Policy scenarios and recommendations on nZEB, deep renovation and RES-H/C diffusion: the case of the Czech Republic

D4.3 and D5.6 from Entranze Project

Written by:

Petr Zahradník and Jiří Karásek, SEVEn

Lukas Kranzl, Agne Toleikyte
Energy Economics Group
University of Technology of Vienna

Tanja Kenkmann, Veit Bürger
Öko-Institut

Reviewed by:

María Fernández Boneta
CENER

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ENTRANZE Project

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Project consortium:

EEG	Energy Economics Group Institute of Power Systems and Energy Economics Vienna University of Technology
NCRC	National Consumer Research Centre
Fraunhofer	Fraunhofer Society for the advancement of applied research
CENER	National Renewable Energy Centre
eERG	end use Efficiency Research Group, Politecnico di Milano
Oeko	Öko-Institut
SOFENA	Sofia Energy Agency
BPIE	Buildings Performance Institute Europe
Enerdata	Enerdata
SEVEn	SEVEn, The Energy Efficiency Center

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The ENTRANZE project

The objective of the ENTRANZE project is to actively support policy making by providing the required data, analysis and guidelines to achieve a fast and strong penetration of nZEB and RES-H/C within the existing national building stocks. The project intends to connect building experts from European research and academia to national decision makers and key stakeholders with a view to build ambitious, but reality proof, policies and roadmaps.

The core part of the project is the dialogue with policy makers and experts and will focus on nine countries, covering >60% of the EU-27 building stock. Data, scenarios and recommendations will also be provided for EU-27 (+ Croatia and Serbia).

This report provides model based policy scenarios and related recommendations for Czech Republic. The input data and results were discussed intensively with policy makers and stakeholders. Similar reports are available for all target countries of the project ENTRANZE, which are Austria, Bulgaria, Czech Republic, Germany, Spain, Finland, France, Italy and Romania.

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Executive Summary

In this paper the methodology and the results of the creation of the policy scenario calculations and the policy recommendations within the ENTRANZE project are described. These are the main results of the work packages 4 and 5 of this Intelligent Energies Europe (IEE) – project for the Czech Republic.

In a first step policy sets have been developed, basing on the findings of the previous work within the project, e.g. data collection about the building sector, analyses of barriers for investors, and cost optimality calculations for renovations. The policy sets have been discussed and revised within the policy group meetings. Eventually the impact of the policy sets has been calculated with the model Invert/EE-Lab, and the recommendations have been derived from the results of the calculation. Again the recommendations have been discussed and revised by the policy group.

In Czech Republic the following policy sets have been chosen and their impact calculated with Invert/EE-Lab:

- **Policy Set 1 – Regulation framework based**
  First policy set is based on existing regulatory framework that corresponds to mandatory implementation of EPBD II and EED requirements. Most important parameters characterizing the policy set are: (1) 3% of floor area of central governmental buildings renovated annually regarding the EED, Article 5 and (2) nZEB implementation based on existing legislation (i.e. new buildings from 2018 respectively 2020 based on EPBD).
- **Policy Set 2 – Business as usual**
  The Business as usual policy set corresponds to Policy Set 1 plus EE supporting policies - mainly financial subsidies – are included. To adjust such set is complicated issue in the Czech Republic as many changes of EE policy approach are carried out every year in buildings.
- **Policy Set 3 – Ambitious regulatory policy**
  The third policy set introduces nZEBs obligation several years earlier than according to EPBD II requirements and broadens the scope to major renovations - we assume start year immediately in 2014 for both new buildings and major renovations for all building types. Starting from 2020, requirements on nZEBs will be strengthened.

Following important findings were identified during results consultations with policy group members as well as with other representatives of relevant organizations (mainly ministries):

- The results of Entranze project modelling of end energy consumption scenarios (based on starting year 2008) reaches about 319 PJ. Results based on national

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energy balance reach 300 PJ. The difference of these two values is not significant so, it was ag**reed that the model is well adjusted and can be used for further analyses** and scenarios comparison.

- The **difference between requirements on new building at present time and new buildings after nZEB requirements** (after they come in force based on existing legislation, implementing EPBD) **is quite small** in the Czech Republic. Difference between scenarios 2 and 3 equals to 6 PJ of overall consumption in the country. This difference provides clear evidence on **very moderate adjustment of parameters of nZEB** in the country (especially the requirement on decrease of non-renewable primary energy). Further, it is evident that due to quite low rate of new buildings construction and renovation, such a small improvement of parameters cannot bring significant results with enough influencing effect on overall building sector consumption.
- **Focus should be put on renovations of existing building stock** as the existing buildings are vital with their major share in the total energy consumption in building sector. **Support of complex solutions should** be intensified (bonuses for complex measures application in addition to partial ones). Potential **introduction of stricter nZEB parameters before 2020 would lead to more significant differences between the outcomes of scenario 2 and scenario 3** as well.
- **Special approach has to be introduced to renovations of historical buildings**. Due to architectural protection of such buildings, huge potential can be found in renewable sources installation.

- **The realization of one of two scenarios "Business as usual" or "Ambitious scenario" (scenarios 2 and 3) assures that the target of EED will be fulfilled**. The EED target says that savings about 27 PJ should be achieved till 2020. Still, there is significant space for more intensive solutions by strengthening the above mentioned rules.
- Additionally, the **Energy performance contracting (EPC) method should have been more visibly supported** within national subsidy programs **interms of setting clear rules for combining the EPC method with subsidies**.**Online data collection system** (e.g. from energy performance certificates) has to be established to create complex sample database of parameters of existing building stock and its renovation intensity.
- To broaden existing **awareness raising through information campaigns among broad public** (mainly via media) **and experts** (via unions, guilds, chambers and other voluntary market based education) will help to support demand side to push the market on energy efficient solutions and support quality of designed solutions.

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1. Introduction

A key element for investigating the potential future impact of policy instruments and for deriving policy recommendations in ENTRANZE is the development of policy scenarios. Policy scenarios are derived for the development of the building stock and its energy demand in the EU-27 (+Croatia and Serbia) up to 2030. In particular, the future deployment of Nearly Zero Energy Buildings and RES-H/C in the EU building stock is investigated and corresponding cost, expenditures and benefits are assessed. The impacts of different policy instruments on the diffusion process and the building related energy demand are investigated, considering economic, technical, non-technical and institutional barriers and rebound-effects. The scenarios are developed until the year 2030 with a particular focus on the year 2020, according to the target setting of the EPBD and the RED.

For each target country, a set of at least three different policy scenarios for two energy price scenarios has been developed. The national policy scenarios have been defined according to the specific needs, ideas and suggestions of the policy makers and stakeholders involved in the national discussion processes.

The discussion process during the project duration has been tailored in relation to actual needs and specifics of topics. That is the main reason why the discussion partners (most of them were policy group members) have been changing too. Although the participants of the policy group meetings were different people from different institutions, with all these persons we are in long-term touch in issues of energy efficiency so, continuation of discussions is not affected by these changes.

The discussions on connection of the Entranze policy sets and developed scenarios results and other relevant outputs on national scene were mostly linked to the directly responsible body in the country for energy efficiency issues - the Ministry of Industry and Trade.

As a crucial task of results discussion and presentation it has been recognized, that concordance with National Energy Efficiency Action Plan (NEEAP) and national energy balance is important as a kind of results verification. It was agreed during policy group meetings as well as during final conference.

This report provides a summary of these national policy scenarios as well as corresponding conclusions and recommendations.

The report starts with a documentation of the methodology in chapter 2. Chapter 3 provides the policy sets which were defined in policy group meetings together with relevant national stakeholders. Chapter 4 presents the resulting scenarios for the energy

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demand in the building stock and related renovation activities. Finally, chapter 5 includes the recommendations.

2. Methodology

The methodology of this report is based on three pillars:

1. Selection and description of policy sets based on a participatory stakeholder process
2. Modelling the potential impact of these policy sets with Invert/EE-Lab
3. Deriving recommendations

In the following chapters the methodology behind the three pillars will be explained in more detail.

2.1 Selection and description of policy sets

The selection of policy sets for the scenario calculation bases on the results of the previous work. These are especially the collected data of the building stock, the study on public and social acceptance and perception of nearly zero-energy buildings and RES-H/C in the target countries, and the cost optimality calculation. Another focus was put on specific barriers for different types of buildings and ownership groups (compare Table 1). All results of the previous work have been discussed with the policy group members in four policy group meetings. Additionally expert interviews have been carried out. Finally current political processes have been considered, and the policy sets have been created in a common process of discussion in the policy group.

Table 1: Barriers for different types of buildings and ownership groups

Building type, target group respectively	Barriers
Owner-occupied single-family homes	Financial barriers: high initial investment costs for refurbishment measures at the building structure or for improving or replacing the heating and cooling system as well as the access to capital or the cost of capital. long payback times for the respective investments
	Information deficit with high information search costs
Owner-occupied multi-family buildings	Financial barriers: high initial costs and long payback periods
	Difficulties with taking a collective loan for the investment in a refurbishment measure (in several countries all dwelling owners of a multi-family building must mortgage their apartment)
	Decisions about refurbishment measures must be more or less

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	taken collectively: different nature of owners in such buildings
Rental Buildings owned by private or social companies	Financial barriers do still apply: mainly the long payback times and in some countries the access to and cost of capital.
	The landlord-tenant dilemma
Public building sector	Public budgeting practises: different budget lines distinguishing between investment and operation costs
	Financial barriers: High initial cost for refurbishment measures and poor financial state of public finance

Other barriers, concerning all target groups, include

- information deficits; there often is a low level of information and awareness concerning economic benefits from refurbishment measures, benefits with regard to comfort, the availability of support schemes;
- the lack of technical/administrative advice (e.g. due to the absence of energy agencies on the local, regional or even national level).
- psychosocial factors such as preferences and attitudes,
- administrative barriers, such as low reliability and continuity of public support programs, and the sometimes complex and complicated administrative procedures (multi-stakeholders decision chain) for undertaking refurbishment measures or for applying for support.
- legal and technical barriers, such as the low value of some buildings, the uncertainty of the long-term value of a property, and the sometimes poor quality of refurbishment measures (In many countries the quality of modernisation measures was identified as a common problem, however the severity varies by countries. Poor quality might derive from inadequately qualified workforce lacking the competence to properly conduct such measures, or from do-it-yourself type of renovations carried out by the homeowners themselves. Lacking measures to substantially improve the renovation competence, the problem will even increase as soon as more ambitious refurbishment levels need to be met. Particularly in the case of deep renovations special attention has to be paid to a sound installation of the different components as well as coordination between the different structural elements (e.g. wall – window, roof – wall).

For more explanation compare deliverable D2.4 (Heiskanen et al., 2012) and Deliverable D5.4 (Bürger, V., 2013).

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2.2 Modelling policy impact in Invert/EE-Lab

Invert/EE-Lab is a dynamic bottom-up simulation tool that evaluates the effects of different promotion schemes (in particular different settings of economic and regulatory incentives) on the total energy demand, energy carrier mix, CO2 reductions and costs for space heating, cooling and hot water preparations in buildings. Furthermore, Invert/EE-Lab is designed to simulate different scenarios (price scenarios, insulation scenarios, different consumer behaviours, etc.) and their respective impact on future trends of energy demand and mix of renewable as well as conventional energy sources on a national and regional level. More information is available on www.invert.at or e.g. in (Kranzl et al., 2013) or (Müller, 2012).

The basic structure and concept is described in Figure 1.

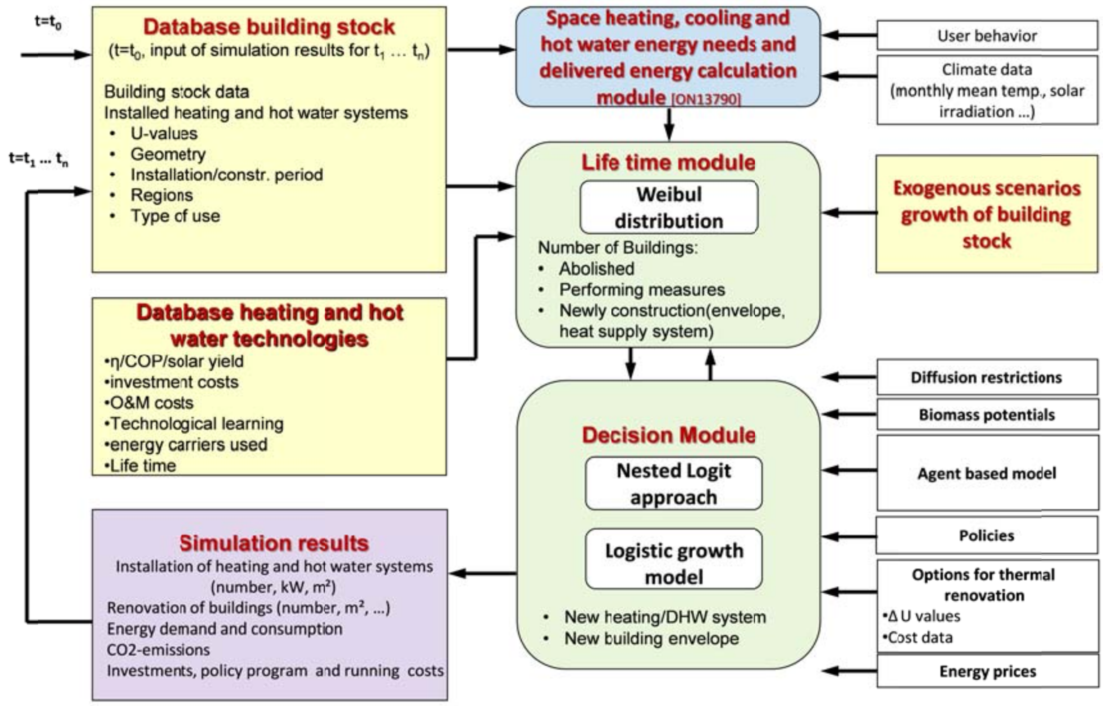

Figure 1: Overview structure of Simulation-Tool Invert/EE-Lab

Invert simulation tool originally has been developed by Vienna University of Technology/EEG in the frame of the Altener project Invert (Investing in RES&RUE technologies: models for saving public money). In more than 30 projects and studies for more than 15 countries, the model has been extended and applied to different regions within Europe, see e.g. (Kranzl et al., 2012), (Kranzl et al., 2013), (Biermayr et al., 2007), (Haas et al., 2009), (Kranzl et al., 2006), (Kranzl et al., 2007), (Nast et al., 2006), (Schriefl, 2007), (Stadler et al., 2007). The last modification of the model in the year 2010 includ-

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ed a re-programming process and accommodation of the tool, in particular taking into account the inhomogeneous structure of decision makers in the building sector and corresponding distributions (Müller, 2010). The current state of the model relies on this new calculation-core (called EE-Lab) leading to the current version of the model Invert/EE-Lab.

