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

## D4.3 and D5.6 from Entranze Project

**Written by:**

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

Tanja Kenkmann, Veit Bürger
Öko-Institut

**Reviewed by:**

Marco Pietrobon

end use Efficiency Research Group, Politecnico di Milano

**October 2014**

Co-funded by the Intelligent Energy Europe
Programme of the European Union

## ENTRANZE Project

| | |
|---|---|
| **Year of implementation:** | April 2012 – September 2014 |
| **Client:** | EACI |
| **Web:** | http://www.entranze.eu |

**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 |



Co-funded by the Intelligent Energy Europe Programme of the European Union

# 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 Austria. 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.

## Acknowledgement:

The authors and the whole project consortium gratefully acknowledge the financial and intellectual support of this work provided by the Intelligent Energy for Europe – Programme.

Co-funded by the Intelligent Energy Europe
Programme of the European Union

## Legal Notice:

# Content





Co-funded by the Intelligent Energy Europe Programme of the European Union

## List of figures





Co-funded by the Intelligent Energy Europe Programme of the European Union

## Executive Summary

In this paper the methodology and the results of the policy scenario calculations and the policy recommendations within the ENTRANZE project are described for the case of Austria. 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 possible future impact of the policy sets has been analysed with the model Invert/EE-Lab, and recommendations have been derived from the results of the calculation. Again the recommendations have been discussed and revised in the policy group and with other experts and stakeholders.

The Austrian policy group decided to investigate the potential impact of an innovative policy packages mainly based on the following elements, on top of the existing ones:

- A **property tax** depending on the energy efficiency of buildings
- Intensified **coaching of building owners** before and during a thermal building retrofit
- **Innovative financing** of thermal building retrofit by initiating public/private funds providing the money for building renovation at low interest rates. Besides private sources of the funds, increased tax revenues from the property tax could partly also be used for this fund.

Three model-based scenarios were developed: (1) a business-as-usual (BAU) scenario with the current schemes remaining more or less constant until 2030, (2) a scenario with a new policy approach described above, however, with a low ambition and (3) a new policy approach with a higher ambition.

The scenarios results[1] show that the BAU scenario from 2008-2030 leads to about 20% -24% reduction of final energy demand and almost 25% -30% of delivered energy demand under low and high energy prices, respectively. The additional measures in scenario 2 induce only very moderate additional reduction of energy demand. Thus, new policies as such do not guarantee a progress. They also have to be designed and implemented in an ambitious way. The third scenario leads to a significantly stronger increase of renovation activities and related energy efficiency gains: a reduction of final energy demand from 2008-2030 of 27%-30% and of delivered energy demand of 32%-36%. However, it has to be taken into account that the implementation of a property tax related to the energy efficiency of buildings would require a comprehensive building registry and corresponding energy performance certificate registry. In Austria, these

[1] All scenario results and more details are also available at the online scenario tool via www.entranze.eu.



Co-funded by the Intelligent Energy Europe Programme of the European Union

databases are under development but still far from being completed and comprehensive. Thus, these activities have to be enhanced. Moreover, it needs further work and elaboration on how coaching of building renovation activities can be carried out in an intensive but still cost effective and manageable way. Pilot projects which are ongoing should be intensified. The initiation of funds to finance building renovation needs to be investigated and designed more concretely on practical examples. Although building codes and the regulatory framework were not in the focus of the scenario work, the comparison with other countries revealed that the Austrian nZEB definition and related building codes are not at the forefront of the European standard (see e.g. Atanasiu et al., 2013). Thus, stricter regulation would be also required to achieve ambitious long term climate and energy policy targets.



Co-funded by the Intelligent Energy Europe Programme of the European Union

# 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 were derived for the development of the building stock and its energy demand in the EU-28 (+ Serbia) until 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. This discussion process included expert interviews, a mid-term workshop in autumn 2013 and in particular four policy group meetings. The policy group included relevant decision makers from the regional governments[2] as well as the Federal Ministry of Science, Research and Economy and the Federal Ministry of Agriculture, Forestry, Environment and Water Management.[3]

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

The overall scenario results for all target countries as well as for EU-28 are documented in Kranzl et al. (2014a). Recommendations which are applicable to all EU-MSs as

[2] In Austria, policies concerning buildings and building related energy demand are mainly in the responsibility of the nine regions.

[3] The following persons were part of the Austrian policy group: Bettina Bergauer-Culver (Federal Ministry of Science, Research and Economy), Gerhard Dell (Energy Commissioner of the region of Upper Austria), Adi Groß (Regional government of Vorarlberg), Wolfgang Jilek (Energy Commissioner of the region of Styria), Alexander Storch (Umweltbundesamt, as representative of the Federal Ministry of Agriculture, Forestry, Environment and Water Management)



Co-funded by the Intelligent Energy Europe Programme of the European Union

well as on the EU-level regarding the further development of building related directives were derived in Kranzl et al., (2014b). All scenario results and more details regarding policy scenarios are also available at the online scenario tool via www.entranze.eu.

# 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 Pillar 1: Methodology for 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). The policies in general should be designed in a way to most effectively address and overcome these barriers. All results of the previous work have been discussed with the policy group members in policy group meetings and bilateral discussions. 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.



Co-funded by the Intelligent Energy Europe Programme of the European Union

**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 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 |

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 lack-



Co-funded by the Intelligent Energy Europe Programme of the European Union

ing 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 Heiskanen and Matschoss (2012) and Bürger (2013).

## 2.2 Pillar 2: Methodology for 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 Müller et al. (2014), Kranzl et al. (2014a), Kranzl et al. (2013) or Müller (2012).

### 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 infor-



Co-funded by the Intelligent Energy Europe Programme of the European Union

mation. 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).

- **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). Annex A.2 lists the main indicators for the renovation packages taken into account for the modelling and scenario development.



Co-funded by the Intelligent Energy Europe Programme of the European Union

### 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. The model 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[4], VAT) and a carbon price[5].

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.

---

[4] Including existing energy & environmental taxes.
[5] 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.

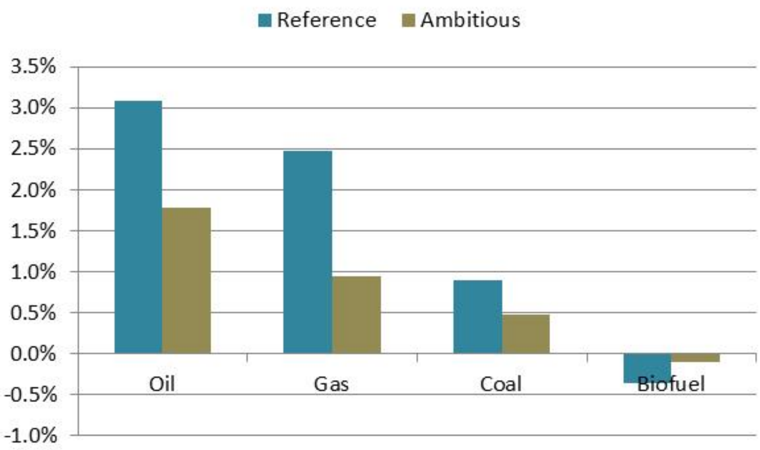


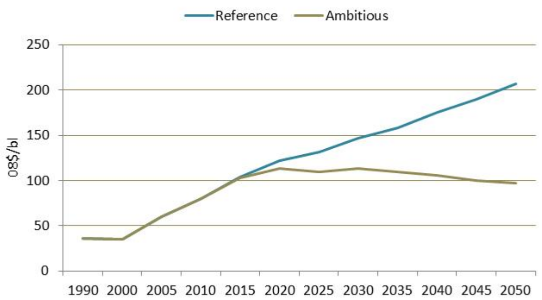

**Figure 1: Annual growth rate of international energy price over 2010-2030**

Source: POLES-Enerdata



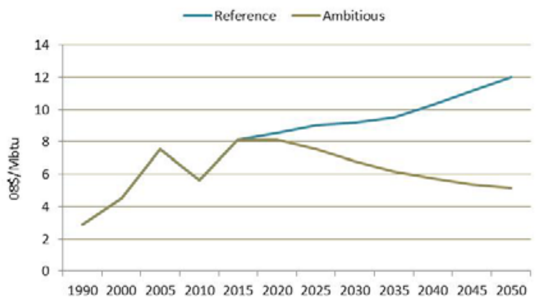
Co-funded by the Intelligent Energy Europe Programme of the European Union

**Oil**



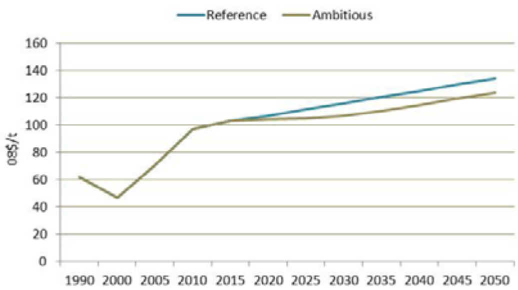

In the reference scenario, oil price is expected to increase at a rapid pace of 6.5%/year from 2000 until 2020, which will then slow down to 2%/year until 2050. In the ambitious scenario, it increases less rapidly until 2020 (3.6%/year), and remains almost steady reaching 100$/bl in 2050. This lower price is explained by the decreasing oil demand.

