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

D4.3 and D5.6 from Entranze Project

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ENTRANZE Project

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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 Italy. 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 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 case of Italy.

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

- *BAU Plus*: Regulatory instruments + preferential loans + information campaigns
- *Medium*: Regulation and incentives for nZEB level for renovation + information campaigns
- *Improved*: Regulation and broader incentives for more ambitious actions for nZEB level for renovations + information campaigns

These policy sets are focused on building refurbishments, in addition also a policy set for new buildings is proposed, mainly focused on nZEB levels in regulations, starting from 2020.

In the following paragraphs the considered policy sets are detailed explained.

The following main findings have been identified:

- The need of more complete indexes for description and ranking of buildings and NZEBs as foreseen by EPBD;
- policy instruments which will remain in force stable and certain for long periods;
- importance of Global costs savings and financial supports to initial investments;
- stimulate the integrated public and private financial support of the initial investments;
- need of investments in quality controls in renovations interventions, particularly if supported by policy measures;
- selection and values of Thermal envelope performances and limits in primary energy demand for regulations presented in the following paragraphs;
- adequate and enough ambitious limits for buildings with architectural / historical constraints;

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- the importance of Information campaigns particularly for demand side (building owners and occupants, housing associations, real estate company, etc.);
- adopting solutions of progressive tariffs with unitary energy price growing with consumption and making real time consumption data available to customers;
- priority to demand reduction policies which will by themselves also reduce the impact on the grid, avoiding high sells of photovoltaic energy concentrated only in summer and high demand of gas or electricity for heating in winter;
- Cost reduction of energy efficiency technologies, investing in R&D for tech amelioration and cost reduction.

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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.

In the last two years meetings were held with national and local policy makers, associations of users, environmental associations and umbrella organization. Several rounds of technical consultation were done too in order to collect comments on calculations and analysis performed and to have discussion on the results.

Some of outcomes and recommendations here presented were confirmed and replicated in comments and suggestions with different kind of policy makers and stakeholders. This confers more strength to the outcomes.

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.

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 up to 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).

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.

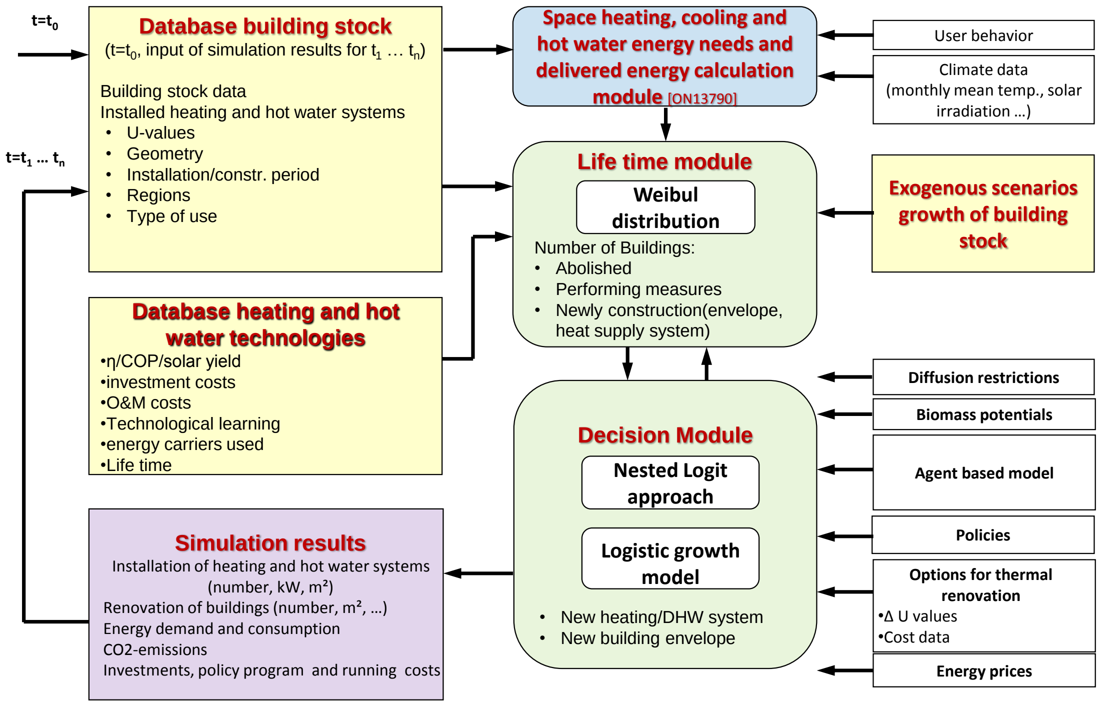

Figure 1: Overview structure of Simulation-Tool Invert/EE-Lab

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).

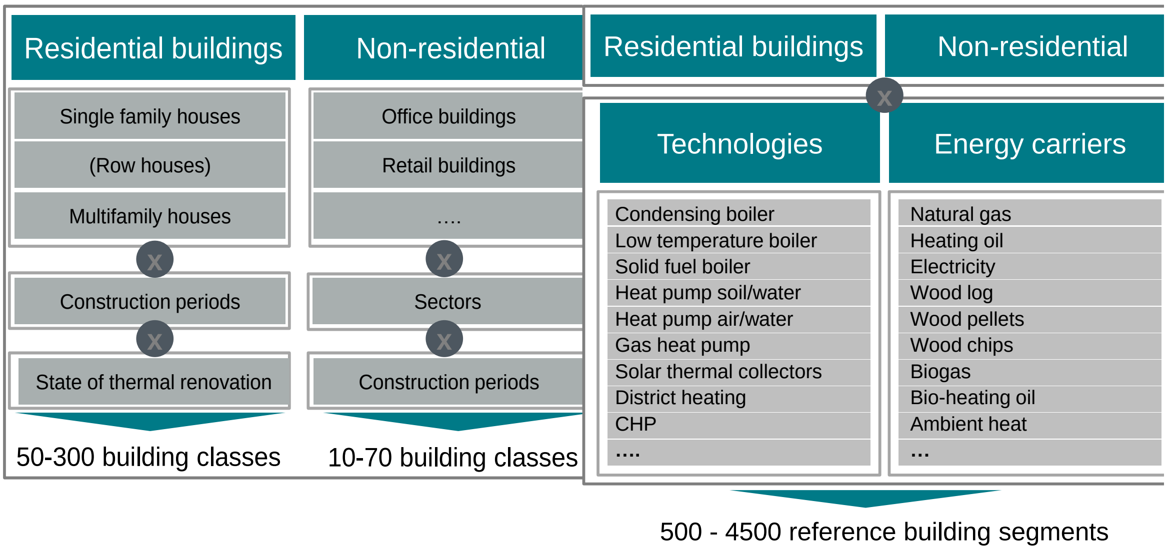

Figure 2: Disaggregated modeling of the building stock within each country. Where relevant climatic zones are taken into account within a country.

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€)

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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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.

2.3 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 adopted in scenarios for Italy (central-North climate regions)

	Roof	Wall	Basement	Windows	Night cooling	Solar shading	Heat recovery
Residential							
Standard / current practice (lower level)	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) according to EN 12207	no	no	no
Good / Regulation level	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) according to EN 12207	Automatised natural ventilation	Automation of solar shading devices	no
Ambitious	30 cm of thermal insulation	20 cm of thermal insulation	15 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) according to EN 12207	Automatised natural ventilation	Automation of solar shading devices	yes
Non-residential							
Standard / current practice (lower level)	10 cm of thermal insulation	5 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) according to EN 12207	no	no	no
Good / Regulation level	15 cm of thermal insulation	10 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= 1,0 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) according to EN 12207	Automatised natural ventilation	Automation of solar shading devices	yes
Ambitious	25 cm of thermal insulation	25 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) according to EN 12207	Automatised natural ventilation	Automation of solar shading devices	yes

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Table 3: Definition of renovation packages adopted in scenarios for Italy (central-South climate regions)

	Roof	Wall	Basement	Windows	Night cooling	Solar shading	Heat recovery
Residential							
Standard / current practice (lower level)	5 cm of thermal insulation	5 cm of thermal insulation	5 cm of thermal insulation	Double glass with air cavity (16mm), thermal transmittance value of glazing Ug= 2,7 W/m²K; g= 0,78; Tvis= 0,82, thermal transmittance value of frame Uf=2,2 W/m2K, reduce air permeability of the window at least to 2nd class (27 m³/hm²) according to EN 12207	no	External window blinds	no
Good / Regulation level	10 cm of thermal insulation	10 cm of thermal insulation	10 cm of thermal insulation	Double glass with air cavity (16mm), thermal transmittance value of glazing Ug= 2,7 W/m²K; g= 0,78; Tvis= 0,82, thermal transmittance value of frame Uf=2,2 W/m2K, reduce air permeability of the window at least to 2nd class (27 m³/hm²) according to EN 12207	no	External window blinds	no
Ambitious	15 cm of thermal insulation	15 cm of thermal insulation	15 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) according to EN 12207	Automatised natural ventilation	Automation of solar shading devices	yes
Non-residential							
Standard / current practice (lower level)	5 cm of thermal insulation	5 cm of thermal insulation	5 cm of thermal insulation	Double glass with air cavity (16mm), thermal transmittance value of glazing Ug= 2,7 W/m²K; g= 0,78; Tvis= 0,82, thermal transmittance value of frame Uf=2,2 W/m2K, reduce air permeability of the window at least to 2nd class (27 m³/hm²) according to EN 12207	no	no	no
Good / Regulation level	15 cm of thermal insulation	10 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) according to EN 12207	Automatised natural ventilation	Automation of solar shading devices	no
Ambitious	25 cm of thermal insulation	20 cm of thermal insulation	15 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) according to EN 12207	Automatised natural ventilation	Automation of solar shading devices	yes

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2.4 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.

[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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2.4.1 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.