The basic idea of the model is to describe the building stock, heating, cooling and hot water systems on highly disaggregated level, calculate related energy needs and delivered energy, determine reinvestment cycles and new investment of building components and technologies and simulate the decisions of various agents (i.e. owner types) in case that an investment decision is due for a specific building segment. The core of the tool is a myopical, multinominal logit approach, which optimizes objectives of "agents" under imperfect information conditions and by that represents the decisions maker concerning building related decisions.

The model enables the definition of a various number of different owner types as instances of predefined investor classes: owner occupier, private landlords, community of owners (joint-ownership), and housing association. The structure is motivated by the different perspectives regarding building related investments. For instance, energy cost savings are only relevant for those owners which occupy the building. The corresponding variable relevant to landlords is a refinancing of energy savings measures through additional rental income (investor-tenant dilemma). Owner types are differentiated by their investment decision behaviour and the perception of the environment. The former is captured by investor-specific weights of economic and non-economic attributes of alternatives. The perception relevant variables – in-formation awareness, energy price calculation, risk aversion – influence the attribute values. More details regarding the integration of stakeholder specific investment behavior in the model Invert/EE-Lab is documented in Steinbach, (2013).

Coverage and data structure

The model Invert/EE-Lab up to now has been applied in all countries of **EU-28 (+ Serbia)**. A representation of the implemented data of the building stock is given at www.entranze.eu.

Invert/EE-Lab covers **residential and non-residential buildings**. Industrial buildings are excluded (as far as they are not included in the official statistics of office or other non-residential buildings).

The following figure shows the disaggregated modeling of the building stock within each country. The level of detail, the number of construction periods etc. depend on the data availability and structure of national statistics. We take into account data from Eurostat, national building statistics, national statistics on various economic sectors for non-residential buildings, BPIE data hub, Odyssee, which are finally summarized in the ENTRANZE database (www.entranze.eu).

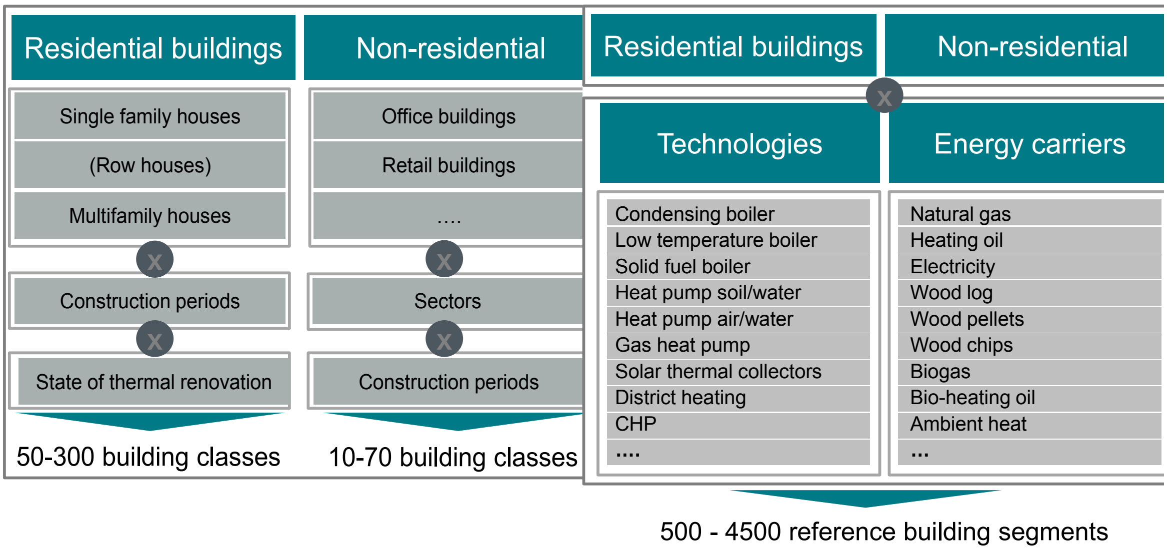

Figure 2: Disaggregated modelling of the building stock within each country

Outputs from Invert/EE-Lab

Standard outputs from the Invert/EE-Lab on an annual basis are:

- Installation of heating and hot water systems by energy carrier and technology (number of buildings, number of dwellings supplied)
- Refurbishment measures by level of refurbishment (number of buildings, number of dwellings)
- Total delivered energy by energy carriers and building categories (GWh)
- Total energy need by building categories (GWh)
- Policy programme costs, e.g. support volume for investment subsidies (M€)
- Total investment (M€)

Moreover, Invert/EE-Lab offers the possibility to derive more detailed and other type of result evaluations as well. Based on the needs of the policy processes we will have to discuss which other type of evaluations of the result data set might be required.

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2.2.1 General approach of modelling policy instruments in Invert/EE-Lab

Invert/EE-Lab models the decision making of agents (i.e. building owner types) regarding building renovation and heating, hot water and cooling systems. Policy instruments may affect these decisions (in reality and in Invert/EE-Lab) in the following ways:

- Economic incentives change the economic effectiveness of different options and thus lead to other investment decisions. This change leads to higher market share of the supported technology in the Invert/EE-Lab (via the nested logit approach).
- Regulatory instruments (e.g. building codes or renewable heat obligations) restrict the technological options that decision makers have; limited compliance with these measures can be taken into account by limiting the information level of different agents regarding this measure (see next bullet point).
- Information, advice, etc: Agents have different levels of information. Lack of information may lead to neglecting of innovative technologies in the decision making process or to a lack of awareness regarding subsidies or other support policies. Information campaigns and advice can increase this level of information. Thus, the consideration of innovative technologies, knowledge about support programmes and compliance with regulatory standards increases.
- R&D can push technological progress. The progress in terms of efficiency increase or cost reduction of technologies can be implemented in Invert/EE-Lab.

More specific examples of modelling policy instruments in Invert/EE-Lab are described in the annex of this report.

2.2.2 Key input data to the model

The model Invert/EE-Lab requires the following main categories of input data:

- **Disaggregated description of the building stock**: The scenarios presented in this report are based on the building stock data as described in the reports "Building sector and energy demand in target countries" and the corresponding online data tool, both available at www.entranze.eu.

- **Cost data of heating, hot water and cooling systems as well as of renovation options**: These data have been collected, checked with national experts and literature in the frame of the cost-optimality calculations. The background data and results of these techno-economic analyses are documented in the report on "Cost of energy efficiency measures in buildings refurbishment: a summary report on target countries" (Fernandez-Boneta, 2013) and the report on cost/energy curves (Pietrobon et al., 2013).

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- **Definition of renovation packages and the link to the cost-optimality calculations:** As described above, for those measures leading to a reduction of the energy need (e.g. renovation of building envelope or heat recovery systems) Invert/EE-Lab requires a set of pre-defined renovation packages from which agents may select. The selection and definition of these renovation packages was done based on the cost-optimality calculations in this project (Pietrobon et al., 2013) and the derived energy-cost matrices (Fernandez-Boneta, 2014). Based on these calculations, three packages have been selected: The standard renovation package more or less reflects the current practice of thermal building renovation, the "good" renovation package reflects a set of measures near the cost-optimality point whereas the "ambitious" renovation package refers to a level of renovation which is near the "minimum primary energy" level as indicated in Pietrobon et al., (2013). The following table shows the main indicators for the renovation packages for the case of the country covered in this report.

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Table 2: Definition of renovation packages

	Roof	Wall	Base	Windows	Night cooling	Solar shading	Heat recovery
Residential							
Standard	15 cm of thermal insulation	10 cm of thermal insulation	5 cm of thermal insulation	Double glass with air cavity (16mm) and a low-e glass, thermal transmittance value of glazing Ug=1,7 W/m²K; g=0,72; Tvis=0,82, thermal transmittance value of frame Uf=1,4 W/m2K, Reduce air permeability of the window at least to 3rd class (9 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification"	no	no	no
Good	20 cm of thermal insulation	15 cm of thermal insulation	10 cm of thermal insulation	Double glass with air cavity (16mm) and a low-e glass, thermal transmittance value of glazing Ug=1,7 W/m²K; g=0,72; Tvis=0,82, thermal transmittance value of frame Uf=1,4 W/m2K, Reduce air permeability of the window at least to 3rd class (9 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification"	yes	yes	no
Ambitious	30 cm of thermal insulation	20 cm of thermal insulation	15 cm of thermal insulation	Triple glass with argon cavity (16mm) and a low-e glass, thermal transmittance value of glazing Ug=1,0 W/m²K; g=0,64; Tvis=0,74, thermal transmittance value of frame Uf=1,0 W/m2K, Reduce air permeability of the window at least to 4th class (3 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification"	yes	yes	yes
Non-residential							
Standard	10 cm of thermal insulation	10 cm of thermal insulation	5 cm of thermal insulation	Double glass with air cavity (16mm) and a low-e glass, thermal transmittance value of glazing Ug=1,7 W/m²K; g=0,72; Tvis=0,82, thermal transmittance value of frame Uf=1,4 W/m2K, Reduce air permeability of the window at least to 3rd class (9 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification"	no	no	no
Good	20 cm of thermal insulation	15 cm of thermal insulation	10 cm of thermal insulation	Double glass with air cavity (16mm) and a low-e glass, thermal transmittance value of glazing Ug=1,7 W/m²K; g=0,72; Tvis=0,82, thermal transmittance value of frame Uf=1,4 W/m2K, Reduce air permeability of the window at least to 3rd class (9 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification"	no	yes	no
Ambitious	30 cm of thermal insulation	20 cm of thermal insulation	15 cm of thermal insulation	Triple glass with argon cavity (16mm) and a low-e glass, thermal transmittance value of glazing Ug=1,0 W/m²K; g=0,64; Tvis=0,74, thermal transmittance value of frame Uf=1,0 W/m2K, Reduce air permeability of the window at least to 4th class (3 m³/hm²) of the standard "EN 12207 Windows and doors - Air permeability - Classification"	yes	yes	no

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2.2.3 Energy price scenarios and the link to the model POLES

Energy price scenarios are a highly relevant and sensitive input data for the Invert/EE-Lab model. POLES has been established. POLES developed two scenarios for the overall development of the global energy system that led to projections of international fuel prices:

The **"Reference"** scenario assumes that only on-going and already planned climate policies are taken into account and that no consensus is reached at international level. Sustained growth of China and other emerging countries is a powerful driver of energy demand at world level leading to high international oil and gas prices but to lower domestic prices. Energy prices for end-users at country level were then projected, taking into account changes in international prices and taxes (excise tax[1], VAT) and a carbon price[2].

The **"Ambitious Climate"** scenario explores the implications of more stringent climate policies and reinforced support for renewables at world level driven by successful. negotiations between advanced and emerging economies on climate change. International fossil fuel prices are lower as a result of a lower demand but domestic prices are higher due to higher taxes and the cost of policies to reach the emissions abatement targets.

The resulting two energy price scenarios were then used in Invert/EE-Lab as an input, as well as the corresponding primary energy factors and CO2-emission factors of electricity, based on POLES projections of the power mix and CO2 emissions by country. On the other hand, the results of the model Invert/EE-Lab were checked with POLES regarding the potential feedback loop on energy prices.

International prices

Over the 2010-2030 period, prices are expected to increase for oil, gas and coal. Trends are significantly stronger in the reference scenario, as in the ambitious scenario the demand for oil and gas is growing less rapidly resulting in lower tensions on the international markets. More details are available below by type of fuel for both scenarios.

[1] Including existing energy & environmental taxes.
[2] Carbon prices are different from EU ETS prices and refer to an aggregate metric in POLES used to characterise the effort necessary to reach climate objectives: they might be seen as "shadow prices" for policies stimulating low-carbon technologies.

