DESCRIPTION OF METHODOLOGIES AND CONCEPTS FOR THE TECHNICAL IMPLEMENTATION OF FEATURES ON IMPROVED HANDLING AND USE OF EPC DATA IN SELECTED COUNTRIES - ENHANCED RECOMMENDATIONS

JUNE 2022

THIS PROJECT HAS RECEIVED FUNDING FROM THE EUROPEAN UNION'S HORIZON 2020 RESEARCH AND INNOVATION PROGRAMME UNDER GRANT AGREEMENT NO 845958.

eXTENDing the energy performance assessment and certification schemes via a mOdular approach

D4.4 Description of methodologies and concepts for the technical implementation of each feature regarding improved handling and use of EPC data in selected implementing countries

June 2022

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 845958.

Project Acronym	X-tendo
Project Name	eXTENDing the energy performance assessment and certification schemes via a mOdular approach
Project Coordinator	Lukas Kranzl und Iná Maia – TU Wien
Project Duration	2019 - 2022
Website	https://x-tendo.eu/

Deliverable No.	D4.4
Dissemination Level	Public
Work Package	WP4
Lead beneficiary	Technische Universität Wien
Contributing beneficiary(ies)	BPIE, ADENE, DEA, TREA, ENEA, CRES
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Date	June, 2022
File Name	D4.4_final

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EXECUTIVE SUMMARY

The X-tendo project is developing a framework of ten "next-generation Energy Performance Certificates (EPC) features", aiming to improve compliance, usability and reliability of the EPC. These features are divided in two categories: 1) innovative indicators and 2) innovative data handling practices.

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

The present report builds on past projects activities and provides input to upcoming technical implementation tools and guidelines (excel spread and programming code), as well as the testing of the methodologies in each implementing country. For additional information and further background, previous project reports are listed below:

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 use of EPC data (Deliverable 4.2)
3. Summary of implementing partners' user needs and detailed technical specifications (Deliverable 4.3)
4. Tools, concepts and guidelines for features: building logbook, enhanced recommendations and EPC databases (Toolbox – area per each feature)
5. Recommendations and replicability potential (Toolbox – area per each feature)

The described methodologies and concepts will be implemented and tested during the forthcoming stages of the project. Together with the general feature concept, also country-specific aspects of the methodology are presented. The complete set of materials will be accessible online via the X-tendo Toolbox (https://x-tendo.eu/toolbox/).

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

INTRODUCTION

This report describes the methodologies and concepts for the technical implementation of each innovative EPC data handling feature - EPC databases, building logbook, enhanced recommendations, financing options and one-stop-shops.

Energy performance certificates (EPCs) are an important instrument across Europe to assess and register information about building's energy performance. They have the potential to be used as more than just as a energy label, as they can provide market participants with relevant information to assess, benchmark and plan the improvement of the building's energy performance. Besides the information included in each document, data handling and the effective use of the information for wider building improvement and decision-making purposes are becoming more and more important. The 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, data mining, data analysis and overall quality of EPCs. Furthermore, the Commissions' proposal to recast the Energy Performance of Buildings Directive 2018/844 (EPBD) introduces comprehensive improvements, such as rescaling, design, additional indicators, and the requirement for the certificates to be available in digital format.

The, especially in regard to the last point, the five X-tendo features explore different functionalities on how to handle with digital EPC data. The present document describes in detail the methodologies and concepts of each feature: EPC databases (Chapter 2), building logbook (Chapter 3), enhanced recommendations (Chapter 4), Financing options (Chapter 5) and one-stop-shops (Chapter 6). For the features EPC databases, building logbook and enhanced recommendation, the described methodologies will be implemented as tools (project report 4.5 "Tools, concepts and guidelines for features: building logbook, enhanced recommendations and EPC databases").

