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Green*Net*-Incentives

Promoting grid-related incentives for large-scale RES-E integration into the different European electricity systems

Deliverable D6b

Report on Energy Efficiency (EE) potentials and costs for several major 35 European countries

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1 INTRODUCTION

The core objective of the project **GreenNet-Incentives** is to promote grid-related incentives for large-scale RES-E integration into different European electricity systems (and taking also into consideration energy efficiency (EE) implementation), to identify existing non-technical barriers for RES-E grid integration, and to actively involve key European market actors in the discussion process towards "green" electricity grids. This is mainly done by organising expert platforms, stakeholder consultation, training/education workshops and summer schools. The major products of this project are tailor-made recommendations and actions plans for several key market actors to establish a common European vision on the implementation of grid-related policies favouring "green" electricity networks.

Within work package 2 the existing database on RES-E and EE potentials and cost developed within the predecessor IEE-project **GreenNet-EU27** has been updated and extended to cover several countries addressed in the present project:

– existing: EU-27 Member States, Norway, Switzerland, Croatia
– newly added: remaining Balkan countries Albania, Bosnia and Herzegovina, Macedonia, Montenegro, Serbia and Turkey

The database on RES-E and EE potentials and costs contains basic input data used for the software tool **GreenNet-Europe**.

This report (Deliverable D6b) gives an overview on potentials and cost of EE for several countries mentioned above.[1] Besides this report a data base (Deliverable D5b) and a PPT presentation (Deliverable D7b) is available for download on the project website www.greennet-europe.org.

The report is organised as follows:

- In chapter 2 the basics and background information for the determination and implementation of potentials and cost of Energy Efficiency (EE) measures are presented. After the description of the analytical framework for the model implementation into **GreenNet-Europe** an overview on already existing empirical data on potentials and cost for Energy Efficiency (EE) in the EU-27 Member States is presented.
- In chapter 3 an overview on the newly derived empirical data on potentials and costs for Energy Efficiency (EE) measures in the Western Balkan Countries (Albania, Bosnia and Herzegovina, Croatia, Macedonia, Montenegro, Serbia) and Turkey is presented.
- The references include selected data sources used in predecessor projects **GreenNet** and **GreenNet-EU27** and most relevant sources describing Energy Efficiency (EE) potentials and cost in the newly added Western Balkan countries and Turkey.
- Annex I provides detailed background information and prospects for energy savings as well as implemented (or intended) efficiency policies, legislation, funds and programs in each of the newly added Western Balkan countries and Turkey.
- Finally, Annex II summarizes the methodological approach of the major energy efficiency support schemes covered by **GreenNet-Europe**.

[1] There exists a similar report on the potentials and cost on RES-E for several 35 European Countries.

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2 POTENTIALS AND COSTS FOR ENERGY EFFICIENCY (EE) IN EU-27+ COUNTRIES

2.1 Robust information about electricity demand

2.1.1 Trade-off between supply and demand

On contrary to the electricity supply curve (see report on RES-E potentials and cost in detail; Deliverable 6a), information about electricity demand is usually less reliable. In general, electricity demand depends on the unit price of electricity, the country (region), time (demand changes over time) and, furthermore, the portfolio of electricity generation technologies as well as policy instruments influencing the wholesale electricity market price (e.g. CO_2 trading, etc.).

The only robust information is – besides historical demand/consumption – actual demand.[2] The marginal unit price of electricity (market price p_M) is given by the intersection of the supply curve with demand q_{el}, see Figure 2.1.

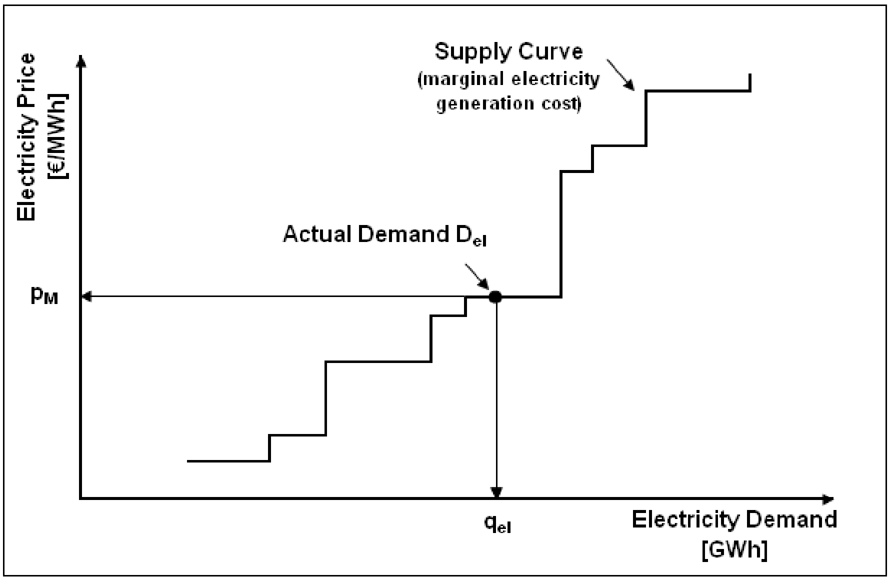

Figure 2.1. Robust information about electricity supply and demand

2.1.2 Characteristics of the electricity demand-curve

The character of the continuous demand curve is depicted in Figure 2.2 below. There are a few qualitative features known about the demand curve:

- In general, electricity demand decreases if electricity prices increase (negative price elasticity). This is true in the short-term as well as in the long-term. In the short-term, the services level is reduced whereas in the long-term investments into energy efficiency technologies are conducted to reduce specific electricity demand.
- The value of price elasticity depends on the absolute price level and, furthermore, whether electricity prices increase or decrease. In general, price elasticity is lower if prices decrease. The reason is that it is not sensible to reverse already implemented

[2] I.e., total electricity demand of several customers and, sometimes, also electricity demand for different customer groups (e.g. industrial customers being equipped with own electricity metering systems).

demand side energy efficiency benefits, e.g. if the industrial customer replaced an inefficient cooling system by purchasing an efficient one and then the electricity unit price decreases, the consumer will still use the new, efficient cooling system.

Total electricity demand can be changed due to both short-term service level adjustment and long-term implementation of demand side energy efficiency measures, see Figure 2.2.

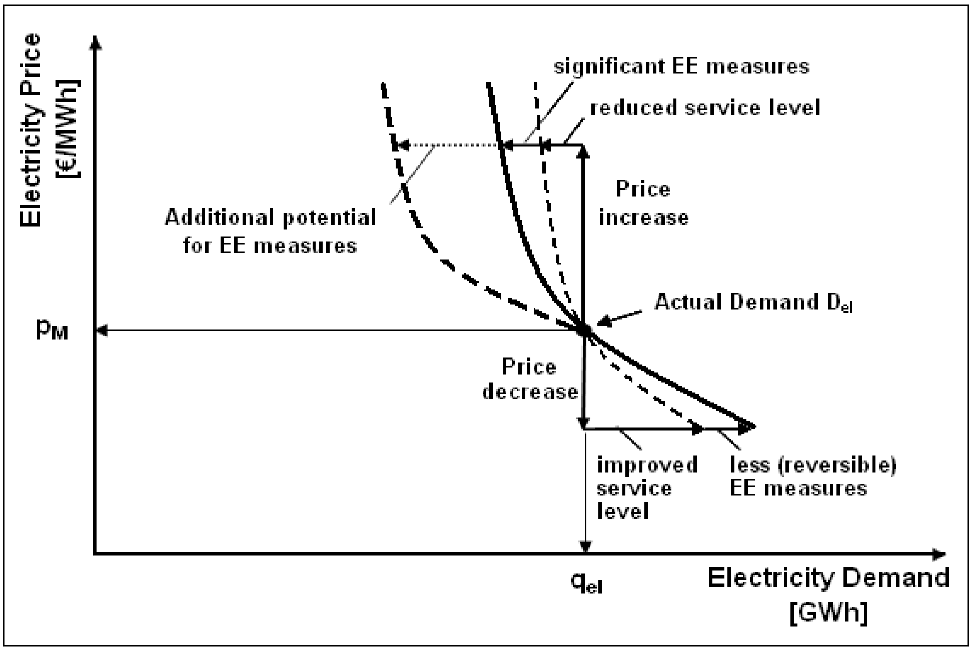

Figure 2.2 Characteristics of the continuous demand curve

In the modelling approach (see section 2.2 in detail) the following effects on the demand curve are considered:

(i) electricity demand changes (increases) with time,
(ii) (service) demand adjustment due to short-term electricity price changes, and
(iii) demand changes due to long-term energy efficiency technology implementation on the demand-side.

2.1.3 Rational for the implementation of demand side energy efficiency measures

On a strictly economic basis, the motivation for the implementation of demand side energy efficiency technologies is to achieve an overall reduction of the total cost of energy services in the long-term. Furthermore, wider effects can be achieved:

- protection of the environment through the reduction of emissions,
- competitiveness of the economy, through the reduction of the national energy bill,
- security of supply, lowering the dependence from countries which export fossil fuels and
- finally, as a consequence of the above, increased employment and consumers' welfare.

Notably, these "side-effects" mentioned above are all included in the major objectives of EU energy policy.

Typical energy efficiency technologies to be considered in several sectors on the demand side (household, industry, tertiary) are:

- installation of efficient appliances or lighting devices,
- insulation measures,
- control system,
- fuel switching (*only in case of reduction of primary energy consumption)*.

2.2 Analytical framework and model implementation

In this section, we explain after an introductory overview the 4 different steps on how to determine the dynamic electricity demand curves.

- Step 1: strategic review;
- Step 2: information required for the demand database;
- Step 3: criteria for setting the cost level for using energy saving technologies;
- Step 4: development of the electricity demand curve.

2.2.1 Basic concept

In contrast to RES-Electricity generation capacities, electricity demand is not fully specified from data within the **Green*Net*-Europe** toolbox. Consequently, specific details of the total electricity demand have to be entered exogenously.[3] This allows flexibility, so users of the software can change the suggested demand forecast (i.e. default value) for their own simulation runs. Nevertheless, electricity demand can be influenced within the toolbox due to the consideration of demand-side activities.

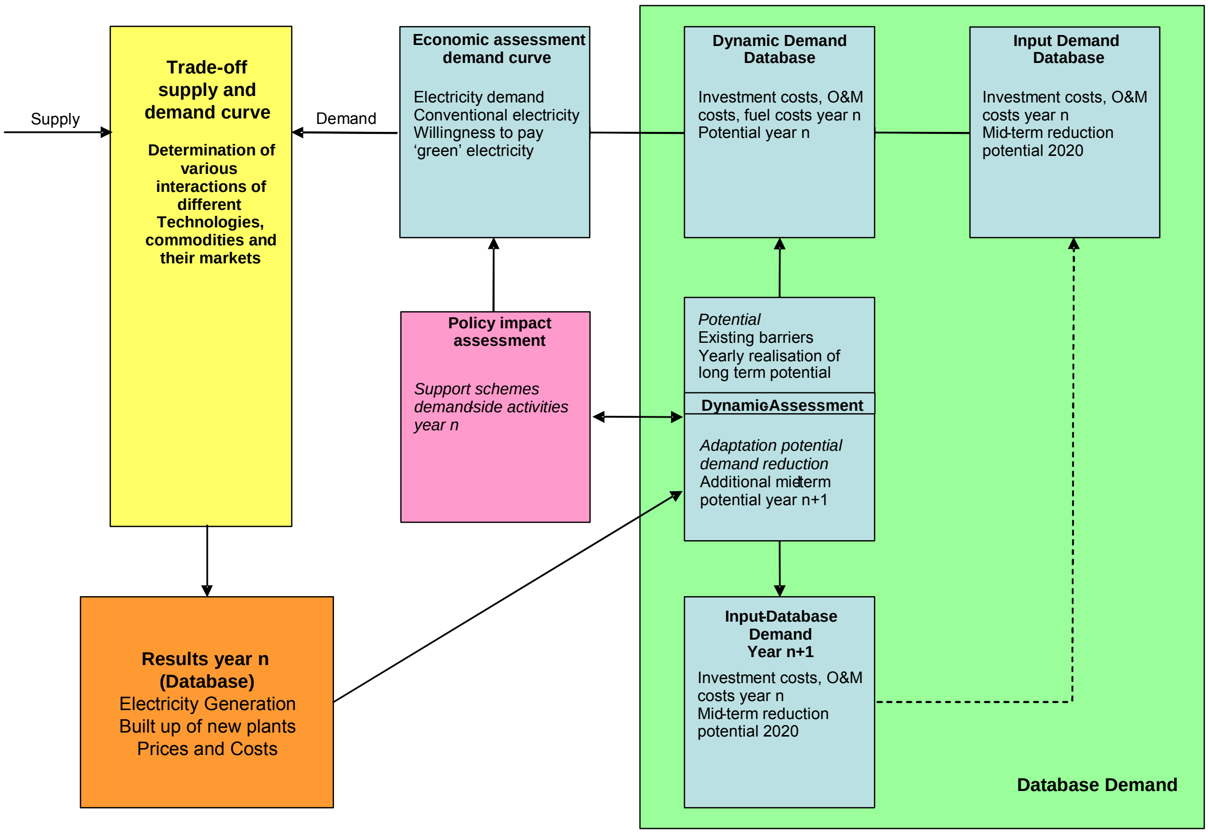

Figure 2.3 Overview of creating dynamic demand curves for electricity generation

Dynamic demand curves for different groups of technology in each country are developed within the **Green*Net*-Europe** toolbox. They are characterised as follows:

- o the price level at which it is rational to use energy saving technologies and
- o the potential for this electricity savings.

[3] The default electricity demand forecast in the **Green*Net*-Europe** toolbox is based on "European Energy and Transport Trends to 2030" (DG TREN - Mantzos et al (2003)).

Both can change year by year. In contrast to the supply side, the magnitude of these changes is given exogenously (as costs) and endogenously in the model (as potential), i.e. the differences in the values compared with the previous year depend on the outcome of the simulated year. The procedure for deriving the dynamic cost curve takes place on four levels, see Figure 2.3.

(i) Determination and calculation of the "input demand database"

For simulating the first year (i.e. year 2004), the **GreenNet-Europe** program goes back to the "input demand database". This database contains information according to technology group within the different sectors (e.g. households, industry and tertiary) and the different countries. This information includes potential electricity savings when using standard technology. Key information includes (i) investment costs, (ii) O&M costs, (iii) electrical efficiency, (iv) full-load-hours, and (v) additional potential of electricity saving to year 2020. For years beyond 2020, the "input demand database" becomes the "adapted input demand database". This database considers the simulation results with respect to the available long-term potential; see step (iv) below.

(ii) Derivation of "dynamic demand database" for the simulation year

The dynamic database for the simulation year is derived by combining the "input demand database" with dynamic parameters, which can be varied or adapted within the model for each year.[4] This dynamic database contains technology-specific information about the electricity price at which (a) it is cost effective to use electricity saving technologies and (b) the possible potential for electricity demand reduction for the simulated year. The detailed procedure deriving the cost-resource curve is described in a following sub-section.

(iii) Consideration of policy support and economic assessment

Before the analysis of the interaction of different promotion schemes and market conditions, a further adaptation of the 'dynamic' demand curve is necessary, namely an economic assessment of the demand curve. Within this step, a possible technology and country-specific policy support mechanism will be considered. In general, such a mechanism reduces the electricity price at which it becomes economic to use the electricity saving technology as compared with the standard technology.

(iv) Adaptation of the "input demand database"

At the end of the simulation run for the year n, the "input demand database" for the following year (n+1) is created by adapting the "input demand database" for the year n. Changes are necessary with respect to the remaining additional electricity saving potential. It must be reduced if part of this potential has already been achieved in the simulated year n. As already mentioned, this adapted "input demand database" serves as a starting point for the subsequent year, see step (i).

Before explaining the single steps in more detail, the empirical data requirements for the demand side will be described.

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[4] These values are available as time-series in a country and technology specific database.

2.2.2 Necessary data

In general, derivation of empirical data for calculating the electricity demand curve is less complex than for the supply-side. On the demand-side, only two categories of data clusters on electricity saving potentials and cost are needed:
(i) by country,
(ii) by technological or economic band.

Country-specific data are characterised by being, valid for all the technologies considered, but varying between different countries and over time. For the derivation of the demand curve, only few data on country level are necessary, see Table 2.1.

Table 2.1 Summary of country-specific data

Parameter	**Aim is to determine…**
Total electricity demand (scenario 1)	Electricity demand for baseline scenario
Total electricity demand (scenario 2)	Electricity demand for CO_2 stabilisation scenario
Total electricity demand (scenario 3)	Electricity demand for Kyoto scenario
Price elasticity	Electricity demand for one country
Investor behaviour / interest rate	Electricity demand for one country
Total heat demand from CHP	CHP demand / capacity

Due to the wide variety of applicable energy saving technologies, most parameters are determined for the particular technology band. In contrast to the supply-side, DSM activities that have already been implemented are <u>not</u> considered, except implicitly through the sector-specific electricity demand. This means that only the energy saving potential and the price at which its implementation is economic, will be derived for new measures.

Table 2.2 Summary of band-specific data

Band Parameters	**Input (In) / Out-put (Out) data**	**Aim is to calculate…**
Technology parameter		
(Minimum) lifespan of energy saving technology	In	Capital recovery factor for energy saving technology
(Minimum) lifespan of alternative technology	In	Capital recovery factor for energy saving technology
Cost parameter		
Investment costs of energy saving technology per output	In	Electricity price where DSM measure is economical
Investment costs of alternative technology per output	In	Electricity price where DSM measure is economical
Operation and maintenance costs independent of electricity consumption of energy saving technology per output	In	Electricity price where DSM measure is economical
Operation and maintenance costs independent of electricity consumption of alternative option per output	In	Electricity price where DSM measure is economical
Payback time of energy saving technology	In	Electricity price where DSM measure is economical
Payback time of alternative technology	In	Electricity price where DSM measure is economical
Interest rate	In	Electricity price where DSM

		measure is economical
Level of electricity price where DSM measure is economical (willingness to invest)	Out	Electricity price where DSM measure is economical
Potential parameter		
Electricity consumption per unit output	In	The mid-term energy saving potential
Electricity consumption per unit output of alternative technology	In	The mid-term energy saving potential
Electricity saving potential per unit output	In	The mid-term energy saving potential
Dynamic restriction of yearly implementation	In	Link with dynamic restriction calculation tool
Mid-term energy saving potential compared to BAU scenario	Out	The annual energy saving potential
Electricity saving potential year n	Out	The maximal energy saving potential of the band for the simulation year n

Figure 2.4 summarises the demand side data-structure. In contrast to the supply side, only country- and band-specific data are required.