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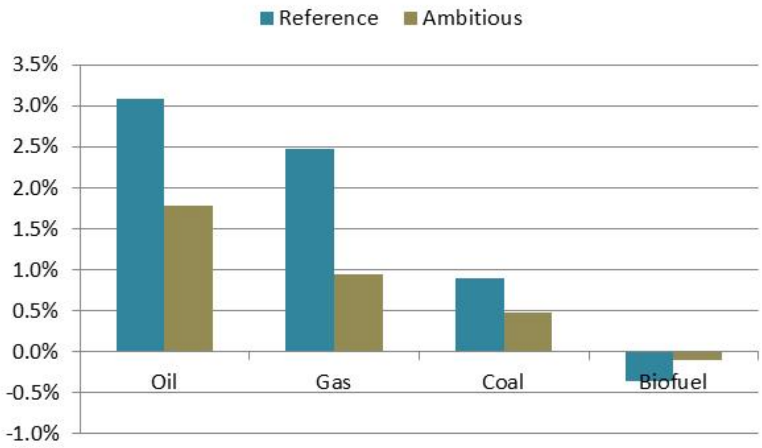

Figure 3: Annual growth rate of international energy price over 2010-2030

Source: POLES-Enerdata

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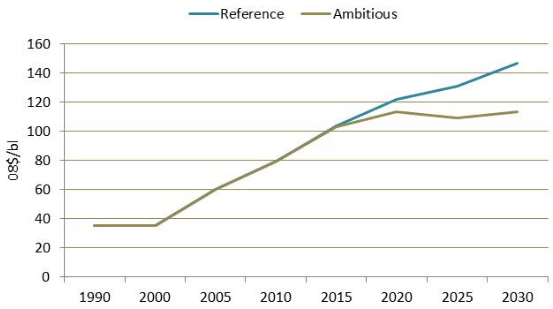
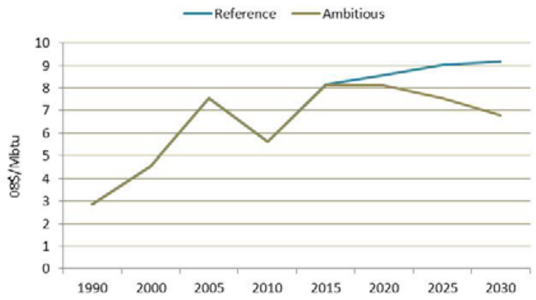
Oil



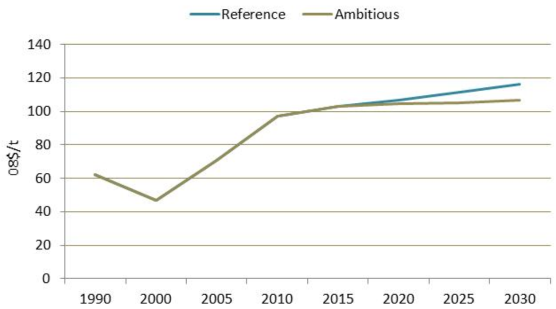
In the reference scenario, oil price is expected to increase at a rapid pace of 6.5%/year from 2000 until 2020, which will then slow down to 2%/year until 2030. In the ambitious scenario, it increases less rapidly until 2020 (3.6%/year), and remains almost steady reaching 100$/bl in 2030. This lower price is explained by the decreasing oil demand.

Gas



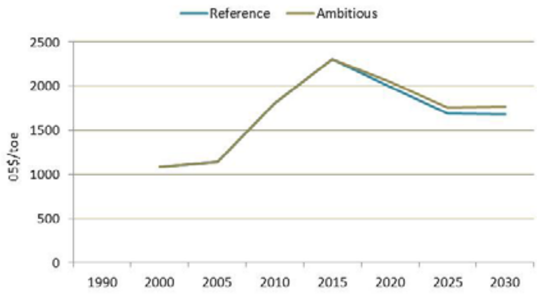
Gas price in Europe is expected to increase by 7.6%/year for both scenarios until 2015 (Figure 8). Then it will continue to increase on average until 2030 by 0.8%/year in the reference scenario whilst it is decreasing in the ambitious scenario by 1.2%/year because of decreasing demand.

Coal



Coal prices are expected to increase steadily across time in Europe, with a slightly less rapid trend concerning the ambitious scenario, i.e. 0.5%/year compared to 0.9%/year for the reference scenario. This price increases in both scenario is due the: the fact that production costs will increase with income in producing regions.

Biomass



After a short-term to increase due to the strong dynamic in biofuel demand in all sectors, the biomass price[3] will decrease by roughly 2%/year until 2025 thanks to market autoregulation. It will again slightly increase (until 2050) because of a strong penetration of biofuels, the high mitigation option.

Figure 4: European energy price forecasts until 2030

3 Prices for biomass refer to modern biomass (i.e. pellets or wood chips). Prices are based on simulation of land use and international biomass trade, and unlike for other fuels they do not take into account historical prices

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Residential domestic prices[4]

Excise taxes and VAT have been assumed constant in these projections. Price of heating oil for households consumers is projected to decrease by -0.8% and price of gas to increase by 1.4%/year in the ambitious scenario over the period 2010-2030, which will be later referred to the “high price” scenario. In the reference scenario the progression is lower because of lower carbon tax (decrease by -1.2% and increase by 1.0%/year respectively for oil and gas) (Figure 5). This scenario will later be referred to as the “low price” scenario. The coal price increases in the ambitious scenario, by up to 2.7%/year, and to a lesser extent in the reference scenario by 0.7%/year.

The electricity price is modelled on the basis of the cost of generation of electricity that results from changes in the price of fossil fuels and in the power mix. It also includes taxes. The average price increases by 1.8%/year in the ambitious/high price scenario and by 1.3%/year in the reference/low price scenario. The electricity price is expected to peak in 2030 at around 1 750 \$/toe (15,1 \$c/kWh)[5] in the ambitious/high price scenario and at 1 600 \$05/toe (13,8 \$c05/kWh) in the reference/low price scenario.

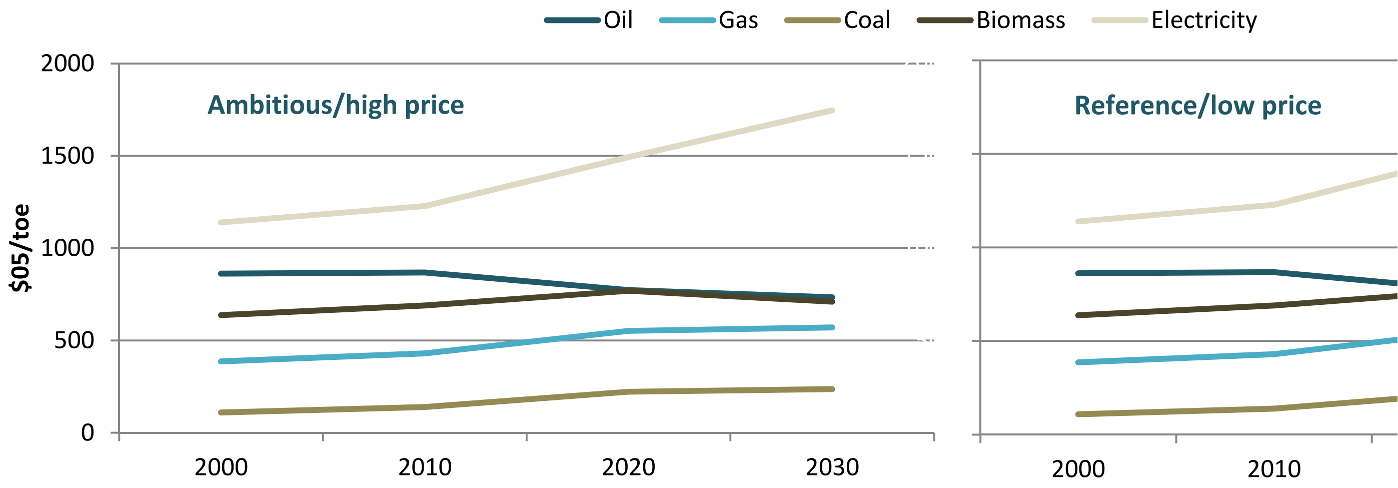

Figure 5: Czech residential domestic prices forecasts by type of energy

Source: POLES-Enerdata

[4] Domestic prices are in constant euros (i.e. without inflation), from which you can derive an average variation by period.

[5] In 2005 prices and exchange rates.

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2.3 Deriving recommendations

The recommendations have been derived in close interaction with the stakeholders basing on the results of the scenario calculation. The results of all previous works have been considered. The results of the national policy process have also been evaluated as to whether recommendations for other Member States can be derived.

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3. Policy set description

In this part of the report we describe the policy sets which will be further investigated regarding their potential impact. We start with an overview of existing instruments, and provide some general considerations for the selection before we define the policy sets according to the discussion process in the policy group meetings.

3.1 Overview of policy instruments for improving energy performance of buildings

Figure 7 and Figure 7 give an overview about the categories of existing policy instruments for the improvement of the energetic condition of buildings. For more detailed information compare the report “Overview and assessment of new and innovative integrated policy sets that aim at the nZEB standard” of the ENTRANZE-project (Bürger, 2013).

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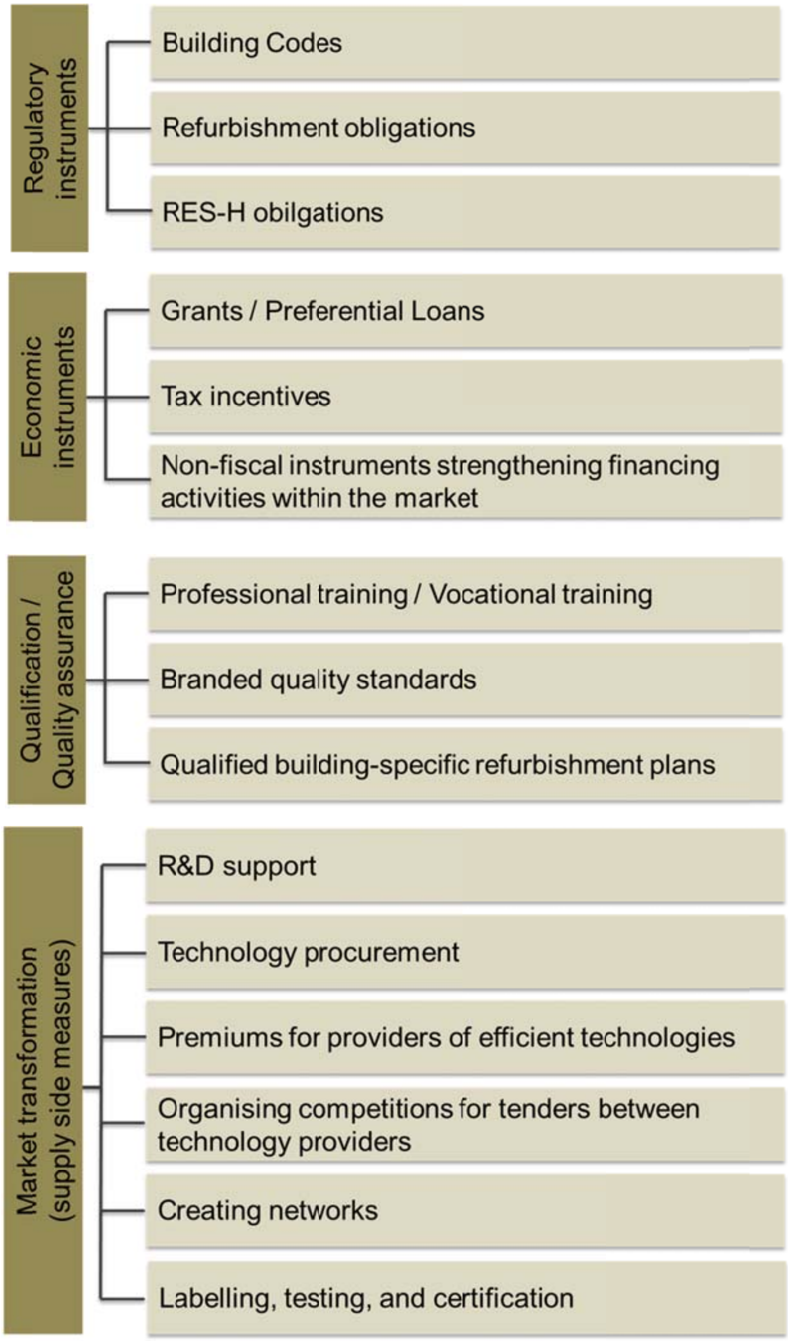

Figure 6: Categories of policy instruments (part 1)

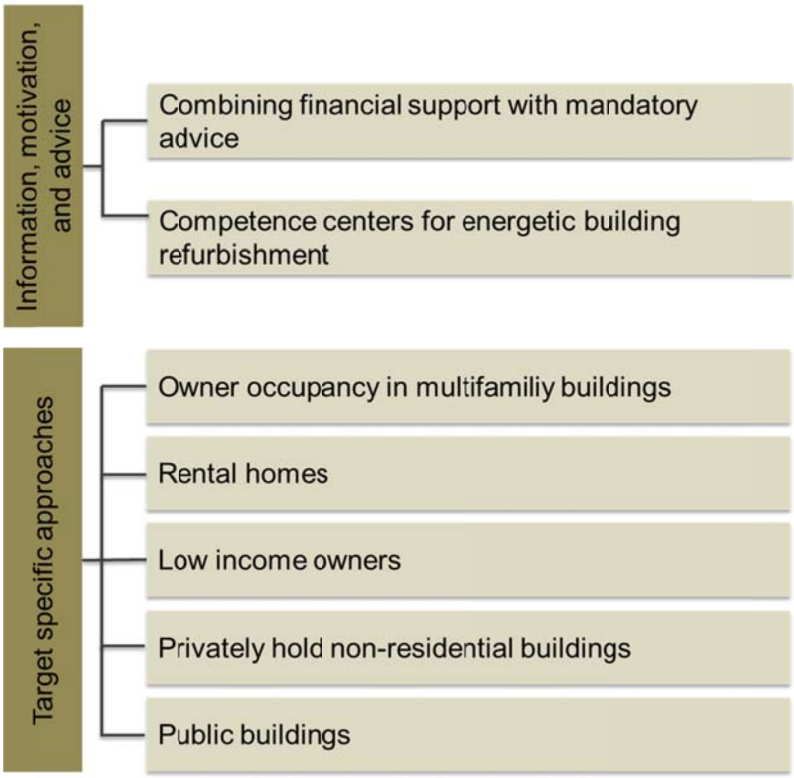

Figure 7: Categories of policy instruments (part 2)

3.2 Key considerations for defining policy sets

For the combination of different instruments to a policy set some considerations should be taken into account:

- Instruments should be designed as to address the main barriers that hamper investments in the efficiency of buildings. In addition the policy package should include elements as to target the needs of the major target groups. The instruments in the policy package should reflect the market maturity of the different technologies.
- If a certain barrier (e.g. a financial barrier) is addressed by two or more instruments at the same time, this should be adequately justified (e.g. by the fact, that the instruments offer different accesses to financial support which might aim at different target groups). It should be avoided that instruments are simply redundant (which might only lead to higher administrative costs).
- In general administrative costs of a policy package should be kept as low as possible. This includes the transaction costs for the state but also all other sys-

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tem participants. For that reason it should be assessed to which extent synergies could be exploited when administering several instruments at the same time.