**Gas**



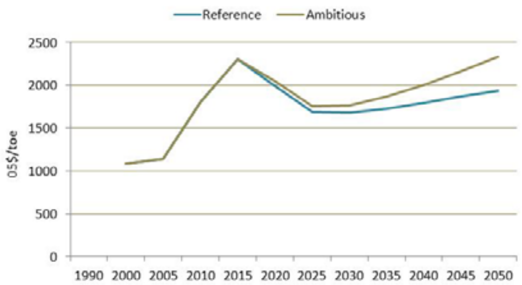

Gas price in Europe is expected to increase by 7.6%/year for both scenarios until 2015 (Figure 8). Then it will continue to increase on average until 2030 by 0.8%/year in the reference scenario whilst it is decreasing in the ambitious scenario by 1.2%/year because of decreasing demand.

**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 price6 will decrease by roughly 2%/year until 2025 thanks to market autoregulation. It will again increase steadily until 2050 because of a strong penetration of biofuels, the high mitigation option

**Figure 2: European energy price forecasts until 2050**

[6] 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



Co-funded by the Intelligent Energy Europe Programme of the European Union

### Residential domestic prices[7]

Excise taxes and VAT have been assumed constant in these projections. Price of heating oil and gas for households consumers are projected to increase by respectively 5.7% and 5.0%/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 (2.7% and 1.2%/year respectively for oil and gas) (Figure 3). This scenario will later be referred to as the “low price” scenario. The coal price increases rapidly as well in the ambitious scenario, by up to 5.4%/year, and to a lesser extent in the reference scenario by 1.3%/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 and also includes taxes. The average price increases by 0.7%/year in the ambitious/high price scenario and by -0.3%/year in the reference/low price scenario. The electricity price is expected to peak in 2025 at around 3080 $/toe (26 $c/kWh)[8] in the ambitious/high price scenario and at 2 455 $05/toe (21 $c05/kWh) in the reference/low price scenario.

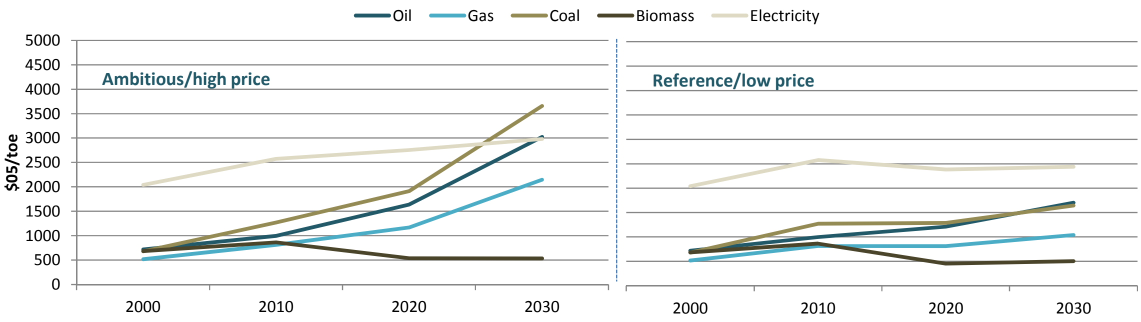



**Figure 3: Austrian residential energy price scenarios by energy carrier**

Source: POLES-Enerdata

[7] Domestic prices are in constant dollars (i.e. without inflation), from which you can derive an average variation by period.
[8] In 2005 prices and exchange rates.



Co-funded by the Intelligent Energy Europe Programme of the European Union

## 2.3 Pillar 3: Methodology for deriving recommendations

The recommendations have been derived in close interaction with the stakeholders based on the results of the scenario calculation. Again 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.

The developed recommendations have been evaluated on the basis of the criteria listed in Table 2.

**Table 2: Selection of qualitative assessment criteria[9]**

| Criteria | Key questions |
|---|---|
| **Target compatibility** | Can the instrument be designed as to incorporate incentives to steer investments into deep renovation measures that are compatible with the long-term needs? |
| **Type and strength of steering effects** | Which steering effects are applied (e.g. steering effect through putting a financial burden or substantive duty on e.g. the building owners or energy consumers; steering effect through the support regime) and how strong are they?<br>Who is addressed with the instrument? |
| **Investment and planning security** | Is the instrument assuring stable conditions (e.g. support conditions) in order to allow investors to build their modernisation decisions on a reliable basis?<br>Are the mid- to long-term support conditions predictable?<br>How resistant is the architecture of the instrument against potential impacts (e.g. from the executive authorities) that could undermine in-vestment and planning security? |
| **Cost allocation** | In case of financial support programs, who is finally providing the counter-financing (e.g. tax payer, energy consumers, building owners)? How does this relate to important environmental economic principles such as the polluters pays principle or generally the ability-to-pay principle? |
| **Suitability for overcoming target-group-specific barriers** | Is an instrument suited to properly address the diverse target-group-specific barriers facing the energy refurbishment of buildings?<br>Is an instrument suited to be implemented as flanking measure specifically addressing a certain target group? |

[9] The full list of criteria has been elaborated in Bürger (2013), p31.



Co-funded by the Intelligent Energy Europe Programme of the European Union

| Criteria | Key questions |
|---|---|
| **Administrative burden** | What kind of administrative burden does an instrument incur for the authorities?<br>Which minimum administrative tasks are assumed necessary to keep the level of compliance high?<br>Are there possibilities for achieving synergies (with other instruments) as regards administrative tasks that can be used to decrease the administrative burden at the authorities' side? |
| **Triggering of dynamic efficiency** | To which extent can an instrument be designed to stimulate innovation and to incentivise technology development and diversification? |
| **Acceptance** | How will an instrument be perceived by the different actor groups involved (especially representatives from the policy sector, building owners, tenants, fuel suppliers and associations, representatives from the finance sector, intermediaries, installers, planners, architects etc.)? |

*Source: Bürger/Klinski 2013 and Bürger/Varga 2009*



Co-funded by the Intelligent Energy Europe Programme of the European Union

# 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 4 and Figure 5 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).