Country Specific Data

Country level	Country A											
Sector level	Sector 1 (Industry)				Sector 2 (Residential)				Sector 3 (Tertiary)			
End-use level	End use 1	End use 2	...	End use m	End use 1	End use 2	...	End use m	End use 1	End use 2	...	End use m
Band level	Band 1	Band 1	...	Band 1	Band 1	Band 1	...	Band 1	Band 1	Band 1	...	Band 1
	Band 2	Band 2	...	Band 2	Band 2	Band 2	...	Band 2	Band 2	Band 2	...	Band 2
	...	...	...	...	...	...	...	...	...	...	...	...
	Band n	Band n	...	Band n	Band n	Band n	...	Band n	Band n	Band n	...	Band n

Country level	Country B											
Sector level	Sector 1 (Industry)				Sector 2 (Residential)				Sector 3 (Tertiary)			
End-use level	End use 1	End use 2	...	End use m	End use 1	End use 2	...	End use m	End use 1	End use 2	...	End use m
Band level	Band 1	Band 1	...	Band 1	Band 1	Band 1	...	Band 1	Band 1	Band 1	...	Band 1
	Band 2	Band 2	...	Band 2	Band 2	Band 2	...	Band 2	Band 2	Band 2	...	Band 2
	...	...	...	...	...	...	...	...	...	...	...	...
	Band n	Band n	...	Band n	Band n	Band n	...	Band n	Band n	Band n	...	Band n

Figure 2.4 Data base structure in the **Green*Net-Europe*** simulation tool quantifying potentials and cost of energy efficiency measures on the demand side

2.2.3 Analytical framework: willingness to invest in demand-side measures

In the **Green*Net*-Europe** toolbox, consumers are assumed to invest in energy saving technologies if these investments are cost effective for them. Consequently, per unit output produced,[5] the total life-cycle cost of the energy saving technology must be less than, or at least equal to, the total life-cycle cost of the equivalent energy demand scenario. In general, accepting the energy saving option as the most cost effective one depends on the electricity price. Moreover, if electricity prices decrease, then the energy saving technology becomes less economic. The willingness to invest into an energy saving technology is characterised by the electricity price level where both energy saving option due to energy efficiency technology and the status quo are equally in economic terms. The formal criterion is given

[5] Output may be, for example, per tonne of steel, or per luminous intensity, per GJ mechanical energy.

below, on the left-hand-side for the 'standard' technology and the right-hand-side for the 'alternative' energy saving technology:

$$p_e * q_{el} + I * CRF + C_{O\&M\ Nel} = p_e * q_{A\ el} + I_A * CRF_A + C_{A\ O\&M\ Nel}$$

where:

p_e .... Minimum electricity price level where the energy efficiency technology is economic, i.e. the so-called “switch price” [€/MWh]
q_{el} .... Electricity consumption per unit output produced [MWh/output]
I .... Investment costs of energy efficiency technology per unit output produced [€/output]
CRF .... Capital recovery factor: $CRF = \frac{z * (1+z)^{PT}}{\left[(1+z)^{PT} - 1\right]}$
z .... Annual interest rate
PT .... Life time of energy saving technology [y]
$C_{O\&M\ Nel}$ .... O&M cost being independent of electricity consumption per unit output energy saving technology [€/output]
q_{Ael} .... Electricity consumption of existing or of alternative energy saving technology, per unit output [MWh/output]
I_A .... Investment cost of alternative energy saving technology per unit output [€/output]
CRF_A .... Capital recovery factor of alternative technology: $CRF_A = \frac{z * (1+z)^{PT_A}}{\left[(1+z)^{PT_A} - 1\right]}$
PT_A .... Life time of the alternative technology [y]
$C_{A\ O\&M\ Nel}$ ... alternative technology O&M cost being independent of electricity consumption, per unit output [€/output]

Hence, the electricity price level – so-called “switch price” or “WTI” (willingness to invest into energy efficiency technology) – triggering the new investment is as follows:

$$WTI = p_e = \frac{(I * CRF - I_A * CRF_A) + (C_{O\&M\ Nel} - C_{A\ O\&M\ Nel})}{q_{Ael} - q_{el}}$$

Note, that the switch price calculated is based purely on the cost of the energy efficiency measures and does not include non-economical barriers. This fact will be reflected by the final results of the simulation.

Note further, that important parameters such as investment cost or O&M cost are normalised per unit output produced:

- Investment Cost: The investment cost for different energy efficiency technologies differ by technology and sub-sector (end-use). In addition, technological development of almost all energy efficiency technologies is still not mature. Moreover, the unit investment cost can be expected to decrease over time. Therefore, it is reasonable to attempt a ‘learning curve approach’ for each energy efficiency technology option. Starting with the currently published investment cost of already available energy efficiency technologies, future investment cost for subsequent years are calculated by forecasts made also in previous studies (e.g. MURE (2003)). For remaining energy efficiency technologies the investment cost are assumed to be constant.
- Capital recovery factor: As lifespan varies considerable between different energy saving technologies, the cost assessment of the investment cost is effected, too.

2.2.4 Modelling demand side energy efficiency measures

In general, electricity demand changes over time. Therefore, different exogenous electricity demand scenarios are implemented in the **GreenNet-Europe** model, considering the general economic, political and social conditions. The Business as usual (BAU) scenario published by the European Commission (DG TREN 2003) is used as a baseline, reflecting the currently implemented policies and trends in the EU Member States. Whereas the data for the electricity demand forecast are implemented exogenously by an external demand scenario energy efficiency measures are modelled by relative changes (details are described below).

Concerning short-term changes of the service level it is assumed that (i) these changes are characterised by different price elasticity and (ii) price elasticity does not vary with unit price. However, both the elasticity and the unit price can vary by time and country. Please note that – due to clearness – in this paper neither analysis of short-term service level adjustments due to price changes nor behavioural effects (e.g. rebound-effect etc.) are presented.

Whereas short-term adjustments of service demand due to electricity price changes are modelled by varying price elasticity, long-term effects on the demand curve are modelled – similar to the supply curve – as a stepped (discrete) function, see Figure 2.5. On the left-hand side in Figure 2.5 a continuous static demand curve is depicted. The stepped (discrete) function on the right-hand side in Figure 2.5 represents the modelled static demand curve. Thereby, different end-uses in different sectors (households, industry, tertiary) are described by different steps ("bands").

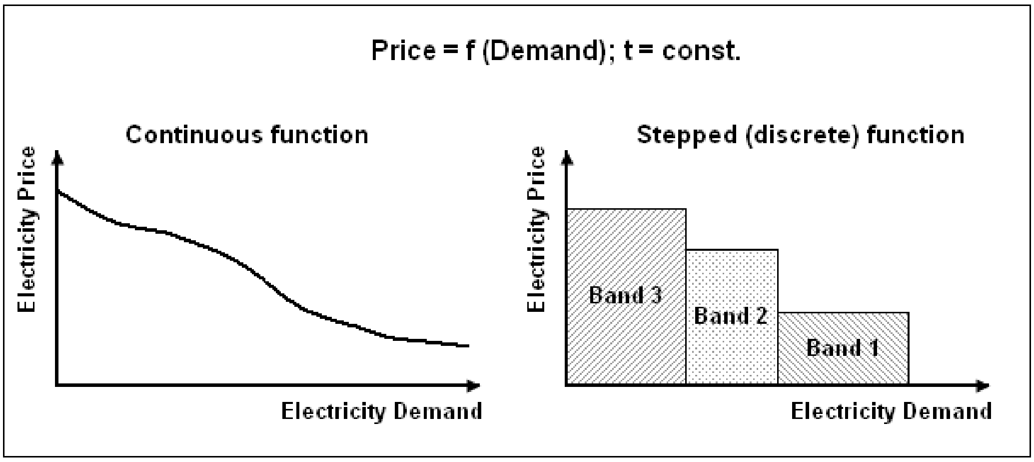


Figure 2.5 Static demand curve: Continuous (left-hand side) and stepped function (right-hand side).

Figure 2.6 below depicts the static stepped demand curve as a function of the electricity price. "Static" in this context means that the technical potential and the corresponding cost for implementation of different demand-side energy efficiency options refers to the total electricity saving potential up to 2020, i.e. the static stepped demand curve represents the relationship between the long-term energy saving potential (= potential of reduced demand) and the price where this potential will be utilized. Similar to the stepped supply curve, the different potentials are scheduled with increasing electricity prices. The economic potential being finally implemented in practise depends on the absolute electricity price level and, furthermore, on the design of additional financial policy instruments. It is assumed, furthermore, that several energy efficiency measures allocated below the electricity price p_M are already implemented, see Figure 2.6.

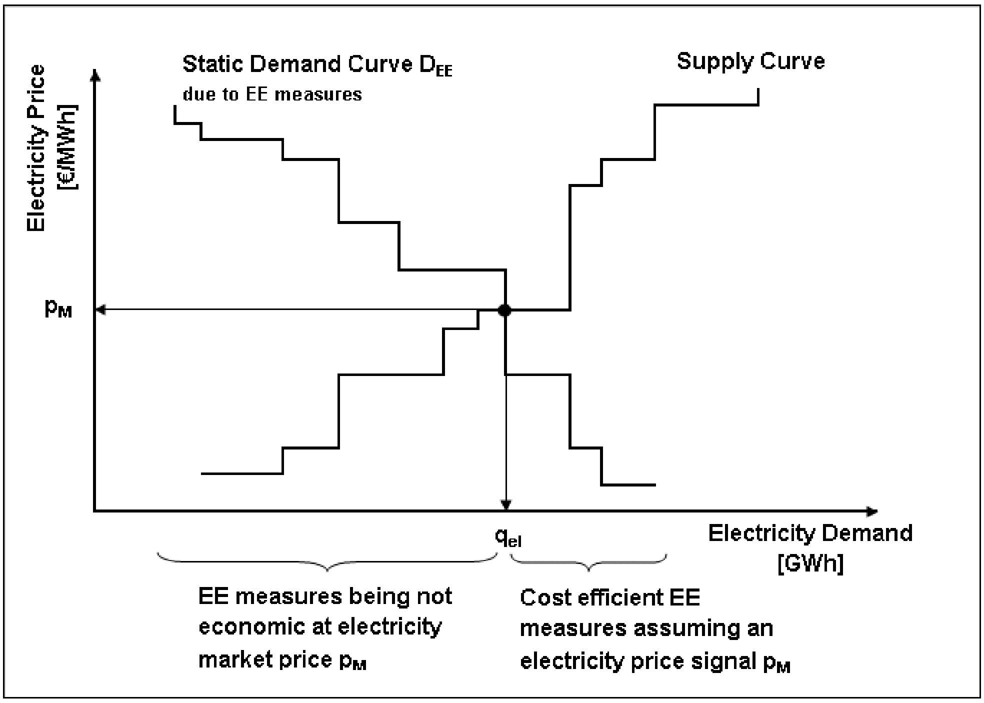


Figure 2.6 Stepped static demand curve as a function of the electricity unit price

Due to the fact that in the **Green*Net*-Europe** model the total electricity demand is an input parameter, demand-side savings represents the reduction compared to the demand level without demand-side activities. Hence, electricity savings represents a negative incremental demand in the model: the energy saving curve must be shifted to the negative x-axis, see Figure 2.7 below.

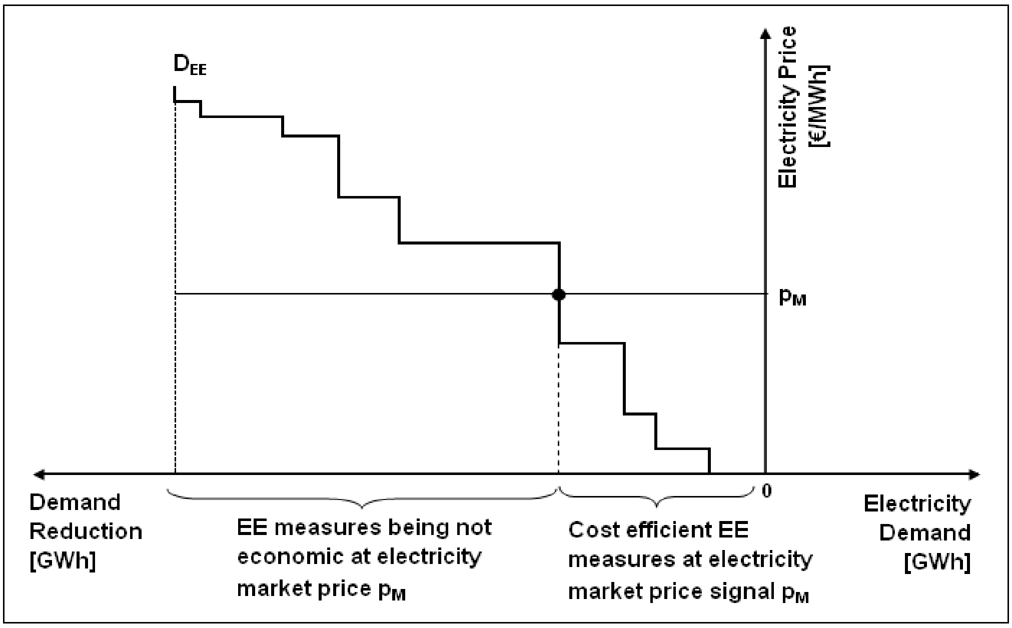


Figure 2.7 Modelling the static stepped demand curve as a negative demand

In practice, however, only parts of the long term energy saving potential can be exploited within a year. Therefore, dynamic assessments must be conducted. Figure 2.8 depicts these dynamic assessments schematically; the total curve represent the long-term energy saving potential up to the year 2020, the bolded parts the additional annual potential which can be utilized in the next year for each technological energy saving option (each band). Obviously, the available potential varies among the different technologies and over time, i.e. the utilizable yearly electricity saving potential is a function of the time. Figure 2.9 finally presents the dynamic energy saving curve for year n, created by adding the bolded parts in Figure 2.8.

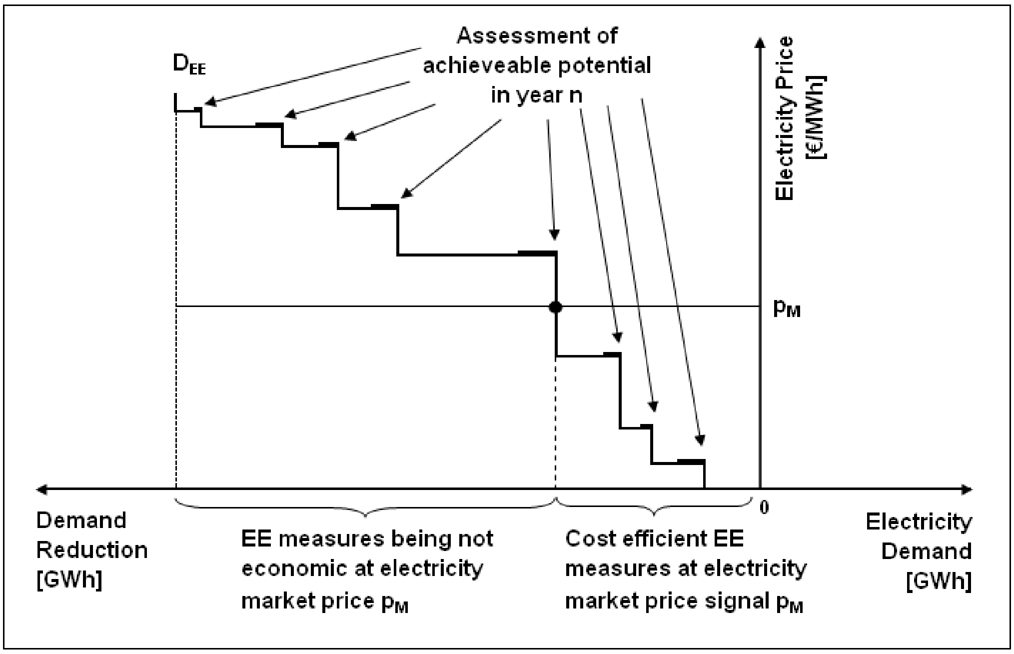


Figure 2.8 Dynamic demand curve assessing the additional annual energy saving potential in year n

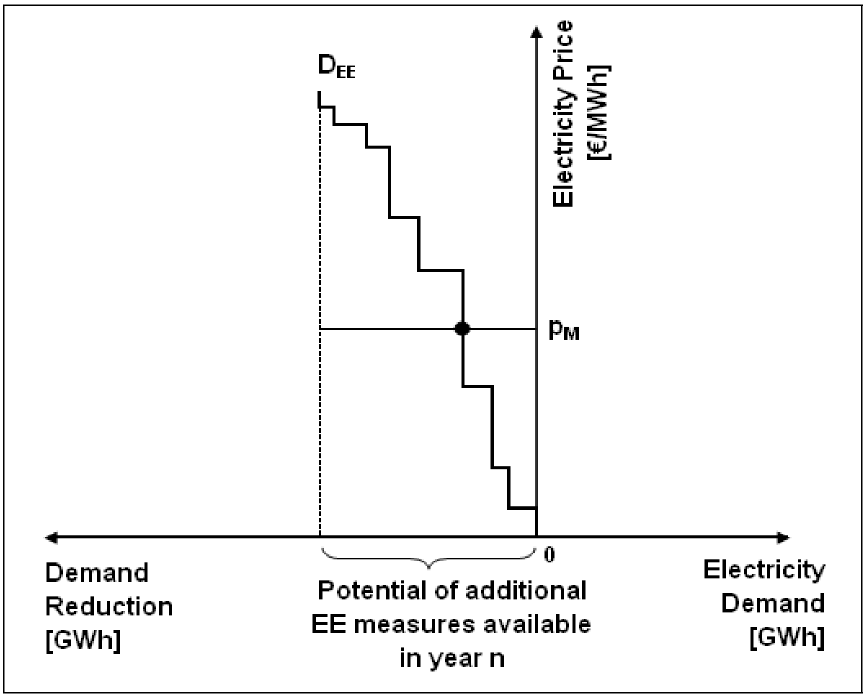


Figure 2.9 Dynamic demand curve due to demand-side energy efficiency technologies for year n

2.2.5 Modelling different policies promoting demand-side energy efficiency measures

Different (financial) policies promoting demand-side energy efficiency measures can influence both the absolute level of the potentials as well as the costs. The following price-driven and demand-driven promotion schemes are considered in the **Green*Net*-Europe** toolbox:

- Price-driven: - Tax incentives
  - Investment subsidies
  - Granted tariffs
- Demand-driven: - Demand quota
  - Standards

Figure 2.10 demonstrates how a financial promotion instrument (e.g. investment subsidy, tax incentive on investment) influences the dynamic demand curve for the investigated year n. A unique financial support per MWh reduces the necessary electricity price level where the switch from the standard to the energy saving technology is economic rational for each technology (band) by a constant level. A comprehensive description of the amendments of the analytical framework determining the WTI (willingness to invest into energy efficiency technologies) and incorporating the different price-driven and demand-driven instruments, which can be implemented within the **Green*Net*-Europe** software is conducted in the Appendix II.

The annual trade-off between generation and the dynamic demand curve (incl. financial promotion instrument) for year n – as implemented in the **Green*Net*-Europe** software - are presented in Figure 2.11. The promotion of demand-side reduction activities causes two effects: Firstly, electricity demand decreases, leading, secondly, to a lower power price. In other words, demand-side policy influences both, demand and electricity price.