- In order to increase public acceptance for the communicative perspective the policy package should be kept as simple as possible. The main elements of a package should be easy to communicate.

One option to define the policy packages would be to choose policy sets according to distinct “policy lines”. For instance a policy package could lay a focus on regulatory measures. Such a package could involve tightening the building code, implementing replacement obligations (e.g. for boilers) and/or unconditional refurbishment obligations (e.g. for the structural components of a building) as well as implementing a use obligation for RES-H. Another policy line would focus on financial support that is offered by state-financed support programs. The core of such a policy package would be grant programs, soft loans, tax incentives that could incentivise building owners to make investments in refurbishment measures.

A third potential policy line could strengthen support and financing activities within the market. Under such a policy line the state would create the framework conditions and support would be given independent from public budgets. Typical instruments within such a policy package would be energy saving obligations under which obliged market actors would start to establish support pro-grams for refurbishment measures. Also typical price-based (e.g. premium schemes) or quantity-based (e.g. quota schemes) approaches could be taken up as long as it is ensured that the support costs are covered by the market participants (finally ending with the end consumer).

The strategy of a policy set should include a long-term goal (expressed in form of a set of indicators) but also milestones that should be met during the sector transformation from the status quo today towards the long-term goal. Another important question is how the different instruments are designed in detail. Often the impact of a political intervention is more dependent on the core design parameters of an instrument than on the question which instrument is applied. For a grant program important design parameters are the grant level(s), potentially tiered according to the efficiency level of a measure, the eligibility to the program etc. For the quantitative impact assessment these parameters must be set. Another dimension is the time. Policy sets might change over time. This applies to the selection of instruments within a package but also to the evolution of the specific instrument designs. The time dimension needs to be taken into account as well when the policy sets are set up. For more information please compare the report “Overview and assessment of new and innovative integrated policy sets that aim at the nZEB standard” of the ENTRANZE Project (Bürger, 2013).

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3.3 Policy sets defined for the scenario calculation

Based on the portfolio of policy instruments and the considerations regarding the selection of policy packages, the policy group decided to analyse the following policy sets:

Table 3: Policy sets definition for Czech Republic

Policy set 1 Regulation framework based	Policy set 2 Business as usual	Policy set 3 Ambitious regulatory policy
based on existing regulatory framework + 3% of floor area of central governmental buildings renovated annually regarding the EED, Article 5 + nZEB implementation based on existing legislation No subsidy programs included.	All parameters correspond to Policy Set 1 + Current relevant subsidy schemes are included to see their impact (in comparison to Policy set 1). Included subsidy schemes are: Green Investment Scheme, PANEL 2013+, Operation Programme Enterprise and Innovation – Eco-energy and Operation Programme Environment	All parameters correspond to Policy Set 2 + nZEBs obligation introduced several years earlier (starting in 2014) + nZEBs obligations is broadened to major renovations (starting in 2014) + Starting from 2020, requirements on nZEBs will be strengthened

There is put a great emphasis on feasibility of policies in the Czech Republic. The maim aim is to set up continual process of EE increasing in the building stock, because the current system opening new programmes without long term financial stability. And it is not suitable for the market players. Drive and stop principle was criticized also by the EC.

The policy sets are crucial to compare current policy results with EU requirements.

- Qualitative assessment criteria have been defined according to NEEAP; the most important criteria are yearly energy savings and cost for subsidy of EE measures.
- The most important discussion is how to fulfill EU directives´ requirements such as 47 PJ energy savings in end use of the Czech Republic or 3 % of refurbished public buildings.

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- The current policy framework is given by regulations and standards under Energy Management Act, 4 different support schemes focused on EE and using of RES –H.
- Since 2001 many EE measures are subsidize. Subsidies started in apartment buildings, and also in public buildings also were subsidized. Later were supported private commercial buildings and family houses.

Policy Set 1 – Regulation framework based

First policy set is based on existing regulatory framework that corresponds to mandatory implementation of EPBD II and EED requirements. Most important parameters characterizing the policy set are: (1) 3% of floor area of central governmental buildings renovated annually regarding the EED, Article 5 and (2) nZEB implementation based on existing legislation (i.e. new buildings from 2018 respectively 2020 based on EPBD).

Further tightening of regulatory mechanisms is not expected in the country in this policy set.

The scenario is requested to compare impact of subsidies in the country. It should help to policy makers in subsidy schemes development and in argumentation, why the subsidy is needed.

Depending on the type of instrument the description address the following instruments:

1. Regulatory instruments

EU level

The requirement of 3% of refurbished public buildings per year.

National level

Act on energy management

- Requirements on energy performance of buildings have to be on the cost optimal level
- nZEB building have to achieve high share of RES
- nZEB level will be achieved in the new public buildings with energy related area
  - Bigger than 1500 sq. m from 2016
  - Bigger than 350 sq. m from 2017
  - Lower than 350 sq. m from 2018

Regulation on energy audit and energy appraisal - since 2013

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- o Energy audits

Regulation on energy performance of buildings – since 2013

- o nZEB level is defined according to reference building, which is a building with the same geometry, orientation and shading, but with standardized using and reference values (i.e. required values given by national legislation) for the building structure and energy systems. At this level, requirement on average U-value strengthening for nZEBs has been introduced.

Reduction of U-value required

Non-renewable primary energy reduction

Other chapters - For detailed information and description see Annex B.

Policy Set 2 – Business as usual

To set up business as usual policy is complicated issue in the Czech Republic. Many changes of EE policy approach are carried out every year in buildings (changes of subsidy schemes, changes of regulatory mechanisms). The current subsidy schemes are Green Investment Scheme, PANEL 2013+, Operation Programme Enterprise and Innovation – Eco-energy and Operation Programme Environment - priority axis 3 Sustainable use of energy sources.

All other parameters correspond to Policy Set 1.

1. ***Regulatory instruments***
   As in PS1
2. ***Economic instruments***

   Description of programmes

   Green investment scheme (GIS)

   - Direct subsidy programme
   - Covers mostly private (98%) but also public sector less than 2% by municipal buildings
   - Existing buildings and new houses in passive energy standard
     Existing buildings:
     - Recommended U-values (walls 0,25; roof 0,16; floor 0,30; windows 1,20)
     - Maximum energy demand for heating in two possible levels 55 or 70 kWh/m^2,a

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- Minimum energy saving in possible levels 40 or 30% compared to existing state of a building.

Passive buildings: the same as for New GIS.

- Biomass boilers, heat pumps, solar thermal collectors
- Average level of subsidy about 57% different according to measures.
- Support is given for the whole duration of the programme; static support
- Data is collected via SEVEn´s project Verification of CO_2 emission savings
- Emission trading

Operational Programme Environment (OPŽP)

- Direct subsidy programme
- Majority of the programme focuses on existing public buildings improvements
- Technical requirements are quite simple as results of energy audits are taken into account only (for system of project applications evaluation, energy savings and CO2 emissions savings are the most important values).No minimal energy saving is defined but maximal U-values of eligible constructions and average U-value are set using Standard ČSN 73 0540.
- Share of subsidized technologies in buildings very low
- Maximum level of subsidy is 90% of eligible costs. This is higher than in Green investment scheme in average
- Support is given for the whole duration of the programme; static support.
- Data is collected via SEVEn´s project EFEKT of the Ministry of industry
- Operational programme environment

Eco-Energy

- Direct subsidy programme
- For existing commercial buildings improvements
- Technologies for RES are subsidized, partly for buildings – CHP, Biomass boilers, change of heating system
- Level of subsidy is according to public subsidy regime for small, middle, large enterprises, average 33%
- Support is given for the whole duration of the programme; static support
- Data is collected via SEVEn´s project EFEKT of the Ministry of industry
- EU Operational Programme Enterprise and Innovations (OPEI) 2007-2013

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Panel

- Soft loans programme
- Existing apartment buildings (actually not only panel ones, differently from its name)
- No technologies for RES are subsidized
- Average level of subsidy 2% of the interest rate reduction
- Support is given for the whole duration of the programme; static support
- Data is collected via SEVEn´s project EFEKT of the Ministry of industry
- State budget

New Green Investment Scheme

- Direct subsidy programme, successor of Green Investment Scheme
- Shall cover both public buildings and private (both family and apartment) buildings but at present (in 2013 and 2014) subsidies of family houses are planned only

- Existing buildings renovation and new passive houses – there exist more levels of subsidy based on parameters that can be reached by calculation. Most important are the U-values, specific energy need for heating, energy consumption for heating and overall energy demand and non-renewable energy. There are 4 levels of parameters intensity and relevant subsidy sum.
  Example: For passive houses there are two levels regarding specific energy need for heating (15 resp. 20 kWh/m2,a) with subsidy in CZK: 400 000,- resp. 550 000,- equals to about EUR: 14 500,- resp. 20 000,-.
- Subsidies for biomass boilers, heat pumps, gas condensing boilers and solar thermal collectors
- The subsidies for biomass boilers, heat pumps, gas condensing boilers can be provided only in case that solid or some liquid fossil fuels are being used in the existing houses.

- Average level of subsidy about 40%; differs according to measures included
- Support is given for the whole duration of the programme; static support
- Data is collected via SEVEn´s project EFEKT of the Ministry of industry
- Emission trading/state budget

3. Capacity building, qualification and quality assurance

As in PS1

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4. Information, motivation and advice

As in PS1

5. Market transformation (supply side) measures

As in PS1

Policy Set 3 – Ambitious regulatory policy

The third policy set introduces nZEBs obligation several years earlier and broadens a scope to major renovations. We are assuming, that the nZEBs implementation will start immediately in 2014 for both new buildings and major renovations for all building types. Starting from 2020, requirements on nZEBs will be strengthened.

It is generally assumed, that the nZEBs will correspond to national cost optimum calculations from 2020. The nZEB U-values will be used as the required values from 2014 to 2020. They are defined by the Regulation on Energy Performance of Buildings. From 2020, passive house values defined by standard ČSN 73 0540 Thermal protection of buildings will be taken into account.

1. Regulatory instruments

EU level

- As in PS1 and 2

National level

Act on energy management

- o As in PS1 and 2

Regulation on energy audit and energy appraisal - since 2013

- o As in PS1 and 2

Regulation on energy performance of buildings – since 2013

Construction	*Reference U-value (i.e. required by standard for both new and renovated buildings)*	*Reduction coefficient*	*U-value required for nZEBs till 2020*	*U-value required for nZEBs after 2020*
Walls	*0,30*	*0,7*	***0,210***	***0,15***
Roof	*0,24*		***0,168***	***0,15***
Floor	*0,45*		***0,315***	***0,18***
Windows	*1,50*		***1,050***	***0,7***

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Notice: The national legislation related to nZEBs defines requirements on new buildings only (according to EPBD 2). We expect the same requirements on constructions for renovated buildings.

After 2020 a further tightening of U values requirement is expected. U values after 2020 will be described according to average passive house U values in the Czech Republic.

- nZEB level is defined according to reference building, building with the same geometry, orientation and shading, but with standardized using and reference values (required values) for the building structure and energy systems.
- Reduction coefficient of average U value 1.0 is used for the existing buildings renovation, 0.7 is used for all new buildings since 2014. It means since 2014 the average U values for the new buildings have to be 0.7 times lower than is required for the existing renovated buildings.
- Decreasing of the nonrenewable primary energy in comparison with the reference building (relates to the explanation on the page 8)

	nZEB from 2014	nZEB from 2020
Family houses	25%	60 kWh/(m2.y)
Apartment buildings	25%	60 kWh/(m2.y)
Other buildings	10%	120 kWh/(m2.y)

Comment:
nZEB values after 2020 will be more ambitious than the values 2014-2020.
nZEB calculation from 2014 to 2020 should be according PS1

2. *Economic instruments*

As in PS2

3. *Capacity building, qualification and quality assurance*

As in PS2

4. *Information, motivation and advice*

As in PS2

5. *Market transformation (supply side) measures*

As in PS2

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4. Model results

This part of the report provides an overview of the model results and analysis of the impacts of three chosen policy sets on final energy demand for heating and domestic hot water preparation, renovation rates, total investments and energy costs. These main results of the policy scenarios modelled with Invert model are shown in following graphs. All these data are also available in an online tool that is included on the project website (www.entranze.eu). The results of policy sets 2 and 3 are highly influenced by used subsidy mechanisms that have motivation effect. In these two policy sets it is expected to continue with these subsidy schemes at least till 2020 respectively 2030.

