

Potentials and Cost of Energy Efficiency Measures

Deliverable 3b

GreenNet-EU27

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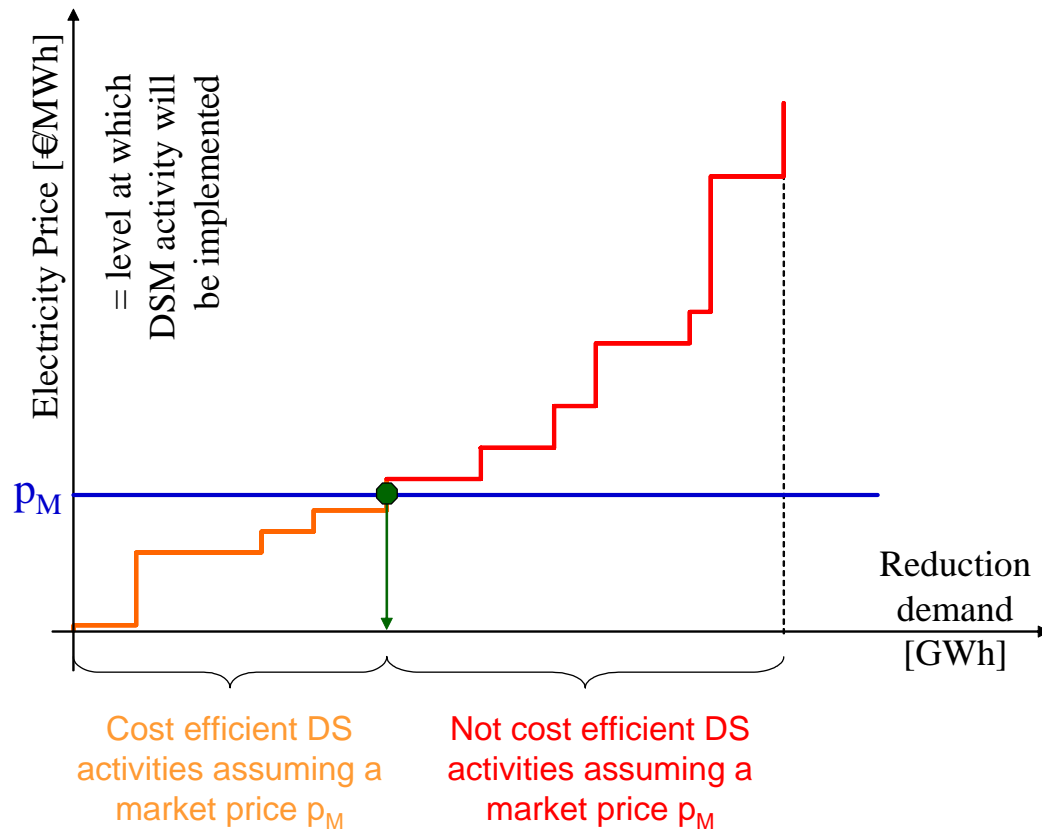
Outline

- How to include demand side options in the **GreenNet** simulation software?
- Definition of cost curves: Potential and costs for different EE-DSM Measures
- Sector / technology level
- Overview of results

Energy Efficiency Demand Side Measures

- Energy Efficiency Demand Side Measures are the energy efficiency activities for achieving an **overall reduction of primary energy supply** for end-use energy demand
- The aim of these activities is to reduce the total cost of energy services and to reduce primary energy consumption
- Typical activities investigated:
 - installation of efficient appliances or lighting devices
 - insulation measures
 - control system
 - fuel switching *where it implies a reduction of primary energy consumption*

Demand Side Measures



- Each possible Demand Side Activity is defined by the reduction of demand that it will generate (GWh) and its implementation costs (€/MWh)
- Given a price of electricity, we can therefore select cost efficient activities as those with a Cost of Conserved Energy lower than the price of electricity

Potential Savings

- The savings are calculated as the difference in consumption that the activity can generate
 - Insulation measures in buildings will reduce the consumption for heating during winter
- For efficient appliances we always consider the alternative appliance as the cheapest on the market
 - The saving generated by a new class A++ fridge freezer is the difference between its consumption and the consumption of the cheapest fridge freezer on the market (with the same volume)

Cost of Demand Side Measures

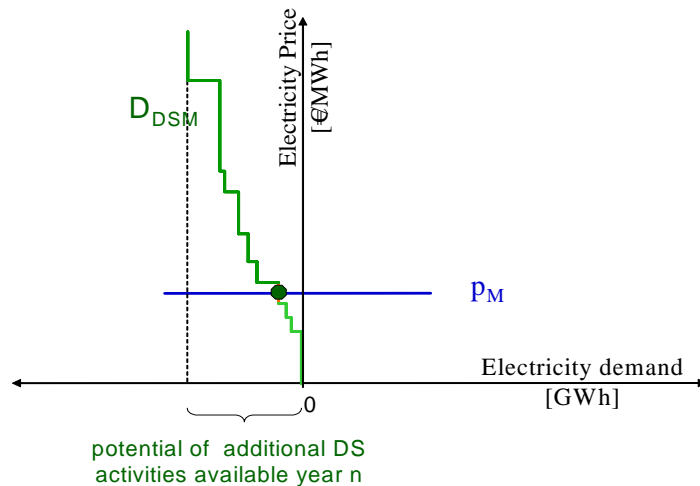
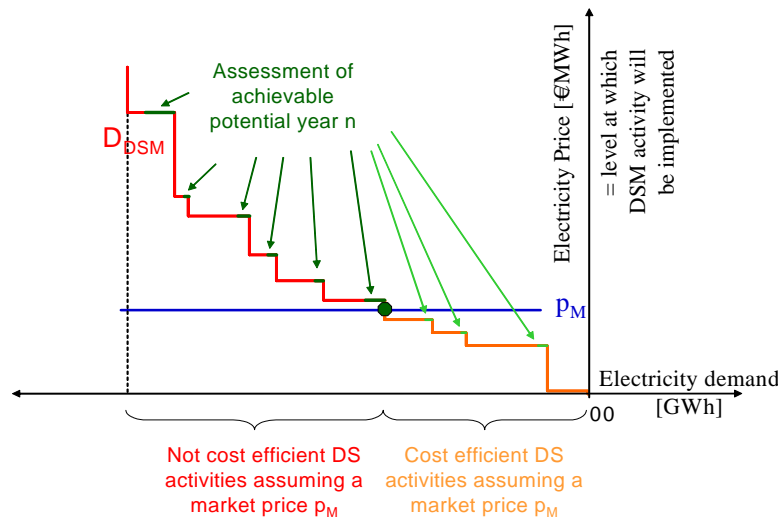
- The Cost of Demand Side Measures is the total cost incurred when implementing it
- In case of an alternative option the cost is the extra cost generated
 - The extra cost of a new class A++ fridge freezer is the difference between its price and the price of the cheapest fridge freezer on the market (with the same volume)
- In case the Demand Side Option generates new O&M costs, we include them in our analysis

The Cost of Conserved Energy

- When a Demand Side Measure is implemented it will generate saving for a number of years, depending on the technology
- When we calculate the cost of conserved energy (€/MWh) we will take account of all the savings generated
- The calculation of the Capital Recovery Factor is needed to take account of the depreciation
- Measures with no costs (behavioural changes, standby reduction, ...) cannot be included

$$CRF = \frac{z * (1 + z)^{PT}}{[(1 + z)^{PT} - 1]}$$

Demand Side Measures in the GreenNet Model



- The simulation model works on annual iterations
- Therefore the potentials were calculated on an annual basis as the % of the total saving potential achievable in year n

Sectors and end-uses

- Since costs may vary depending on the sector in which we implement a DSM measure, three different sector where highlighted
- For each sector, six different end-use were analysed

1. Residential	2. Industry	3. Tertiary sector
a. Single family houses		a. Commercial service
b. Multi-family houses		b. Public service
i. Space heating	i. Space and water heating	i. Space and water heating
ii. Sanitary (potable) hot water	ii. Air conditioning	ii. Ventilation – air conditioning
iii. Lighting	iii. Lighting	iii. Lighting
iv. Refrigeration	iv. Refrigeration	iv. Refrigeration
v. Electrical appliances	v. Motors/drives	v. Motors/drives
	vi. Compressed air	vi. ICT/office machinery

Domestic Demand Side Measures

- Space Heating
 - control devices
 - fuel substitution
 - ground insulation
 - roof insulation
 - wall insulation
 - double glazing
- Water heating
 - fuel substitution
- Lighting
 - efficient bulbs

For each measure we considered the most cost efficient option (e.g. the insulation technology with lower cost of conserved energy)

- Refrigeration
 - freezer
 - refrigerator
- Appliances
 - washing machine
 - dish washer
 - television

Tertiary and Industrial Demand Side Measures

- Space and water heating
 - Auto/manual control devices
 - Insulation
- Air conditioning
 - Auto/manual control devices
 - Insulation
- Lighting
 - High efficiency Lamps
 - High efficiency Fixtures
 - High Efficiency Ballasts
 - Occupancy Sensors
 - Daylight Control

Tertiary and Industrial Demand Side Measures

- Refrigeration *very small potential*
 - Thicker Insulation
 - Improved Insulation
 - Floating Head Pressure
 - Anti-sweat Heat Controls
 - Defrost Controls
 - High-Efficiency Fan Blades
- Motors
 - High Efficiency Motors
 - Variable speed drivers
 - All system redesign

Tertiary and Industrial Demand Side Measures

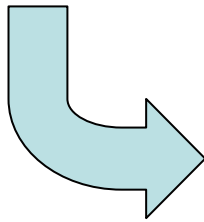
- *ICT only for tertiary sector*
 - LCD Monitors
- *Compressed air only for industrial sector*
 - Upgrading of compressor
 - Recovering waste heat
 - Overall system design
 - Reducing pressure losses
 - Reducing air leaks
 - Frequent filter replacement

