member family using hot sanitary water in the amount of 2 kWh/person/day; source: Recknagel/Sprenger, 2002).

[30] If there are no data, the standardised value of SPF=2.5 is used.

U_{SSE} : annual yield [kWh/m^{2}year] of solar collectors by type[31]:
- panel SC = 500 kWh/m^{2}year
- vacuum SC = 600 kWh/m^{2}year

n : efficiency of (average) conventional system for heating sanitary water, standardised value 0.8
n_{ss} : efficiency of solar system, standardised value 0.8
A : net surface area [m^2] of installed SC[32]

CO2 emission reduction

The reduction of CO_2 emissions (ZEC) is determined using the following equations (depending on the type and method of heating sanitary water):

Replacement of an electric heater with a new electric heater or instant gas heater:

$$ZEC_{SV,GR} = \left(\frac{ef_{EL}}{\eta_{stari}} - \frac{ef}{\eta_{novi}} \right) \cdot E_{SV} \qquad [kgCO_2/year] \qquad [56]$$

or

$$\boxed{ZEC_{SV,GR} = (1{,}250 \cdot ef_{EL} - 1{,}111 \cdot ef) \cdot E_{SV}} \qquad [kg\ CO2/year] \qquad [57]$$

$ZEC_{SV,GR}$: reduced CO2 emissions [kgCO2/year] in the case of installing an instant gas heater or new electric heater (boiler)
ef : the emission factor [kgCO2/kWh] for natural gas or electricity - depending on the type of new sanitary water heater (ANNEX A)
ef_{EL} : the emission factor [kgCO_2/kWh] in electricity generation at power plants (ANNEX A)

Replacement of an electric heater with a heat pump (air/water):

$$ZEC_{SV,TČ} = \left(\frac{1}{\eta_{stari}} - \frac{1}{\eta_{novi}} \cdot \frac{1}{SPF} \right) \cdot ef_{EL} \cdot E_{SV} \qquad [kg\ CO2/year] \qquad [58]$$

[31] The values of annual yield from SC are determined on the basis of a review of professional literature and technical data from the manufacturers of solar systems, where it is taken into account that the average annual value of solar energy in Slovenia is 1,200 kWh/m^2. The standardised values (annual yields of SC) are also harmonised with the values given in the Rules on Efficient Use of Energy in Buildings (Off. Gaz. RS, No 52/2010).
[32] Where there are no specific project data, the following standardised values may be used:
- A = 6 m^2 (panel collectors),
- A = 5 m^2 (vacuum collectors).

or

$$ZEC_{SV,TČ} = \left(1{,}250 - \frac{1{,}111}{SPF}\right) \cdot ef_{EL} \cdot E_{SV}$$

[$kgCO_2$/year] [59]

$ZEC_{SV,TČ}$: reduction of CO_2 emissions [$kgCO_2$/year] in the case if installing a heat pump
ef_{EL} : the emission factor [$kgCO_2$/kWh] in electricity generation at power plants (ANNEX A)

Replacement of electric heater with solar collectors:

$$ZEC_{SV,SSE} = \frac{U_{SSE}}{\eta} \cdot \eta_{SS} \cdot A \cdot ef_{EL}$$

[$kgCO_2$/year] [60]

$ZEC_{SV,SSE}$: reduction of CO_2 emissions [$kgCO_2$/year] in the case if installing solar collectors (SC)
ef_{EL} : the emission factor [$kgCO_2$/kWh] in electricity generation at power plants (ANNEX A)
Increased use of renewable energy sources

Replacement of an electric heater with a heat pump (air/water):

$$POVE_{SV,TČ} = \frac{E_{SV}}{\eta_{novi,TČ}} \cdot \left(1 - \frac{1}{SPF}\right)$$

[kWh/year] [61]

$POVE_{SV,TČ\ :\ (AIR\text{-}WATER)}$ increased use of renewable energy sources [kWh/year] where a heat pump is installed

Replacement of electric heater with solar collectors:

$$POVE_{SV,SSE} = U_{SSE} \cdot \eta_{SS} \cdot A$$

[kWh/year] [62]

$POVE_{SV,SSE}$: increased use of renewable energy sources [kWh/year] where solar collectors are installed

Data requirements

Irrespective of the type of replacement or improvement, data are need on the type of building (single or multi-dwelling). The reduction of CO_2 emissions is determined on the basis of standardised emission factors. We do not need additional data to determine the increased use of renewable energy sources.

1.1.7 MEASURE 7: Installation of heat pumps for heating buildings

Sector

Households and service sector (buildings where heat pumps can be used for heating).

Description of measure

This measure relates to the replacement of a boiler with a heat pump for heating. The installation of heat pumps is emerging as a frequent alternative to conventional heating systems (boilers), especially in the case of low-energy and passive houses. Their use is contingent on low-temperature heating bodies (floor heating, wall heating etc.).

Methodological background

Energy savings can be determined in two different ways, depending on the available data:

- taking the standardised requirements for heat to provide heating in buildings while knowing the (actual) heated surface area of the building, or
- taking the (actual) rated heating power of the heat pump while also taking the standardised operating hours of the heat pump in the heating season.

Energy savings

Primary energy savings are determined as follows:

$$\boxed{PPE_{TČ} = \left(\frac{1}{\eta_{kotel}} - \frac{2,5}{SPF} \cdot \frac{1}{\eta_{TČ}} \right) \cdot S \cdot A}$$ [kWh/year] [63]

or

$$\boxed{PPE_{TČ} = \left(\frac{\eta_{TČ}}{\eta_{kotel}} - \frac{2,5}{SPF} \right) \cdot P \cdot t}$$ [kWh/year] [64]

Energy consumption to drive the heat pump:

$$E_{TČ} = \frac{P \cdot t}{SPF}$$ [kWh/year] [65]

Energy consumption to drive the boiler:

$$E_{kotel} = \left(\frac{1}{\eta_{kotel}} \right) \cdot P \cdot t = 1{,}515 \cdot P \cdot t$$ [kWh/year] [66]

$$\boxed{PE(ESD)_{TČ} = PPE_{TČ}}$$ [kWh/year] [67]

NOTE: In the case of heat pumps (HP), for the purpose of objective determination of energy savings in cases where electricity replaces the use of other energy sources, savings are not evaluated on the end-use energy level but on the primary energy level, using a factor of 2.5.

$PPE_{TČ}$:	primary energy savings [kWh/year] using the factor of 2.5 for electricity (ESD directive) owing to installation of a heat pump (replacing boiler)
$PE(ESD)_{TČ}$:	ESD energy savings [kWh/year] owing to installation of heat pump (replacing boiler)
ETČ :	energy consumption [kWh/year] in the operation of the heat pump
E_{kotel} :	energy consumption [kWh/year] in the operation of the boiler
S :	average energy figure [kWh/year] for buildings, Table 7:

Table 7: Average energy figure for buildings[33]

Type of building	heating	Heating + sanitary water[34]
Single-dwelling	132 kWh/m^{2}year	162 kWh/m^{2}year
Mluti-dwelling	94 kWh/m^{2}year	126 kWh/m^{2}year

Note: instead of “average energy figure (S)” we can also use where applicable “thermal energy requirement for heating building (PTE)”, determined using the calculation of construction physics for the specific building or case. This applies especially to those measures that derive from calls for applications requiring a calculation of construction physics. In such cases the use of the PTE values is recommended (since they are more precise values and data).

A :	heated surface area [m^2] of building provided with heat pump
P :	rated thermal capacity [kW] of boiler or heat pump
t :	average effective operating time [h/year] of HP in the heating season (at full power) - standardised value 1,500 hours/year (household sector)
n_{kotel} :	efficiency of old heating system with boiler - standardised value of 0.66 (for explanations see MEASURE 1)
$n_{TČ}$:	efficiency of heating system with heat pump - standardised value 0.93[35] (for explanations see MEASURE 1)

[33] Source: IJS, ZRMK: Prognosis of energy consumption in buildings based on statistical surveys. Values are for 2008.
[34] The average (standardised) requirement for hot sanitary water in single-dwelling buildings amounts to 3,000 kWh/household/year or 30 kWh/m^{2}year, which takes the average size of building to be 100 m^2 housing a 4-member family using hot sanitary water in the amount of 2 kWh/person/day; source: Recknagel/Sprenger, 2002).
[35] Takes into account the efficiency of the piping and of the regulation system. Here we apply the assumption that the heat pump itself is not a source of additional losses.

SPF : annual heating figure of heat pump (SPF - Seasonal Performance Factor), standardised values, Table 8 and Figure 3, below:

Table 8: SPF values

Type of heat pump	Average (standardised) annual heating figure (SPF)
Air/water	2.8
Ground/water	3.5
Water/water	4

SPF
Preflow temperature °C

Source: Technical specifications from heat pump manufacturers (Danfoss, CTC, Konig, Termotehnika, Viessnnann, Nibe)

Figure 3: Effect of temperature preflow on the annual heating figure (SPF) depending on source of heat

CO2 emission reduction

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$ZEC_{TČ} = \left(\frac{ef_G}{\eta_{kotel}} - \frac{1}{SPF} \cdot \frac{ef_{EL}}{\eta_{TČ}} \right) \cdot P \cdot t \quad [kgCO_2/year] \quad [68]$$

or

$$\boxed{ZEC_{TČ} = \left(1{,}515 \cdot ef_G - 1{,}075 \cdot \frac{ef_{EL}}{SPF} \right) \cdot P \cdot t} \quad [[kgCO_2/year] \quad [69]$$

ef_G : emission factor [kgCO$_2$/kWh] for fuel (ANNEX A)
ef_{EL} : emission factor [kgCO$_2$/kWh] in electricity generation at power plants (ANNEX A)

Increased use of renewable energy sources

Where an air/water heat pump is used, the use of renewable energy sources increases (POVE) as follows:

$$POVE_{TČ} = P \cdot t \cdot \left(1 - \frac{1}{SPF}\right) \quad \text{[kWh/year]} \qquad [70]$$

Data requirements

Depending on the method of calculation, we need to know the heated surface area in the buildings and the heating capacity of the heat pump.

1.1.8 MEASURE 8: Installation of solar collectors (SC)

Sector

Households, service sector and industry.

Description of measure

The installation of solar collectors is a relatively simple yet effective measure, since it significantly increases the energy efficiency of heating sanitary water (compared to the usual methods such as heating it with a boiler), while at the same time it can also be used to boost the heating of rooms.

In general we distinguish between two types of solar collectors (SC):
- panels and
- vacuum collectors.

This measure relates to the following cases of application: Existing buildings:
- heating sanitary water: switching from a boiler to solar collectors
- heating sanitary water and boosting the heating of rooms: switching from a boiler to solar collectors

New buildings:
- heating sanitary water: using solar collectors instead of a boiler
- heating sanitary water and boosting the heating of rooms: using solar collectors instead of a boiler

Methodological background

The calculation of energy savings is based on the annual energy yield, where compared to solar panels, vacuum collectors are approximately 20% more efficient with the same surface area, meaning consequently the use of different standardised values for the annual energy yield of solar collectors.

The reduction of CO_2 emissions and increased use of renewable energy sources are determined on the basis of the calculated energy savings.

Energy savings

Energy savings from the installation of solar collectors for all the above-described cases[36] are determined as shown in the following equation:

$$\boxed{PKE_{SSE} = \frac{U_{SSE}}{\eta} \cdot \eta_{SS} \cdot A} \qquad \text{[kWh/year]} \qquad [72]$$

[36] In view of the specific cases of installation (applications) described above, there may be certain (relatively small) differences, especially regarding the different efficiency values (summer/winter, old/new boiler etc.), but for a simple calculation and ease of comparison it makes sense to use the same (standardised) values.

$$PE(ESD)_{SSE} = PKE_{SSE}$$ [kWh/year] [73]

PKE_{SSE} :	end-use energy savings [kWh/year] from the installation of solar collectors
$PE(ESD)_{SSE:}$	ESD energy savings [kWh/year] from the installation of solar collectors
U_{SSE} :	annual yield [kWh/m^{2}year] of solar collectors by type[37]: - panels 500 kWh/m^{2}year - vacuum collectors - 600 kW/m year
n :	average efficiency of the system of heating and/or making sanitary hot water (e.g. using fossil fuels) - standardised value 0.75[38]
n_{ss} :	efficiency of a solar system - not all the energy obtained from the sun can be used, especially not in summer, when there is more energy than we need. Efficiency depends on the method of using the energy (hot sanitary water/heating rooms), the size of the solar system, losses in cylinders/piping etc. - standardised value 0.8
A :	net surface area [m^2] of installed solar collectors

CO2 emission reduction

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$ZEC_{SSE} = PKE_{SSE} \cdot ef$$ [kgCO_2/year] [74]

ef : emission factor [kgCO_2/kWh] for fuel (which is replaced) - ANNEX A

Increased use of renewable energy sources

Increased use of renewable energy sources (POVE) is determined as follows:

$$POVE_{SSE} = U_{SEE} \cdot \eta_{SSE} \cdot A$$ [kWh/year [75]

$POVE_{SSE}$: increased use [kWh/year] of renewable energy sources using SC

[37] The values of the annual yield from SC are determined on the basis of a review of professional literature and technical data from the manufacturers of solar systems, where it is taken into account that the average annual value of solar energy in Slovenia is 1,200 kWh/m^2. The standardised values (annual yields of SC) are also harmonised with the values given in the Rules on Efficient Use of Energy in Buildings (Off. Gaz. RS, No 52/2010).

[38] The average value determined using various sources and principles (empirical engineering values in Slovenia, use of values in other countries such as Austria etc.).

Data requirements

Use of this method requires a knowledge of the type of solar collectors (panels or vacuum) and their surface area. In the case where the type of collector is not known, we use the value for panel collectors.

1.1.9 MEASURE 9: Compulsory division and calculation of heating costs according to actual consumption

Sector

Households and service sector (multi-dwelling, residential/commercial buildings and commercial buildings).

Description of measure

The measure covers:

- introduction of the system of dividing and calculating heating costs based on actual consumption using split meters for heating
- installation of thermostat valves and hydraulic balancing of the heat distribution system.

i.

Methodological background

The basis for determining savings is the average energy consumption for heating in multi-dwelling buildings (standardised or determined from analysis of energy consumption in practice) and the standardised estimate of savings determined on the basis of an analysis of previously implemented measures.

Energy savings

Energy savings are determined using the following equation:

$$PKE_{OS,HV} = \frac{S \cdot A}{\eta} \cdot f$$ [kWh/year] [76]

$$PE(ESD)_{OS,HV} = PKE_{OS,HV}$$ [kWh/year] [77]

$PKE_{OS,HV}$:	end-use energy savings [kWh/year] from the introduction of a system of dividing and calculating heating costs and installation of thermostat valves and hydraulic balancing of the heating system, calculated separately for buildings connected to the district heating system and separately for buildings with their own boiler units
$PE(ESD)_{OS,HV}$:	ESD energy savings [kWh/year] from the introduction of a system of dividing and calculating heating costs and installation of thermostat valves and hydraulic balancing of the heating system
S :	average energy figure [kWh/m^{2}leto] for multi-dwelling buildings [39]
A :	heated surface area [m^2] of building

[39] 94 kWh/m^{2}year - average value for 2008 - source: IJS, ZRMK: Prognosis of energy consumption in buildings based on statistical surveys.

n : average efficiency of heating system in multi-dwelling buildings - standardised value : in the case of their own (or common) boiler unit the value is 0.75, and in the case of district heating it is 1.0

f : factor (standardised) of energy savings determined using the equation:

f=0.15 + 0.1 * otv

where otv represents the share of buildings in which apartments and commercial units are generally furnished with thermostat valves

Note: where hot water is also prepared centrally, in determining energy savings from the introduction of dividing and calculating costs by actual consumption, we need to use S = 124 kWh/m^2year.