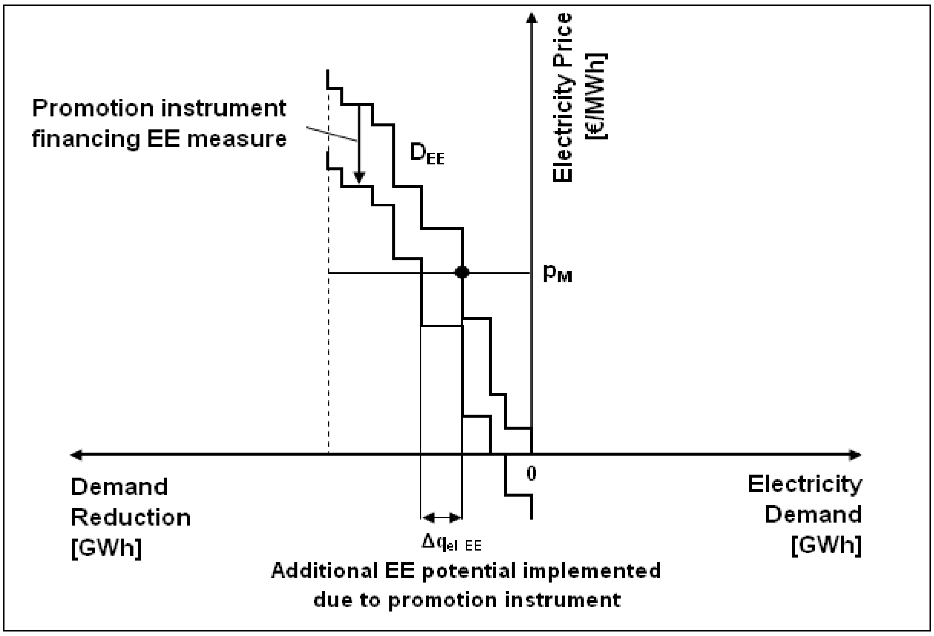


Figure 2.10 Dynamic demand curve due to demand-side energy efficiency technologies (incl. financial promotion instrument) in year n

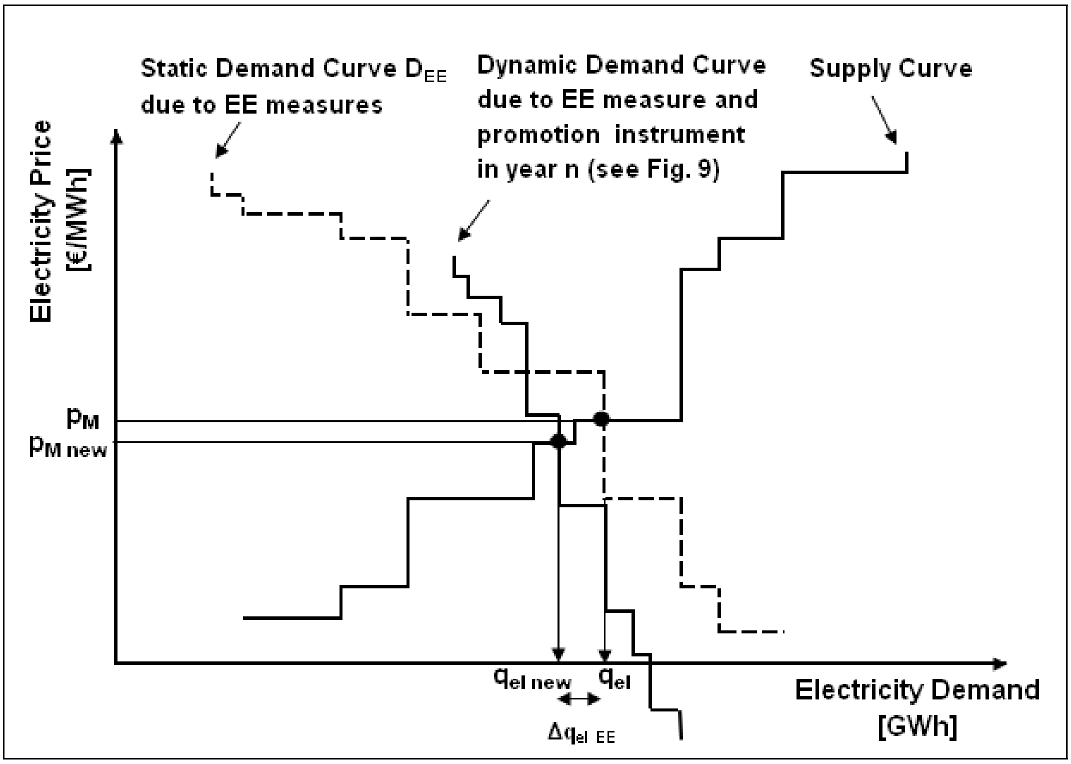


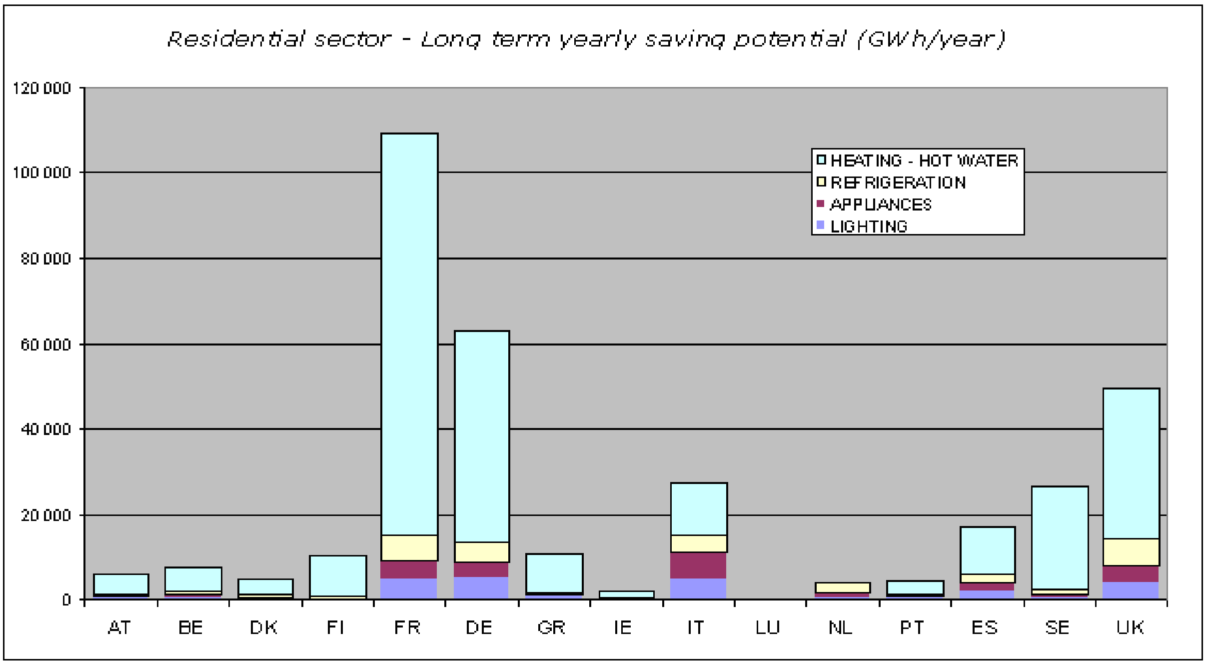
Figure 2.11 Annual trade-off between generation and the dynamic demand curve (incl. financial promotion instrument) in year n

2.3 Overview on already existing data on potentials and cost for Energy Efficiency (EE) in the EU-27 Member States

In the following section 2.3 a brief summary on the empirical data on potentials and cost for Energy Efficiency (EE) in the EU-27 Member States is conducted, which have been derived already in the previous projects **Green*Net*** and **Green*Net*-EU27**. Several of these data in this section are already presented in the different reports and ppt-presentations being available for download on the project website www.greennet-europe.org. In general, the following set of data is presented: long-term saving potentials up to the year 2020 (GWh/year$_{2020_cum.}$) as well as annual saving potentials (GWh/year) for the residential, industrial and tertiary sector.

2.3.1 EE-Potentials in the EU27 Member States

2.3.1.1 Residential sector



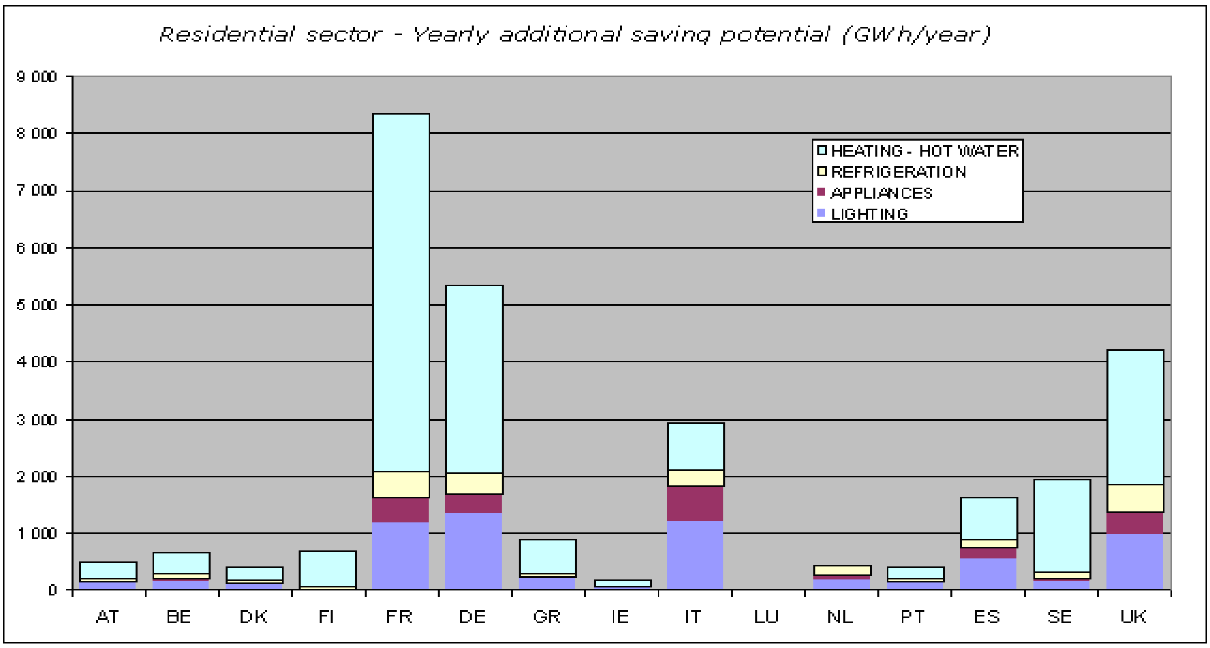


Figure 2.12 Residential sector: EE-Potentials (year$_{2020}$, annual) in the EU15 Member States

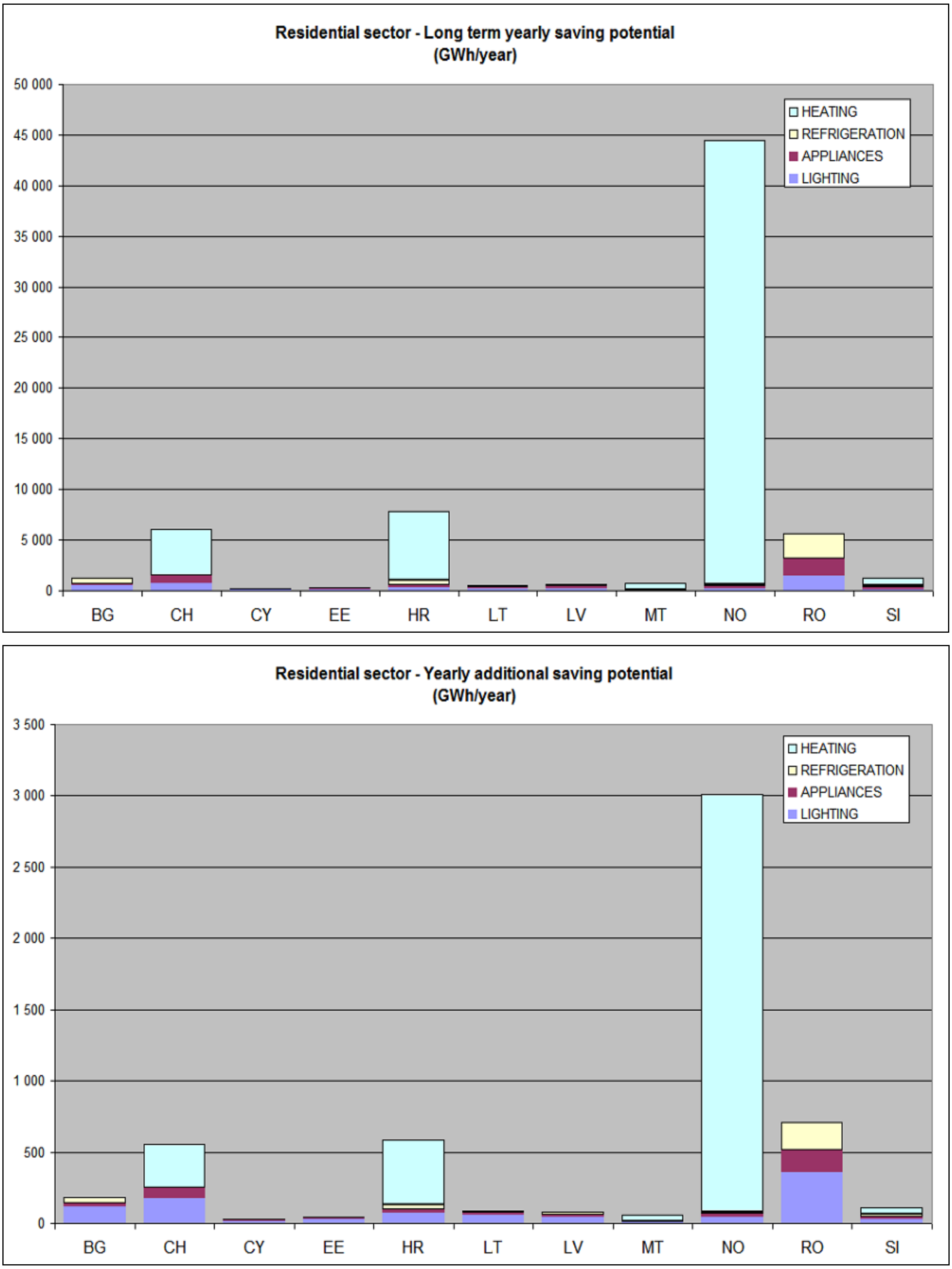
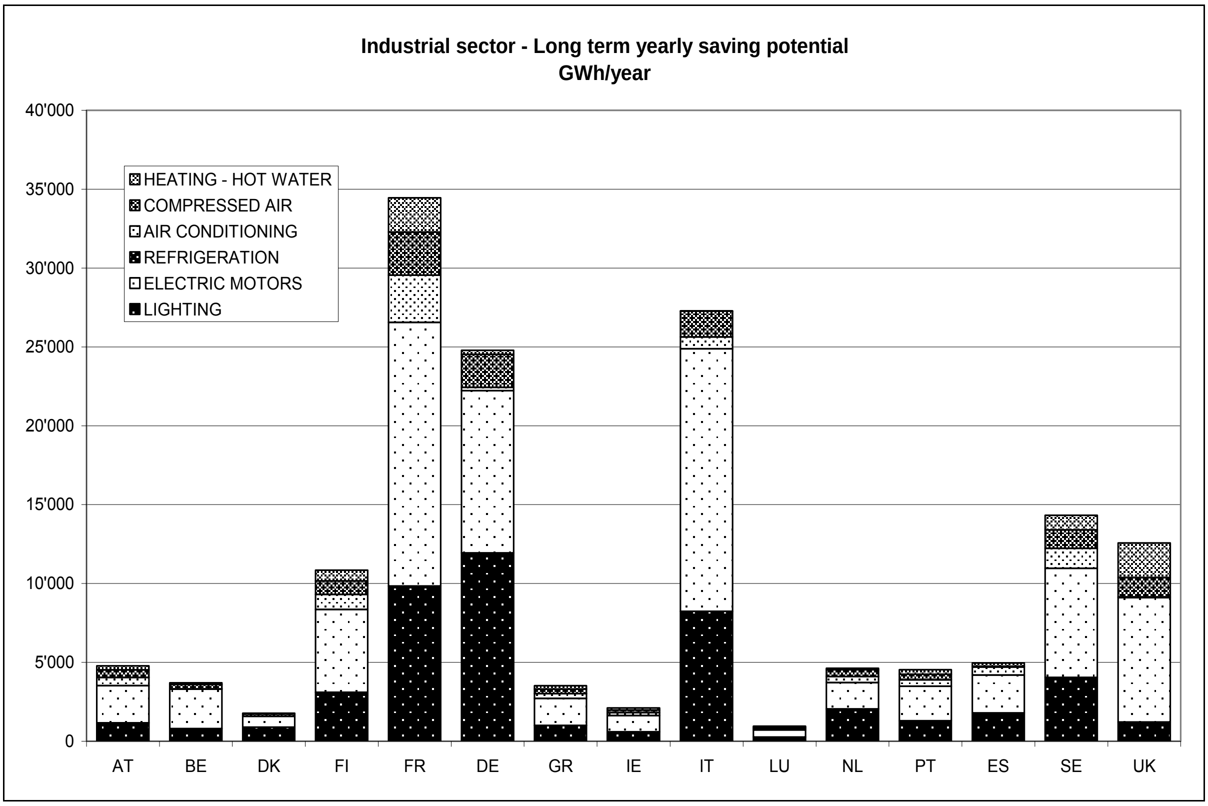


Figure 2.13 Residential sector: EE-Potentials (year$_{2020}$, annual) in the EU12+ Member States[6]

[6] The data for the countries Poland, Czech Republic, Slovakia and Hungary are not presented in this Figure 2.13. They are available for download in the corresponding GreenNet-Report (WP7) on www.greennet-europe.org.