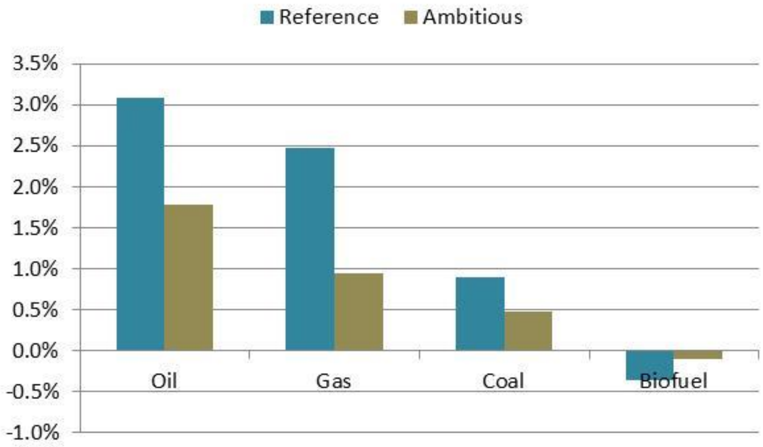

Figure 2: Annual growth rate of international energy price over 2010-2030

Source: POLES-Enerdata

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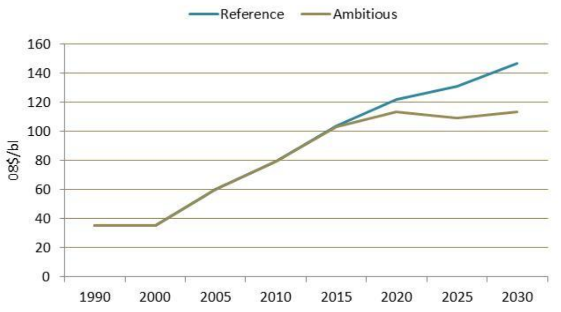
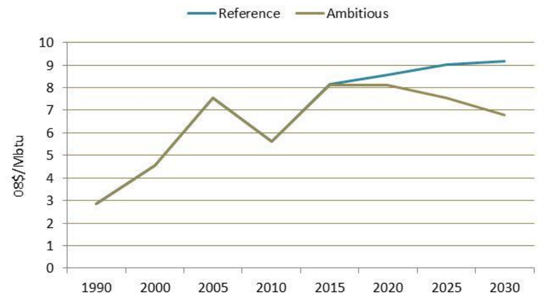
Oil



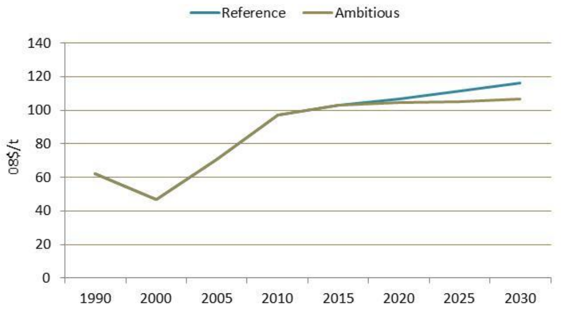
In the reference scenario, oil price is expected to increase at a rapid pace of 6.5%/year from 2000 until 2020, which will then slow down to 2%/year until 2030. In the ambitious scenario, it increases less rapidly until 2020 (3.6%/year), and remains almost steady reaching 100$/bl in 2030. This lower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

Gas



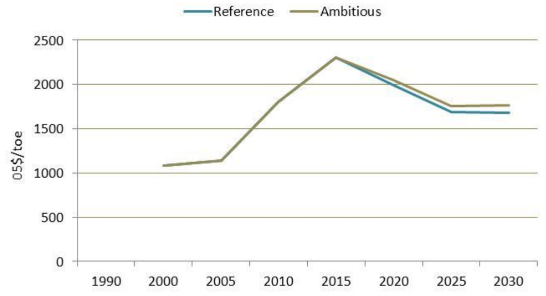
Gas price in Europe is expected to increase by 7.6%/year for both scenarios until 2015 (Figure 8). Then it will continue to increase on average until 2030 by 0.8%/year in the reference scenario whilst it is decreasing in the ambitious scenario by 1.2%/year because of decreasing demand.

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 3: 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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2.4.2 Residential domestic prices[4]

Excise taxes and VAT have been assumed constant in these projections. In Italy price of heating oil and gas for households consumers are projected to increase by respectively 4,3 %/year and 4,5 %/y 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 (1,9 %/y and 1,0 %/y respectively for oil and gas) (Figure 4). 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 7,1 %/y, and to a lesser extent in the reference scenario by 1,9 %/y.

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. It also includes taxes. The average price increases by 1,3 %/y in the ambitious/high price scenario and decreases by 0,1%/y in the reference/low price scenario. The electricity price is expected to peak in 2030 at around 3 500 \$/toe (41 \$c/kWh)[5] in the ambitious/high price scenario and at 2 500 \$05/toe (29 \$c05/kWh) in the reference/low price scenario.

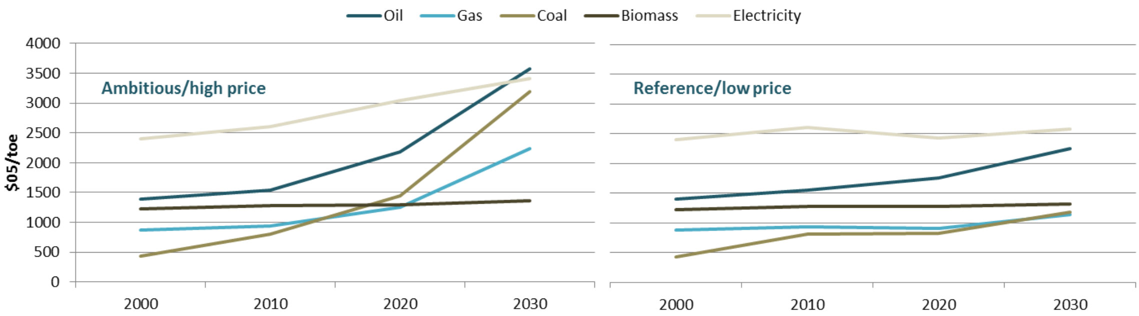

Figure 4: Italian residential domestic prices forecasts by type of energy

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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2.5 Deriving recommendations

The recommendations have been derived in close interaction with the stakeholders basing 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 some of the criteria listed in Table 4.

Table 4: Selection of qualitative assessment criteria, taken from D5.4, page 31

Criteria	Key questions
Target achievement	To which extent is an instrument appropriate to achieve a quantifiable target (e.g. renovation rate, annual final/primary energy savings, GHG reduction)?
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? Who is targeted by 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? Are the mid- to long-term support conditions predictable? 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? Is support granted ex ante (e.g. at the time of financing a refurbishment measure) or ex post (e.g. once the measure has been completed)?
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? Does the instrument allow for avoiding asymmetric allocation burdens (e.g. allocating all costs to e.g. private households due to their generally low price elasticity of demand)?
Suitability for overcoming target-group-specific bar-	Is an instrument suited to properly address the diverse target-group-specific barriers facing the energy refurbishment of

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riers	buildings? Is an instrument suited to be implemented as flanking measure specifically addressing a certain target group?
Administrative burden	What kind of administrative burden does an instrument incur for the authorities? Which minimum administrative tasks are assumed necessary to keep the level of compliance high? 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? Which administrative burden does an instrument incur for all other market participants (incl. building owners)?
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

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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 6 gives 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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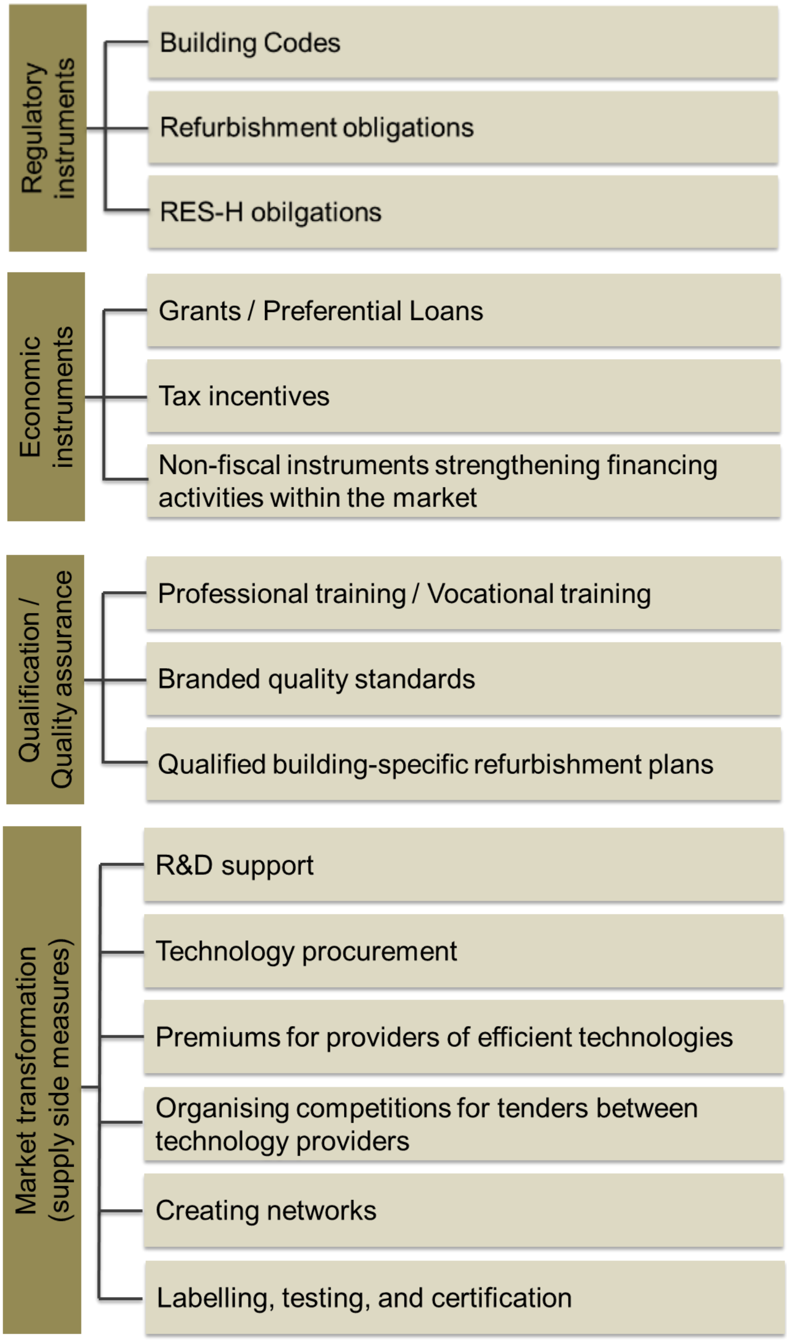

Figure 5: Categories of policy instruments (part 1)