CO2 emission reduction

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$\boxed{ZEC = PKE_{OS,HV} \cdot ef} \qquad [kgCO_2/year] \qquad [78]$$

ef : emission for heating in households (excluding heating by electricity) - ANNEX A

Data requirements

This method requires no particular data, since the calculation is based on standardised values. It is vital to have precise data on the heated surface area of the buildings in which the measure has been implemented.

Other notes and features

Factor f is based on findings from the analysis (MESP/ME; AURE) of measures carried out and from the experiences of those implementing the division of heating costs.

1.1.10 MEASURE 10: Regular inspections of boilers

Sector

Households and service sector.

Description of measure

In line with Slovenian legislation covering combustion plants, inspections must be performed once a year on all combustion plants, and this includes cleaning combustion and flue components and measuring emissions. This measure is provided as part of the public chimney maintenance service.

Methodological background

Calculating energy savings resulting from implementation of this measure is based on the total consumption of specific types of fuel in broad consumption, taking account of specific factors.

Energy savings

Energy savings through inspections of boilers in 2008 are determined with the following equation:

$$\begin{aligned}PKE_{PK} &= PKE_{PK,ZP} + PKE_{PK,TeG} + PKE_{PK,TrG} = \\ &\tfrac{1}{9}\cdot E_{1}\cdot f_{kon}\cdot\left(f_{mer}\cdot f_{prih\_mer} + f_{čišč}\cdot f_{prih\_čišč}\right) + \\ &\tfrac{1}{9}\cdot E_{2}\cdot f_{kon}\cdot\left(f_{mer}\cdot f_{prih\_mer} + f_{čišč}\cdot f_{prih\_čišč}\right) + \\ &\tfrac{1}{9}\cdot E_{3}\cdot f_{kon}\cdot\left(f_{mer}\cdot f_{prih\_mer} + f_{čišč}\cdot f_{prih\_čišč}\right)\end{aligned}$$

[kWh/year] [79]

$$PE(ESD)_{PK} = PKE_{PK}$$

[kWh/year] [80]

PKE_{PK} :	end-use energy savings [kWh/year] through boiler inspections
PKE_{PKZP} :	end-use energy savings [kWh/year] through natural gas boiler inspections
PKE_{PKTEG} :	end-use energy savings [kWh/year] through liquid fuel boiler inspections
PKE_{PKTRG} :	end-use energy savings [kWh/year] through solid fuel boiler inspections
$PE(ESD)_{PK}$:	ESD energy savings [kWh/year] through boiler inspections
E_1 :	energy of consumed natural gas in broad consumption[40] (annual level)
E_2 :	energy of consumed liquid fuels in broad consumption (annual level)
E_3 :	energy of consumed solid fuels in broad consumption (annual level)
f_{kon} :	concession awarding factor (0-1)
f_{mer} :	factor of measuring flue gases (0-1)
f_{prih_mer} :	factor of savings through performing measurements (0-1)

[40] Households and service sector.

$f_{čišč}$: factor of performing cleaning (0-1)
$f_{prih\_čišč}$: factor of savings through performing cleaning (0-1)

Notes/explanations

- in equation [65] values for 2008 are divided by a factor of 9, since the measure has no cumulative effect (for the 2008-2016 period). This factor is reduced yearly by a factor of 1, so for 2016 it has a value of 1.
- equation [65] is based on MESP methodology, while the values of individual factors for 2008 are given in Table 10;

Table 10: Values of factors in equation [53] for calendar year 2008

Type of fuel	f_{kon}	f_{mer}	f_{prih_mer}	$f_{čišč}$	$f_{prih\_čišč}$
Natural gas	0.658	0.7	0.02	0.8	0.005
Liquid fuels	0.658	0.7	0.02	0.8	0.02
Solid fuels	0.658	0.7	0	0.8	0.04

Reduction of $CO_{2\ emissions}$

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$ZEC_{PK} = PKE_{PK,ZP} \cdot ef_{ZP} + PKE_{PK,TeG} \cdot ef_{TeG} + PKE_{PK,TrG} \cdot ef_{TrG}$$ [kgCO2/year][81]

ef_{ZP} : emission factor [kgCO2/kWh] for natural gas (ANNEX A)
ef_{TeG} : emission factor [kgCO2/kWh] for liquid fuels[41] (ANNEX A)
ef_{TrG} : emission factor [kgCO2/kWh] for solid fuels[42] (ANNEX A)

Data requirements

To use this method we need data on consumption by specific type of fuel in broad consumption for the calendar year. Correction factors are determined on the basis of annual analysis of providing chimney maintenance services and expert assessments.

[41] Extra light heating oil (ELHO)
[42] Wood biomass.

1.2 ENERGY ADVICE

1.2.1 MEASURE 11: Providing energy advice for citizens (ENSVET)

Sector

Households.

Description of measure

The provision of energy advice for citizens (ENSVET), which is aimed at providing advice and raising awareness and the level of information for the public regarding sensible use of energy and the exploitation of renewable energy sources. Advice is provided by authorised advisers via a network of advice offices throughout Slovenia. Advice is provided to the public for free. The network of advice offices is also involved in other activities, such as help for citizens in preparing investments in accordance with calls for the allocation of subsidies and loans for investments in EEU and RES.

Methodological background

The calculation of energy savings in the individual year is based on data obtained through surveys of citizens that received advice two years before the evaluation year. Here we determine how many surveyed households carried out investments and what amount of energy was saved.

To convert energy savings from the sample to the total number of households involved in obtaining advice, correction factors are used. Something that needs to be taken into account in evaluating the implementation of the measure is what is called double counting, which can arise owing to the subsidising of measures carried out.

Energy savings

The energy savings resulting from the provision of energy advice as part of the ENSVET programme are indicated by the following equation:

$$\boxed{PKE_{ENSVET} = S \cdot (f_1 \cdot f_2 \cdot f_3 \cdot f_4 \cdot f_5 \cdot f_6 \cdot f_7) \cdot M}$$ [kWh/year] [82]

$$\boxed{PE(ESD)_{ENSVET} = PKE_{ENSVET}}$$ [kWh/year] [83]

PKE_{ENSVET} :	end-use energy savings (kWh/year] from providing energy advice for citizens (ENSVET)
$PE(ESD)_{ENSVET}$:	ESD energy savings (kWh/year] from providing energy advice for citizens (ENSVET)
S :	average annual energy savings made [kWh/year] per piece of advice (taking only households that carried out measures) [43]

[43] Determined in the analysis of measures carried out in the period based on a special survey (for the 2007-2008 period this amounts to 9.23 MWh/advice).

f_1 :	factor of measures carried out, taking the proportion of surveyed citizens that carried out measures proposed	by the advice (0-1),
f_2 :	the factor of existing buildings taking into account the proportion of existing buildings where advice was carried out (0-1)	all buildings, for
f_3 :	factor for those returning for (supplemented) advice (0-1)	
f_4 :	factor of duplication through incentive scheme (0-1)	
f_5 :	factor of other influences of VSS (0-1)	
f_6 :	factor of control group (0-1)	
M :	number of pieces of advice given in previous year but one	

The values of factors from equation [67] for 2008 are given in the following table:

Table 11: Values of factors in equation [55] for 2008

Factor	f1	f2	f3	f4	f5	f6
Value	0.62	0.75	0.95	0.95	0.80	1

Note: Factor of control group f6 has not yet been determined. Taking the above values we obtain:

$$\boxed{PKE_{ENSVET} = 3100 \cdot M}$$ [kWh/year] [84]

Reduction of CO_2 emissions

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$\boxed{ZEC_{ENSVET} = PKE_{ENSVET} \cdot ef}$$ [kgCO_2/year] [85]

efficiency : average emission factor [kgCO_2/kWh] for heating (households) - ANNEX A

Data requirements

This method does not require any particular data, but first and foremost we need data on the average energy saving achieved in the specified period of time.

1.2.2 MEASURE 12: Energy audits in industry and the service sector

Sector

Industry and service sector.

Description of measure

Performing energy audits intended for drawing up measures in the area of energy efficiency and raising awareness and the level of information among energy consumers. Energy audits cover auditing the situation in respect of energy use and supply, identification of possible measures for effective energy management and analysis of the technical and economic feasibility of such measures by determining attainable savings and the necessary investment. They set out the breakdown and costs of energy consumption, and offer a selection of priority organisational and investment measures for energy efficiency, on the basis of which a programme for implementing the proposed measures is formulated.

Methodological background

The energy savings that result from performing energy audits are determined as the share of potential energy savings estimated on the basis of the energy audit carried out. Energy savings differ depending on the type of fuel/energy product and type of sector in which the energy audit was performed.

The reductions of CO_2 emissions are determined as the sum of reduced emissions owing to reduced consumption of fuels and electricity.

Energy savings

Energy savings through the performance of energy audits are defined by the following equation:

$$\boxed{PKE_{EP} = PP_{EL} \cdot p_{EL} + PP_{T+G} \cdot p_{T+G}} \qquad [kWh/year] \qquad [86]$$

$$\boxed{PE(ESD)_{EP} = 2{,}5 \cdot PP_{EL} \cdot p_{EL} + PP_{T+G} \cdot p_{T+G}} \qquad [kWh/year] \qquad [87]$$

PKE_{EP} :	end-use energy savings [kWh/year] owing to energy audit
$PE(ESD)_{EP}$:	ESD energy savings [kWh/year] owing to energy audit
PP_{EL} :	potential end-use energy savings [kWh/year] related to electricity consumption, estimated on the basis of the energy audit
PP_{T+G} :	potential end-use energy savings [kWh/year] related to heat or fuel consumption, estimated on the basis of the energy audit
p_{EL} :	factor of attained end-use energy savings that relate to electricity consumption as a result of the energy audit as a proportion of potential savings, Table 12.
p_{T+G} :	factor of attained end-use energy savings that relate to heat and fuel consumption as a result of the energy audit as a proportion of potential savings, Table 12.

Table 12: Factors of energy savings in performing energy audits

Sector	Factors of energy savings attained p	
	electricity	heat and fuels
Buildings (service sector)	0.25	0.25
Industry	0.20	0.15

CO2 emission reduction

Reductions of CO_2 emissions (ZEC in the equations) are determined as follows:

$$ZEC = PP_{EL} \cdot p_{EL} \cdot ef_{EL} + PP_{T+G} \cdot p_{T+G} \cdot ef_G$$ [kg CO2/year] [88]

ef_{EL} : emission factor [kgCO2/kWh] in electricity generation at power plants - ANNEX A

ef_G : emission factor (average) [kgCO2/kWh] for fuels in industry and the service sector - ANNEX A

Data requirements

Implementation of this method is based on data from energy audits, separated up by sector. An important point in performing energy audits is that they are carried out in accordance with the methodology for energy audits.

1.3 ENERGY EFFICIENT ROAD VEHICLES

1.3.1 MEASURE 13: New private vehicles with specific emissions up to 130 gCO_2/km

Sector

Road traffic (private vehicles).

Description of measure

This measure relates to promoting the purchase of new vehicles with low CO_2 emissions. The Act Amending the Motor Vehicles Tax Act - ZDMV-C (Off. Gaz. RS, No 9/10 of 9 Feb. 2010) introduced tax classes in the purchasing of new vehicles in respect of specific emissions of CO_2, where a lower emission class[44] is subject to a lower tax rate.

In contrast to past practice, when tax classes were divided up on the basis of the vehicle purchase price, the new act encourages buyers of new vehicles to choose vehicles that are more efficient in terms of emissions and energy consumption.

Methodological background

Energy savings can be determined in two ways as follows:

- on the basis of the difference between the average emissions of all new private vehicles in a specific year (e.g. in 2007 this was 157 gCO_2/km[45]) and the average emissions of new private vehicles in emission classes up to 130 gCO_2/km for the same year (method A),
- on the basis of the difference between the average emissions of all new private vehicles in a specific year relative to the previous year (method B).

Use of the individual method depends in particular on the availability of data, where method B is slightly simpler in this respect, since it requires data for all new vehicles together (as a whole), while method A requires broken down data (by groups of vehicle emission classes).

Energy savings

METHOD A: The calculation of energy savings based on the difference in average emissions of all new vehicles in classes up to 130 gCO_2/km is given in the following equation:

$$\boxed{PKE_{vozila} = \left(e_{CO_2,vsi} - e_{CO_2,do130}\right) \cdot 0{,}00385 \cdot PR \cdot N} \quad \text{[kWh/year]} \quad [89]$$

$$\boxed{\mathrm{PE(ESD)}_{\mathrm{vozila}} = \mathrm{PKE}_{\mathrm{vozila}}} \quad \text{[kWh/year]} \quad [90]$$

PKE_{vozila}: end-use energy savings [kWh/year] owing to purchase of new, more energy and emission-efficient, private vehicle

[44] Emission classes in 2010: 0-120, 120-130, 130-150, 150-170, 170-190, 190-210, 210-230, 230-250, over 250 (all in gCO2/km).
[45] source: MESP; Slovenian reporting in accordance with Directive 1999/94/EC.

$PE(ESD)_{vozila}$:	ESD energy savings [kWh/year] owing to purchase of new, more energy and emission-efficient, private vehicle
$e_{CO2,VSI}$:	average emissions of CO_2 [gCO_2/km] for all new private vehicles in the calendar year
$e_{CO2,DO\ 130}$:	average emissions of CO_2 [gCO_2/km] for all new private vehicles with emissions up to 130 gCO_2/km in the calendar year
PR :	the average number of kilometres travelled each year [km/vehicle] for private vehicles in the calendar year[46]
N :	number of new private vehicles purchased with emissions up to 130 gCO_2/km in the calendar year
0.00385:	factor for conversion from savings of CO_2 emissions to energy savings (1/(260 gCO_2/kWh)), taking the average specific emissions of fuel[47].

METHOD B: The calculation of energy savings based on the difference in average emissions of all new vehicles in the current and previous year is given in the following equation:

$$PKE_{vozila} = \left(e_{CO_2,vsi,leto-1} - e_{CO_2,vsi,leto}\right) \cdot 0{,}00385 \cdot PR \cdot N_{vsi}$$ [kWh/year] [91]

$$\mathrm{PE(ESD)}_{vozila} = \mathrm{PKE}_{vozila}$$ [kWh/year] [92]

PKE_{vozila}:	end-use energy savings [kWh/year] owing to purchase of new, more energy and emission-efficient, private vehicle
$PE(ESD)_{vozila}$:	ESD energy savings [kWh/year] owing to purchase of new, more energy and emission-efficient, private vehicle
$e_{CO2,vsi,\ leto}$:	average emissions of CO2 [gCO2/km] for all new private vehicles in the calendar year
$e_{CO2,vsi,\ leto-1}$:	average emissions of CO2 [gCO2/km] for all new private vehicles in the previous calendar year (year-1)
PR :	the average number of kilometres travelled each year [km/vehicle] for private vehicles in the calendar year[48]
N_{vsi} :	number of (all) new private vehicles purchased in the calendar year
0.00385:	factor for conversion from savings of CO_2 emissions to energy savings (1/(260 gCO_2/kWh)), taking the average specific emissions of fuel.

[46] for instance for 2007 it was 15,815 km/year, SORS.

[47] The differences between specific emissions in burning petrol and gas oil per kWh of fuel are minimal (249 gCO_2/kWh or 266 gCO_2/kWh). For this reason we take an average suitable for conversion of CO_2 emission savings into energy. (This takes account of the emission factors 69.2 tCO_2/Tj and 74.0 tCO_2/TJ and the density of 0.755 kg/l for petrol and 0.855 kg/l for gas oil/diesel; see also ANNEX A).

[48] for instance for 2007 it was 15,815 km/year, SORS.