2.3.1.2 Industrial sector



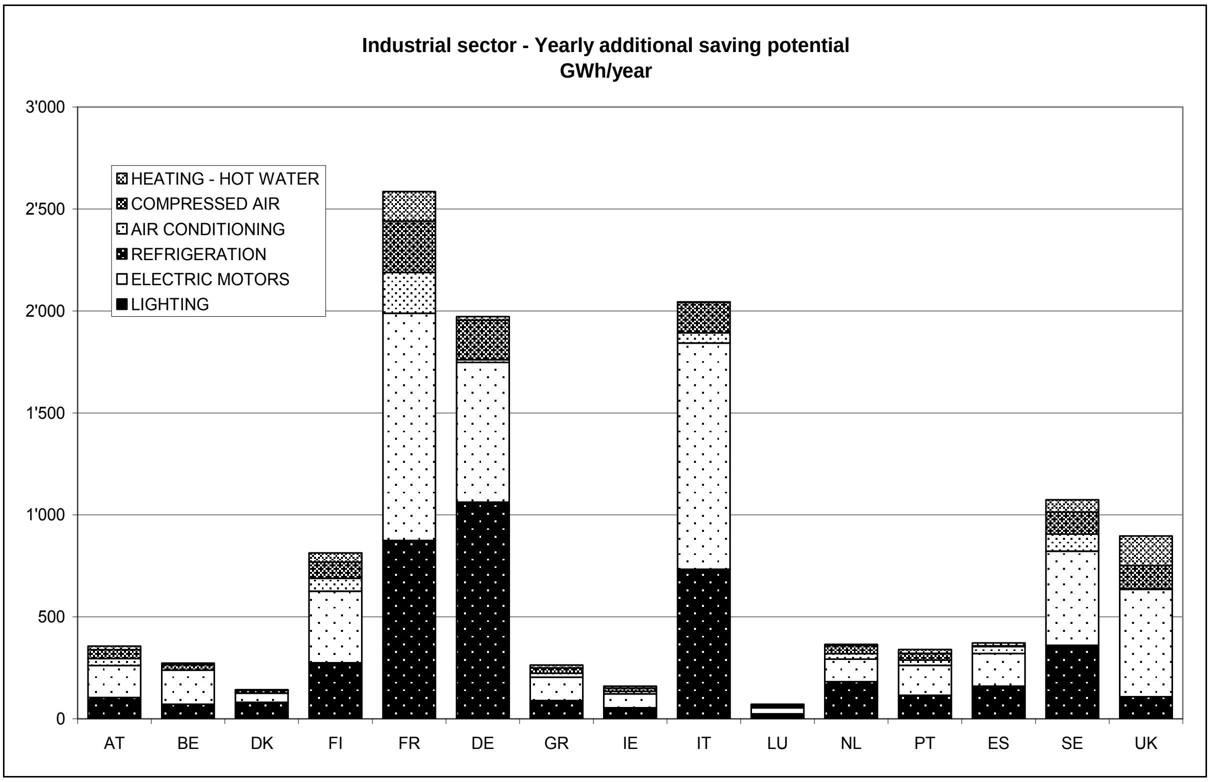


Figure 2.14 Industrial sector: EE-Potentials (year$_{2020}$, annual) in the EU15 Member States

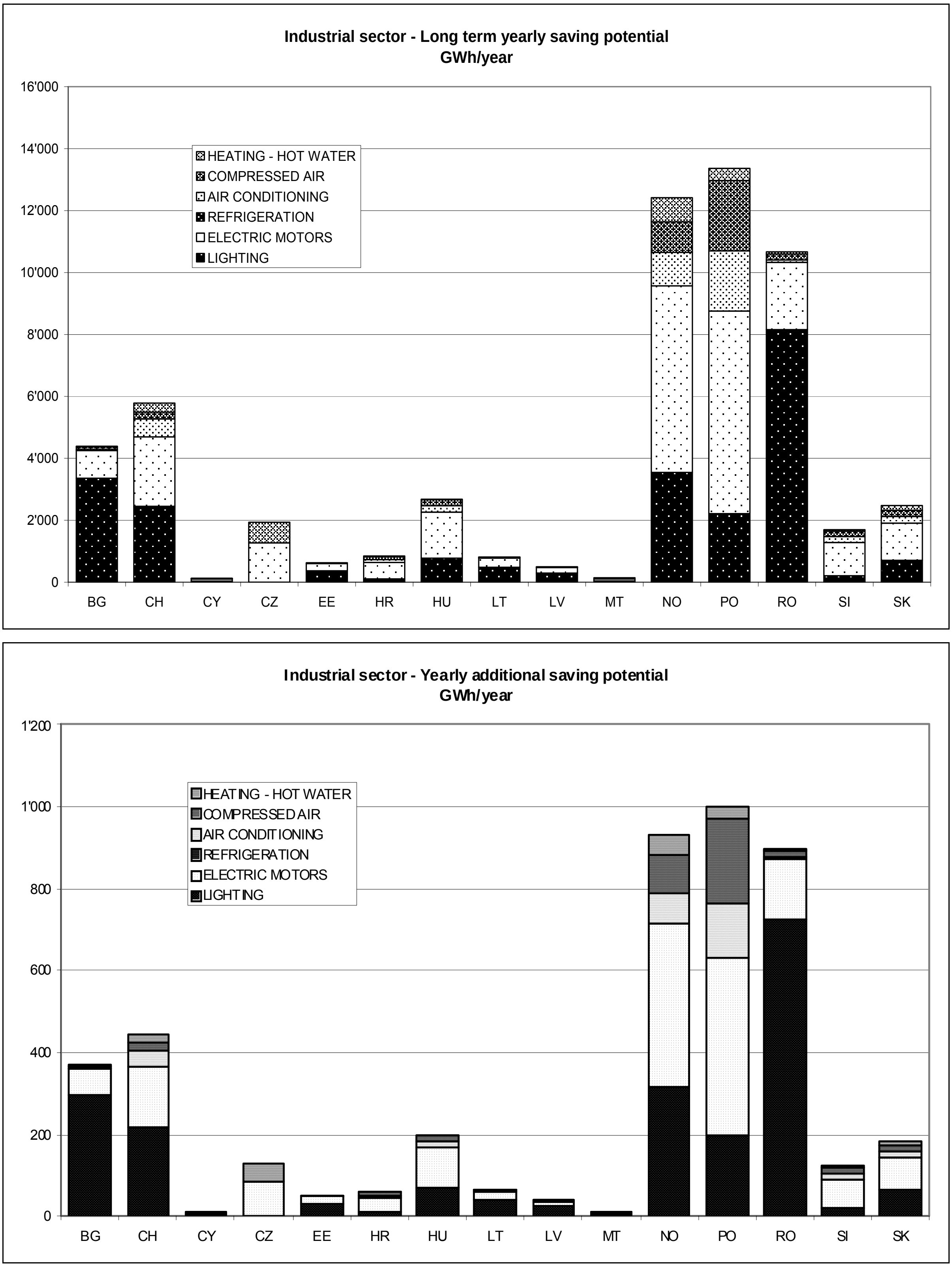


Figure 2.15 Industrial sector: EE-Potentials (year$_{2020}$, annual) in the EU12+ Member States

2.3.1.3 Tertiary sector

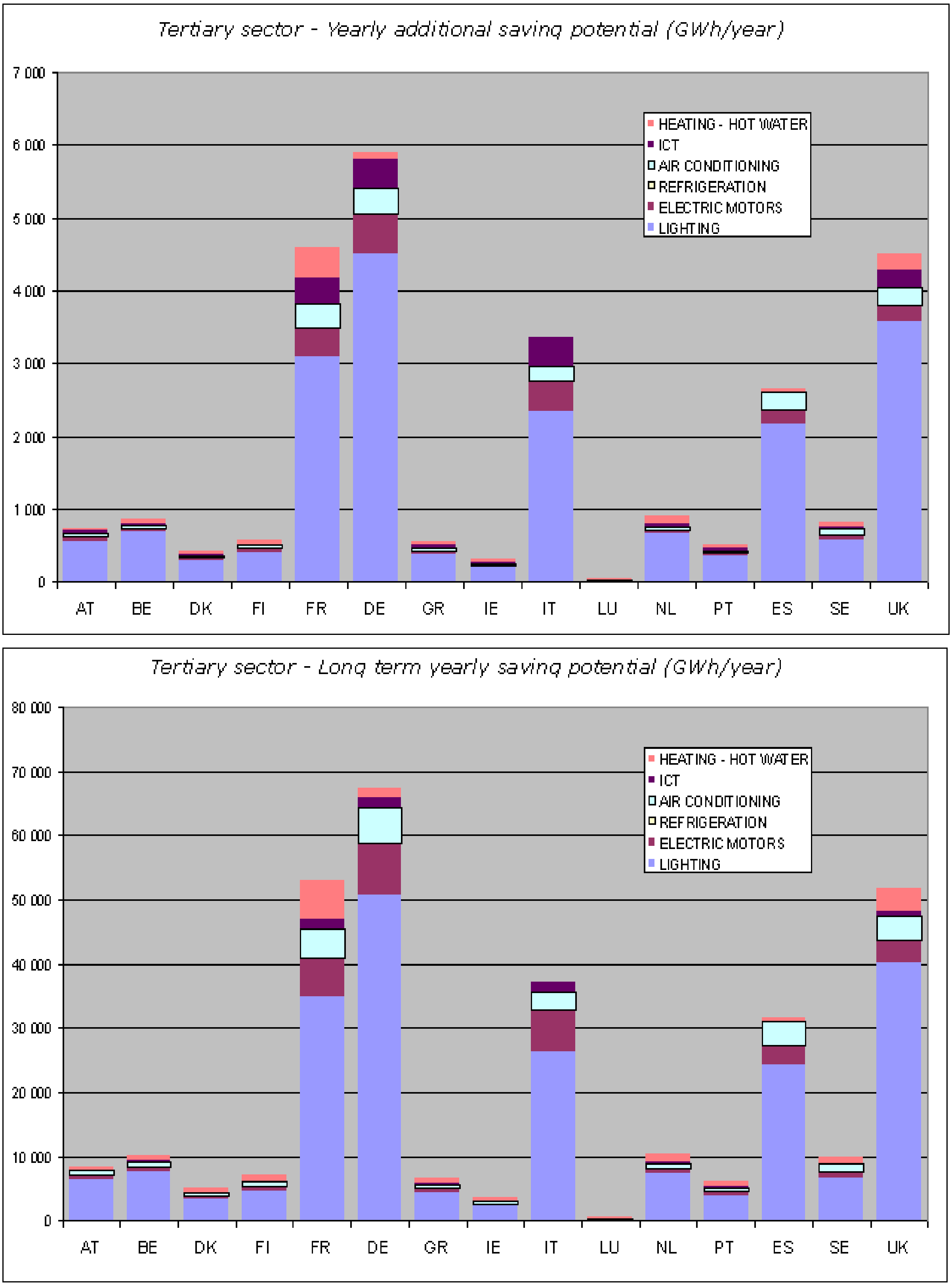
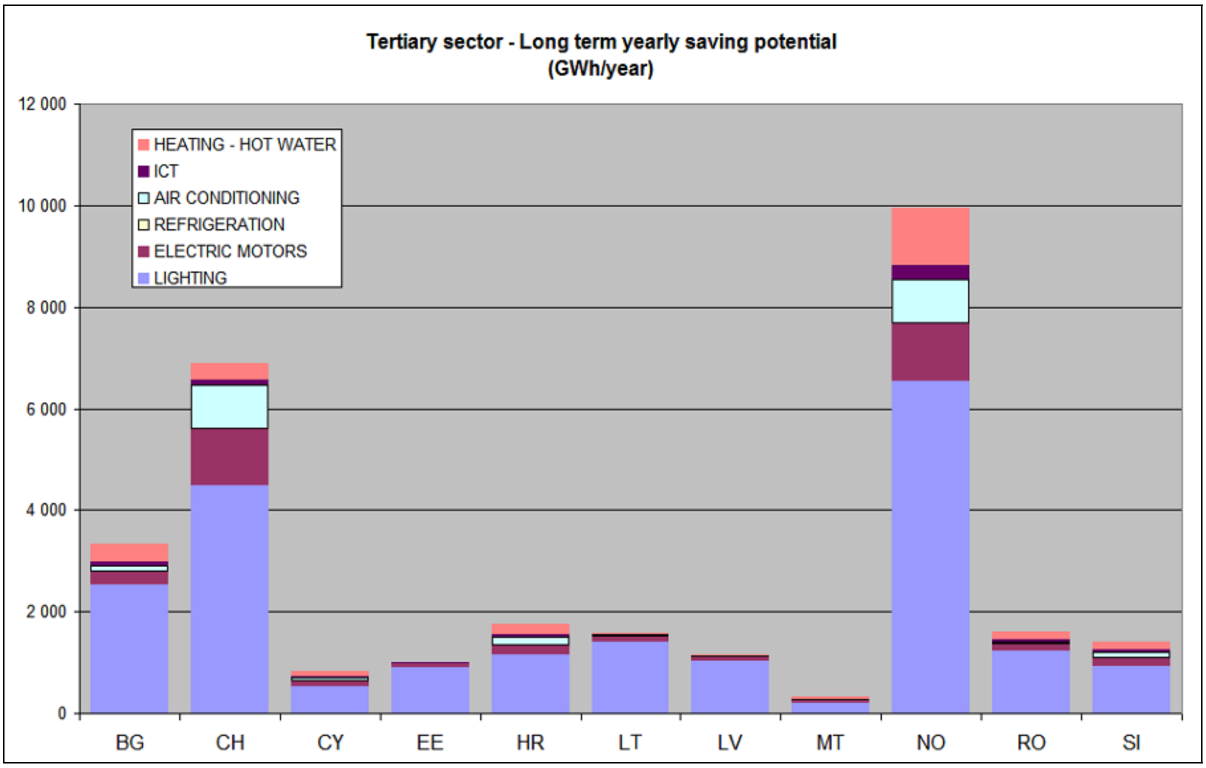


Figure 2.16 Tertiary sector: EE-Potentials (year$_{2020}$, annual) in the EU15 Member States



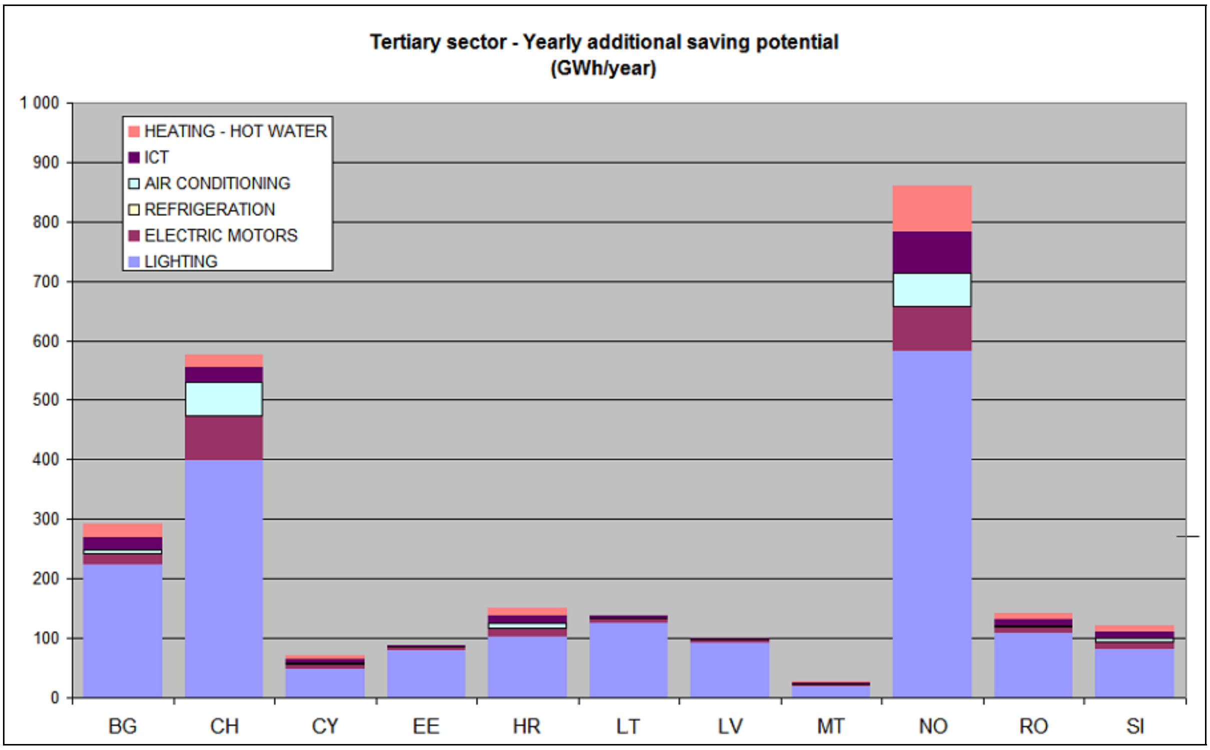


Figure 2.17 Tertiary sector: EE-Potentials (year$_{2020}$, annual) in the EU12+ Member States[7]

[7] The data for the countries Poland, Czech Republic, Slovakia and Hungary are not presented in this Figure 2.17. They are available for download in the corresponding GreenNet-Report (WP7) on www.greennet-europe.org.

2.3.2 EE-Cost in the EU27 Member States

The following section 2.3.2 presents the bandwidth of cost of Energy Efficiency (EE) measures in the EU27 Member States for the residential, industrial and tertiary sector.

2.3.2.1 Residential sector

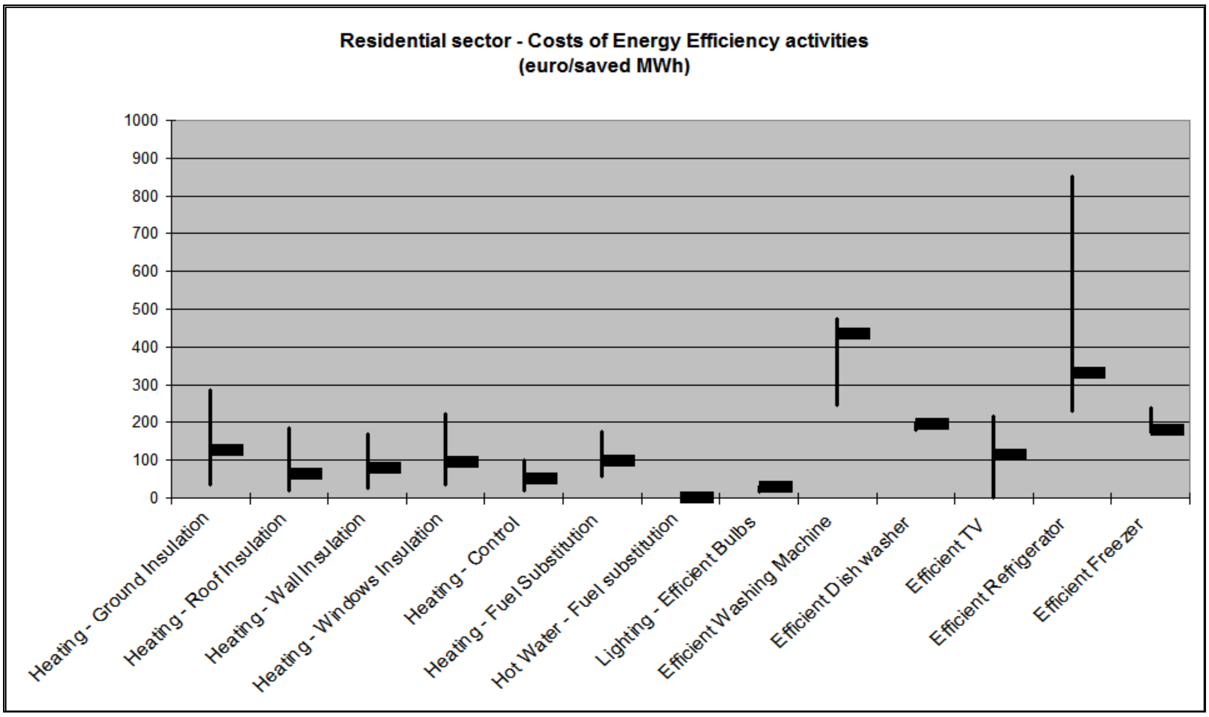


Figure 2.18 Overview on Energy Efficiency cost in the EU27 in the residential sector

2.3.2.2 Industry and tertiary sector

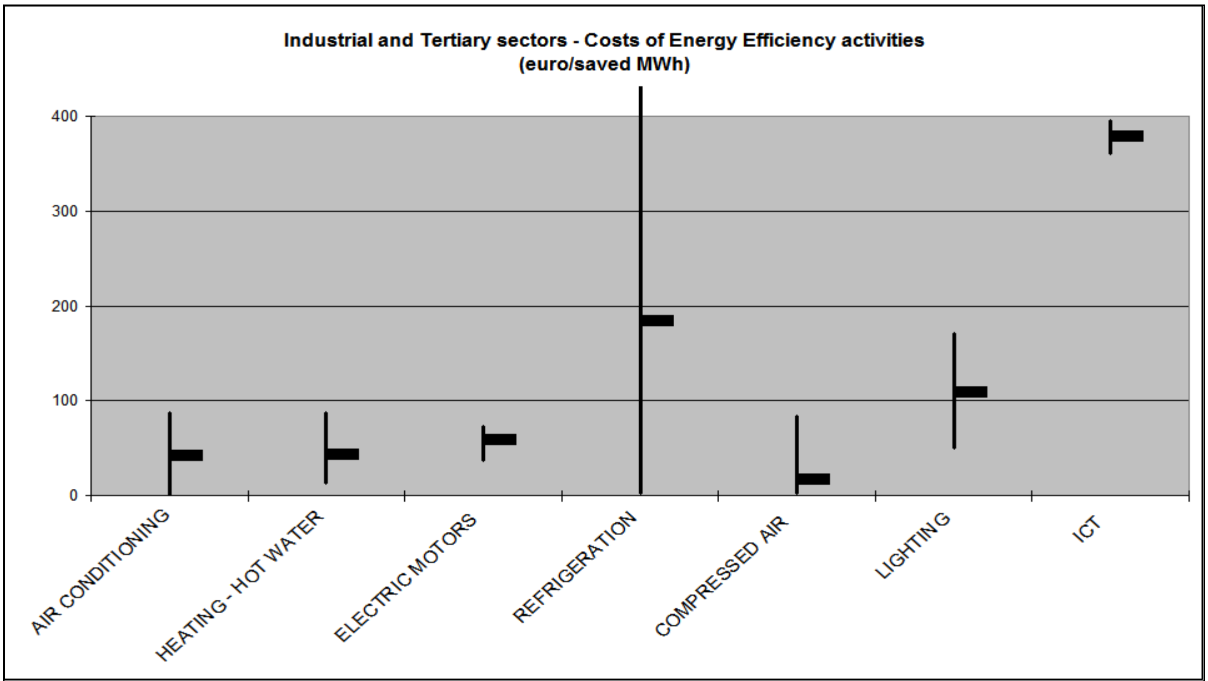


Figure 2.19 Overview on Energy Efficiency cost in the EU27 in the industrial/tertiary sector

3 OVERVIEW ON NEWLY DERIVED DATA ON POTENTIALS AND COSTS FOR ENERGY EFFICIENCY (EE) IN THE WESTERN BALKAN COUNTRIES AND TURKEY

Chapter 3 provides an overview on additional mid-term Energy Efficiency (EE) potentials up to the year 2020 on country level for several Western Balkan countries and Turkey.

