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NATIONAL REPORTS ON ENERGY EFFICIENCY POLICY SCENARIO ANALYSIS FOR THE BUILDINGS AND TRANSPORT SECTORS

D.4.1

PART OF WORK PACKAGE 4: FORWARD-LOOKING SCENARIO ANALYSIS, FOCUSING
ON MACROECONOMIC AND MICROECONOMIC IMPACTS OF ENERGY EFFICIENCY
POLICY OPTIONS

7 NATIONAL REPORTS

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HERON: Forward – looking socio-economic research on Energy Efficiency in EU countries

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INTRODUCTION

This is the summary report of the results of the Tasks 4.1., 4.2., 4.4. and 4.5. of the Work Package 4 (WP4) “Forward-looking scenarios analysis, focusing on macro-economic and microeconomic impact of energy efficiency policy options”. Task 4.3. was implemented by UoA-KEPA and delivered as an independent report (Annex 8).

WP4 aimed at 1) determining and comparing different policy options (scenarios) to achieve energy efficiency targets on national and regional level, 2) assessing and analysing of key socio-economic drivers to promote energy efficiency development at national level, 3) evaluating the significance of certain barriers linked with the behaviour of the energy consumer (on the example of buildings and transport sector) towards the updated energy efficiency measures, and 4) determining advantages and disadvantages of best policy options in comparison with present policies.

The WP4 was divided into five tasks. Task 4.1. was expected to deliver the baseline statistical data on buildings and transport that would be further used in the following tasks. Task 4.2. delivered the configuration of scenarios developed by using LEAP ([Long-range Energy Alternatives Planning](#)) software. Task 4.3. delivered a report by UoA-KEPA on the aggregate energy demand econometric functions for the 8 countries: Belgium, Bulgaria, Estonia, Germany, Greece, Italy, Serbia, UK, for the transport and buildings sector. Task 4.4. delivered national policy scenarios for energy efficiency on building and transport sectors. In addition to BAU and Energy Efficiency (EE) scenario, also four scenarios based on the Decision Support Tool (DST) developed in WP3 were created. And finally, the Task 4.5. summarises the modelling work of partners on their country’s different policy options to achieve the European Union energy efficiency targets in building and transport sector by 2020 and 2030. Each of the seven partner organisations (UoA-KEPA, UB, BSERC, OBU, WI, UB-FMG, SEI Tallinn) developed an independent national report (Greece, Italy, Bulgaria, UK, Germany, Serbia and Estonia, respectively) that has been attached to the current report as an annex (Annex 1-7). The responsibility of the content of the national report lies with the respective authors.

The challenge of implementing the WP4 was mainly three-fold. Firstly, the complexity of the tasks, ranging from collecting and developing data sets of buildings and transport in countries with variable statistical frameworks and updates, to different policy frameworks and implementation. Secondly, application of LEAP by modellers of different levels of previous experience with the software. Although, using LEAP in scenario building was a learning-by-doing exercise, it enhanced notably the professional capacity of researchers and the number of users of LEAP. Thirdly, the interdependence of WP4 with WP3 and WP5 required constant adjustments to the scenario work and to reporting by the researchers in order to meet the different needs of the WPs and relevant tasks.

In order to accomplish the complex tasks, the WP4 work was organised in the following way. SEI Tallinn as the Lead Beneficiary, created a common data and document sharing platform in Dropbox, where the interim and final work files as well as meeting memos were stored and accessed by all project partners. SEI Tallinn provided a 1,5-day training course on the application of LEAP software for partners in Tallinn on 28-29 January 2016. This training course was delivered by Dr Charlie Heaps, senior expert on LEAP working at SEI US centre. Dr Heaps also provided some assistance to project partners on the application of LEAP modelling software during the scenario work. The costs of Dr Heaps were covered by SEI Tallinn from external to Heron project funds. SEI Tallinn together with UB-FMG organised a one-day workshop on the interim results of Heron scenarios on 19 May 2016 in Belgrade. This was a very useful face-to-face meeting where project partners could share views and ideas how to proceed with scenario work with a common approach. SEI Tallinn organised six internet-based meetings of project partners in 2016 (25 Febr, 5 Apr, 20 Apr, 11 May, 2 Sept and 15 Dec). The agenda of the meetings usually covered the status of work and pending questions, but also further actions and deadlines. Since the scenario work proceeded different phases, interim professional feedback was much

appreciated. A pairwise internal reviewing of draft LEAP Heron scenarios and draft national reports was implemented in a way where comments were received from at least one partner organisation. Applying DST (Task 4.4.) in the third set of scenarios by project partners was assisted by UoA-KEPA. UoA-KEPA also provided guidance on the drafting of national reports to ensure useful input to synthesis of national reports under WP5 Task 5.2.

In this report, the executive summaries of the seven national reports (Bulgaria, Estonia, Germany, Greece, Italy, Serbia and UK) have been collected to provide a short overview of the results of a large and complex work done in WP4. The full national reports and the current summary report form the deliverable D4.1. of the WP4.

SUMMARIES OF NATIONAL REPORTS:

The collection of executive summaries of seven national reports (Bulgaria, Estonia, Germany, Greece, Italy, Serbia and UK) is following. The summaries briefly describe the framework of scenarios and make the final statement whether the respective country would meet the European Union energy efficiency targets in building and transport sector by 2020 and 2030. The details on scenarios, socio-economic barriers and policy measures are provided in the national reports attached to the current report (Annex 1 to 7).

1. BULGARIA

In this report, the different policy options (scenarios) are determined to achieve the currently set and proposed energy efficiency targets in residential buildings and transport sectors on national level in Bulgaria. Energy efficiency scenarios for the Bulgarian building and transport sectors were developed until 2030. While the transport scenarios cover all modes of passenger and freight transport, only two subsectors were included in the building scenarios: residential buildings (including all energy applications there) and public buildings space heating.