Reduction of CO_2 emissions

Reductions of CO_2 emissions (ZEC in the equations) are determined as follows:

$$\boxed{ZEC_{vozila} = 0{,}260 \cdot PE_{vozila}} \qquad [kgCO_2/year] \qquad [93]$$

Data requirements

Depending on the individual method, to calculate energy savings we need data on:

- average emissions of CO2 [gCO_2/km] for all new vehicles in Slovenia in the calendar year (and in the previous year if method B is used)
- average emissions of CO2 [gCO_2/km] for all new vehicles in Slovenia in emission classes up to 130 gCO_2/km in the calendar year
- the number of average kilometres travelled per vehicle in Slovenia in the calendar year
- the number of new vehicles purchased in Slovenia in emission classes up to 130 gCO_2/km in the calendar year
- the number of all new vehicles purchased in Slovenia in the calendar year (irrespective of emission class)

1.4 PLANTS AND EQUIPMENT FOR GENERATING ELECTRICITY

In line with the European Commission position, measures falling within the ESD framework include only those electricity generation plants that are located at final customers and generate less electricity than the individual final customer consumes[49].

1.4.1 MEASURE 14: Systems for cogeneration of heat and power (CHP)

Sector

Households, service sector and industry.

Description of measure

This measure relates to the construction of systems for cogenerating heat and electricity (CHP) as follows: gas engines, gas turbines, steam turbines and engines etc.

Methodological background

The calculation of energy savings is based on a comparison between energy consumption in CHP systems and in the separate production of heat and electricity. Energy savings are determined on the primary energy level in accordance with the ESD.

In Slovenia, the most prominent place among more recent combined heat and power installations is held by gas engine technology, while for the future we anticipate in industry new gas turbines[50] and cogeneration using the gas-steam process, as well as steam technology in the exploitation of wood biomass (steam engines and turbines, ORC etc.).

A precise methodological background is given and explained only for gas engines, which are the most common systems, while arithmetical equations for determining energy savings can be used for all types of CHP technology.

Gas engines

- The typical electrical capacity of installed gas engines in Slovenia hovers around 1 MWe - in 2008 there were five engines installed with a combined capacity of 4.1 MWe, of which four were installed in district heating systems, and just one (with capacity of 1 MWe) in industry.
- The electricity yield of gas engines is markedly increased with the size of the engine, and at capacities of around 1 MWe it is approximately 40%, as shown in Figure 4, which sets out:
    - the results of market research of gas engines of capacity from 4 to 6,800 kWe in the German market in 2005[51]. Yields for the majority of engines with NO_X emissions are 250-mg/Nm^3.
    - yields of gas engines from the manufacturer GE Jenbacher, which are most commonly found in cogeneration projects in Slovenia. This shows standard[52] yields of engines in attaining two standards for NO_X emissions, which also have an effect on the efficiency of the devices:
        - 500 mgNO_X/Nm^3 (currently the permissible limit in Slovenian legislation)
        - 250 mgNO_X/Nm^3 (the anticipated value upon tightening of environmental requirements)

[49] In view of the key significance of cogeneration, which is tied to local consumption of heat, systems are located in the direct vicinity of electricity consumption, which in terms of energy savings achieved also justified the partial sale of electricity surpluses that are not conveyed via the network (local and nearby take-off without additional network losses).
[50] The only major gas turbine was installed in 1999 at Energetika Ljubljana, while all other cogeneration plants using fossil fuels run gas engines, and this includes all the new units in 2008.
[51] BHKW - Kenndaten 2005, Energie Refereat Stadt Frankfurt am Main, 2005.
[52] Standard yields in accordance with ISO 30461 /I-1991.

- As electricity yield increases, heat yield falls (Figure 5), while combined yield ranges between 80% and 90%, in new engines mainly over 85%.
- The following factors have the greatest influence on actual yield and savings of primary energy:
  - operating at partial loading (lower electricity yield)
  - operating without useful heat recovery (lower combined yield)
  - in gas engines of around 1 MWe power, the primary energy savings factor (FPPE in the equations) ranges between 1.25 and 1.3 for new engines. The proposed value of 1.25 is at the lower margin of standard values from 2005, which is the anticipated value in the actual operation of new cogeneration plants, where yields are increasing further with technological development.

Electricity yield [%]
Electrical power [kWel]

BHKV 2005
Jenbacher (NOx 500mg/nm3)
Jenbacher (NOx 250mg/nm3)
Power (Jenbacher (NOx 250mg/nm3))

Figure 4: Electricity yield of gas engines - market research

Heat yield [%]
Electrical power [kWel]
BHKV 2005
Jenbacher (NOx 500mg/Nm3)
Jenbacher (NOX 250mg/nm3)
Power (Jenbacher (NOX 250mg/nm3))

Figure 5: Heat yield of gas engines - market research

Combined yield [%]
Electrical power [kWel]
BHKV 2005
Jenbacher (NOx 500mg/Nm3)
Jenbacher (NOx 250mg/Nm3)
Power (Jenbacher (NOx 250mg/Nm3))

Figure 6: Combined yield of gas engines - market research

Primary energy saving factor F_{PPE}
Electrical power [kWel]
BHKV 2005
Jenbacher (NOX 250mg/Nm3)
Jenbacher (NOx 500mg/Nm3)
Power (Jenbacher (NOX 250mg/Nm3))

Figure 7: Primary energy saving factor of gas engines - market research

Energy savings

Energy savings through the introduction of CHP systems (SPTE in the equations) are determined as follows:

$$\boxed{PPE_{SPTE} = 2{,}5 \cdot E_{elektrika,SPTE} - E_{gorivo,pov.rabe}}$$ [kWh/year] [94]

$$\boxed{PE(ESD)_{SPTE} = PPE_{SPTE}}$$ [kWh/year] [95]

PPE_{SPTE} :	primary energy savings [kWh/year] through the installation of systems for cogeneration of heat and power
$PE(ESD)_{SPTE}$:	ESD energy savings [kWh/year] through the installation of systems for cogeneration of heat and power
$E_{elektrika,\ SPTE}$:	annual generation of electricity [kWh/year] from a system for cogeneration of heat and power (source: Borzen - Support Centre
$E_{gorivo,\ pov.\ rabe}$:	increased fuel consumption [[kWh/year] owing to the operation of CHP (annual level)

$$E_{gorivo,pov.rabe} = \frac{E_{elektrika,SPTE}}{\eta_{elektrika,SPTE}} - \frac{E_{elektrika,SPTE} \cdot r}{\eta_{toplota,lo\check{c}.proiz.}} =$$

[kWh/year] [96]

$$= E_{elektrika,SPTE} \cdot \left(\frac{1}{\eta_{elektrika,SPTE}} - \frac{r}{\eta_{toplota,lo\check{c}.proiz.}} \right)$$

$\eta_{elektrika,SPTE}$:	electricity yield from CHP (by technology, Table 13)
$\eta_{toplota,lo\check{c}.\ proiz.}$:	yield in separate production of thermal energy[53] : - 90% for fossil fuels - 86% for wood biomass
r :	relationship between heat and electricity produced (by technology, Table 13)

Table 13 shows typical values for the parameters of cogeneration technologies and a calculation of factors for evaluating savings achieved through the installation of cogeneration.

Table 13: Parameters of cogeneration technology and savings factors

CHP technology	Electricity yield $\eta_{electricity,CHP}$	Heat yield	Combined yield	Relationship heat/el. r	Factor of increased fuel consumption F_{PPG}	Primary energy saving factor F_{PPE}
Gas engine	40%	45%	85%	1.125	1.25	1.25
Gas turbine	31%	48%	79%	1.548	1.51	0.99
Gas steam process	38%	42%	80%	1.105	1.40	1.10
Steam turbine*	17%	66%	83%	3.882	1.37	1.13
Steam engine*	12%	71%	83%	5.917	1.45	1.05

Source: Methodology for determining reference costs in high-efficiency cogeneration (ME, 2009) * Smaller units for exploiting wood biomass.

Taking the parameters from the above table, the bracket in equation [96] can be replaced with the factor of increased fuel consumption F_{PPG} and the increased fuel consumption owing to cogeneration can be noted simply with the equation:

$$E_{gorivo,pov.raba} = F_{PPG} \cdot E_{elektrika,SPTE}$$

[kWh/year] [97]

[53] Commission Decision 2007/74/EC establishing harmonised efficiency reference values for separate production of electricity and heat in application of Directive 2004/8/EC.

Energy savings owing to the introduction of a CHP system are thus noted in their final form:

$$PE_{SPTE} = 2{,}5 \cdot E_{elektrika,SPTE} - F_{PPG} \cdot E_{elektrika,SPTE} = \\ = F_{PPE} \cdot E_{elektrika,SPTE}$$ [kWh/year] [98]

CO2 emission reduction

Reductions of CO_2 emissions (ZEC in the equations) are determined as follows:

$$ZEC_{SPTE} = e_{toplota} + e_{elektrika} - e_{SPTE} = \\ = E_{elektrika,SPTE} \cdot \left(\frac{ef_{ZP} \cdot r}{\eta_{toplota,loč.proiz.}} + ef_{EL} - \frac{ef_{ZP}}{\eta_{elektrika,SPTE}} \right)$$ [$kgCO_2$/year] [99]

$e_{toplota}$: CO2 emissions [kgCO2/year] from separate heat production
$e_{elektrika}$: CO2 emissions [kgCO2/year] from separate electricity production
ef_{ZP} : emission factor [$kgCO_2$/kWh] for natural gas (ANNEX A)
ef_{EL} : emission factor [$kgCO_2$/kWh] in electricity generation at power plants (ANNEX A)

Explanations (notes):

- the basic assumption is that produced thermal energy is consumed entirely (100%) in a useful way.

Increased use of renewable energy sources

In the case of CHP using renewable energy sources, the increased use of renewable energy sources is indicated in the following equation:

$$POVE_{SPTE} = \frac{E_{elektrika,SPTE}}{\eta_{elektrika,SPTE}}$$ [kWh/year] [100]

$POVE_{SPTE}$: increased use [kWh/year] of renewable energy sources using CHP

Data requirements

1.4.2 To calculate energy savings using this method, we need credible data on the type (manufacture, capacity etc.), number of newly installed cogeneration systems and their annual output of electricity. MEASURE 15: Photovoltaic power plants

Sector

Households, service sector and industry.

Description of measure

In recent years there has been a boom in the installation of photovoltaic systems or solar power plants, since these are technically quite simple systems that can be installed practically anywhere with adequate solar radiation.

Methodological background

The methodological assumption that underpins the calculation of energy savings is that all electricity generated from photovoltaic systems is counted as a reduction in take-off from the network or rather thereby indirectly as a saving of electricity.

Energy savings

Energy savings are determined as follows:

$$\boxed{PKE_{PV} = E_{PV}} \qquad [kWh/year] \qquad [101]$$

$$\boxed{PE(ESD)_{PV} = 2{,}5 \cdot E_{PV}} \qquad [kWh/year] \qquad [102]$$

PKE_{PV} : end-use energy savings [kWh/year] as a result of installing a photovoltaic system
$PE(ESD)_{PV}$: ESD energy savings [kWh/year] as a result of installing a photovoltaic system
E_{PV} : annual electricity generation [kWh/year] from a photovoltaic system[54]

Reduction of CO_2 emissions

Reductions of CO_2 emissions (ZEC in the equations) are determined as follows:

$$\boxed{ZEC_{PV} = E_{PV} \cdot ef_{EL}} \qquad [kgCO_2/year] \qquad [103]$$

ef_{EL} : the emission factor [$kgCO_2/kWh$] in electricity generation at power plants (ANNEX A)

[54] source: Borzen, Support Centre.

Increased use of renewable energy sources

Increased use of renewable energy sources (POVE) is determined using the following equation:

$$POVE_{PV} = E_{PV}$$ [kWh/year] [104]

$POVE_{PV}$: elektrarn — increased use [kWh/year] of renewable energy sources using photovoltaic systems

Data requirements

The main data required for a calculation under this method are data on electricity generated in (new) photovoltaic systems.

1.4.3 MEASURE 16: Small hydroelectric plants

Sector

Industry and broad consumption (households and service sector).

Description of measure

Construction of small hydroelectric plants, which is an important component in ensuring green electricity, since it involves net savings of energy and greenhouse gas emissions, and taking into account their permanent placement in the environment, they do not represent any major negative impacts on the environment.

Methodological background

Energy savings through the construction of small hydroelectric plants are determined as the sum of all energy generated or purchased from newly established units.

The methodological assumption is that all electricity generated from small hydroelectric plants is counted as a reduction in take-off from the network and thereby indirectly as a saving of electricity.

Energy savings

Energy savings from the operation of small hydroelectric plants are determined using the following equation:

$$\boxed{PKE_{HE} = E_{HE}} \qquad \text{[kWh/year]} \qquad [105]$$

$$\boxed{PE(ESD)_{HE} = 2{,}5 \cdot E_{HE}} \qquad \text{[kWh/year]} \qquad [106]$$

PKE_{HE} : end-use energy savings [kWh/year] through the construction of small hydroelectric plants

$PE(ESD)_{HE}$: ESD energy savings [kWh/year] through the construction of small hydroelectric plants

E_{HE} : annual electricity generation [kWh/year] from small hydroelectric plants[55]

Reduction of CO_2 emissions

Reductions of CO_2 emissions (ZEC in the equations) are determined as follows:

$$\boxed{ZEC_{HE} = E_{HE} \cdot ef_{EL}} \qquad [kgCO_2/year] \qquad [107]$$

ef_{EL}: the emission factor [$kgCO_2$/kWh] in electricity generation at power plants (ANNEX A)

[55] Source: Borzen; Support Centre.

Increased use of renewable energy sources

Increased use of renewable energy sources (POVE) is determined using the following equation:

$$\boxed{POVE_{HE} = E_{HE}} \qquad \text{[kWh/year]} \qquad [108]$$

$POVE_{HE}$: increased use [kWh/year] of renewable energy sources using small hydroelectric plants

Data requirements

The main data required for a calculation under this method are data on electricity generated in (new) small hydroelectric plants.

1.5 ELECTRIC APPLIANCES (CONSUMERS) AND OTHER ENERGY SYSTEMS

1.5.1 MEASURE 17: Energy-efficient lighting in buildings

Sector

Households and service sector.

Description of measure

Installation of energy-efficient lights or systems for interior lighting in buildings. Modern technical capabilities offer average savings (depending on application) in the region of 20-80%.

Methodological background

This method offers a determination of energy savings on two different levels:

- based on standardised values
- based on project data.

Selection of method depends on the data available.

The method is based on the assumption that all upgrades are carried out in a way that ensure the same or better lighting conditions than those prior to the installation of the new system.

CO_2 emissions and savings thereof resulting from improved energy efficiency are determined on the basis of the calculated value of the energy saving, taking into account the relevant emission factor in the generation of electricity in Slovenia.