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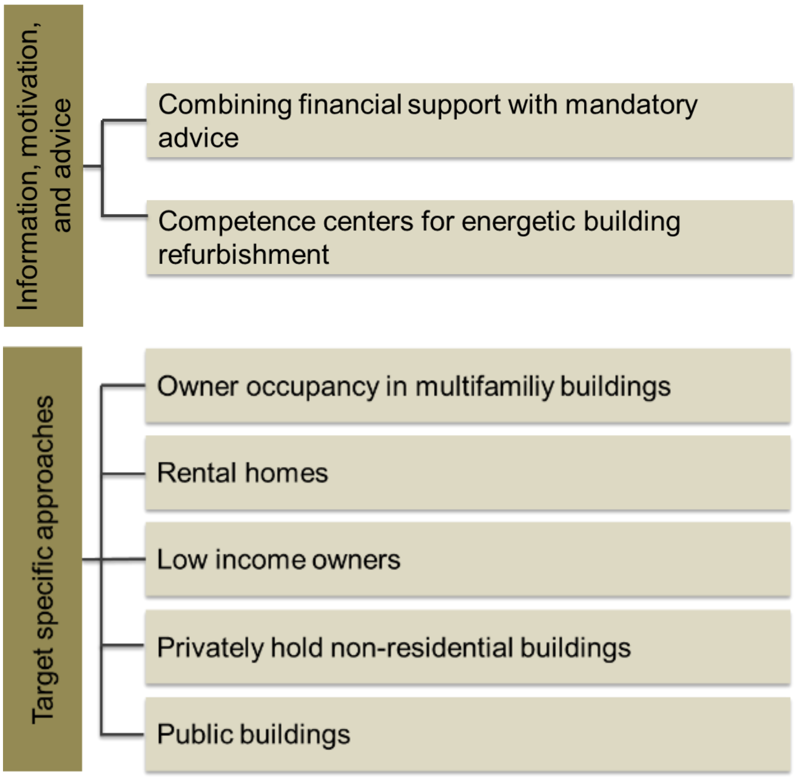

Figure 6: Categories of policy instruments (part 2)

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:

We developed **three** possible policy sets here described, starting from indications and discussions in the two Entranze policy group meetings we had in Italy.

As starting point we considered also structure and limits of the national building regulations now in force in our country for new buildings and refurbishments. The limits improvements from actual starting point consider the trend already adopted in the last ten years to improve the regulation limits.

According to EPBD requirements, in general we selected cost-optimal or better intermediate solution as limits for regulation and nZEB solution as target to benefit of proposed incentives.

We focused on cost-optimal solutions to determine **REGULATION limits** for refurbishments. In some circumstances (depending on building types and climate contexts), we saw selected cost-optimal solutions has been overtaken by regulation limits now in force in Italy. In this cases we selected more ambitious renovations levels to follow regulations improvements and avoid to worsen actual regulation. With these goals we proposed regulation corresponding to these limits

- Renovation has to reach a saving greater than **50%** in total net primary energy (excluded electrical appliances), respect base refurbishment level
- Anyway total net primary energy has to be lower than maximum limit of **100 kWh/m²/y**
- **Cost-optimal** (minimum global cost) selected solution has to be adopted if its net primary energy demand is lower
- Indicated minimum **percentages** of primary energy demand have to be cover by **renewable** energy systems (RES). These percentages increase in considered regulation period (please see following tables in the document)

These regulation levels and selected solutions are indicated with blue colour and labels in the following tables.

While cost-optimal or intermediate limits were chosen as targets for regulation, in more ambitious policy sets we considered selected solutions for **nearly Zero Energy Buildings** (nZEB) as limits to take advantage of proposed **INCENTIVES**.

Selected solutions and related envelope and performance limits for nZEB and incentives levels are indicated with green colour and labels in the following tables.

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regulation levels	threshold 50% saving (100 kWh/m^2/y maximum limit) or cost optimal level if lower RES cover **nn % **** of total primary energy demand (excluded electrical appliances)
incentives levels	nZEB RES cover **nn % **** of total primary energy demand (excluded electrical appliances)

** RES coverage percentages vary in the policies different steps, for instance between period form 2015, and from 2020, etc. (please see tables about policy sets).

The following kind of policy measures were considered

- Regulatory instruments
- Tax deductions
- Economic incentives
- Preferential loans
- Information campaigns

They are combined and quantified in different ways for the 3 policy sets (ps) for RENOVATIONS described the tables in the following pages and listed here

ps1 (*BAU Plus*): Regulation requesting limits on building envelope, systems and overall energy performances at cost-optimal level: particularly, for deep renovations, the regulation requests savings > 50% and consumption < 100 kWh/m^2/y (total net primary energy, excluding electrical appliances), or cost-optimal (minimum global cost) selected solutions at national level has to be adopted, if their net primary energy demand is lower. Minimum share of primary energy demand supplied with renewables, from 35% in 2015 to 50% in 2025. Regulatory instruments supported by a preferential loan covering 75% of initial investment for refurbishments, with an interest rate of 1%, valid for all buildings. In addition information campaign targeted on the preferential loans opportunity for all sectors.

ps2 (*Medium*): Regulations as in BAU supported with economic incentives only for selected nZEB levels: tax deductions of 36% of investments for renovation, or an economic incentive for 40% of investment for all building types. Same preferential loan as in BAU but only for action at nZEB level. Information campaigns targeted on all incentives for all sectors. Minimum share of primary energy demand supplied with renewables, from 50% in 2015 to 75% in 2025.

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ps3 (*Improved*): Regulations as in BAU. For all buildings, tax deduction for up to 65% of investments for renovation at nZEB selected level, or economic incentive for 40% of investment. Same preferential loan as in BAU but only for action at nZEB level with higher budget than scenario 2. Information campaigns targeted on all incentives for all sectors. Minimum share of primary demand supplied with renewables as in scenario 2 (50% in 2015; 75% in 2025).

In addition also a **policy set for new buildings** is proposed, mainly focused on nZEB levels in regulations, starting from 2020.

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Table 5: Policy set 1 for renovations considered for Italy (*BAU Plus*).

policy set 1	from 2015	from 2020	from 2025 to 2030
regulation levels	as current standard: threshold 50% saving (100 kWh/m^2/y limit) or cost optimal level if lower RES cover **35%** of total primary energy demand (excluded electrical appliances)	as current standard: threshold 50% saving (100 kWh/m^2/y limit) or cost optimal level if lower RES cover **35%** of total primary energy demand (excluded electrical appliances)	as current standard: threshold 50% saving (100 kWh/m^2/y limit) or cost optimal level if lower RES cover **50%** of total primary energy demand (excluded electrical appliances)
preferential loans co-funding % limit interest rate loan duration payment frequency sector total budget supported measures	 measures as regulation levels limits 75% of initial investment max: - €/apartment 1% 7 years 6 months all (residential, tertiary, private, public) 200 000 000 €/y	 -	 -
Information campaign target group budget	Information campaigns for buildings users, owners, real-estates 5 000 000 €/y (about 2,5% of the considered budget for preferential loan)	Information campaigns for buildings users, owners, real-estates 5 000 000 €/y (about 2,5% of the considered budget for preferential loan)	-

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Table 6: Policy set 2 for renovations considered for Italy (*Medium*).

policy set 2	**from 2015**	**from 2020**	**from 2025 to 2030**
regulation levels	threshold 50% saving (100 kWh/m^2/y limit) or cost optimal level if lower RES cover **35%** of total primary energy demand (excluded electrical appliances)	threshold 50% saving (100 kWh/m^2/y limit) or cost optimal level if lower RES cover **35%** of total primary energy demand (excluded electrical appliances)	threshold 50% saving (100 kWh/m^2/y limit) or cost optimal level if lower RES cover **50%** of total primary energy demand (excluded electrical appliances)
incentives levels	nZEB RES cover **50%** of total primary energy demand (excluded electrical appliances)	nZEB RES cover **50%** of total primary energy demand (excluded electrical appliances)	nZEB RES cover **75%** of total primary energy demand (excluded electrical appliances)
tax deductions			
amount	36% of initial investments	36% of initial investments	-
deduction limit	max 96 000 €/apartment (A)	max 96 000 €/apartment (A)	
deduction period	10 years	10 years	
sector	residential private sector	residential private sector	
total public budget	- €/y	- €/y	
supported measures	measures as nZEB limits, see below (B)	measures as nZEB limits, see below (B)	
economic incentives			
amount	40% of initial investments	-	-
incentives limit	max - €/apartment		
incentives period	5 years		
sector	all (residential, tertiary, private, public)		
total public budget	200 000 000 €/y for public sector + 700 000 000 €/y for private sector		
supported measures	measures as nZEB limits, see below (C)		
preferential loans	measures as nZEB limits, see below (D)	measures as nZEB limits, see below (D)	
co-funding %	75% of initial investment	75% of initial investment	-
limit	max: - €/apartment	max: - €/apartment	
interest rate	1%	1%	
loan duration	7 years	7 years	
payment frequency	6 months	6 months	

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sector total budget	all (residential, tertiary, private, public) 200 000 000 €/y	all (residential, tertiary, private, public) 200 000 000 €/y	
Information campaign target group budget	Information campaigns for buildings users, owners, real-estates 5 000 000 €/y	-	-

Considering the following notes:

(A)
deduction limit: for instance, when the amount of tax deduction is 36%, the deduction limit equal to 96 000 €/apartment means that the maximum total investment supported by the tax deduction amounts to about 266 667 €/apartment (whose 36% is equal to 96 000 € which is the tax deduction maximum value).

IMPORTANT: *When the tax deductions and the economic incentives support the same EE or RES measures (e.g. solar thermal systems, high efficiency heat pumps, … .- see below) it's NOT possible to adopt them in combination on the same measures. Investors can decide to use the tax deductions OR the economic incentives OR nothing.*
While the preferential loans are possible in combination at the same time with two previous policy measures (Tax deduction and Economic incentives).