Addressed Countries

- Cyprus - CY
- Estonia - EE
- Latvia - LV
- Lithuania - LT
- Malta - MT
- Slovenia - SI
- Bulgaria - BG
- Romania - RO
- Croatia - HR
- Switzerland - CH
- Norway - NO

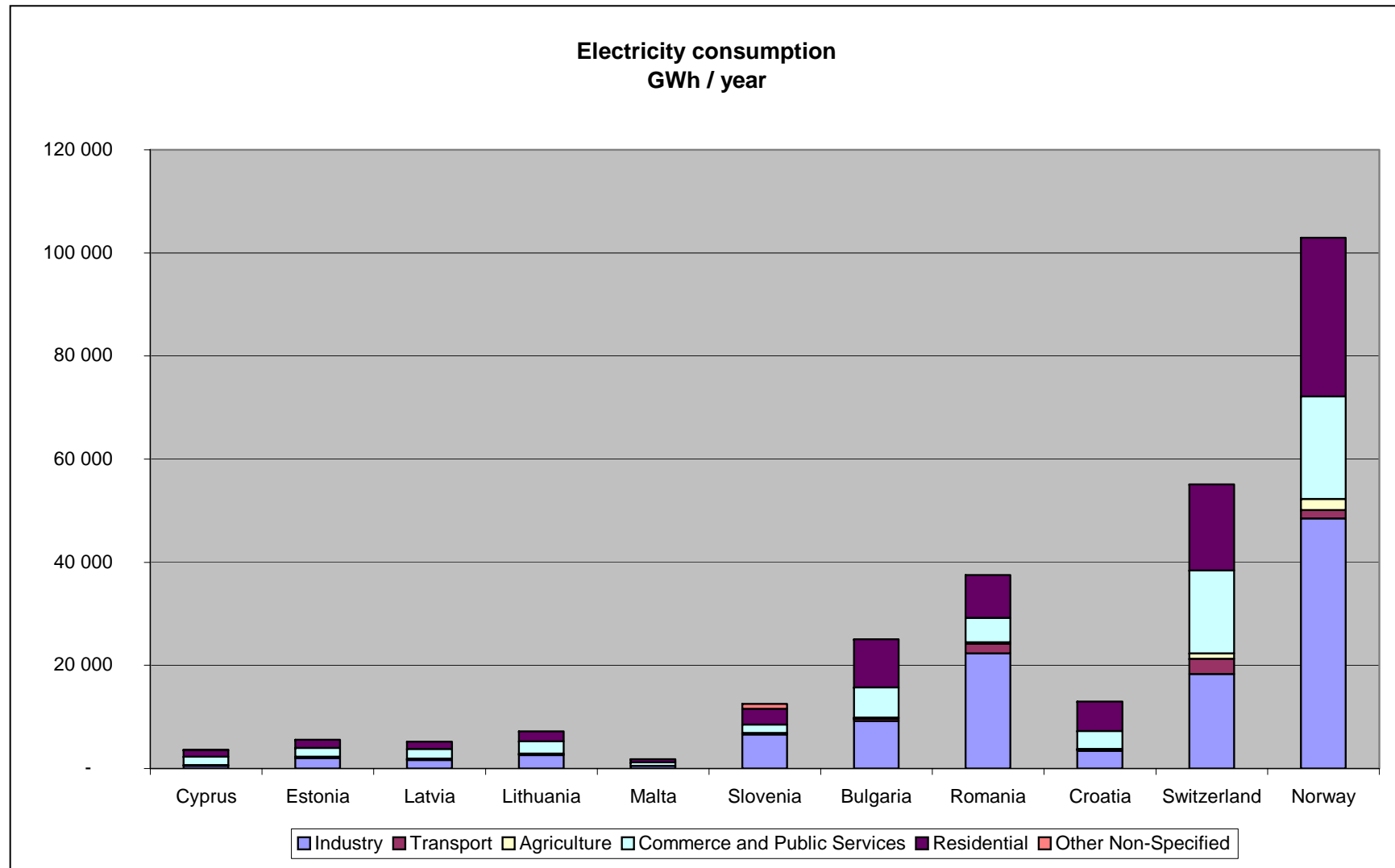
Data Sources

Investigated countries (except NO and CH) are not included in the *MURE* database

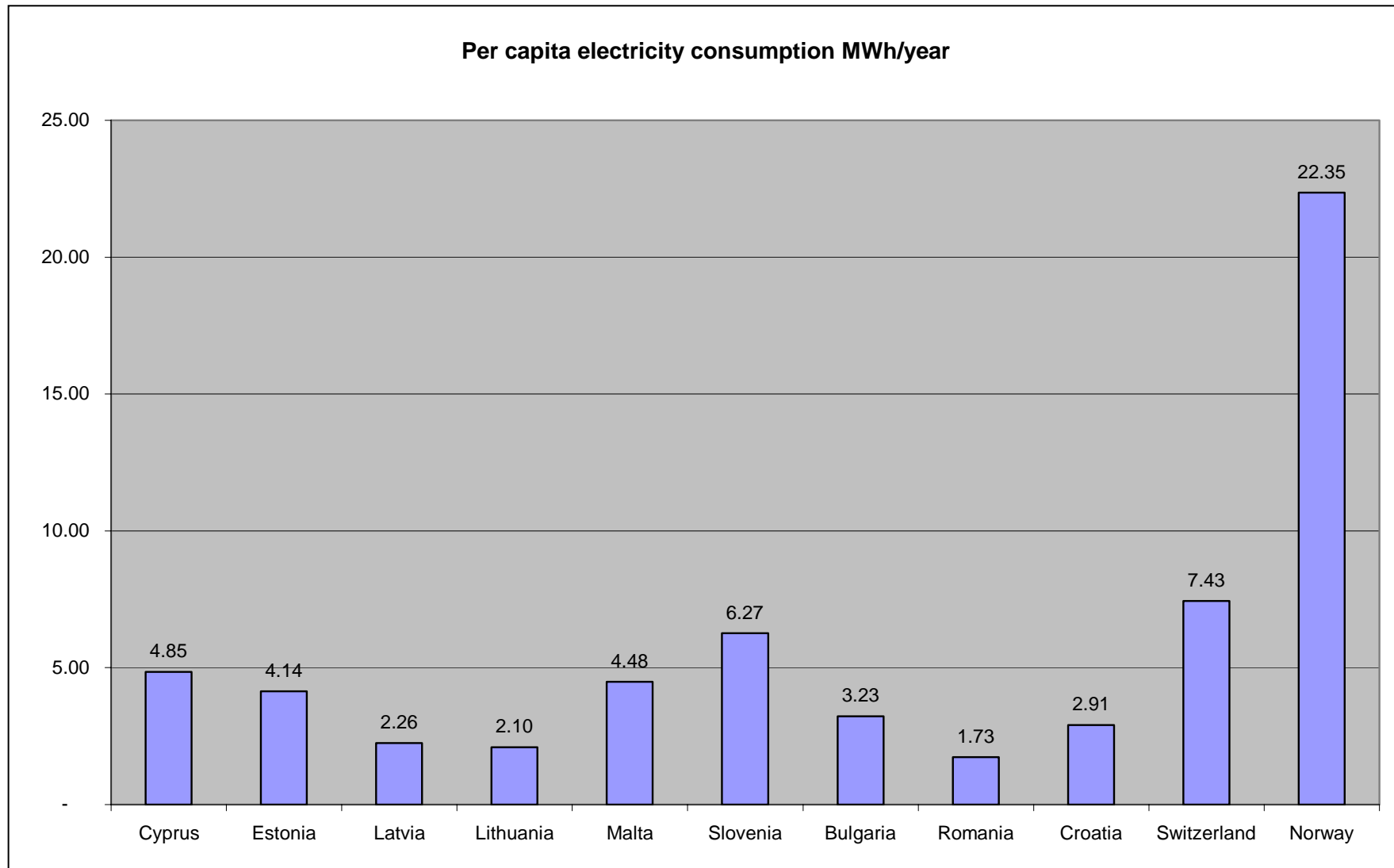


- ✓ National Statistical Offices
- ✓ National Energy Institutes
- ✓ IEA
- ✓ UNECE - United Nations Economic Commission for Europe
- ✓ CEEC Indicators - Energy Efficiency Indicators for Central and Eastern European Countries
- ✓ *Local consultants*

