X-tendo

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

JUNE 2022

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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

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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").

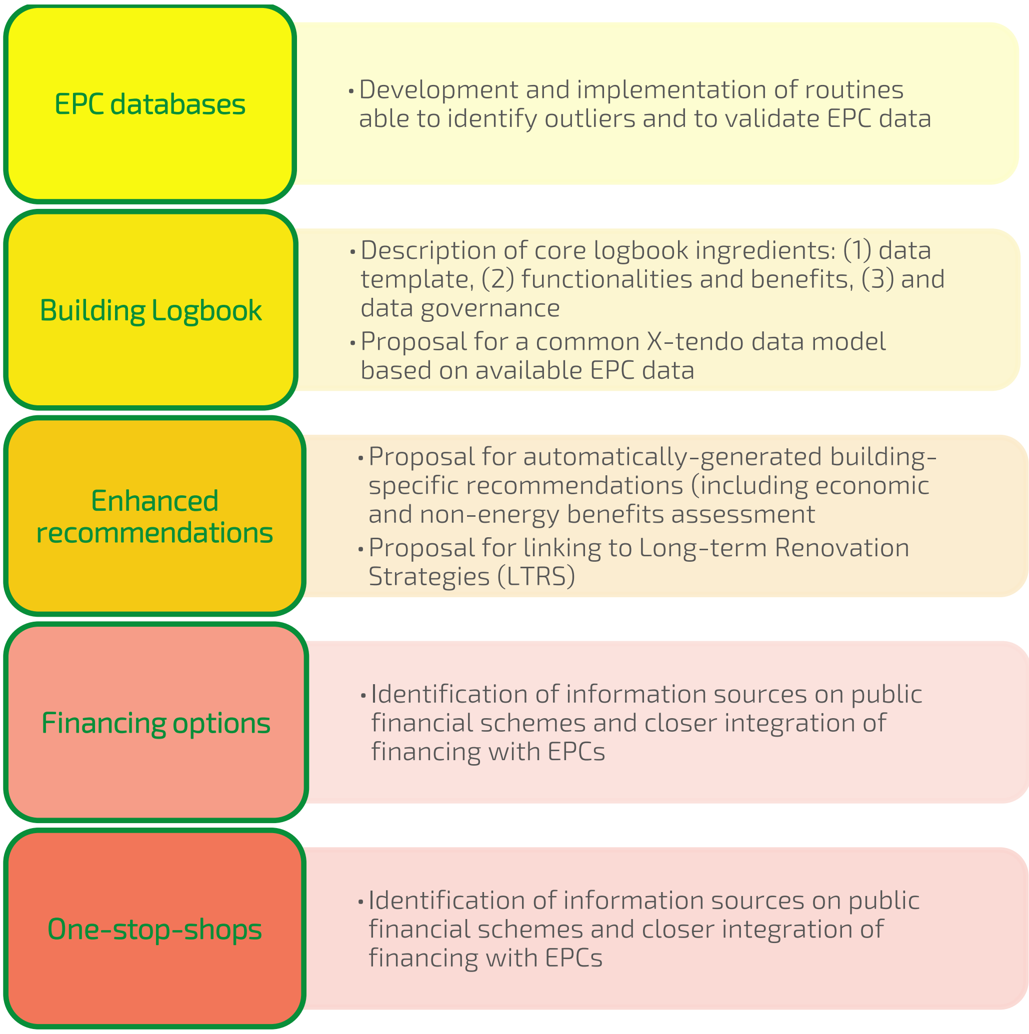


Figure 1: X-tendo methodology for features EPC databases, building logbook, enhanced recommendations, financing options and one-stop-shops

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.

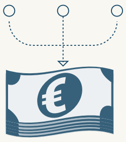
	 EPC databases	 Building Logbook	 Enhanced Recommendations	 Financing Options	 One Stop Shops
Feature lead	*TU Wien*	*BPIE*	*TU Wien*	*ADENE*	*ADENE*
Austria, EAST			Expert		
Denmark, DEA	Implementer		Implementer	Implementer	Implementer
Estonia, TREA		Implementer			
Greece, CRES	Implementer	Implementer			
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 BUILDING LOGBOOK

1.1 Feature introduction

Improving the energy and climate performance of the building stock is a complex task, as building renovations typically involve a large number of stakeholders and decision processes. Fragmentation in the sector is one of the most significant barriers to realising the efforts targeted at making the sector less carbon- and resource-intensive, as information is not effectively shared between different actors, which often leads to inefficiencies, time and cost overruns, performance and quality gaps.