Energy savings

A - savings based on standardised values Savings are determined using the following equation:

$$PKE_{razsvetljava} = \sum_i NP_i \cdot n_i$$ [kWh/year] [109]

$$PE(ESD)_{razsvetljava} = 2{,}5 \cdot PKE_{razsvetljava} = 2{,}5 \cdot \sum_i NP_i \cdot n_i$$ [kWh/year] [110]

$PKE_{razsvetljava}$:	end-use energy savings [kWh/year] owing to the use of energy-efficient or improved lighting systems
$PE(ESD)_{razsvetljava}$:	ESD energy savings [kWh/year] owing to the use of energy-efficient or improved lighting systems
NP_i :	standardised energy savings [kWh/year/system] in the replacement or upgrading of various lighting systems (values are given in Table 14 on the next page).
n_i :	number of installed (or sold) lighting systems or upgrades

Table 14: Annual standardised energy savings in various lighting systems and upgrades[56]

Type of lighting system	Service sector Standardised annual energy savings (SS) in kWh/year[57]	Households Standardised annual energy savings (SS) in kWh/year[58]
Installation of CFL[59] instead of ordinary light bulbs	118	47
Replacing T8 fluorescent lights with T5	22.5	9
Installing electronic ballasts (instead of magnetic ballasts)	15	6
Installing presence detectors	40	16

B - Savings based on project data

Savings may also be determined on the basis of project data, where account is taken of actual power and the number of operating hours of the new and old (replaced) lighting.

$$\boxed{PKE_{razsvetljava} = \sum_i \left(P_{i,staro} \cdot n_{i,staro} \cdot t_{i,staro}\right) - \sum_j \left(P_{j,novo} \cdot n_{i,novo} \cdot t_{i,novo}\right)} \quad [kWh/year] \quad [111]$$

$$\boxed{\begin{aligned} PE(ESD)_{razsvetljava} &= 2{,}5 \cdot PKE_{razsvetljava} = \\ &= 2{,}5 \cdot \left[\sum_i \left(P_{i,staro} \cdot n_{i,staro} \cdot t_{i,staro}\right) - \sum_j \left(P_{j,novo} \cdot n_{i,novo} \cdot t_{i,novo}\right)\right] \end{aligned}} \quad [kWh/year] \quad [112]$$

$PKE_{razsvetljava}$:	end-use energy savings [kWh/year] owing to the use of energy-efficient or improved lighting systems
$PE(ESD)_{razsvetljava}$:	ESD energy savings [kWh/year] owing to the use of energy-efficient or improved lighting systems
$P_{i,staro}$:	electrical power [kW/unit] of old (replaced) lighting system (lights), including auxiliary devices (e.g. ballasts, sensors etc.)
$P_{j,novo}$:	electrical power [kW/unit] of new (replaced) lighting system (lights), including auxiliary devices (e.g. ballasts, sensors etc.)
$n_{i,staro}$:	number of old (replaced) lights or lighting systems
$n_{j,novo}$:	number of new lights or lighting systems

[56] Source: European Commission - RECOMMENDATIONS ON MEASUREMENT AND VERIFICATION METHODS IN THE FRAMEWORK OF DIRECTIVE 2006/32/EC ON ENERGY END-USE EFFICIENCY AND ENERGY SERVICES, preliminary draft, October 2010

[57] On the assumption of 2,500 operating hours a year.

[58] On the assumption of 1,000 operating hours a year.

[59] CFL - compact fluorescent lights (energy-saving light bulbs)

$t_{i,staro}$: period of operation [h] of old lighting system
$t_{j,novo}$: period of operation [h] of new lighting system

Reduction of $CO_{2\ emissions}$

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$\boxed{ZEC_{razsvetljava} = PKE_{razsvetljava} \cdot ef_{EL}} \quad [kgCO_2/year] \qquad [113]$$

ef_{EL} : the emission factor [$kgCO_2/kWh$] in electricity generation at power plants (ANNEX A)

Data requirements

Implementation of this method requires the knowledge at least of data on the type and number of installed (or sold) new lights or lighting systems, and in the case of a calculation based on project data, we also need to know data on the type and number of new lights and the number of operating hours both for the new (refurbished) and old (replaced) lighting system.

1.5.2 MEASURE 18: Refurbishing public lighting systems

Sector

Public street lighting in all sectors

Description of measure

This measure is the refurbishing and installation of public street lighting systems. Various technical options are available that yield significant energy savings relative to old systems, on average more than 30%.

Methodological background

The actual calculation of energy savings is based on the difference between the electricity consumption of the old and new (more efficient) lighting systems. Basically there are two possible methods of calculation:

- based on project data
- based on standardised values.

Energy savings

A - Savings based on project data

$$PKE_{javna\ razsvetljava} = \sum_i \left(P_{i,staro} \cdot n_{i,staro} \cdot t_{i,staro}\right) - \sum_j \left(P_{j,novo} \cdot n_{j,novo} \cdot t_{j,novo} \cdot f_{p,novo}\right) \qquad [114]$$

$$\begin{aligned} \mathrm{PE(ESD)}_{javna\ razsvetljava} &= 2{,}5 \cdot \mathrm{PKE}_{javna\ razsvetljava} = \\ &= 2{,}5 \cdot \left[\sum_i \left(P_{i,staro} \cdot n_{i,staro} \cdot t_{i,staro}\right) - \sum_j \left(P_{j,novo} \cdot n_{j,novo} \cdot t_{j,novo} \cdot f_{p,novo}\right)\right] \end{aligned} \qquad \text{[kWh/year]} \quad [115]$$

$PKE_{javna\ razsvetljava}$:	end-use energy savings [kWh/year] owing to refurbishment of public lighting system
$PE(ESD)_{javna\ razsvetljava}$:	ESD energy savings [kWh/year] owing to refurbishment of public lighting system
$P_{i,staro}$:	electrical power [kW] for the individual type of old (replaced) street lamp (power of light, ballasts, local regulation etc.)
$P_{j,novo}$:	electrical power [kW] for the individual type of new street lamp (power of light, ballasts, local regulation etc.)
n_i :	number of installed old (replaced) lamps of specific type
n_j :	number of installed new lamps of specific type
$t_{i,staro}$:	period of operation [h] of old public lighting system
$t_{j,novo}$:	period of operation [h] of new public lighting system
$f_{p,novo}$:	factor of night adaptation of illumination level:

- value of 0.8 for lighting systems using night adaptation
- value of 1 for lighting systems without night adaptation

Note:

- in replacing or upgrading street lighting, account needs to be taken of all project design conditions (e.g. illumination level, method of installation etc.), standards and recommendations (e.g. CIE; Commission internationale de l'eclairage - International Commission on Illumination) that are used for the individual application or purpose of use.
- all replacements or upgrades that ensure at least 30% electricity savings (relative to the existing or old state) are deemed to be technically appropriate.

B - Savings based on standardised values.

Energy savings owing to refurbishment of a public lighting system can also be determined on the basis of standardised savings given for some of the most common systems or applications (Table 15, below), as follows:

$$\boxed{PKE_{\text{javna razsvetljava}} = \sum_i NP_i \cdot n_i} \quad \text{[kWh/year]} \quad [116]$$

$$\boxed{PE(ESD)_{\text{javna razsvetljava}} = 2{,}5 \cdot PKE_{\text{javna razsvetljava}} = 2{,}5 \cdot \sum_i NP_i \cdot n_i} \quad \text{[kWh/year]} \quad [117]$$

$PKE_{\text{javna razsvetljava}}$:	end-use energy savings [kWh/year] owing to refurbishment of public lighting system
$PE(ESD)_{\text{javna razsvetljava}}$:	ESD energy savings [kWh/year] owing to refurbishment of public lighting system
NP_i :	annual standardised energy savings [kWh/year] in the replacement or upgrading of various public lighting systems (values are given in Table 15, below).
n_i :	number of installed public lighting systems or upgrades

Table 15: Annual standardised energy savings in some of the most common public lighting systems/applications[60]

Old state (type and power of light)	New state (type and power of light)	Standardised savings (SS) per individual lamp
Mercury (400 W)	High-pressure sodium (250 W)	608 kWh/year
Mercury (400 W)	Metal halogenide (250 W)	608 kWh/year
Mercury (250 W)	High-pressure sodium (150 W)	420 kWh/year
Mercury (250 W)	Metal halogenide (150 W)	420 kWh/year
Mercury (150 W)	Fluorescent (2x36 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

[60] The calculation of standardised savings takes into account the capacity of the ballasts and 4,000 hours of annual operation (at full power).

Reduction of CO_2 emissions

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$\boxed{ZEC_{javna\ razsvetljava} = PKE_{javna\ razsveljava} \cdot ef_{EL}} \quad \text{[kg CO2/year]} \qquad [118]$$

ef_{EL} : emission factor [kgCO2/kWh] in electricity generation at power plants - ANNEX A

Data requirements

In the case of using standardised values we require only data on the number and type of new systems, but in the case of calculating by project we need precise data on the power and number of lights before and after installation/refurbishing.

1.5.3 MEASURE 19: Energy-efficient household appliances

Sector

Households.

Description of measure

This measure is the replacement of old household appliances with energy-saving new ones. This is an important measure since there is a very large target group and potentially very high energy savings. The state of technology in this area ensures constant improvements, which means consequently lower energy consumption and lower pollution for each new generation of household appliances appearing in the market.

Methodological background

This method deals with determining energy savings in the replacement of household appliances in two ways:

- through the use of standardised values for savings
- by determining savings based on market analysis.

In the second case precise data need to be provided on the structure of the household appliances market (going back several years) and the proportion of new appliances replacing old ones, something that is not possible without appropriate market analysis. Here we proceed from the assumption that household appliances are replaced on average every 10 years.

In calculating reduced CO_2 emissions, an emission factor is used that takes the average emissions in generating electricity in Slovenia.

Energy savings

A - Savings based on standardised values

$$\boxed{PKE_{\text{gospodnijski aparati}} = \sum_i NP_i \cdot n_i}$$ [kWh/year] [119]

$$\boxed{PE(ESD)_{\text{gospodnijski aparati}} = 2{,}5 \cdot PKE_{\text{gospodnijski aparati}} = 2{,}5 \cdot \sum_i NP_i \cdot n_i}$$ [kWh/year] [120]

$PKE_{\text{gospodinjski aparati}}$:	end-use energy savings [kWh/year] owing to the use of more energy-saving household appliances
$PE(ESD)_{\text{gospodinjski aparati}}$:	ESD energy savings [kWh/year] owing to the use of more energy-saving household appliances
NP_i :	standardised energy savings [kWh/year/unit] in the use of more energy-saving household appliances, Table 16
n_i :	number of new household appliances in an individual year (by type of appliance or purpose, see Table 16, below)

Table 16: Standardised savings for the specific type of household appliance[61]

Type of household appliance	Standardised annual energy savings per household appliance (kWh/year)
Washing machine	13
Dishwashing machine	44
Refrigerator	67
Freezer	71
Combination appliance (fridge/freezer)	69

B - Savings based on market analysis

Where there are more precise data on the state of the market for household appliances (market analysis), savings may be determined in the following way:

$$PKE_{gospodnijski\ aparati} = \sum_i \left(PPE_{i,leto-10} - PPE_{i,leto}\right) \cdot f_z \cdot n_i$$ [kWh/year] [121]

$$PE(ESD)_{gospodnijski\ aparati} = 2{,}5 \cdot PKE_{gospodnijski\ aparati} = 2{,}5 \cdot \sum_i \left(PPE_{i,leto-10} - PPE_{i,leto}\right) \cdot f_z \cdot n_i$$ [kWh/year] [122]

$PKE_{gospodinjski\ aparati}$:	end-use energy savings [kWh/year] owing to the purchase of more energy-saving household appliances
$PE(ESD)_{gospodinjski\ aparati}$:	ESD energy savings [kWh/year] owing to the use of more energy-saving household appliances
$PPE_{i,leto-10}$:	average annual specific energy consumption [kWh/year/unit] of a specific type of 10-year-old household appliance (10 years prior to the year for which energy savings are counted); see Table 17
$PPE_{i\ leto}$:	average annual specific energy consumption [kWh/year/unit] of a specific type of new household appliance sold in the year for which savings are counted
f_z	factor of the share of new appliances replacing old appliances; see Table 18
n_i :	number of the specific type of new household appliances in an individual year

[61] Source: European Commission - RECOMMENDATIONS ON MEASUREMENT AND VERIFICATION METHODS IN THE FRAMEWORK OF DIRECTIVE 2006/32/EC ON ENERGY END-USE EFFICIENCY AND ENERGY SERVICES, preliminary draft, October 2010

Table 17: Average consumption of specific types of household appliances in Slovenia[62]

Year	Washing machine		Dishwashing machine		Refrigerators		Freezer		Drying machine	
	Average consumption of new appliances	Average consumption of all appliances	Average consumption of new appliances	Average consumption of all appliances	Average consumption of new appliances	Average consumption of all appliances	Average consumption of new appliances	Average consumption of all appliances	Average consumption of new appliances	Average consumption of all appliances
	[kWh/year]	[kWh/year]	[kWh/year]	[kWh/year]	[kWh/year]	[kWh/year]	[kWh/year]	[kWh/year]	[kWh/year]	[kWh/year]
1998	281.3	437.9	332.0	370.3	350.0	394.2	569.5	643.2	244.8	249.7
1999	262.7	415.7	323.9	362.9	345.7	388.1	548.8	636.6	243.7	248.7
2000	244.2	395.0	315.9	355.5	341.2	382.1	528.1	629.4	242.5	247.6
2001	225.8	374.6	307.9	348.2	336.4	376.2	507.4	621.3	241.4	246.7
2002	207.5	355.7	299.9	341.0	326.7	370.3	486.8	611.4	240.2	245.7
2003	204.6	337.7	291.9	333.7	309.0	363.5	466.1	599.4	239.0	244.7
2004	201.8	319.4	277.6	325.8	301.7	356.7	445.4	586.4	238.6	243.7
2005	196.5	302.5	271.8	318.1	295.9	349.8	408.6	571.1	237.9	242.8
2006	192.1	286.8	269.9	311.0	301.2	343.8	376.8	554.2	236.2	241.8
2007	186.4	271.9	267.0	304.1	293.9	337.5	343.5	534.9	232.4	240.5
2008	180.2	258.5	265.5	298.0	281.8	331.0	328.7	516.3	222.2	238.4

Table 18: Share of new appliances replacing old appliances in Slovenia[63]

		2007	2008	2009	2010
Refrigerator	[%]		81%	87%	82%
Freezer	[%]		99%	100%	100%
Dishwashing machine	[%]		48%	53%	53%
Washing machine	[%]		87%	93%	87%
Drying machine	[%]		39%	46%	48%

Reduction of CO_2 emissions

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$ZEC_{gospodinjski\ aparati} = PKE_{gospodinjski\ aparati} \cdot ef_{EL} \qquad [kgCO_2/year] \qquad [123]$$

ef_{EL} : the emission factor [$kgCO_2/kWh$] in electricity generation at power plants (ANNEX A)

Data requirements

[62] Average consumption of specific types of household appliances in Slovenia; source: IJS (model for projected energy consumption in Slovenia, 2010).

[63] Shares of new appliances replacing old appliances. These proportions depend on the type of appliance and change from year to year; source: IJS (model for projected energy consumption in Slovenia,2010).

In using this method we require data on the number of new household appliances purchased, or where a method based on market research is used, we also need data on the average consumption of the specific type of household appliance for new and old appliances.

1.5.4 MEASURE 20: Energy-efficient office equipment

Sector

Households, service sector and industry.

Description of measure

This measure relates to the purchase of new, more energy-efficient computers and monitors.

Methodological background

Total energy savings are determined on the basis of standardised values of energy savings and the number of units of the specific type of office equipment.

Reductions in CO_2 emissions are determined on the basis of the determined energy saving and the emission factor in the generation of electricity in Slovenia.

Energy savings

Energy savings from the purchase of new office equipment (computers, monitors) are determined using the following equation:

$$\boxed{PKE_{\text{pisarniška oprema}} = \sum_i NP_i \cdot n_i} \qquad \text{[kWh/year]} \qquad [124]$$

$$\boxed{PE(ESD)_{\text{pisarniška oprema}} = 2{,}5 \cdot PKE_{\text{pisarniška oprema}} = 2{,}5 \cdot \sum_i NP_i \cdot n_i} \qquad \text{[kWh/year]} \qquad [125]$$

$PKE_{\text{pisarniška oprema}}$:	end-use energy savings [kWh/year] owing to the use of more energy-saving office equipment (computers, monitors)
$PE(ESD)_{\text{pisarniška oprema}}$:	ESD energy savings [kWh/year] owing to the use of more energy-saving office equipment (computers, monitors)
NP_i :	standardised energy savings [kWh/year/unit] in the use of more energy-saving office equipment, Table 19
n_i :	number of new pieces of office equipment (by type/purpose)

Table 19: Standardised savings for office equipment

Type of office equipment	Standardised saving per item of new office equipment[64]
Desktop computer (PC)	39 kWh/year
Monitor (LCD)	11 kWh/year

Reduction of $CO_{2\ emissions}$

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$ZEC_{pisarniška\ oprema} = PKE_{pisarniška\ oprema} \cdot ef_{EL}$$ [$kgCO_2$/year] [126]

ef_{EL} : the emission factor [$kgCO_2$/kWh] in electricity generation at power plants (ANNEX A)

Data requirements

To use this method we need data on computers and monitors sold.

