TOOLS AND IT-COMPONENTS OF THE PROPOSED CALCULATION AND DATA HANDLING PROCEDURES TESTED IN X-TENDO

BUILDING LOGBOOK

JUNE 2022

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

D4.6

Tools, IT-components and related documentation of the proposed calculation and data handling procedures to be tested in WP5

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https://x-tendo.eu/wp-content/uploads/2022/08/X-tendo-D4.6_rev_RDA_with-cover.pdf

TABLE OF CONTENT

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, respectively, innovative indicators and innovative data handling.

This report describes the tools and IT-components of the proposed calculation and data handling procedures to be tested in WP5. For the feature **EPC databases** this document provides a summary of the quality control methodology for EPCs in the Database, an explanation of the programming algorithm in Python language, that implements this methodology and the explanation to the repository link. For the feature **enhanced recommendations** this document provides the explanation to the calculation spread sheets and guidelines. For the feature **building logbook** this document provides the technical specifications for linking the national logbook with the EPC data (or even EPC database). In the **building logbook** chapter, country specific solutions for Portugal, Estonia and Greece are presented.

This report builds on past project's activities. Moreover, upcoming project activities include the testing of these tools and data-handling concepts in the implementing partners (foreseen in the project phase for "**testing and developing guidelines**"). Below, the series of previous project reports are listed that present complementary information to the present report:

1. Introductory reports of the 10 innovative EPC features (Deliverable 2.3)
2. Development of assessment methods of next-generation EPC – features 1-5 (Deliverable (3.2)
3. Beta version of algorithms and calculation tools for assessment of next-generation EPC – features 1-5 (Deliverable 3.3)
4. Description of implementing partners' user needs and detailed technical specifications regarding features on handling and user of EPC data – features 6 to 10 (Deliverable 4.2)
5. Summary of implementing partners' user needs and detailed technical specifications – features 6 to 10 (Deliverable 4.3)
6. Description of methodologies and concepts for the technical implementation of each feature regarding improved handling and use of EPC data in selected implementing countries– features 6 to 10 (Toolbox – area per each feature)
7. Tools, concepts and guidelines for features: building logbook, enhanced recommendations and EPC databases (Toolbox – area per each feature)
8. Recommendations and replicability potential (Toolbox – area per each feature)

The complete material is online accessible in the X-tendo Toolbox (https://x-tendo.eu/toolbox/).

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

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 for example through providing 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. Besides that, the EPDB review is an activity going on recently and could an important opportunity to include insights and learning outputs from the X-tendo project.

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. For the features **EPC databases, building logbooks and enhanced recommendations**, the X-tendo project deep dived on the technical aspects of the implementation of feature, getting closer to the praxis. This was done by developing tools and technical concepts based on lessons learned from the current practice in the X-tendo expert countries (Table 1). For the features **financing options and one-stop shops** embracing concepts were explored. The complete material will be online accessible in the X-tendo Toolbox (https://x-tendo.eu/toolbox/).

The Figure 1 below summarizes the main objectives of each feature. Because of the focus on the technical components, the present document covers the features EPC databases, logbook and enhanced recommendations.

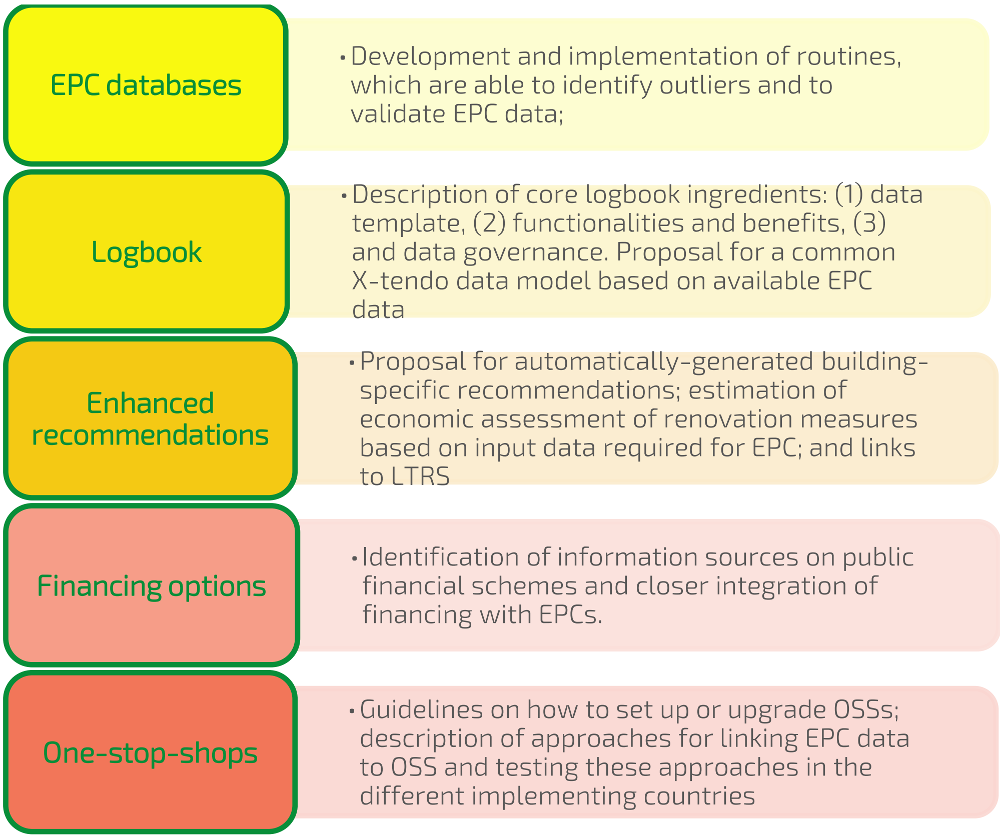

Figure 1: X-tendo methodology for features EPC Databases, Logbook, Enhanced recommendations, Financing options and One-stop-shops

