PRELIMINARY VERSION

# EXPLORING METHODOLOGIES AND CONCEPTS FOR THE IMPLEMENTATION OF NEW ENERGY PERFORMANCE CERTIFICATES FEATURES FOR BETTER DATA HANDLING

## ENHANCED RECOMMENDATIONS

JUNE 2021

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## Preliminary version

This document is a preliminary version. It will be further adapted in the coming months through the findings of the test phase of the project.

## Legal Notice

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# EXECUTIVE SUMMARY

The X-tendo project is developing a framework of ten "next-generation EPC features", aiming to improve compliance, usability and reliability of the EPC. These features are divided in two categories, innovative indicators and innovative data handling.

This report describes the methodologies and concepts for the technical implementation of each innovative data handling feature - **EPC databases, building logbooks, enhanced recommendations, financing options and one-stop shops**. It also presents more in detail how the developed methodologies will be country specific implemented in the X-tendo target countries.

The present report builds on past projects activities. Upcoming project activities include the technical implementation with excel spread and programming code, providing guidelines to handle with the tools as well as, the testing of the present methodology, in each implementing country. Below, the series of previous project reports are listed, which present complementary information to the present one:

1. Introductory reports of the 10 innovative EPC features (Deliverable 2.3)
2. Description of implementing partners' user needs and detailed technical specifications regarding features on handling and user of EPC data (Deliverable 4.2)
3. Summary of implementing partners' user needs and detailed technical specifications (Deliverable 4.3)
4. Tools, concepts (country-specific for the Logbook feature) and guidelines for features Enhanced recommendations and EPC Database) (Deliverable 4.5)

Beyond that, the described the methodologies and concepts for the technical implementation methodology will be technically implemented and tested during the forthcoming stages of the project. The complete material will be online accessible in the X-tendo Toolbox.

This document is the revised version of the report completed in April 2021.

# 1 INTRODUCTION

EPCs are the most widely available information documents on building energy performance across Europe. They have the potential to be used as more than just an informative document, as they have the potential to provide market participants with relevant information to assess, benchmark and improve the building's energy performance. Besides the information included in each document, the usage of these information and data handling are becoming more and more important. The recent Renovation Wave Communication published by the European Commission in October 2020 reinforced the importance of the existing EPC frameworks to improve the data gathering, storage and overall quality of EPCs.

In this context, the five X-tendo EPC features **EPC databases, building logbooks, enhanced recommendations, financing options and one-stop shops** play a relevant role, targeting to improve the way EPC data is being handled and used for different objectives and targeted stakeholders. The main objectives of the features are summarized below. The present document describes in detail the methodologies and concepts for the technical implementation of each feature: EPC databases (Chapter 2), logbook (Chapter 3), enhanced recommendations (Chapter 4), Financing options (Chapter 5) and one-stop-shops (Chapter 6).