For each sector, 6 scenarios were developed - a Business as usual (BAU) scenario, based only on the policies adopted by 2013, and 5 energy efficiency scenarios, based on ambitious (compared to BAU) energy efficiency targets, leading to at least 27% energy savings compared to the 2007 EU PRIMES BAU scenario. The energy efficiency scenarios are as follows:

- One that does not consider the negative impact of the existing barriers;
- One that considers the negative impact of existing barriers;
- Three scenarios, each considering minimization of the impact of a given set of barriers.

Each scenario is built around specific (different) penetration levels of a number of technologies or measures. In the building sector these technologies are the following:

- Building shell improvements
- Efficient heating
- Efficient air conditioning
- Efficient appliances
- Efficient lighting.

Respectively, in the transport sector, the technologies (measures) are the following:

- Penetration of electric and hybrid vehicles in passenger and freight transport
- Eco-driving in passenger and freight transport
- Modal shift in passenger and freight transport
- Use of biofuels in passenger and freight transport
- More efficient vehicles in passenger and freight transport.

The scenarios are modelled using the energy modelling tool LEAP developed by SEI. The impact of barriers and their minimization are quantified using the Decision Support Tool (DST), developed by NKUA-KEPA.

For the **building sector**, the main scenario results for 2030 are as follows:

- BAU scenario is not in line with EU 2030 energy saving target, as its energy consumption is only 19,2 % below EU BAU PRIMES baseline scenario.
- The energy efficiency scenario that does not take into account the impact of barriers would achieve savings of 38,7%, compared to EU BAU PRIMES.
- Taking into consideration the effect of barriers, the energy savings drop to 27,3%. In other words barriers would prevent most of the target energy savings.
- The minimization of barriers in the remaining three scenarios shows only marginal effect of the minimization efforts – the savings in these scenarios are in the range 27,6% – 27,9%.
- All scenarios achieve the CO₂ emission targets for the national non-ETS sectors.

For the **transport sector**, the main scenario results for 2030 are as follows:

- All 6 scenarios result in substantial energy savings, compared to 2007 EU PRIMES BAU scenario – these range from 39,3% in our BAU scenario up to 46,9% in the energy efficiency scenario that does not consider the impact of barriers.

- The negative effect of barriers is relatively low – their presence (to a full extent) would result in 45,0% savings, compared to the abovementioned 46,9% in the “ideal” case.
- The minimization of barriers has only negligible effect on energy savings. The three scenarios assuming minimization of different sets of barriers would achieve savings 45,3% – 45,4%.
- All scenarios, except the BAU one, achieve the CO₂ emission targets for the national non-ETS sectors.

2. ESTONIA

In this report, the different policy options (scenarios) are determined to achieve the currently set and proposed energy efficiency targets in residential buildings and transport sectors on national level in Estonia. Also, the key socio-economic drivers to promote energy efficiency development at national level are described. The advantages and disadvantages of the different policy options are presented in the developed scenarios in comparison with present policies. The work is carried out using the LEAP tool.

For the **buildings sector**, historical data is available for the years 1990 and 1995-2014. Within the HERON project, future energy efficiency scenarios up to 2030 were modelled for tertiary buildings and residential buildings. The residential buildings sector energy efficiency scenarios in this project account with the years 2014-2030. For the tertiary sector, historical data is available only from 2000 onward until 2014. The report presents the assumptions made within the tertiary and residential buildings sector separately, yet the outcomes of the two sectors have been presented together in tables 23-29 of this report.

Under each of the two sectors, a number of energy efficiency scenarios were modelled. In total 6 scenarios under the residential buildings sector and 6 under the tertiary buildings sector were created as follows:

Scenarios	Residential buildings	Tertiary buildings
1. HERON BAU - Business as Usual Scenario	x	x
2.EE – B0: EE scenario with zero DST impact	x	x
3. EE - B1: EE DST scenario which considers the current barriers across all the sub-scenarios	x	x
4.EE - B2: EE DST scenario with the minimization of barriers within the building shell improvement sub-scenario	x	x
5. EE – B3: EE DST scenario with the minimization of barriers within efficient lighting sub-scenario	x	x
6. EE – B4: EE DST scenario with the minimization of barriers within efficient appliances sub-scenario (combination of: EE-B4 (residential) and EE-B1 (tertiary))	x	x (EE-B1)

Each of the energy efficiency scenario consists of 3 sub-scenarios/policy measures: 1) building shell improvements (renovation together with efficient heating); 2) efficient lighting; and 3) efficient appliances. Tertiary and residential sector scenarios together form one overall buildings scenario per each scenario type. It should be noted though that under the last scenario EE-B4, the tertiary sector does not count with the efficient appliances policy measure and therefore under this scenario the barriers under the tertiary sector have not been minimized (meaning that to calculate an overall buildings sector scenario EE-B4, EE-B1 was used under the tertiary sector instead).

The results show that compared to the business as usual (BAU) scenario, 19% reduction in the energy consumption is needed to achieve the EU 2030 target. After the implementation of various assumptions, it appeared that the EU 2030 target both in terms of the energy consumption (1.23 Mtoe target exactly achieved) and GHG emissions (0.37 MtCO₂ 5 % even lower from the target) could be achieved if the maximum energy efficiency scenario (EE B0) is applied. The EU2020 targets will be achieved as well, as the energy consumption does not exceed the 2010 level (national policy) and the GHG emissions do not exceed more than 11% compared to 2005, according to the Estonian non-ETS target. The highest

impact on the energy efficiency of the residential and tertiary buildings sector has the building shell improvement, demonstrated the comparison of scenarios. That is mainly due to the policies that assume large scale building renovations (40% of single-family dwellings and 58% of multi-family dwellings). This can also be proven by the EE B2 scenario that has the highest impact in terms of the energy efficiency when barriers under the building shell improvement are to be minimized.