Co-funded by the Intelligent Energy Europe Programme of the European Union

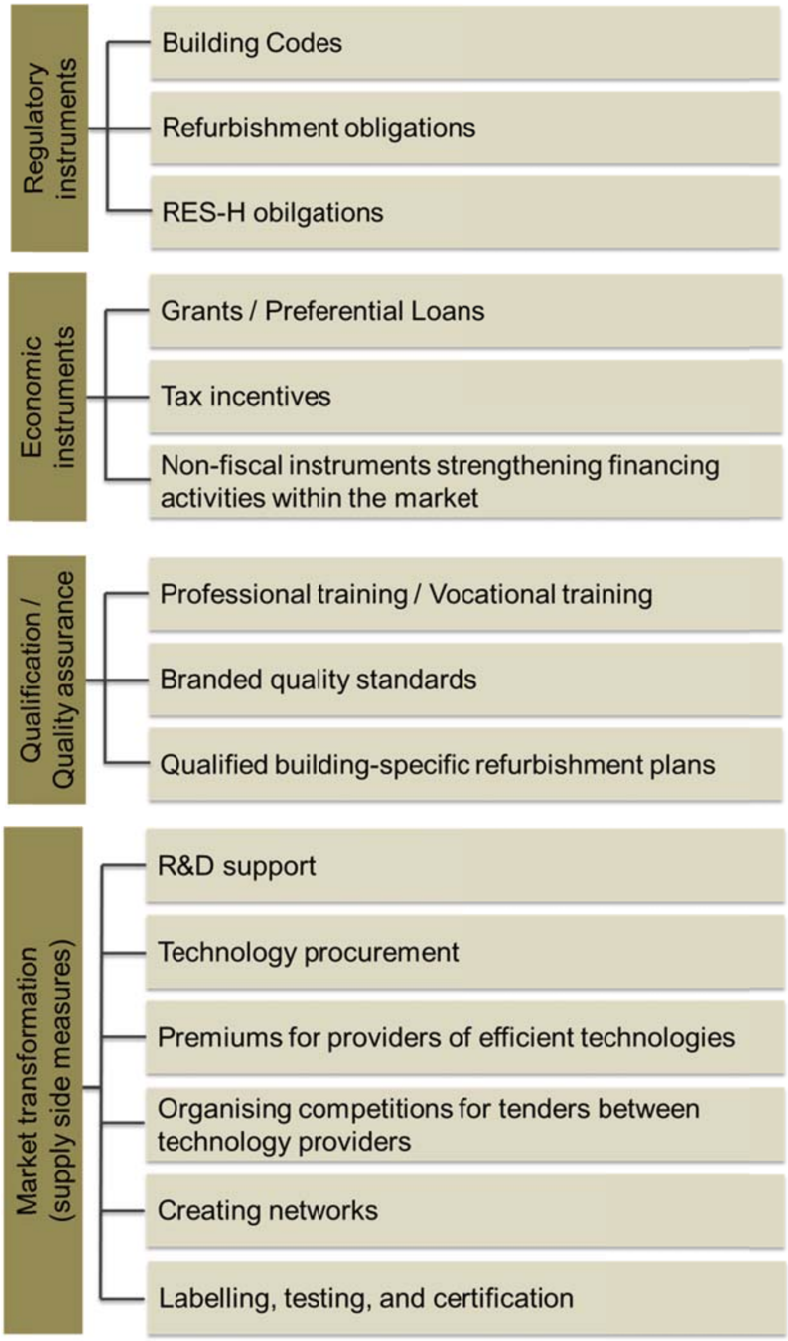



**Figure 4: Categories of policy instruments (part 1)**



Co-funded by the Intelligent Energy Europe Programme of the European Union

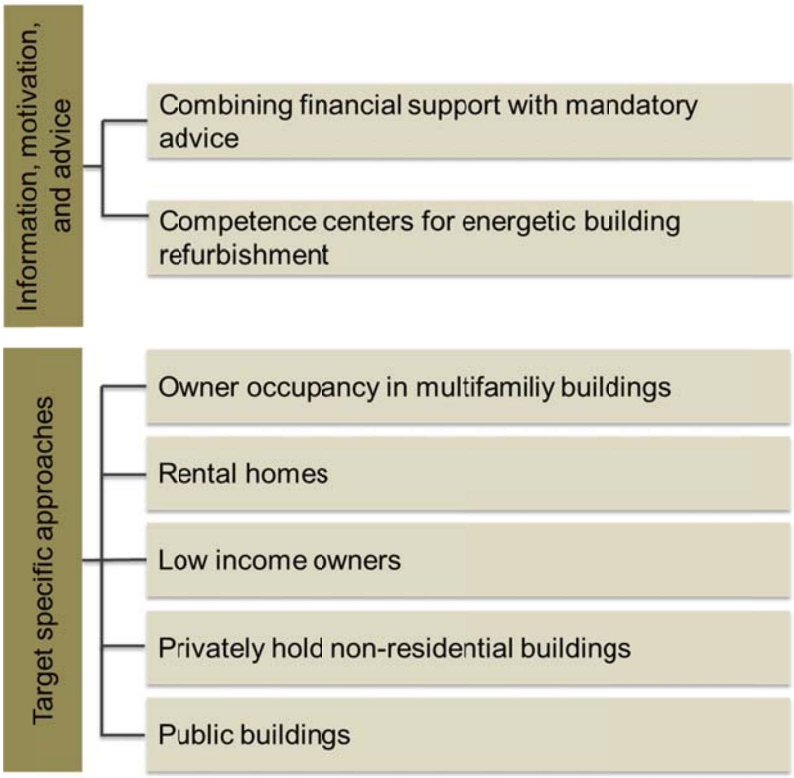



**Figure 5: Categories of policy instruments (part 2)**

## 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-


Co-funded by the Intelligent Energy Europe Programme of the European Union

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 put 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 programs 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).



Co-funded by the Intelligent Energy Europe Programme of the European Union

## 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 discussion with the policy group led to the following policy sets which were analysed:

### 3.3.1 Policy set 1: "current policy instruments"

In this policy set, we investigated different design options of the currently implemented policy instruments. This policy package focuses on investment subsidies, the support of residential building construction and renovation (Wohnbauförderung), on training and advice activities and to a smaller extent on RES-H/C use obligation.

### 3.3.2 Policy set 2: "obligation (property tax depending on energy efficiency standards) + innovative financing + intensified coaching"

This policy set consists of the following elements:

a. A regulatory framework obliges building owners to apply certain type of renovation measures and RES-H/C. These obligations should come into place in case of new building construction and major renovation. Moreover, from a certain year on, each building has to comply with certain standards which are increased dynamically. These dynamic targets are communicated in a very transparent and clear way. The obligation should refer to cost-optimal levels (or only moderate additional costs) and make sure that no lock-in-effects occur for additional refurbishment measures at a later stage.

b. Those buildings not achieving the target are taxed with a certain property tax which increases from year to year.

c. The government initiates a fund in which enterprises and private households can invest and receive a long term moderate, but highly secure payback. Though the fund would be initiated by the public, the money should mainly come from private sources who look for long term, stable low risk investment. The fund provides the investment for the building renovation measures. Building owners pay back the amount on a long term basis. This pay back should be in the range of energy cost savings. The loan should be linked to the object (renovated building or heating system), not on the person.

d. Intensified target group oriented coaching is provided to support the building owners in the refurbishment process. This would mean an intensified advice process not only during the planning phase but also during the implementation of the whole package of renovation measures to ensure high quality. The corresponding renovation measures may include insulation of the building



Co-funded by the Intelligent Energy Europe Programme of the European Union

envelope, windows exchange, installation of new heating and hot water systems, lighting, mechanical ventilation etc.

e. If this is not enough to provide a social balanced approach, additional social measures and maybe exemptions of the obligation have to be foreseen.

Although the policy set includes a package of consistent, innovative measures, the overall ambition level in this scenario is moderate. E.g. the property tax includes energy efficiency elements but remains on a low level.

### 3.3.3 Policy set 3: "property tax depending on energy efficiency standards + innovative financing + intensified coaching (high ambition)"

This policy set consists of the same elements as those in policy set 2. However, the ambition level is much stronger: the property tax incentive is much higher than in policy set 2, the budget available from the innovative financing is in-creased and the intensified coaching delivers considerable results.

### 3.3.4 Detailed design of the property tax:

The basic principle of a property tax which depends on the energy efficiency of a building has been designed and modelled in the following way:

An additional tax has to be paid per m² of gross floor area for the corresponding building if:

- there is a cost-efficient or low-cost renovation option available; this should make sure, that the tax is justifiable and broadly accepted, i.e. in those cases where due to the specific building design or characteristics it is not possible to renovate the building with acceptable costs, no energy efficiency component of the property tax has to be paid;
- the last renovation measure in the past has not been carried out within a certain minimum period (i.e. the "age" of the last renovation measure is smaller than a certain threshold)
- the energy need for space heating exceeds a certain threshold

For each of these conditions, a steady multiplicative factor between 0 and 1 has been introduced:

$$\text{tax payment} = f_{economics} * f_{age} * f_{energy\_need} * \text{Base\_Tax } [€/(year.m^2)]$$

The factors f [0;1] are defined below.

In Policy Set 2, the Base_Tax is 1.1 €/m² in 2015 and increases to 3.7 €/m² in 2030. Thus, in 2015 it approximately reflects the current level of the current property tax (Grundsteuer). In Policy Set 3, the Base_Tax (according to the formular above) is set to 4.4 €/yr/m² in 2015 and increases to 14.8 €/yr/m² in 2030.

The factor $f_{economics}$ considers the economic efficiency[10] of the available refurbishments. If the additional costs (compared to the costs of the maintenance option[11]) most economic refurbishments exceeds a certain threshold ($f_{economic\_th\_upper}$), then $f_{economics}$ is set to Zero, if the additional costs are below a certain threshold ($f_{economic\_th\_lower}$), then $f_{economics}$ is set to 1. In-between, linear interpolation is applied.

$f_{economics}$ = 0, if minimum($c_{renovation}$) > $f_{economic\_th\_upper}$ * $c_{maintenance}$

$f_{economics}$ = 1, if minimum($c_{renovation}$) < $f_{economic\_th\_lower}$ * $c_{maintenance}$

The following settings are applied:

- Policy package 2: $f_{economic\_th\_upper}$ = +20%, $f_{economic\_th\_lower}$ = + 5%
- Policy package 3 and sensitivities to policy package 2: $f_{economic\_th\_upper}$ = +20%, $f_{economic\_th\_lower}$ = + 20%

The factor $f_{age}$ considers the time since the last refurbishment action. $f_{age}$ = 1, if years since last refurbishment > $f_{age\_th\_upper}$; $f_{age}$ = 0, if years since last refurbishment < $f_{age\_th\_lower}$; In-between linear interpolation is applied. The following settings are used:

- Policy package 2: $f_{age\_th\_upper}$ = 45 years, $f_{age\_th\_lower}$ = 25 years
- Policy package 3 and sensitivities to policy package 2: $f_{economic\_th\_upper}$ = 25 years, $f_{economic\_th\_lower}$ = 25 years[12]

The energy need factor $f_{energy\_need}$ considers the current energy performance of the building, in particular of the thermal building envelope. The energy performance of building is measured using the specific energy need for space heating, corrected by the

[10] For the economic efficiency, the overall economic viability of the measure is calculated, i.e. discounted energy cost savings over the whole period minus discounted investments.

[11] As "maintenance option", we define the base refurbishment level which would be carried out only for aesthetical or security reasons, without any improvement of the energetic performance of the building.

[12] Thus, in policy package 3 no linear adaptation between the minimum and maximum value occurs, rather the full tax has to be paid as soon as the threshold value (of 25 years) is achieved.