Electricity Consumption per Final Sector

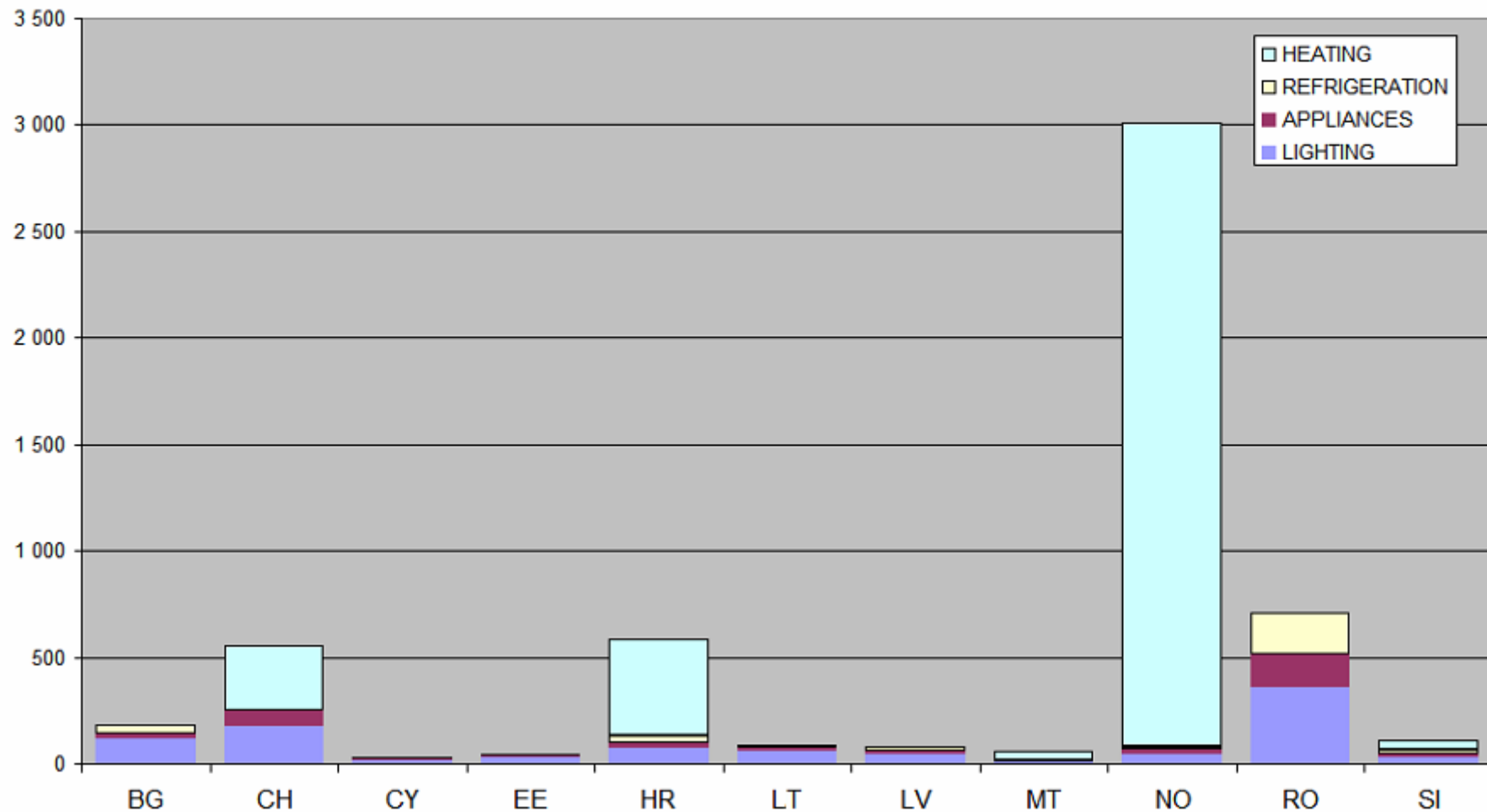


Per Capita Electricity Consumption



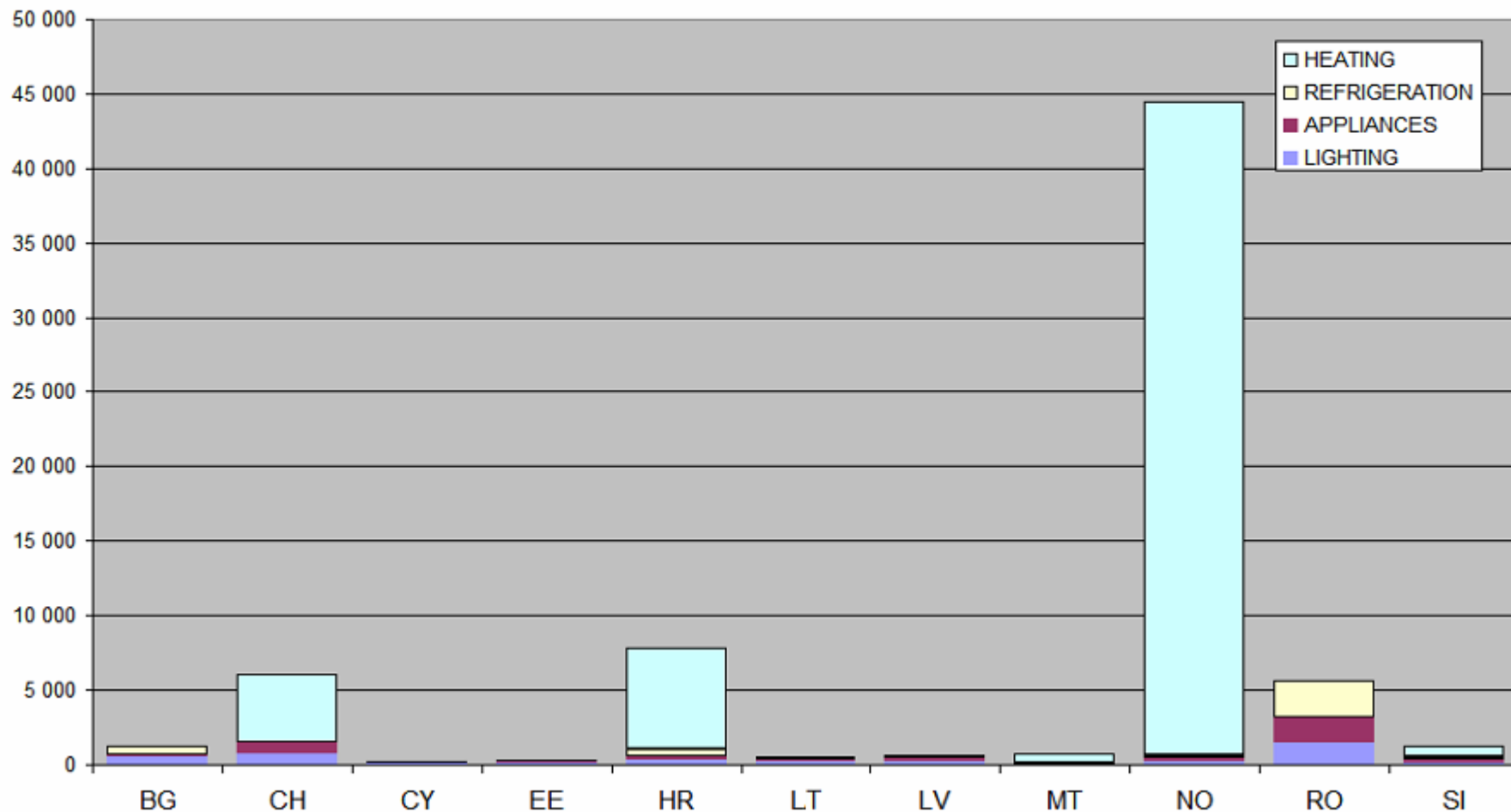
Resulting Potentials - Residential - Overview

Residential sector - Yearly additional saving potential (GWh/year)



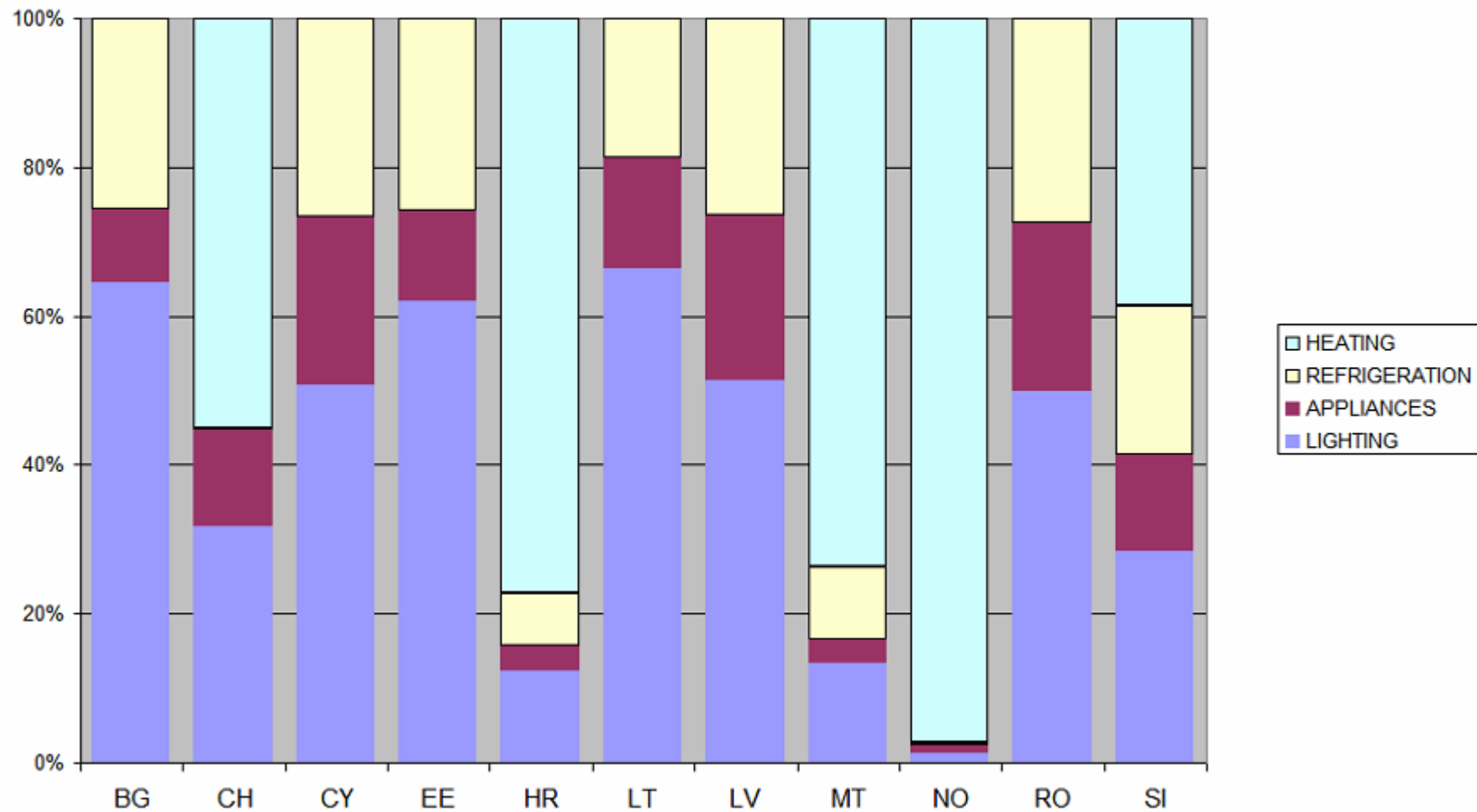
Resulting Potentials - Residential - Overview