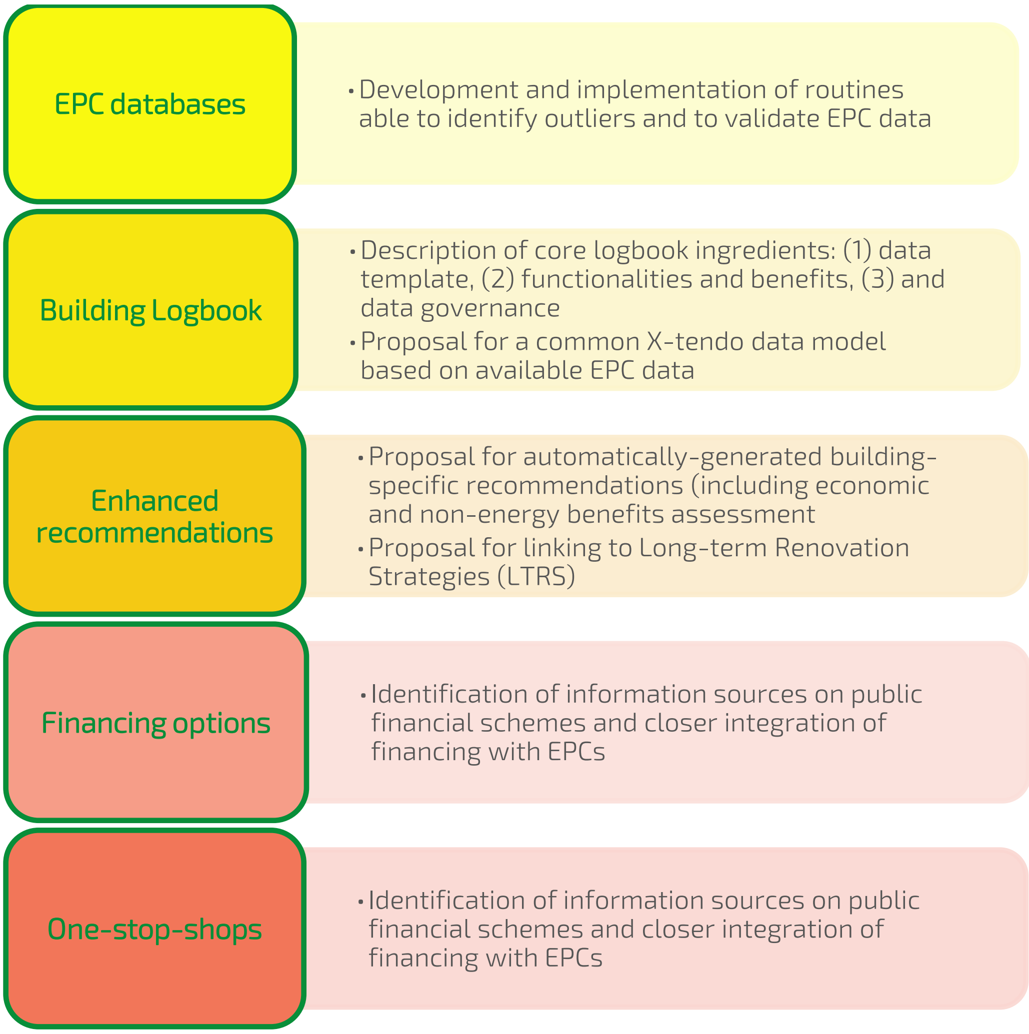

Figure 1: X-tendo methodology for features EPC databases, building logbook, enhanced recommendations, financing options and one-stop-shops

The methodology will be tested in different X-tendo implementing countries, as shown in the Table 1 below. The expert partners were responsible to share their national experience, especially relevant for setting up the final methodology.

	EPC databases	Building Logbook	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 feature

1 ENHANCED RECOMMENDATIONS

1.1 Feature 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 automated 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.