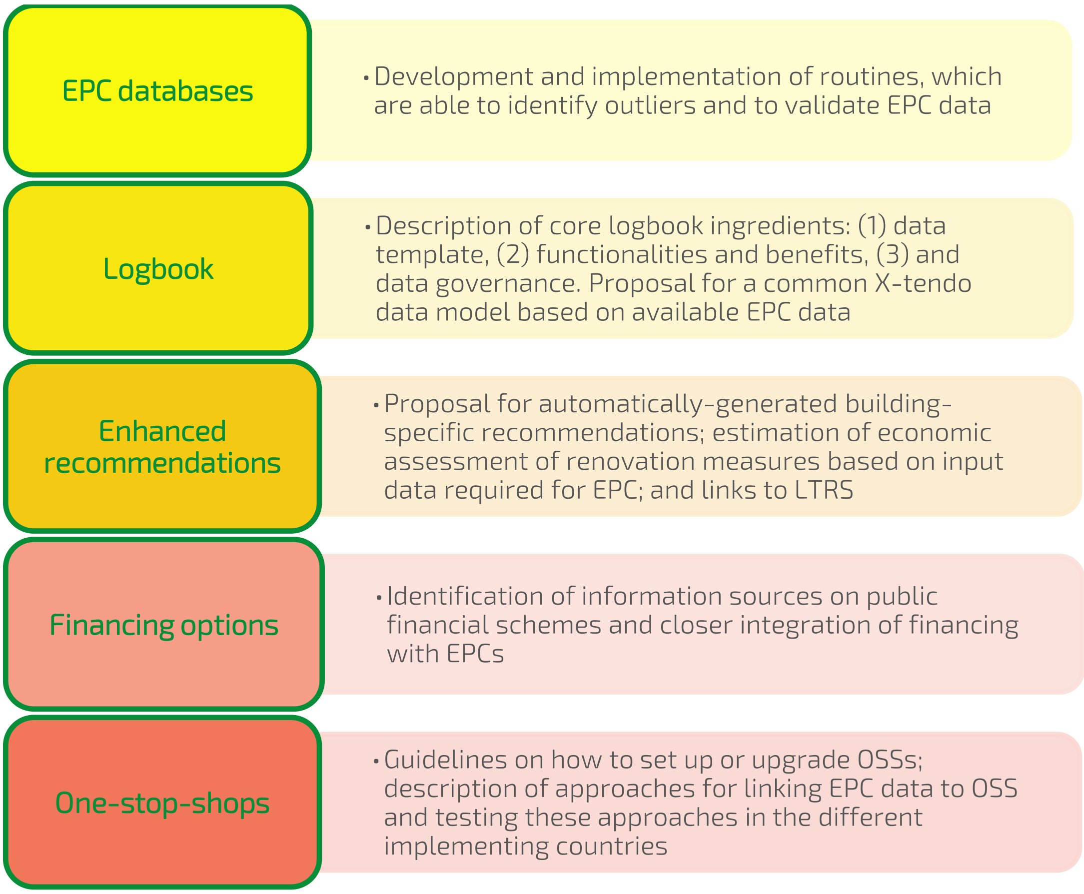


Figure 1: X-tendo methodology for features EPC Databases, Logbook, Enhanced recommendations, Financing options and One-stop-shops

The methodology will be tested in different X-tendo target countries, as showed in the table below.

| | EPC databases | Building Logbooks | Enhanced Recommendations | Financing Options | One Stop Shops |
|---|---|---|---|---|---|
| *Feature lead* | *TU Wien* | *BPIE* | *TU Wien* | *ADENE* | *ADENE* |
| Austria, EAST | | | Expert | | |
| Denmark, DEA | Implementer | | Implementer | Implementer | Implementer |
| Estonia, TREA | | Implementer | | | |
| Greece, CRES | Implementer | Implementer | | | |
| Italy, ENEA | Implementer | | | | |
| Poland, NAPE | | | Implementer | Expert | |
| Portugal, ADENE | | Expert / Implementer | | Implementer | Expert |
| Romania, AAECR | | | | Implementer | Implementer |
| UK, EST | Expert | | Implementer | | Implementer |

Table 1: Implementing and expert countries per features

# 2 ENHANCED RECOMMENDATIONS

## 2.1 Introduction

Today in many EU-countries, the EPC recommendations are not sufficiently informative. The information which is really relevant for building owners and users differs by EPC purpose – which are mostly either for real estate transactions or for renovation (some for new buildings). Thus, the question what an appropriate and accurate recommendation is depends on the main EPC objective. While for real estate transactions reliable, usable and indicative recommendations are sufficient, for the planning of deep renovations detailed and tailored recommendations are required. In the cases of deep renovation, recommendations are important for owners undertaking and implementing them. The accuracy and detail are the key differences that consequently reflect on the amount of information needed and adequate tool to generate the targeted recommendation. These aspects have a direct influence on the EPC prices, and represent in fact a trade-off between accuracy and higher EPC prices against less accuracy and lower prices. The X-tendo methodology proposes a method for an automatically provision of EPC recommendations, mainly for real estate transaction. The main objectives of the methodology are to demonstrate how to provide automatically enhanced EPC recommendations, to demonstrate how costs can be included in the EPC recommendations and to demonstrate how the EPC recommendations can be linked to national long-term and climate strategies for the building stock.