(B)
Tax deductions for the following measures
According to nZEB limits

- Thermal insulation of opaque envelope components (external walls, roofs, basements, external floors)
- Windows replacement, also including external solar shading systems (if requested by nZEB limits selected, see tables in previous paragraphs)
- Solar thermal systems
- High efficiency condensing boilers (with climatic+room control)
- High efficiency biomass boilers

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- High efficiency heat pumps (air to air, geothermal, …)
- Mechanical Ventilation with Heat Recovery Systems
- Global renovations which allow to reach nZEB performances (see tables in previous paragraphs)

(C)
Economic incentives for the following measures
according to nZEB limits
for PUBLIC investments

- Thermal insulation of opaque envelope components (external walls, roofs, basements, external floors)
- Windows replacement, also including external solar shading systems (if requested by nZEB limits selected, see tables in previous paragraphs)
- High efficiency condensing boilers (with climatic+room control)
- Mechanical Ventilation with Heat Recovery Systems

for both PUBLIC and PRIVATE investments

- High efficiency heat pumps (air to air, geothermal, …)
- Solar thermal systems
- Mechanical Ventilation with Heat Recovery Systems

(D)
Preferential loans
possible in combination at the same with two previous policy measures (Tax deduction and Economic incentives)

according to nZEB limits
for all measures listed above in this page

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Table 7: Policy set 3 for renovations considered for Italy (*Improved*).

policy set 3	**from 2015**	**from 2020**	**from 2025 to 2030**
regulation levels	threshold 50% saving (100 kWh/m^2/y limit) or cost optimal level if lower (100 kWh/m^2/y limit) RES cover **35%** of total primary energy demand (excluded electrical appliances)	threshold 50% saving (100 kWh/m^2/y limit) or cost optimal level if lower (100 kWh/m^2/y limit) RES cover **35%** of total primary energy demand (excluded electrical appliances)	threshold 50% saving (100 kWh/m^2/y limit) or cost optimal level if lower (100 kWh/m^2/y limit) RES cover **50%** of total primary energy demand (excluded electrical appliances)
incentives levels	nZEB RES cover **50%** of total primary energy demand (excluded electrical appliances)	nZEB RES cover **50%** of total primary energy demand (excluded electrical appliances)	nZEB RES cover **75%** of total primary energy demand (excluded electrical appliances)
tax deductions amount deduction limit deduction period sector total public budget supported measures	 65% of initial investments max 100 000 €/apartment (A) 10 years all sectors (excluded public sector) - €/y measures as nZEB limits, see below (B)	 45% of initial investments max 90 000 €/apartment (A) 10 years all sectors (excluded public sector) - €/y measures as nZEB limits, see below (B)	 36% of initial investments max 48 000 €/apartment (A) 10 years all sectors (excluded public sector) - €/y measures as nZEB limits, see below (B)
economic incentives amount incentives limit incentives period sector total public budget supported measures	 40% of initial investments max - €/apartment 5 years all (residential, tertiary, private, public) 200 000 000 €/y for public sector + 700 000 000 €/y for private sector measures as nZEB limits, see below (C)	 40% of initial investments max - €/apartment 5 years all (residential, tertiary, private, public) 200 000 000 €/y for public sector + 700 000 000 €/y for private sector measures as nZEB limits, see below (C)	 40% of initial investments max - €/apartment 5 years all (residential, tertiary, private, public) 200 000 000 €/y for public sector + 700 000 000 €/y for private sector measures as nZEB limits, see below (C)
preferential loans co-funding % limit interest rate loan duration	measures as nZEB limits, see below (D) 75% of initial investment max: - €/apartment 1% 7 years	measures as nZEB limits, see below (D) 75% of initial investment max: - €/apartment 1% 7 years	measures as nZEB limits, see below (D) 75% of initial investment max: - €/apartment 1% 7 years

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payment frequency sector total budget	6 months all (residential, tertiary, private, public) 300 000 000 €/y	6 months all (residential, tertiary, private, public) 300 000 000 €/y	6 months all (residential, tertiary, private, public) 300 000 000 €/y
Information campaign target group budget	Information campaigns for buildings users, owners, real-estates 5 000 000 €/y	-	-

Table 8: Policy set for new buildings considered for Italy.

	from 2015	**from 2020**	**from 2025 to 2030**
regulation levels	threshold (100 kWh/m^2/y limit) or cost optimal level if lower (100 kWh/m^2/y limit) RES cover **50%** of total primary energy demand (excluded electrical appliances)	nZEB RES cover **75%** of total primary energy demand (excluded electrical appliances)	nZEB RES cover **75%** of total primary energy demand (excluded electrical appliances)

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4. Model results

A summary of the results from the Invert/EE-Lab simulations of the selected policy sets for Italy are presented here below. In addition further results and analysis can be displayed and exported on the Scenario Tool available on the web-site www.entranze.eu.

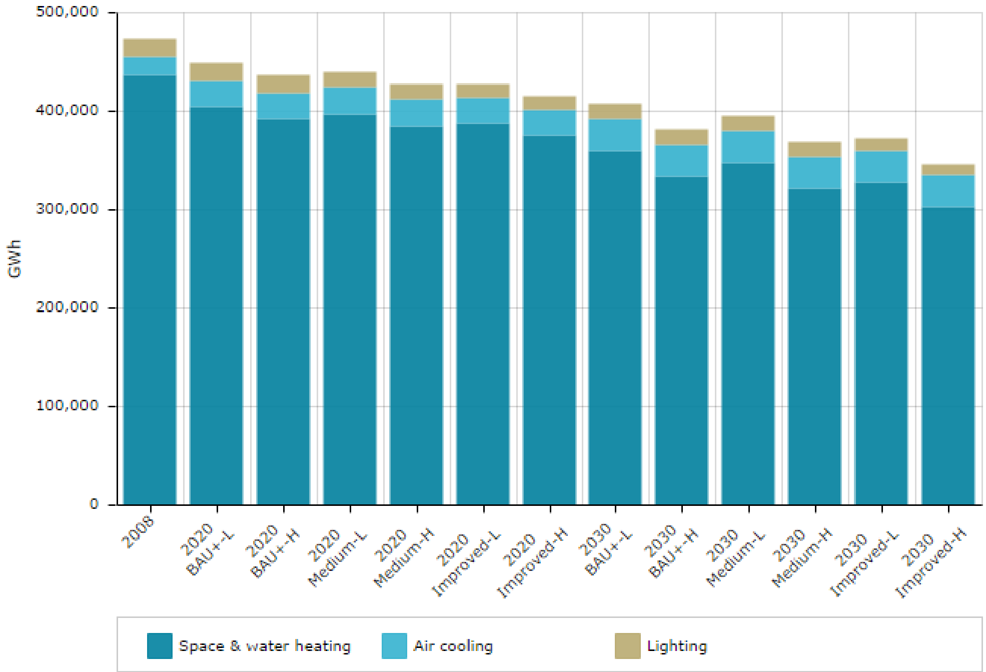

Figure 7: Final energy demand by end-use [GWh/y] - (L) Reference/Low price and (H) Ambitious/High prices scenario.

We can see that policy sets BAU Plus (+) leads to a final energy demand reduction of about 5% in lower (L) prices scenario and of 8% in high (H) prices scenario in the period from 2008 until 2020, reaching then respectively a reduction of about 14% and 19% until 2030, respect the initial condition in year 2008.

Medium policy set reach a savings about between 7% and 10% in 2020 and 16% and 22% in 2030. Improved scenario leads to a demand reduction between 10% and 12% in 2020 and 21% and 27% in 2030.

The annual final energy demand for space heating and domestic hot water preparation is higher respect the other considered uses. We have to consider we see this in term of final energy. The energy demand for space cooling has an increasing trend (about +40% until 2020 and +70% until 2030). This could reflect the market trends for cooling equipment and it stresses the importance of adopt policy measures considering also the building energy performance in summer and high efficient cooling solutions. The final energy for lighting has a decreasing trend.

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The graph Figure 8 focuses on the final energy demand for space and water heating. They are visible the saving trends of gas and oil demand and the increase of energy production from biomass, solar sources and heat pumps (renewable part of the energy provided by heat pumps indicated as “Ambient energy”), as we can see in grey and brown bar portions. The trends remain similar also for high energy prices scenario.

The Improved policy set allow to reach better targets in terms of savings and RES share. This is visible particularly until 2030 for the stable long-term measures adopted in the Improved policy set.

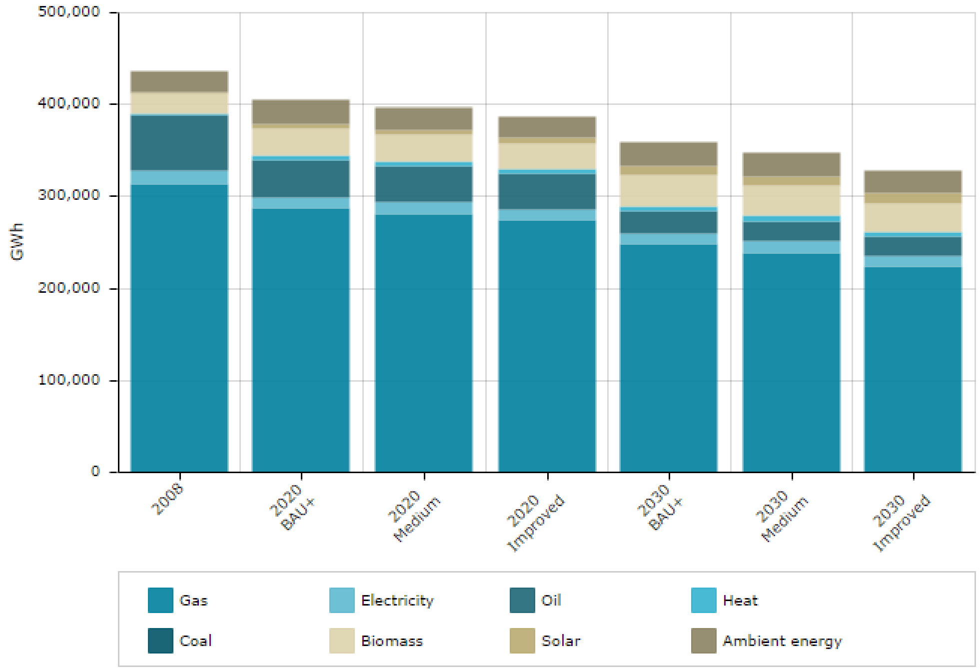

Figure 8: Final building energy demand for space and water heating [GWh/year] (Reference / Low prices scenario).