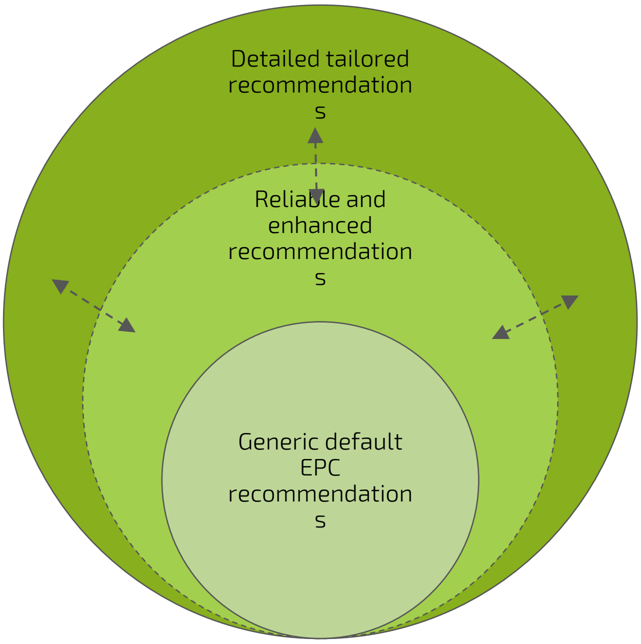

Figure 2: The boundaries of EPC recommendations

1.2 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.

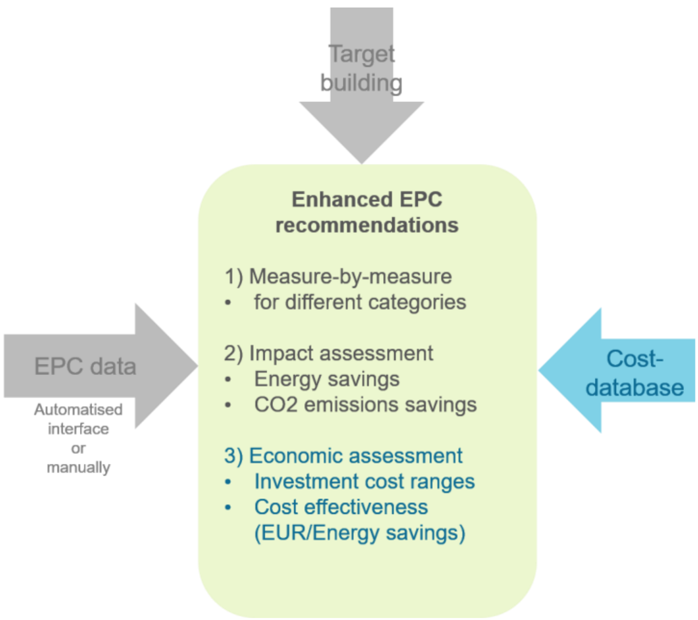

Figure 3: Overview of the Enhanced EPC recommendations

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.

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 0).

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

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 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 CO2 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

Table 2: Specification of measure-by-measure recommendations

Recommendation calculation methods

The next sections present the calculation procedures used to calculate the recommendations (according to Table 2).

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 consist 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

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

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

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

external wall) and floor (or upper basement ceiling). The Rsi and Rse-values vary according to the building element position:

Equation 2

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

η = annual efficiency [-]

Rt,r = sum of the thermal resistance value of all current layers [m²K/W]

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

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

Ai = surface area of the building element [m²]

ΔUtb =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]

[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

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]

en_prod_{PV}= energy production from PV system [kWh/yr]

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

As introduced in the chapter 1.2, 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 allow 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 by 2050 the latest. 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. 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.