Co-funded by the Intelligent Energy Europe Programme of the European Union

characteristic length of the building, ($HWB^* = HWB / (1+2.5/l_c)$), (where $l_c$ corresponds to the characteristic length according to the definition of the national building code in Austria). $f_{energy\_need}$ = 1, if HWB* > $f_{HWB*\_upper}$; $f_{energy\_need}$ = 0, if HWB* > $f_{HWB*\_lower}$; In-between linear interpolation is applied.
The following settings are used:

- Policy package 2: $f_{HWB*\_upper}$ = 55 kWh/m²/yr, $f_{HWB*\_lower}$ = 20 kWh/m²/yr
- Policy package 3 and sensitivities to policy package 2: $f_{HWB*\_upper}$ = 20 kWh/m²/yr, $f_{HWB*\_lower}$ = 20 kWh/m²/yr

The following graph shows which buildings would currently be affected by this regulation.

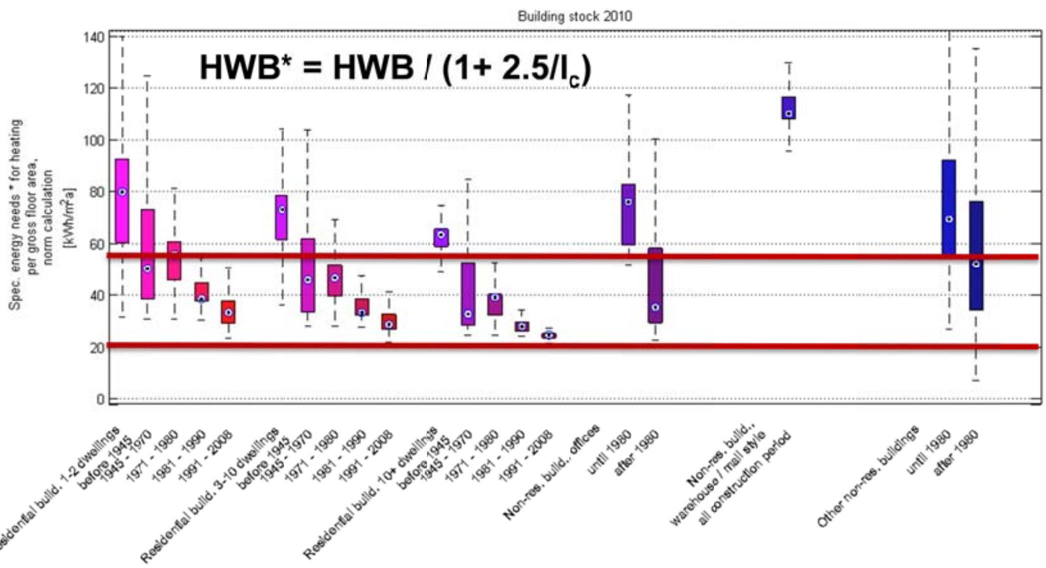



**Figure 6: Energy need thresholds and the current energy need of the Austrian building stock**

The property tax instrument could also be implemented as a bonus/malus[13] system, which would not change the key economic incentive as modelled in Invert/EE-Lab.

[13] A bonus would mean that for high energy efficiency buildings, the property tax could also decrease starting from a base level.



Co-funded by the Intelligent Energy Europe Programme of the European Union

However, for sure it would change the public perception and acceptance of the instrument.

Moreover, social factors could be introduced in order to take avoid social hardship.



Co-funded by the Intelligent Energy Europe Programme of the European Union

# 4. Model results

The following figures show the effect of the different policy packages on the energy demand. *All scenario results and more details are also available at the online scenario tool via [www.entranze.eu](http://www.entranze.eu).*

The BAU scenario from 2008-2030 leads to about 20%-24% reduction of final energy demand and almost 25%-30% of delivered energy demand under low and high energy prices, respectively. The additional measures in scenario 2 induce only very moderate additional reduction of energy demand. Thus, new policies as such do not guarantee a progress. They also have to be designed and implemented in an ambitious way. The third scenario leads to a significantly stronger increase of renovation activities and related energy efficiency gains: a reduction of final energy demand from 2008-2030 of 27%-30% and of delivered energy demand of 32%-36%.

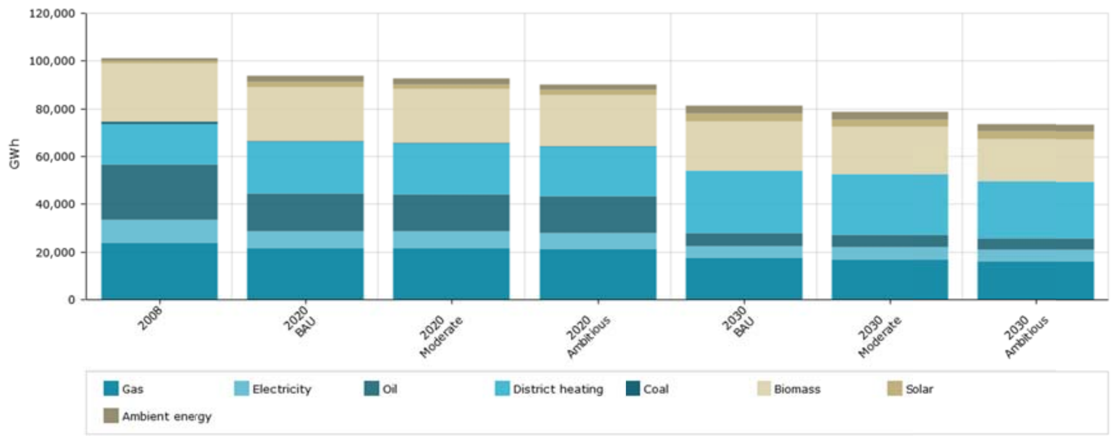



**Figure 7: Total building energy demand for space and water heating by energy carrier– low energy price scenario**



Co-funded by the Intelligent Energy Europe Programme of the European Union

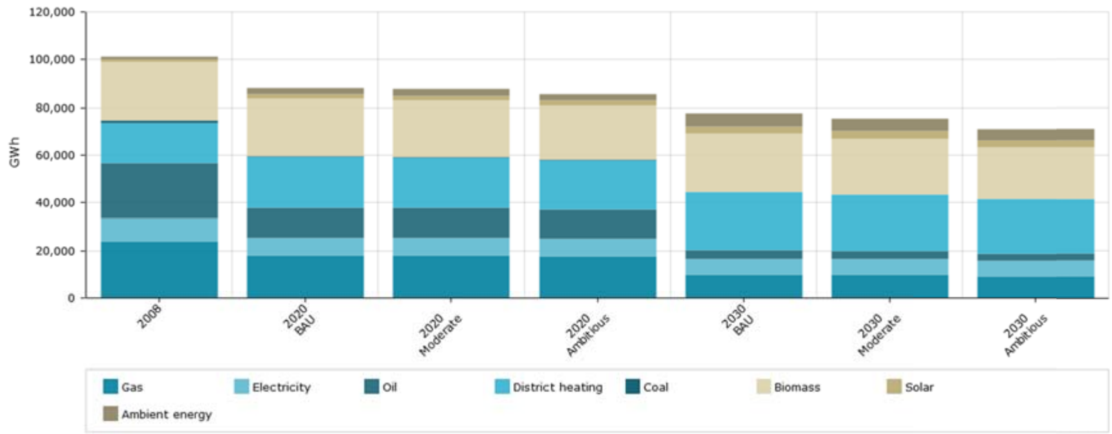



**Figure 8: Total building energy demand for space and water heating by energy carrier– high energy price scenario**

The analysis concentrated on the largest part of building related energy demand, which is the end-use space heating and hot water preparation. Lighting covers a share of about 4% of the building related energy demand, where cooling in Austria, 2008 accounts for less than 1%. However, the scenario results show that final energy demand for air cooling increases in all scenarios whereas lighting and space heating and hot water demand are strongly reduced due to the corresponding measures in place.

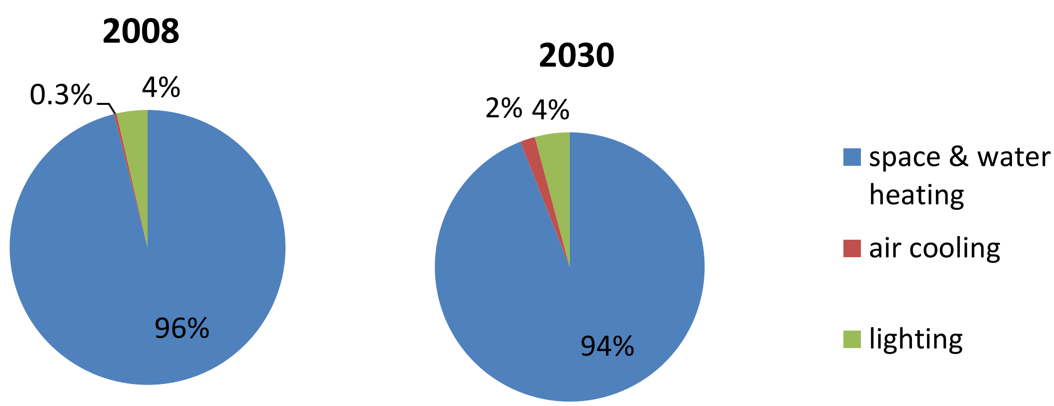



**Figure 9: Total final energy demand by end-use 2008 (left) and 2030, policy scenario 1, low energy prices**



Co-funded by the Intelligent Energy Europe Programme of the European Union

Since the focus of the Austrian policy scenarios was more on energy efficiency improvement and less on renewable heating, the share of renewable heating (excluding renewable energy in district heating) in all three policy scenarios is in a similar range of about 42% in 2030 (starting with 26% in 2008 and 32% in 2020) under high energy prices, where the share of RES-H increases only to about 32% in 2030 (and 29% in 2020) under low energy prices.