Residential sector - Long term yearly saving potential (GWh/year)



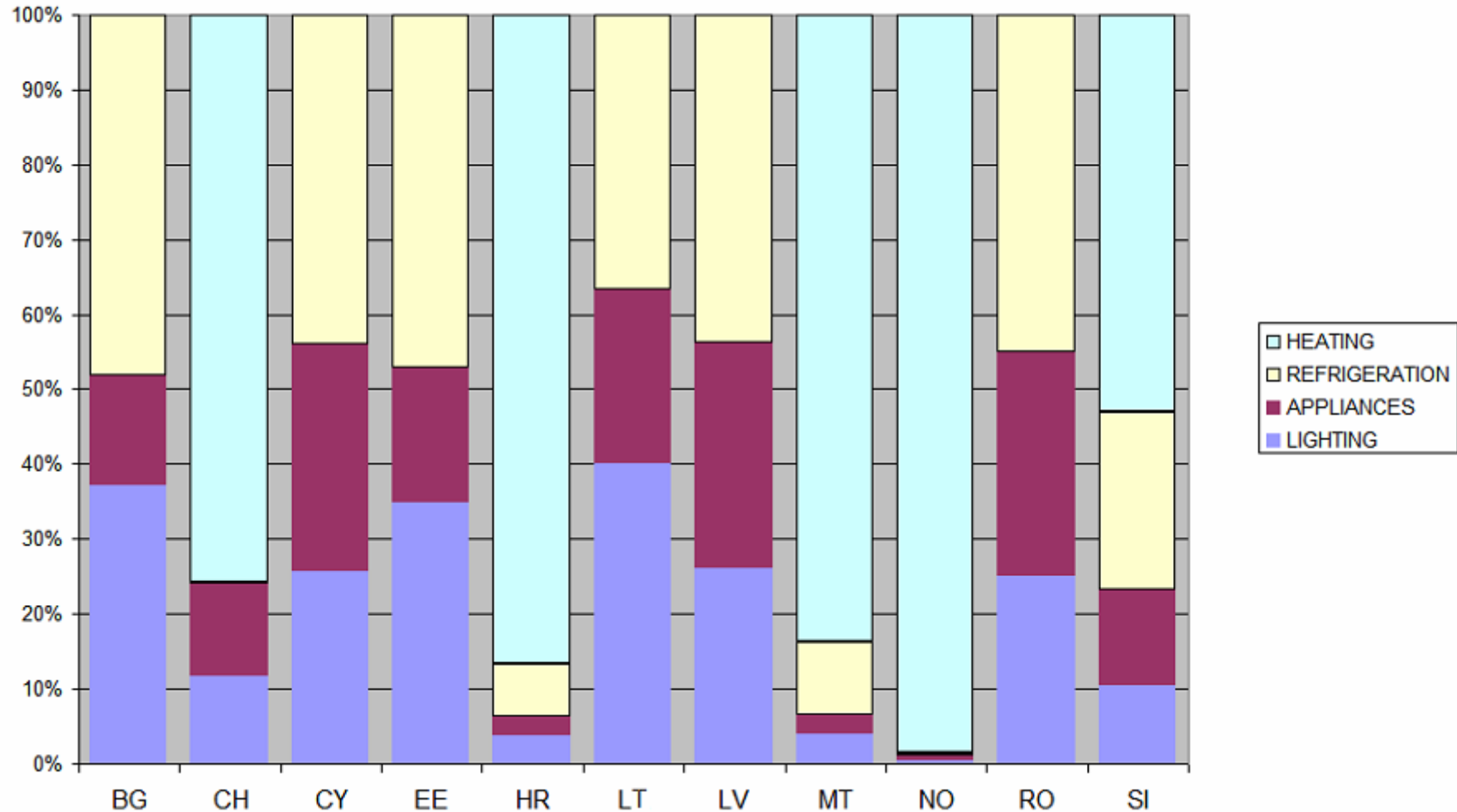
Resulting Potentials - Residential - Overview

Residential sector - Yearly additional saving potential



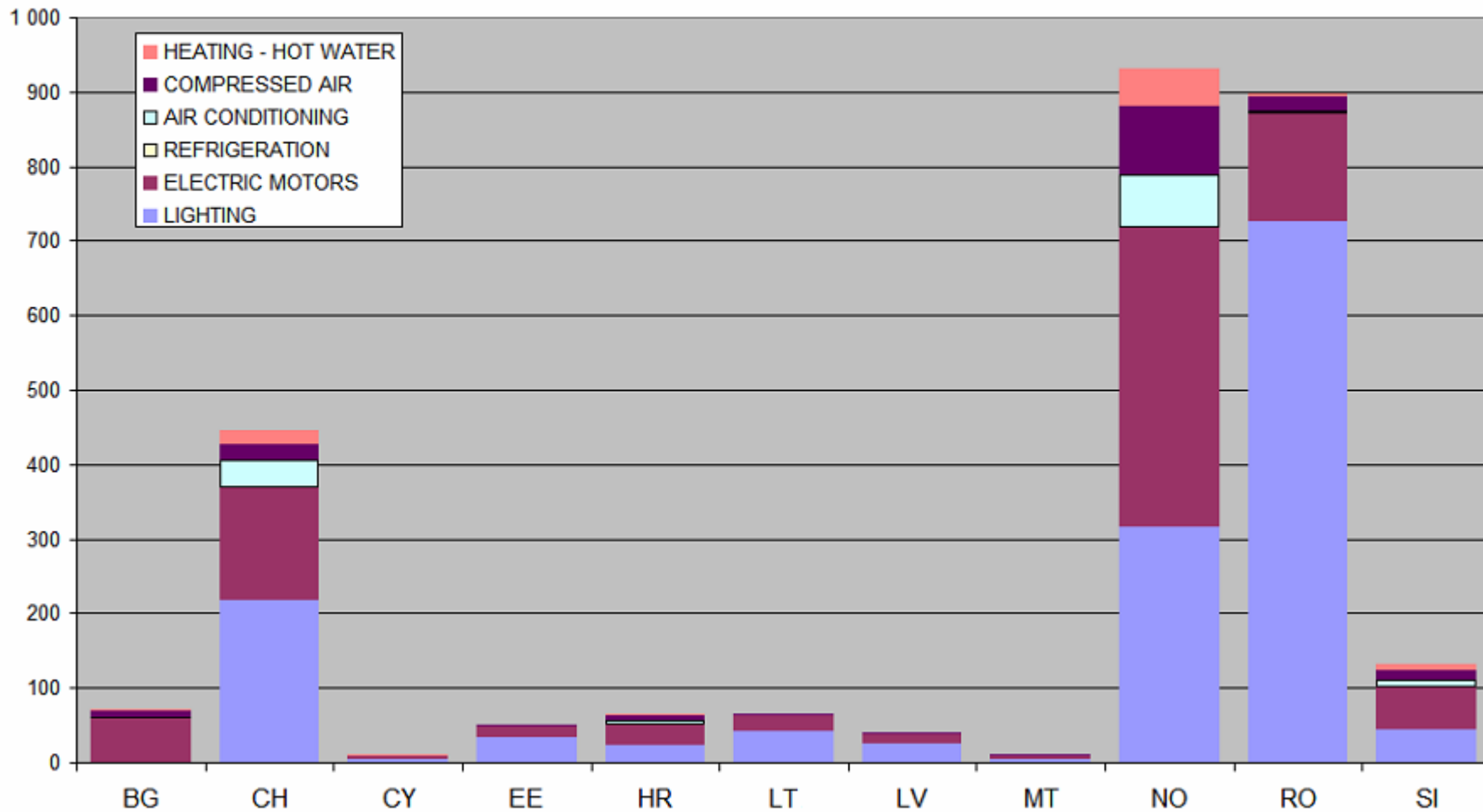
Resulting Potentials - Residential - Overview