[64] Source: European Commission - RECOMMENDATIONS ON MEASUREMENT AND VERIFICATION METHODS IN THE FRAMEWORK OF DIRECTIVE 2006/32/EC ON ENERGY END-USE EFFICIENCY AND ENERGY SERVICES, preliminary draft, October 2010

1.5.5 MEASURE 21: Energy-efficient electric motors

Sector

Industry and service sector.

Description of measure

This measure involves the installation of new, more energy-efficient electric motors to replace old electric motors.

Electric motor drive systems are one of the biggest consumers of electricity in industry and also elsewhere, especially in the service sector. The basic building blocks of such systems are electric motors, whose efficiency has a decisive impact on the energy efficiency of the entire system. Installation of energy-efficient electric motors is a measure with a short payback period, especially with motors where the number of annual operating hours exceeds 4,000.

Methodological background

Energy savings owing to the installation of energy-efficient electric motors are determined on the basis of knowing the power, number of operating hours, the load factor and the state or possible upgrading of driven systems (consequently lower power requirement for the system). It is recommended that the loading factor be determined for each specific system separately, while in exceptions, standardised values can be used for low-power systems.

Energy savings

Energy savings from the replacement of electric motors are determined using the following equation:

$$PKE_{el.\,motorji} = \left(\frac{1}{\eta_{st} - 0{,}02} - \frac{1}{\eta_{ef}} \right) \cdot P_M \cdot t_M \cdot LF \quad \text{[kWh/year]} \qquad [127]$$

$$PE(ESD)_{el.\,motorji} = 2{,}5 \cdot PKE_{el.\,motorji} = 2{,}5 \cdot \left(\frac{1}{\eta_{st} - 0{,}02} - \frac{1}{\eta_{ef}} \right) \cdot P_M \cdot t_M \cdot LF \quad \text{[kWh/year]} \qquad [128]$$

$PKE_{el.\ motorni\ pogoni}$:	end-use energy savings [kWh/year] owing to the use of energy-efficient electric motors
$PE(ESD)_{el.\ motorni\ pogoni}$:	ESD energy savings [kWh/year] owing to the use of energy-efficient electric motors
n_{st} :	efficiency of standard electric motor, Table 20
n_{ef} :	efficiency of (new) energy-efficient electric motors (IE3 standard; “Premium Efficiency”), Table 20
P_M :	rated electric power [kW] of new drive electric motor
t_M :	number of annual operating hours

LF : the load factor that needs to be determined on the basis of analysing the operation of the specific drive system; for certain general applications up to 22kW of power, standardised values can also be used, as shown in Table 21

Note: the above equation takes into account ageing and the effect of rotation of an old electric motor, with a 2% reduction in efficiency.

Table 20: Efficiency of electric motors[65]

Rated power of electric motor (kW)	n_{st}(IE1 - Standard)	n_{ef} (IE3 - Premium Efficiency)
0.75	0.721	0.840
1.1	0.750	0.853
1.5	0.772	0.863
2.2	0.797	0.875
3	0.815	0.884
4	0.831	0.892
5.5	0.847	0.900
7.5	0.860	0.908
11	0.876	0.917
15	0.887	0.923
18.5	0.893	0.927
22	0.899	0.931
30	0.907	0.936
37	0.912	0.940
45	0.917	0.943
55	0.921	0.945
75	0.927	0.950
90	0.930	0.952
110	0.933	0.954
132	0.935	0.956
160	0.938	0.958
200 to 370	0.940	0.960

[65] Source of data: IEC 60034-30 Ed.1: Rotating Electrical Machines - Part 30: Efficiency Classes of Single Speed 3-Phase Cage Induction Motors.

Table 21: Load factor (LF) for certain typical applications[66]

Rated power of electric motor (kW)	Type of application	Load factor (LF) INDUSTRY	SERVICE SECTOR
0.75-4	Pumps	0.55	0.55
4-10		0.58	0.60
10-22		0.59	0.60
0.75-4	Ventilators	0.53	0.60
4-10		0.56	0.65
10-22		0.59	0.65
0.75-4	Air compressors	0.63	0.40
4-10		0.60	0.45
10-22		0.68	0.45
0.75-4	Transport systems (conveyor belts)	0.42	0.61
4-10		0.41	0.53
10-22		0.51	0.49
0.75-4	Refrigeration compressors	0.60	-
4-10		0.65	-
10-22		0.70	-
0.75-4	Freezing systems	-	0.70
4-10		-	0.70
10-22		-	0.75
0.75-4	Other	0.34	0.30
4-10		0.39	0.30
10-22		0.45	0.30

Reduction of $CO_{2\ emissions}$

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$ZEC_{el.\ motorji} = PKE_{el.\ motorji} \cdot ef_{EL}$$ [$kgCO_2$/year [129]

ef_{EL} : emission factor [kgCO2/kWh] in electricity generation at power plants - ANNEX A

Data requirements

We need to know all the operating characteristics of the electric motor system (based on an energy audit of electric motor systems or a pre-investment system study). The use of standardised values is only permissible in the case of lower power or in non-demanding drive applications.

66 Data source: “Improving the Penetration of Efficient Electrical Motors and Drives” - study performed as part of the EU project SAVE II.

1.5.6 MEASURE 22: Use of frequency converters

Sector

Industry and service sector.

Description of measure

This measure involves the enhancing of electric motor systems with frequency converters.

Since the measure is in itself linked directly to electric motor, such system or set must be dealt with as a whole, meaning that the efficiency of installing a frequency converter depends in part on the adequacy of the electric motor itself and on the actual method (dynamic) of operation for the entire drive system.

Methodological background

Determining energy savings requires a knowledge of as much data as possible on the specific drive system, and only in certain cases (e.g. low-power systems) can we make use of standardised values.

The reduction of CO_2 emissions is determined on the basis of the calculated energy saving, taking into account the relevant emission factor.

Energy savings

Energy savings are determined using the following equation:

$$PKE_{frekv.\,pretvornik\,i} = \frac{P_M}{\eta} \cdot t_M \cdot LF \cdot f$$ [kWh/year] [130]

$$PE(ESD)_{frekv.\,pretvornik\,i} = 2{,}5 \cdot PKE_{frekv.\,pretvornik\,i} = 2{,}5 \cdot \frac{P_M}{\eta} \cdot t_M \cdot LF \cdot f$$ [kWh/year] [131]

$PKE_{frekv.\ pretvorniki}$:	end-use energy savings [kWh/year] owing to the use of frequency converters
$PE(ESD)_{frekv.\ pretvorniki}$:	ESD energy savings [kWh/year] owing to the use of frequency converters
n :	efficiency of the electric motor, Table 19
P_M :	rated power [kW] of the drive electric motor
t_M :	number of annual operating hours [h]
L_F :	the load factor that needs to be determined on the basis of analysing the operation of the specific drive system; for certain general applications up to 22kW of power, standardised values can also be used, as shown in Table 20.
f :	the factor of energy saving owing to the installation of a frequency converter. Savings need to be determined using an analysis of the operation of the specific drive system. For simple applications standardised savings can be used, as shown in Table 21.

Table 21: Energy savings owing to the installation of frequency converters for certain typical applications.[67]

Type of application	The average factor of energy saving owing to the installation of a frequency converter
Pumps	0.28
Ventilators	0.28
Air compressors	0.12
Refrigeration compressors	0.12
Transport systems (conveyor belts)	0.12
Other	0.12

Reduction of CO_2 emissions

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$\boxed{ZEC_{\text{frekv. pretvorniki}} = PKE_{\text{frekv. pretvorniki}} \cdot ef_{EL}} \quad [kgCO_2/year] \qquad [132]$$

ef_{EL} : emission factor [kgCO2/kWh] in electricity generation at power plants - ANNEX A

Data requirements

A precise calculation requires knowledge of the characteristics of the electric motor drive system: power, load factor, number of operating hours etc. Only in the case of low-power drive systems can we make use of standardised values.

[67] Data source: “Improving the Penetration of Efficient Electrical Motors and Drives” - study performed as part of the EU project SAVE II.

1.5.7 MEASURE 23: Systems for exploiting waste heat

Sector

Households.

Description of measure

The measure relates to the installation of ventilation systems with waste heat recovery in residential buildings, especially in connection with the construction of low-energy and passive houses. This replaces the natural ventilation of rooms. While the primary task of such a ventilation system is to ensure high-quality living conditions (fresh air), the energy savings that arise through this are not negligible.

Methodological background

The calculation of savings is based on the amount of heat that is transferred to the air piped in from the warm air exiting the building, and this is determined on the basis of knowing the size of rooms being ventilated, and based on certain assumptions (rate of air exchange, period of operation of system in the heating season, temperature difference between the air exiting the room and the outside air, recovery rate etc.).

The method is based on the assumption that both ventilation systems (mechanical with recovery or natural with the opening of windows) ensure the same quality of air.

Energy savings

The energy savings owing to the installation of a ventilation system with waste heat recovery are determined as follows:

$$PKE_{izk.\ odpadne\ toplote} = A \cdot h \cdot \beta \cdot t \cdot c \cdot \rho \cdot \Delta T \cdot \eta$$ [kWh/year] [133]

$$PE(ESD)_{izk.\ odpadne\ toplote} = PKE_{izk.\ odpadne\ toplote}$$ [kWh/year] [134]

$PKE_{izk.\ odpadne\ toplote}$:	end-use energy savings [kWh/year] owing to the recovery of waste heat in ventilation systems (recuperation)
$PE(ESD)_{izk.\ odpadne\ toplote}$:	ESD energy savings [kWh/year] owing to the recovery of waste heat in ventilation systems (recuperation)
A :	surface area of building [m^2] to which the central ventilation system pertains
h :	height [m] of rooms (from floor to ceiling) - standardised value 2.5 m
ß :	rate of air exchange [h^{-1}] - standardised value 0.5 h^{-1}
t :	period of operation [h] of ventilation system in heating season - standardised value 3,000 h
c :	specific heat of the air (1 kJ/kgK)

p: density of the air (1.2 kg/m^3)

AT : difference between the air temperature in the room and the average temperature of the outside air during the heating season - standardised value (22-4) = 18 K

n : rate of recovery - standardised value 0.7

Taking the above standardised values we obtain the following equation:

$$PKE_{izk.\ odpadne\ toplote} = 13{,}125 \cdot A$$

[kWh/year] [135]

where:

A : surface area of building [m^2] to which the central ventilation system pertains

CO2 emission reduction

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$ZEC_{izk.\ odpadne\ toplote} = PKE_{izk.\ odpadne\ toplote} \cdot ef$$

[kg CO2/year] [136]

ef : average emission factor [kgCO_2/kWh] for heating in households (ANNEX A)

Data requirements

To use this method we need data on the surface area of the building (taking into account certain assumptions and standardised values).

1.6 IMPLEMENTING VOLUNTARY AGREEMENTS

1.6.1 MEASURE 24: Implementing voluntary agreements (exemption from payment of environmental tax)

Sector

Industry and service sector.

Description of measure

The implementation of various measures to raise energy efficiency based on a contract between a company or institution and the Ministry of the Environment and Spatial Planning, in accordance with the Decree on Reducing Pollution of the Air from Emissions of Carbon Dioxide. Under the contracts, organisations have undertaken to carry out all the prescribed measures and to reduce total (directly from fuel consumption and indirectly from electricity consumption) specific emissions of CO_2 (per unit of quantity of products or services) by at least 2.5% by the end of 2008 relative to the reference year, regarding which operators report annually. The reference year is the year with the highest total specific emissions in the 1999-2002 period, or the first full operating year in the case of new facilities.

Methodological background

This method covers the calculation or determination of energy savings owing to the implementation of voluntary agreements as part of implementing the Decree on Reducing Pollution of the Air from Emissions of Carbon Dioxide. The method is based on a comparison of specific fuel and electricity consumption in 2007 and 2008.

Given that the measure is no longer being implemented in practice (in line with the provisions of the decree, the implementation of voluntary agreements ended at the end of 2008), in the future we will need to adapt the method appropriately or develop a new version, in line with the provisions of the new decree being drafted.

Energy savings

Energy savings and CO2 emission reductions are calculated separately for electricity and energy from consumed fuels.

End-use energy savings from the consumption of electricity (in 2008):

$$PKE_{elektrika} = \left(\frac{E_{2007}}{n_{2007}} - \frac{E_{2008}}{n_{2008}} \right)_i \cdot n_{2008,i} \cdot k \qquad \text{[kWh/year]} \qquad [137]$$

$PKE_{elektrika}$:	end-use energy savings from the consumption of electricity [kWh/year] in implementing voluntary agreements
E_{2008} :	electricity consumption [kWh/year] in 2008
E_{2007} :	electricity consumption [kWh/year] in 2007
n_{2008} :	number of products or services in 2008
n_{2007} :	number of products or services in 2007
k :	correction factor (0-1)[68]

[68] For 2008 the correction factor amounts to 0.5, which follows from the estimate that only half of the implemented measures are likely to be active in 2016.

End-use energy savings from fuel consumption (in 2008):

$$PKE_{goriva} = \left(\frac{G_{2007}}{n_{2007}} - \frac{G_{2008}}{n_{2008}} \right)_i \cdot n_{2008,i} \cdot k \qquad \text{[kWh/year]} \qquad [138]$$

PKE_{goriva} :	end-use energy savings from fuel consumption [kWh/year] in implementing voluntary agreements
G_{2008} :	fuel consumption [kWh/year] in 2008
G_{2007} :	fuel consumption [kWh/year] in 2007
n_{2008} :	number of products or services in 2008
n_{2007} :	number of products or services in 2007
k :	correction factor (0-1)

Total end-use energy savings:

$$\boxed{PKE_{CO_2 taksa} = PKE_{elektrika} + PKE_{goriva}} \qquad \text{[kWh/year]} \qquad [139]$$

ESD saving:

$$\boxed{PE(ESD)_{CO_2 taksa} = 2{,}5 \cdot PKE_{elektrika} + PKE_{goriva}} \qquad \text{[kWh/year]} \qquad [140]$$

Explanations (notes):

- in determining savings, we only use those savings or the savings of those companies/facilities where savings have also been achieved in fuel and electricity
- in methodological terms we need to exclude all facilities where individual years show any significant deviation in the quantity of units of products or services

Reduction of CO_2 emissions

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$\boxed{ZEC_{CO_2 taksa} = PKE_{elektrika} \cdot ef_{EL} + PKE_{goriva} \cdot ef_G} \qquad [kgCO_2/year] \qquad [141]$$

ef_{EL} :	the emission factor [$kgCO_2/kWh$] in electricity generation at power plants (ANNEX A)
ef_G :	emission factor (average) [$kgCO_2/kWh$] for fuels in industry and the service sector (ANNEX A)

Data requirements

We use ARSO data on the implementation of voluntary agreements collected on the basis of mandatory annual reporting by participants in the scheme.

Other notes and features

Implementation of the measure or instrument was concluded in 2008, in line with the valid decree. A new system of voluntary agreements is being drawn up.

1.6.2 MEASURE 25: Introducing energy management systems

Sector

Industry and service sector.

Description of measure

This measure relates to the introduction of a system of energy management, i.e. the installation of a computer-supported system for energy management, introduction of the SIST EN 16001 standard and other progressive methods of energy management (targeted monitoring of energy consumption, “smart metering” systems), which represent an important tool for raising energy efficiency. The measure represents an enhancement of existing practices of monitoring energy consumption. Significant savings can be achieved by introducing energy management systems.