The feature methodologies 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					
Denmark, DEA	System-test		In-building test	User and system test	User and system test
Estonia, TREA		User and system test			
Greece, CRES	System-test	User and system test			
Italy, ENEA	System-test				
Poland, NAPE			In-building and system test		
Portugal, ADENE		User and system test		User and system test	
Romania, AAECR				User and system test	User and system test
UK, EST			In-building test		User and system test

Table 1: Implementing and expert countries per feature

FEATURE: LOGBOOK

X-tendo methodology

The building logbook concept comprises three core ingredients: (1) data template, (2) functionalities, and (3) data governance, which are briefly summarised below.[1] The implementing countries have developed different approaches to the logbook, which are on different stages of development, based on their local context, the status of EPC frameworks and local needs. The logbook starts with the EPC database and can be expanded until it covers all relevant building information and even beyond that. The three testing will, therefore, contribute with different insights into how a building logbook can be built around an EPC framework.

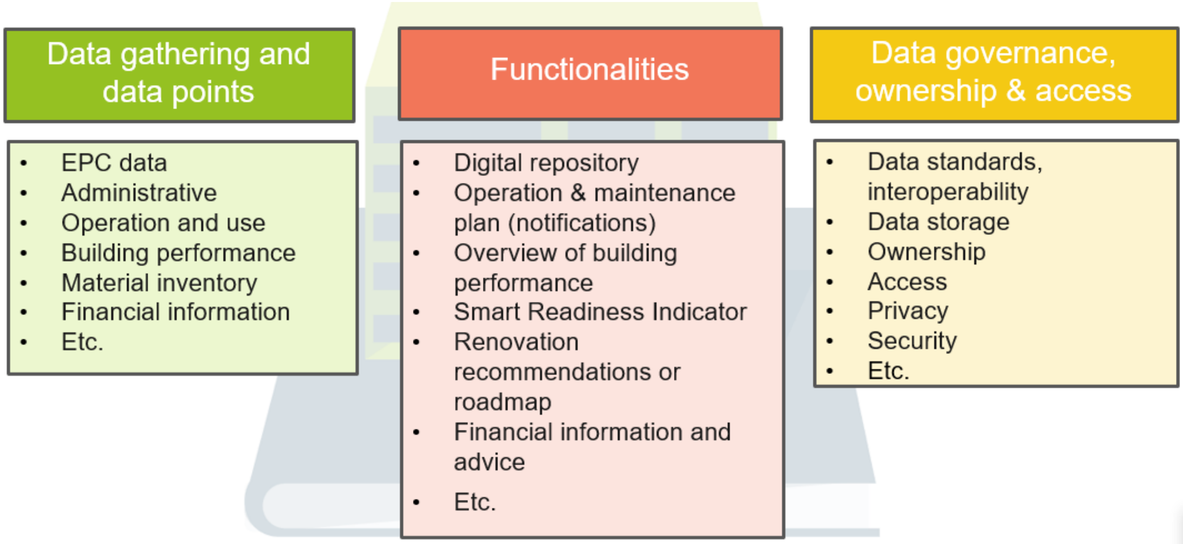

Figure 2: The building blocks of a logbook. The bullets are the most common aspects included but it is not an exhaustive list.

Data sources and 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

[1] Also described in detail the X-tendo 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).

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.
- 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 further data privacy and security constraints: the logbook should be able to accommodate these to fully reap the benefits. logbook should be sufficiently flexible to serve both national/regional needs and also to integrate into a wider European approach.

Figure 3 shows which data gathering and data points the different logbook approaches address. The only point not being addressed is the material inventory, which was not foreseen in the X-tendo project planning. Portugal includes financial information as a functionality, but does not link specific financial data to the logbook.