4.1 Final energy demand and model verification

Following two graphs describe the projections of energy demand for heating and domestic hot water preparation in the country. The projections start in year 2008 (baseline year of the project) to year 2030 through year 2020. For both these projection years there are modelled values for all three policy sets that have been defined in cooperation with policy group members and that are introduced in previous chapter. Further, the two graphs relate to low energy prices and high energy prices options.

Overall energy demand is separated according to the energy bearers.

The low energy price scenario (Figure 8) represents a more conservative option regarding the potential energy demand decrease. Still, the consumption decrease is significant for both policy sets 2 and 3 in both time milestones.

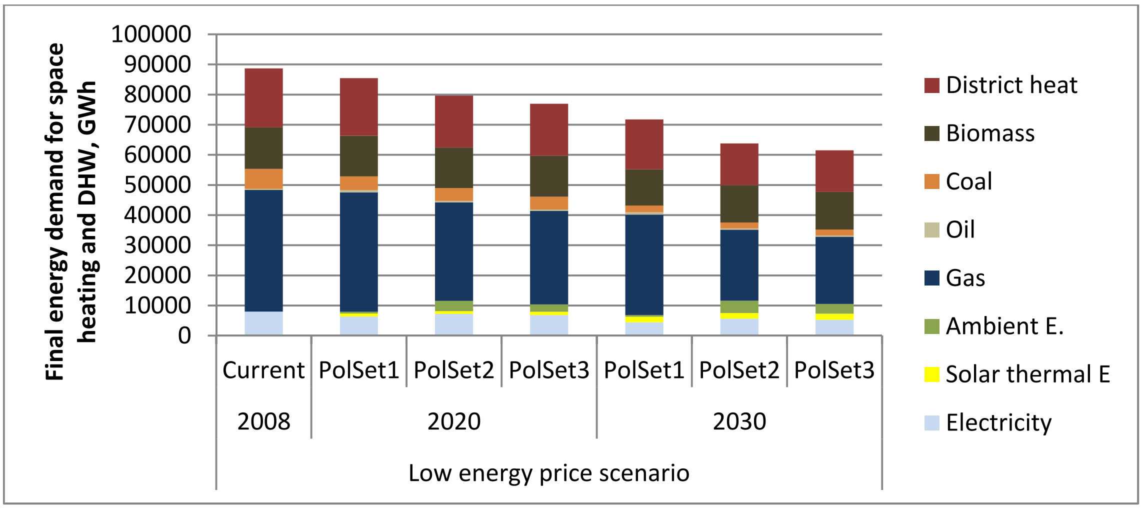

Figure 8: Final energy demand for space heating and DHW (low energy prices)

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The reduction in 2020 compared to 2008 for the policy set 2 (Business as usual) is about 10%, compared to the most ambitious policy set 3, that brings absolutely highest savings with about 31% in 2030 compared to 2008.

Very similar results (in terms of ratios of achievable savings by the defined policy sets) can be found in the following graph (Figure 9) that relates to the same modelling and time milestones, but using high energy prices.

The reduction in 2020 compared to 2008 for the policy set 2 (Business as usual) is about 14%, compared to the most ambitious policy set 3, that brings absolutely highest savings with about 36% in 2030 compared to 2008.

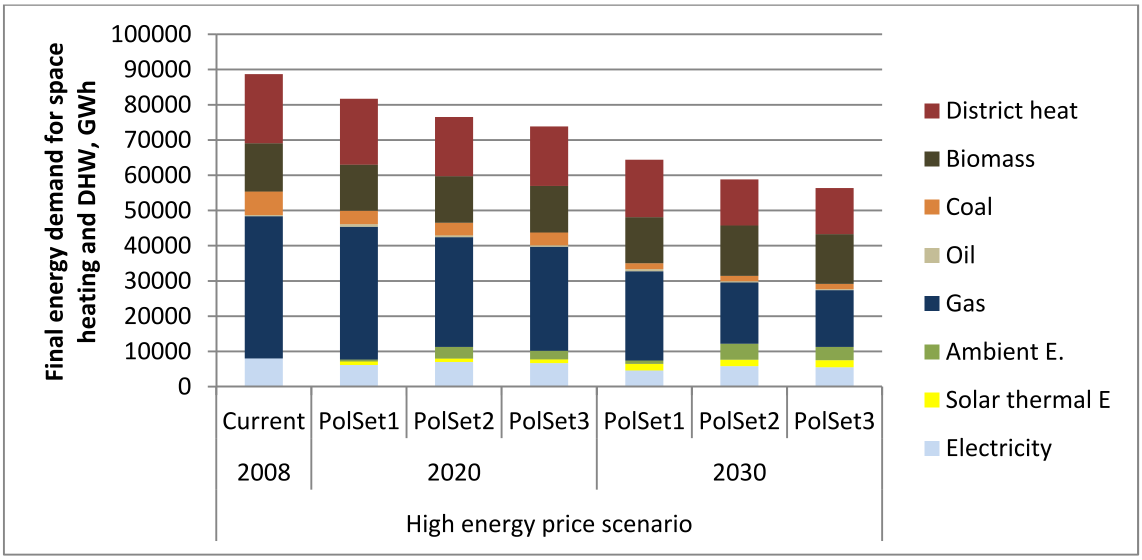

Figure 9: Final energy demand for space heating and DHW (high energy prices)

In the Czech Republic, within the policy group meetings 3 and 4, the modelled results were discussed and then verified by comparison to the Czech energy balance. The modelled results (based on starting year 2008) reaches about 319 PJ of final energy consumption. Results based on national energy balance reach 300 PJ. The difference of these two values is not significant.

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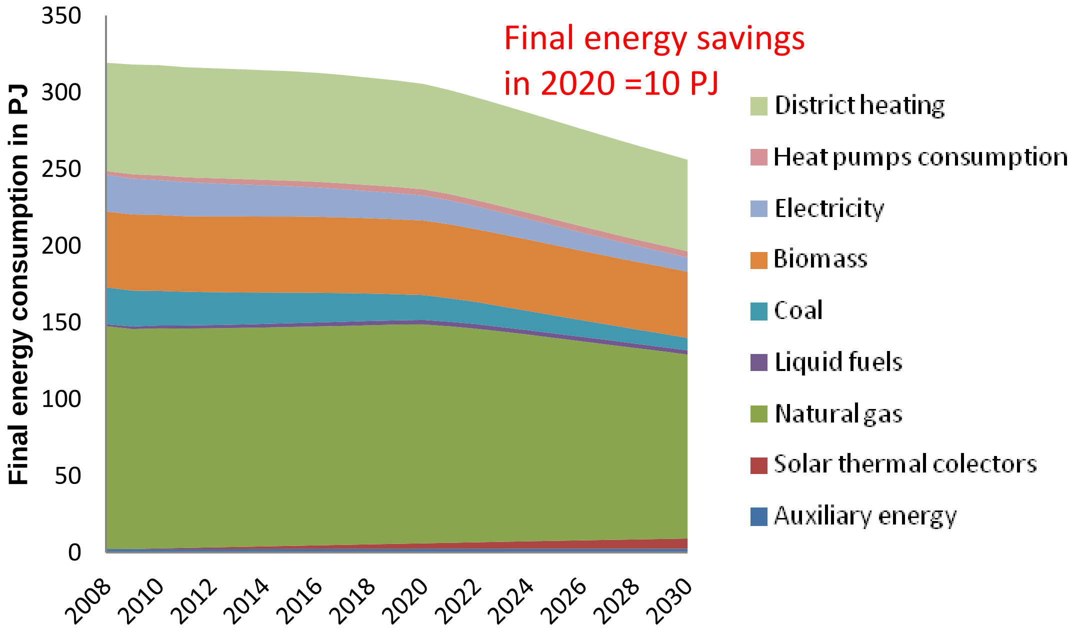

Figure 10: Final energy consumption and saving potential – Scenario 1 - Regulatory framework only

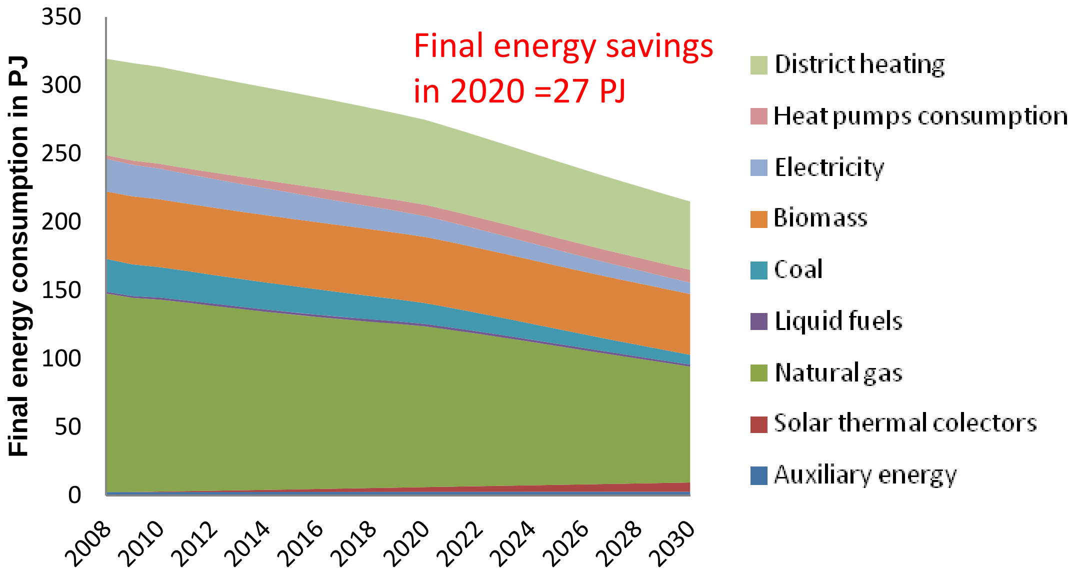

Figure 11: Final energy consumption and saving potential – Scenario 2 - Business as usual

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The difference between requirements on new building at present time and new buildings after nZEB requirements (after they come in force based on existing legislation, implementing EPBD) is quite small in the Czech Republic. Difference between scenarios 2 and 3 equals to 6 PJ of overall consumption in the country.

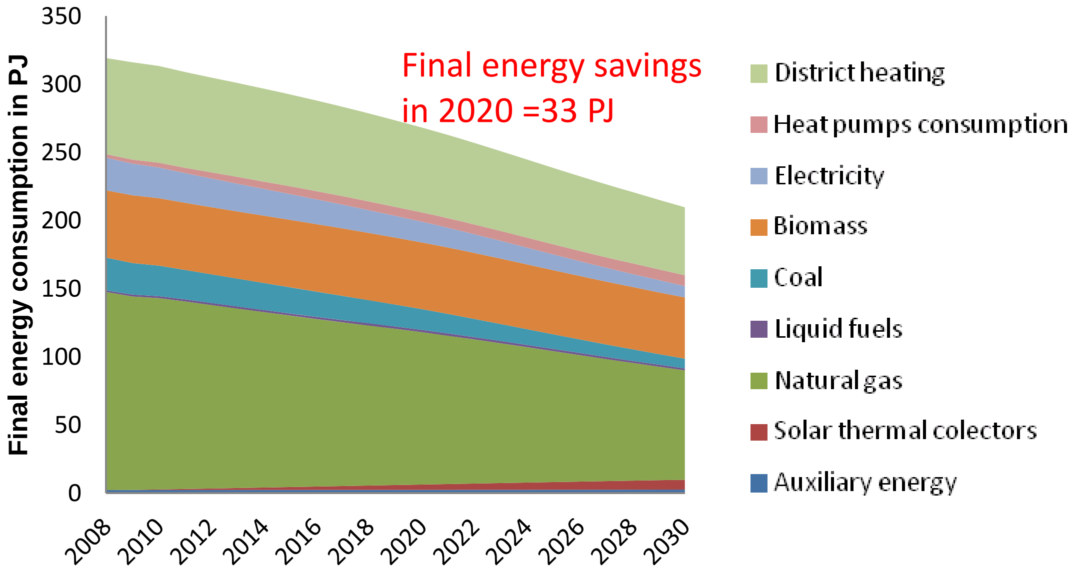

Figure 12: Final energy consumption and saving potential – Scenario 3 - Ambitious scenario

The realization of one of two scenarios “Business as usual” or “Ambitious scenario” assures that the target of EED will be fulfilled. The EED target says that savings about 27 PJ should be achieved till 2020.

4.2 Running costs

Costs of energy or running costs directly relate to the energy demand development for each policy set and energy prices. Following graphs describe the annual costs of energy carriers as it is shown in the following two graphs. Only in low energy prices cases, similar or lower overall running costs can be identified for the three policy sets in 2020. In case of high energy prices scenario, the running costs raise significantly in 2020 as well as 2030. The policy set 1 reaches almost doubled running costs in 2030 compared to the base year 2008.