3.1 Basic assumptions

3.1.1 Residential sector

Within the **Green*Net-Europe*** database (covering the empirical data of the predecessor projects **Green*Net*** and **Green*Net*-EU27** as well as the ongoing project **Green*Net*-Incentives**) information for the residential, tertiary and industrial sector are collected and categorised by country, end-use and technology. Each band in each of these sectors of the demand curve in the **Green*Net-Europe*** database could be

- either derived directly from MURE II (done for EU15 Member States incl. Norway),
- derived from data already existing in MURE II with some further calculations (done for EU15 Member States incl. Norway) or
- calculated from the other references mentioned below and comprehensively described in Appendix AI.1-AI.7 (EU12+ Member States, Western Balkan Countries and Turkey).

MURE II (comprehensive data base incl. simulation tool) has been the major tool for the derivation of empirical data for the demand-side data base in the **Green*Net-Europe*** model as far as E15 Member States and Norway are addressed. MURE II is comprehensively described on the corresponding project website (www.isis-it.com/mure/).[8] The MURE II database consists of four separate sectors on the demand side: industry, residential, tertiary, and transport. Each sector contains the corresponding energy conservation measures, statistical data and a simulation tool.

However, EU12+ countries (see project **Green*Net*-EU27**) as well as Western Balkan countries and Turkey are not present in MURE database. In addition, data collection for EU12+ countries (see project **Green*Net*-EU27**) has been difficult since the depth, precision and, in general, the effort in the statistical science is at a different level compared to the EU15 Member States. As a consequence it has not been possible to apply the same methodology adopted in the initial project **Green*Net*** for the 'old' EU15 Member States. In case, neither national statistical offices, national energy institutes and/or energy consultants/analysts were able to provide requested data, numerous assumptions have been made based on related documents available. Here is a brief explanation of assumptions common to all countries or most of them.

[8] MURE II provides information on energy conservation measures having been carried out in the EU15 Member States and Norway. It was designed and developed within the framework of the DGXVII SAVE programme by a team of experts from INESTENE (F), ISI-Fraunhofer (D), March Consulting Group (UK) and ISIS (Institute of System Integration Studies), Italy. MURE II enables simulations and comparisons of the impact of energy efficiency and DSM measures on national level for each of the EU15 Member States and Norway.

Similarly to assumptions made in the predecessor projects **Green*Net*** and **Green*Net*-EU27** (corresponding reports are available for download on the project website www.greennet-europe.org), following fields have been put at the same value for all countries.

- Life time of implemented technology,
- Share of realisable energy saving potential compared to long-term potential,
- Investment costs of alternative option (year n),
- O&M costs independent from electricity consumption alternative,
- Interest rate,
- Life time alternative option:

Investment costs are the same as those used in the project **Green*Net*-EU27** for the Mediterranean countries (Spain, Italy, Portugal, Greece, Cyprus, Malta).

Analogously to the analyses in the predecessor projects **Green*Net*** and **Green*Net*-EU27** **Green*Net*** the field "Energy consumption per unit service output" is assumed to be the same for several Western Balkan countries and Turkey. Specified bands refer both to "multiple houses" bands (MH) and to "single houses" ones (SH) for bands:

- heating, fuel substitution
- lighting, efficient bulbs
- efficient washing machine
- efficient dish washer
- efficient TV
- efficient refrigerator

The same has been assumed for parameter "Energy consumption of alternative per unit service output", as regards to bands (both MH and SH)

- lighting, efficient bulbs
- lighting, efficient bulbs
- efficient washing machine
- efficient dish washer
- efficient TV
- efficient washing machine
- efficient dish washer
- efficient TV
- efficient refrigerator
- efficient freezer

and for parameter "Investment costs" , as regards to bands

- heating, wall insulation (MH and SH)
- heating, windows technologies (MH and SH)
- heating, control devices (MH and SH)
- heating, fuel substitution (MH)
- lighting, efficient bulbs (MH and SH)
- efficient washing machine
- efficient dish washer
- efficient TV
- efficient refrigerator
- efficient freezer

For the field **"**Appliances stock yearly growth rate" assumptions (similar to those in case of the EU12+ Member States in the predecessor project **Green*Net*-EU27**) have been made on the basis of other European countries' data in the MURE database, since no corresponding data, references or documents were available and nobody among contacted experts in the Western Balkan countries and Turkey could provide estimates on these data.

Fields **"**Stock of dwellings average yearly growth rate" and "Stock of dwellings annual rate of stock demolition" have been calculated on the basis of UNECE (United Nations Economic Commission for Europe) data (http://w3.unece.org/stat/HumanSettlements.asp); the same way like for the EU12+ Member States in the project **Green*Net*-EU27**.

The field **"**Consumption of efficient technology (% of alternative)" was calculated for the EU15 Member States in the **Green*Net*** project with data derived from MURE simulations. In the predecessor project **Green*Net*-EU27** for the EU12+ Member States as well as here in **Green*Net*-Incentives** for the Western Balkan Countries and Turkey average values – having been reviewed by national consultants; see Appendix AI – have been used.

When data was sufficient to calculate values for the band "heating, fuel substitution", it was always more feasible the use of gas rather than other fuels. The source of Energy prices for gas in different countries is Eurostat. Data refer to 2005.

Concerning structural data (e.g. share between single-family and multi-family dwellings, distribution of consumption for heating among fuels, share of hot sanitary water, etc.) similarities to have been used compared to the South-Eastern European Countries (like Romania, Bulgary, Croatia, Slovenia, etc.) from the project **Green*Net*-EU27** in order to be able to derive corresponding empirical data on the different potentials for different end-uses in the residential sector for several Western Balkan Countries and Turkey.

Finally, the bandwidth of cost of Energy Efficiency (EE) measures in the EU27 Member States for the residential sector (having been derived in the project **Green*Net*-EU27**) is also the same for the Western Balkan Countries and Turkey. Therefore, it is referred to the empirical overview given in Figure 2.18 in the previous section 2.3.2.

3.1.2 Industrial and tertiary sector

In general, the data in the industrial and tertiary sector are derived based on the following hypothesis:

- Consumption per sector and end-use in the industrial and tertiary sector differs from country to country.
- Data on energy savings from specific technologies, maximum possible penetration rate and actual penetration rate are depending on technology but not on country.
- Percentage of potential to be implemented per year: assumptions are made for different technologies.

For the industrial and tertiary sector the total annual saving potential corresponding to each energy efficiency measure is calculated for each country as follows:

$$SP_{i,j} = C_{k,j} * s_i * (PR_{\max,i} - PR_{act,i})$$

where

$SP_{i,j}$ ....Total annual saving potential of energy efficiency measure (or technology) i in country j [MWh/year]

$C_{k,j}$ ....Total annual consumption in end-use k in country j [MWh/year]
$s_{,j}$ ....Savings generated by energy efficiency measure (or technology) i, expressed as a percentage reduction of consumption
$PR_{\max,\,i}$ ....Maximum possible penetration rate of energy efficiency measure (or technology) i (were relevant)
$PR_{act,\,i}$ ....Actual penetration rate of the energy efficiency measure (or technology) i (were relevant)

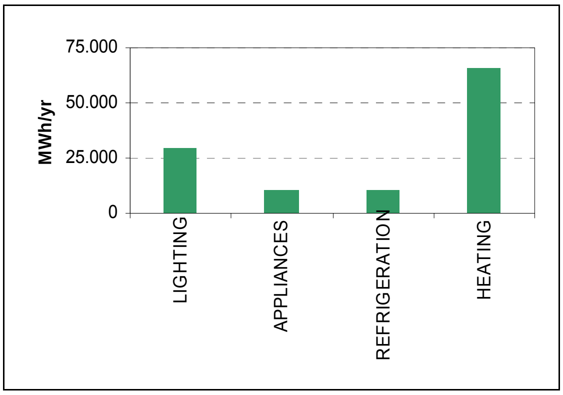
As already mentioned above, it is not possible to calculate the costs per kWh saved for the industrial and tertiary sector utilising the MURE II database. These data are, therefore, obtained through a survey of studies dedicated to specific end-uses, following the hypothesis that, in general, costs depend on technology, not on country. The cost per kWh saved is calculated bearing in mind that, once an energy efficiency measure is implemented, the saving will last for the lifetime of the technology. The interest rate for the actualisation is assumed to be 8%.

Finally, the bandwidth of cost of Energy Efficiency (EE) measures in the EU27 Member States for the industrial and tertiary sector (having been derived in the project **Green*Net*-EU27**) is also the same for the Western Balkan Countries and Turkey. Therefore, it is referred to the empirical overview given in Figure 2.19 in the previous section 2.3.2.

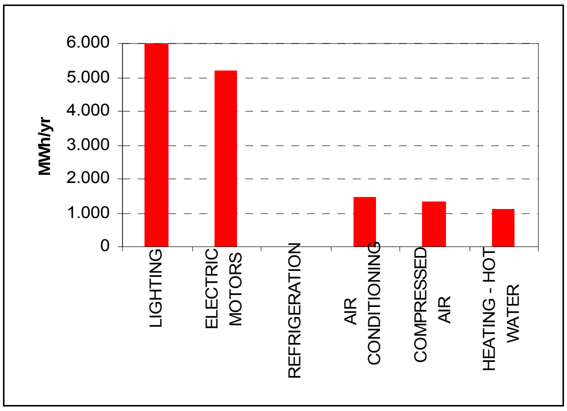
3.2 Albania

Comprehensive country-specific background information like energy efficiency policies and priorities, legislation, empirical data sources and references is presented in Annex AI.1.

Residential Sector	E-DSM-RE Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	29.171
APPLIANCES	10.287
REFRIGERATION	10.469
HEATING	65.821
TOTAL	*115.748*



Industrial Sector	E-DSM-IN Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	5.992
ELECTRIC MOTORS	5.195
REFRIGERATION	0
AIR CONDITIONING	1.452
COMPRESSED AIR	1.348
HEATING - HOT WATER	1.111
TOTAL	*15.098*



Tertiary Sector	E-DSM-TS Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	28.757
ELECTRIC MOTORS	3.878
REFRIGERATION	0
AIR CONDITIONING	3.993
ICT	3.637
HEATING - HOT WATER	3.274
TOTAL	*43.539*

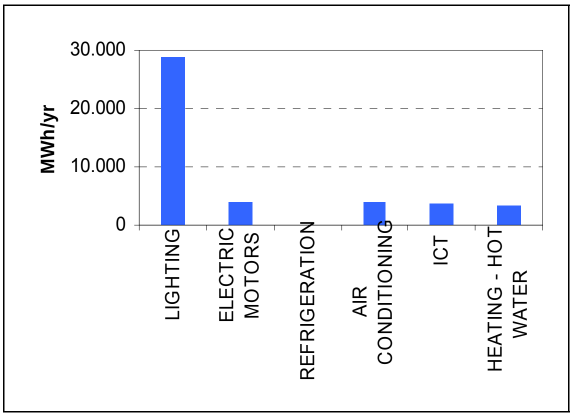
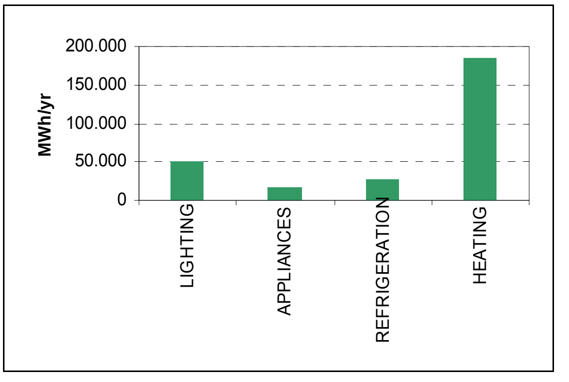


Figure 20. Yearly realisable energy saving potentials in the residential, industrial and tertiary sector up to 2020 compared to the BAU scenario in Albania

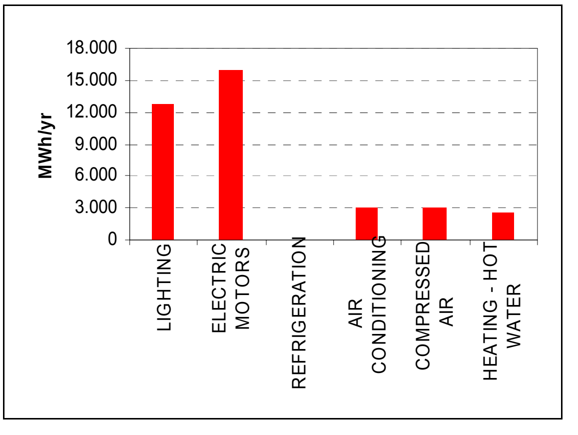
3.3 Bosnia and Herzegovina

Comprehensive country-specific background information like energy efficiency policies and priorities, legislation, empirical data sources and references is presented in Annex AI.2.

Residential Sector	E-DSM-RE Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	49.723
APPLIANCES	16.768
REFRIGERATION	26.379
HEATING	185.324
TOTAL	*278.194*



Industrial Sector	E-DSM-IN Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	12.769
ELECTRIC MOTORS	15.976
REFRIGERATION	0
AIR CONDITIONING	3.058
COMPRESSED AIR	2.998
HEATING - HOT WATER	2.501
TOTAL	*37.302*



Tertiary Sector	E-DSM-TS Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	65.991
ELECTRIC MOTORS	8.178
REFRIGERATION	0
AIR CONDITIONING	6.428
ICT	9.734
HEATING - HOT WATER	10.235
TOTAL	*100.566*

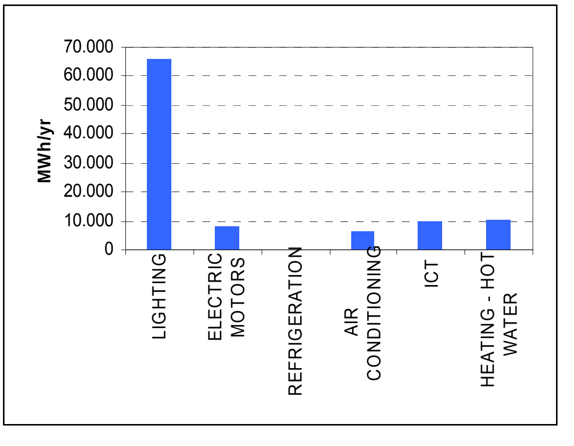
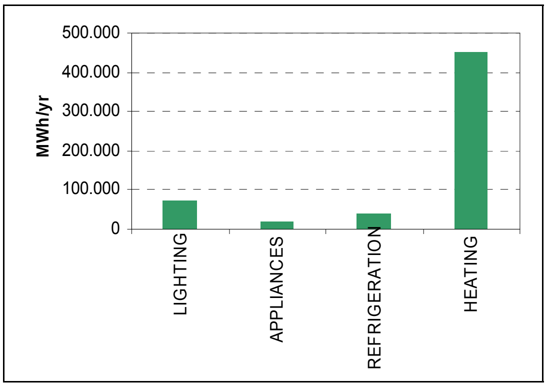


Figure 21. Yearly realisable energy saving potentials in the residential, industrial and tertiary sector up to 2020 compared to the BAU scenario in Bosnia/Herzegovina

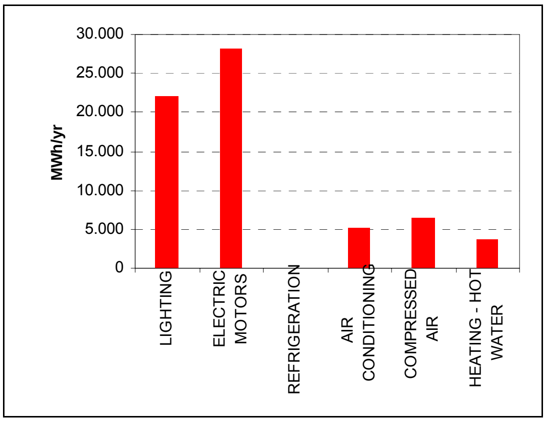
3.4 Croatia

Comprehensive country-specific background information like energy efficiency policies and priorities, legislation, empirical data sources and references is presented in Annex AI.3.

Residential Sector	E-DSM-RE Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	71.499
APPLIANCES	19.951
REFRIGERATION	41.840
HEATING	451.755
TOTAL	*585.046*



Industrial Sector	E-DSM-IN Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	22.174
ELECTRIC MOTORS	28.252
REFRIGERATION	0
AIR CONDITIONING	5.069
COMPRESSED AIR	6.389
HEATING - HOT WATER	3.671
TOTAL	*65.554*



Tertiary Sector	E-DSM-TS Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	101.829
ELECTRIC MOTORS	12.960
REFRIGERATION	1
AIR CONDITIONING	10.220
ICT	12.020
HEATING - HOT WATER	13.379
TOTAL	*150.408*

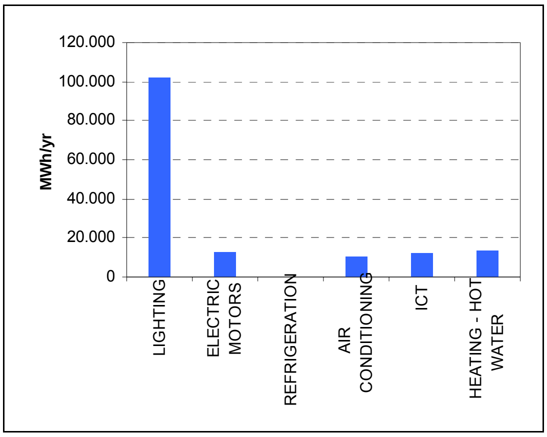
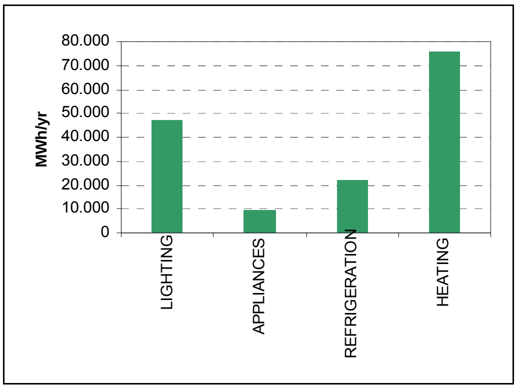


Figure 22. Yearly realisable energy saving potentials in the residential, industrial and tertiary sector up to 2020 compared to the BAU scenario in Croatia

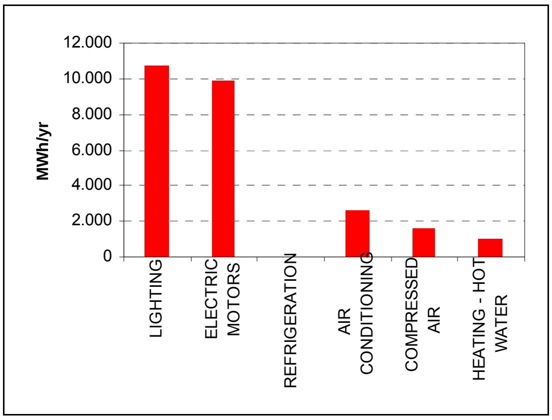
3.5 Macedonia

Comprehensive country-specific background information like energy efficiency policies and priorities, legislation, empirical data sources and references is presented in Annex AI.4.