Chapter 3.3.2 of Annex 2 presents the results of the detailed analysis of the energy efficiency scenarios of the buildings sector in Estonia.

As to the energy efficiency in **transport sector**, the energy demand has been growing in Estonia during the last 20 years. The growth in demand has been highly coupled with the economic growth of the country and its main drivers have been the increasing car use and purchasing power, suburbanization, relocation of jobs and services. The fuel economy of the car fleet has not improved as quickly as the European average and Estonian new car sales stands out as one of the least fuel-efficient. Urban sprawl, increasing commuting distances and relocation of jobs have contributed to decreased shares of public transport and walking.

For the transport sector, a BAU scenario and an EE scenario with total five sub-scenarios, representing different policy packages and technology penetration rates, were analysed with the LEAP model and DST tool. The BAU scenario (representing current policies in place) projects a further growth in energy demand in the Estonian transport sector, growing by 18% from 2010 until 2030, failing to deliver the national and EU policy targets. The growth is driven by increased motorization, higher purchasing power, road freight and only slow improvement in fuel efficiency of the vehicles.

The Energy Efficiency (EE T0) scenario consists of the following policy measures: Fuel efficient vehicles, Eco-driving, Urban Planning, Passenger Transport Modal Shift, Freight demand management. While applying the EE scenario, transport energy consumption will be reduced by 7.3% by 2030 compared to 2010, and the national and EU targets are reached. The highest share of this energy efficiency gains is delivered by policies encouraging the take-up of fuel efficient vehicles, including electric and hybrid vehicles. The second priority should be given to managing the demand for personal mobility through integrated urban planning, the third priority to managing the demand of freight transport and the fourth priority - by encouraging the modal shift in passenger transport and the fifth priority should be given to eco-driving. As to the national and EU energy efficiency targets for Estonia Heron Transport EE-T0 scenario almost delivers the national energy efficiency target by 2020, and reduces transport energy demand to a level of 13% below the EU 2030 target.

Compared to the EU non-ETS targets for 2020 and 2030 the transport sector with five EE T-0 measures combined would meet the 2020 targets (-10% lower than target) and closely meets the 2030 targets (-0,1% lower than target), the emissions of BAU scenario would exceed the non-ETS target with 29.5% higher emissions.

The highest barriers in transport sector are the following: lack of limited finance and fiscal incentives; the negative role of current investment schemes that prioritize new investment into car based solutions; perverse incentives related to employee benefits related to car use; limited infrastructure investment for public transport and lack of integrated governance in the field of transport, mobility and urban planning in Estonia.

In order to analyse the impact of barriers on energy efficiency gains four additional transport scenarios were built with the Decision Support Tool and LEAP. EE T1 scenario showed that with all barriers in place the EE-T0 scenario energy efficiency improvements are not delivered and the energy demand will be 8% higher than the EU target. While combining the scenarios with least barriers and minimizing the barriers, the DST tool showed that energy efficiency gains with more fuel efficient vehicles and Eco-Driving have least barriers and the scenario of modal shift in passenger transport and electric vehicles have barriers with highest impact for reaching the energy efficiency gains and GHG reduction targets.

3. GERMANY

In this report, two sectors - buildings and transport - each with two principal sub-sectors (residential/tertiary buildings and passenger/freight transport) in Germany are analysed.

The forward-looking scenario exercise for Germany presented in this report analyses the two sectors buildings and transport each with two principal sub-sectors (residential/tertiary buildings and passenger/freight transport). For each sector, a baseline scenario (“business as usual”, BAU) is developed presenting a likely scenario reflecting the existing (and certain-to-come) policies and technological developments. In addition, for both main sectors, we defined a number of scenarios that reflect the implementation of additional policy measures and consequent effects on energy demand. Those sub-scenarios are then combined to one efficiency scenario for each sector: “B0 – building measures” and “T0 – transport measures”. Section 3 describes building scenarios in detail and section 4 the transport scenarios. Table 1 gives an overview of the scenarios calculated for this report.

Table 1: Overview of scenarios in the German D4.1 HERON report

Residential Buildings		Tertiary Buildings	
BAS	Baseline	BAS	Baseline
HBUILD	Building efficiency (shell & heat system)	HBUILD	Building efficiency
HLIGHT	Lighting		
HAPP	Household appliances		
B0	Total Building Efficiency		
B1	Incl. DST-quantified barriers		
B2	Overcoming most DST-quantified barriers for BUILD		
B3	Overcoming most DST-quantified barriers for HLIGHT		
B4	Overcoming most DST-quantified barriers for HAPP		
Passenger Transport		Freight transport	
BAS	Baseline	BAS	Baseline
TEFF	Transport Efficiency	TEFF	Transport Efficiency
TMODE	Transport Modal Shift	TMODE	Transport Modal Shift
TDRIVE	Eco-driving & speed limits	TDRIVE	Eco-driving & speed limits
TP0	Passenger transport measures	TF0	Passenger transport measures
T0	Total Transport Efficiency		
T1	Incl. DST-quantified barriers		
T2	Overcoming most of the DST-quantified barriers for TEFF		
T3	Overcoming most of the DST-quantified barriers for TMODE		
T4	Overcoming most of the DST-quantified barriers for TDRIVE		

Scenario-building follows the logic of step-wise inclusion of barriers and modelling their overcoming (

). Following the construction of an efficiency scenario for buildings (B0) and transport (T0), the decision support tool (DST) developed in the HERON project is applied to these scenarios for the purpose of creating a scenario that includes the existing barriers (B1/T1) and thus does not fulfil the ambition of the efficiency scenario. In the following, some of those quantified barriers can be argued to be overcome until 2030. At this quantification aim the following sub-scenarios (B/T2-4), that model each the overcoming of (most of the) barriers for one sub-scenario/technology, together with side-effects on other technologies.

below gives a graphical representation of the sequential proceeding within the HERON quantifications.