Residential sector - Long term yearly saving potential



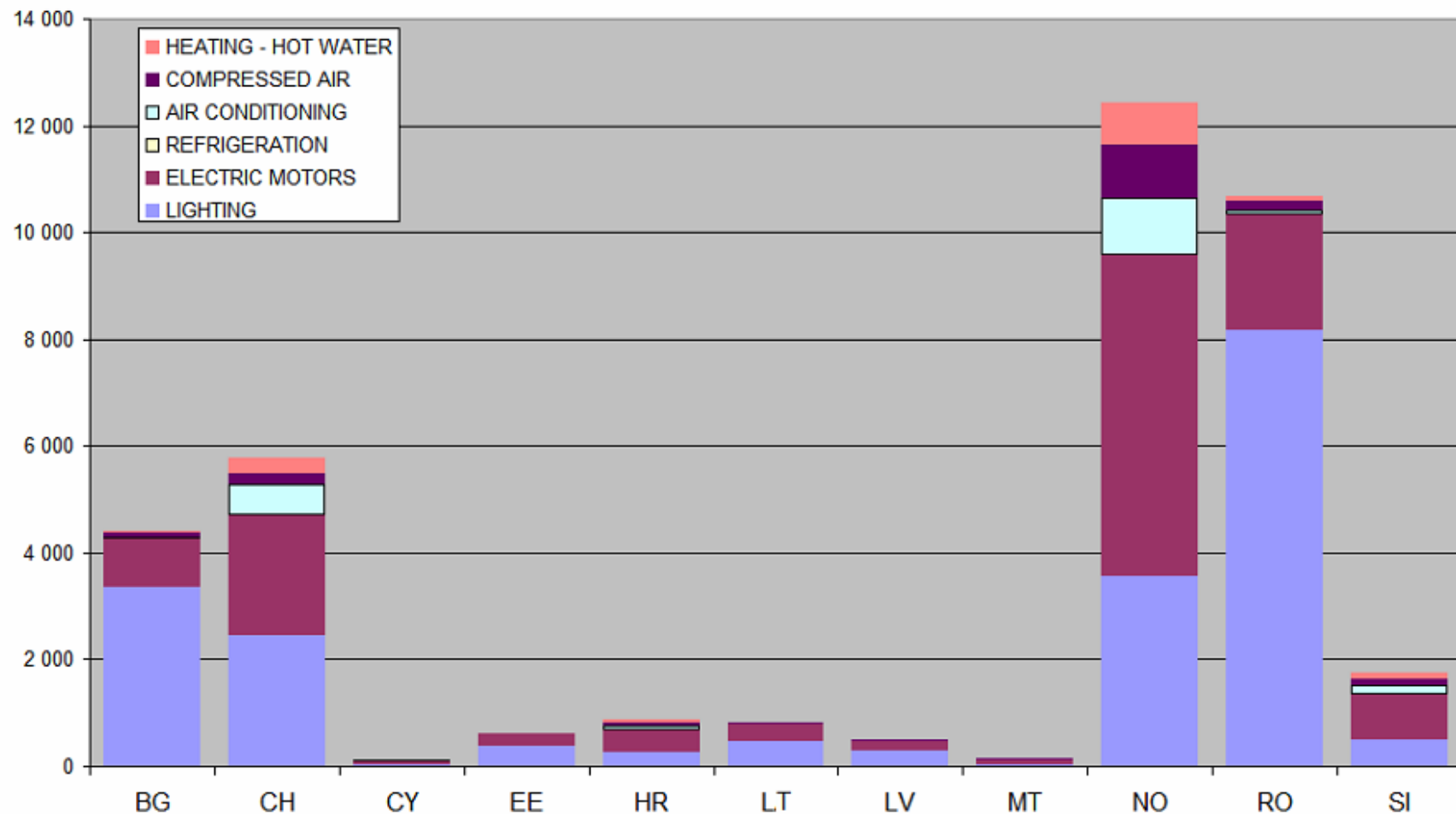
Resulting Potentials - *Industrial* - Overview

Industrial sector - Yearly additional saving potential (GWh/year)



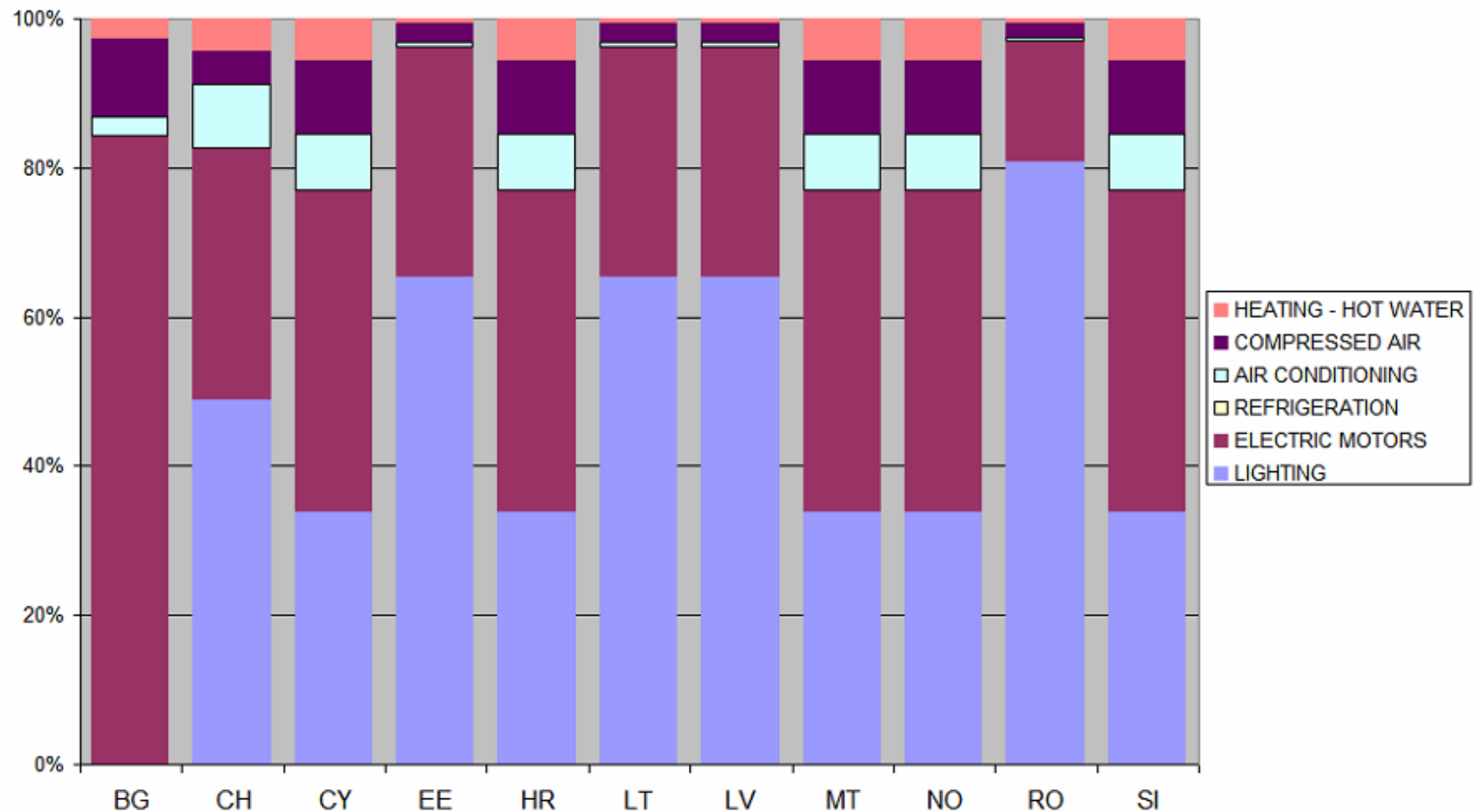
Resulting Potentials - *Industrial* - Overview

Industrial sector - Long term yearly additional saving potential (GWh/year)



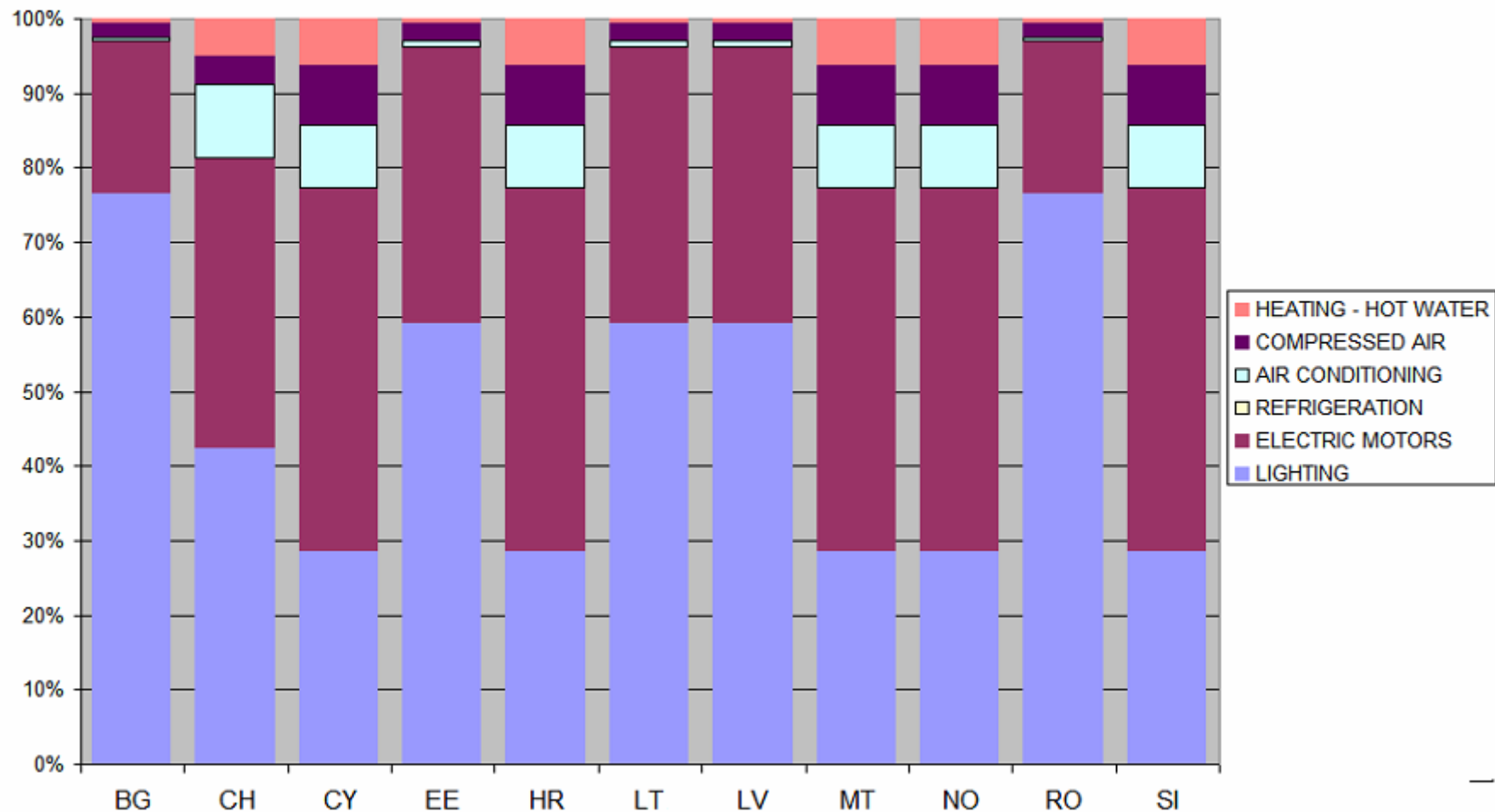
Resulting Potentials - *Industrial* - Overview