Residential Sector	E-DSM-RE Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	47.115
APPLIANCES	9.715
REFRIGERATION	22.069
HEATING	75.978
TOTAL	*154.877*



Industrial Sector	E-DSM-IN Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	10.704
ELECTRIC MOTORS	9.937
REFRIGERATION	0
AIR CONDITIONING	2.561
COMPRESSED AIR	1.628
HEATING - HOT WATER	999
TOTAL	*25.829*



Tertiary Sector	E-DSM-TS Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	48.327
ELECTRIC MOTORS	7.360
REFRIGERATION	0
AIR CONDITIONING	6.578
ICT	6.842
HEATING - HOT WATER	5.999
TOTAL	*75.106*

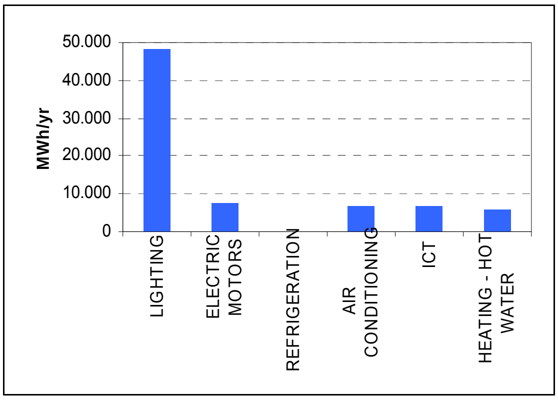
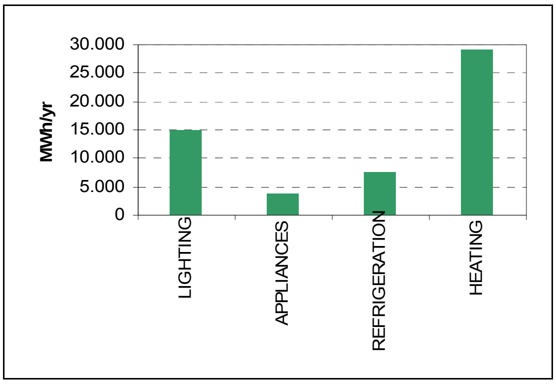


Figure 23. Yearly realisable energy saving potentials in the residential, industrial and tertiary sector up to 2020 compared to the BAU scenario in Macedonia

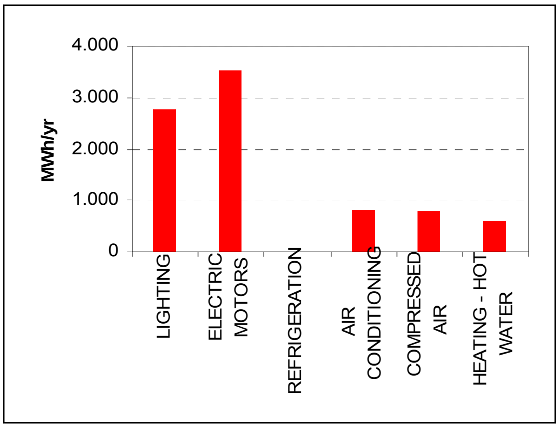
3.6 Montenegro

Comprehensive country-specific background information like energy efficiency policies and priorities, legislation, empirical data sources and references is presented in Annex AI.5.

Residential Sector	E-DSM-RE Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	15.003
APPLIANCES	3.692
REFRIGERATION	7.511
HEATING	29.120
TOTAL	*55.326*



Industrial Sector	E-DSM-IN Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	2.765
ELECTRIC MOTORS	3.523
REFRIGERATION	0
AIR CONDITIONING	826
COMPRESSED AIR	778
HEATING - HOT WATER	598
TOTAL	*8.489*



Tertiary Sector	E-DSM-TS Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	7.433
ELECTRIC MOTORS	1.056
REFRIGERATION	0
AIR CONDITIONING	987
ICT	922
HEATING - HOT WATER	831
TOTAL	*11.229*

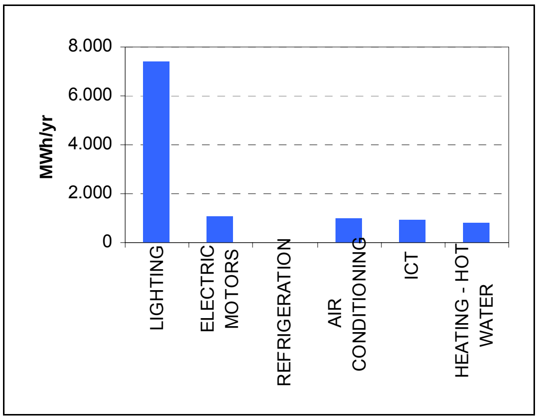
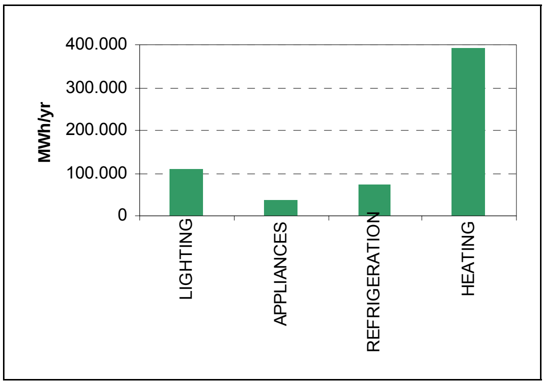


Figure 24. Yearly realisable energy saving potentials in the residential, industrial and tertiary sector up to 2020 compared to the BAU scenario in Montenegro

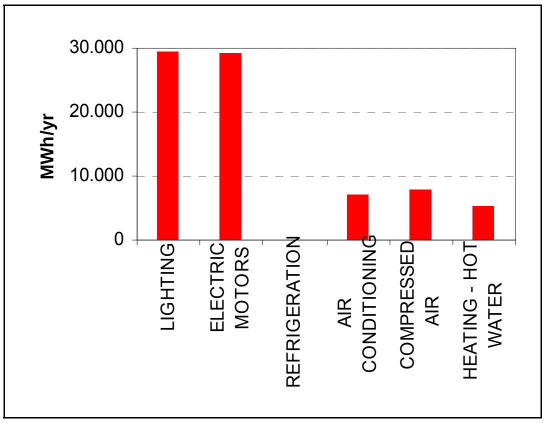
3.7 Serbia

Comprehensive country-specific background information like energy efficiency policies and priorities, legislation, empirical data sources and references is presented in Annex AI.6.

Residential Sector	E-DSM-RE Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	108.794
APPLIANCES	35.269
REFRIGERATION	71.311
HEATING	390.938
TOTAL	*606.312*



Industrial Sector	E-DSM-IN Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	29.536
ELECTRIC MOTORS	29.341
REFRIGERATION	0
AIR CONDITIONING	7.181
COMPRESSED AIR	7.831
HEATING - HOT WATER	5.371
TOTAL	*79.260*



Tertiary Sector	E-DSM-TS Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	76.137
ELECTRIC MOTORS	11.341
REFRIGERATION	0
AIR CONDITIONING	9.248
ICT	8.701
HEATING - HOT WATER	7.999
TOTAL	*113.426*

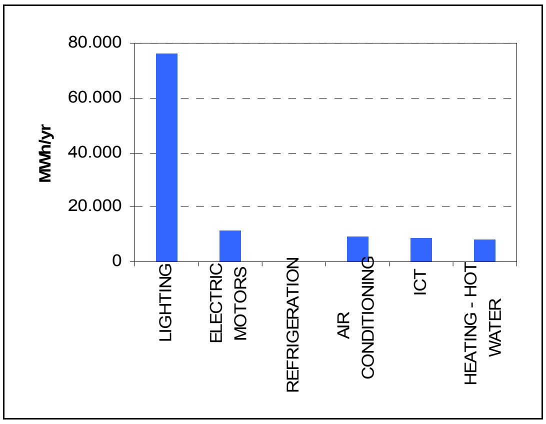
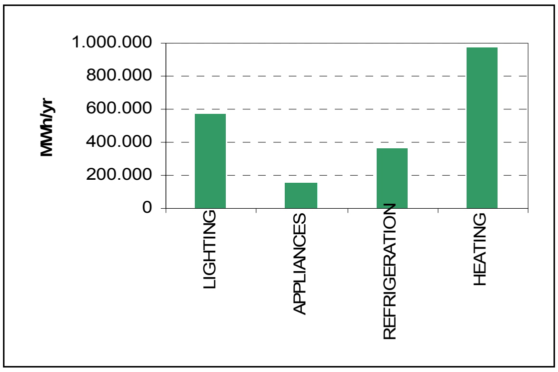


Figure 25. Yearly realisable energy saving potentials in the residential, industrial and tertiary sector up to 2020 compared to the BAU scenario in Serbia

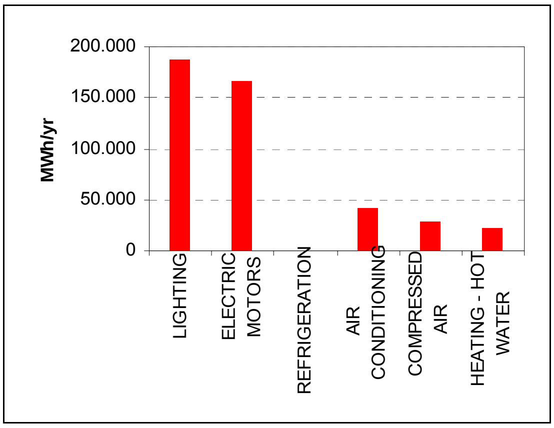
3.8 Turkey

Comprehensive country-specific background information like energy efficiency policies and priorities, legislation, empirical data sources and references is presented in Annex AI.7.

Residential Sector	E-DSM-RE Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	573.721
APPLIANCES	155.598
REFRIGERATION	367.290
HEATING	975.238
TOTAL	*2.071.847*



Industrial Sector	E-DSM-IN Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	186.923
ELECTRIC MOTORS	166.555
REFRIGERATION	0
AIR CONDITIONING	40.991
COMPRESSED AIR	28.942
HEATING - HOT WATER	22.023
TOTAL	*445.434*



Tertiary Sector	E-DSM-TS Maximum yearly realisable penetration of energy saving compared to BAU *[MWh/year]*
LIGHTING	328.721
ELECTRIC MOTORS	38.009
REFRIGERATION	0
AIR CONDITIONING	56.187
ICT	47.023
HEATING - HOT WATER	22.740
TOTAL	*492.680*

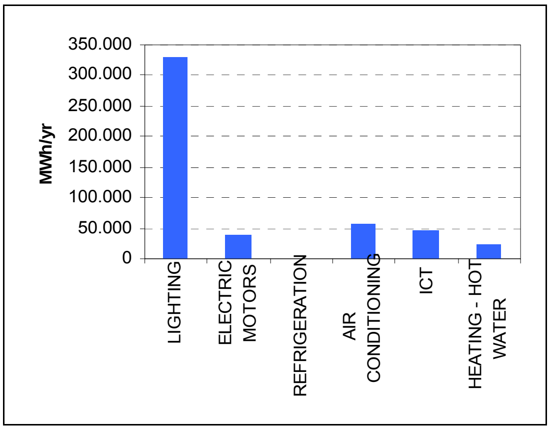


Figure 26. Yearly realisable energy saving potentials in the residential, industrial and tertiary sector up to 2020 compared to the BAU scenario in Turkey

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ANNEX I PROSPECTS FOR ENERGY SAVINGS AND INITIATIVES IN THE WESTERN BALKAN COUNTRIES AND TURKEY

AI.1 Albania

1. Energy Demand and Energy Intensity

- **Energy Demand:** Total final energy consumption was 86,777 TJ in 2003. Consumption per capita was 41,87 GJ in 2003. After a decrease between 1990 and 1998 (-10 % p.a. on average), the final energy consumption has been increasing again. This fall mainly affected coal and natural gas. Their share in the final consumption decreased respectively from 26 % in 1990 to 1 % and from 9 % to an almost 0 % in 1998. In 2003, oil accounts for two thirds of final energy consumption (against 40 % in 1990). The share of electricity is 24 % in 2003 (while it was only 6% in 1990).

- **Demand per Sector:** The share of transport in final consumption increased strongly (32 % in 2003 against 11 % in 1990) at the expense of industry. According to 2005 data of the Institute of Statistics, the use of electric power by domestic users indicated a slight increase with 0.9 % compared with the first half-year in 2004. The quantity used was 1,880 GWh, equivalent to 51.2 percent of the total supply. The daily average use for this period is 20.3 GWh or 7.4 percent higher than the first half-year of 2004. The residential sector continues to be the main consumer of electric power. In the first half of 2005, household consumption accounted for 58.9 % of the quantity used by domestic users. During this period, the quantity consumed by the households decreased by 3.4 % compared with the respective period of the previous year and 4.5 % compared with the first half-year in 2003. The monthly average quantity of household consumption in the first half of 2005 is 184 GWh and the daily average is 6.1 GWh. The monthly average of the quantity consumed by households in the first half-year of 2004 was 191 GWh and daily average was 6.3 GWh.

- **Energy Intensity:** Total primary energy consumption per dollar of gross domestic product in 2003 was 6.7 MJ.

2. Prospects for Energy Savings

According to Albania's Energy Strategy, energy savings are expected to be around 34 PJ or 22.48% of the total energy consumption by 2015 (forecasted at 118 PJ) according to the Passive Scenario of the National Agency of Energy (NAE). The contribution in these savings by 2015 shall come from the transport sector with 27.28%, industry with 24.58%, agriculture with 24.67%, service with 17.86% and the residential sector with 7.4% of the total savings. In this section a description follows in regard to all implied actions in order to fully realise the implementation of Albania’s Energy Strategy, including energy efficiency increase:

- **Implementation of the Energy Building Code:** The existing stock of buildings is not insulated, it has old windows and in most cases electricity is used for space heating. Based on the world experience and studies carried out by the National Agency of Energy (NAE) and other institutions, the insulation of public building stock until 2015 and the substitution of the existing windows with double glasses windows is foreseen. For the implementation of thermal insulation measures according to the Active Scenario, the following steps are necessary:
  1. Household awareness campaign on the positive effects of thermal insulation for energy saving; reduction of family budget for energy. This objective will be achieved through pilot projects, television programs, newspaper articles, awareness campaigns. A special fund for the energy efficiency should be established. The fund may be collected as an energy efficiency tax from all subjects that sale energy sources, different international programs for energy efficiency and environmental protection in the frame of KYOTO Protocol, as well as from the State Budget.
  2. Implementation and improvement of the Energy Building Code, applying simple procedures. Application forms fulfilled by the construction subjects should be prepared in order to fulfil the

requirements of the Energy Building Code. These data will serve for software thermal calculations in buildings used by town-planner offices in Municipalities and Districts. This task will require employees training to analyze the thermal insulation aspects of construction projects.

- **Promotion of Penetration of Solar Energy Use For Preparation of Hot Water in Households and Service Sectors:** Penetration norms of solar panels have been selected based on the experience of neighboring countries such as Greece and Turkey, which after 30 years of experience have managed to provide domestic hot water produced by solar panels at the national level in values of 80-85 %. Using solar panels result by saving electricity, environmental protection and by economic profitability as well as household and service sector. Investment costs will be shared between state budget (for hospitals, nurseries, schools, etc) and private subjects (households).

- **Promotion of Individual Central Heating, District Heating and Combined Heat and Power Plants in Service, Industry and Households Sectors:** Many services, industrial and households need energy in form of heat (steam or hot water) and electricity for their technological processes. Based on the existing technologies, the most efficient one that guarantees heat and power energy needs is the cogeneration, which means combined production of thermal and electricity. The National Agency of Energy together with the Energy Efficiency Centre has carried out some different studies for the penetration of small scale combined heat and power plants (SSCHP). Investment costs will be shared between state budget and private subjects (households).

- **Promotion of Efficient Lighting in Households, Service and Industry Sectors:** Investment costs will be shared between state budget (for public buildings) and private subjects (households).

- **Substitution of Coal, Fuel Wood, Residual Fuel Oil with Heavy Fuel Oil in Boilers/Furnaces:** Energy saving in industry and service sectors will come from substitution of coal, fuel wood, residual fuel oil with heavy fuel oil in existing stock boilers/furnaces (the penetration rate for the year 2015 is taken 30 %).

- **Promotion of Public Transport and Other Measures in Transport Sector:** The following measures were analyzed for the passenger transport: roads rehabilitation, construction of new roads, better management of transport sector, use of efficient vehicles with lower engine power and higher efficiency, lower growth rate for the number of cars, increase the contribution of passenger transport through buses and trains, etc.

- **Increase of Energy Efficiency in Agriculture Sector in General, and Irrigation in Particular:** Use of efficient irrigating schemes, which means that superficial irrigation with drills or flooding will be substituted with pressured irrigation in the form of rain and droplets. Expected result is the reduction of 50 % of the energy consumption in agriculture sector. Investment for this measure will be from budget and farmers. The budget will carry out big investments related with irrigation projects, while farmers will carry out the equipment for irrigation with droplets.

[Source Albania: Enerdata, enerCEE.net, EEG Database, Dr. Besim Islami, Dr. Nenad Keseric]

AI.2 Bosnia and Herzegovina

1. Energy Demand and Energy Intensity

- **Energy Demand:** Total primary energy consumption in Bosnia & Herzegovina in 2003 was 176,062 TJ.

- **Demand per Sector:** Final energy consumption by sector was in BiH in 2005: (i) households, services and agriculture: 52%;(ii) transport: 27%; (iii) industry: 21%. Final energy demand of the residential sector was in BiH in 2005: (i) electricity 51%; (ii) biomass 27,4%, (iii) 21,6%.

- **Energy Intensity:** Total primary energy consumption per dollar of gross domestic product in 2001 was 35,444 Btu.

2. Prospects for Energy Savings

The Center for Energy in BiH has prepared a document as basis for a long-term energy strategy in Federation of Bosnia and Herzegovina (BiH). The strategy should help to implement EU Energy Law into Bosnian Energy Law to accept and ratified all environment protocols such as Kyoto Protocol.

The medium-term strategy for the energy sector of Bosnia and Herzegovina developed by Bosnian Council of Ministers has outlined the following goals:
1. Attracting domestic and foreign investments;
2. Reliable energy supplying conforming with defined standards and the lowest price possible;
3. Turn towards international markets, by developing single electricity and gas market;
4. Economical and rational use of energy resources and energy efficiency improvements;
5. Liberalization by introducing competition and transparency;
6. Environmental protection according to domestic and foreign standards;
7. Protection system user's interests;
8. Increased use of renewable energy;
9. Fulfillment the European Energy Charter and other international agreements and conventions.