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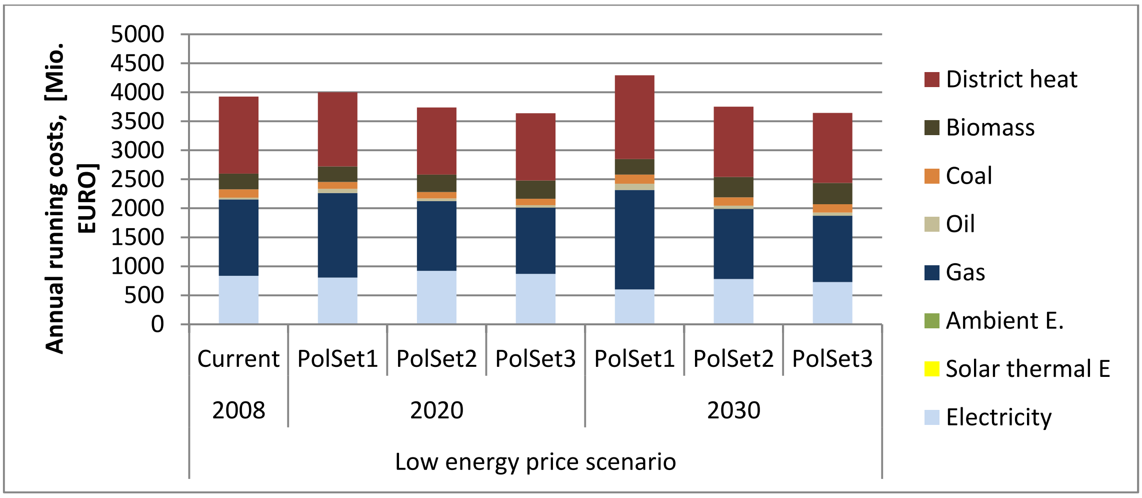

Figure 13: Annual running costs, [Mio. EURO] (low energy price scenario)

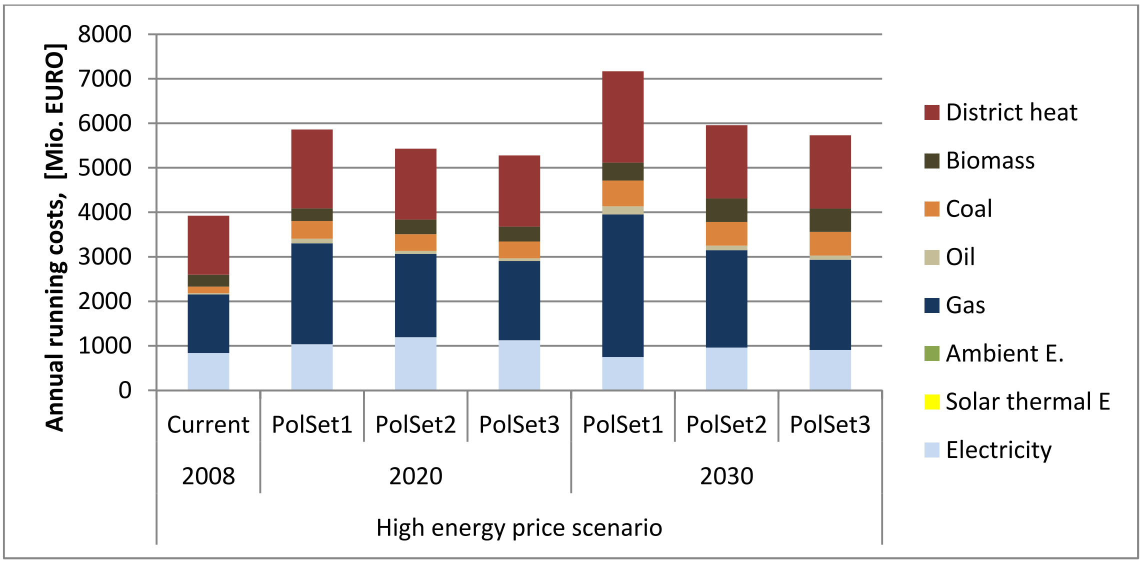

Figure 14: Annual running costs, [Mio. EURO] (high energy price scenario)

4.3 Renovation rates and activities

Based on the calculation model, following rates of renovations of different building types are expected for both low and high energy prices. Logically, renovation rates will raise with higher energy prices and running costs. Market is visibly reacting on the energy prices as any measures become more feasible.

Note: SFHdh – single family house detached; SFHr – single family row house; MFH – multi-family house

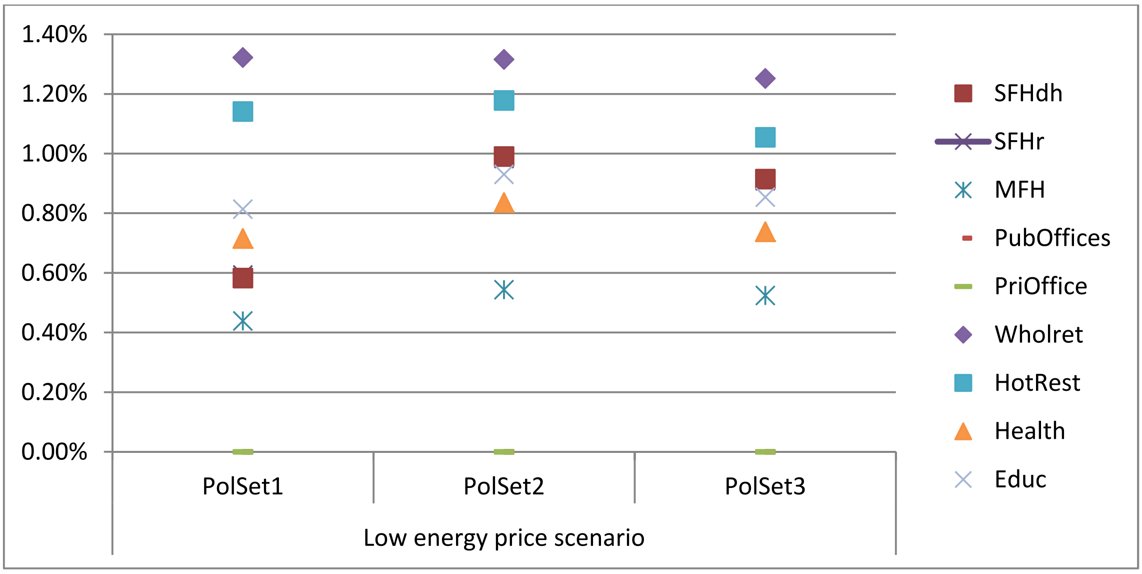

Figure 15: Renovation rates under low energy price scenario

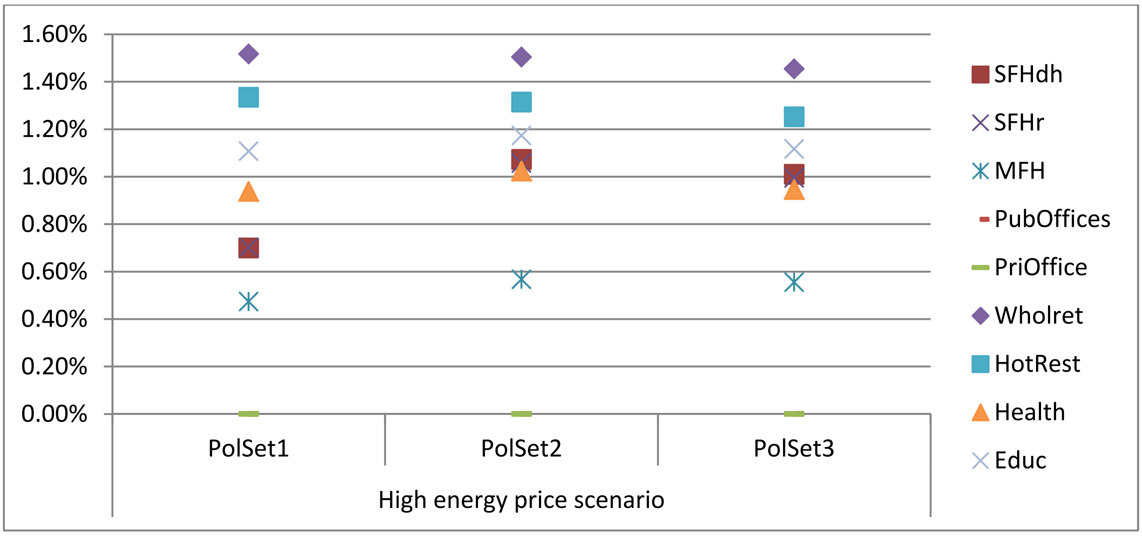

Figure 16: Renovation rates under high energy price scenario

Following graphs relate to the previous renovation rates. They show expected numbers of renovated buildings in absolute numbers. All the graphs set values for the three policy sets for years 2020 and 2030. First two graphs define numbers of renovated residential buildings, second two relate to non-residential buildings in the Czech Republic.

Further, the renovation activities of the building envelope have been divided into three categories within the Invert model: standard, good and ambitious level. As can be seen

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in the following four graphs, better policy (i.e. the most ambitious policy set 3) leads to a higher share of buildings renovated in very ambitious quality, but the total number of renovated buildings is lower compared to policy set 2. Still, thanks to the higher number of buildings that are being renovated in higher (ambitious) quality, the total energy savings are higher in policy set 3 (see Figure 8 and Figure 9).

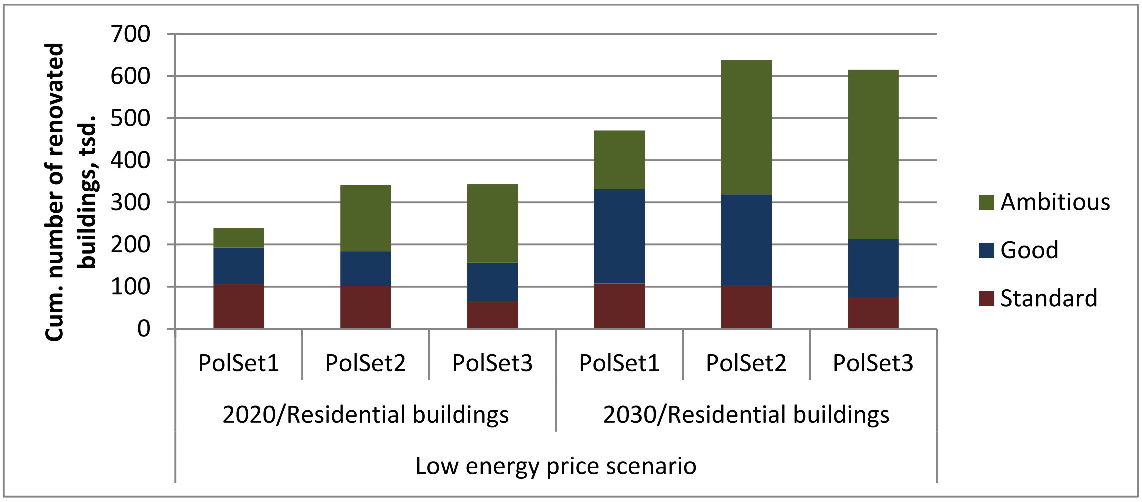

Figure 17: Cumulative number of renovated residential buildings (low prices)

Further, it can be said that in case of non-residential buildings the influence of policy sets on total number of renovated buildings is minimal, but the quality of these buildings is significantly higher in case of the third policy set.

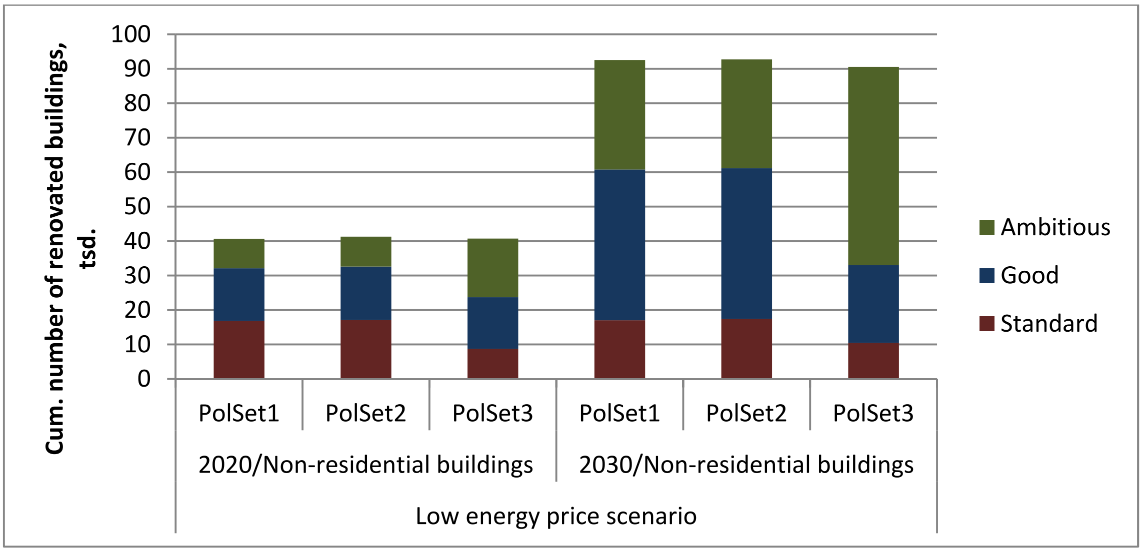

Figure 18: Cumulative number of renovated non-residential buildings (low price)

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The same resume can be stated both for low and high energy prices scenarios.