Industrial sector - Yearly additional saving potential



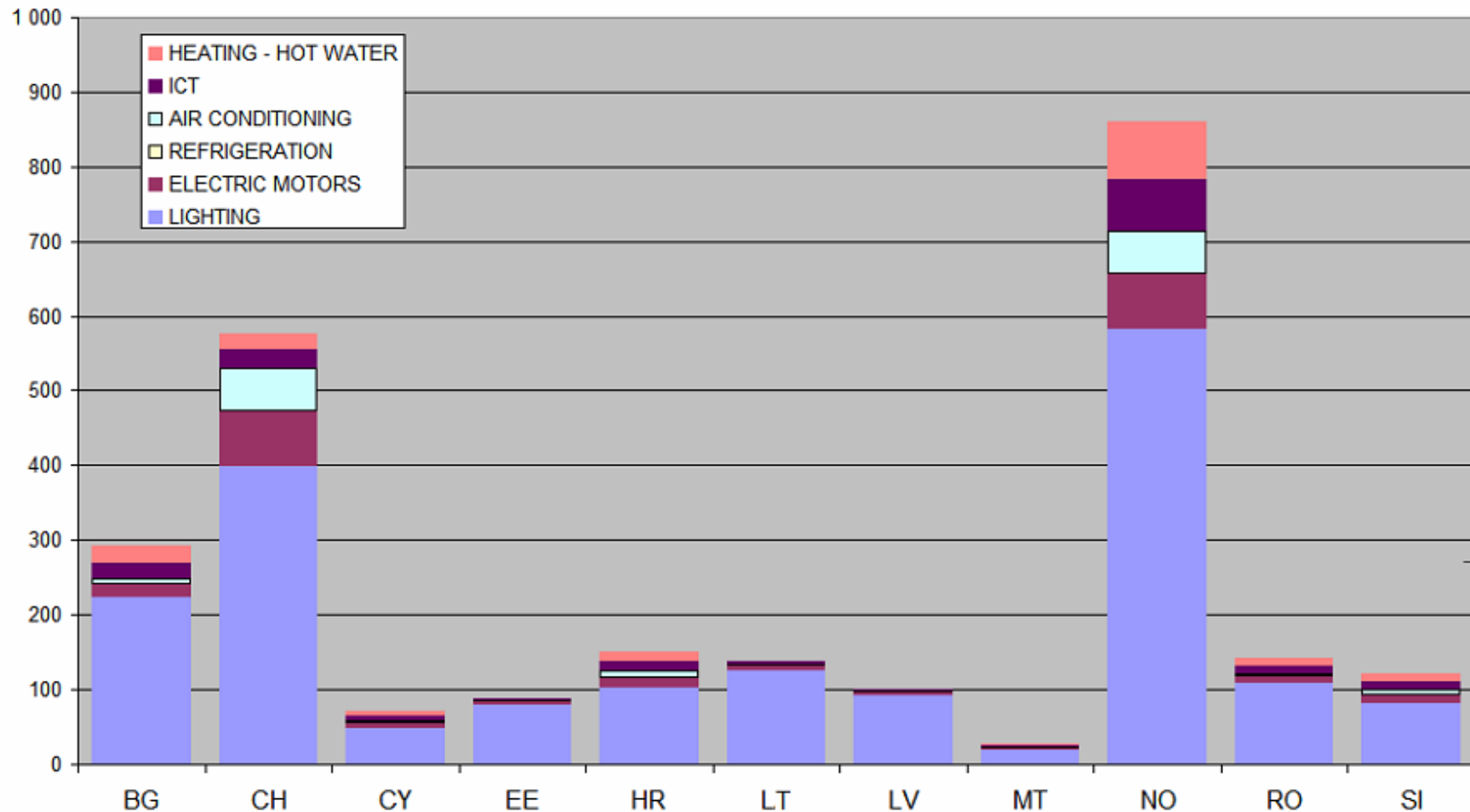
Resulting Potentials - *Industrial* - Overview

Industrial sector - Long term yearly saving potential



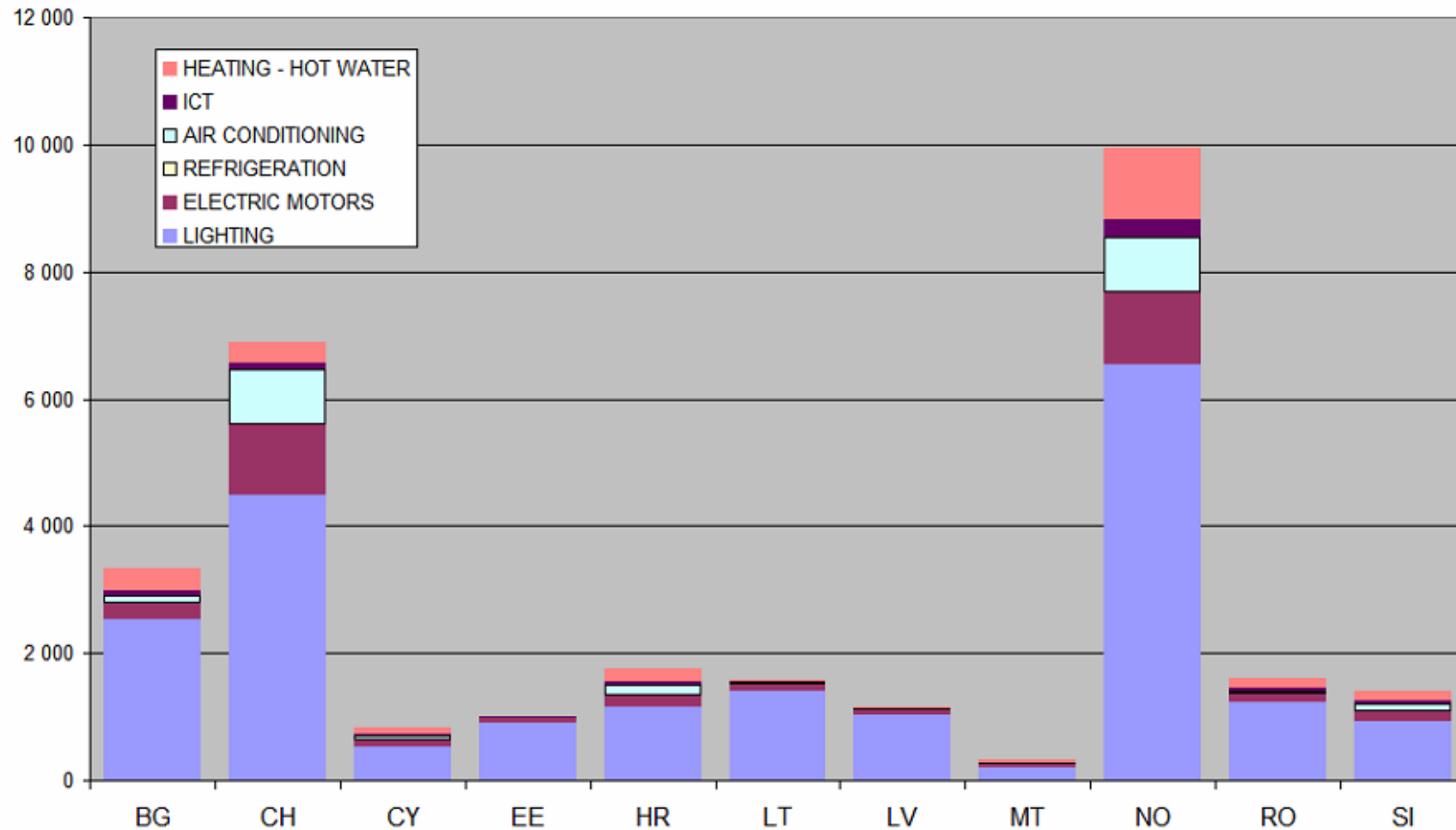
Resulting Potentials - Tertiary - Overview

Tertiary sector - Yearly additional saving potential (GWh/year)



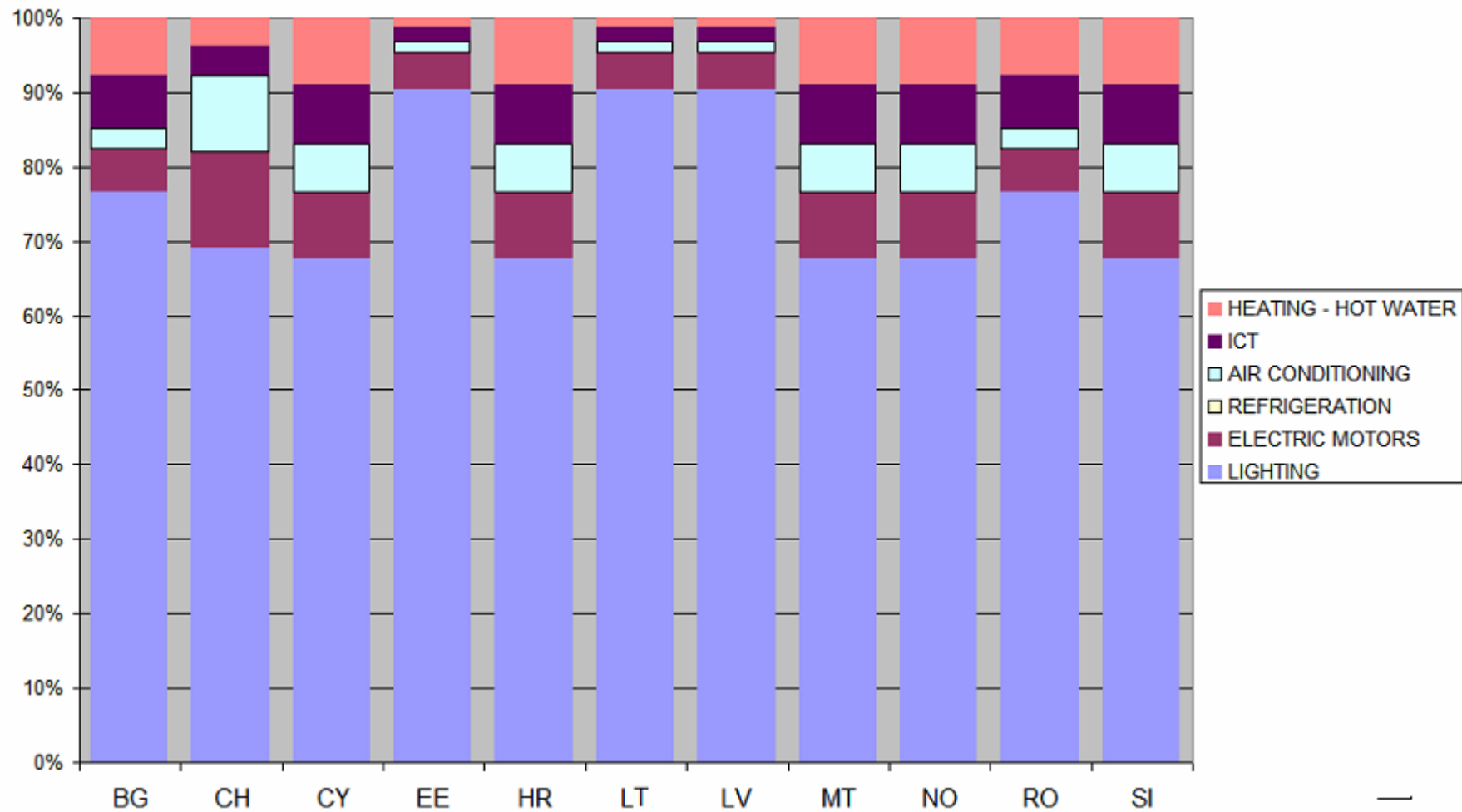
Resulting Potentials - Tertiary - Overview