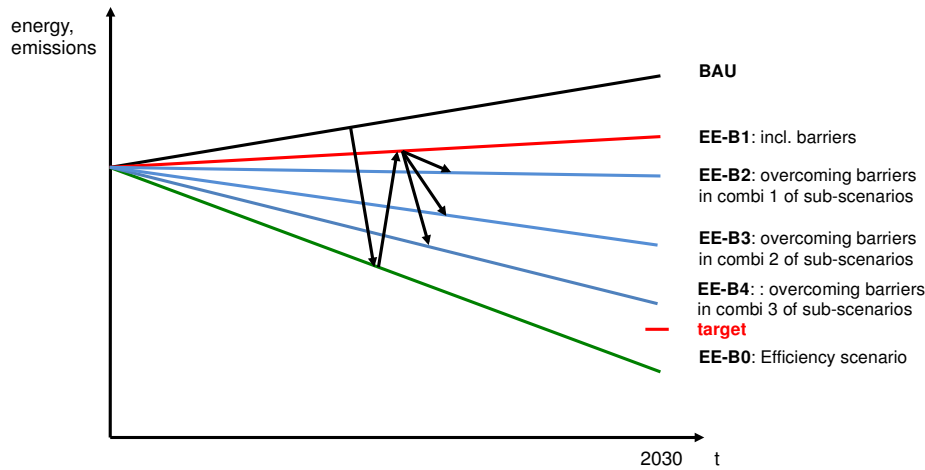
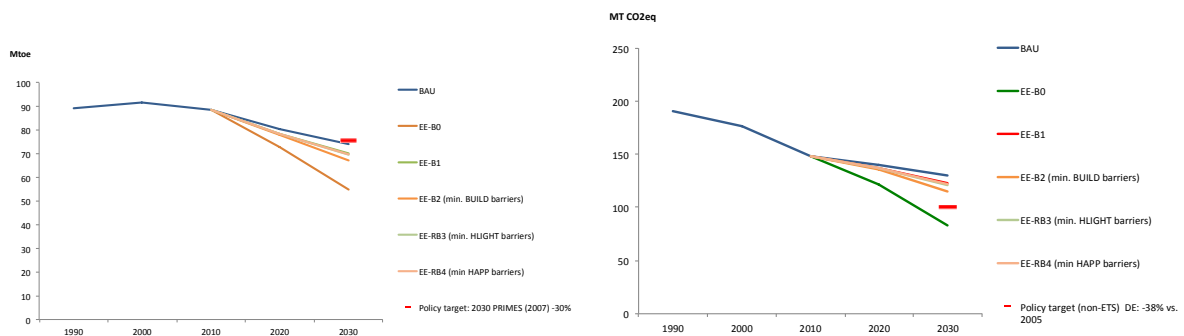


Figure 1. Overview of HERON scenarios

The scenario analysis shows (Figure 2), that if barriers are accounted for in calculations, energy and GHG savings are not as high as initially expected and EU energy and climate targets for Germany will probably be missed¹ (EE-B1 and T1 scenarios). However, if policies are enacted that effectively overcome (most of) the existing barriers, most of the targets can be achieved.

a) Buildings



¹ The only exception is the building energy target achieved by all (even BAU) scenarios, due to a sectoral mismatch: the target is based on the PRIMES “residential” and “services and agriculture” sector, but HERON calculations include of the latter only tertiary building energy consumption (excl. other tertiary energy and agriculture). For more details see buildings section.

b) Transport

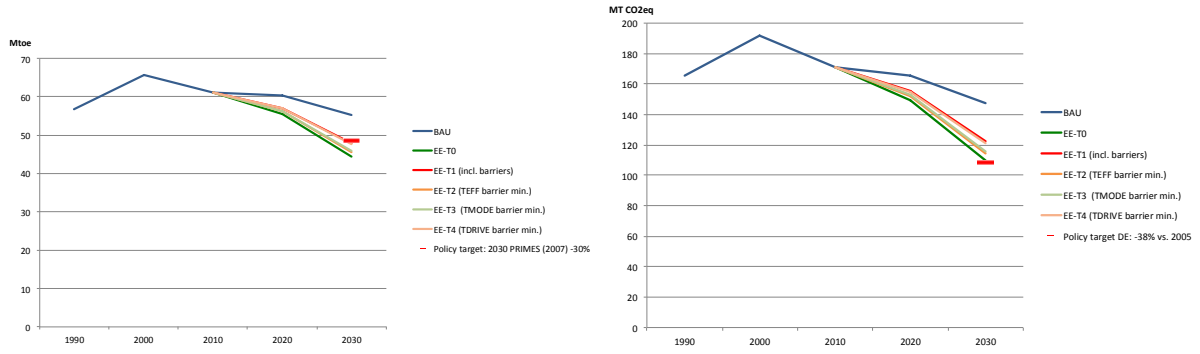


Figure 2: Summary outcomes: Building (a) & transport (b) energy demand and GHG emissions by DST-scenarios

4. GREECE

In this report, forward-looking scenarios for energy efficiency in Greece were developed with time horizon until the year 2030. These scenarios concerned the building and the transport sectors. The developed scenarios for the national **building sector** (same for residential and tertiary subsectors) were:

- **Business as Usual (BAU) scenario:** It looks into current possible trends until 2030 with policy measures/instruments already implemented.
- **Energy Efficiency (EE B0) scenario:** It reflects a forward-looking path towards a situation that is sought (to achieve the maximum possible amount of energy savings based on the national potential through a combination of technologies). It is the synthesis of six (6) developed sub-scenarios for buildings (residential and tertiary), each of which was assumed to have a specific level of penetration in LEAP for one technology/measure that was included in the WP2 survey. The sub-scenarios are the following:
 1. Efficient heating: This scenario focuses only on the penetration of heat pumps (such as air-to-air, water source, and geothermal) and on highly energy efficient heating systems (such as new or maintained oil systems with high performance, central heating systems with natural gas etc.) in existing buildings (single-family, multi-family, tertiary).
 2. Building shell improvement (building fabric upgrade): This scenario focuses only on the improvement of insulation in existing buildings (single-family, multi-family, tertiary). This scenario decreases the energy intensity of the space heating for all housing types of the existing building stock.
 3. Efficient cooling: This scenario focuses only on the penetration of highly energy efficient air-conditioning (A, A+, A++) in existing buildings (single-family, multi-family, tertiary).
 4. Efficient appliances: This scenario focuses only on the penetration of highly energy efficient appliances (A, A+, A++) in existing buildings (single-family, multi-family, tertiary) including cooking devices and water heaters.
 5. Efficient lighting: This scenario focuses only on the penetration of LED in existing buildings (single-family, multi-family, tertiary).
 6. Application of BEMS: This scenario focuses only on the penetration of BEMS that leads to energy savings in space heating and lighting and ensures better functioning of building installations where applicable (single-family, multi-family, tertiary).

The combination of all developed sub-scenarios into one scenario aimed to lead to at least 27% energy savings compared to BAU scenario, without taking into consideration the impact of barriers linked with end-users behavior. Four energy efficiency scenarios were developed:

- **Energy Efficiency (EE B1) scenario:** It reflects the forward-looking path of EE B0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. The existence of barriers prevents the achievement of this intended situation. With the use of the DST, the deviation of this situation is now quantified in this scenario and reflected in its outcomes.
- **Energy Efficiency (EE B2) scenario:** It reflects the forward-looking path of improving the situation of EE B1 scenario, through the most promising combination of three technologies (Building Shell Improvement – Efficient cooling – Efficient Appliances). The DST allowed the recognition of this combination (higher number of barriers among three technologies and lower impact of barriers). The situation was improved compared to EE B1 through the minimization of specifically selected (by the user) barriers linked with the “Building Shell Improvement” option that was considered as the priority option out of the three due to the larger number of its

barriers. The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies resulted in higher energy savings compared to EE B1.

- **Energy Efficiency (EE B3) scenario:** It reflects the forward-looking path of improving the situation of EE B1 scenario, through the second most promising combination of three technologies (Building Shell Improvement – Efficient heating – Efficient Appliances) (based on DST). The situation was improved compared to EE B1 and EE B2 through the minimization of specifically selected barriers linked with the “Building Shell Improvement” option.
- **Energy Efficiency (EE B4) scenario:** It reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (Efficient cooling – Efficient heating – Efficient Appliances) (based on DST). The situation was improved compared to EE B1, but not compared to EE B2 and EE B3 through the minimization of specifically selected barriers linked with the “Efficient appliances” option.

In summary, the EE B3 scenario has the lowest final energy consumption in 2020 (5.623Mtoe against 5.676Mtoe of the EE B1 scenario) and in 2030 (5.281Mtoe against 5.462Mtoe of the EE B1 scenario). All scenarios are very close regarding the amount of GHG emissions in 2020, but EE B3 is among the lowest (3.65MtCO₂ compared the respective amount of the EE B1, which is 3.68MtCO₂) and in 2030 (2.96MtCO₂ against 3.09MtCO₂ of the EE T1).

The developed scenarios for the Hellenic **transport sector** are the following, similarly to those of the building sector:

- **Business as Usual (BAU) scenario:** It looks into current possible trends until 2030 with policy measures/instruments already implemented.
- **Energy Efficiency (EE T0) scenario:** It reflects a forward-looking path towards a situation that is sought (to achieve the maximum possible amount of energy savings based on the national potential through a combination of technologies). It is the synthesis of five (5) developed sub-scenarios for the transport sector, each of which was assumed to have a specific level of penetration in LEAP for one technology/measure that was included in the WP2 survey. These sub-scenarios were the following:
 - Penetration of electric and hybrid vehicles in passenger and freight transport (where applicable);
 - Eco-driving in freight and passenger transport;
 - Modal shift in freight and passenger transport;
 - Use of biofuels in freight and passenger transport;
 - More efficient vehicles in passenger and freight transport.

The combination of all developed sub-scenarios into one scenario again aimed to lead to at least 27% energy savings compared to BAU scenario, without taking into consideration the impact of barriers linked with end-users behavior using DST.

- **Energy Efficiency (EE T1) scenario:** It reflects the forward-looking path of EE T0 scenario but after incorporating the impact of the barriers linked with the end-users behaviour. The existence of barriers prevents the achievement of the intended situation of EE T0. With the use of the DST, the deviation of this situation is now quantified and reflected in the results of this scenario.
- **Energy Efficiency (EE T2) scenario:** It reflects the forward-looking path of improving the situation of EE T1 scenario, through the most promising combination of three technologies/actions (Electric and hybrid vehicles – Modal shift – More efficient vehicles) (based on DST). The situation was improved compared to EE T1 through the minimization of specifically selected – by the user - barriers linked with the “Electric and hybrid vehicles” option that was considered as the priority action out of the three due to the larger number of its barriers.