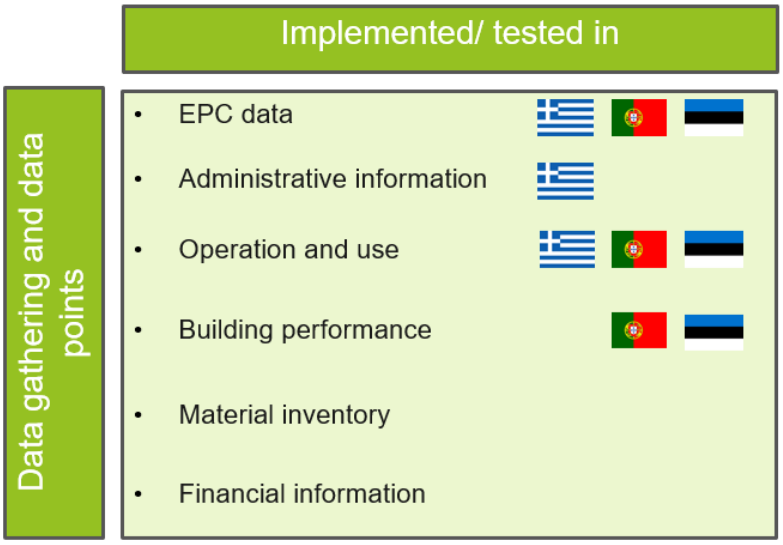

Figure 3: Data gathering and data points in the three X-tendo logbook approaches

Data flow and functionalities

The X-tendo report "Description of implementing partners' user needs and detailed technical specifications regarding features on handling and user 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** refers to the process, organization 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.

It is already now evident, that integrating additional data sources to the logbook, will yield new functionalities. The Portuguese logbook is more advanced, with multiple linked data sources, which allows them to enable additional functionalities. The Smart Readiness Indicator is a potential data source to integrate in the logbook, but the instrument has not been widely launched and is therefore not included.

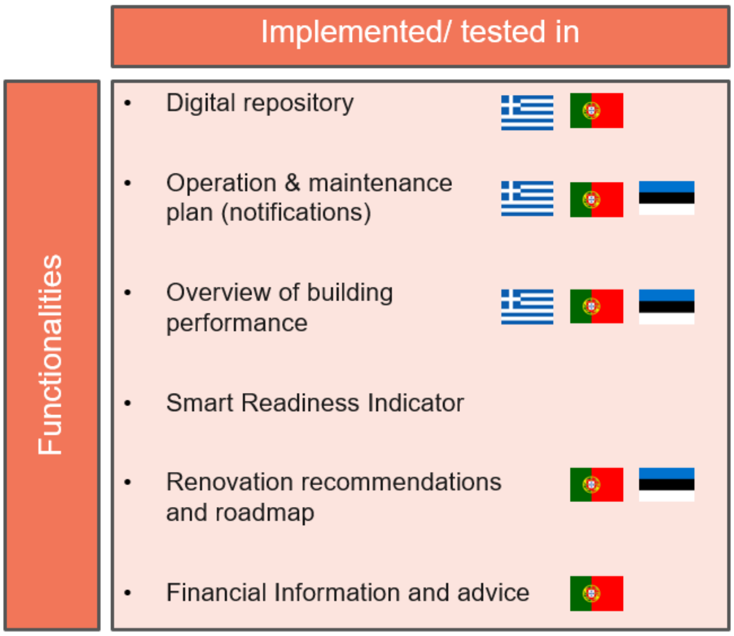

Figure 4: Functionalities in the three X-tendo logbook approaches

Data governance

Data governance refers to the process, organisation and standards implemented to ensure the effective and efficient storage and access to information. The X-tendo logbooks are different but meet the same data governance challenges: Where is the data stored? Who owns it? How do we ensure interoperability in a secure manner? Etc.

The issues being address are:

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

Figure 5 shows that all three countries are addressing the main data governance issues, including data standards and operability, data storage, access and ownership. Portugal and Greece are also considering data privacy and security issues, while these are not major issues for the Estonian logbook for the moment.

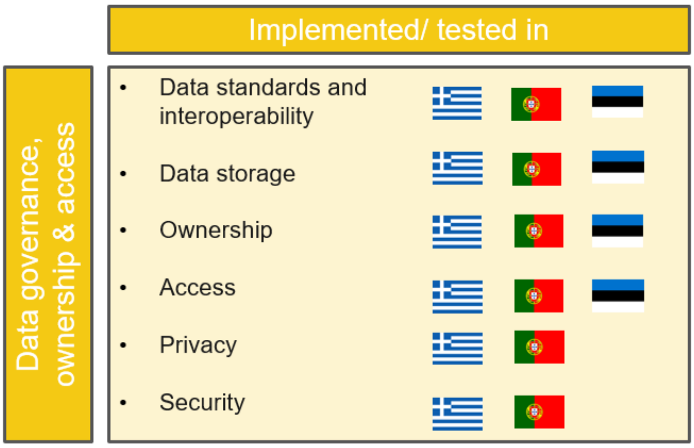

Figure 5: Data governance in the three X-tendo logbook approaches.

The next section describes how Estonia, Greece and Portugal are addressing the technical components and data handling issues of the logbook.

Technical design of the national logbook

The following questions are answered for Estonia, Greece and Portugal for their logbook implementation:

- What type of data and data sources?
- What is the rationale behind the data collected?
- What is the data flow?

- How to link the databases to the building logbook?
- How are the data stored in the building logbook?

Estonia

What type of data and data sources?

The technical design of the Estonian building logbook follows the logic of how the EPCs are set up and implemented. The logbook advances the existing EPC framework by allowing real-time (monthly) calculation linked to EPCs, making it possible to assess the concrete impact of energy renovation, and the influence of behavioural changes and use of the building space.

For new built and renovated buildings, the EPC is based on a theoretical asset rating, calculated based on standardised use profiles as an Energy Performance Indicator (EPI). For existing buildings, the EPCs are calculated based on real energy consumption[2] as a Weighted Specific Energy Use (WSEU)[3]. According to the calculation methodology, both EPI and WSEU take into account all imported and exported energy including also domestic hot water and appliance electricity.