[Source Bosnia and Herzegovina: Enerdata, enerCEE.net, EEG Database, Dr. Vedran Uran, Dr. Nenad Keseric]

AI.3 Croatia

1. Energy Demand and Energy Intensity

- **Energy Demand:** The final energy demand increased in 2004 by 3.3 per cent compared to 2003, while the consumption of coal had the fastest growth, by 107,8 per cent. Electricity consumption, steam and hot water, and natural gas consumption were also growing. The consumption of liquid fuels was minimally increased, and fuel wood consumption was 2,3 per cent below the previous year level. Over a six year period (1999-2004) there was an increase in all energy forms consumption, where total final energy demand grow at a rate of 2,9 per cent.

- **Demand per Sector:** Final energy consumption by sector was in Croatia in 2005: (i) household, services, agriculture: 51%;(ii) transport: 20%, (iii) industry: 20%; (iv) non-energy use: 9%. Compared to the year 2003, the Transport Sector amounted 30 % of final energy consumption and increased to the previous year by 4 %. The share of households, services and agriculture decreased by 5 % and the portion of industry is the lowest and in the past period it did not change very much. Final energy demand of the residential sector was in Croatia in 2005: (i) electricity: 28%; (ii) gas: 29%; (iii) oil: 19%; (iv) biomass: 16%; (v) heat: 8%. The final energy demand of the residential sector is dominated by electricity. The most significant change, compared to the previous year, can be seen in the share of biomass with an increase by 8 %.

- **Energy Intensity:** Total primary energy consumption per dollar of gross domestic product was in Croatia in 2004: 8 MJ. Primary energy intensity is an indicator to show how much energy is needed to produce one quantity of economic output.

2. Prospects for Energy Savings

The First National Communication to the United Nations Framework Convention on Climate Change gives the following figures on energy saving potentials:

- Low-Temperature Heat Generation: 2.1% in 2005 - up to 0.4% in 2030.
- Industrial Electric Motors Efficiency Improvement: up to 7.5% of electricity, so that this figure is set up as an objective in the mitigation scenario. In that way it would be possible to conserve energy and save from 254 GWh in 2010 up to 487 GWh in 2020.
- DSM Measures in Non-Heat Electricity Use: The overall savings potential is estimated at around 24 GWh in the beginning and around 50 GWh at the end of the planning period. A more intensive use of the district heating systems enables saving of about 6.3% of the overall final energy from the baseline scenario.
- DSM Measures in Households (Low-Energy Bulbs and Refrigerators): The potential of electricity consumption trimming ranges from 93 GWh at the beginning of the observed period to almost 600 GWh at its end.

[Source Croatia: GreenNet-EU27, EEG Database, Enerdata, enerCEE.net, Dr. Nenad Keseric]

AI.4 Macedonia

1. Energy Demand and Energy Intensity

- **Energy Demand:** Total primary energy consumption in Macedonia in 2006 was 115.78 TJ. 49.84 % of the country's primary energy demand are covered by imports of, mostly, oil and coal (oil 38.01 %, coal 3.33 %, gas 2.38 %, electrical energy 5.99 %).

- **Demand per Sector:** Energy consumption in industry is characterized by a high level of electricity use in metal processing industry and low efficiency in electricity generation, supply and consumption. As regards the residential sector, the practice of using electricity for heating by residential users during winter leads to very high electricity consumption in this sector. Final energy consumption per sector in Macedonia in 2005 is as follows: (i) households, services and agriculture: 47,9%; (ii) industry: 28,8%; (iii) transport: 20,7%; (iv) non-energy use: 2,6%. Final energy demand in the residential sector was in Macedonia in 2005: (i) electricity: 52,8%; (ii) biomass: 30%; (iii) heat: 9%; (iv) oil: 7,8%, (v) solid fuels: 0,8%.

- **Energy Intensity:** Total primary energy consumption per dollar of gross domestic product in 2002 was 22,857 Btu (24 MJ). Macedonia's primary energy intensity is 40 % above the average of the EU 15. The reason for the high-energy intensity can be traced to: (i) heavy use of energy in metal processing industry; (ii) low-efficiency power generation, supply and consumption; (iii) the prevalence of using electric energy for residential heating during the winter.

2. Prospects for Energy Savings

Macedonia has a considerable untapped energy conservation potential, unlocking of which would help to maintain energy balance. The strongest indication of this potential is the high energy intensity. The Energy Strategy states, that the adoption of well-proven and readily available technologies including efficient appliances, controls and insulation will ensure the reduction of energy consumption, allow to postpone investment in new facilities and the reduction of emissions.

The World Bank in its 2004 Energy Policy Paper for Macedonia states the following barriers hampering the investment in energy efficiency (EE) projects, most notably:

- lack of awareness, information, and confidence on the part of Small and Medium Enterprises (SMEs), Government/budget entities, and residential consumers, on the efficiency of EE investments and technology,
- lack of capacity in EE project development, including engineering, installation, and monitoring of energy efficiency measurers,
- lack of understanding and capital available through Financial Institutions (FIs) for EE investments,
- perceived risks of EE investments by FIs,
- low price of electrical energy,
- weak economical condition of companies and householders.

The thrust of the realization of the measures foreseen Energy Strategy would be to improve the investments climate for EE and RE. The World Bank is providing support through a new GEF grant project, with the objective to remove barriers for investments in sustainable energy, defined as energy efficiency and renewable energy. The GEF project will support development of the Energy Efficiency and Renewable Energy Strategy.

The implementation of the energy programs foreseen in the Energy Strategy could achieve savings of a total of 128,780 MWh (low scenario) or up to 232,448 MWh (high scenario). The highest savings potential is given in the residential sector (59,883 MWh in the low scenario). In industry and agriculture, 34,771 MWh could be saved, whereas 4,508 MWh could be saved through improvements in street lighting.

In 2004, the Macedonian government adopted the "Energy Efficiency Strategy until 2020". It focuses on the implementation of technologies to provide for efficient energy use, and provides guidance for the energy efficiency policy in the Republic of Macedonia.

As reasons for the slow implementation of energy efficiency as well as renewable energy projects, the Energy Regulatory Commission names lack of information, awareness and confidence in the industry sector as well as the government agencies and the population, a lack of institutions to develop these projects, plan and monitor them, further the lack of institutional framework for renewable energy projects and also a lack of capital and absence of mechanisms for favorable long-term credits.

The following elements are foreseen in the strategy:
Institutional and capacity building:

- Establishment of the Energy Efficiency Agency
- Introducing Certificates for Energy Auditors
- Building energy codes
- Equipment standards
- Energy Efficiency Fund

Technical programs:

- Residential building program
- Commercial building program
- Institutional building program
- Industrial programs
- Street lighting programs

In the residential sector, the following measures should be implemented: consumption based billing, extension of district heating systems, insulation of windows, reflection shields for radiators, and thermostatic valves. Where possible, the shift from electricity to natural gas for heating should be achieved, or otherwise insulation of the building shell implemented.

Industry with an energy intensity 5 times higher than industry in England or France, the measures target at substitution of electric engines and drives, avoiding the conversion of electricity to heat, saving measures at lighting systems, air compressors, thermal insulation and improved capacity factor.

In the commercial and institutional sector, the improvement of buildings, heating systems and lighting and efficient use of air conditioners are mentioned. In the area of street lighting, the substitution of existing lamps by HPS lamps savings of 10-40%, by introduction of controls (turning off the light when it is not used) 25-50 % are expected. The return of investment in street lighting is estimated with 1 year or less, whereas in the other sectors it is estimated at between 2 and 5 years.

[Source Macedonia: Enerdata, enerCEE.net, EEG Database, World Bank, ERC, Macedonian Centre for Energy Efficiency (MACEF), Dr. Nenad Keseric]

AI.5 Montenegro

1. Energy Demand and Energy Intensity

- **Energy Demand:** Final energy consumption was in Montenegro in 2003 45 GJ (1.08 toe) per capita.

- **Demand per Sector:** Final energy consumption by sector was in Montenegro in 2005: (i) household, services and agriculture: 40%; (ii) industry: 27%; (iii) transport: 25%; (iv) non-energy use: 8%. Final energy consumption per fuel was in Montenegro in 2005: (i) electricity: 51%; (ii) oil derivates: 38%; (iii) wood: 7%; (iv) coal: 3%, (v) others: 1%. Final energy demand per fuel in residential sector was in Montenegro in 2005: (i) residential: 45,3%; (ii) biomass: 25,1%; (iii) heat: 11,8%; (iv) solid fuels: 10,4%; (v) gas: 6,5%; (vi) oil: 0,8%.

  Due to very high consumption of Aluminium Smelter Podgorica (KAP), Montenegro has gross per capita electricity consumption of 6.500 KWh annually. KAP participates on gross consumption with 44 %.

- **Energy Intensity:** Energy intensity factor is very high, e.g. in 2003 – 18 MJ/EUR (0.432 kgoe/EUR).

2. Prospects for Energy Savings

Considering RES potential, main focuses of Energy Efficiency strategy and low-energy intensity of whole economy is the agreed path to sustainable development. The main tasks are:
- Energy efficiency in building stock,
- Energy efficiency in industry – energy management in industry,
- Substitution, where possible and progressive use of renewable energy sources,
- Rationalization and increased efficiency in transport,
- Establishing of energy efficiency units in Montenegro (CJEE),
- Regulatory and legislative changes,
- Sub – regulatory measures,
- International co-operation,
- Internationally related economic programs within energy sector.

In line with the economic development of the Republic of Montenegro, and also with the energy practices and relevant standards for candidate countries for EU accession, Energy Policy particularly outlines the need to establish adequate legal, institutional, financial and regulatory frameworks required for sustainable development of the energy sector. Together with the national energy strategy document (Energy Development Strategy of the Republic of Montenegro), the Energy Policy defines the role of energy undertakings in the reform process of the energy sector and encourages both domestic and international investors to invest in new energy facilities.

This Energy Policy identifies the goals and objectives, as well as the instruments to be used by the Government of the Republic of Montenegro, aimed to develop the energy sector with respect to:
- Secure and reliable power supply,
- Environmental protection,
- Ownership,
- Market operation,
- Investments,
- Energy efficiency,
- New renewable resources,
- Regional and broader integrations,
- Social protection measures
- Others.

[Source Montenegro: Enerdata, enerCEE.net, EEG Database, Energy Efficiency Strategy Government of Montenegro, Dr. Nenad Keseric]

AI.6 Serbia

1. Energy Demand and Energy Intensity

- **Energy Demand:** The gross primary energy consumption in Serbia in 2004 was 13,4 Mtoe.

- **Demand per Sector:** Final energy consumption by sector was in Serbia and Montenegro in 2005: (i) households, services, agriculture: 40%; (ii) industry: 27%; (iii) transport: 25%; (iv) non-energy use: 8%. Final energy demand of the residential sector was in Serbia and Montenegro in 2005: (i) electricity: 45,3%; (ii) biomass: 25.1%; (iii) heat: 11,8%; (iv) solid fuels: 10,4%; (v) gas: 6.5%; (vi) oil: 0,8%.

- **Energy Intensity:** Total primary energy consumption per dollar of gross domestic product in 2002 was 47,814 Btu.

2. Prospects for Energy Savings

Primary energy consumption in Serbia declined between 1990 and 2002 by 21%. Between these two years much political and economical turbulence happened in the region and as result the data for these years become completely irregular. The year 1990 was the last one that can be treated as regular, and 2002 was the year when the country has started to recover in political and economical sense. Unfortunately, decrease of the primary and final energy consumption does not mean increase in energy efficiency, but is the consequence many dramatic political, social and economical shocks that happened in Serbia.

The most important aspects of rationalization, and increased energy efficiency in consumption and reduction of electricity losses are as following:

- **Rationalisation in Electricity Consumption:** Application of measures which should lead to better electricity consumption efficiency has begun and shall be intensified:
  -> Establishing favourable price parities regarding electricity and other forms of energy through price corrections and application and improvement of the tariff system, which should first of all discourage its application for heating purposes.
  -> Encouraging the application of energy-saving materials and devices (e.g. Compact fluorescent bulbs etc).
  -> Information programmes, media campaigns etc.
  -> Reduction of electricity losses - The share of total losses in the total annual electricity consumption shall be reduced from nearly 19 percent in 1998 to 14.6 percent in 2006. Reduction of currently very high losses in distribution shall be achieved by: (i) more efficiently preventing theft of electricity and transferring it to regular consumption, (ii) constructing priority plants on the network, (iii) activating the existing ones and installing new facilities for compensation of reactive power, (iv) improving consumers' measuring and controlling connections.

- **Three crucial elements of sustainable development:** (i) competitive energy markets, (ii) environment protection, (iii) energy efficiency and use of renewables.

  Competitive electricity markets are already at the centre of intense political discussions with the ongoing restructuring of the energy markets. Though the outcome of the discussion has not yet been established, it can be asserted that the current energy system will not remain in its present shape. It will certainly not be revolutionized, especially not in the first years, but pressure from the Regional Electricity Market after 2006 and the growing integration with the European Union will favour this market transformation process. Energy policy has to promote this process, though the speed with which this can be carried out depends on many factors.

  The integration of energy efficiency improvement (and of renewables) as permanent, basic principle for the energy system, is still far from being achieved in reality, although the strong emphasis in Energy Law and the early introduction of the Serbian Energy Efficiency Agency are a good starting point.

Special EAR (European Agency for Reconstruction) Fund Program supervised by Serbian Energy Efficiency Agency has the following targets:

-> Industry
- Energy Audits and Energy Saving Potential in Industry
- Training Program in Industry and Demonstration Projects
- Awareness Campaigns in Industry

-> Municipal and Public Buildings
- Training Program in Energy Auditing in municipal and public buildings
- Energy Efficiency standards for the new buildings
- Demonstration Program for EE projects in existing buildings
- Awareness campaign

-> Municipal Sector
- Municipal Energy Management and Planning
- Energy Efficiency in Municipal Services
- Energy Efficiency in District Heating
- Awareness and Dissemination Campaigns

[Source Serbia: Enerdata, enerCEE.net, EEG Database, Serbian Ministry of Mining and Energy, Dr. Nenad Keseric]

AI.7 Turkey

1. Energy Demand and Energy Intensity

Located in southeast Europe and southwest Asia, Turkey has a population of about 67 million and has a surface area of 780,580 km2. Agriculture represents 14% of GDP, with 40% of the population working in this sector, industry represents 22% of GDP and services 64%. The Turkish economy has experienced an average annual growth of 5% for the past 20 years, although in 2000 and 2001 the country suffered a severe financial crisis from which it is only starting to recover. The State, which traditionally played a major role in the economy, is gradually implementing reforms aimed at decreasing its role.

Energy demand has grown constantly since 1973, at a similar rate to that of GDP. Energy intensity has remained constant, which is unusual in OECD countries, where there has been a considerable decline in energy intensity from the 1970s to the 1990s. Energy intensity is higher than the OECD average for GDP measured at market prices, but similar if purchasing power parity is taken into account.

The only indigenous energy resources available in significant quantity in Turkey are hydro and lignite. The country is very dependent on foreign energy imports. In 2002 the degree of dependence was 65% and, according to projections from the Ministry of Energy and Natural Resources (MENR) this figure is going to increase to 83% by 2030. Electricity demand is also expected to experience considerable growth, from 133 TWh in 2002 to 566 TWh in 2020 (according to MENR), the increase being covered by natural gas fired generation.

The industrial sector represents around 38% of Total Final Consumption (TFC) and is therefore the main focus of energy efficiency policy. The residential sector with around 34% of TFC is also targeted. All industrial establishments consuming more than 2000 toe of energy per year must set up an energy management system. These establishments must also do audits in order to determine their energy savings potential. The National Energy Conservation Centre (NECC) has played a major role in providing the appropriate training.

2. Prospects for Energy Savings

Industry

There is no general energy conservation law in Turkey, but there is a 1995 Regulation on the rational use of energy aiming at increasing efficiency in industrial energy use. As industry consumes almost 40% of TFC, this sector has been given priority in energy efficiency policies and programmes. According to this 1995 Regulation, all establishments consuming over 2000 toe of energy per year must set up an energy management system. This affects some 600 industrial establishments, out of 10,000, and they represent 70% of the total industrial consumption in the country.

In March 2000, a project agreement was signed between EIE/NECC and the Japan International Co-operation Agency (JICA). The project aims at solving potential problems associated with infrastructural deficiencies in promoting energy savings and establishing a common basis in the industrial sector. It encompasses efficiency courses with practical applications, including training, technology and information transfer, as well as donations for the acquisition of the necessary equipment. A training centre, which contains a model factory with equipment such as a boiler, a furnace, an air pressure system and a fan and a pump system, was established. The plant began operation on 21 October 2001. It is expected that within 5 years most energy managers will be trained and an efficiency increase of 10% will be achieved throughout Turkish industry by 2020 (complementing and strengthening the training programme of NECC). The project is not only directed to Turkish industry, but it is open also to neighbouring countries. NECC aims to act as an international/regional centre. The first international energy managers course was held in co-operation with the United Nations Asian Pacific Countries Economic and Social Commission (UN-ESCAP) on 4-14 June 2002 for participants from Central and West Asian Countries. The centre will act as an international centre where courses will be organised for the participants from the Black Sea, Balkan, Middle East, Asia and Mediterranean countries in the near future.

Buildings

The building sector accounts for 34% of the TFC and 43% of the electricity consumption. On the basis of a survey carried out nationwide by the State Institute for Statistics (SIS) in 1998 it was found that only 10% of residential buildings had good roof insulation and only 12% had double-glazing. About 86% of the housing units were heated with stoves, while the other 14% had central heating systems. EIE collected data for public buildings. This survey showed that 40% had roof insulation and 48% double glazing, and only 17% of their heating systems were equipped with automatic control devices. With this data it is estimated that the potential for energy conservation in the residential sector is 50%, while the potential for public buildings is 30%. Hence, together with the industrial sector, the building sector is a priority for energy efficiency policy.

There are a number of legislative measures aimed in the building sector:

- National insulation standards for new buildings (TS 825) were issued in June 1999. These standards set thermal insulation standards for new and existing buildings where renovation with 15% ratio or more is carried out. Their mandatory application started in June 2000. TS 825 defines rules for the calculation methods of heating energy requirements in buildings and is in compliance with international standards. It divides Turkey into four climatic zones (depending on average temperature) and limits heat loss from the building envelope. Heat loss limits have been reduced by half compared with the old standards.

- The TS 825 standard was complemented by the Regulation on Heat Insulation in Buildings, issued on 8 May 2000. It sets limits for annual heating energy requirements of buildings, which are different depending on the climatic zone (defined in the TS 825 standard). Inspections related to heat insulation must be conducted in all phases of the construction by the municipalities in the urban areas or by the governors in other areas. This regulation also introduces an obligation for new buildings to possess an energy certificate ("identity certificate of heat requirement") that shows it energy consumption per m_2 and per m_3. The certificate should be included in the file of the building administrator, and a certified copy should be displayed at the entrance of the building.

- It is expected that the annual energy consumption of new buildings will be reduced from 200-250 kWh/m2 to 100-120 kWh/m2. According to IZODER, the Turkish Association of Insulation Companies, only 2.4% (as of the second half of 2002) of existing dwellings are subject to the TS 825 standard.

- Double-glazing for new buildings is now compulsory, and 70% of new buildings have it. There are some obstacles to encouraging this practice further:
  -> Consumers have other priorities than insulation due to their low income level and severe impediments of the economic crisis;
  -> Not all buildings in big cities are licensed or registered;
  -> In apartment buildings with central heating, the costs of heating are shared by everyone living in the building giving no incentive to promote energy efficiency.