Methodological background

The method covers the calculation or determination of energy savings owing to the introduction of a computer-supported energy management system or introduction of the SIST EN 16001 standard or other methods of energy management, in a way that is based on minimal standardised savings, which are defined as savings factors[69] by type of energy and sector to which the individual company or institution belongs, taking into account overall energy consumption (separated into electricity and heat and fuel) prior to the introduction of the energy management system. Energy savings are determined just once for the entire lifetime of the measure (i.e. five years).

Emission savings CO_2 are determined taking into account the average emission factors for fuel or electricity in the sector.

Energy savings

End-use energy savings owing to the introduction of an energy management system:

$$\boxed{PKE_{\text{sistemi upravljanja}} = E \cdot r_{EL} + G \cdot r_G} \quad \text{[kWh/year]} \quad [142]$$

ESD saving:

$$\boxed{PE(ESD)_{\text{sistemi upravljanja}} = 2{,}5 \cdot E \cdot r_{EL} + G \cdot r_G} \quad \text{[kWh/year]} \quad [143]$$

$PKE_{\text{sistemi upravljanja}}$: end-use energy savings [kWh/year] in the lifetime of the measure (i.e. five years) owing to the introduction of energy management systems

[69] Introducing an energy management system in line with the latest document is a process that lasts from three to five years. The duration depends on the size and capacity of organisations to introduce change. The duration of the introduction period is also affected by work already performed in this area. Experiences from Denmark and Ireland show that companies with a system of energy management up and running made savings of 5 to 15%. With regard to the approaches noted in documents and general practice in Slovenian companies in the area of energy efficiency, we may take the view that Slovenia has similar potentials, but they cannot be achieved all at once. By promoting energy efficiency and active introduction of an energy management system, it is possible to raise energy efficiency by 1 to 3% a year. The savings factors used (Table 22) are the default average standardised values determined on the basis of practical experience and the above-described cases from abroad.

$PE(ESD)_{sistemi\ upravljanja}$:	ESD energy savings [kWh/year] in the lifetime of the measure (i.e. five years) owing to the introduction of energy management systems
E :	electricity consumption [kWh/year] in an enterprise or company in the year prior to introduction of an energy management system
r_{EL} :	electricity saving factor owing to the introduction of an energy management system - Table 23
G :	fuel consumption [kWh/year] in an enterprise or company in the year prior to introduction of an energy management system
r_G :	fuel and heat saving factor owing to the introduction of an energy management system - Table 23

Table 23: Energy saving factors owing to the introduction of an energy management system

Sector	Factors of energy savings r	
	electricity	heat and fuels
Buildings (service sector)	0.07	0.10
Industry	0.05	0.07

Reduction of CO_2 emissions

Reductions of CO_2 emissions (ZEC in the equations) are determined using the following equation:

$$\boxed{ZEC_{sistemi\ upravljanja} = E \cdot r_{EL} \cdot ef_{EL} + G \cdot r_G \cdot ef_G} \quad [kgCO_2/year] \qquad [144]$$

ef_{EL} :	the emission factor [$kgCO_2$/kWh] in electricity generation at power plants (ANNEX A)
ef_G :	emission factor (average) [$kgCO_2$/kWh] for fuels in industry and the service sector (ANNEX A)

Data requirements

To use this method we need data on energy consumption (separated into electricity and fuel) in companies or institutions that introduced an appropriate computer-supported system for energy management, or standard SIST EN 16001.

Other notes and features

Given that this is a relatively new measure (especially standard SIST EN 16001), in which there is in practice very little experience, this method will need to be updated and adapted when it becomes possible to perform an appropriate analysis of the effects of specific cases in practice.

2. TOP-DOWN (TD) METHODS FOR DETERMINING ENERGY SAVINGS

The top-down (TD) methods for estimating energy savings are based on aggregated data for the national level, the sector or subsector of the specific activity in question.

The entire energy saving calculated using TD methods includes savings from independent advances, the effect of price changes, structural changes, the effect of prior measures and the effect of retroactive functioning of measures (rebound effect).

These methods are formulated using indicators of energy efficiency that were previously developed as part of European projects (Odyssee - Mure). The methods were deliberated and harmonised within an expert group for top-down methods under the aegis of the Committee of the ESD Implementation Commission. The selection of methods set out below is based on the (current) availability of data in Slovenia, which enables their use.

Table 24: Review of energy savings calculations using the top-down (TD) method.

Method (No.)	Name/title of method	Status	Designation as proposed by the European Commission[70]
1	Energy savings in household energy consumption (excluding electricity consumption) (M1)	method formulated	M1
2	Energy savings in household electricity consumption (M2)	method formulated	M2
3	Energy savings in service sector energy consumption (excluding electricity consumption) (M3)	method formulated	M3
4	Energy savings in service sector electricity consumption (M4)	method formulated	M4
5	Energy savings in road transport (M5)	further development of method required	M5
6	Energy savings of private road vehicles (P8)	method formulated	P8
7	Energy savings of private road vehicles (P8-A1)	method formulated	P8 - A1
8	Energy savings of road freight vehicles (P9)	method formulated	P9
9	Energy savings of road freight vehicles (P9-A2)	method formulated	P9 - A2
10	Energy savings in rail passenger transport (P10)	method formulated	P10
11	Energy savings in rail freight transport (P11)	method formulated	P11
12	Energy savings in manufacturing, determined using the industrial output index (P14)	method formulated	P14
13	Energy savings in manufacturing, determined using value added (M8)	method formulated	M8

[70] Source: European Commission - RECOMMENDATIONS ON MEASUREMENT AND VERIFICATION METHODS IN THE FRAMEWORK OF DIRECTIVE 2006/32/EC ON ENERGY END-USE EFFICIENCY AND ENERGY SERVICES, preliminary draft, October 2010

2.1 ENERGY SAVINGS IN HOUSEHOLDS

The calculation of energy savings in households using the top-down method is based on available data on energy consumption and on the number and surface area of occupied (heated) residences.

The methods for estimating energy savings in households deal with end-use energy savings in electricity consumption ($PKE_{G\ EE}$) and in the consumption of other types of energy excluding electricity ($PKE_{G\ E\ brez\ EE}$).

2.1.1 METHOD 1: Savings of end-use energy consumption in households (excluding electricity consumption) (M1)

Description of method

This method of calculating energy savings ($PKE_{G,\ E\ brez\ EE}$) is intended to calculate energy savings in household energy consumption excluding electricity consumption. The calculation of savings is based on the difference in specific energy consumption excluding electricity in an occupied (heated) residence during the observed and base years, corrected for climate conditions. The correction for climate conditions is needed to estimate the real energy consumption in similar climate conditions, which is achieved through the correction of consumption based on conditions over a long (25-year) heating average temperature deficit[71] (degree days) and the heating temperature deficit in the observed year.

In this method a calculation is made of household savings of energy (excluding electricity) used primarily for heating rooms, sanitary hot water and for cooking.

The method calculates energy savings owing to improvements to the building's energy performance, which is the result of better insulation of the building shell and improvements to the energy efficiency of the heating system and the sanitary water heating system.

The method relates to the calculation of energy savings for all occupied residences. Energy savings

Energy savings ($PKE_{G,\ E\ brez\ EE}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$\mathrm{PKE}_{\mathrm{G,\,E\ brez\ EE}} = \left[\left(\frac{E_{2007}^{G_{brez-EE}}}{\check{S}ST_{2007}} * \frac{PTP_{25}^{ogr.}}{LTP_{2007}^{ogr.}}\right) - \left(\frac{E_{t}^{G_{brez-EE}}}{\check{S}ST_{t}} * \frac{PTP_{25}^{ogr.}}{LTP_{t}^{ogr.}}\right)\right] * \check{S}ST_t \quad \text{[GWh/year]} \qquad [145]$$

where:

$E_{2007}^{G_{brez-EE}}$ energy savings [GWh] excluding electricity consumption in households in 2007,

$E_{t}^{G_{brez-EE}}$ energy savings [GWh] excluding electricity consumption in households in the observed year (t),

$\check{S}ST_{2007}$ number of used (occupied) residences [1000 x] in 2007,

[71] Temperature deficit is the monthly amount of days of difference between 18 °C and the average daily temperature, if that is lower than or equal to 15 °C (TS_i <15 °C), (Source: Eurostat).

$ŠST_t$: number of used (occupied) residences [1000 x] in the observed year (t),

$PTP_{25}^{ogr.}$: average long-term (25-year) temperature deficit [K*day/year] (average long-term degree days),

$LTP_{2007}^{ogr.}$: heating temperature deficit [K*day/year] in 2007 and

$LTP_{t}^{ogr.}$: heating temperature deficit [K*day/year] in the observed year (t).

Data requirements

Calculating energy savings with this method requires data on annual energy consumption excluding electricity in households and the number of occupied residences for the base (t_o) and observed (t) years. We also need data on the (heating) temperature deficit:

- long-term (3,033 K*day/year[72]) and
- temperature deficit for the base year (2007: 2,792° K*day/year) and observed year.

Temperature deficit data are published by ARSO (Slovenian Environment Agency) by statistical region. The average annual temperature deficit was calculated for Slovenia taking into account the number of inhabitants in each region[73].

Data on energy consumption are available in the database of the Statistical Office of the Republic of Slovenia (SORS).

For certain years, data on the number of occupied residences are available in the database of the population census. For other (intervening) years, we can calculate the number of occupied residences based on data from the population census or we can use data prepared by other institutions for other purposes.

[72] The long-term average temperature deficit is calculated for a period of 17 years (1992-2008) based on available ARSO data on temperature deficit by statistical region (IJS-CEU calculation).

[73] Since Eurostat uses the temperatures 18°C/15°C (originally used for Britain, and they conform less to the climate conditions and method of heating in Slovenia) to calculate the temperature deficit, while in calculating the national average it does not take into account the weighting of settlement density by individual region, which is reflected in a lower temperature deficit that takes less adequate account of the regional distribution of consumption, a weighted temperature deficit was used to calculate energy savings for Slovenia, and this is calculated on the basis of ARSO data on the temperature deficit (temperatures of 20°C/12°C) for individual Slovenian regions (IJS-CEU calculation). Analysis of the calculation of savings using the two temperature deficits has shown that using Slovenian data we obtain greater savings, mainly because of the more objective temperature correction in terms of both the spread of consumption and more appropriate baseline temperatures.

2.1.2 METHOD 2: Savings of end-use energy in electricity consumption in households (M2)

Description of method

This method is intended for calculating energy savings in electricity consumption in households chiefly for household appliances, lighting and heating (of rooms and sanitary hot water). The method is based on the indicator of specific consumption of electricity in households - consumption per residence.

The calculation of electricity savings is thus determined on the basis of the average saving in electricity consumption per residence (the difference in the value of the indicator of specific consumption in the base and observed years), multiplied by the number of occupied residences.

The method determines electricity savings owing to the improved efficiency of household electrical appliances, lighting and other consumers (electric cookers, electric sanitary water heaters etc.).

The method relates to the calculation of electricity savings for all occupied residences. Energy savings

End-use electricity savings ($PKE_{G,\ EE}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$PKE_{G,EE} = \left(\frac{EE_{2007}^{G_{EE}}}{\check{S}ST_{2007}} - \frac{EE_{t}^{G_{EE}}}{\check{S}ST_{t}} \right) * \check{S}ST_{t} \quad \text{[GWh/year]} \qquad [146]$$

where:

$EE_{2007}^{G_{EE}}$: electricity consumption [GWh] in households in 2007,

$EE_{t}^{G_{EE}}$: electricity consumption [GWh] in households in the observed year (t),

$\check{S}ST_{2007}$ number of used (occupied) residences [1000 x] in 2007 and

$\check{S}ST_{t}$: number of used (occupied) residences [1000 x] in the observed year (t)

Data requirements

Calculating energy savings with this method requires data on annual electricity consumption in households and the number of occupied residences for 2007 and the observed year (t).

Data on electricity consumption are available in the database of the Statistical Office of the Republic of Slovenia (SORS).

For certain years, data on the number of occupied residences are available in the database of the population census. For other (intervening) years, we can calculate the number of occupied residences based on data from the population census or we can use data prepared by other institutions for other purposes.

2.2 END-USE ENERGY SAVINGS IN THE SERVICE SECTOR

The service sector comprises a range of activities which the Standard Classification of Activities (SKD 2008) divides into the following areas:

G: retail; maintenance and repair of motor vehicles,
H: transport and storage,
I: accommodation and food service industry,
J: information and communications technology,
K: financial and insurance activities,
L: real estate brokerage,
M: expert, scientific and technical activities,
N: other miscellaneous business activities,
O: public administration and defence; compulsory social security activities,
P: education,
Q: health and social security,
R: cultural, entertainment and recreational activities,
S: other activities,
T: households with employed staff; production for proprietary use,
U: activities of ex-territorial organisations and bodies.

The biggest problem in calculating energy savings in this sector is the lack of data on energy consumption, the number and type of equipment and other data for the specific activity.

The calculation of energy savings in the service sector is performed using two indicators:

- energy consumption (excluding electricity) per employee in the service sector, taking account of climate conditions and
- electricity consumption per employee in the service sector.

2.2.1 METHOD 3: Savings of end-use energy consumption in the service sector (excluding electricity consumption) (M3)

Description of method

This method of calculating energy savings (excluding electricity) in the service sector is intended to calculate energy savings in all service activities. In this method a calculation is made of end-use energy savings excluding electricity, used primarily for heating rooms, sanitary hot water, cooking and other purposes.

The method is based on the indicator of specific energy consumption per employee, taking into account climate conditions (temperature deficit). The correction of energy consumption owing to climate conditions is performed using the long-term (heating) average temperature deficit (degree days) and the heating temperature deficit in the given year.

The method determines energy savings excluding electricity that arise from improvements to the building's energy performance, which is the result of better insulation of the building shell and improvements to the energy efficiency of the heating system (savings in heating rooms), the sanitary water heating system and other consumers.

End-use energy savings

Energy savings ($PKE_{ST,\ E\ brez\ EE}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$\mathrm{PKE}_{\mathrm{ST,\,E\,brez\ EE}} = \left[\left(\frac{E_{2007}^{S_{brez\cdot EE\cdot}}}{\check{S}t.zap_{2007}^{S^{pz}}} * \frac{PTP_{25}^{ogr.}}{LTP_{2007}^{ogr.}}\right) - \left(\frac{E_{t}^{S_{brez\cdot EE\cdot}}}{\check{S}t.zap_{t}^{S^{pz}}} * \frac{PTP_{25}^{ogr.}}{LTP_{t}^{ogr.}}\right)\right] * \check{S}t.zap_{t}^{S^{pz}}$$ [GWh/year] [147]

where:

$\mathrm{E}_{2007}^{\mathrm{S_{brez}\cdot EE\cdot}}$: energy savings [GWh] excluding electricity consumption in the service sector in 2007,

$\mathrm{E}_{t}^{\mathrm{S_{brez}\cdot EE\cdot}}$: energy savings [GWh] excluding electricity consumption in the observed year (t),

$\check{\mathrm{S}}\mathrm{t.zap}_{2007}^{\mathrm{S^{pz}}}$: total number of employees [1000 x] in the service sector (full-time employment) in 2007,

$\check{\mathrm{S}}\mathrm{t.zap}_{t}^{\mathrm{S^{pz}}}$: total number of employees [1000 x] in the service sector (full-time employment) in the observed year (t),

$\mathrm{PTP}_{25}^{\mathrm{ogr.}}$: average long-term temperature deficit [K*day/year],

$\mathrm{LTP}_{2007}^{\mathrm{ogr.}}$: heating temperature deficit [K*day/year] in 2007 and

$\mathrm{LTP}_{t}^{\mathrm{ogr.}}$: heating temperature deficit [K*day/year] in the observed year (t).

Data requirements

Calculating energy savings with this method requires data on annual energy consumption excluding electricity and the number of employees in the service sector for the base (2007) and observed (t) years. We also need data on the long-term average (heating) temperature deficit and the temperature deficit for 2007 and the observed year (t).