The minimization of the barriers – by using the DST - among which were also common barriers for all three technologies resulted in higher energy savings compared to EE T1.

- **Energy Efficiency (EE B3) scenario:** It reflects the forward-looking path of improving the situation of EE T1 scenario, through the second most promising combination of three technologies/actions (Electric and hybrid vehicles – Use of biofuels – more efficient vehicles) (based on DST). The situation was improved compared to EE T1 and EE T2 through the minimization of specifically selected barriers linked with the “Electric and hybrid vehicles” option.
- **Energy Efficiency (EE T4) scenario:** It reflects the forward-looking path of improving the situation of EE B1 scenario, through the third most promising combination of three technologies (More efficient vehicles – Eco-driving – Use of biofuels) (based on DST). The situation was improved compared to EE T1, but not compared to EE T2 and EE T3 through the minimization of specifically selected barriers linked with the “More efficient vehicles” option.

In summary, the EE T2 scenario has the lowest final energy consumption in 2020 (6.288 Mtoe against 6.373Mtoe of the EE T1 scenario) and in 2030 (6.286Mtoe against 6.463Mtoe of the EE T1 scenario). Simultaneously it has the lowest amount of GHG emissions in 2020 (17.123MtCO₂ compared to the other scenarios and particularly with the respective amount of the EE T1, which is 17.492MtCO₂) and in 2030 (15.103MtCO₂ against 15.909MtCO₂ of the EE T1).

5. ITALY

In this report, we present the forward-looking scenario on energy efficiency in the building and transport sectors for Italy. For each sector, a baseline scenario (“business as usual”, BAU) is developed, presenting a likely scenario reflecting the existing (and certain-to-come) policies and technological developments. The second scenario elaborated for each sector, named EE-0, represents a cost-effective energy efficiency scenario aimed at meeting the 2020 and 2030 targets at minimum cost. Cost-effectiveness is determined by the adoption of specific technologies and by the introduction (in the transport sector only) of additional financial measures aimed at fostering the penetration of zero emission technologies.

All other scenarios are elaborated using the Decision Support Tool (DST). At first, we test the effect of the barriers on the cost-effective scenario. In a second step, we elaborate scenarios, which overcome the effect of some of the barriers, by introducing additional policies.

below gives a graphical representation of the sequential proceeding within the HERON quantifications.

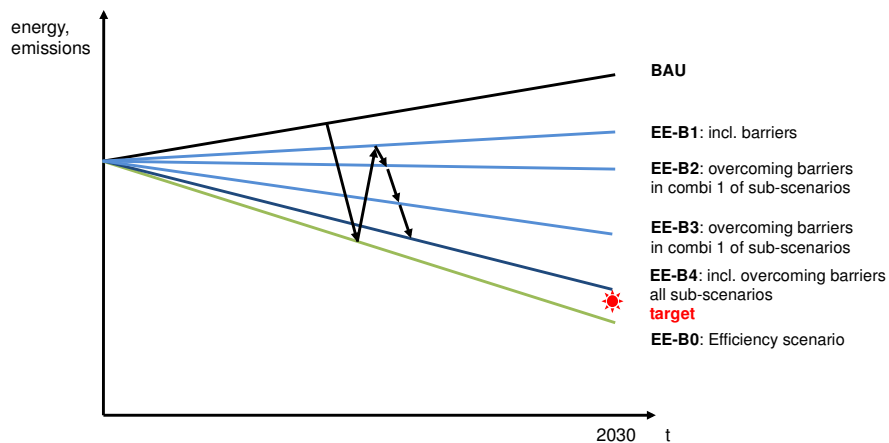


Figure 3: Overview of HERON scenarios – source: Germany National Report.

The scenario analysis shows (see Figure 2 – **Error! Reference source not found.**), that if barriers are accounted for in calculations, EU energy and climate targets for Italy will probably be missed in the building sector, but not in the transport sector. However, if policies are enacted that effectively overcome (most of) the existing barriers, then also the residential sector can almost achieve its targets.

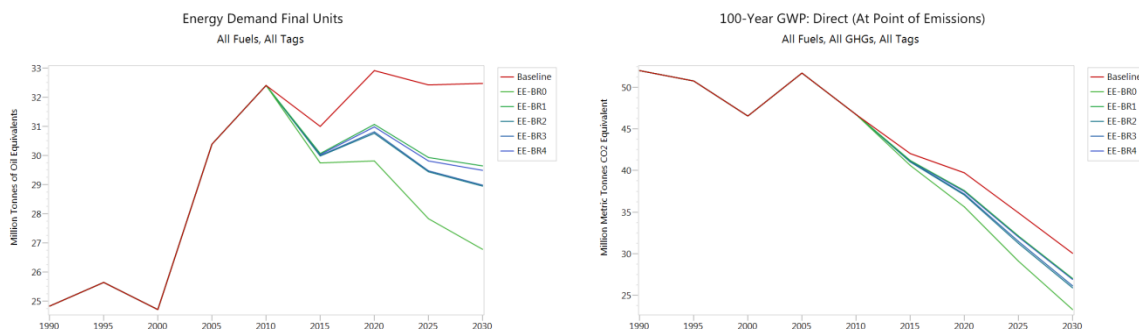


Figure 4: Residential building energy demand and GHG emissions by DST-scenarios.