Figure 10 and Figure 11 show the share of buildings renovated from 2008 until 2020 and 2030 by different levels of renovation depth. Although the property tax as such does not provide an incentive for deep renovation, the additional measures implemented in this policy scenario (intensified coaching, higher financial support for deep renovation financed e.g. through the increased property tax revenue) lead to a significant increase of deep renovation activities. However, since an enhancement of the regulatory framework for renovation depth and related compliance activities was not foreseen, still a significant share of buildings are renovated with low and medium quality. This can be understood as lost opportunity and as an indicator for a lock-in effect, since these buildings probably are locked for deeper renovation at least until mid of the century.

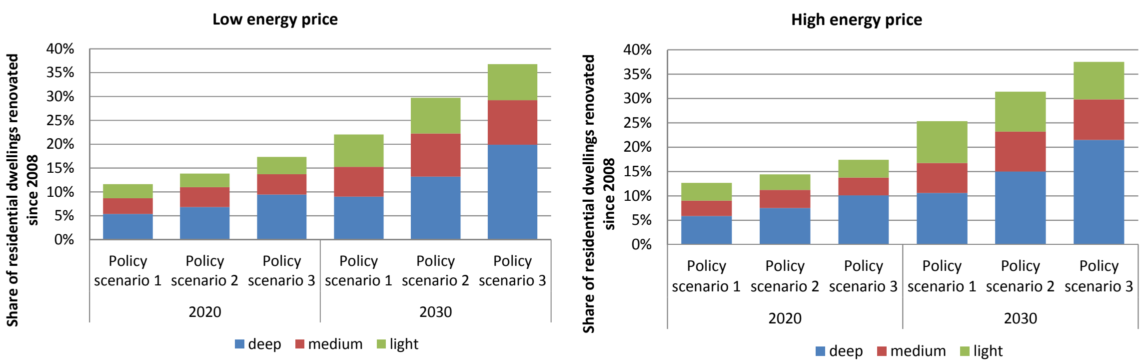



**Figure 10: Share of residential dwellings renovated since 2008 by renovation quality[14] under low energy prices (left) and high energy prices (right)**

[14] Renovation quality levels deep, medium and light are defined in Annex A.2.



Co-funded by the Intelligent Energy Europe Programme of the European Union

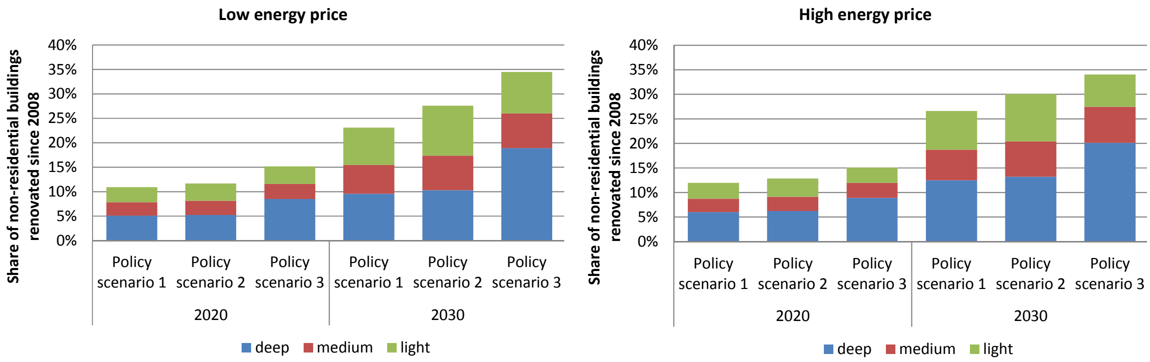



**Figure 11: Share of non-residential buildings renovated since 2008 by renovation quality[15] under low energy prices (left) and high energy prices (right)**

Tax revenues from the property tax related to building's energy efficiency account for 140 mio €/yr in the period of 2015-2030 under policy scenario 2 (i.e. moderate implementation of the new policy package). In policy scenario 3 (i.e. ambitious, strong implementation of the new, innovative policy package) the tax revenues are about 1200 mio €/yr. In the latter case, we assumed that about 400 Mio €/yr of these tax revenues are redirected into an increase of budgets for thermal building renovation.

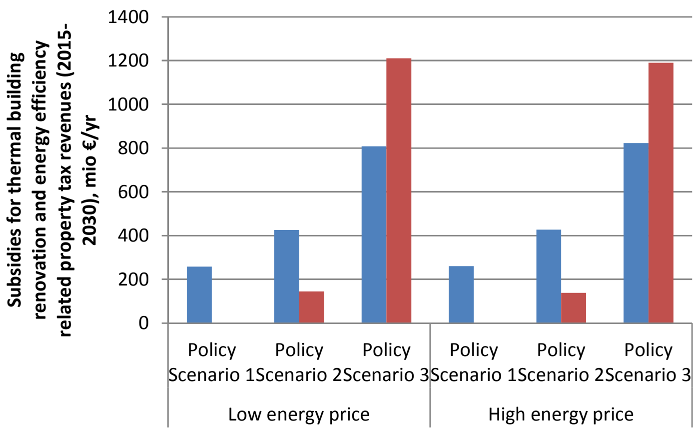



**Figure 12: Subsidies for thermal building renovation and energy efficiency related property tax revenues**

[15] Renovation quality levels deep, medium and light are defined in Annex A.2.



Co-funded by the Intelligent Energy Europe Programme of the European Union

# 5. Recommendations

This chapter discusses recommendations based on the results of the ENTRANZE-project. Firstly these are recommendations and conclusions regarding national policy making. Recommendations on the EU-Commission and recommendations applicable to all EU-MSs have been developed in the report "Policies to enforce the transition to nZEB: Synthesis report and policy recommendations from the project ENTRANZE" (Kranzl et al., 2014b).

The recommendations described below were derived from the results of the work packages of the ENTRANZE-project, especially from the calculation of the policy scenarios and the discussion within the policy group and with other experts and stakeholders.

Based on the scenario calculations recommendations regarding a bundle of new and adapted instruments have been developed. The main instruments should always be accompanied by supporting instruments. Thus, the building related energy sector always needs policy bundles which involve a set of measures and go beyond the consideration of single policy instruments. The main pillars of additional elements in the policy bundle are shown in the following figure. Due to the discussions with experts and policy makers, there seems to be a higher need for intensifying and improving building renovation activities, whereas current RES-H share in Austria is already higher than the EU average and comprehensive measures are in place. Therefore, the recommendations and main pillars of policy instruments focus on efficiency improvement and thermal renovation.