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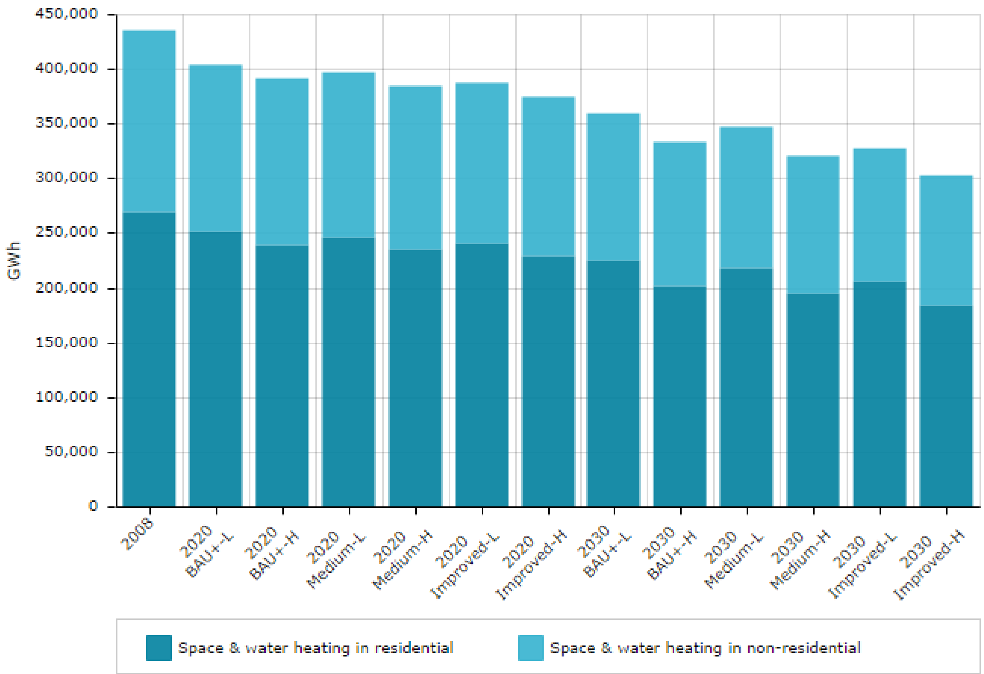

Figure 9: Final energy demand [GWh/y] by building type for space and water heating - (L) Reference/Low and (H) Ambitious/High prices scenario.

For Italy, we can see the final energy demand for space and water heating for the whole residential sector is a bit higher, but the not-residential ones is also relevant (Figure 9). This shows the importance of addressing policy measures for both residential and non-residential buildings.

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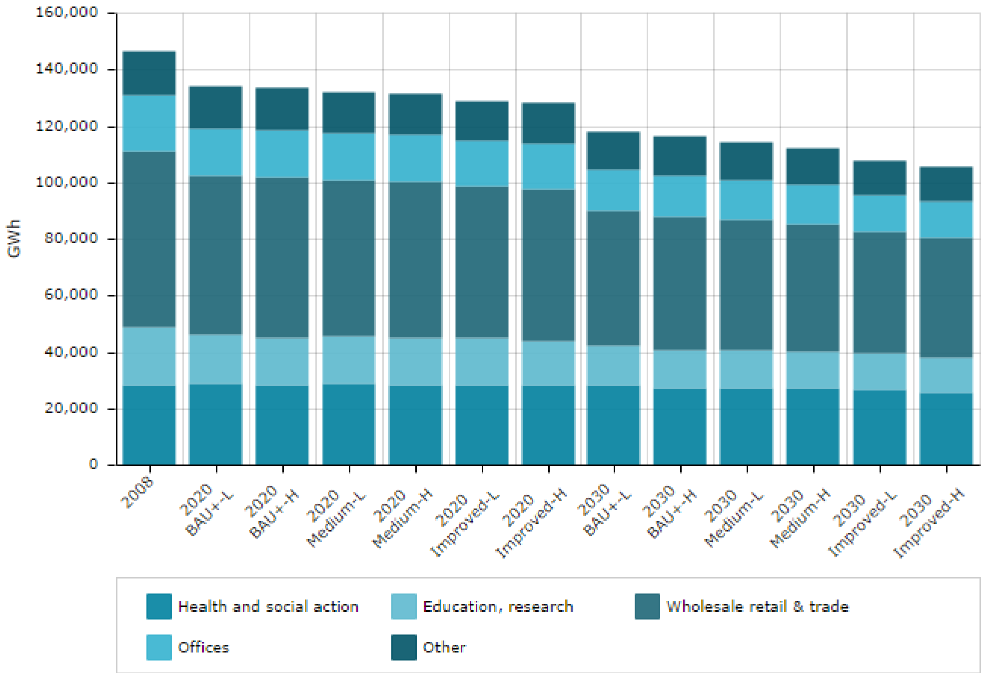

Figure 10: Final energy consumption [GWh/y] by building type in non-residential sector - (L) Reference / Low and (H) Ambitious / High prices scenario.

Focusing on non-residential buildings (Figure 10) we can recognize high potential for wholesale retail and trade building types, followed by offices and buildings for education / research.

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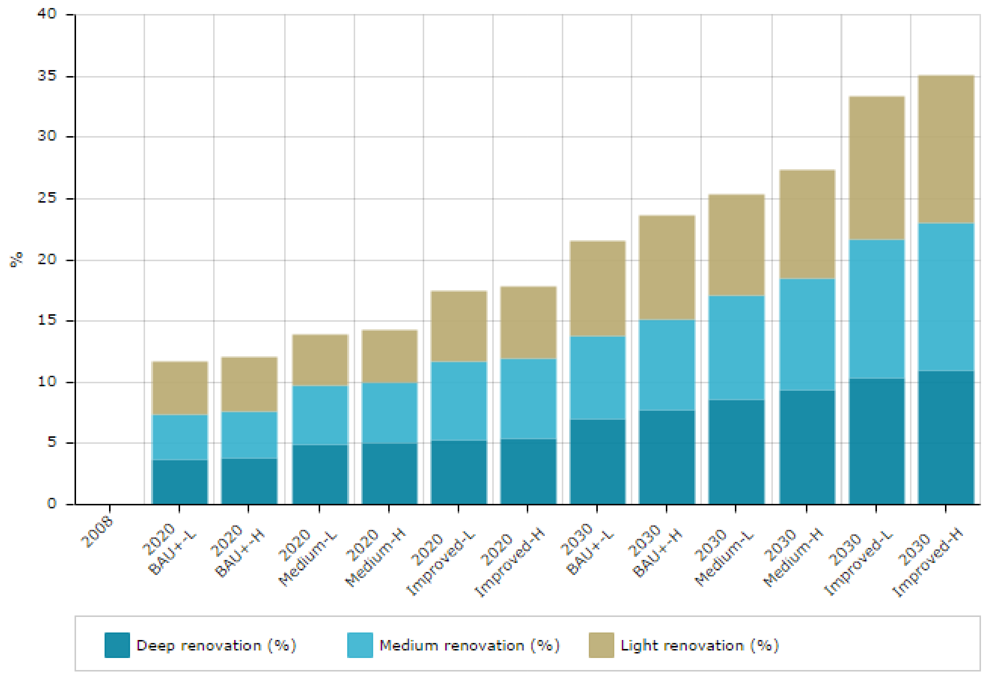

Figure 11: share of building stock renovated since 2008 [%] - (L) Reference / Low and (H) Ambitious / High prices scenario.

We can see the relevant increasing of the percentage of renovated buildings in building stock, respect 2008, considering the three policy sets. In Figure 11 *Deep renovation* correspond to most ambitious towards nZEB limits we considered to be support by the policy measures analyses; the term *Medium renovation* corresponds to the regulation level described in chapters 3.3 and 5; Light renovation corresponds to partial intervention in buildings refurbishments.

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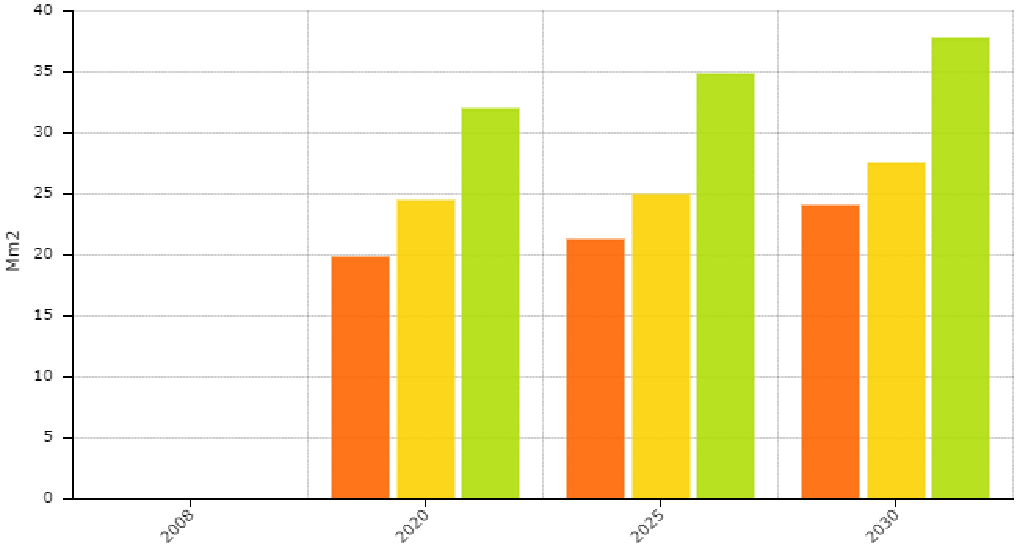
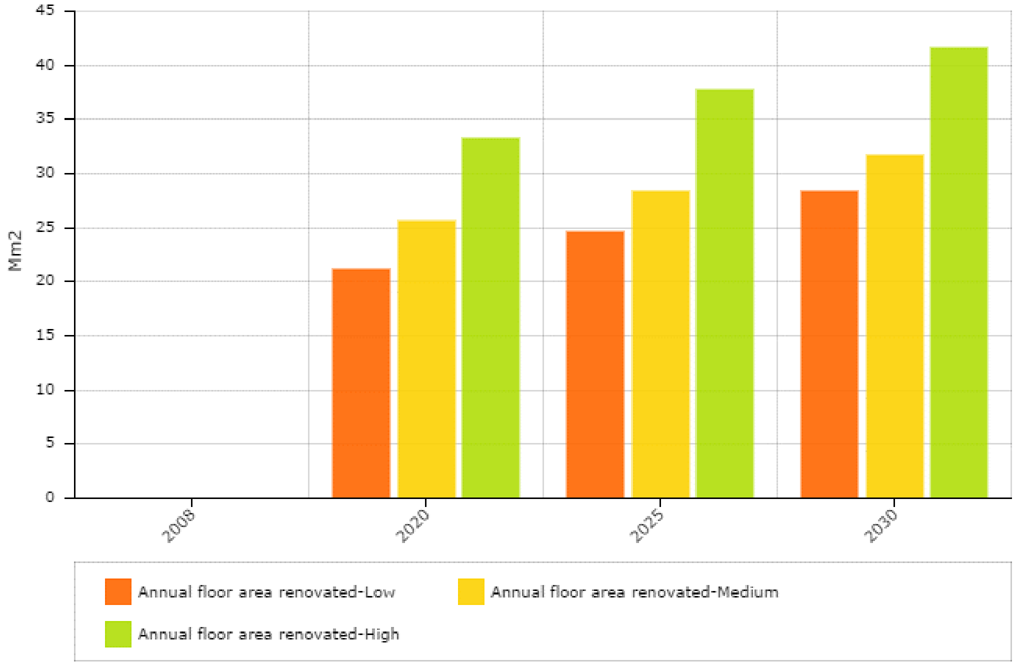
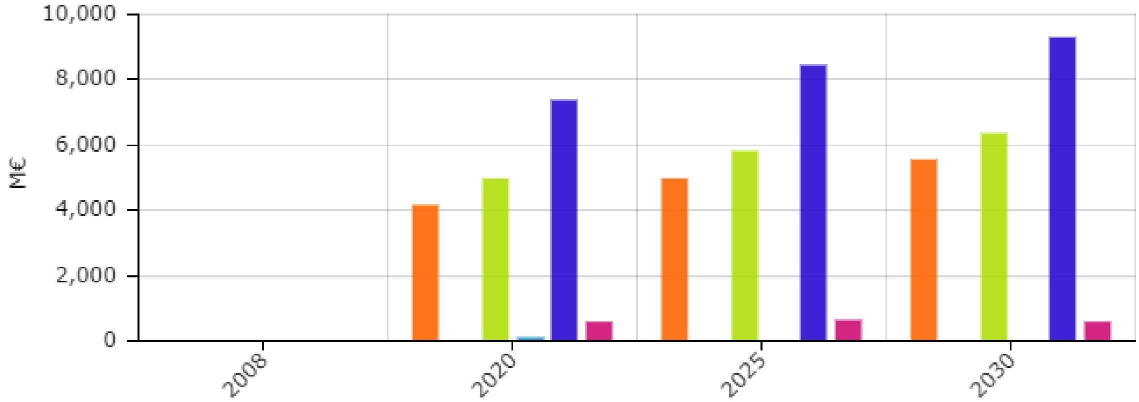