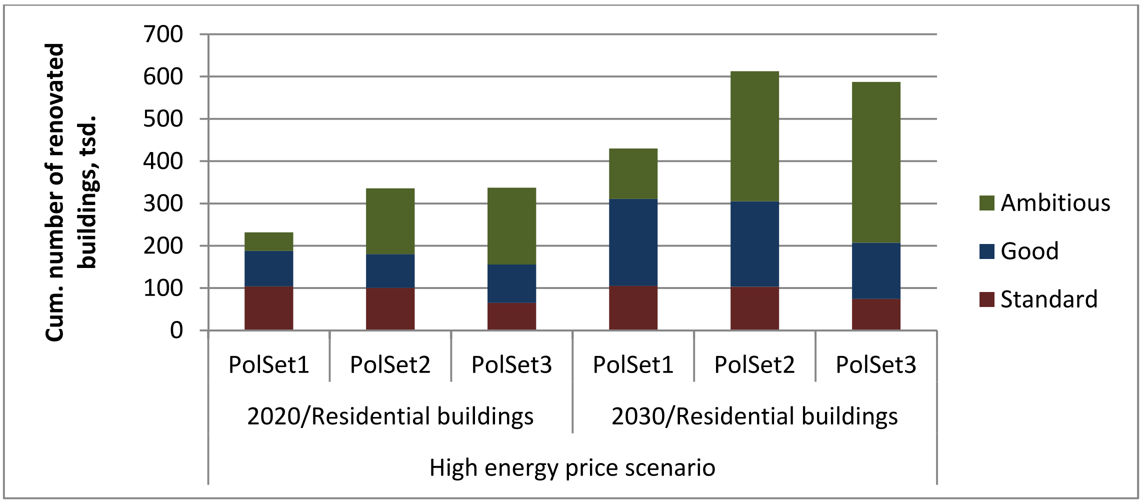

Figure 19: Cumulative number of renovated residential buildings (high)

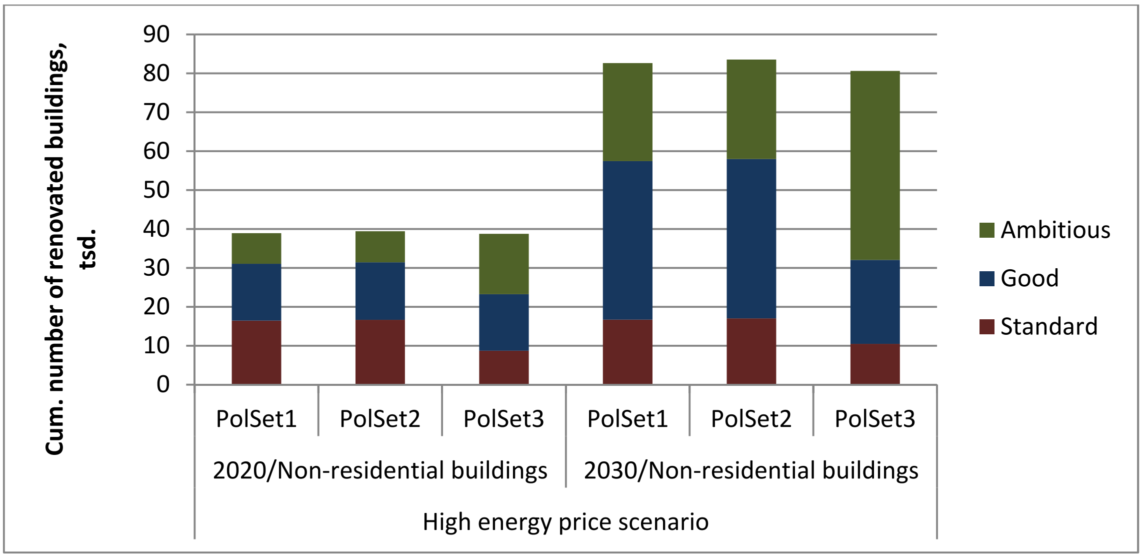

Figure 20: Cumulative number of renovated non-residential buildings (high)

4.4 Investments and subsidies

Following two graphs show the overall expected necessary investments and subsidies that are needed for keeping the renovation rates and quality according to the previous modelled scenarios.

The Figure 21 shows expected cumulative subsidizing for renovation of both residential and non-residential buildings. According to the definition of policy sets, the subsidies are not taken into account in the basic policy set 1 as it consists only of regulatory framework mechanisms without supporting schemes. The same amounts are being calculated for the policy sets 2 and 3 as their definition contains keeping the same subsidy mechanisms for the whole evaluation period.

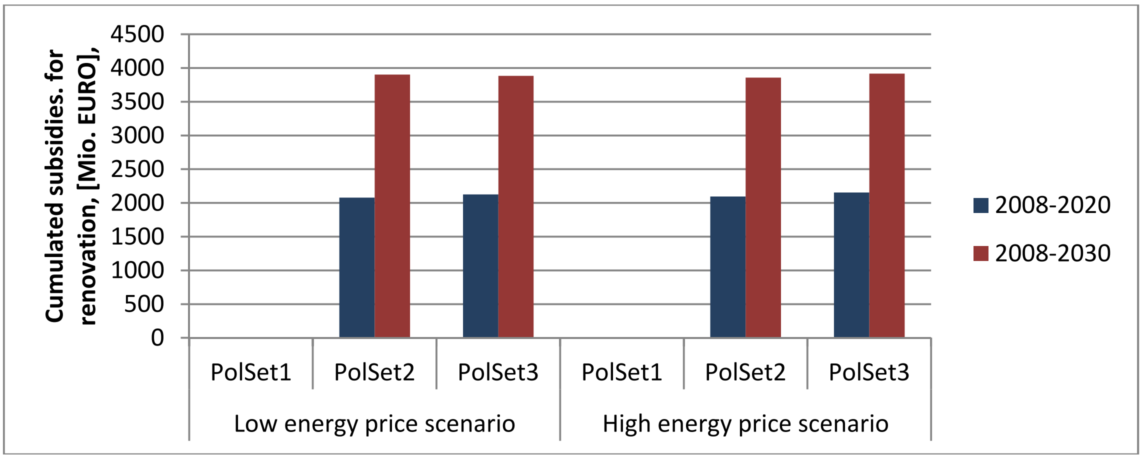

Figure 21: Cumulative subsidies for renovation

Following graph shows expected cumulative amounts of investment to the renovation regarding the overall building sector (residential and non-residential buildings together) for the three policy sets, for both low and high energy prices and for periods till 2020 and 2030 in relation to base year 2008.

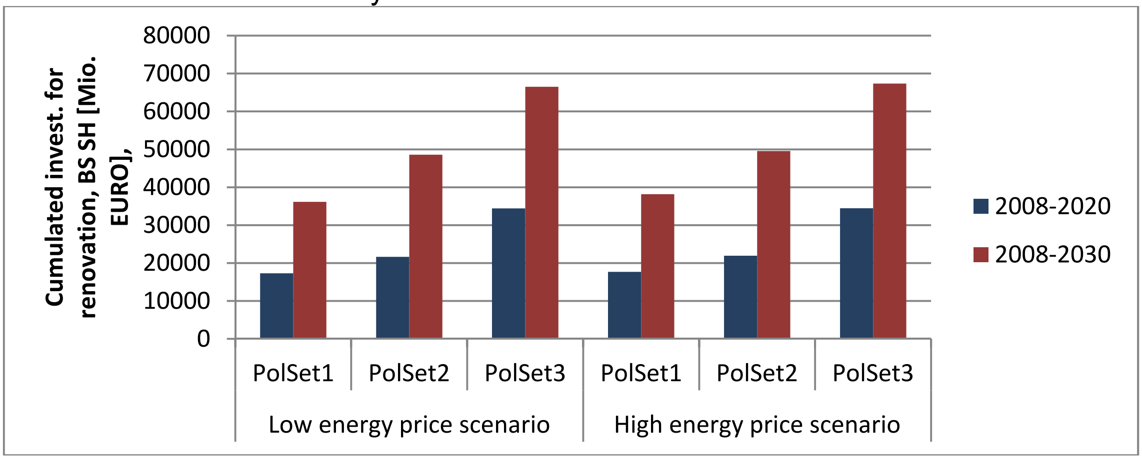

Figure 22: Cumulative investments for renovation

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5. Recommendations

Following chapter represents the main outputs from the modelling process and continuous discussions on the results. The specific recommendations for the Czech Republic have risen as well as more general recommendations that can be applicable for other EU Member states.

The following recommendations have been carried out after modelling the energy demand scenarios and after continuous discussions within policy groups and individual meetings. Preparation of policy sets and discussion on model results were being made in close cooperation with representatives on the Ministry of Industry and Trade.

Use of scenarios for development in energy consumption in buildings

The scenarios formulated from the project policy group meetings are sufficient for presenting a general idea of the impact of the key energy policy trends on the buildings sector. A continuous process of drafting scenarios at least for the 2020 horizon and ideally for the 2030 horizon should be established under subsequent projects similar to the ENTRANZE project. The option of **continual assignment of scenarios in view of updates of the National Energy Efficiency Action Plan and the State Energy Policy would be ideal from the point of view of the Ministry of Industry and Trade** (MIT).

Supporting schemes

Keeping the present system of supporting schemes for wide scale of building types as well as keeping the volume of funding is crucial factor for reaching the projected model scenarios 2 or 3 that expect fulfilment of EED requirements as well as lead to significant increase of energy efficiency of building stock.

Comparison of the cost optimum calculations and nZEB

The issue of cost optimum for buildings and the impact of nZEB implementation on energy consumption in buildings has been discussed at numerous project meetings at the national level. The difference between the recommended values and the requirements for nZEB is too small to show any major consequences of the implementation of nZEB in the scenario from 2014. **The greatest chances of achieving energy savings therefore lie in the transition of buildings with a low energy standard to the required or recommended standard. This is also a way of achieving cost-effective implementation of energy savings in buildings**. Present definition of nZEB is adjusted on levels that are not too far from cost optimal levels in 2013 and according to EC explanation, it is expected that the nZEB standard will be almost cost optimal in 2020.

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According to this understanding, the intensity of nZEB definition (especially the requirements on decrease of non-renewable primary energy) is quite mild.

Cost optimality

The **scrutiny of the cost optimum calculation should be intensified to reduce the pressure of local interest groups, which could have significantly influenced the outcomes** at the national level. Furthermore, intensive monitoring of buildings with low energy standard should be introduced at the EU level as these buildings offer the greatest saving potential.

Absorption capacity definition

Representatives of the Ministry of Industry and Trade (have already expressed) and should support in more concrete way the need for determining cost-optimal allocation of savings in individual buildings sectors from the state's and the owners' point of view due to the potentially increasing marginal costs of measures. This means that the group of measures that achieve full and the most effective savings in the final consumption and in the primary energy is expected to become smaller. Representatives of the MIT have partially signalled, but **should express stronger interest in a requirement for defining the so-called absorption capacity of individual types of buildings. MIT should require and support these calculations of the cost optimum for the following period. They should be more detailed** on the part of the owners of buildings and on the part of the member states.

Data collection

Issues relating to data collection have also been discussed during negotiations. This included in particular the percentage of previously reconstructed buildings and the level of their reconstruction, i.e. partial, comprehensive or resource-based. **Databases addressing these issues at the national level need to be improved**. Statistics of energy sources used in different buildings are the second major topic. The structure of sources has changed significantly over the last decade. However, as no official continuous statistics are available, it is necessary to ensure continuous data collection including projections for individual sources.

Representatives of the MIT have stressed the planned ENERGO survey (the last survey was completed approximately 10 years ago), as they would be interested in providing comments on the details requested in the questionnaire survey. A survey of this type could significantly improve the database on energy consumption especially in the industry.

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Energy management as an instrument for reaching the projected energy saving goals

Energy management is generally perceived as a major energy saving category. The MIT currently cooperates with individual regions to determine the level of energy management and subsequently plans to work with large towns to ensure high-quality collection of data on real energy consumption. **A strengthened role of energy management and especially collection of data measured at building base and secondary measurements is seen as a crucial task** as without quality energy management (i.e. good operation of buildings, the projected results can not be achieved).

Energy management, specifically its introduction, is currently supported under the national EFEKT programme. Utilising the Eco-energy support to bind recipients to implement energy management should be considered. Gradual pressure on compulsory introduction of energy management through the EU was also discussed.

Further verification of modelled scenarios results

Representatives of the MIT have raised a requirement for comparing outputs of the model against other models focused on total energy consumption in buildings over a longer term, for example in the case models of Chance for Buildings or Porsenna organizations. Therefore, it is apparent that the **development of energy consumption in buildings should be monitored long-term by a national platform comprising representatives of state institutions and expert organisations**.

Additional recommendations that have risen during discussion on stronger link of the scenarios to NEEAP

With regard to declaration of energy savings, factors that are not reflected in the NEEAP, such as the impact of investors who achieve energy savings outside support programmes, have been discussed. Additional undocumented factors include modification of the housing stock and replacement of removed buildings with new buildings.

- Collection of data for state administration buildings in view of compliance with Article 5 EED was one of the discussed issues relating to buildings. The MIT is preparing a data collection methodology and communicates with individual departments to obtain information on the current condition of buildings (approximately 500 buildings situated in the Czech Republic). Collection of data

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on EE needs to be improved especially in measures outside the existing support programmes.