Co-funded by the Intelligent Energy Europe Programme of the European Union

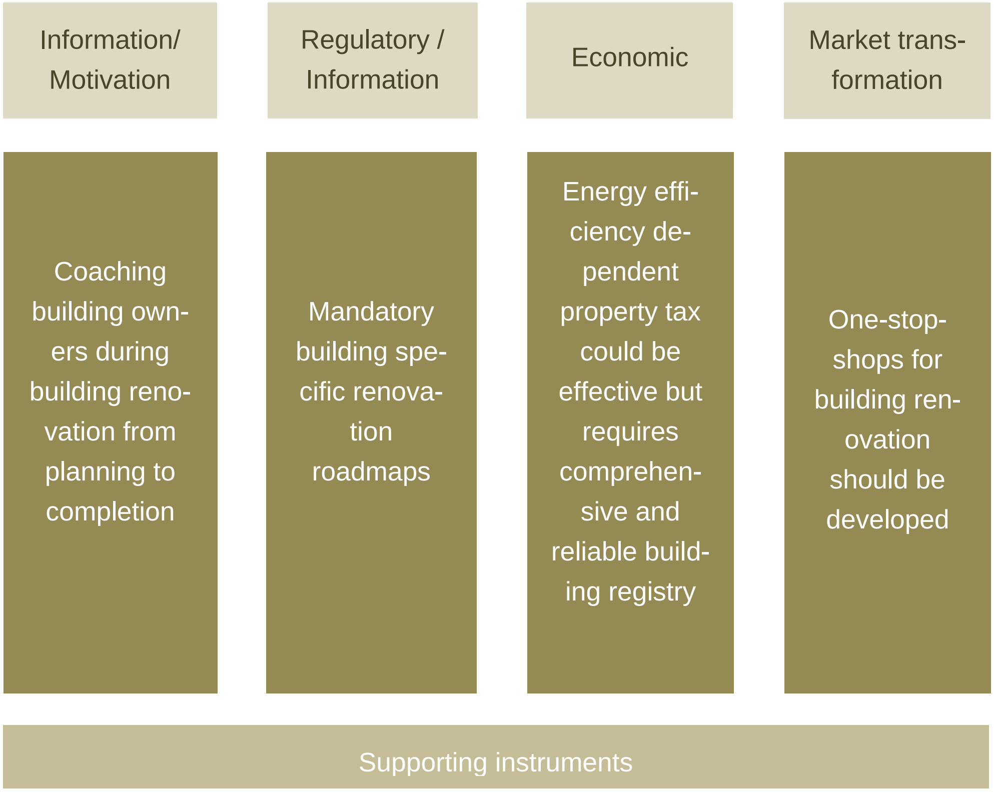



**Figure 13: Bundle of new, additional instruments considered for recommendations**

In Austria there already are quite attractive subsidies for building renovation, still the renovation rate remains low. In the discussion within the policy group it was assumed that an additional financial incentive could help to trigger building renovation. The implementation of mandatory building renovation roadmaps can, depending on the design, be an effective instrument as well. The same is true for one-stop-shops for building renovation.

A main barrier for building renovation that has been identified during the discussion process is a lack of information and motivation of building owners. The improvement of information and motivation could be another approach to increase renovation activities. Additionally to the main instruments there are some supporting instruments; all recommended instruments are described below.

Regarding a possible implementation of a property tax related to buildings' energy efficiency, it has to be taken into account that this would require a comprehensive building registry and corresponding energy performance certificate registry. In Austria, these



Co-funded by the Intelligent Energy Europe Programme of the European Union

databases are under development but still far from being completed and comprehensive. Thus, these activities have to be enhanced.

## 5.1 Coaching building owners during building renovation from planning to completion

- If an intensified coaching process is established, legal questions also have to be addressed and clarified (e.g. warranty issues of the building owners towards the coach).
- Quality management and quality assurance of the coaching process and for renovation planning have to be established.
    - In several Austrian regions (e.g. Vorarlberg) currently quality management and quality assurance processes for renovation planning and renovation advice are carried out. These processes are very relevant to guarantee a high quality of the coaching activities.
- A research project has been done for such a coaching process in Lower Austria (Haus-der-Zukunft project; Contact: Umweltberatung NÖ, Doris Hammermüller)
- In Styria, currently a pilot phase is under preparation where 10 building owners will be supported in a highly intensive way. This process is very expensive and it will be necessary to find ways to share the costs.

The coaching could be performed by regional and local energy agencies. It should be available at low cost or even free of charge for the building owners. Currently, there are only a few examples of corresponding experience and no reliable cost estimation for a broad implementation of such a programme. If the coaching would address the needs of building owners, it can be expected that the public acceptance of the coaching would be probably high, as far as total public expenditures for the programme would be acceptable. As shown in the scenario calculation the effects of such an instrument would also be significant, although there are uncertainties regarding the modelling of this type of instruments (see Annex A.3). If the reached renovation standard is very high, this instrument is compatible to long term-energy efficiency-targets. So, the compatibility with long-term efficiency targets depends on how the coaching process exactly is implemented and how effective it is. If the process only leads to higher renovation rate without increasing the quality of renovation and the depth of the renovation activities, it might not contribute to the long-term target. If the coaching process also takes into account a long-term strategy of the building renovation which is in line with overall, aggregate long-term energy efficiency targets, the instrument contributes also to a large extent to long-term compatibility. Thus, it is important to integrate intensified coaching with building specific renovation roadmaps, which are the second element of the policy bundle.



Co-funded by the Intelligent Energy Europe Programme of the European Union

## 5.2 (Mandatory) building specific renovation roadmaps

- A step-by-step plan for the introduction of building specific renovation roadmaps should be introduced. This plan could foresee that buildings which are older than e.g. 40 years and which have not been renovated yet have to provide a renovation plan (e.g. starting in 2016).
- The development of a renovation roadmap for a certain building could also be one of the reasons for an exemption of the property tax, e.g. for 1 or 2 years.
- Mandatory building specific renovation roadmaps could also be integrated in the rental law and the residential property law.
- Could be made mandatory in case of each change of ownership or change of tenant. For condominiums, a similar approach as in the case of the energy performance certificates could be followed.
- Such renovation roadmaps are currently subsidized e.g. in Styria. However, up to now there is no obligation to provide a building renovation roadmap.

There should be a strong incentive or even obligation to implement the renovations shown in the roadmap; the compliance must be ensured. There might be problems with the public acceptance of the obligatory building renovation roadmaps; that's why relevant stakeholders should be integrated in the process to implement this instrument. The renovation roadmaps should target on high energy efficiency standards up to the nZEB-standard or even better. The social impacts of this instrument are still an open question and should be explored. There is a very high compatibility of this instrument with long-term energy efficiency targets, because it reduces potential lock-in effects which could occur by short-term renovation measures without a clear long-term target. Thus, the building specific renovation roadmaps could help to break down the aggregated long-term targets to building specific targets and measures.

## 5.3 Energy efficiency dependent property tax (Grundsteuer)

- A new component in the property tax (Grundsteuer) depending on the energy efficiency of the building could introduce a new incentive and – if properly implemented – could be a strong driver for increasing renovation activities.
- A general revision of the property tax (Grundsteuer) is currently under discussion. This could be a good chance to introduce the topic of an energy efficiency dependent property tax in Austria. The property tax is regulated in the constitution and thus requires a 2/3 majority in the national parliament to be changed. Thus, also non-governmental parties may have a relevant role in the discussion process.



Co-funded by the Intelligent Energy Europe Programme of the European Union

- It will be important to communicate the energy efficiency dependency in the property tax effectively in order to create a strong signal effect, e.g. by marking the energy efficiency bonus/malus in yellow on the tax assessment notice.
- Dynamic setting of the property tax will be important: how fast should the tax be introduced? In which time steps should the energy efficiency indicators be increased? These details would also have to be clarified in the implementation of such a tax.
- Currently, the property tax (Grundsteuer) is calculated based on the overall area of a piece of land. In the scenarios shown above, the tax was calculated based on the useable gross floor area of a building. It would be necessary to find a common denominator for the energy efficiency bonus/malus and the current base property tax.

A key precondition for an implementation of the property tax depending on buildings' energy efficiency is the availability of unambiguous, comprehensive and reliable data for the determination of tax levels. In this context, the following aspects have to be taken into account:

- The **taxation needs a reliable and comprehensive data source** of all buildings. Statistical values e.g. from building census are not sufficient. Moreover, it also needs technically trained persons to implement, control and administrate the scheme. As long as such a reliable and comprehensive data source is not available, an implementation is difficult and could lead to high transaction costs.
- The Austrian **buildings registry act** foresees 250 parameters which can be stored per building. This allows to cover all relevant building data required for such an instrument (property tax related to energy efficiency of buildings). However, the data is still not complete and level of details vary strongly between the nine regions. Up to now, a concrete application of this database is not available, which is one of the reasons why the motivation and incentive for a comprehensive data collection and implementation of the registry is moderate. Thus, **a full building registry could allow the implementation of a property tax** related to energy efficiency with moderate transaction costs.
  In Switzerland, there is an obligation to fill the building registry in course of a mandatory energy strategy on level of the regions.
- The **database on energy performance certificates** is another relevant source, in particular regarding the assessment of energy needs of buildings. Difficulties are well known (e.g. regarding different qualities of certificates). However, in the coming years it can be expected that quality and reliability of certificates will further improve and that a continuously growing number of buildings will be included in the database. Buildings which are not covered by the database could be taxed by the use of typical default values based on the construction period of the building.


Co-funded by the Intelligent Energy Europe Programme of the European Union

The acceptance for an additional tax for energy efficiency might be low. However, since a significant increase of the property tax is currently under discussion, a bonus for energy efficiency should be granted. Also a bonus/malus system could be feasible.

The social implications of a revised property tax have to be taken into account carefully:

- The social impacts regarding **low-income people, fuel poverty** and possible impacts on rental fees should be further analysed.
  Thus, exemptions from the property tax due to social reasons could be foreseen. However, it should be taken into account that this may lead to additional administrative costs.
  The current model version did not fully implement all aspects of fuel poverty and low-income groups.
- The **current rent law (§21)** lists the property tax (Grundsteuer) as an element which the landlord can include in the rental fee. This should be removed from the rent law.
- Discussion to which extent **user behaviour, comfort aspects** and rebound effects should be taken into account in such a scheme. We should be aware that the discussed instrument is a taxation of the building (and its energy efficiency) but not a taxation of real, actual energy consumption. The latter is strongly depending on user behaviour and individual aspects (e.g. also the number and age of occupants).
- There are also open questions regarding the **real impact of the instrument**: low-income persons would have problems to carry out the investment in building renovation. Persons with a higher income would not really care about an increased property tax. This leads to the conclusion that a specific support of low-income people is important, e.g. by adding an income related component of the property tax. On the other hand, a strong visibility and clear communication of the instrument is highly relevant for the impact of the scheme.