(A)

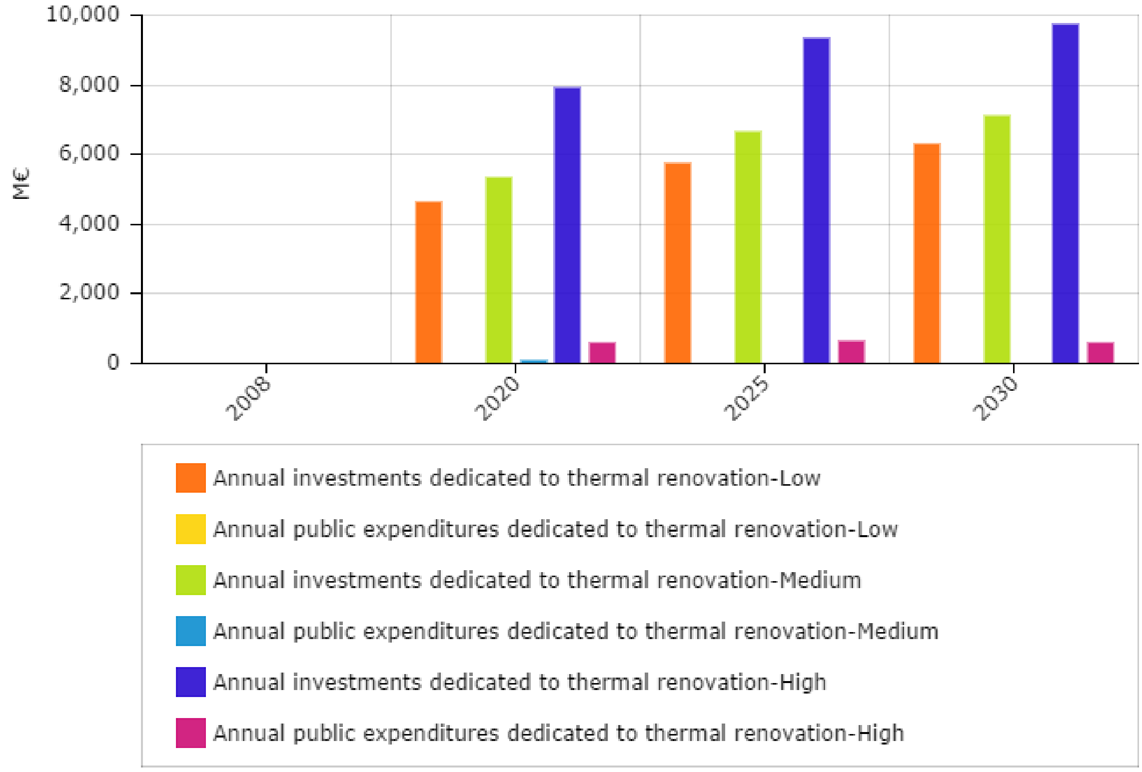


(B)

Figure 12: Total annual floor area renovated [millions of m^2/y] for Reference (A) and Ambitious (B) prices scenario (policy sets here indicated as Low: *BAU Plus*; Medium: *Medium*; High: *Improved*).



(A)



(B)

Figure 13: Annual investments [millions of €/y] dedicated to thermal renovations (building envelope and systems) and corresponding public expenditure according policy sets for Reference (A) and Ambitious (B) prices scenario (Policy sets here indicated as Low: *BAU Plus*; Medium: *Medium*; High: *Improved*).

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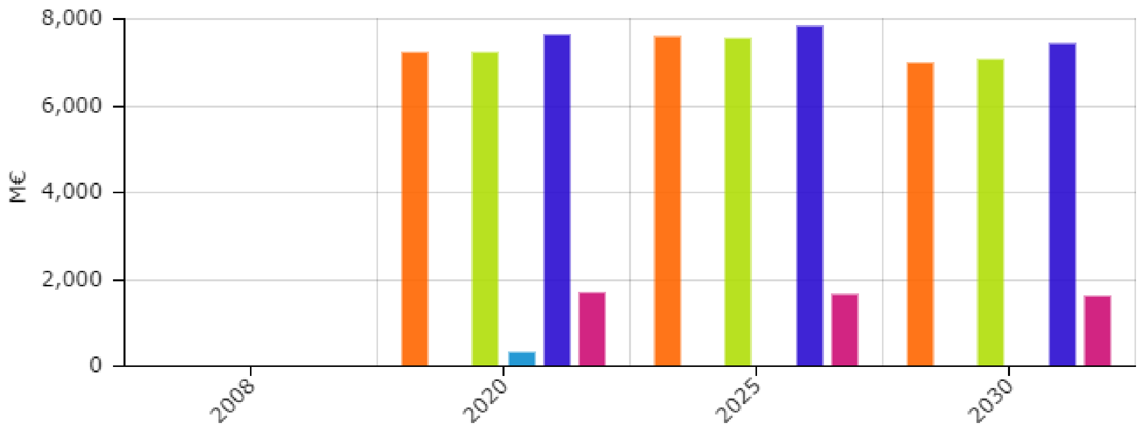
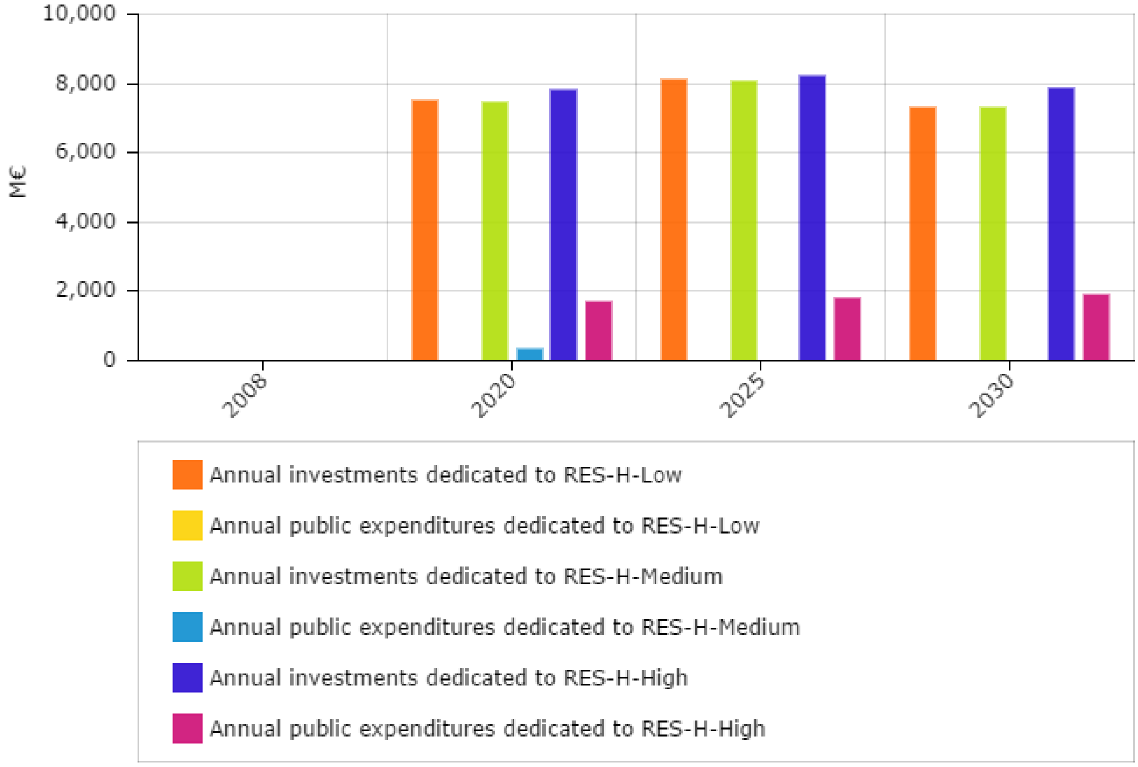


(A)



(B)

Figure 14: Annual investments [millions of €/y] dedicated to RES-H and corresponding public expenditure according policy sets for Reference (A) and Ambitious (B) prices scenario (Policy sets here indicated as Low: *BAU Plus*; Medium: *Medium*; High: *Improved*).