Building logbooks enable better decision-making throughout the building lifecycle, including management of technical and functional aspects, safety, conservation of economic value, certification, improved energy and environmental performance. Organised and shared data reduce uncertainty, but also the time and cost needed for collecting missing information. In this sense, building logbooks can reinforce the successful implementation of all other X-tendo features.

Over the lifespan of buildings, data is routinely collected by multiple stakeholders for various reasons as many decisions rely on data availability. However, the lack of a common approach and structure among stakeholders makes this data often unusable as it gets discarded, forgotten or it is not compatible with other stakeholders' systems. The lack of an overarching information management system structure shared across the built environment leads to information asymmetry, lack of transparency and higher risk for investment and renovation decisions. Then, there is a need for solutions that makes this wealth of information widely available, organised and easily accessible.

The Circular Economy Action Plan recognises Digital Building Logbooks (DBLs) as circularity enablers. The Renovation Wave states that DBLs will integrate all related data from upcoming building renovation passports, smart readiness indicators, Level(s) and energy performance certificates (EPCs). The strategy Annex includes an EU proposal on Building Renovation Passports due in 2023 and integrated with DBLs. Important exploratory work has been carried out in 2020 laying the foundation of a common EU DBL definition and framework. According to the EU definition,

"Building logbooks are a repository for detailed building information. Logbooks act as a single point of input, access, and visualisation of all the information associated with a building unit throughout its lifecycle."

1.2 Proposed methodology

Logbooks involve three core ingredients: (1) data template, (2) functionalities and benefits, and (3) data governance which are briefly summarised below:[1]

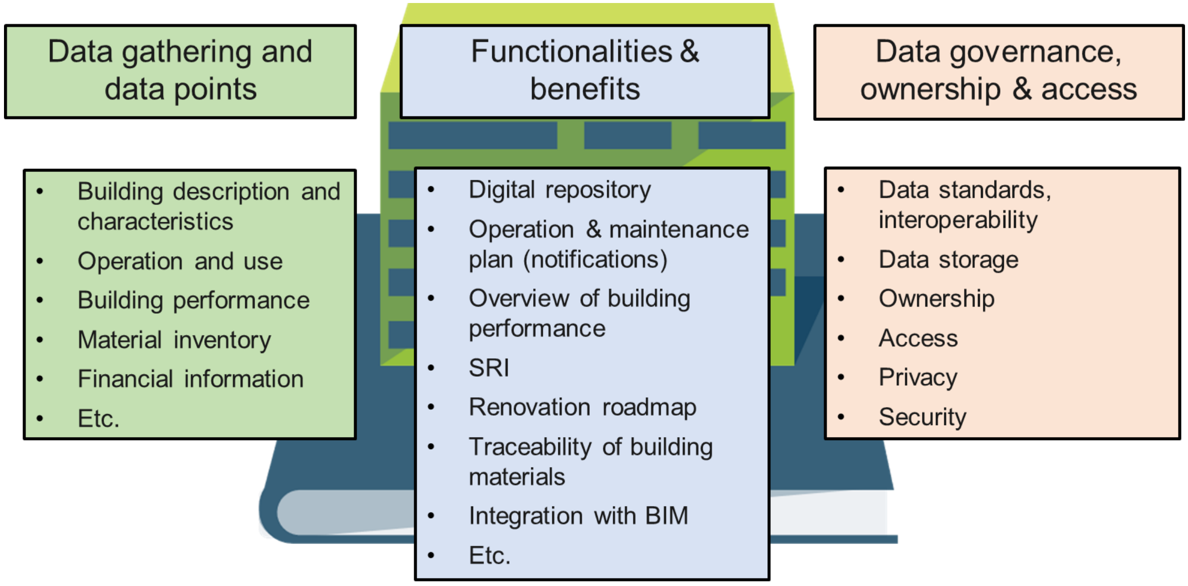


Figure 2: The core ingredients of a building logbook

Data template

The X-tendo logbook data template is based on a detailed country-specific scoping and review of the EPC data points that are relevant and reliable enough to be included in or linked to the logbook. The X-tendo report "Description of implementing partners' user needs and detailed technical specifications regarding features on handling and user of EPC data" includes a comprehensive data template for the required data fields and the current status of these in the three implementing countries. More broadly, the organisation of logbook data needs to fulfil the following main requirements:

- The logbook should accommodate a wide range of data sources and data categories, including administrative data, building characteristics, energy performance data, operational, maintenance, and financial/legal information.