- The Czech Republic under the NAPEE continues in the current support of EE and increases this support further by the Integrated Regional Operational Programme under the Ministry for Regional Development. Representatives of this programme should consistently monitor activities in reporting savings to ensure that their savings are reported and transported.
- As for increased international cooperation in policy-making, representatives of the MIT have expressed their interest in ex-post assessment of support programmes from the EU cohesion funds. Thorough ex-post assessment of support programmes should take place in the EU.
- Development of the monitoring and targeting system at the national level - representatives of the MIT see a continuous process of data collection or at least annual data collection playing a crucial role to ensure that the data is compared against the specified objectives once a year. This system should be introduced for large buildings used by the state administration and municipalities.
- The Czech Republic generally prefers positive motivation to achieve energy savings before the creation of major compulsory schemes. The outcomes of scenarios are very significant and complex, require comparison against other models and energy balance of individual states, and subsequently will lead to the comparison of directions of chosen state energy policies. This is why a consistent continuous monitoring of the compliance with individual articles of the EED should be introduced.

Monitoring of absorption capacity of projects for energy efficiency support programmes

No general studies that would serve as the basis for **continuous collection of data have so far been completed for non-residential buildings**. This involves especially the typology and energy efficiency parameters of these buildings. Collection of data relating to non-residential buildings is considered more difficult due to the greater share of privately owned buildings and a more diverse typology of buildings compared to residential buildings and therefore needs to be introduced for this sphere.

Discussion also dealt with **monitoring of the share of thermally insulated buildings in the total stock of buildings and the level of thermal insulation. This type of monitoring is generally considered insufficient**. Monitoring thermal insulation sales may be a potentially useful indirect method. However,

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application of this indirect method may be subject to numerous obstacles, such as the export and import of building materials.

Collection of data on bound (grey) energy of buildings

Studies of bound energy have shown that individual energy consumption catalogues apply different methodologies and therefore arrive at vastly different results. A **product catalogue at the national level has not been established adequately. Reporting bound energy should therefore be subject to a unified methodology**.

Overview of historical buildings, their number and energy saving potential in view of the EED

Historical buildings in the Czech Republic are not sufficiently monitored with regard to their number or classification according to the potential for increasing their energy efficiency or applying RES. Historical buildings are perceived as buildings with a cultural value far greater than any value potentially achievable through energy savings. Therefore, **partial measures in addition to comprehensive reconstruction appear to be suitable for historical buildings. More extensive monitoring of the number of these buildings and their floor area appears appropriate in this case**.

Stock of buildings in 2020 and 2030 horizon

Participants in the workshop concluded that reconstructions of the existing buildings are vital due to their major share in the total energy consumption in buildings. In addition, the development outlined in the scenarios points to a relatively small difference between the requirements of the current legislation and parameters for nZEB in the CR. **Potential introduction of stricter nZEB parameters before 2020 would probably produce more significant differences** between the outcomes of scenario 2 and scenario 3 described above.

A way to fulfilment of the obligations arising from the EED in the Czech Republic

The calculation of scenarios completed under the Entranze project has shown that the **implementation of the “Business as usual” scenario and the “Ambitious scenario” will be sufficient for meeting the EED objective for buildings** (households and services), i.e. achieving savings of 27 PJ by 2020.

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Participants of the workshop see the following two contradictory trends as crucial with regard to reporting energy savings:

1. Firstly, it is reporting of savings outside support programmes. The representative of ČKAIT (The Czech Chamber of Authorized Engineers) pointed out that approximately 30% of potential applicants in the Green Savings programme did not find their place in the programme parameters and therefore implemented saving measures without subsidies. It is therefore reasonable to assume that significant savings are achieved outside support programmes.

   Data on thermal insulation and installation of effective heating sources outside support programmes is not included in the available statistics or building permits because thermal insulation and installation of sources is usually not subject to a building permit. This data needs to be monitored more extensively.

2. Secondly, it is the contradictory trend of reporting savings according to certificates of energy performance of buildings. Certificates implemented at the national level contain evaluation of buildings according to their standardised use. Savings reported in this manner are mostly higher than actually achieved savings. However, this assessment is completed exclusively for smaller buildings, such as family houses and similar types. We should focus on comparisons on actual consumption of buildings and their calculated consumption according to energy performance certificates.

The preparation of support programmes for the new programme period should include combination of thermal insulation and the Energy Performance Contracting method to achieve comprehensive results in the implementation of measures.

Fulfilment of the additionality criterion in support programmes

Additionality requirements are considered a major issue.

How to address setting up the system for monitoring and evaluation of achieved energy savings in buildings (not only in buildings) in accordance with the EED – inter-departmental evaluation of programmes.

The outcomes of the scenarios of the final energy consumption under the ENTRANZE project from 2008 amount to 319 PJ; the same value according to the energy balance of the Czech Republic is 300 PJ. The difference in favour of the ENTRANZE outcome is insignificant and is caused mainly by the application of a different calculation method under the ENTRANZE project compared to the methodology applied in the case of the energy balance of the Czech Republic. This information shows that energy consumption scenarios calculated with the bottom up approach are a suitable and realistic calculation tool.

The discussion has also opened the issue of different approaches to reporting energy savings for various building types according to their size, type of ownership and complexity of energy management. Participants in the workshop have concluded that it is necessary to differentiate at least family houses, larger apartment buildings, buildings with significant cooling and buildings associated with industrial production. Energy audits should be completed as part of subsidy management for the remaining building types and the appropriate amounts of support should be determined according to the measured energy savings.

Quality control of the implemented measures should be linked to the builder's certified technical supervision. Broader consensus regarding the appropriate certification method needs to be reached with professional organisations.

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A Annex: Specific examples of modelling policy instruments in Invert/EE-lab

In the following, we will give some examples how policy instruments can be modelled and which level of detail we can cover. However, in most cases I would try not to overwhelm policy makers with details. For the policy group meeting it might be absolute sufficient to decide on the principle design of the instrument. The specific design will be suggested (and simulated) by us and can be discussed in a further step with policy makers (during the summer/autumn), if required.

- Investment subsidies for renovation measures

For simulating the impact of investment subsidies for renovation measures, the following parameters have to be defined:

- The standard of renovation measures being supported (e.g. in terms of U-values for building components; may differ between building categories; three different levels of renovation packages can be defined for each building category).
- The percentage of overall investment costs being granted by the scheme (may differ between building categories).
- Optional: maximum support level in €/m² floor area and/or €/building (Investment subsidies)
- Optional: Total support budget (M€ on an annual basis, can change from year to year)

The agents in Invert/EE-Lab decide among the options "no thermal renovation measure" and several different renovation measures including policy measures, as defined above, targeting on them individually. The policy instrument will increase the market uptake of this specific type of renovation measure addressed in the policy instrument depending on the agents awareness of the instrument and the relevance of economic aspects in the decision making process of different agents.

- Investment subsidies for renewable heating

For simulating the impact of investment subsidies for renovation measures, the following parameters need to be defined:

- The percentage of overall investment costs being granted by the scheme for different heating technologies.

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- Optional: maximum support level €/building and/or dwelling (Investment subsidies)
- Optional: Total support budget (M€ on an annual basis, can change from year to year)

The agents in Invert/EE-Lab decide among the different heating and hot water options. The instrument will increase the market uptake of the specific type of (renewable) heating system addressed in the policy instrument depending on the agents awareness of the instrument and the relevance of economic aspects in the decision making process of different agents.

- Investment subsidies for renewable heating independent on public budget

Similar to the conventional investment subsidies financed by the public budget we are able to simulate the impact of instruments financed e.g. on a levy on fossil fuels. (see. e.g. Bürger, 2013) There are different specific options for adapting the levy automatically on the support level of renewable heating systems. In case that you select such a system, we will decide together with you on the detailed setting of these systems.

- Building codes for new buildings

Minimum standards for new buildings are defined exogenously in Invert/EE-Lab. All new buildings will have at least this minimum standard. So, the definition of this standard is a relevant regulatory instrument. For this definition, we need the U-values of relevant building components (if there are performance based criteria in kWh/m²/a, we will have to convert this value into typical U-values consistent with this performance based criteria).

(Optional, also geometry data of new buildings may be changed. As a default, we will use the geometry data from the last building construction period, e.g. 2000-2008.)

- Building codes for renovation of buildings

As a default, in Invert/EE-Lab building owners are free to select either “no thermal renovation measure” or some level of renovation measures. However, Invert/EE-Lab can introduce an obligation to carry out at least a minimum set of thermal renovation measures in case that a building is being refurbished.

- RES-H obligations

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For an obligation to use renewable heating, there are the following options to be defined in Invert/EE-Lab:

- When will the obligation come into force? (a) in case of new building construction, (b) in case of renovation of buildings or (c) in case of each change of heating systems
- Which share of renewable heating is obligatory for this specific building? (e.g. 25%, 50%, 75%?)
- Are there penalties in case that the obligation is not being fulfilled? How high are they (€/m² floor area).
- Optional: the penalty may also be linked to increasing the thermal efficiency of the building
- Optional: there might be a weighting between different renewable energy carriers, i.e. solar thermal might be weighted higher than biomass.

- Information, training, advice

Information, training advice may lead to higher awareness level of different type of agents. Invert/EE-Lab is able to model the impact of a higher level of awareness from different type of agents. However, Invert/EE-Lab is not able to model the link between information campaigns and the increase of the awareness level.

- R&D

For each technology implemented in Invert/EE-Lab, cost reduction (or increase) or efficiency development over time up to 2030/2050 can be defined. This changes the attractiveness of the different options and subsequently (according to the logit-approach) the market share of different measures, energy carriers and technology options.

Invert/EE-Lab is not able to model the link between R&D-expenses and the cost reductions. So, there is the need to make own assumptions based on expert guess to which extent R&D policies might lead to technological progress.

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B Annex: Detailed description of regulatory framework instruments for policy sets definition

Depending on the type of instrument the description address the following instruments:

2. Regulatory instruments

EU level

- The requirement of 3% of refurbished public buildings per year.

National level

Act on energy management

- Requirements on energy performance of buildings have to be on the cost optimal level
- nZEB building have to achieve high share of RES
- nZEB level will be achieved in the new public buildings with energy related area

  Bigger than 1500 sq. m from 2016

  Bigger than 350 sq. m from 2017

  Lower than 350 sq. m from 2018

Regulation on energy audit and energy appraisal - since 2013

- Energy audits

Private:

Obliged from 35.000 GJ for all building of the owner

Obliged from 700 GJ for one specific building

State:

Obliged from 1.500 GJ for all building of the owner

Obliged from 700 GJ for one specific building

Regulation on energy performance of buildings – since 2013

- nZEB level is defined according to reference building, which is a building with the same geometry, orientation and shading, but with standardized using and reference values (i.e. required values given by national legislation) for the building structure and energy systems. At this level, requirement on average U-value strengthening for nZEBs has been introduced.

Reduction of U-value required

For a calculation of requirement on building constructions, an average U-value (as a weighted average of separate required U-values plus surcharge on thermal bridges) is being calculated. This average is called reference value.

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In the period of 2013-2020, this reference value for buildings that shall undergo renovation is not anyhow reduced (coeff. 1,0) but for newly built buildings the reduction coefficient 0,8 (strengthening of requirement) has been introduced. It means, since 2013 the required average U-value for new buildings have to be 0,8 times lower than is required for renovation of existing buildings.
Further, for the period after 2020 (resp. 2018), reduction coefficient 0,7 (stronger) for newly built nZEBs has been introduced too.

For Entranze project modeling, following simplification can be taken into account: Instead of the reduction coefficient that is being defined for average U-value by law, the same reduction coefficient will be used for separate construction´s U-values as follows:

Construction	Reference U-value (i.e. required by standard for both new and renovated buildings)	Reduction coefficient	U-value required for nZEBs
Walls	0,30	0,7	**0,210**
Roof	0,24		**0,168**
Floor	0,45		**0,315**
Windows	1,50		**1,050**

Notice: The national legislation related to nZEBs defines requirements on new buildings only (according to EPBD 2). We expect the same requirements on constructions for renovated buildings.

Non-renewable primary energy reduction

Decreasing of the non-renewable primary energy in comparison with the reference building (the reference building is stated as a requirement for period 2013-2020).
Following percentages are clearly defined by the legislation. But the base (the non-renewable primary energy) must be calculated for each building separately by using reference building calculation defined above.

	New buildings	New buildings since 2015	nZEB
Family houses	3%	10%	25%

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Apartment buildings	3%	10%	20%
Other buildings	3%	8%	10%

Calculated reference value of non-renewable part of primary energy differs significantly based on delivered energy, obviously. For its calculation, following primary energy coefficients must be taken into account: heating and DHW 1,1, others 3,0. This is given by national regulation related to energy performance. Typically, the reference value (before the reduction based on the table above) of non-renewable primary energy can be:

For family houses between 120-170 kWh/m2,a
For apartment buildings between 100-150 kWh/m2,a
For other buildings between 150-400 kWh/m2,a

- Energy performance certificates

Established in 2007 about 100.000 till 2013, for the selling or renting of the building or deep renovation.
Private:
Obliged from energy related area bigger than 1500 sq. m from 2015
Obliged from energy related area bigger than 1000 sq. m from 2017
Obliged from energy related area lower than 1000 sq. m from 2019
State:
Obliged from 500 sq. m from 2013
Obliged from 250 sq. m from 2015

3. Capacity building, qualification and quality assurance

- Via BUILD UP Skills initiative, about 60.000 construction workers should be trained to increase current quality of construction works to be prepared for nZEB till 2020
- Requirements for the qualification of the investor´s control will be described

4. Information, motivation and advice

- Energy performance certificates – described in regulatory instruments
- Energy audits – described in regulatory instruments

5. Market transformation (supply side) measures

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- The cost for the EE and RES technologies will be reduced in terms of EU market; other specific reductions can not be expected

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