What is the rationale behind the collected data?

Real energy consumption data is one input, based on which the energy performance of existing buildings can be calculated. In contrast to theoretical asset ratings, it can be influenced by the tenants changing consumption patterns and habits, which makes it clear that we need logging of consumption data in order to be able to track and influence the changes in consumption habits and patterns but also to assess alterations in buildings´ energy systems.

Eventually turning out to be the first EPC related building logbook application in Estonia, the software tool "**Energiamonitor**" is an application originally developed for monitoring, analysing and reducing energy consumption in buildings. It visualises consumption data for individual users and activates end-users to reflect their energy consumption habits. Users – be it building owners, facility managers and tenants – can easily discover recommendations and tips for reducing energy consumption and saving money by entering electricity, heating and water heating data.

One of the benefits of the benchmarking tool is that it supports the efforts to pioneer district-level energy planning processes and to involve energy end-users in these processes. Once a statistically solid number of dwellings in an Energy Improvement District

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[2] It is based on smart / remote metering where applicable. The process of phasing out manual metering is ongoing. Currently, the input of consumption data is done manually. In the near future, it is foreseen to integrate automatic consumption data through energy service providers and aligned with the development of the National Building Register.

[3]https://www.riigiteataja.ee/en/eli/ee/MKM/reg/527102014001/consolide; https://www.riigiteataja.ee/en/eli/ee/MKM/reg/520102014002/consolide

is equipped with the tool, stakeholders of the district can use the data provided by the tool to allow for more evidence-based decision-making.

What is the data flow?

The tool allows monitoring energy consumption and the energy efficiency of the building. The application allows the user to calculate the current EPC (EPI) of the buildings, compare with other buildings, and share their energy-related reports. The tool also features a built-in solution to seek advice from energy experts regarding the potential of possible renovations solutions. The reference values are set according to the Estonian regulations and standards.

Users can register through a simple registration page by providing their e-mail address and password. Further, the newly registered user will connect him/herself with one or several buildings. Connecting with more than one building will be an option for building managers, city officials and other stakeholders.

Upon initiating a new building in **Energiamonitor** database, the user has to input descriptions of the building. The description includes main physical parameters – net usable area, heated area, number of apartments, number of floors, type of room heating, description of domestic hot water and also administrative – year of assembly, address, code assigned to the building in national Building Register, providers of heat, water and power etc. Figure 6 displays what the input data template looks like in the application.

In addition, all major renovations and changes in the physical parameters of the building are recorded in the database.

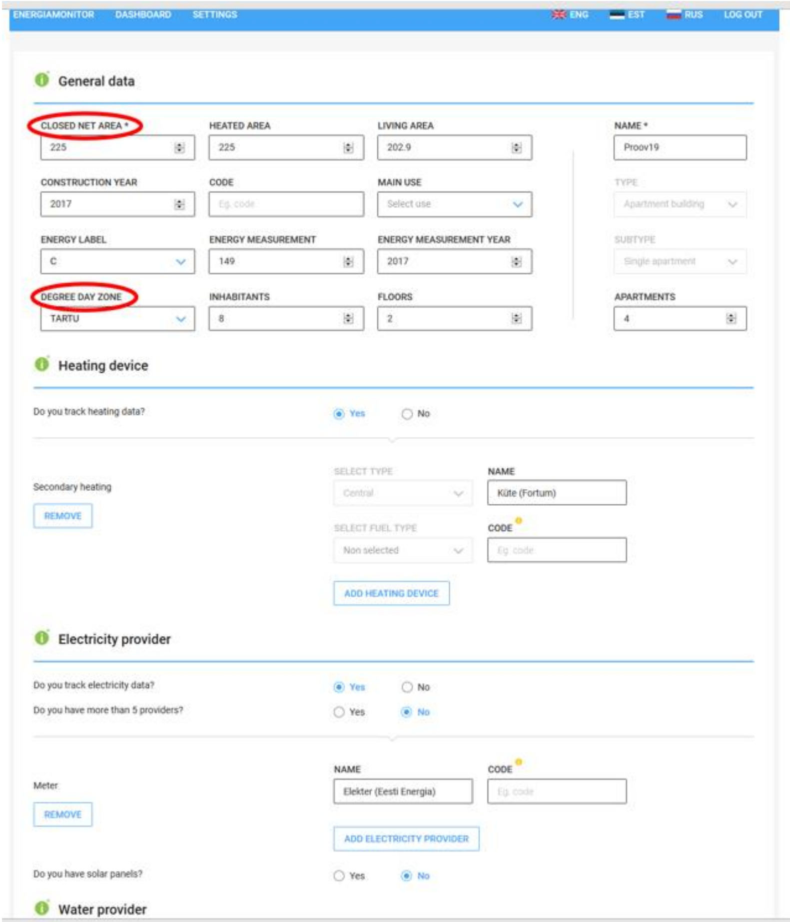

Figure 6: Screenshot of input site of Energiamonitor.