[1] Also described in the project reports "Description of implementing partners' user needs and detailed technical specifications regarding features on handling and user of EPC data" (Deliverable 4.2) and "Summary of implementing partners' user needs and detailed technical specifications" (Deliverable 4.3).

- The logbook should link with existing data sources and information tools, such as the Smart Readiness Indicator, Energy Performance Certificates, sustainability ratings and material passports.
- The advancement of ICT technologies in the built environment opens up new opportunities to collect data (e.g. sensors, real-time energy use, IoT) but also brings

Functionalities & benefits

The X-tendo report "Description of implementing partners' user needs and detailed technical specifications regarding features on handling and use of EPC data" outlined the possible main functionalities and benefits of the logbook. Enabling these functionalities and benefits requires a common "logbook data infrastructure" that would provide: a) digital interface, b) interoperability, c) data syncing/matching, d) storage of data and information, and e) user-friendly navigation and visualisation.

- Functionalities refer to the services built around the logbook and the features mentioned above. Functionalities have corresponding benefits or sets of benefits for the user. The number and type of functionalities determine the scope, quality and type of information that the logbook covers. Examples could include building diagnosis and pre-emptive maintenance, tailored renovation recommendations and roadmaps, benchmarks, alerts and reminders, third party renovation services, etc. By linking the logbook with other existing databases and tools such as building registries, environmental certification systems and BIM models, the logbook can act as a one-stop-shop portal and bring together building sector stakeholders, overcome value chain fragmentation and enable new/streamlined services.
- Benefits represent the additional value delivered to logbook users. Rather than being limited to specific types of features and areas, such as energy or administrative information, the logbook has the potential to bring a wide range of benefits to different actors. Clearly articulating these benefits is crucial to get the buy-in of all market actors involved.

Data governance & ownership

Data governance refers to the process, organisation and standards implemented to ensure the effective and efficient storage of and access to data. The development and proper implementation of logbooks require settling a series of questions around data ownership, access, storage, privacy and security.

Developing and implementing a fully functional logbook thus requires:

- Development of the logbook data model, including protocols for data capturing and data sharing (e.g. via a common webservice).

- Stakeholder engagement over the use of data and access by third parties; map logbook related benefits, costs, drivers and potential challenges; mapping of information flows, i.e. who needs what data, when, from what sources and in what form?
- Clarifications of data governance requirements (both legal and technical, such as GDPR, IP rights, data access and storage)

The X-tendo implementing partners will take steps towards this broader ambition of developing fully functional building logbooks, however it should be noted that the development of complete products and services falls outside of the scope of this project. The logbook concepts to be implemented in the countries Greece, Portugal and Estonia will be described in the next chapter.

1.3 Countries' implementation

Estonia – Benchmarking application Energiamonitor

The benchmarking tool "Energiamonitor" is developed as a logbook functionality for monitoring, analysing and reducing energy consumption in buildings. The tool contributes to energy improvement of buildings by visualising consumption data for individual users and nudging change in user behaviour. Users include building owners, facility managers and tenants who can easily access recommendations and tips for reducing energy consumption and saving costs by entering electricity, heating and water heating data. The tool has several features:

- It allows monitoring energy consumption and energy efficiency with vivid graphs;
- The application offers the ability to calculate the current energy label of the buildings and to compare and share the energy-related reports of the individual dwellings;
- Energiamonitor features a built-in dashboard to seek advice from energy experts regarding the potential renovations solutions based on the present condition of the building. The reference values are set according to the Estonian regulations and standards.
- The tool stores data for each building. In addition to basic physical data (area, capacity, number of dwellings/rooms, type of construction and main materials) and information on utilities systems (type of heating, power capacity, type of water heating etc.) there is also possibility to log all significant repairs and enhancements.

Energiamonitor includes logbook features, specifically the storage of consumption data, basic physical parameters of building (living and heating area, number of dwellings/rooms, volume etc), description of utilities´ systems and changes made to the above mentioned. Consumption data, if derived via remote metering, will be inputted automatically but manual monthly input is also possible.

Interoperability links between the national Building Register and Energiamonitor are currently in the planning stage and it is not part of the X-tendo project.

The Building Registry collects and organises a wide range of information on buildings including detailed design drawings, building characteristics and administrative/legal data on every building. There are also plans to store consumption data in this centralised database.