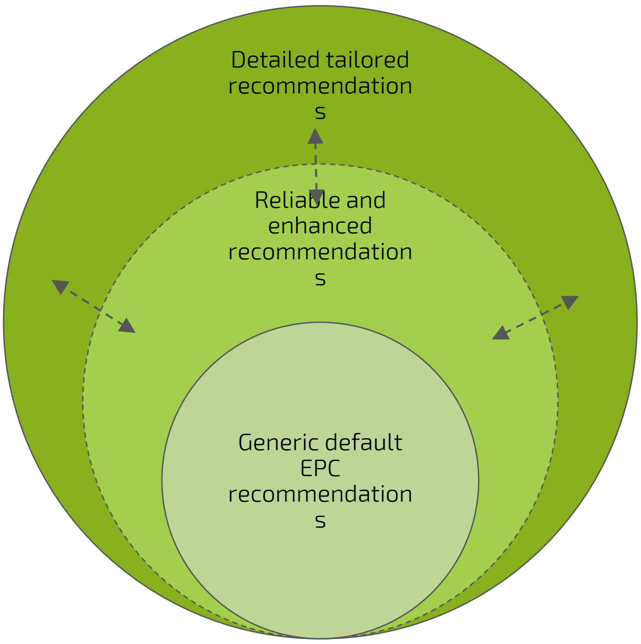


Figure 2: The boundaries of EPC recommendations

## 2.2 Proposed methodology

The main objective of the X-tendo methodology is to support public authorities in increasing the usefulness and accuracy of EPC recommendations. In the context of the X-tendo project, this feature will be tested in the following countries of Denmark, Poland and Scotland.

The proposed method is built on three pillars:

1) Enhancing actual recommendations, by automatically-generated additional building-specific recommendations: in addition to techno-economic considerations, this will comprise a discussion of how co-benefits resulting from these recommended measures can be included in the EPC recommendations.
2) Showing how the costs of recommended measures can be included in the EPC provision process, enabling calculation of the cost-effectiveness of the recommended measures.
3) Setting targeted values for recommendations in order to guarantee that they are in line with national long-term and climate strategies for the building stock. In addition to the calculation methods, guidelines will also be provided on how to perform the calculations and assess the values, as a support handbook for energy auditors.

Figure 3 below presents the overview of the method. In general, this method can be divided in three parts: providing measure-by-measure recommendations, defining the whole building impact of all recommendations and providing an economic assessment. The third part – the economic assessment – is optional, as it will depend on the availability and link to external databases, as cost databases.