The EPC (EPI) is calculated based on consumption data, physical parameters of the building, climate data (degree days) and weighting factors of fuels. The result is displayed on output as running energy label which is not an official document as issued by a certified person but a feature to inform building owners and tenants about the condition of the building energy-wise. Among output data (i.e. logbook functionality) is the option to extract and share the data on the building with an external consultant for some advice of potential energy saving measures.

Figure 7 displays the data flows of the Energiemonitor.

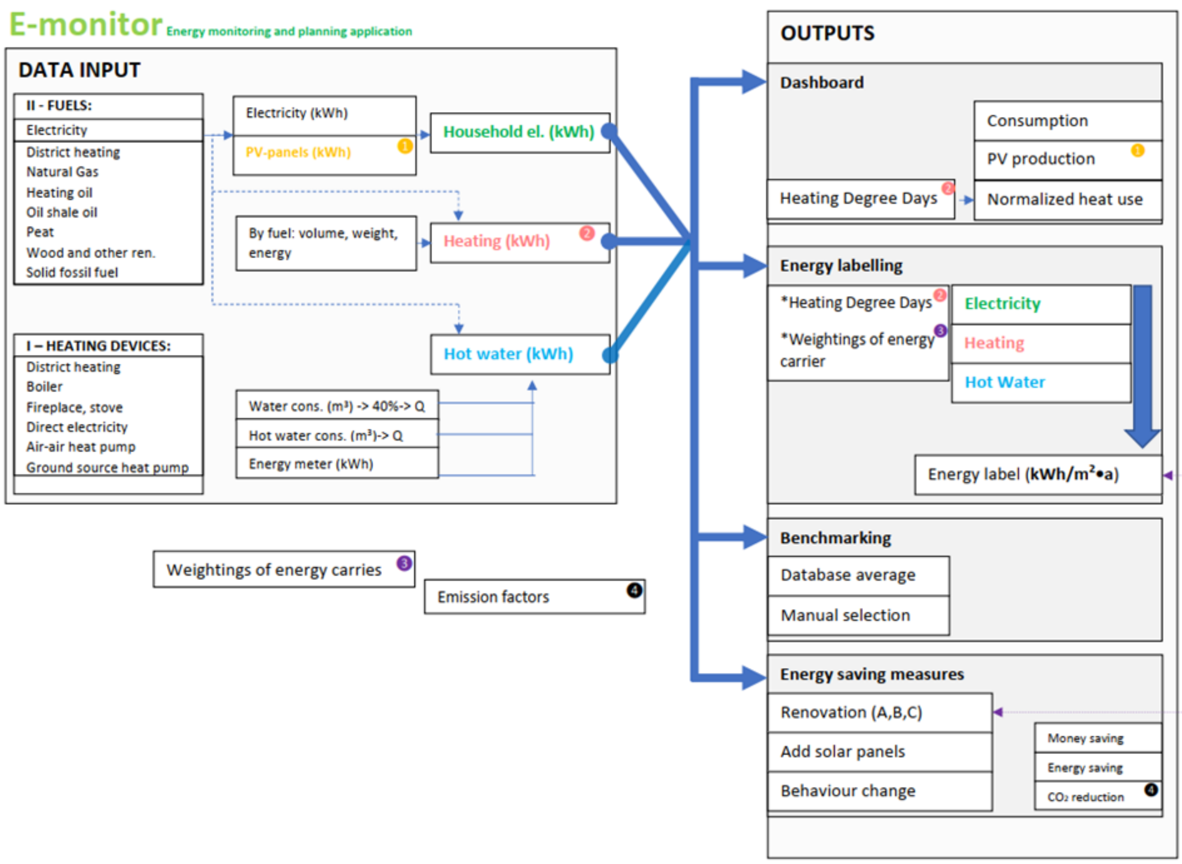

Figure 7: E-monitor, data input and output

How to link the databases to the building logbook?

The National Building Register is the main building database in Estonia. It is currently undergoing a major update with the aim to create a digital twin of the country's built environment. The main aim of the National Building Register is to store data concerning the construction process of buildings and technical facilities.

By the end of 2021, it is planned to launch a pilot of adding consumption data to actual physical and administrative data. As it has become customary in Estonia, the data flow between different databases is realized by using X-road (X-tee in Estonian).

How are the data stored in the building logbook?

X-tee is a data exchange platform that allows secure and standardized data exchange between the state and the private sector. To exchange data, an organization creates services and enables other organizations to use their services. Since there are a lot of systems and services on X-tee, organizations can use the services and data of other institutions to optimize their business services. X-tee has a versatile security solution: authentication, multi-level authorisation, high-level system for processing logs, and data traffic that is encrypted and signed. The X-tee platform has become an unofficial standard of data exchange with almost 900 institutional users.

Greece

What type of data and data sources?

The Greek logbook approach focus on developing a data aggregator feature, i.e. a gateway to external data sources, rather than a database that stores data of its own. In this way, various public sector agencies can collect, store and attain the data they need, while a subset of it is accessible to other logbook users. Such data sources can be the Land Registry, building permits databases, EPC registries, etc.

What is the rationale behind the collected data?

This approach takes advantage of already existing public sector information systems that are tested and supported. The data is regularly updated which enables an updated and relevant logbook. Building on the existing system also avoids data and work duplications. Moreover, the individual information systems maintain their independence, with their administrators free to implement the technical solutions they feel more suitable for their needs. The solution also circumvents most data privacy concerns, as the data is still governed by their owners.