Greece – EPC registry web services

The X-tendo project designed a concept of a web-service and interface with a national logbook. The buildingcert.gr[2] web services[3] were developed by CRES and are current hosted in CRES's hardware and software infrastructure. The services enable third party applications to access a subset of EPC data for different purposes. Currently, it is used by two separate applications, namely:

The X-tendo project designed a concept of a web-service and interface with a national logbook. The buildingcert.gr[4] web services[5] were developed by CRES and are current hosted in CRES's hardware and software infrastructure. The services enable third party applications to access a subset of EPC data for different purposes. Currently, it is used by two separate applications, namely:

a. The tax department web application which uses the CRES web services to perform validation checks on EPCs that are attached to lease agreements entered into the tax department's Information Systems, thus reinforcing the requirement of displaying an EPC at the point of selling or renting a property
b. The web application of the Greek government's energy efficiency funding scheme which uses the web services to extract EPC data needed for the assessment of funding requests. The EPC has a central role in the scheme as it is used for the assessment of the initial state of the building, the improvements proposed by the energy expert and the achieved performance levels via a second EPC issued after the improvement's works were carried out.

These web services can provide *back end* to the logbook data exchange, especially if the latter is implemented as an aggregator of data stored across various databases. In this

[2] buildingcert.gr is the Greek EPC Registry web application and database.
[3] Web services are information systems that use the www infrastructure for A2A (application-to-application) data exchange, typically used to allow a web application (the data consumer application) to incorporate and use another web application's (the data provider application) data.
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sense, the logbook can access data from the IT system of the tax department or that of the financial schemes, but also from other data sources such as the EPC Registry.

As of December 2020, there are two endpoints[6] to the CRES web services. The first one, unofficially called *checkcert*, is used to check the validity of an EPC and to access its most basic data. It is designed to be the basis on which all other endpoints are built upon. The second, unofficially called *exoik* (pronounced exeek – from the greek word `εξοικονόμηση' meaning 'saving') is used to access the EPC data needed by the above-mentioned funding scheme's information system.

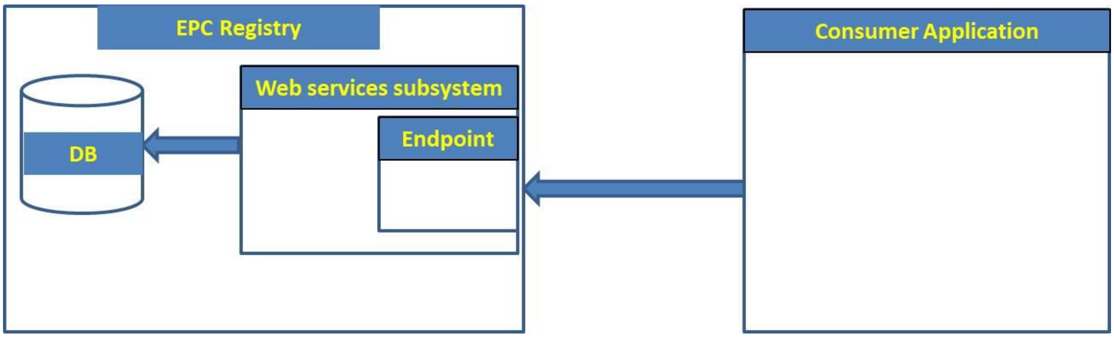

Figure 3: The concept of the Greek EPC registry web services

To use any of the two endpoints, the consumer application sends mainly two pieces of data:

1. The 'protocol number' of the EPC which is the year of the EPC along with a sequential number within that year.
2. The *secucode*, which is a 16-digit code comprising latin alphabet uppercase letters and numbers, issued by buildingcert.gr when an EPC is finalised and printed on it.

These two parameters can be thought of as the username/password pair of the EPC, the former specifying which EPC should be accessed, while the latter ensures that the end user isn't just trying to refer to a random EPC, to which it should not be given access. The building owner can give the above mentioned information to anyone needing to check the validity of the EPC.