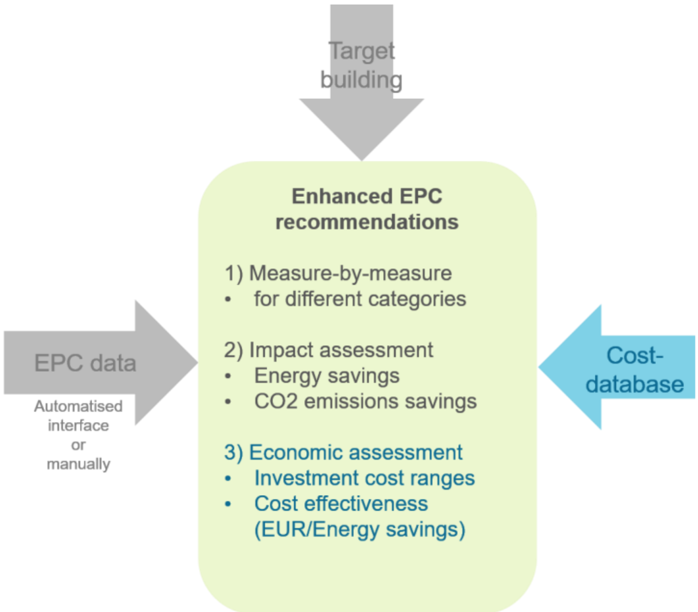


Figure 3: Overview of the Enhanced EPC recommendations

The recommendations will be delivered for different categories: measures for improving the building envelope (for example: insulation thickness), technical building systems (for example: dimension size of heating system) and integration of renewable energy systems (for example: recommended area of PV systems to be installed). The impact of the provided recommendations will be assessed by using indicators as energy savings and CO2 emission reductions. The economic assessment is based on the results generated in the previous steps. Therefore, a link with external databases (i.e. measures' costs and energy prices) is necessary, and a database structure will be proposed. The impact of the provided recommendations will be assessed by using indicators as cost-effectiveness (EUR/energy savings) and energy cost savings.

Another aspect covered by the methodology refers to the definition of the target building. The target building can be set based on: 1) actual building standards regulations or other standard (passive house, nearly zero energy building etc.), or 2) energy auditors expertise or, 3) according to national long-term renovation strategies or other climate plans.

In many countries, building codes for existing buildings are not as restrictive as for new buildings. This means that the energy performance achieved after the renovation might not be sufficient to achieve decarbonisation targets. In the short term, if a high number of buildings perform less efficient renovations, the decarbonisation target (e.g. set for the year 2025) can still be met. However, in the long term – and given the need to move towards a fully decarbonised building stock – shallow-level renovations will not provide enough savings and carbon reductions to meet the target.

This kind of trade-off analysis can be realised by building stock models, which study different pathways to achieve a set goal. For this purpose, the use of building stock model analysis is proposed as a relevant instrument to help set ambitious whole-building renovation target values for several specific building types. This should take into account policies and specifications, for example, long-term renovation strategies or decarbonisation scenarios and targets. And, the ambitious whole-indicator could also enhance EPC recommendations, by ensuring that they are not only in line with energy efficiency standards, but also with long-term low-carbon emissions targets and national policies.

## 2.3 Implementation of the proposed methodology

The proposed method will be implemented in a spread sheet. Additionally, a country specific interface between the national EPC software (as .xml-file format or other machine readable format) and the X-tendo spread sheet can be implemented. The objective of this interface is to automatically read the EPC data required in the calculation. An automatized interface will be demonstrated between xml-Files of Danish EPCs and the X-tendo spread sheet.

In general, the approach should be elaborated in a way to be commonly applied for all implementing countries, and in the future replicated to EU MSs. Table 2 below shows the country specific implementation of the proposed methodology:

Table 2: Summary of X-tendo activity per implementing country

| | Denmark | Poland | Scotland |
|---|---|---|---|
| Enhanced measure-by-measure recommendations | | Target building standards will be set according to Polish building regulations | |
| Enhanced measure-by-measure recommendations | Target building standards will be set according to Danish | | Target building standards will be set according to UK |

| | | | |
|---|---|---|---|
| including economic assessment | building regulations. Cost data will be defined according to actual market values | | building regulations. Cost data will be gathered from internal tools, such as Insight & Analytics |

To validate the method proposed, following activities are foreseen: 1) apply the developed approaches on NAPE's EPC recommendations database and compare the results; and 2) test in planned X-tendo in-building testing activities.

## 2.4 Measure-by-measure recommendations

Table 5 (below) presents the measure-by-measure recommendations and their specifications, including:

1. List of measure-by-measure enhanced recommendations, grouped according to different categories. This list of proposed recommendations can be further extended by the EU-Member state (categories and types of recommendation);
2. Definition of the parameter (and respective units) which should be used to provide the recommendation;
3. Definition of the input data (ideally is should be provided by the EPC) to provide the recommendation;
4. Definition of the criteria to assess, if the recommendation is necessary or not
5. Definition of the calculation procedures for each recommendation (also presented in chapter 2.5).