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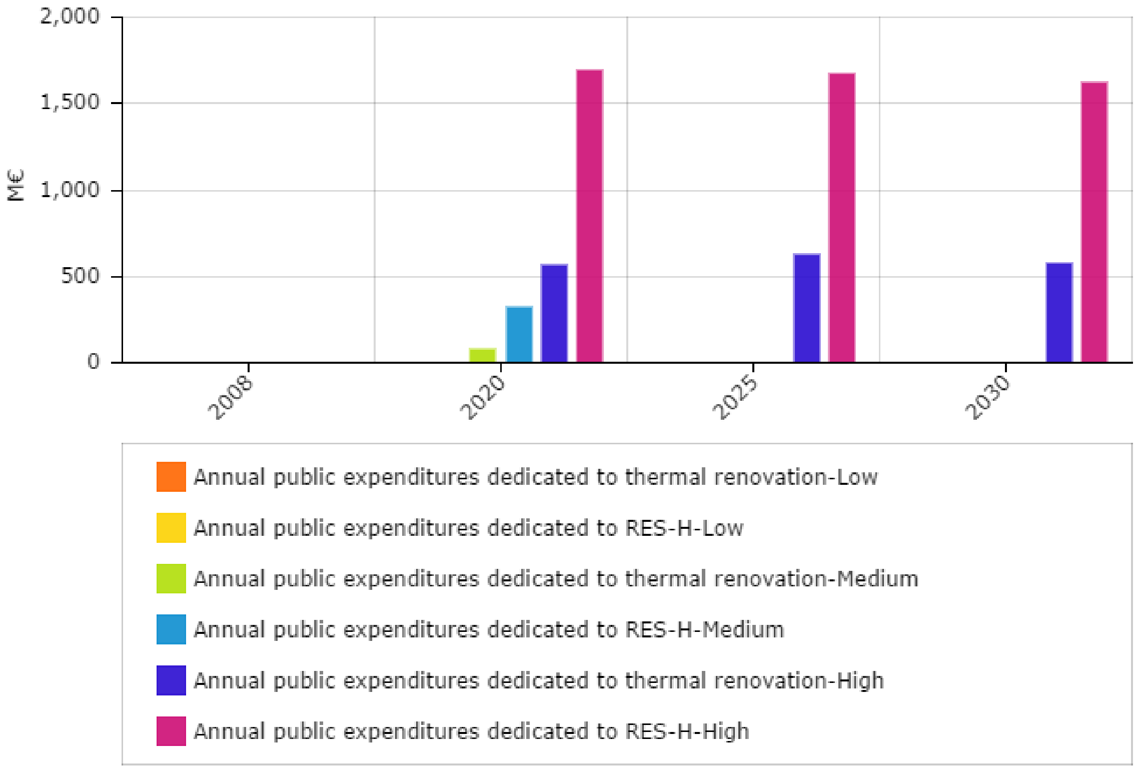

Figure 15: Annual public expenditure [millions of €/y] dedicated to thermal renovations (buildings envelope and systems) and RES-H for Reference prices scenario (Policy sets here indicated as Low: *BAU Plus*; Medium: *Medium*; High: *Improved*).

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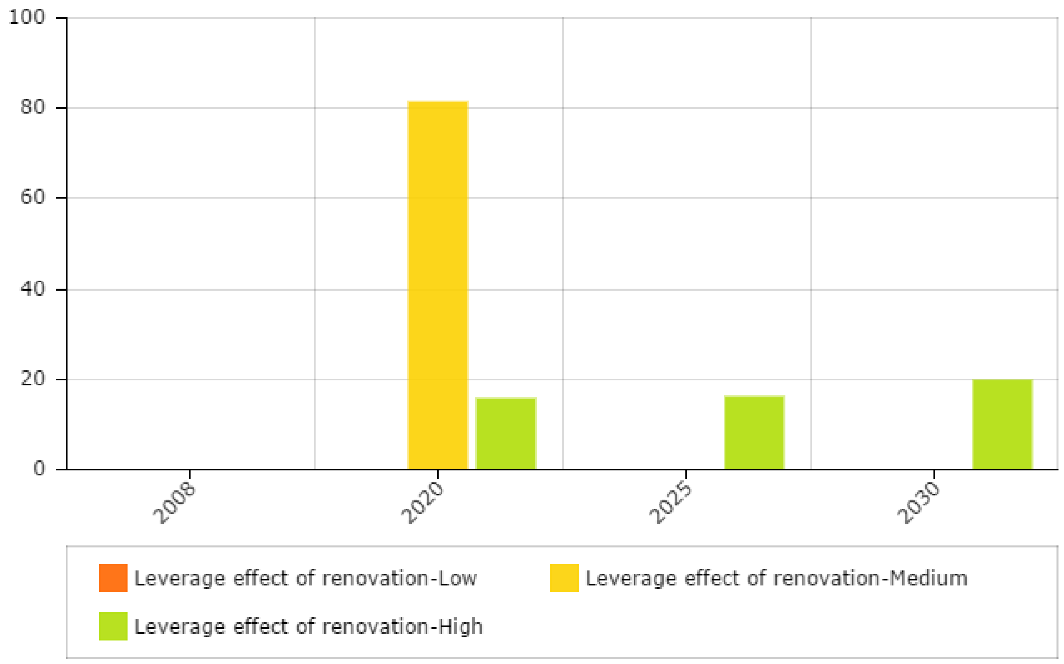

Figure 16: Leverage effect [ratio] of public expenditures on private investments, for Reference prices scenario (Policy sets here indicated as Low: *BAU Plus*; Medium: *Medium*; High: *Improved*).

Leverage effect in terms of investments is the ratio between the private investments induced and the public costs.

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5. Recommendations to national policy makers

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

For a complete and more precise description of renovations targets and limits toward nZEB levels, we think it's crucial considering more complete indexes for **description and ranking of buildings and NZEBs** as foreseen by EPBD. This set of indexes, presented below, could describe in quite comprehensive way the building performance in terms of energy efficiency and comfort. These represents also indexes which can be easily and directly understood and interpreted, avoiding or reducing the use of some kind of indirect or normalize indexes, on which we could not have direct references for comparison.

- **heating and cooling energy need** (which give account of the entity of heat losses/gains via the envelope and ventilation), considering **a performance part and a prescriptive part on energy needs and energy uses:**
  - Energy needs for heating, cooling and hot water and energy use for lighting (and optionally energy use for ventilation, auxiliaries and plug loads)
  - This has the advantage of not requiring any weighting factors (performance part).
  - Additionally, a related prescriptive approach (e.g. U-values for windows and walls, g-values for solar protections, air tightness limits and control tests, (built-in) lighting installations, etc.).
  - This approach is used for instance in Norway regulation (2015), Minergie label (Switzerland), Passivhaus label, Brussels regulation.
- **an index of long term comfort conditions** (which gives account of both **winter and summer comfort** conditions integrating the hourly conditions over the entire year) for instance as indicated in **standard EN 15251.**
- an index evaluating grid stress induced by **temporal mismatch** of energy generated onsite or nearby (by RES, high efficient cogeneration, etc.) and building energy demand
  - **a "load matching index" or other similar indices** in the end showing the share of self-consumed locally generated renewable energy - **calculated with time steps of a month , day or (preferably) hour**;
- an index based **on net yearly primary energy demand**

To overcome the main financial barriers, **more coherent and stable economic support to initial investments for renovations** appears important to put in place, based on quantitative physical and economic analysis.

Policy instruments which will remain in force **stable and certain for long periods** (certainty for manufacturers, investors and users), e.g. energy efficiency obligation (Italy, France) and favorable revenue regulation of energy utilities, as in Italian market. Stable and long-term financial support measures are requested by all players in the building sectors. This can help to plan medium and long term renovations on both small and large scale. Small private investors, like apartments and building owners, need stable financial supports and in general policy makers to act safety choice on their buildings. And larger building market actors, like owners associations or real estate company, need to have long term suitable conditions for large interventions on relevant parts of building stock.

Global costs savings and financial **supports to initial investments**: Entranze results of cost-optimal calculations (Pietrobon et al., 2013) and scenarios analysis (see chapter 4. Model results), show the high potential in saving energy of the selected refurbishments interventions and related supporting policies. Both cost-optimal solution selected for the basic regulations both nZEB targets supported by policy measures lead to relevant savings in terms of primary energy and energy needs. It's interesting considering that these achievable goals and savings in the Italian context lead also to **savings in term of money as concern global cost** over 30 years respect the corresponding base refurbishment level. So selected solutions for regulations and supporting policy measures toward nZEB renovations presents lower costs in term of global cost over considered life span, while generally the initial investments to reach the selected targets are higher respect the corresponding base refurbishment levels. In some cases the increases in the initial investments are relevant. Their entities and the current economic context lead to the need of policy measures to **stimulate the financial support of the initial investments** for target refurbishment levels. This kind of support could be provided by both private (e.g. via preferential loans from private sources) both public actors, as simulated in the presented scenarios. Figure 17 below shows percentages of relevant savings in terms of primary energy, energy needs, global costs and increasing in initial investments required, respect the corresponding base refurbishment levels in the considered italian climate.

In the initial investments supports, **private measures** (as preferential loans - also partly supported by public contributions) and policy foreseeing **public expenditures** could be put in place in integrated way to strengthen each other. This could give comprehensive supports to initial investments. Preferential loans mainly from private financial players and tax deductions and other financial incentives via public budget have been modeled and evaluated in the presented scenario (see also chapter 4. Model results).