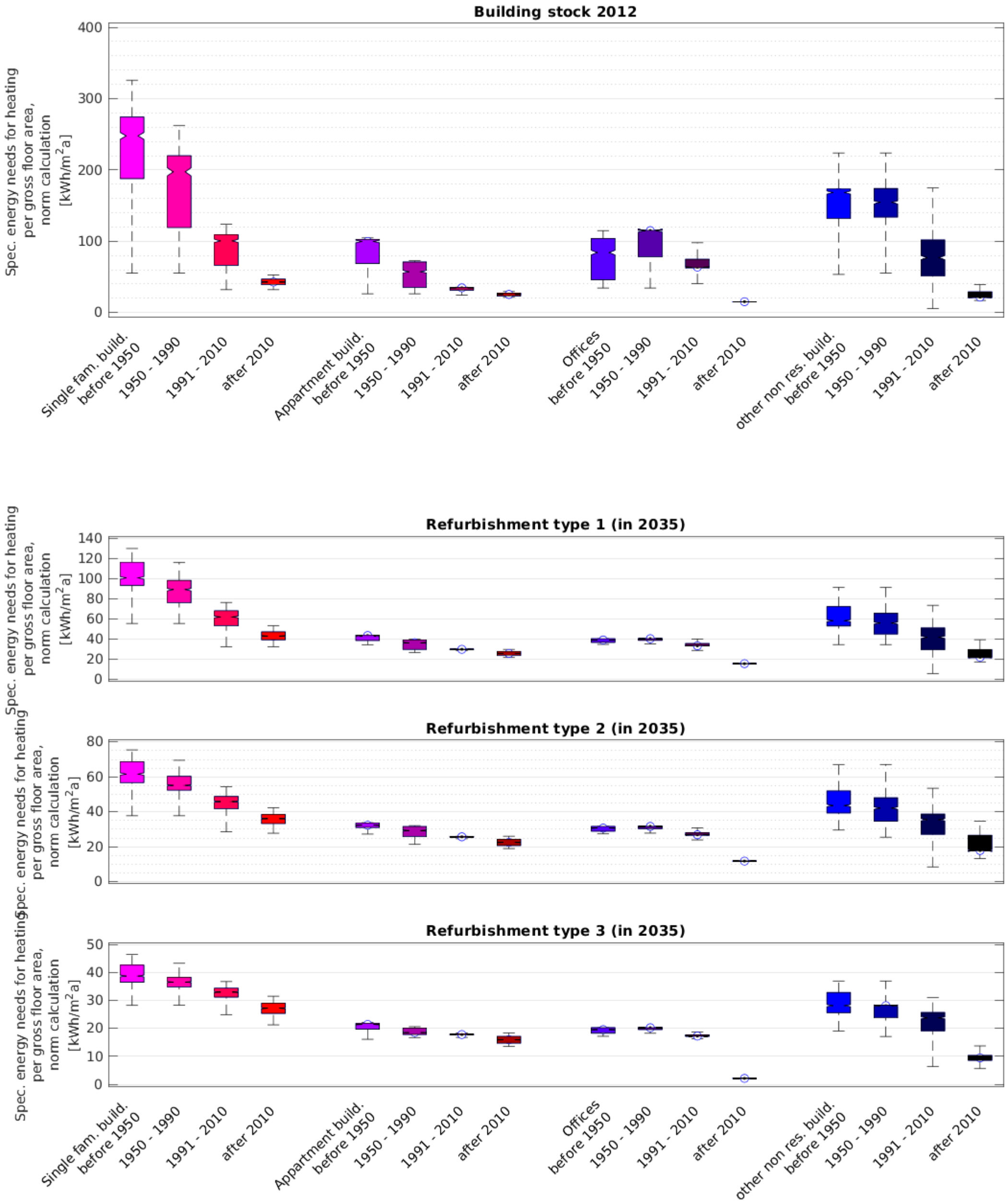

Figure 4: Building stock model analysis. Source: Invert-EE/Lab ("Invert/EE-Lab," 2021)

1.3 Countries' implementation

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 automatised 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 3 below shows the country specific implementation of the proposed methodology:

	Denmark	Poland	Scotland
Enhanced measure-by-measure recommendations		Target building standards will be set according to Polish building regulations	
Enhanced measure-by-measure recommendations including economic assessment	Target building standards will be set according to Danish building regulations. Cost data will be defined according to actual market values		Target building standards will be set according to UK building regulations. Cost data will be gathered from internal tools, such as Insight & Analytics

Table 3: Summary of X-tendo activity per implementing country

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.

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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.