For each enhanced recommendation also the co-benefits (one or more) are qualitatively indicated, as listed below. Also, pre-fabricated texts (Annex I) should help the assessor to further explain about additional benefits provided, when implementing the enhanced recommendations:

- Generation of energy savings
- Prevent or reduce pathologies (for example, in energy poor households)
- Easy implementation
- Increase of thermal comfort
- Increase of indoor air quality
- Link to renewable energy

## Table 3: Specification of measure-by-measure recommendations

| Categories and types of recommendations | | | | Input data | Criteria | Calculation methods |
|---|---|---|---|---|---|---|
| **Recommendation category** | **Enhanced recommendation** | **Parameter to specify the recommendation** | **Parameter unit** | **Necessary EPC input data** | **Criteria for deciding if recommendation is necessary** | **Method to calculate the recommendation** |
| thermal quality of the building envelope | top floor ceiling or roof insulation | thickness of the insulation | mm | building element construction (or top floor ceiling) and U-value | current U-value should be lower than the target value | thickness calculation (based on the U-value) and cost-optimal calculation |
| | external wall thermal insulation | thickness of the insulation | mm | building element construction (external wall) and U-value | current U-value should be lower than the target value | thickness calculation (based on the U-value) and cost-optimal calculation |
| | window and door replacement | thermal transmittance | U-value | U-value window (including frames) and door | current U-value should be lower than the target value | comparision between "target value" and "input data value" |
| | basement ceiling or floor insulation | thickness of the insulation | mm | building element construction (basement ceiling or floor insulation) and U-value | current U-value should be lower than the target value | thickness calculation (based on the U-value) and cost-optimal calculation |
| | air tightness | n50 - air tightness coefficient and ventilation system | h-1 | existing mechanical ventilation system and n50 | if mechanical ventilation exist, than n50 >= 1.5 is considered to be high<br>if mechanical ventilation does not exist,than n50 >= 3 is considered to be high | comparision of the current value according to the ranges |
| heating technology and dhw systems | insulation of heating system pipelines | thickness of the insulation | mm | U-value pipeline | current U-value should be lower than the target value | comparision between "target value" and "input data value" |
| | heating system efficiency standard | heating system system efficiency | - | heating system efficiency | current U-value should be lower than the target value | comparision between "target value" and "input data value" |
| | heat supply system's nominal power | capacity of heating system | kW | building envelope quality and HDD | suggested if the envelope measures are not compliant | calculation of targeted heat load |
| | thermostatic valves installation | exisiting thermostatics | thermostatic installation -yes/no | existing room thermostatics | if room thermostatics are available or not | verification if thermostatic are installed or not |
| ventilation technology systems | installation mechanical ventilation for heat recovery systems | efficiency of HR (heat recovery) | ideal efficiency range | existing mechanical ventilation and heat recovery rate | current U-value should be lower than the target value | comparision between "target value" and "input data value" |
| renewable energy sources and $CO_2$ emissions | install PV system | kWpeak | kWh | available roof area; PV cells specifications; weather data about solar radiation | if more than 10m² area is available | PV energy production calculation (according to DIN18599) |
| | PV system coverage | electricity consumption | % | electric energy consumption | potential for PV production exist | potential PV production / electric energy consumption |
| | connect to district heating grid | Conntected to district heating | connect to grid - yes/no | heat generation system (actual) | if the building is connected or not to disctrict heating | according to available database |

## 2.5 Recommendation calculation methods

The next sections present the calculation procedures used to calculate the recommendations (according to Table 3).

### Insulation thickness based on the targeted U-value (method 1)

The method 1 is based on the U-value calculation. Considering that a building element can be construction by one or more material layers, and each material has a thickness and thermal conductivity, that deliver the U-value. The calculation of the new insulation thickness consists basically of the reverted U-value calculation, based on targeted value. This equation can be applicable to the building elements roof (or upper ceiling), façade (or external wall) and floor (or upper basement ceiling). The Rsi and Rse-values vary according

$$d\_build\ elem = \lambda_{build\ element\ insul} * \left(\frac{1}{U-value_{\ build\ element}} - Rsi_{build\ element} - Rse_{build\ element} - \sum_{i=1}^{n} \frac{dn}{\lambda n}\right)$$