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			CO	nZEB
SINGLE FAMILY HOUSE			**CO**	**nZEB**
	Rome	net primary energy demand	-79%	-97%
		energy needs for heating + cooling	-48%	-80%
		global cost (30 years)	**-11%**	**+4%**
		initial investment	**+30%**	**+62%**
	Milan	net primary energy demand	-86%	-95%
		energy needs for heating + cooling	-86%	-86%
		global cost (30 years)	**-26%**	**+2%**
		initial investment	**+51%**	**+126%**
APARTMENT BLOCK			**CO**	**nZEB**
	Rome	net primary energy demand	-56%	-80%
		energy needs for heating + cooling	-54%	-75%
		global cost (30 years)	**-21%**	**-9%**
		initial investment	**+23%**	**+40%**
	Milan	net primary energy demand	-62%	-85%
		energy needs for heating + cooling	-72%	-83%
		global cost (30 years)	**-53%**	**-13%**
		initial investment	**-6%**	**+72%**
OFFICE			**CO**	**nZEB**
	Rome	net primary energy demand	-76%	-94%
		energy needs for heating + cooling	-71%	-72%
		global cost (30 years)	**-4%**	**+5%**
		initial investment	**+60%**	**+91%**
	Milan	net primary energy demand	-81%	-98%
		energy needs for heating + cooling	-86%	-90%
		global cost (30 years)	**-12%**	**-14%**
		initial investment	**+68%**	**+96%**
SCHOOL			**CO**	**nZEB**
	Rome	net primary energy demand	-72%	-98%
		energy needs for heating + cooling	-67%	-70%
		global cost (30 years)	**-5%**	**+9%**
		initial investment	**+57%**	**+102%**
	Milan	net primary energy demand	-76%	-98%
		energy needs for heating + cooling	-87%	-89%
		global cost (30 years)	**-17%**	**-9%**
		initial investment	**+67%**	**+94%**

(net primary energy for heating, cooling, domestic hot water, lighting, ventilation and auxiliary systems)

Figure 17: energy and costs variations [%] respect the corresponding base refurbishment level[6], by building type (negative values means savings).

[6] The base refurbishment level (BRL) corresponds to the adoption of renovation measures only for aesthetic, functional and safety reasons of the same building components considered for renovation packages in other cases. In BRL the old generators and systems is replaced with component of the same technology and with efficiency of current state of the market.

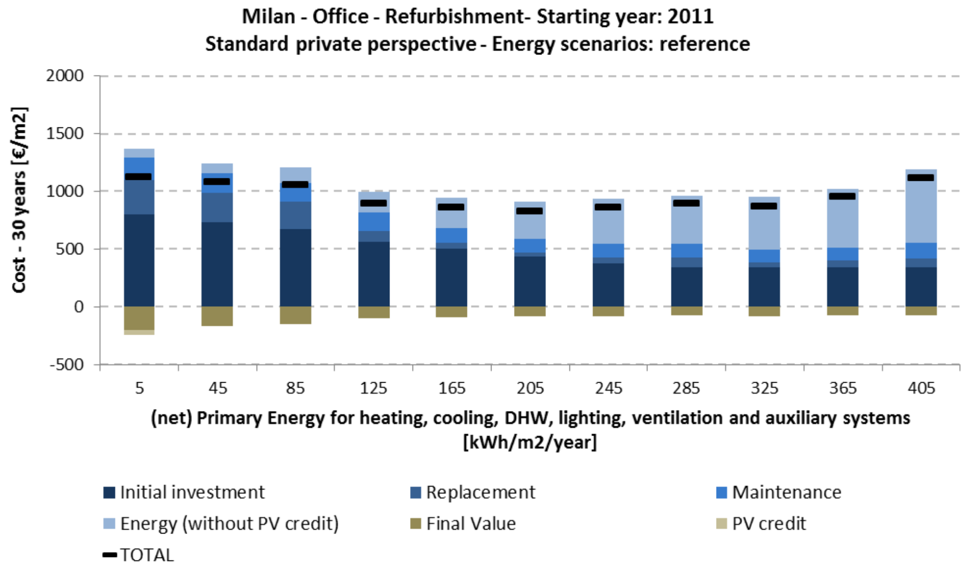

Figure 18: example of disaggregation of building costs for several building variants positioned on the lower profile of the energy/cost domain, also with initial investment represented.

Compliance and quality controls put in place by public or private players and related **need of investments in controls**. So high quality interventions and good performance targets for renovations and new building can be reached, and financial support can be used only for intervention which reach targets and limits in actual way.

- On this we can consider the Geneva example: the Swiss regulation imposes that a building owner is allowed to install air conditioning ONLY IF the building envelope has good features for summer comfort (solar protections, exposed thermal mass, ventilation, etc.). Compliance is monitored for ALL buildings in Geneva. The City has access to the data of electric consumption via the electric utility and looking at peak demand of individual buildings and comparing with the “licenses to install air conditioning” they can detect if buildings showing summer peak demand corresponding to air conditioning have or not a “license”.

Thermal envelope performances and **limits in primary energy** demand for regulations: the following Table 9 shows limits for thermal transmittance (U) of envelope components and for net primary energy demand (PE) selected in the cost-optimal calculations for renovations interventions (Pietrobon et al., 2013) performed in ENTRANZE project. These values are the results of the comprehensive analysis and rigorous selection of suitable solutions for cost-optimal interventions

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Table 9: thermal transmittance and net primary energy limits of selected solutions for regulation on renovations.

building type	locations	climate zones	HDD	useful floor area	S/V [m^2]	$A_{windows}$ / $A_{envelope}$	(net) PE [kwh/m^2]	U_{wall} [$W/(m^2K)$]	$U_{roof/ceiling}$ [$W/(m^2K)$]	U_{floor} [$W/(m^2K)$]	U_{window} [$W/(m^2K)$]
single family house	*Milan*	E	2404	140	0.7	0.095	50	0.17	0.12	0.23	1.71
	Rome	D	1415				40	0.30	0.32	0.32	2.60
apartments block	*Milan*	E	2404	1000	0.33	0.1	100	0.22	0.18	0.32	1.69
	Rome	D	1415				70	0.30	0.32	0.32	1.69
office	*Milan*	E	2404	2400	0.33	0.34	75	0.27	0.20	0.29	0.77
	Rome	D	1415				70	0.27	0.20	0.29	2.11
school	*Milan*	E	2404	3500	0.46	0.13	85	0.27	0.20	0.29	0.77
	Rome	D	1415				100	0.27	0.20	0.29	2.10

Adequate and enough ambitious limits for buildings with architectural / historical constraints: for buildings in contexts presenting constraints for technical, architectural or historical reasons, the limits could be relaxed and adequately defined and calculated, but should not be completely avoided.

Information campaigns particularly for **demand side** (building owners and occupants, housing associations, real estate company, etc.) are considered important for the development of demand of targets refurbishments interventions presented. Information should focus also on energy and environmental benefits of targets renovations level, but also on improvement of indoor comfort conditions, which are all relevant aspects for the building users.

Progressive tariffs with **unitary energy price growing with consumption** and **making real time consumption data available to customers**, examples are adopted in Italy, Belgium, California, Japan, part of Canada and about other 90 countries. This can be done for electricity, gas and water consumptions. This kind of measure can push some kind of investors, as owners who occupy the building, to adopt energy efficiency renovations.

In general we think useful giving **priority to demand reduction policies which will by themselves also reduce the impact on the grid**, avoiding high sells of photovoltaic energy concentrated only in summer and high demand of gas or electricity for heating in winter, hence high costs for the grid, transmission lines, storage systems).

It's also important to emphasize orders of magnitude of **external benefits**: for example investment level inferior to military expense results on energy security spectacularly higher.

Cost reduction of energy efficiency technologies, investing in R&D for tech amelioration and cost reduction.

Selection of **lists of technological solutions** (only *cost optimal* technologies) based on cost optimal and other criteria economic and environmental criteria.

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Box 1: Target conditions of the buildings in energy terms after the renovation

The recommendations developed focus on different conditions of buildings in energy terms. Main target is reaching the nZEB-standard after renovation, but some recommendations might target on the general efficiency improvement of the building, another group on deep renovation. Looking at the nZEB radar concept by BPIE in Figure 19 the nZEB-condition reached through deep renovation could be located at the smallest circle in the middle of the radar.

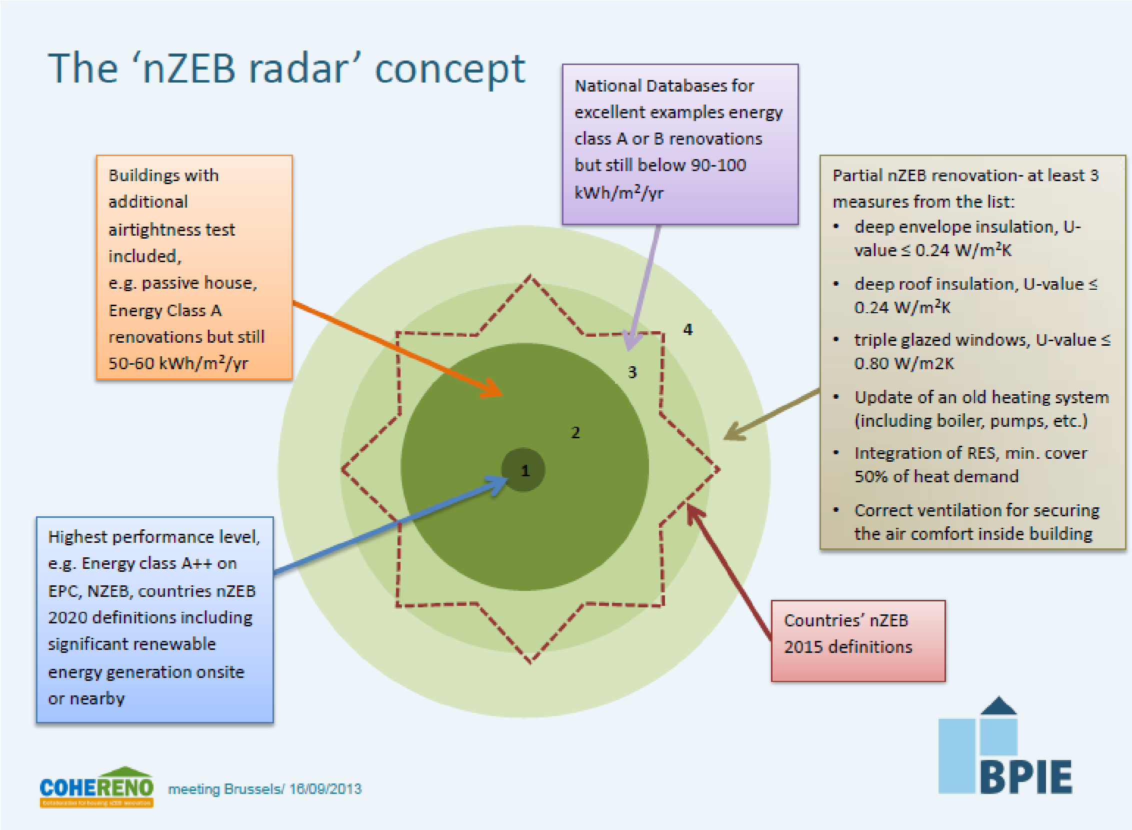

Figure 19: nZEB radar concept by BPIE.

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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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