Tertiary sector - Long term yearly saving potential (GWh/year)



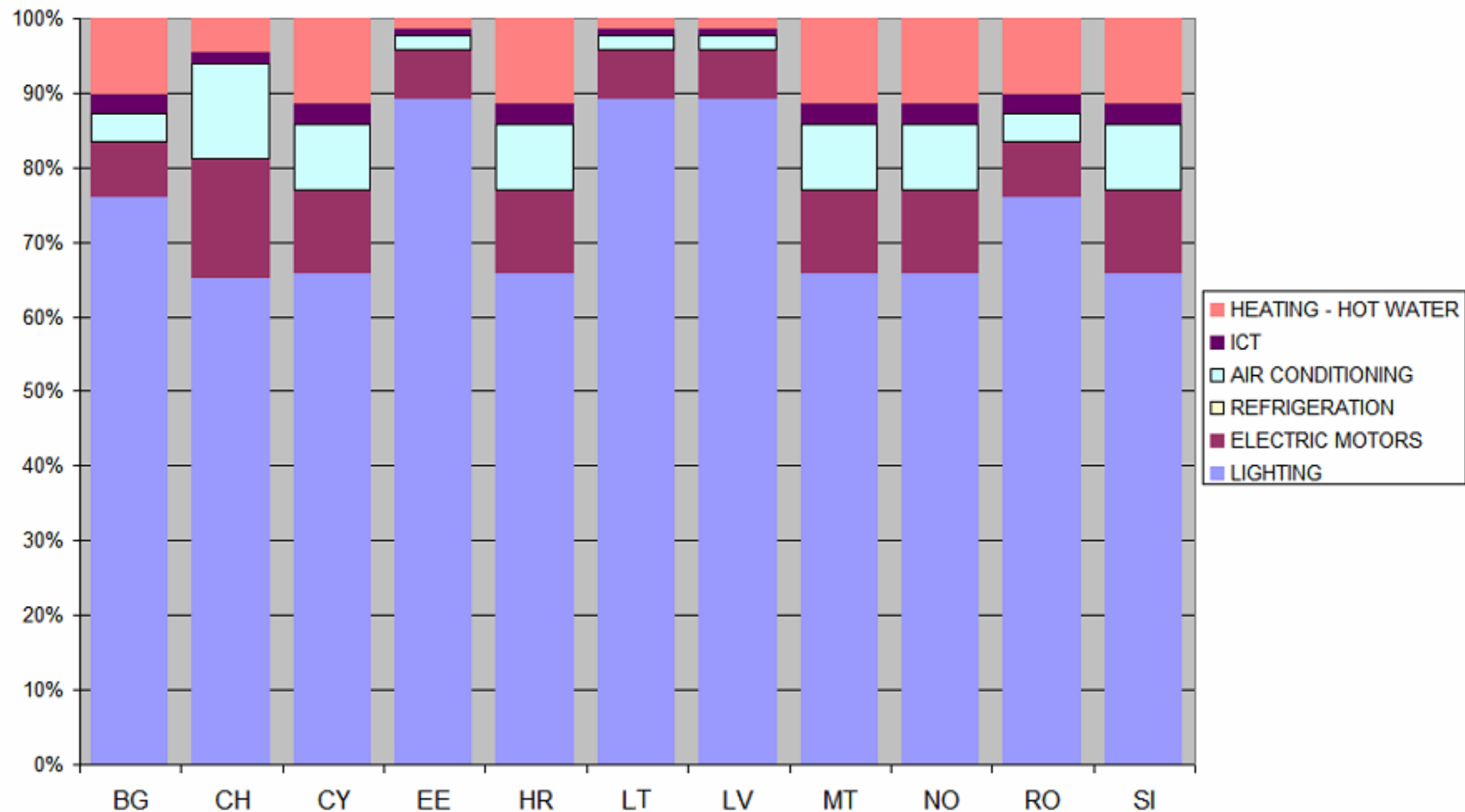
Resulting Potentials - Tertiary - Overview

Tertiary sector - Yearly additional saving potential



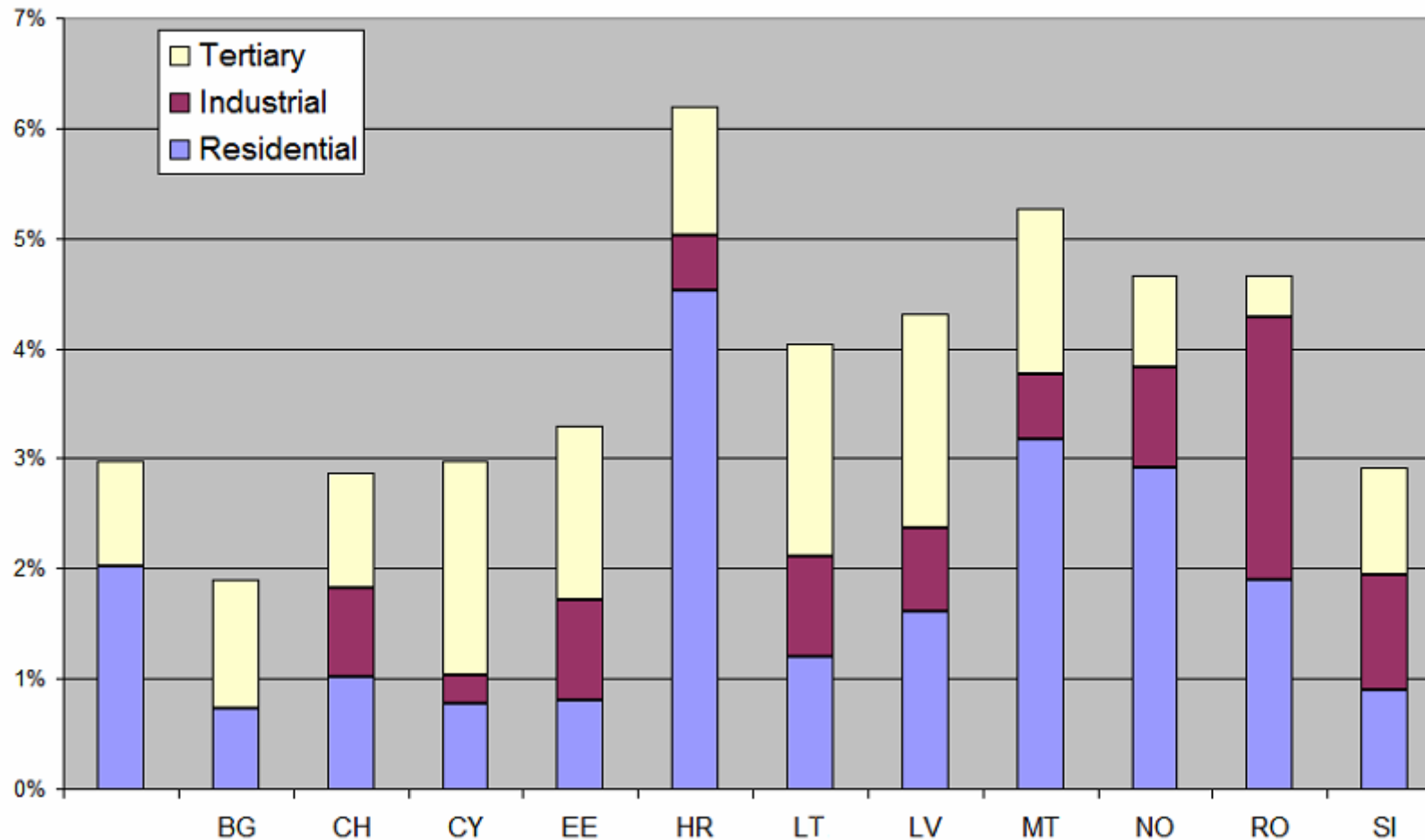
Resulting Potentials - Tertiary - Overview