**Equation 1**

to the building element position:

n, external wall layer

d_build elem = thickness of the new building element insulation [m]

$\lambda_{build\ element\ insul}$ = thermal conductivity of the new insulation layer [W/mK]

$U - value_{\ build\ element}$ = target U-value of the building element [W/m²K]

$Rsi_{build\ element}$ = inner coefficient of thermal resistance [m²K/W]

$Rse_{build\ element}$ = external coefficient of thermal resistance [m²K/W]

n = number of the building element layer

d = insulation thickness of the layer n [m]

### Insulation thickness based on cost-optimal calculation (method 2)

The method 2 follows the Austrian Standard ÖNORM B 8110-4 ("ÖNORM B 8110-4:2011 07 15 - Lesesaal - Austrian Standards," 2011) to calculate cost optimal insulation thickness. This equation can be applicable to the building elements roof (or upper ceiling), façade (or external wall) and floor (or upper basement ceiling). The Rsi and Rse-values vary according to the building element position:

Equation 2

$$d\_build\ elem\_opt = \lambda_{build\ elem\ insul} * [\sqrt{\frac{HDD * 24 * EPneeds * fret}{\lambda_{build\ elem\ insul} * IVP}} - (Rsi + Rse + Rt,r)]$$

$$EP\ needs = \frac{EP\ use}{\eta}\ ]$$

Equation 3

d_build elem_opt = cost optimised insulation thickness of the new insulation layer [m]

HDD = heating degree day [Kd]

EP needs = price energy needs [Euro/kWh]

fret = rate of return, default value or entered by the user [-]

IVP = insulation volume price [Euro/m³]

EP use = price energy use [Euro/kWh]

$\eta$ = annual efficiency [-]

$Rt,r$ = sum of the thermal resistance value of all current layers [$m^2K/W$]

$Rsi_{build\ element}$ = inner coefficient of thermal resistance [$m^2K/W$]

$Rse_{build\ element}$ = external coefficient of thermal resistance [$m^2K/W$]

## Heat load

This method is based on the Norm DIN 18599 (DIN V 18599-2, 2011) to calculate the maximal heating system capacity.

$$\Phi heat = [\sum_{i=1}^{n}(Ui * Ai) + \Delta Utb * \sum_{i=1}^{n}(Ai)] * Fx * HDD/24/1000$$

Equation 4

i = building element (roof (or upper ceiling), façade (or external wall), floor (or upper basement ceiling), window and door) (opaque and transparent building element)

Φheat = maximal heating system capacity [kW]

Ui = U-value of the building element [$W/m^2K$]

Ai = surface area of the building element [$m^2$]

$\Delta Utb$ =default building thermal bridge[1] [W/m²K]

HDD = heating degree day (annual) [Kd]

Fx = temperature correction factor[2] [-]

## PV production

This method is based on the Norm DIN 18599 (DIN V 18599-9, 2011) to calculate the maximal solar energy production with a PV system.

$$en\_prod_{PV} = \frac{I_{sol} * cpk * fperf}{refI}$$ Equation 5

$en\_prod_{PV}$= energy production from PV system [kWh/yr]

$I_{sol}$= solar irradiation in the PV system [kWh/m²yr]

$cpk$= peak capacity of the PV system [kW]

$fperf$ = system performance factor [-]

$refI$ = reference solar irradiation intensity[3] [kW/m²]

$$cpk = specpK * A$$ Equation 6

$cpk$= peak capacity of the PV system [kW]

$specpK$ = specific peak capacity of the PV system [kW/m²]

$A$ = area of the PV system [m²]

## PV consumption percentage

The PV consumption percentage defines the percentage of the total electric energy consumption that can be covered by an on-site PV production system:

$$PV\_coverage = \frac{el\_en\_consumption}{en\_prod_{PV}}$$ Equation 7

$PV\_coverage$ = PV consumption coverage percentage [%]

$el\_en\_consumption$= total electric energy consumption [kWh/yr]