Data on energy consumption and the number of employees are available in the database of the Statistical Office of the Republic of Slovenia (SORS).

Other notes and features

SORS determines energy consumption excluding electricity in the service sector as the difference between total energy consumed and consumption in other sectors (industry, construction, transport and households), which presents considerable uncertainty in determining service sector consumption, since every variance or error in other sectors is reflected in service sector consumption, so in recent years large variations in consumption have been observed between individual years in this sector.

2.2.2 METHOD 4: Savings of end-use electricity consumption in the service sector (M4)

Description of method

This method is intended to calculate energy savings in the consumption of electricity in all service activities. In this method a calculation is made of the savings of electricity, used primarily for lighting, electric appliances, computers and other information technology, electric sanitary water heaters, air conditioning, electric cookers and other purposes.

The method is based on a calculation of electricity savings based on the indicator of specific electricity consumption per employee.

The method determines electricity savings owing to the improved efficiency of electrical appliances, lighting, air conditioning, ventilation, computers and other information technology, systems with electric sanitary water heaters and other electrical appliances.

End-use energy savings

Energy savings ($PE_{ST,\ EE}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$\boxed{PKE_{ST,EE} = \left(\frac{EE_{2007}^{S_{EE}}}{\check{S}t.zap_{2007}^{S^{pz}}} - \frac{EE_{t}^{S_{EE}}}{\check{S}t.zap_{t}^{S^{pz}}} \right) * \check{S}t.zap_{t}^{S^{pz}}} \quad \text{[GWh/year]} \qquad [148]$$

where:

$EE_{2007}^{S_{EE}}$: electricity consumption [GWh] in the service sector in 2007,

$EE_{t}^{S_{EE}}$: electricity consumption [GWh] in the service sector in the observed year (t),

$\check{S}t.zap_{2007}^{S^{pz}}$: total number of employees [1000 x] in the service sector (full-time employment) in 2007

and

$\check{S}t.zap_{t}^{S^{pz}}$: total number of employees [1000 x] in the service sector (full-time employment) in the observed year (t).

Data requirements

Calculating energy savings with this method requires data on annual electricity consumption and the number of employees in the service sector for the base (2007) and observed (t) years.

Data on total annual electricity consumption and the number of employees in the service sector are collected and published by the Statistical Office of the Republic of Slovenia (SORS).

Other notes and features

SORS determines electricity consumption in the service sector as the difference between total electricity consumed and consumption in other sectors (industry, construction, transport and households), which presents considerable uncertainty in determining service sector consumption, since every variance or error in other sectors is reflected in service sector consumption, so in recent years large variations in consumption have been observed between individual years in this sector.

2.3 ENERGY SAVINGS IN TRANSPORT

The transport sector comprises several subsectors.

- road,
- rail,
- air and
- water.

The highest consumption of energy is in road transport, followed by rail transport for passengers and goods. Inland air and water transport is limited to private and tourist trips.

The methods for calculating end-use energy savings in transport, depending on available data, are formulated on the basis of four indicators:

- specific energy consumption in road transport with regard to the equivalent number of private vehicles,
- specific energy consumption in rail freight transport in million ton-km
- specific energy consumption in rail passenger transport in million passenger-km and
- specific energy consumption of a private vehicle per 100 km.

2.3.1 METHOD 5: End-use energy savings in road transport (M 5)

Description of method

This method is intended to calculate energy savings in the consumption of energy (motor fuel) in road transport. The method is based on the indicator of specific energy consumption in road transport with regard to the equivalent number of private vehicles.

The method determines end-use energy savings on the basis of indicators of specific energy consumption per equivalent private vehicle in the observed year (t) relative to the base year (2007). The number of all road vehicles must be converted into the number of equivalent private vehicles based on coefficients that express the relationship between average annual fuel consumption by a certain type of vehicle (motor cycle, goods vehicle, bus) and consumption by a private vehicle.

End-use energy savings

Energy savings in road transport ($PKE_{P,\,cp}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$\mathrm{PKE}_{\mathrm{P,\,cp}} = \left(\frac{E_{2007}^{CP}}{\check{S}t_{2007}^{CP^{VOZekv}}} - \frac{E_{t}^{CP}}{\check{S}t_{t}^{CP^{VOZekv}}} \right) * \check{S}t_{t}^{CP^{VOZekv}} \quad \text{[GWh/year]} \qquad [149]$$

where:

$\mathrm{KE}_{2007}^{\mathrm{CP}}$:	energy consumption [GWh] in road transport in 2007,
$\mathrm{KE}_{\mathrm{t}}^{\mathrm{CP}}$:	energy consumption [GWh] in road transport in the observed year (t),
$\check{\mathrm{S}}\mathrm{t}_{2007}^{\mathrm{CP^{VOZekv}}}$:	number road vehicles [1000 x] in equivalent private vehicles in 2007 and
$\check{\mathrm{S}}\mathrm{t}_{\mathrm{t}}^{\mathrm{CP^{VOZekv}}}$:	number road vehicles [1000 x] in equivalent private vehicles in the observed year (t).

The total number of road vehicles, converted into the equivalent number of private vehicles based on the number of vehicles of an individual type in a given year and the coefficients of equivalent private vehicles for

specific types (the relationship between average fuel consumption of the specific type and private vehicle), is determined using the following equation:

$$\check{S}t_t^{CP^{VOZekv}} = \check{S}t^{ov} + k^{mk} * \check{S}t^{mk} + k^{bus} * \check{S}t^{bus} + k^{tov} * \check{S}t^{tov} \quad [150]$$

where:

$\check{S}t^{ov}$: number of private vehicles [1000 x],
$\check{S}t^{mk}$: number of motor cycles [1000 x],
k^{mk}: coefficient of the relationship between motor cycles and private vehicles,
$\check{S}t^{bus}$: number of buses [1000 x],
k^{bus}: coefficient of the relationship between buses and private vehicles,
$\check{S}t^{tov}$: number of goods vehicles [1000 x],
k^{tov}: coefficient of the relationship between goods vehicles and private vehicles.

Data requirements

Calculating energy savings with this method requires data on annual energy consumption (motor fuel) and the number of road vehicles by type of vehicle (motor cycles, private vehicles, buses, goods vehicles) for 2007 and the observed year (t).

Data on energy consumption in road transport and the number of vehicles are collected and published by the Statistical Office of the Republic of Slovenia (SORS).

To convert the number of vehicles to equivalent private vehicles (PV_{eqv}) the following values are used[74]:

- 1 motor cycle = 0.15 PV_{eqv},
- 1 bus = 15 PV_{eqv},
- 1 average goods (light and heavy) vehicle = 4 PVeqv.

The suggested coefficients for converting all types of vehicles into equivalent private vehicles thus amount to:

$k^{mk} = 0.15$
$k^{bus} = 15$
$k^{tov} = 4$

Other notes and features

The biggest problem in estimating energy consumption in road transport is presented by the share of fuel consumption by foreign vehicles (transit), which is vital in the data on fuel consumption in road transport. At a time when fuel prices in Slovenia are lower than prices in neighbouring countries, the share of consumption by transit vehicles and vehicles from the order areas of neighbouring countries is between 20 and 30% of total consumption, which can have a major influence on the calculation of energy savings.

[74] Source: European Commission - RECOMMENDATIONS ON MEASUREMENT AND VERIFICATION METHODS IN THE FRAMEWORK OF DIRECTIVE 2006/32/EC ON ENERGY END-USE EFFICIENCY AND ENERGY SERVICES, draft 2.7.2010

2.3.2 METHOD 6: Energy savings of private road vehicles (P8)

Description of method

The method for calculating energy savings in road transport for private vehicles is based on the indicator of the average consumption of private vehicles in road passenger kilometres.

The method determines energy savings based on the difference in the indicators of specific consumption by private vehicles in the base year (2007) and the observed year (t) and the average annual transport of passengers in private vehicles

Energy savings

Energy savings in road transport for private vehicles ($PE_{P,\ CP\text{-}ov}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$PE_{P,CP-OV} = \left(\frac{E_{2007}^{OV}}{P_{2007}^{OV}} - \frac{E_{t}^{OV}}{P_{t}^{OV}}\right) * P_{t}^{OV}$$ [GWh/year] [151]

where:

E_{2007}^{OV} - annual energy consumption (of motor fuel) by private vehicles [GWh] in 2007,

E_{t}^{OV} - annual energy consumption (of motor fuel) by private vehicles [GWh] in year (t),

P_{2007}^{OV} - annual passenger transport by private vehicle in passenger-km in 2007 and

P_{t}^{OV} - annual passenger transport by private vehicle in passenger-km in year (t).

Data requirements

Calculating energy savings with this method requires the following data for the base (2007) and observed (t) years:

- average specific energy consumption: average fuel consumption per 100 km for private vehicles running on petrol and gas oil,
- the average annual distance travelled by private vehicles,
- annual consumption of petrol and gas oil for private vehicles,
- the number of private vehicles on the road.

The data are not available, and they will need to be obtained (surveys etc.) and/or calculated (based on samples or modelling).

2.3.3 METHOD 7: Energy savings of private road vehicles (P8-A1)

Description of method

The method for calculating energy savings in road transport for private vehicles is based on the indicator of the average specific consumption of private vehicles in road transport. This method will be used instead of the previous method 8, only in the event that the necessary data on private road vehicles are available.

The method determines energy savings based on the difference in the indicators of specific consumption by private vehicles in the base year (2007) and the observed year (t) and the average annual distance travelled by private vehicles

Energy savings

Energy savings in road transport for private vehicles ($PE_{P,\ CP\text{-}ov}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$PE_{P,cp-ov} = \left(SE_{2007}^{ov_{spec}} - SE_{t}^{ov_{spec}}\right) \cdot \frac{Di_{t}^{pov.km.ov}}{100} \cdot \check{S}t_{t}^{ov} * K_{t} \quad \text{[toe]} \qquad [152]$$

where:

$SE_{2007}^{ov_{spec}}$: specific energy consumption of a private vehicle in litre/100 km in 2007,

$SE_{t}^{ov_{spec}}$: specific energy consumption of a private vehicle in litre/100 km in the observed year (t),

$Di_{t}^{pov.km.ov}$: the average distance [km/vehicle] travelled by private vehicles in the observed year (t),

$\check{S}t_{t}^{ov}$: number of private vehicles [1000 x] in the observed year (t) and

K_{t} : the average weighting coefficient for petrol and gas oil in the observed year (t).

The average weighting coefficient is calculated using the following equation:

$$K_{t} = \frac{\left(E_{t}^{ov^{bencin}} * F_{bencin}\right) + \left(E_{t}^{ov^{pl.olje}} * F_{pl.olje}\right)}{E_{t}^{ov}} \qquad [153]$$

where:

$E_{t}^{ov^{bencin}}$: annual consumption of petrol [ktoe] for private vehicles in the observed year (t),

$E_{t}^{ov^{pl.olje}}$: annual consumption of gas oil [ktoe] for private vehicles in the observed year (t),

F_{bencin} : conversion factor for petrol,

$F_{pl.olje}$: conversion factor for gas oil,

E_{t}^{ov} : total consumption of petrol and gas oil [ktoe] for private vehicles in the observed year (t),

The values of the conversion factors [koe/litre] for petrol and gas oil for calculating savings in (ktoe), are: F_{bencin} = 0.79 [koe/litre]

$F_{pl.olje} = 0.86$ [koe/litre]

Here we took into account the energy value (calorific value) and density of the petrol (43.85 MJ/kg, 0.755 kg/l) and gas oil (42.60 KJ/kg, 0.845 kg/l), and the energy savings are determined in ktoe.

Data requirements

Calculating savings with this method requires the following data for the base (2007) and observed (t) years:

- average specific energy consumption: average fuel consumption per 100 km for private vehicles running on petrol and gas oil,
- the average annual distance travelled by private vehicles,
- annual consumption of petrol and gas oil for private vehicles and
- the number of private vehicles on the road.

The data are not available, and they will need to be obtained (surveys etc.) and/or calculated (based on samples or in other ways).

2.3.4 METHOD 8: Energy savings of road freight vehicles (P9)

Description of method

The method for calculating energy savings in road transport for goods vehicles is based on the indicator of the average specific consumption of goods vehicles in road transport in ton-km.

The method determines energy savings based on the difference in the average specific consumption of energy by goods vehicles in the base year (2007) and the observed year (t) and the annual transport of goods by road in ton-km.

Energy savings

Energy savings in road transport for goods vehicles ($PE_{T,\ CP\text{-}TV}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$\boxed{PE_{T,CP-TV} = \left(\frac{E^{TV}_{2007}}{T^{TV}_{2007}} - \frac{E^{TV}_{t}}{T^{TV}_{t}}\right) * T^{TV}_{t}} \quad \text{[GWh/year]} \qquad [154]$$

where:

E^{TV}_{2007}: annual energy consumption (of motor fuel) by goods vehicles [GWh] in 2007,

E^{TV}_{t}: annual energy consumption (of motor fuel) by goods vehicles [GWh] in the observed year (t),

T^{TV}_{2007}: total road freight transport in million ton-km in 2007 and

T^{TV}_{t}: total road freight transport in million ton-km in the observed year (t).

Data requirements

Calculating energy savings with this method requires the following data for the base (2007) and observed (t) years:

- annual energy consumption (of motor fuel) by goods vehicles,
- total road freight transport in million ton-km,

The data are not available, and they will need to be obtained and/or calculated (based on samples or in other ways).

2.3.5 METHOD 9: Energy savings of road freight vehicles (P9-A2)

Description of method

The method for calculating energy savings in road transport for goods vehicles is based on the indicator of the average annual consumption of goods vehicles in road transport. This method will be used instead of method 9 only in the event that the necessary data on road freight vehicles are available.

The method determines energy savings based on the difference in the average annual consumption of energy by goods vehicles in the base year (2007) and the observed year (t).

Energy savings

Energy savings in road transport for goods vehicles ($PE_{TP,\ CP}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$PE_{\ TP,\ CP} = \left(\frac{E_{2007}^{TLV}}{\check{S}t_{2007}^{TV}} - \frac{E_{t}^{TV}}{\check{S}t_{t}^{TV}}\right) * \check{S}t_{t}^{LV} \quad \text{[GWh]} \qquad [155]$$

where:

E_{2007}^{TV}: annual energy consumption (of motor fuel) by goods (light and heavy) vehicles [GWh] in 2007,

E_{t}^{TV}: annual energy consumption (of motor fuel) by goods (light and heavy) vehicles [GWh] in the observed year (t),

Data requirements

Calculating savings with this method requires the following data for the base (2007) and observed (t) years:

- annual energy consumption (of motor fuel) by goods vehicles (light and heavy),
- total number of goods vehicles (light and heavy).

The data are not available, and they will need to be obtained and/or calculated (based on samples or in other ways).

2.3.6 METHOD 10: End-use energy savings in rail passenger transport (P10)

Description of method

This method is intended to calculate end-use energy savings in the consumption of energy in rail passenger transport.

This method determines energy savings based on the difference in the indicators of specific consumption of energy for rail passenger transport in the base year (2007) and the observed year (t).

End-use energy savings

Energy savings in rail passenger transport ($PKE_{P,\ žP\text{-}pot}$) in the observed year (t) relative to 2007 are determined using the following equation:

$$\mathrm{PKE}_{\mathrm{P},\ \check{Z}\mathrm{P\text{-}pot}} = \left(\frac{E_{2007}^{\check{Z}P-pot}}{P_{2007}^{\check{Z}P}} - \frac{E_{t}^{\check{Z}P-pot}}{P_{t}^{\check{Z}P}} \right) \cdot P_{t}^{\check{Z}P} \quad [\mathrm{GWh}] \qquad [156]$$

where:

$\mathrm{E}_{2007}^{\check{Z}P-pot}$: energy consumption [GWh] in rail passenger transport in 2007,

$\mathrm{E}_{t}^{\check{Z}P-pot}$: energy consumption [GWh] in rail passenger transport in the observed year (t),

$\mathrm{P}_{2007}^{\check{Z}P}$: total rail passenger transport in million passenger-km in 2007 and

$\mathrm{P}_{t}^{\check{Z}P}$: total rail passenger transport in million passenger-km in the observed year (t).