If the 'protocol number + secucode' validation check succeeds, the web service responds with the data requested by the consumer application. In the case of *checkcert*, these data are:

1. The building address
2. The name(s) of the owner(s).

[6] In the web services terminology an endpoint is the part of the software to which the consumer application is connected. A web service can have multiple endpoints, each providing access to a different subset of the service's functionality

3. Energy data: Primary energy consumption of both the existing and the reference building, CO_2 emissions, energy class of the building

When accessing the *exoik* endpoint the consumer application receives the above data along with:

1. The initial construction year
2. A verbal description of each of the 'scenarios', i.e. the energy expert suggestions for improvement.
3. Primary energy consumption, CO_2 emissions and the energy class of the 'scenarios'.
4. P/V data[7] from the existing building (if it has P/V) or the scenarios, if the energy expert suggested installing P/V

When designing the buildingcert.gr web services, CRES aimed to keep the software development of both the services and the consumer applications, as simple as possible. Consequently, CRES opted for rather simple web service technologies: RESTful services accepting HTTP POST requests and responding in the JSON format. Authentication is done via an API key. When designing endpoints for a logbook, one may want to consider more advanced technologies, i.e. XML and SOAP based services.

Portugal – Portal casA+

Portal casA+ is a one stop shop dedicated to energy efficiency. The goal of this Portal is to act as a property ID, facilitating the access of the homeowner to building related information while encouraging energy efficiency home improvements. The portal also facilitates communication between the homeowner, the building expert and companies/service suppliers, by providing:

- the homeowner with information on companies contact, expertise and service's evaluation
- and the companies with requests from the homeowners for budget proposals on specific improvement measures

The target audience of Portal casA+ are homeowners and tenants, building experts and energy/water efficiency companies. In the future, Portal casA+ is intended to be expanded to multiple owners, public authorities and financial institutions.

The building logbook is the foundation of Portal casA+. The data can be uploaded into the portal in 3 different ways (Figure 4):

1. By the homeowner when the building does not have any EPC or when additional information - not available in the EPC - is required. The homeowners can access the

[7] In the context of the funding scheme, photovoltaics are especially important

portal via their EPC which offers organised access to all information about the building

2. By the Portuguese EPC Registry Database - SCE (Sistema de Certificação Energética dos Edifícios) to upload energy related information
3. By the Portuguese Water Performance Classification Database – AQUA+ (Classificação de Eficiência Hídrica de Edifícios) – in development.

The information stored in the building logbook is organised across 8 categories: Building Identification (EPC code, INSPIRE ID, etc.), Building Characterization (construction period, type of building, etc.), Envelope (walls, roof, etc.), Lighting & Appliances (light bulbs, washing machine, fridge, etc.), Technical Systems (heating, cooling, DHW, etc.), Energy Balance Indicators (heating, cooling, DHW energy needs), Improvement Measures (Type of measure, cost, payback period, etc.) and Energy/Water Consumption.