ANNEX II – RULES FIRST THRESHOLD CHECK (PER COUNTRY)

Greece

Variable Name	Rule
Climate zone	In the range [1;4]
U-value external wall	Greater than 0
U-value roof	Greater than 0
U-value door	Greater than 0
U-value floor against ground	Greater than 0
Surface area external wall	Greater than 0
Surface area roof	Greater than 0
Surface area door	Greater than 0
Surface area floor against ground	Greater than 0
Surface area window	Greater than 0
Window glazing U-value	Greater than 0
Window g-Value	Greater than 0
Sun protection (Shading)	Greater than 0
Heat Efficiency	Greater than 0
Cooling Efficiency	Greater than 0
Lighting	Greater than 0
Building use	In the range [1;60]
Reason	In the range [1;19] or Equals 99
Suggestions	If the energy class is C or worse, at least one suggestion is required
Primary Energy For Heating	Greater than 0
Primary Energy For Cooling	Greater than 0
Primary Energy For Lighting	Greater than 0
Primary Energy Consumption	Smaller than 5000
Reference Building Primary Energy Consumption	Smaller than 5000
CO2 emmissions	Greater than 0
Gross building area	Greater than 0
Useful building area	Greater than 0 and less than or equal to Gross building area

Useful building volume	Greater than 0
Heated area	Greater than 0 and less than or equal to Gross building area
Cooled area	Greater than 0 and less than or equal to Gross building area
Heating days	In the range [1;364]
Climate region	In the range [1;4]
Windows orientation	In the range [1;359]
Ventilation system type	Is not null
Mechanical ventilation system exists	In the range [0;1]
Heating energy source	Element of ["LPG", "Natural Gas", "Electricity", "Heating Diesel oil", "Transport Diesel oil", "Distrinct Heating (PPC)", "Distrinct Heating (Renewable)", "Biomass", "Standardized Biomass"]
Reference heating energy needs	Greater than 0
Building's heating energy needs	Greater than 0
Domestic hot water energy needs	Greater than 0
Useful heating energy (dhw)	Greater than 0
Useful electricity demand	Greater than 0
Primary energy demand	Greater than 0
Carbon dioxid emission	Greater than 0

Italy

Variable Name	**Rule**
Cadatral identification of buildig ID	Is not null
User profile (name or code)	In the range [0;14]
Statistical code of the Region	In the string range [01;22]
Regional ID of the EPC	Is not null
Heated area	Greater than 0
Cooled area	Greater than 0
Heated bruto-volume	Greater than 0
Cooled bruto-volume	Greater than 0

Building envelope area (heat loss area)	Greater than 0
Compactness (based on heat loss area)	Greater than 0
Heat degree days	Complex table-based check
Climate region	Complex table-based check
Yie-value periodic thermal transmittance	Greater than 0
Equivalent solar Area/net heated area Ratio	Greater than or equal to 0
Mechanical ventilation system exists	Boolean value
Building structure	In the range [0;14]
Heating energy sources	In the range [0;15] if Space heating service exists
Cooling energy sources	In the range [0;15] if Space heating service exists
Energy demand for each energy source	Greater than 0
EPhnd,lim -> indicator	Greater than 0
Building's heating energy needs	Greater than 0
Reference Global primary energy demand (not renewable)	Greater than 0
Global primary energy demand (not renewable)	Greater than or equal to 0
Global primary energy demand (renewable)	Greater than or equal to 0
Global carbon dioxid emission	Greater than 0
Exported eletrical energy (for example: PV)	Greater than or equal to 0 or null
Primary energy demand (not renewable)	Complex table-based check
Space heating service exists	True
Heating primary energy demand (not renewable)	Greater than or equal to 0
Heating primary energy demand (renewable)	Greater than or equal to 0
Heating system efficiency	Greater than 0
Space cooling service exists	Boolean value
Cooling primary energy demand (not renewable)	If Space cooling service exists then Greater than or equal to 0
Cooling primary energy demand (renewable)	If Space cooling service exists then Greater than or equal to 0
Cooling system efficiency	If Space cooling service exists then Greater than to 0
DHW service exists	True if user profile equals 0 or 2