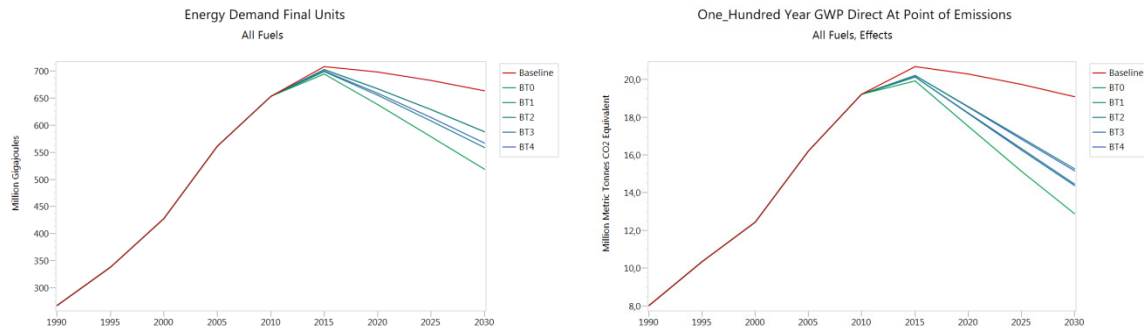


Figure 5: Tertiary building energy demand and GHG emissions by DST-scenarios.

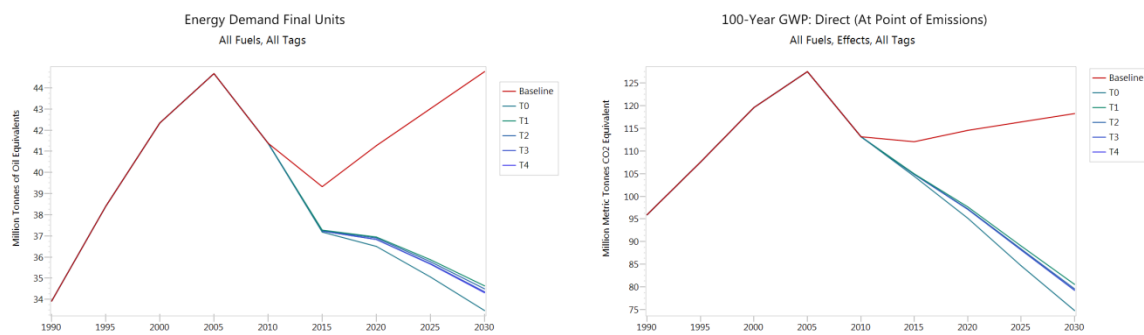


Figure 6: Transportation sector energy demand and GHG emissions by DST-scenarios.

6. SERBIA

In this report, the different policy options (scenarios) are determined to achieve the currently set and proposed energy efficiency targets in residential buildings and transport sectors on national level in Serbia.

The **buildings sector** (residential and public and commercial) in Serbia accounted for 42.9% of final energy consumption in the base year (Statistical Office of the Republic of Serbia, 2012), indicating high potential for energy savings.

Conducted analysis of historical consumption in the residential buildings has shown that final energy consumption had not followed real GDP changes in the analysed period. Therefore, the LEAP model for the residential buildings has been developed, as a bottom-up model, based on the historical trend of total number and area of dwellings and The National Typology of the Residential Buildings (Jovanovic Popovic et al, 2013).

In order to explore potential of energy savings, due to different measures that can be undertaken in the buildings sector, six exploratory scenarios for residential buildings and for public and commercial sector were developed by using LEAP tool. As the reference scenarios for both buildings' subsectors, baseline scenarios were developed. For the five sub-scenarios in residential sector, the assumptions were, as follows:

1. Introduction of billing of heat energy supplied by district heating systems based on actual consumption,
2. Building shell improvements,
3. Penetration of efficient heating appliances,
4. Introduction of efficient appliances,
5. Introduction of efficient light bulbs,

Simultaneous application of all aforementioned measures would lead to final energy savings of 23% comparing to Baseline scenario in 2030.

Data on energy consumption in public and commercial buildings can be found in energy balances of the Republic of Serbia², but only in total, for the whole sector, without additional disaggregated data regarding the consumption for specific purposes (heating, lighting, cooling, etc.)(World Bank, 2010).

Development of Baseline scenario for Public and Commercial buildings, due to the lack of necessary data, was done only at a level of final energy consumption forecast with corresponding structure of fuels/energy sources. Projection of energy consumption was developed separately for each fuel, based on historical data and following observed historical trend. For this sector three exploratory scenarios for implementation of energy efficiency measures were developed, with assumptions, as follows:

1. Introduction of heat pumps,
2. Building shell improvement,
3. Introduction of efficient lighting.

Simultaneous application of these measures would lead to final energy demand reduction of 18% in 2030, compared to the Baseline scenario.

Implementation of energy efficiency measures in the building sector in Serbia is affected by socio-economic, educational, institutional and cultural barriers, identified in Deliverables 2.1 and 2.2 of the HERON project. These barriers limit the full potential of energy savings that could be achieved by implementation of energy efficiency measures.

²<http://webrzs.stat.gov.rs/WebSite/Public/PageView.aspx?pKey=114>

DST software was used for analysis and calculation of the influence of specific barriers to energy efficiency technologies implementation. As an output, software provides data for the LEAP model correction, by determining limitations to assumed penetration of energy efficiency technologies due to barriers. Analysis of obtained LEAP scenarios for the building sector, after implementation of DST calculation tools, has shown, that the highest energy savings can be achieved by using Building shell improvement as technology. Hence, Building shell improvement sub-scenario is optimal in both (Residential and Tertiary) subsectors.

Building shell improvement is identified as the technology with the largest number of barriers. However, minimization of barriers that affect technology Building Shell improvement, has positive effects on other energy efficiency technologies.

Simultaneous application of all aforementioned measures for Residential subsector would lead to final energy savings of 15,2% comparing to Baseline scenario in 2030, which is almost 8% less than in EE scenarios for Building sector - Residential subsector without barriers involved.