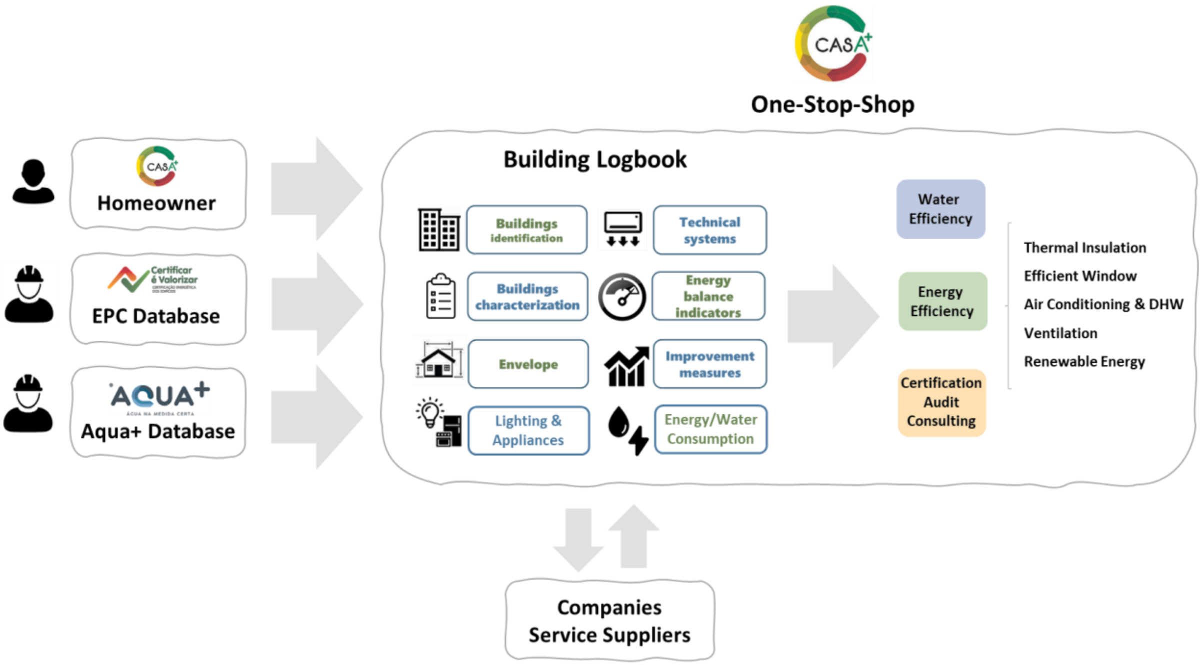

Figure 4: Portuguese Building Logbook integrated in Portal casA+

Building experts have an important role in the portal, as they are responsible for informing homeowners about the improvement measures recommended in the EPC and AQUA+ or even advise about the advantages of producing a new EPC/AQUA+. Energy and Water efficiency companies will be able to access parts of the logbook data (as for example Envelope or Technical systems) and to propose commercial offers on the execution of the improvement works. The building logbook stores EPC and AQUA+ data, making also available a historic overview of data from expired EPCs or retrofitted building components.

In the beginning of 2020, ADENE conducted user tests with small groups of users. In a first stage, ADENE led focus groups and collected the opinion of its employees, while in the second stage, tests were conducted with a larger sample involving students and professionals from the energy and water efficiency sectors. These tests consisted in an evaluation survey on the navigation, design and intuitiveness of the portal. The results were encouraging, and the feedback helped to improve some design features of the portal and the inclusion of new functionalities.

The building logbook enables different casA+ functionalities organised in 10 main action areas: Thermal Insulation, Efficient Windows, Air Conditioning & DHW, Ventilation, Renewable Energy (these 5 related to Energy Efficiency), Water Efficiency, Certification/Audit/Consulting, Bioclimatic Architecture, Waterproofing and Sustainable Mobility.

Some of these areas, namely the water efficiency and the auditing/consulting are still in development phase. These are already functionating but not connected yet to the water certification system – AQUA+.

The portal is available online and since September 2020 it had 27 companies registered, split across the 5 action areas related to energy efficiency. ADENE also prepared a series of webinars and training sessions targeting energy efficiency companies. These workshops aimed to inform companies about the registration criteria, the requirements and functionalities of casA+ and the best practices to manage the improvement measures proposals available for the different action areas.

casA+ current overview

The functionalities enabled by the building logbook which are currently available in casA+ are:

- Access to the building related information and available financial incentives;
- Registration with associated EPC (not mandatory);
- Registration, use and interaction with both consumer and companies;
- Improvement measures proposals and access to a list of service suppliers to simplify the energy and water renovation of buildings;
- Energy and water efficiency guides and recommendations;
- House energy efficiency simulator;
- New action areas on “water efficiency” and “audit and consulting” (not connected yet to AQUA+)

In the close future, ADENE intends to add the following features:

- Buildings components dashboard (added through the X-tendo testing);
- Automatic improvement measures proposal (added through the X-tendo testing);
- Information on financial incentives (added through the X-tendo testing);
- Energy and water consumption monitoring (added through the X-tendo testing);
- Renovation or request of an EPC or AQUA+;

One of the greatest challenges to the building logbook development and implementation is the availability and access of the EPC data, since the majority of the data comes from this data source. According to the existing legislation, EPCs are being issued by energy assessors following a request taken by the homeowners. However, the implementation of the EPBD revised in 2018 will give the authorisation to ADENE to provide EPCs via Portal casA+, upon proof of ownership. It is expected that the number of buildings with registered EPCs will significantly increase which will enable more data to be logged and further functionalities to be added.

Similarly, it is expected that the "water efficiency" area will be supported by AQUA+, an ADENE initiative which is already implemented for residential buildings. AQUA+ is a system for evaluating and classifying properties based on its water use. The AQUA+ database will provide the building logbook data on the infrastructure, water using equipment and fitouts of the buildings, as well as improvement measures on water efficiency.

The official launch of portal casA+ took place in April 2021.

Questions that should be addressed in the future:

- Interaction with stakeholders and added casA+ functionalities: ADENE will organize a series of webinars with stakeholder associations representing the building sector, homeowners, building experts, banks and service suppliers;
- Validation process to access EPC/AQUA+ and how to promote EPC/AQUA+ data exchange between former and new homeowners. casA+ has already a functioning algorithm to validate the homeowner identity. ADENE intends to improve and extend this mechanism

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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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