**Long-term impact, duration and "sustainability" of tax revenues**: Since the proposed scheme is aiming to improve energy efficiency of buildings, this would reduce the tax revenues if the scheme would be effective. This should be taken into account. This is a typical effect of these type of taxes (e.g. like in the case of CO2-taxes). For the future revenue of the tax, the absolute tax level, but also the renovation rate is relevant. In the proposed dynamic setting, the tax revenue would increase until 2030, since the increase of the tax level compensates the lower number of buildings which are assessable to the energy efficient component of the property tax. It should be taken into



Co-funded by the Intelligent Energy Europe Programme of the European Union

account that the building stock is very inert which would make it very unlikely that renovation rates would increase very quickly and strongly.

The scenario calculations showed that the effects of this instrument would be high, if implemented in an ambitious way and integrated into an overall ambitious policy bundle. The tax in general is not very well suited to increase the quality and depth of renovation activities. Rather, it increases the renovation rate. Thus, low ambitious renovation measures have to be avoided by other elements in the policy bundle. The tax-instrument alone, without accompanying measures does not ensure compatibility with long-term energy efficiency targets. However, the tax could also provide an incentive for RES-H if the reference value is set regarding primary energy and final energy. In order to ensure consistency, it should be based on the same indicators as they are included in the energy performance certificate The social impacts of this instrument should be explored. Moreover, there are open questions how the tax will affect the dwellings market and to which extent the building owners will pass on the tax on the rental.

Due to legal implementation, the new instrument should not be called “Grundsteuer” but “Immobiliensteuer”.

## 5.4 One-stop-shops for building renovation should be set up by the companies obliged to initiate energy efficiency measures by the energy efficiency directive and the national energy efficiency law

Current economic conditions for building renovation are already quite attractive in Austria. Up to 30% of investment costs are covered by subsidies. However, nevertheless the renovation rate remains at a very low level and in some regions, not the full budgets are drawn due to various barriers. Even more, the very high transaction costs in organising the renovation process are a crucial barrier. Thus, there should not only be a focus on the property tax but on the whole package of instruments. It needs to develop one-stop shops for building renovation. This issue will be crucial for every type of building renovation strategy.

According to the energy efficiency directive and the national energy efficiency law the energy distributing companies will have to initiate energy efficiency measures. The public institutions could recommend those companies to develop such type of one-stop-shops for building renovation (or act as general contractor for building renovation). These one-stop-shops, initiated by energy distributors or traders, could act in a similar way as contractors. Their activity should clearly go beyond training but involve the organisation of the full renovation activity of a building. The efficiency gains could be accounted by the company for reaching their energy efficiency obligation. This should be



Co-funded by the Intelligent Energy Europe Programme of the European Union

the driving force for companies to invest in such schemes. On the one hand, the public authorities should support these initiatives and adapt the support instruments to the specific needs of these projects. On the other hand, free-rider effects for companies, who should fulfil their energy efficiency obligations, should be avoided.

The instrument as such does not guarantee compatibility with long-term energy efficiency targets, because companies mainly have in to fulfil their short term obligation targets. Thus, it is important to embed this instrument in a bundle of other instruments.

Thus, the energy efficiency law should be used as an instrument also for increasing building renovation activities.

## 5.5 Supporting instruments and other measures

- “e5 Gemeinden” and other similar programs on community level: An **extra bonus on the subsidy for building renovation in these communities** could provide an additional incentive for the mayors to adopt the program and join these initiatives. Thus, different existing programs and initiatives should be stronger linked to each other.

- **Linking energy efficiency measures and spatial planning**:
    - For high efficient buildings exemptions e.g. regarding permitted number of floors might be granted.
        - E.g. Brixen, is an example of energy related spatial planning. For high efficient buildings, higher densification (higher number of floors) is permitted.
    - In general, spatial planning issues should stronger be integrated in energy efficiency improvement strategies of buildings (and vice versa: energy issues should be implemented in spatial planning issues), in particular regarding district heating, smart grids issues and energy issues for the whole settlement rather than for one building only (e.g. the optimal use of solar energy source (solar gains control through envelope and solar RES systems - also at settlement scale) and the control of urban heat island effects particularly in dense urban areas).

- Some regions are currently considering the establishment of **regional energy efficiency laws**. These efficiency laws could be used to integrate some of the above mentioned issues.



Co-funded by the Intelligent Energy Europe Programme of the European Union

- Although **building codes and the regulatory framework** were not in the focus of the scenario work for Austria, the comparison with other countries revealed that the Austrian nZEB definition and related building codes are not at the fore-front of the European standard (see e.g. Atanasiu et al., 2013). Thus, stricter regulation would be also required to achieve ambitious long term climate and energy policy targets.


Co-funded by the Intelligent Energy Europe Programme of the European Union

## References

Atanasiu, B., Maio, J., Staniaszek, D., Kouloumpi, I., 2013. Building policies and programs in the EU-27 -EU overview and nine factsheets on ENTRANZE countries. Deliverables D5.1 and D5.2 of WP5 from Entranze Project.

Biermayr, P., Cremer, C., Faber, T., Kranzl, L., Ragwitz, M., Resch, G., Toro, F., 2007. Bestimmung der Potenziale und Ausarbeitung von Strategien zur verstärkten Nutzung von erneuerbaren Energien in Luxemburg. Endbericht im Auftrag des Ministeriums für Energie.

Bürger, V., 2013. Overview and assessment of new and innovative integrated policy sets that aim at the nZEB standard, Report in the frame of the IEE project ENTRANZE.

Fernandez-Boneta, M., 2013. Cost of energy efficiency measures in buildings refurbishment: a summary report on target countries, Report in the frame of the IEE project ENTRANZE.

Fernandez-Boneta, M., 2014. Energy cost matrices, Deliverable from the project ENTRANZE.

Haas, R., Müller, A., Kranzl, L., 2009. Energieszenarien bis 2020: Wärmebedarf der Kleinverbraucher. Ein Projekt im Rahmen der Erstellung von energiewirtschaftlichen Input-parametern und Szenarien zur Erfüllung der Berichtspflichten des Monitoring Mechanisms. Im Auftrag der Umweltbundesamt GmbH. Wien.

Heiskanen, E., Matschoss, K., 2012. Working paper: Literature review of key stakeholders, users and investors. Report in the frame of the project ENTRANZE.

Kranzl, L., Brakhage, A., Gürtler, P., Pett, J., Ragwitz, M., Stadler, M., 2007. Integrating policies for renewables and energy efficiency: Comparing results from Germany, Luxembourg and Northern Ireland. Presented at the eceee 2007 summer study, La colle sur Loup, France.

Kranzl, L., Fette, M., Herbst, A., Hummel, M., Jochem, E., Kockat, J., Lifschiz, I., Müller, A., Reitze, F., Schulz, W., Steinbach, J., Toro, F., 2012. Erarbeitung einer Integrierten Wärme- und Kältestrategie. Integrale Modellierung auf Basis vorhandener sektoraler Modelle und Erstellen eines integrierten Rechenmodells des Wärme- und Kältebereichs. Wien, Karlsruhe, Bremen.

Kranzl, L., Hummel, M., Müller, A., Steinbach, J., 2013. Renewable heating: Perspectives and the impact of policy instruments. Energy Policy. doi:10.1016/j.enpol.2013.03.050

Kranzl, L., Müller, A., Toleikyte, A., Hummel, M., Forthuber, S., Steinbach, J., Kockat, J., 2014a. Policy pathways for reducing the carbon emissions of the building stock until 2030. Report within the project ENTRANZE.

Kranzl, L., Stadler, M., Huber, C., Haas, R., Ragwitz, M., Brakhage, A., Gula, A., Figorski, A., 2006. Deriving efficient policy portfolios promoting sustainable energy systems–Case studies applying Invert simulation tool. Renewable energy 31, 2393–2410.

Kranzl, L., Toleikyte, A., Müller, A., Hummel, M., Heiskanen, E., Matschoss, K., Pietrobon, M., Armani, R., Pagliano, L., Sebi, C., Lapillone, B., Atanasiu, B., Steinbach, J., Kockat, J., Rohde, C., Georgiev, Z., Fernandez-Boneta, M., Diaz-Regodon, I., Bürger, V., Kenkmann, T., Zahradnik, P., Karasedk, J., 2014b. Policies to enforce the transition to nZEB: Synthesis report and policy recommendations from the project ENTRANZE.



Co-funded by the Intelligent Energy Europe Programme of the European Union

Müller, A., 2010. Hat Heizen Zukunft? Eine langfristige Betrachtung für Österreich. Presented at the Symposium Energieinnovation, Graz.