Tertiary sector - Long term yearly saving potential

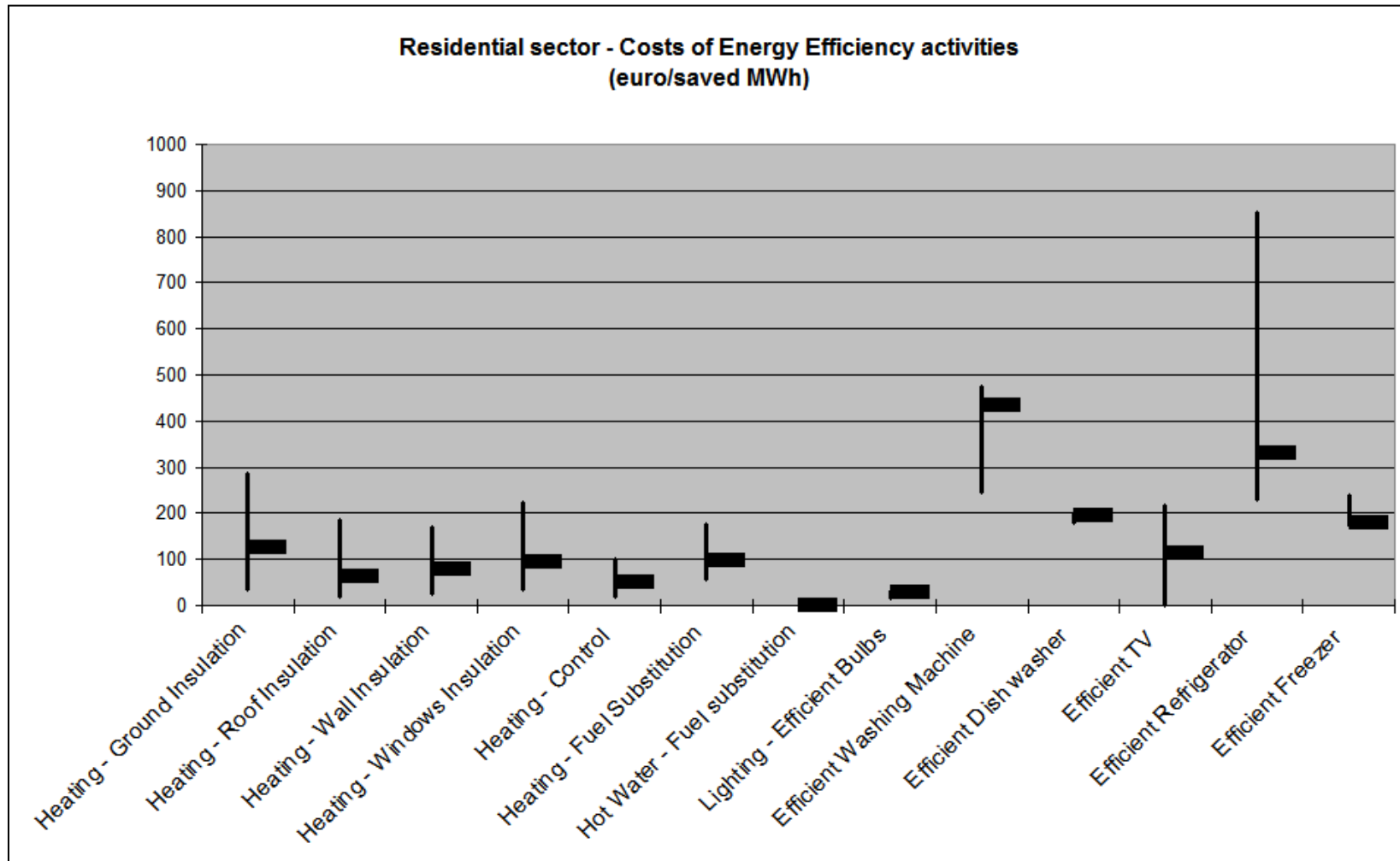


Total Energy Saving Potentials

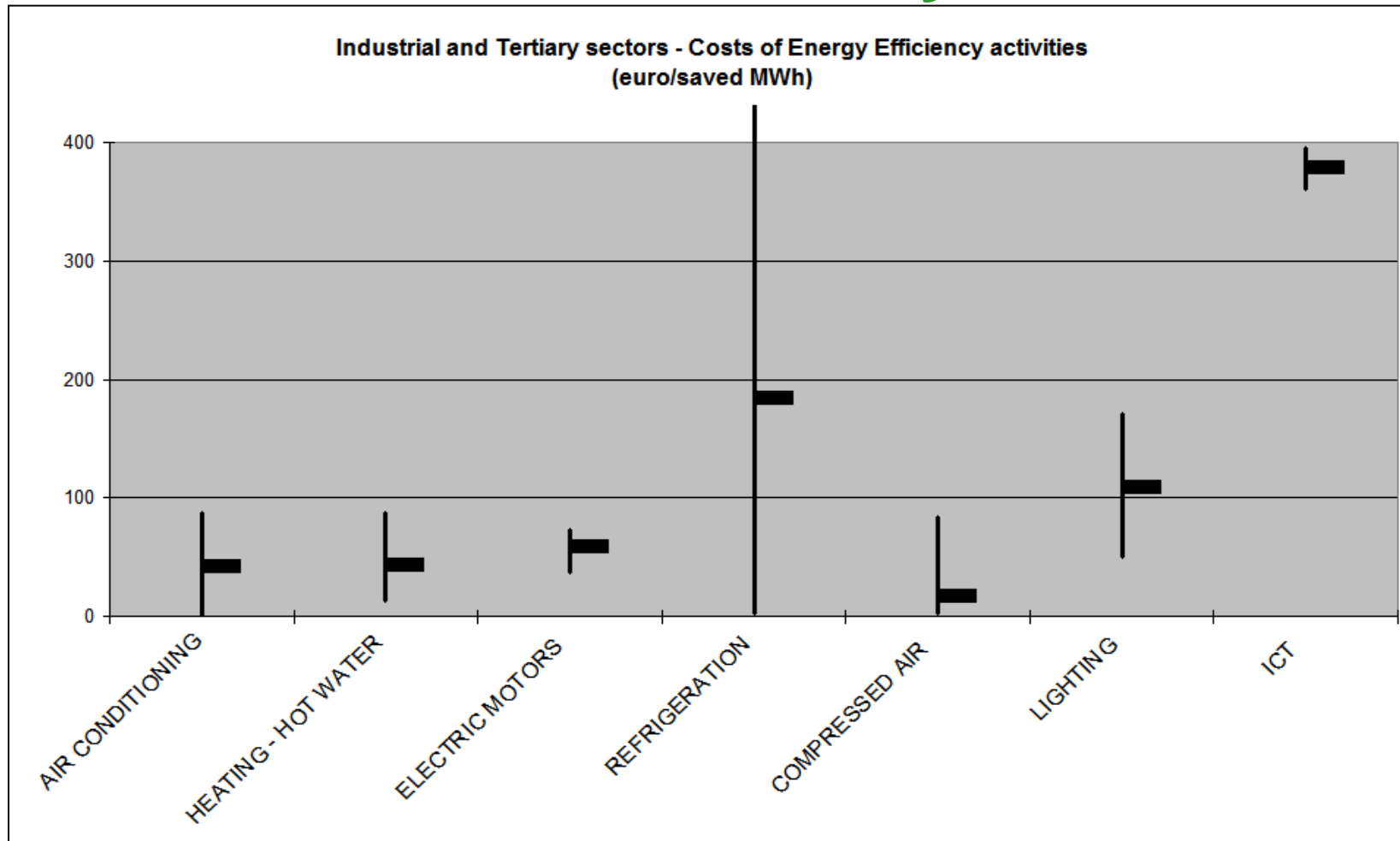
Yearly additional saving potential
as a percentage of the total consumption



Overview of Energy Efficiency Costs Residential Sector



Overview of Energy Efficiency Costs Industrial and Tertiary Sector



Assumptions

Similarly to assumptions made in the *GreenNet* project, 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**

Assumptions

Investment costs are the same for all EU-15 except from Mediterranean countries, whose values differ from those of other countries and among them. Thus, for Non-Mediterranean countries, old values have been adopted while, for Mediterranean countries (Cyprus, Malta), the average of previously used values for Spain, Italy, Portugal and Greece have been adopted.

Assumptions

Analogously to **GreenNet** project study, the field **Energy consumption per unit service output**, for bands:

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

is assumed to be the same for all EU-25+ countries. Specified bands refer both to “multiple houses” bands (MH) and to “single houses” ones (SH)

Assumptions

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

- 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 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

Assumptions

For the field **Appliances stock yearly growth rate** assumptions have been made on the basis of other European countries' data in MURE database, since nobody among contacted experts could provide these data.

Similarities have been noted among three groups of countries: Mediterranean countries, Central European countries, Northern countries.

Average values for each of the three groups have been adopted respectively for

- Cyprus, Malta;
- Slovenia, Hungary, Bulgaria, Romania, Croatia
- Estonia, Lithuania, Latvia.

Assumptions

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. Future growth rates have been adopted equal to the latest available. Croatia (whose consultant provided these data, and Malta (data not available neither in UNECE database) are the exceptions.

Assumptions

The field **Consumption of efficient technology (% of alternative)** was calculated in GreenNet project with data obtained by mean of MURE simulations. Here average percentages of that data have been proposed to consultants in order to receive corrections based on available data and experience. Only Croatian consultant was able to make this correction, for other countries average values have been used

Assumptions

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 2003

Assumptions

Reports of the project *Energy Efficiency Indicators for Central and Eastern European Countries* were a valuable, and unique source – referring to year 2002, to estimate the distribution of dwellings among different fuels for heating, and the distribution of consumption for heating among fuels. In some cases no clear data was declared (only charts), but it was sufficient to estimate that **in some countries electric consumption for heating is not relevant. This is the case of Bulgaria, Estonia, Lithuania, Romania.** For Cyprus and Latvia there are no sufficient data to calculate bands referring to heating, and neither to say that these are not relevant

Assumptions

- In all EU-25+ countries there are no sufficient data to estimate potential and costs of “hot sanitary water” bands.
- When no data about multiple and single housing stock was available, the overall stock have been equally split in the two fields