[1] Suggested default value = 0,1 W/m²K
[2] Suggested default value = 1 (for building elements outside ground) and 0,5 (for all other building elements)
[3] Suggested default value = 1kWh/m²

$en\_prod_{PV}$ = energy production from PV system [kWh/yr]

## 2.6 Whole building indicators derived from regional or national long-term strategies

As introduced in the chapter 2.2, regional or national long-term strategies, developed e.g. by building stock models can be a helpful instrument to define targets for whole building indicators. This type of models allows the quantification of future building stocks' development in form of different scenarios, including scenarios achieving a certain climate or energy target. According to a foreseeing pathway, the model can provide various assessments as for example the final or useful energy demand, the share of new buildings, the renovation rates and achieved energy efficiency standards and the demolition of existing buildings. The pathways can represent climate and political targets, market penetration of technologies, renovation rates trends, etc.

The EU has set as an overall target to fully decarbonise their building stocks latest until 2050. And to achieve this target, Member States should specify their long-term renovation strategies and decarbonisation targets. In this context, a building stock modelling can help to project and estimate how fast the specified strategies could be achieved. More specifically, one of the model outputs can be ambitious targets for whole building indicators – as in many countries, the set building standards have not been sufficient to achieve the targets.

The Figure 4 below presents an example of building stock energy demand analysis. The first graph shows the specific energy needs for heating per gross floor area (kWh/m2a) for different building typologies, characterized by the building use and the building construction period – building stock status in the year 2012. Then, the second to fourth graphs below show the resulting specific energy needs (and their ranges) according to different refurbishment depths, for the year 2035. The depth of the refurbishment can be seen by the different ranges of specific energy needs – refurbishment type 3 is the most ambitious one. The analysis below suggests the (specific) energy needs as possible metrics to whole building indicator. Moreover, the graphs provided possible values and their ranges that could be used as targeted values in the recommendations.