What is the data flow?

In the Greek approach, the logbook communicates with the different data sources via web services. Web services are information exchange systems that use the Internet for direct application-to-application interaction. In most applications of this technology, the communication takes place between a data provider application, that has access to a data repository, and a data consumer application that will receive and use the information.

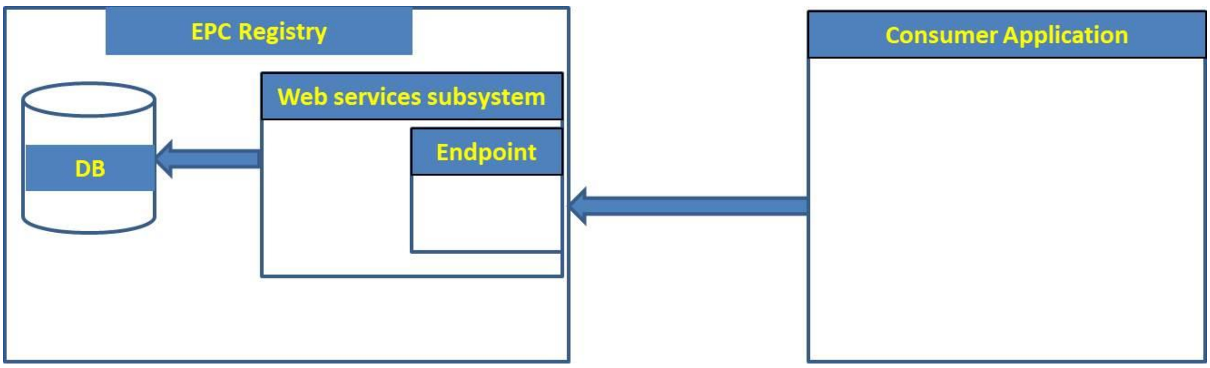

Figure 8: Logbook as a data aggregator, web service to provide the back end to the logbook data exchange (EPC registry, tax department and renovation financing programme)

Web services are built on top of open standards such as TCP/IP, HTTP, Java, HTML, and XML. The core of a web service is its messaging protocol, which defines the exact elements that constitute both the request sent by the data consumer and the response sent by the data provider. The protocol, along with all the details needed to use a web service is typically described in, usually XML based, languages specially developed for this purpose, the most popular of which is the Web Service Description Language (WSDL). Most modern web services define and implement an extension of the Simple Object Access Protocol (SOAP).

However, the RESTful – JSON approach has already gained momentum in the software industry, tending to become a de facto standard.

To implement a logbook in this approach, a Logbook Messaging Protocol must be defined that will describe the process with which the logbook will exchange data with the various data sources. Each of the data sources will have to implement the relevant subset of protocol. Every time data regarding a specific building is required by the logbook, the logbook application communicates with the various data sources, using the above-mentioned protocol and presents the data to the user. The logbook application could cache the data so that if the user requests data for the same building again, it does not necessarily have to communicate with the data provider again. For this purpose, a cache mechanism must be incorporated in the messaging protocol, that either allows the data provider to provide a cache expiration date or allows the logbook to query the data provider as to whether the data last retrieved for the specific building are still valid.

How to link the databases to the building logbook?

It is highly recommended that the building ID, i.e., a unique ID number or alphanumeric, specifying the building and / or building unit are at the centre of the data exchange process. This would bridge the silos of automation, that the various data sources represent.

An important part of the design of a logbook data exchange processes and protocols, should be the study of various file formats already utilized by the various data sources, e.g., DXF, STEP, IGES, gbXML, etc.

Regarding security issues, the RESTful – JSON approach should be implemented over a Secure Sockets Layer (SSL) allowing requests and responses to be digitally signed and encrypted. If SOAP is utilised, WS-Security, an extension of the SOAP protocol allows the applications to:

- Sign SOAP messages to assure integrity. Signed messages also provide non-rejection.
- Encrypt SOAP messages to assure confidentiality.
- Attach security tokens to ascertain the sender's identity.

How are the data stored in the building logbook?

As written, the logbook will be a gateway to which data and information can be fetched via a unique building ID. The primary storage of the data is thus assured by the owners of the external data sources. Local storage on the end user's PC, can also be implemented as a cache, for fast access. The advantage of this approach is that information can be collated from various sources and the information is up to date whenever data is being updated at the logbook itself.

Portugal

What type of data and data sources?

The building logbook is the foundation of the Portuguese portal casA+. The data can be uploaded into the portal in four different ways (as depicted in Figure 9):

1. **User inserted information** is possible when the building does not have an EPC or when additional information – which is not available in the EPC - is required. This can for example be data related to the occupancy of the buildings.
2. Through the Portuguese **EPC Registry Database** - SCE (Sistema de Certificação Energética dos Edifícios), which is used to upload building and energy related information. The link between the building logbook to the EPC database is necessary as it allows the homeowner to input the EPC identification number in casA+.
3. Through the Portuguese **Water Performance Classification Database** – AQUA+ (Classificação de Eficiência Hídrica de Edifícios). The link between the building logbook and the AQUA+ database is necessary as it allows the homeowner to input the AQUA+ number in the casA+.
4. **Third parties** (companies and installers) can use the services to provide the homeowners with specific budget proposals on the suggested works.