DHW primary energy demand (not renewable)	If DHW service exists then Greater than or equal to 0
DHW primary energy demand (renewable)	If DHW service exists then Greater than or equal to 0
DHW system efficiency	If DHW service exists then Greater than 0
Mech Vent primary energy demand (not renewable)	If Mechanical_Ventilation System Exists then Greater than or equal to 0
Mech Vent primary energy demand (renewable)	If Mechanical_Ventilation System Exists then Greater than or equal to 0
Mech Vent system efficiency	If Mechanical_Ventilation System Exists then Greater than 0
Lightning is considered	Boolean value
Lighting primary energy demand (not renewable)	If Lightning is considered then Greater than or equal to 0
Lighting primary energy demand (renewable)	If Lightning is considered then Greater than or equal to 0
Lighting system efficiency	If Lightning is considered then Greater than 0
Transport systems are considered/exist	Boolean value
Transport primary energy demand (not renewable)	If Transport systems are considered then Greater than or equal to 0
Transport primary energy demand (renewable)	If Transport systems are considered then Greater than or equal to 0
Transport system efficiency	If Transport systems are considered then Greater than 0

ANNEX III – CLUSTER PARAMETERS (PER COUNTRY)

Greece

Building uses

Residential single family houses
Residential multifamily houses
Hotels of continuous yearly operation
Hotels of intermittent operation – summer
Primary education schools
Secondary education schools
Higher education buildings
Hospitals
Offices

Climate zones

A
B
C
D

Construction period

1	Before 1980	no any insulation regulations in force
2	1980-2010	1st Building Insulation Regulation
3	2010-todate	2010-Transposition of EPBD & 1st Energy Performance Regulation

Renovation period

1	No renovation
2	2010-2017
3	after 2017

Italy

Building uses

1	Residential
2	Office buildings
3	Commercial buildings
4	Buildings for industrial and craft activities
5	Other not residential

Building constructions period

1	Before 1945
2	1945-1976
3	1977-1991
4	1992-2005
5	2006-2015
6	From 2016

Climate zone

1	A+B (<= 900 HDD)
2	C (901<=HDD<=1400)
3	D (1401<=HDD<=2100)
4	E (2101<=HDD<=3000)
5	F (HDD>= 3001)

ANNEX IV – PARAMETERS SECOND THRESHOLD CHECK (PER COUNTRY)

Greece

Envelope characteristics	**Unit / comment**
U-value external wall	W/m2K
U-value roof	W/m2K
U-value floor against ground	W/m2K
U-value floor on pilotis	W/m2K
U-value windows	W/m2K
Energy consumption class	
Total Primary Energy Consumption	kWh/m2
HVAC Systems Data	
Heating System Efficiency	SCOP
Cooling System Efficiency	SEER
Mechanical Ventilation system (air supply)	m3/h
Solar Collector Area	m2
Energy Consumption Indicators	
Total final Energy Consumption	kWh/m2
Energy Consumption for Heating (final)	kWh/m2
Energy Consumption for Cooling (final)	kWh/m2
Energy Consumption for Lighting ** (final)	kWh/m2
Energy Consumption for DHW (final	kWh/m2

** only for non-residential

Italy

Building characteristics	**Unit / comments**
compactness	1/m
yie-value periodic thermal transmittance	W/m2K
Equivalent solar Area/net heated area Ratio	[-]
Specific energy demand indicators	
building's heating energy needs	kWh/m²a
Global primary energy demand (not renewable)	kWh/m²a
Global primary energy demand (renewable)	kWh/m²a
Global carbon dioxid emission	kg/m²a
Specific energy demand indicators	
Heating primary energy demand (not renewable)	kWh/m²a
DHW primary energy demand (not renewable)	kWh/m²a
Dimensionless energy indicators	
Heating primary energy demand (not renewable)/building's heating energy needs ratio	[-]
Reachable global primary energy demand (not renewable)/ Global primary energy demand (not renewable) ratio	[-]

X-tendo

eXTENDing the energy performance assessment and certification schemes via a mOdular approach

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 845958.