Simultaneous application of all provided measures included impact of barriers would lead to final energy demand reduction of 11% in 2030, compared to the Baseline scenario, which is 7% less than in EE scenarios for Building sector - Public and Commercial subsector without barriers involved

Transport sector in Serbia has some differences in comparison to most neighbouring and European countries. Main differences are: high average age of vehicle fleet, relatively large proportion of road transport in total transport sector energy consumption and obsolescence and underdevelopment of railway sector resulting in low share of railway transport of goods and passengers (Kovacic, 2012). During previous years, road transport represented a dominant mode of transport, participating with about 80% of the total freight transport, and about 74% of the total passenger transport (Government of the Republic of Serbia, 2008). Analyses of energy consumption in passenger transport in the base year shows that 87.4% was related to car transport, 11.6% to bus transport, while less than 1% was related to rail and motorcycle transport. Hence, the major share of passenger kilometres is realized by car and bus transport.

Comparing energy consumption in transport and real GDP indicates strong relation between them. Thus, the key assumption for developing Baseline scenario for transport was that energy consumption in passenger transport would follow the growth of average household income, while energy consumption in freight transport would follow GDP growth rate. For exploring effects of energy efficiency measures in the transport sector six additional exploratory energy efficiency scenarios were developed assuming, as follows:

1. Introduction of more efficient vehicles,
2. Transport modal shift,
3. Driving behaviour - Eco driving,
4. Introduction of car sharing,
5. Introduction of biofuels,
6. Penetration of electric vehicles.

If all aforementioned measures are applied simultaneously in the transport sector, reduced energy demand can be expected at the level of 23% compared to Baseline scenario in 2030.

Similar as in Building sector, DST software is used to calculate the influence of specific barriers for the technologies and to take into account their impact on final energy consumption in transport sector. Analysis of LEAP scenarios with introduced barriers shows that the highest energy savings can be achieved through the Modal shift sub-scenario in Transport sector.

Simultaneous application of all aforementioned measures in transport sector, with included barriers, reduces energy demand for 14.5% compared to baseline scenario in 2030, which is 8.5% less than in scenarios without including of barriers impact.

7. UK

In this report, the different policy options (scenarios) are determined to achieve the currently set and proposed energy efficiency targets in the buildings and transport sectors on national level. In addition, the key socio-economic drivers to promote energy efficiency development at national level are described. The advantages and disadvantages of the different policy options included in the developed scenarios in comparison with present policies are presented. The work is carried out using the LEAP and DST calculation tools.

The **building sector** Energy Efficiency scenario consists of the categories (for which there are applicable policy measures and barriers): 1) efficient heating; 2) building shell improvements; 3) efficient cooling (tertiary sector only); 4) efficient appliances; 5) efficient lighting; and 6) Building energy management systems (BEMS). The crosscutting barrier with the greatest impact on the sub-scenarios is *high costs and risks*.

The best-case energy efficiency scenario *EE-B0* results are aligned with the fifth carbon budget (2016) *central estimate* which reflects a cost-effective path to the UK's 2050 target to reduce emissions by at least 80% on 1990 levels. Therefore, in this sense national targets are met. In contrast, the NEEAP (2014) projects that the residential and tertiary sectors would be below what is expected for the fifth carbon budget by 2020 (no projections for 2030 in NEEAP). Though the most recently published reduction scenario is below this, other sectors are offsetting this shortage. This can be seen in the transport sector.

Considering the residential, tertiary and transport sector together *EE-B0* 2020 = 95.1 Mtoe. This is 7.3% below (bettering) the sum of these sectors (102.6 Mtoe) as projected in NEEAP (2014), which is a sum of the three sector's projected final energy targets to meet the EU energy saving target of 20% by 2020, against a 2007 business-as-usual projection.

Compared to the EU GHG non-ETS targets for 2030, the total building sector EE scenarios tested range from 11 – 19% below (bettering) the target. In contrast, the BAU case is 16% short of meeting the target.

Transport demand in the UK represents the greatest UK GHG emissions just below the energy supply sector. As 21% of the total UK GHG emissions, this is up 6% from 1990 levels. Ninety three per cent of the total emissions from domestic transport are from road transport. All forms of public transportation are also up from 1990 levels (DfT, 2015a).

The **transport sector** Energy Efficiency scenarios consists of the categories (for which there are applicable policy measures and barriers): 1) Penetration of electric and hybrid vehicles in passenger and freight transport; 2) Eco-driving in freight and passenger transport; 3) Modal shift in freight and passenger transport; 4) Use of biofuels in freight and passenger transport; 5) More efficient vehicles in passenger and freight transport.

The best case energy efficiency scenario *EE-T0* results are aligned with the fifth carbon budget (2016) *central estimate* which reflects a cost-effective path to the UK's 2050 target to reduce emissions by at least 80% on 1990 levels. Therefore, in this sense national targets are met. The fifth carbon budget *central estimate* provides a 2020 transport sector projection below that projected by the NEEAP (2014) (no projections for 2030 in NEEAP).

Compared to the EU GHG non-ETS targets for 2030, the total transport sector EE scenarios tested range from 24-38% below (bettering) the target. In contrast, the BAU case is 24% short of meeting the target.

ANNEXES

The following annexes are attached (in separate pdf-files):

Annex 1. National report of Bulgaria (BSERC)

Annex 2. National report of Estonia (SEI Tallinn)

Annex 3. National report of Germany (WI)

Annex 4. National report of Greece (UoA-KEPA)

Annex 5. National report of Italy (UB)

Annex 6. National report of Serbia (UB-FMG)

Annex 7. National report of UK (OBU)

Annex 8. Task 4.3. Report on the aggregate energy demand econometric functions for the 8 countries: Belgium, Bulgaria, Estonia, Germany, Greece, Italy, Serbia, UK, for the transport and buildings sector (UoA-KEPA).