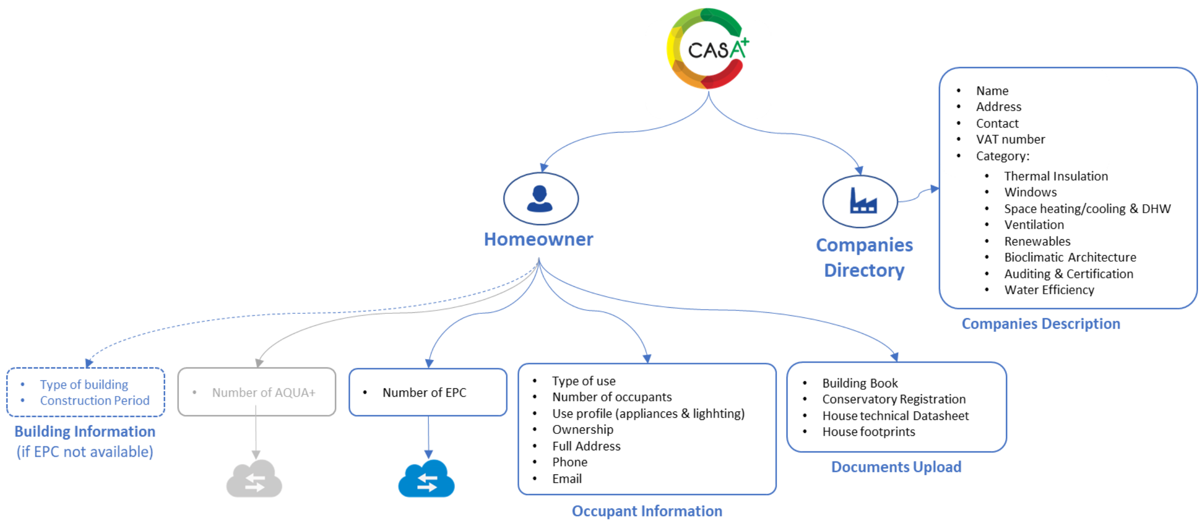

Figure 9: casA+ building logbook data input model

The administrator (in this case ADENE) uploads additional information to the building logbook, including tips/guides on energy/water efficiency measures and information on available funding sources. However, this is public information, and it is not directly linked to a specific improvement need.

What is the rationale behind the data collected?

The building logbook available in portal casA+ aims to have all the relevant information of a building in one place (see Figure 10). This includes data on building identification (EPC code, address, etc.), building characterization (construction period, type of building, etc.), envelope information (walls, roof, etc.), lighting and appliances (light bulbs, washing machine, fridge, etc.), technical systems (heating, cooling, DWH, etc.), energy balance indicators (heating, cooling, dhw energy needs), improvement measures (type of measure, cost, payback period, etc.) and energy/water consumption.

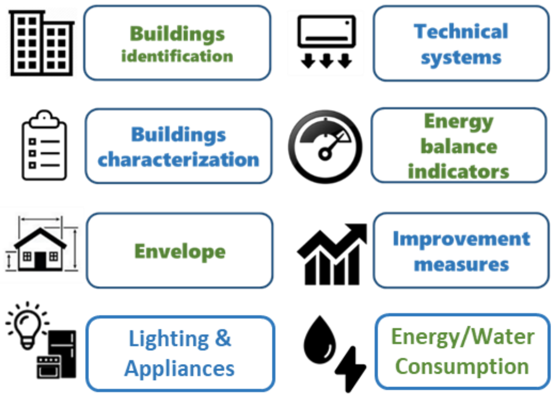

Figure 10: Categories of data stored by the building logbook.

The Portuguese EPC database is the primary data source of casA+ building logbook, since it has more than 400 different variables registered, covering the majority of data categories identified in Figure 10. However, not all variables available are relevant for the building logbook and casA+ functionalities and therefore a pre-selection work was carried out.

Furthermore, the EPC database does not alone have all the data that could possibly populate a complete building logbook (for example, data related to the buildings occupancy or water use), necessary for casA+ functionalities.

A continuous work identifying which are the functionalities to which the building logbook can answer is crucial to identify the data needed, possible sources of information and the interoperability requirements. The development of the building logbook/functionalities data flow is an important tool in identifying eventual data gaps and in finding important relations between different data sources.

What is the data flow?

Figure 11 maps the implemented data flows, i.e. what data, from what sources (left) to which casA+ functionalities (right). The width of the streak illustrates the number of inputs being transferred. The building logbook is the functionality that concentrates the majority of the data coming from the EPC database since it works as a repository of information made available for the homeowner consultation. Nevertheless, additional/complementary data uploaded directly by the homeowner is also critical for specific functionalities, such as improvement measures proposals and energy-saving simulator (guidance to the homeowner on renovation) and budget proposals (linking homeowners and companies/installers). Since this data is specifically related to the person occupying the building at that moment, it can be separated from the building logbook itself.