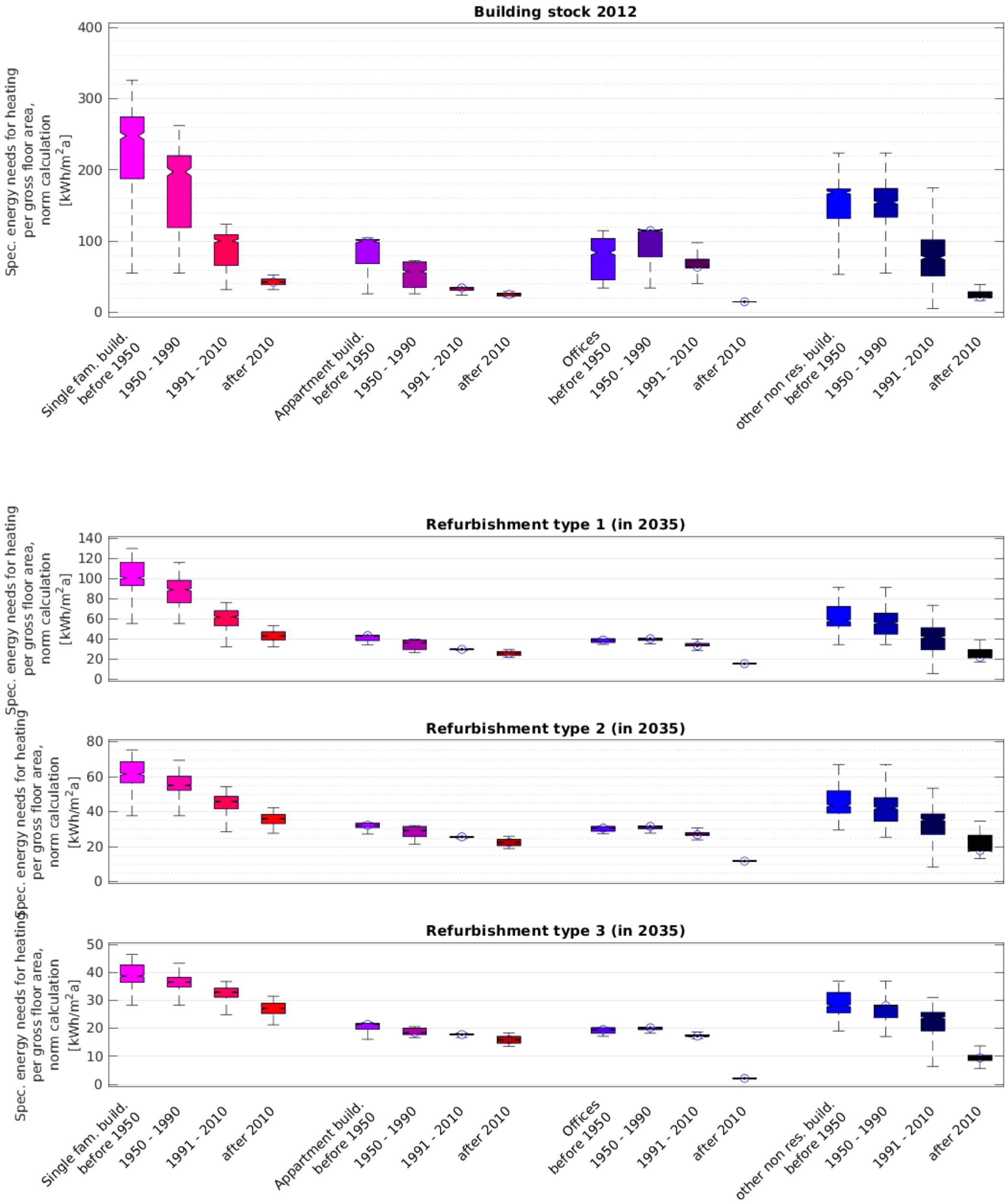


Figure 4: Building stock model analysis. Source: Invert-EE/Lab ("Invert/EE-Lab," 2021)

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# ANNEX I – PRE FABRICATED RECOMMENDATIONS

| Number | Benefit |
|---|---|
| 1 | Decrease heating energy demand: every degree lower room temperature saves heating energy. Usually 20 to 22 C° is sufficient in living rooms, 18 to 20 C° in the kitchen, 23 C° in the bathroom and 16 to 18 C° in the bedroom. |
| | |
| 2 | Decrease heating energy demand and increase indoor air quality: tilted windows provide constant fresh air. However they also cool down the air. Correct ventilation should be provided 2 to 3 times a day for about 4 to 5 minutes, with open windows and doors in all rooms. This ensures the necessary air exchange. |
| | |
| 3 | Decrease heating energy demand by keeping radiators free: Prevent furniture, curtains and curtains in front of radiators so the heat can spread evenly throughout the room. |
| | |
| 4 | Decrease heating energy demand and increase thermal comfort with automatic regulation: programmable thermostats ensure more comfort and less heating energy consumption. This allows rooms to be heated according to the use of the room, and end-user presence. |
| | |
| 5 | Decrease heating energy demand and increase indoor air quality with efficiency radiators: if radiators do not warm up properly even though the thermostat is fully turned on, it causes a waste of energy. By using regular valves energy savings can be provided. |
| | |
| 6 | Decrease heating energy demand and increase indoor air quality by cleaning the radiator regularly. Dust has an insulating effect and reduces the efficiency of the radiator. |
| | |
| 7 | Decrease heating energy demand: install insulation panels behind radiators. An insulation layer behind the radiator reduces the heat loss via the outer wall. Attention: check regularly whether moisture is forming between the panel and the wall. |
| | |
| 8 | Decrease heating energy demand: windows insulation by using sealing tape can provide high energy savings with lower investments costs. |
| | |
| 9 | Decrease heating energy demand: keep blinds and curtains closed at night to prevent heat from escaping the room on cold nights. |

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Danish Energy Agency

ENEA

ENERGIE AGENTUR Steiermark

energy saving trust

think Energy Research

NAPE NATIONAL ENERGY CONSERVATION AGENCY

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