Müller, A., 2012. Stochastic Building Simulation, working paper. Available at http://www.marshallplan.at/images/papers_scholarship/2012/Mueller.pdf., Berkely.

Müller, A., Kranzl, L., Hummel, M., 2014. The model Invert/EE-Lab. A tool applied in the frame of the project ENTRANZE.

Nast, M., Leprich, U., Ragwitz, M., Bürger, V., Klinski, S., Kranzl, L., Stadler, M., 2006. Eckpunkte für die Entwicklung und Einführung budgetunabhängiger Instrumente zur Marktdurchdringung erneuerbarer Energien im Wärmemarkt“ Endbericht. Im Auftrag des deutschen Bundesministeriums für Umwelt, Naturschutz und Reaktorsicherheit.

Pietrobon, M., Armani, R., Zangheri, P., Pagliano, L., 2013. Report on Cost/Energy curves calculation, Report in the frame of the IEE project ENTRANZE.

Schriefl, E., 2007. Modellierung der Entwicklung von Treibhausgasemissionen und Energieverbrauch für Raumwärme und Warmwasser im Österreichischen Wohngebäudebestand unter Annahme verschiedener Optimierungsziele. Technische Universität Wien, Wien.

Stadler, M., Kranzl, L., Huber, C., Haas, R., Tsioliaridou, E., 2007. Policy strategies and paths to promote sustainable energy systems–The dynamic Invert simulation tool. Energy policy 35, 597–608.

Steinbach, J., 2013. Literature review of integrating user and investment behaviour in bottom-up simulation models, Internal working paper from the project ENTRANZE.

Sebi, C., , Lapillonne B. 2013 Exogeneous framework conditions for Entranze scenarios, Internal working paper from the project ENTRANZE.



Co-funded by the Intelligent Energy Europe Programme of the European Union

# A Annex

## A.1 : 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.



Co-funded by the Intelligent Energy Europe Programme of the European Union

- 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



Co-funded by the Intelligent Energy Europe Programme of the European Union

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.

## A.2 : Renovation packages taken into account in the modelling or thermal building retrofit

**Table 3: Definition of renovation packages**

| | Roof | Wall | Base | Windows | Night cooling | Solar shading | Heat recovery |
|---|---|---|---|---|---|---|---|
| Residential | | | | | | | |
| Standard | 10 cm of thermal insulation | 15 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= 1,6 W/m²K; g= 0,72; Tvis= 0,82, thermal transmittance value of frame Uf=1,4 W/m2K, | no | no | no |
| Good | 20 cm of thermal insulation | 15 cm of thermal insulation | 10 cm of thermal insulation | Triple glass with argon cavity (16mm) and a low-e glass, thermal transmittance value of glazing Ug= 1,1 W/m²K; g= 0,64; Tvis= 0,74, thermal transmittance value of frame Uf=1,1 W/m2K, | no | yes | no |
| Ambitious | 20 cm of thermal insulation | 30 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= 1,1 W/m²K; g= 0,64; Tvis= 0,74, thermal transmittance value of frame Uf=1,1 W/m2K, | no | 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, | no | no | no |
| Good | 20 cm of thermal insulation | 20 cm of thermal insulation | 10 cm of thermal insulation | Triple glass with argon cavity (16mm) and a low-e glass, thermal transmittance value of glazing Ug= 1,1 W/m²K; g= 0,64; Tvis= 0,74, thermal transmittance value of frame Uf=1,1 W/m2K, | no | yes | no |
| Ambitious | 30 cm of thermal insulation | 30 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= 1,1 W/m²K; g= 0,64; Tvis= 0,74, thermal transmittance value of frame Uf=1,1 W/m2K, | no | yes | yes |


Co-funded by the Intelligent Energy Europe Programme of the European Union

## A.3 Documentation of the model Invert/EE-Lab

In addition to the short overview of the model Invert/EE-Lab in chapter 2, this annex provides a few more information.

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 **Fehler! Verweisquelle konnte nicht gefunden werden.**.

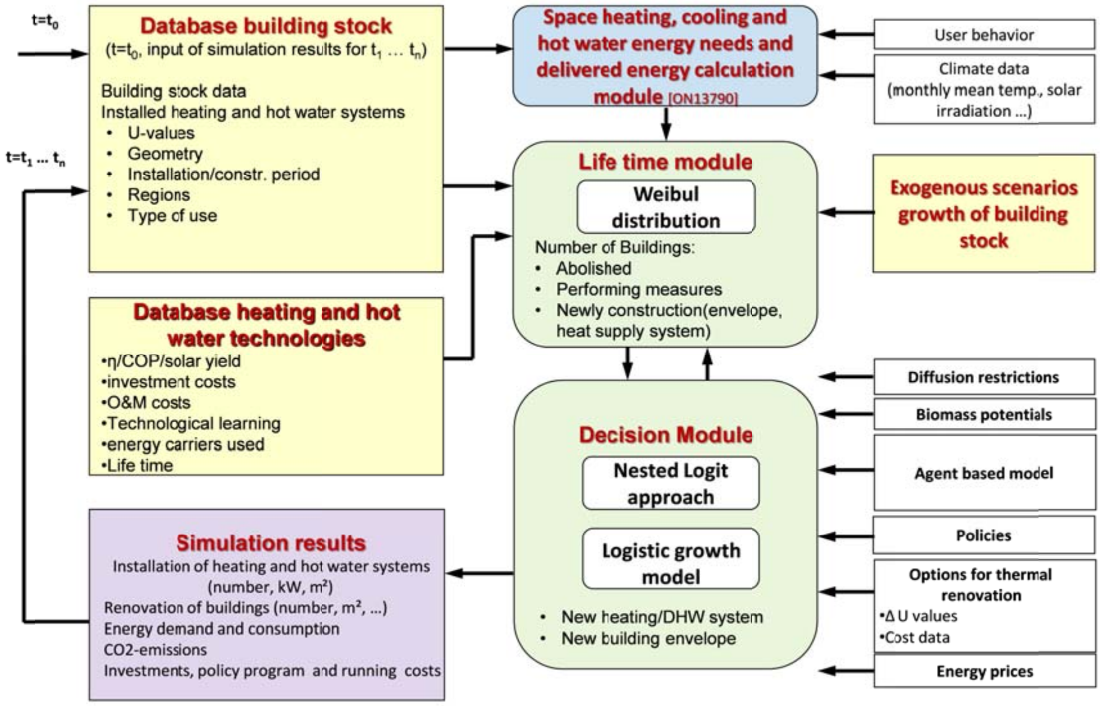



**Figure 14: Overview structure of Simulation-Tool Invert/EE-Lab**



Co-funded by the Intelligent Energy Europe Programme of the European Union

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 included 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.



Co-funded by the Intelligent Energy Europe Programme of the European Union

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).

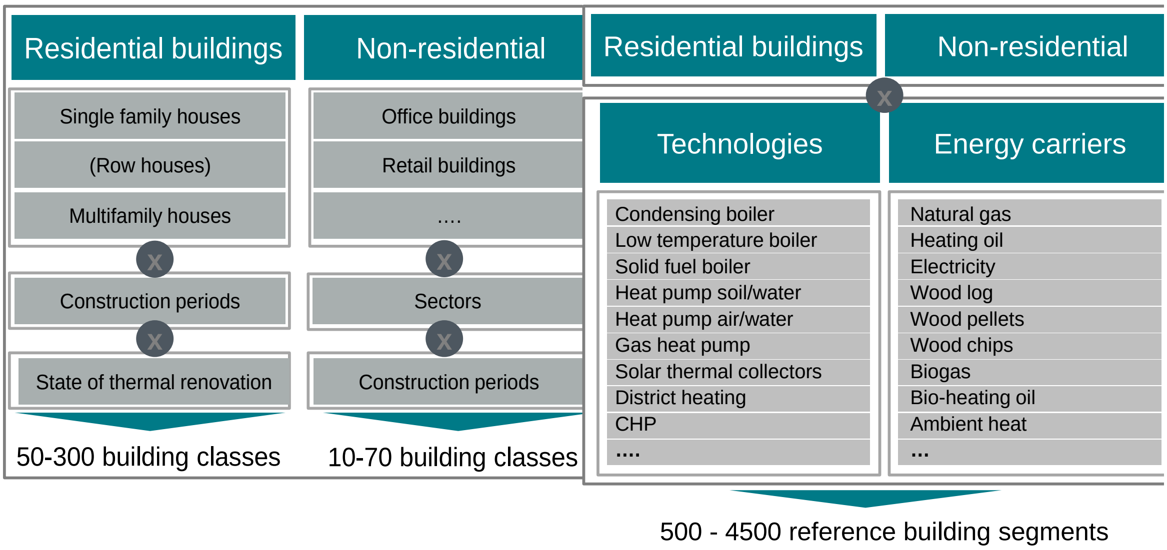



**Figure 15: Disaggregated modeling of the building stock within each country. Where relevant climatic zones are taken into account within a country.**

### 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€)



Co-funded by the Intelligent Energy Europe Programme of the European Union

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.


Co-funded by the Intelligent Energy Europe Programme of the European Union