Data requirements

Calculating energy savings with this method requires data on annual energy consumption in rail passenger transport in 2007 and in the observed year (t).

Data on energy consumption and passenger transport by mode of transport (road, rail, air) are collected and published by the Statistical Office of the Republic of Slovenia (SORS). Energy consumption in rail transport by mode of transport (passenger or freight) is available from Slovenske železnice.

2.3.7 METHOD 11: End-use energy savings in rail freight transport (P11)

Description of method

This method is designed to calculate energy savings in the transport of goods by rail, and determines savings based on the difference in the indicators of specific consumption of energy for rail freight in the base year (2007) and the observed year (t).

End-use energy savings

Energy savings in rail freight transport ($PKE_{P,\ \check{z}P\text{-}tov}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$\boxed{PKE_{P,\ \check{Z}P\text{-}tov} = \left(\frac{E_{2007}^{\check{Z}P-tov}}{T_{2007}^{\check{Z}P}} - \frac{E_{t}^{\check{Z}P-tov}}{T_{t}^{\check{Z}P}} \right) * T_{t}^{\check{Z}P}} \quad \text{[GWh]} \qquad [157]$$

where:

$E_{2007}^{\check{Z}P-tov}$: energy consumption [GWh] in rail freight transport in 2007,

$E_{t}^{\check{Z}P-tov}$: energy consumption [GWh] in rail freight transport in the observed year (t),

$T_{2007}^{\check{Z}P}$: total rail freight transport in million ton-km in 2007 and

$T_{t}^{\check{Z}P}$: total rail freight transport in million ton-km in the observed year (t).

Data requirements

Calculating energy savings with this method requires data on annual energy consumption in rail freight transport in 2007 and in the observed year (t).

Data on energy consumption and freight transport by mode of transport (road, rail, air) are collected and published by the Statistical Office of the Republic of Slovenia (SORS). Energy consumption in rail transport by mode of transport (passenger or freight) is available from Slovenske železnice.

2.4 END-USE ENERGY SAVINGS IN MANUFACTURING

The methods for calculating end-use energy savings in manufacturing are formulated on the basis of two indicators:

- energy savings of the branch of industry relative to volume of output,
- energy savings of the branch of industry in terms of value added.

The methods are formulated to calculate end-use energy savings by individual subsector of manufacturing (branch of industry). Under the Standard Classification (2002), manufacturing activities[75] are divided in 13 subsectors falling under Directive 2006/32/EC[76]:

- D: Manufacturing

1) DA: Production of food, beverages and tobacco products
2) DB: Manufacture of textiles and textile and fur products
3) DC: Manufacture of leather and related products
4) DD: Production and processing of wood
5) DE: Manufacture of fibres and paper; publishing and printing
6) DG: Manufacture of chemicals, chemical products and synthetic fibres
7) DH: Manufacture of rubber and plastics products
8) DI: Manufacture of other non-metallic mineral products
9) DJ: Manufacture of metals and metal products
10) DK: Manufacture of machinery and equipment
11) DL: Manufacture of electrical and optical equipment
12) DM: Manufacture of vehicles and vessels
13) DN: Manufacture of furniture, other manufacturing activities, recycling

Subsector DF (manufacture of coke, petroleum derivatives and nuclear fuel) does not fall under Directive 2006/32/EC, because it is not treated statistically as end-use energy.

A new (revised) Standard Classification of Activities entered into force in 2008[77] (SKD 2008), and this replaced the previous classification (SKD 2002).

Manufacturing activities (C) are divided into 23 subsectors. Subsector C 19 (Manufacture of coke and petroleum derivatives) does not fall under Directive 2006/32/EC. These subsectors are as follows:

1) C 10: Manufacture of food products
2) C 11: Manufacture of beverages
3) C 12: Manufacture of tobacco products
4) C 13: Manufacture of textiles
5) C 14: Manufacture of wearing apparel
6) C 15: Manufacture of leather and related products
7) C 16: Manufacture of wood and of products of wood and cork, articles of straw and plaiting materials except furniture
8) C 17: Manufacture of paper and paper products
9) C 18: Printing and reproduction of recorded media
10) C 20: Manufacture of chemicals and chemical products
11) C 21: Manufacture of basic pharmaceutical products and pharmaceutical preparations
12) C 22: Manufacture of rubber and plastics products
13) C 23: Manufacture of non-metallic mineral products
14) C 24: Manufacture of basic metals
15) C 25: Manufacture of fabricated metal products, except machinery and equipment

[75] Decree on the Introduction and Application of the Standard Classification of Activities, Off. Gaz. RS, No. 2/2002.
[76] According to Directive 2006/32/EC, consumption of end-use energy by companies included in the Emissions Trading System (- ETS) IS NOT TAKEN INTO ACCOUNT IN END-USE ENERGY CONSUMPTION.
[77] Decree on the Standard Classification of Activities (Off. Gaz. RS No. 69/2007 and 17/2008).

16) C 26: Manufacture of computer, electronic and optical products
17) C 27: Manufacture of electrical equipment
18) C 28: Manufacture of other machinery and equipment
19) C 29: Manufacture of motor vehicles, trailers and semi-trailers
20) C 30: Manufacture of other transport equipment
21) C 31: Manufacture of furniture
22) C 32: Other manufacturing
23) C 33: Repair and installation of machinery and equipment

Consumption of end-use energy by companies included in the Emissions Trading System (ETS) is not taken into account in baseline end-use energy consumption.

To calculate energy savings for 2008 we need to use the classification of activities from SKD 2002, depending on the availability of data. In the coming years, as previous statistical data under the new classification (SKD 2008) become available, we will need to switch to the calculation of indicators according to the new classification.

2.4.1 METHOD 12: Energy savings in manufacturing, determined using the industrial output index (METHOD A-P14)

Description of method

This method is intended to calculate energy savings in the manufacturing sector by individual subsector on the basis of energy consumption and the industrial output index. The industrial output index is the relationship between the volume of industrial output in the observed year (t) relative to a given base year (e.g. 2007).

The relationship between consumed energy and the index of output in the observed year (t) represents the specific energy consumption for producing the same quantity of products as in the base year for determining the index. The difference in the relationship of energy consumption and the output index between the base year (2007) and the observed year (t) represents the change in energy consumption (positive or negative) for the same quantity of production in the industrial sector or subsector. The difference therefore represents the improvement or deterioration in efficiency of the observed subsector.

Industrial output indices are used relative to the same base year.

End-use energy savings

Energy savings in manufacturing ($PE_{ind,\ 1}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$\mathrm{PKE}_{\mathrm{ind},1}=\sum_{x=1}^{x=n}\left(\frac{E_{2007}^{I^x}}{IIP_{2007}^{I^x}}-\frac{E_t^{I^x}}{IIP_t^{I^x}}\right)*IIP_t^{I^x}*K_{2007}^{I^x}$$ [GWh] [158]

where:

$E_{2007}^{I^x}$:	energy consumption [GWh] in the individual industrial subsector (x) in 2007,
$E_t^{I^x}$:	energy consumption [GWh] in the individual industrial subsector (x) in the observed year (t),
$IIP_{2007}^{I^x}$:	the index of output in the individual industrial subsector (x) in 2007,
$IIP_t^{I^x}$:	the index of output in the individual industrial subsector (x) in the observed year (t),
$K_{2007}^{I^x}$:	the share of energy consumption in the individual industrial subsector (x) in 2007 that is not included in the Emissions Trading System (ETS),
$I^{\%}$:	industrial subsector or branch (DA, DB....DN) according to SKD 2002 or (C10, C11...C33) according to SKD 2008,
n:	the number of manufacturing subsectors is 13 according to SKD 2002 and 23 according to SKD 2008.

Data requirements

Calculating energy savings with this method requires data on annual energy consumption and industrial output indices by manufacturing subsector for 2007 and the observed year (t).

Data on total annual energy consumption and indices of industrial output by manufacturing subsector are collected and published by the Statistical Office of the Republic of Slovenia (SORS).

Other notes and features

Data on industrial output indices need to be used (with regard to the base year for calculating the index, SORS currently publishes indices relative to 2000). The index of output represents the relationship between production in a given year and production in the base year (in our case 2000).

2.4.2 METHOD 13: End-use energy savings in manufacturing, determined using value added (METHOD B-M8)

Description of method

This method for calculating energy savings in the manufacturing sector is designed to calculate end-use energy savings by individual subsector on the basis of energy consumption and value added, expressed in fixed prices.

This method is used in cases where data other than energy consumption and value added are not available. Value added must be expressed in fixed prices for a given reference year (e.g. 2000) and for a fixed currency rate (e.g. the fixed rate for 2007).

This method determines end-use energy savings by estimating the difference in the relationship between energy consumed and value added in the base year (2007) and the observed year (t).

End-use energy savings

With this method, energy savings in manufacturing ($PKE_{ind,\ 2}$) in the observed year (t) relative to the base year (2007) are determined using the following equation:

$$\mathrm{PKE}_{\mathrm{ind},2} = \sum_{x=1}^{x=n}\left(\frac{E_{2007}^{I^x}}{DV_{2007}^{I^x}} - \frac{E_t^{I^x}}{DV_t^{I^x}}\right)\cdot DV_t^{I^x}\cdot K_{2007}^{I^x} \text{ [GWh]} \qquad [159]$$

where:

$E_{2007}^{I^x}$:	energy consumption [GWh] in the individual industrial subsector (x) in 2007,
$E_t^{I^x}$:	energy consumption [GWh] in the individual industrial subsector (x) in the observed year (t),
$DV_{2007}^{I^x}$:	value added [EUR million] in the individual industrial subsector (x) in 2007,
$DV_t^{I^x}$:	value added [EUR million] in the individual industrial subsector (x) in the observed year (t),
$K_{2007}^{I^x}$:	the share of energy consumption in the individual industrial subsector (x) in 2007 that is not included in the Emissions Trading System (ETS),
$I^{\%}$:	industrial subsector or branch (DA, DB....DN) according to SKD 2002 or (C10, C11... C33) according to SKD 2008,
n:	the number of manufacturing subsectors is 13 according to SKD 2002 and 23 according to SKD 2008.

Data requirements

Calculating energy savings with this method requires data on annual energy consumption and value added by manufacturing subsector for the base (2007) and observed (t) years.

Data on total annual energy consumption and value added in fixed prices in the given year for a fixed euro rate by manufacturing subsector are collected and published by the Statistical Office of the Republic of Slovenia (SORS).

ANNEX A: EMISSION FACTORS

Source of energy/sector	Households	Service sector	Industry
FUELS			
Natural gas	0.20 kgCO2/kWhNG[78]	0.20 kgCO2/kWhNG	0.20 kgCO2/kWhNG
Extra light heating oil (ELHO)	0.26 kgCO2/kWhELHO[79]	0.26 kgCO2/kWhELHO	0.26 kgCO2/kWhELHO
Biomass (wood)	0.00 $kgCO2/kWh_{BIOMASS}$	0.00 $kgCO2/kWh_{BIOMASS}$	0.00 $kgCO2/kWh_{BIOMASS}$
Sectoral average for fuels	0.14 kgCO2/kWh[80]	0.25 kgCO2/kWh[81]	0.21 kgCO2/kWh[82]
HEATING ENERGY[83]			
Sectoral average	0.17 kgCO2/kWh	0.27 kgCO2/kWh	-
Broad consumption - average	0.19 $kgCO_2/kWh$		-
Sectoral average for heating (excluding electric heating)	0.15 $kgCO_2/kWh$	0.21 $kgCO_2/kWh$	-
ELECTRICITY			
Electricity kWh_{el}[84]	0.55 $kgCO_2/kWh_{el}$	0.55 $kgCO_2/kWh_{el}$	0.55 $kgCO_2/kWh_{el}$
DISTRICT HEATING[85]			
District heating	0.28 kgCO2/kWh	0.28 kgCO2/kWh	0.28 kgCO2/kWh

Emission factors for transport (motor fuel):

Type of fuel	Emission factors[86]
Automotive petrol	69.2 tCO2/TJ or 249.1 gCO2/kWh
Gas oil	74.0 tCO_2/TJ or 266.4 gCO_2/kWh

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78 Emission factor for natural gas; source: UNFCCC/ARSO 2009.
79 Emission factor for extra light heating oil (ELHO); source: UNFCCC/ARSO 2009.
80 Average emission factor for 2006-2008 for fuel consumed in households; source: ARSO - emission records
81 Average emission factor for 2006-2008 for fuel consumed in the sector other consumption (services, public sector); source: ARSO - emission records
82 Average emission factor for 2006-2008 for fuel consumed in industry; source: ARSO - emission records
83 In addition to fuels, energy for heating includes district heating and electricity. The share of electricity consumption for heating (excluding sanitary water heating) in total electricity consumption amounts to (IJS model estimate) 9% in households and 5% in the service sector (other consumption).
84 Emission factor in electricity generation at power plants (average of different operating sources); source: IJS (Average emissions in electricity supply 2006-2008, methodology VEM-base Tool).
85 source: IJS (Average emissions in district heating supply 2006-2008, methodology VEM-base Tool).
86 Default baseline values for motor fuels; source: IPPC Guidelines from 2006.

ANNEX B: LIFETIME OF MEASURES TO IMPROVE ENERGY EFFICIENCY

Arranged according to: Preliminary list of harmonised average lifetimes of energy efficiency improvement measures and programmes for bottom-up calculations, Commission, June 2009

Measures by sector		Lifetime of measure [in years]	No of measure
Households sector			
1	Thermal insulation of the exterior shell of buildings, installation of exterior building fixtures (windows/panes, doors)	30	1, 3
	New constructions		
2	Boilers	20	1, 2, 5
3	Regulation of heating (timers, thermostats and thermostat heads on radiator valves), hydraulic balancing of central heating in buildings, split meters for heating costs	10	9
4	Systems for exploiting waste heat	17	23
5a	Heat pumps (air-water) for heating sanitary water (replacing el. boiler)	15	6
5b	Heat pumps (ground-water, water-water)	25	1, 2, 7
6	Construction of new or refurbishment of common heating system for several buildings	30	/
7	Solar heat collectors for heating sanitary water and heating support	20	8
8	Energy-efficient cooling appliances (refrigerators, freezers etc.)	15	19
9	Energy-efficient cleaning appliances (dishwashers, washing and drying machines etc.)	12	19
10	Energy-efficient (compact) fluorescent lights (for house/domestic use)	6	17

Public/service sector			
11	Thermal insulation of the exterior shell of buildings, installation of exterior building fixtures (windows/panes, doors)	30	1, 3
	New constructions		
12	Systems for exploiting waste heat	20	23
13	Heat pumps (ground-water, water-water)	25	1, 2, 7
14	Energy-efficient devices for cooling and air conditioning	17	/
15	Efficient ventilation systems (mechanically controlled system for removing waste air, pre-heating of fresh air etc.)	15	/
16	Energy-efficient lighting systems	12	17
17	Energy-efficient street and public lighting	15	18
18	Individual boilers and boiler units for common heating	25	/
19	Energy audits	5	12
20	Introducing energy management systems	5	25
Industrial sector			
21	Energy-efficient electric motors	12	21
22	Energy frequency converters	12	22
23	Efficient pumping systems in industrial processes	15	21
24	Efficient systems for preparing compressed air	15	21
25	Systems for exploiting waste heat	15	23
26	Energy-efficient lighting systems	12	17
27	Energy audits	5	12
28	Introducing energy management systems	5	25

ANNEX C: EUROPEAN COMMISSION RECOMMENDATIONS FOR USING METHODS TO CALCULATE ENERGY SAVINGS