- The monitoring of the implementation of insulation regulations is done in two ways:
  -> For public buildings constructed under the control of the Ministry of Reconstruction and Resettlements, controlling and monitoring is carried out by the provincial directorates under the supervision of the governor;
  -> For private buildings this function is carried out by the "Building Inspection Agencies" under the control and inspection of the municipalities (developed after the 1999 earthquake when monitoring became stricter). These agencies are authorised by the Ministry of Reconstruction and Resettlements. They use building control firms to carry out the inspections.

The main sources of heating in the residential sector are biomass (6,38 Mtoe), petroleum products (3,68 Mtoe), gas (2,69 Mtoe), electricity (2,05 Mtoe) and coal (1,68 Mtoe). The Government is encouraging switching to natural gas where this is available. The distribution of natural gas is undertaken through municipalities, which generally own the gas distribution companies:

- In 1997, a Circular was issued on measures to be taken by governmental institutions to reduce energy consumption in the building sector. Measures to be undertaken include:
  -> Monitor energy consumption;
  -> Create awareness among the personnel on how to limit energy consumption;
  -> Use low consumption office equipment;
  -> Use daylight as much as possible and automatic switch-off of lighting during non-office hours;
  -> Avoid electric heating;
  -> Limit the use of air conditioning;
  -> Decorative lighting is to be paid by the municipalities that use it.

- In October 2000 another Circular was issued in order to initiate an action nationwide to decrease electricity consumption following the period of potential constraints on electricity supply due to the drought season. Between October 2000 and May 2001 a number of measures such as reducing the number of lamps in public buildings, adjusting the working hours to daylight and decreasing the level of street lighting were applied.

- An agreement was signed between the Turkish and the German Government for the project "Efficient Utilisation of Energy in the Building sector in Turkey". The project will be carried out in co-operation with the German Technical Co-operation Agency (GTZ), EIE and the municipality of Erzurum (located in the Eastern Anatolian region). It aims to establish an energy efficiency unit in this municipality and will include training programmes, energy efficiency policy studies for cities and preparation of standards and regulations for energy efficiency. The project also aims at reduction of environmental pollution at city level. The project is planned to last for 3 years.

- The project was initiated in November 2002. Two separate project teams were established in Erzurum and at the EIE. At present, activities are underway to prepare the plan of operation in order to specify the detailed time schedule for implementing the envisaged activities. Aworkshop will be organised in April with participation of entities from both the private and the public sectors.

- Pilot demonstration projects will be carried out in Erzurum in order to provide the necessary input for developing the related legal arrangements for heat insulation and efficient use of energy.

- The EU Energy Labelling Directives for refrigerators and freezers, washing machines and dishwashers have been implemented into Turkish legislation. For refrigerators and freezers, application started on 24 September 2002 and for washing machines and dishwashers it is planned to start on 20 February 2003.

- The Turkish households appliance sector is represented in CECED (European Household Appliance Organisation) and CEN (European Normalisation Committee) and EU energy and environmental standards are applied to these domestic products. ARCELIK, the biggest appliance manufacturer in Turkey, reported that energy consumption in household appliances had decreased by around 40% over the last 15 years. And, as in the EU, Turkish household appliances do not use ozone-depleting substances such as CFC gases.

[Source Turkey: EE-Review of Turkey of the Energy Charter Secretariat, Bosseboeuf/Lpillonne (2006), enerCEE.net, EEG Database, Dr. Nenad Keseric]

ANNEX II ENERGY EFFICIENCY SUPPORT SCHEMES COVERED BY GREENNET-EUROPE

In the following, the economical supportive schemes for energy efficiency measures being included the **GreenNet-Europe** model are presented. Practical schemes adopted in different European countries, however, are often designed trough the integration of different supportive mechanisms: for example in Italy a demand quota system is integrated with a granted tariff scheme (including a cap to the budget).

AII.1 Investment Incentives

The **GreenNet-Europe** model simulates the effects of investment incentives as a percentage of total investment cost for the electricity saving technologies. In practise, investment incentives are restricted to a specific budget allocation. This fact is also considered in the **GreenNet-Europe** model. Analytically, investment subsidies are expressed by the following equations:

$$\tilde{p}_e * q_{el} + I * CRF + C_{O\&M\ Nel} - \beta * I * CRF = \tilde{p}_e * q_{A\ el} + I_A * CRF_A + C_{A\,O\&M\ Nel}$$

$$\tilde{p}_e = \frac{((1-\beta) * I * CRF - I_A * CRF_A) + (C_{O\&M\ Nel} - C_{A\,O\&M\ Nel})}{q_{A\ el} - q_{el}}$$

subject to: $\sum_{i=1}^{n} \beta * I < Budget$

where

$\tilde{p}_e$ .... (Minimum) electricity unit price for energy efficiency technology to be economic, considering possible tariffs, grants, benefits, etc: [€/MWh]
q_{el} .... Electricity consumption per unit output produced [MWh/output]
I .... Investment cost of energy efficiency technology per unit output produced [€/output]
CRF .... Capital recovery factor: $CRF = \frac{z*(1+z)^{PT}}{[(1+z)^{PT}-1]}$
z .... Interest rate
PT .... Life time of energy saving technology [y]
$C_{O\&M\ Nel}$ .... annual O&M cost of energy efficiency technology per unit output [€/output]
q_{Ael} .... electricity consumption of alternative energy efficiency technology per unit output [MWh/output]
I_A .... annual investment cost of alternative energy efficiency technology per unit output [€/output]
CRF_A .... Capital recovery factor of alternative energy efficiency technology: $CRF_A = \frac{z*(1+z)^{PT_A}}{[(1+z)^{PT_A}-1]}$
PT_A .... Life time of the alternative technology [y]
$C_{A\ O\&M\ Nel}$ .... O&M annual cost of alternative energy efficiency technology per unit output [€/(output, y)]
n .... number of different technologies receiving investment subsidies
$Budget$ .... maximum amount of total grant for year n for several technologies [Million Euro/y]

With an investment incentive scheme, the switch price for the implementation of an energy efficiency technology will be reduced: $\tilde{p}_e < p_e$

AII.2 Tax Incentives

In the **Green*Net-Europe*** model it is assumed that tax incentives are granted to investments into energy saving technologies. In contrast to investment subsides, however, it is assumed that the budget for the tax incentives scheme is not restricted.[9] Analytically this means:

$$\tilde{p}_e * q_{el} + I * CRF + C_{O\&M\ Nel} - \beta * I * CRF = \tilde{p}_e * q_{A\ el} + I_A * CRF_A + C_{A\,O\&M\ Nel}$$

$$\tilde{p}_e = \frac{\left((1-\beta) * I * CRF - I_A * CRF_A\right) + \left(C_{O\&M\ Nel} - C_{A\,O\&M\ Nel}\right)}{q_{A\ el} - q_{el}}$$

where

$\tilde{p}_e$ .... (Minimum) electricity unit price for energy efficiency technology to be economic, considering possible tariffs, grants, benefits, etc: [€/MWh]

q_{el} .... Electricity consumption per unit output produced [MWh/output]

I .... Investment cost of energy saving technology per unit output produced [€/output]

CRF .... Capital recovery factor: $CRF = \frac{z * (1+z)^{PT}}{\left[(1+z)^{PT} - 1\right]}$

z .... Interest rate

PT .... Life time of energy saving technology [y]

$C_{O\&M\ Nel}$ .... annual O&M cost of energy efficiency technology per unit output [€/output]

q_{Ael} .... electricity consumption of alternative energy efficiency technology per unit output [MWh/output]

I_A .... Investment cost of alternative energy efficiency technology per unit output [€/output]

CRF_A .... Capital recovery factor of alternative energy efficiency technology: $CRF_A = \frac{z * (1+z)^{PT_A}}{\left[(1+z)^{PT_A} - 1\right]}$

PT_A .... Life time of the alternative technology [y]

$C_{A\ O\&M\ Nel}$ ..... O&M annual cost of alternative energy efficiency technology per unit output [€/output]

Note: In order to be able to calculate the electricity “switch price” in both cases, investment incentives and the tax incentives, the investments of both energy efficiency technology as well as “standard” technologies shall be known. Therefore, the costs of the unitary technology (for example an incandescent lamp versus a compact fluorescent lamp) should be included and not only the cost per kWh saved. In practice, however, it is not always possible to have these data available. Therefore, an additional approach (requiring less information) has been included into the **Green*Net-Europe*** model in order to able to simulate the effects of these kinds of energy efficiency policies.

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9 In practise this fact is expressed by the so-called „uniformity" principle, i.e. no one can be excluded from the scheme. Therefore, in the model the instrument "investment subsidy" and "tax incentives" differs in the model implementation just in the restriction of the available budget.

AII.3 Granted Tariffs

A simple approach is the so-called "granted tariff". With this support scheme, the investor receives a grant if particular energy saving technologies are installed or "standard" technologies are replaced. This means that each kWh saved will be granted by a payment. It is a similar approach to the one adopted in Italy in the framework of the *White Certificate Scheme*. In order to avoid high transaction cost it is assumed that the electricity saved refers to average savings of a standard technology (i.e. savings compared to a baseline). Quantifying actual savings is very difficult. For the "granted tariff" approach there is also a budget restriction implemented in the **Green*Net-Europe*** model. This approach is analytically determined by:

$$\tilde{p}_e * q_{el} + I * CRF + C_{O\&M\ Nel} - p_G * (q_{A\,el} - q_{el}) = \tilde{p}_e * q_{A\ el} + I_A * CRF_A + C_{A\,O\&M\ Nel}$$

Converted and compared with the corresponding equation for the "electricity switch" price without any support mechanism the following relationship occurs:

$$\tilde{p}_e + p_G = \frac{\left(I * CRF - I_A * CRF_A\right) + \left(C_{O\&M\ Nel} - C_{A\,O\&M\ Nel}\right)}{q_{A\ el} - q_{el}} = p_e$$

$$\tilde{p}_e = p_e - p_G \text{ subject to } \sum_{i=1}^{n} p_{Gi} * (q_{A\,el\,i} - q_{el\,i}) < Budget$$

where

- p_e .... (Minimum) electricity price for energy efficiency technology to be economic without any support: [€/MWh]
- $\tilde{p}_e$ .... (Minimum) electricity price for energy efficiency technology to be economic considering the granted tariff: [€/MWh]
- p_G .... Granted tariff for each kWh electricity saved compared to a standard technology [€/MWh]
- q_{el} .... Electricity consumption per unit output produced [MWh/output]
- I.................. Investment cost of energy saving technology per unit output produced [€/output]
- CRF............ Capital recovery factor: $CRF = \frac{z * (1+z)^{PT}}{\left[(1+z)^{PT} - 1\right]}$
- z.................. Interest rate
- PT .... Life time of energy saving technology [y]
- $C_{O\&M\ Nel}$ .... annual O&M cost of energy efficiency technology per unit output [€/output]
- q_{Ael}............... Electricity consumption of alternative energy saving technology per unit output [MWh/output]
- I_A .... Investment cost of alternative energy saving technology per unit output [€/output]
- CRF_A........... Capital recovery factor of alternative energy efficiency technology: $CRF_A = \frac{z * (1+z)^{PT_A}}{\left[(1+z)^{PT_A} - 1\right]}$
- PT_A............. Life time of the alternative technology [y]
- $C_{A\ O\&M\ Nel}$..... annual O&M cost of alternative energy saving technology per unit output [€/output]
- n................. number of different grant tariffs
- $Budget$......... maximum amount of total grant for several technologies [Mill Euro/y]

AII.4 Promotional Tariffs

An alternative approach is the promotion of special electricity price tariffs for particular energy efficiency applications. For each kWh consumed of this particular application, a guaranteed (reduced) electricity price is charged instead of the standard electricity price.[10] This approach has the advantage that actual consumption is charged instead of an estimated "average" saving. The disadvantage is that separate electric meters must be installed at each connection point of an energy efficiency application. The following analytical relationship occurs:

$$p_{pr} * q_{el} + I * CRF + C_{O\&MNel} = p_e * q_{A\ el} + I_A * CRF_A + C_{A\,O\&MNel} \qquad \text{with } p_{pr} < p_e$$

$$WTI = p_e = \frac{\left(I * CRF - I_A * CRF_A\right) + \left(C_{O\&MNel} - C_{A\,O\&MNel}\right)}{q_{A\ el}} + p_{pr} * \frac{q_{el}}{q_{A\ el}}$$

$$p_e = \frac{\left(I * CRF - I_A * CRF_A\right) + \left(C_{O\&MNel} - C_{A\,O\&MNel}\right)}{q_{A\ el}} + p_{pr} * \frac{q_{el}}{q_{A\ el}}$$

where:

p_e ....(Minimum) electricity price where the energy saving technology is economic: [€/MWh]
p_{pr} ....guaranteed electricity price (promotion tariff) when using energy saving technology: [€/MWh]
q_{el} ....Electricity consumption per unit output [MWh/output]
I ....Investment cost energy saving technology per unit output [€/output]
CRF ....Capital recovery factor: $CRF = \frac{z * (1+z)^{PT}}{\left[(1+z)^{PT} - 1\right]}$
z ....Interest rate
PT ....Life time of energy saving technology [y]
$C_{O\&M\ Nel}$ ....annual O&M cost of energy efficiency technology per unit output [€/output]
q_{Ael} ....Electricity consumption of alternative energy saving technology per unit output [MWh/output]
I_A ....Investment cost of alternative energy saving technology per unit output [€/output]
CRF_A ....Capital recovery factor alternative: $CRF_A = \frac{z * (1+z)^{PT_A}}{\left[(1+z)^{PT_A} - 1\right]}$
PT_A ....Life time of the alternative technology [y]
$C_{A\ O\&M\ Nel}$ ....annual O&M cost of alternative energy saving technology per unit output [€/output]

[10] Obviously, the promotion tariff must be lower than the „standard" tariff, otherwise no incentives exist to implement this tariff.

AII.5 Demand Quota

One option to promote energy efficiency technologies is to restrict demand (growth) to a certain level. More precisely, a fine (penalty) has to be paid for exceeding electricity consumption above a predefined level. A quota system on the demand-side can be implemented either as non-tradable system (with absolute targets in different sectors) or as a tradable system. In the latter case, trade of "demand certificates" is feasible between and within the sectors. The demand restriction imposed by the demand quota is expressed as follows:

$$D_{Quota\ n} = \left(1 + \frac{\alpha}{100}\right) \cdot D_{el\ n-1}$$

The demand-quota obligation may not be binding in all cases, e.g. if an increase of electricity demand is allowed for a new (industrial) customer (α high). In general, the actual demand is given by:

$$\widetilde{D}_{el\ n} = Min\left[D_{Quota\ n}, D_{el\ n}\right] = Min\left[\left(1 + \frac{\alpha}{100}\right) \cdot D_{el\ n-1}, D_{el\ n}\right]$$

where:

α………..	Quota restriction; maximum increase of total demand in year (n) compared to year (n-1) [%]; α can be positive (increase of demand) or negative (reduction of demand)
$D_{el\ n-1}$	Total electricity demand year (n-1) [MWh/y]
$D_{el\ n}$	Total electricity demand year (n) without demand quota [MWh/y]
$D_{Quotal\ n}$	Maximum total electricity demand year (n) imposed by the quota [MWh/y]
$\widetilde{D}_{el\ n}$	Actual total demand curve year (n) [MWh/y]

This situation is illustrated in Figure A1.1 below. As long as the electricity price does not increase dramatically, the quota system restricts total demand. For a high electricity price,[11] demand decreases due to economic efficiency of reduction of electricity demand beyond the quota level. This means that based on this assumption, electricity demand is less than the quota obligation $D_{Quota\ n}$. The actual total demand curve for year n is depicted by the full lines in Figure A.1 – the red line relates to binding quotas, the green line to demand decreased below the necessary level imposed by the quota.

[11] E.g., due to the implementation of low CO_2 targets or also supply shortages.

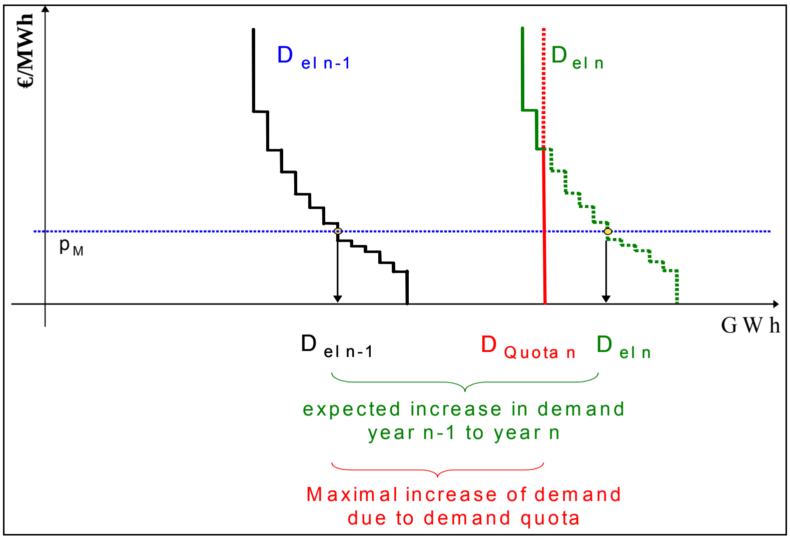

Figure AII.1: Demand quota: Determination of the demand curve

AII.6 Standards

Standards are a powerful instrument for implementing energy saving technologies for different end-uses and sectors. With an obligation to use efficient devices, a demand reduction is guaranteed.[12] As a 'command-and-control' instrument, no direct costs occur for administration. Nevertheless, costs may occur for the end user, since the end user must pay several additional costs themselves.

By introducing a standard it is assumed, furthermore, that the energy saving option is fully implemented. This means that the entire potential for demand reducing is used. The switch price is set zero for those technologies with a standard, see Figure A II.2.

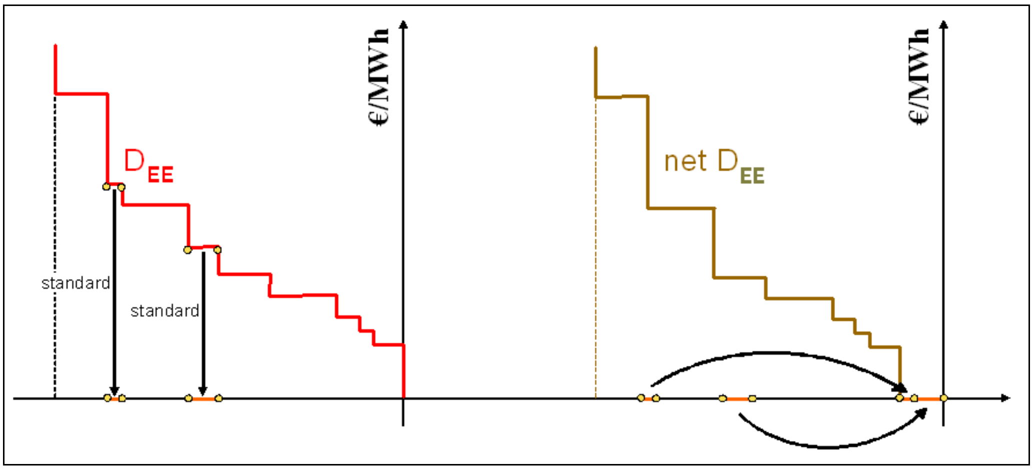

Figure AII.2: Determination of the net demand curve incl. the implementation of energy efficiency technologies assuming that for two technology-bands a standard is introduced

[12] Neglecting the rebound effect due to behavioural changes and switching to a higher service level.