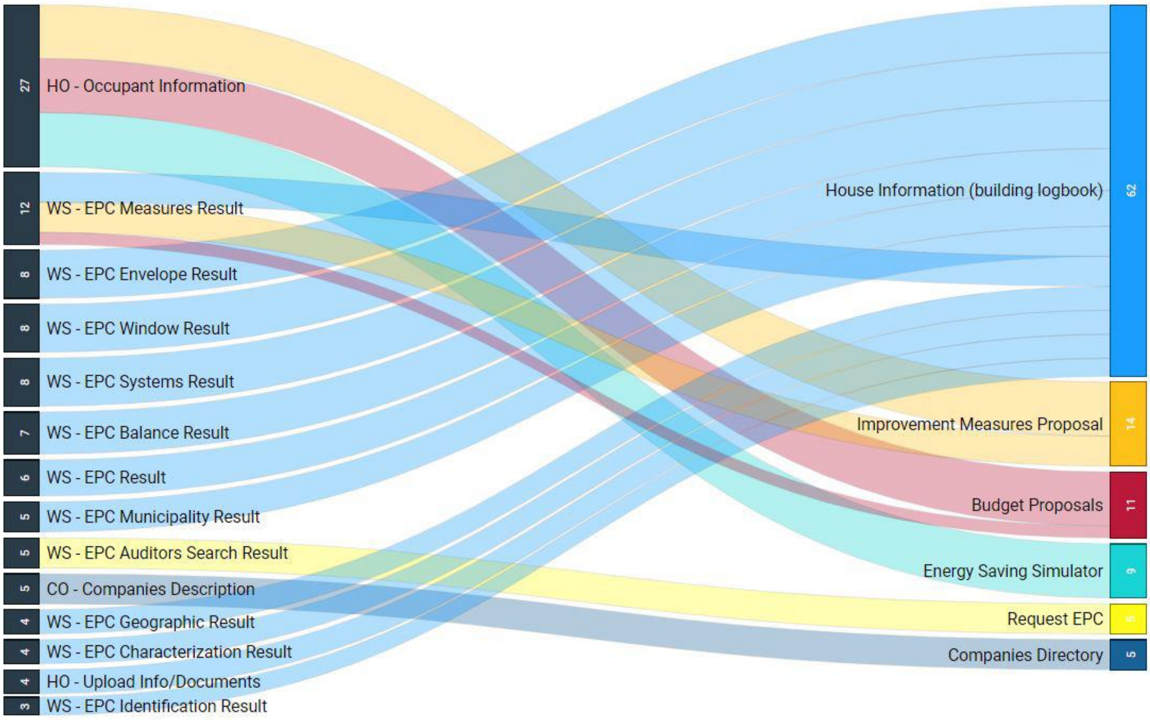

Figure 11: casA+ data flow (implemented)
Legend: HO – Homeowners, WS – Webservice, CO - Companies

How to link the databases to the building logbook?

As presented previously in Figure 9 portal casA+, uses web services to have access to the EPC database (Sistema de Certificação Energética – SCE) and the AQUA+ database (not yet implemented). According to W3C[4], web services provide a standard means of interoperating between different software applications, running on a variety of platforms and/or frameworks. Webservices are characterized by their great interoperability and extensibility, as well as their machine-processable descriptions thanks to the use of XML. They can be combined in a loosely coupled way in order to achieve complex operations. Programs providing simple services can interact with each other in order to deliver sophisticated added-value services.

To use any of the EPC or AQUA+ endpoints the consumer application (casA+) sends the certificate number to identify de building to which the data is requested, which is a unique alphanumeric field (Figure 12).

[4] W3C, Webservices Activity

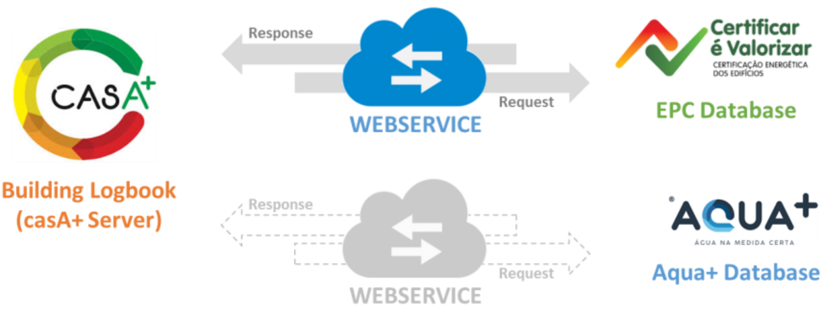

Figure 12: EPC and AQUA+ database web services

The EPC web services were developed by ADENE and are currently hosted in ADENE's infrastructure. It enables casA+ application to access a subset of the EPC data, as described previously. Currently, casA+ can access data only from the EPC database registry. The AQUA+ web service is still not available since the database platform is currently in production. When this database comes into operation, it will be implemented a web service following the same principles of the EPC web service.

In terms of information security, the use of the web service implies the next conditions to be followed:

- Only users with valid credentials can access to the web services;
- The user credentials (username/password) are made available by ADENE;
- After authentication, users only have access to the methods they have authorization. This solution is granted through the customized user authentication/authorization with validation in Windows Active Directory.

If the number of the EPC succeeds, the web service responds with the data requested by the consumer application. Figure 13 illustrates the SCE/casA+ web services operations results.

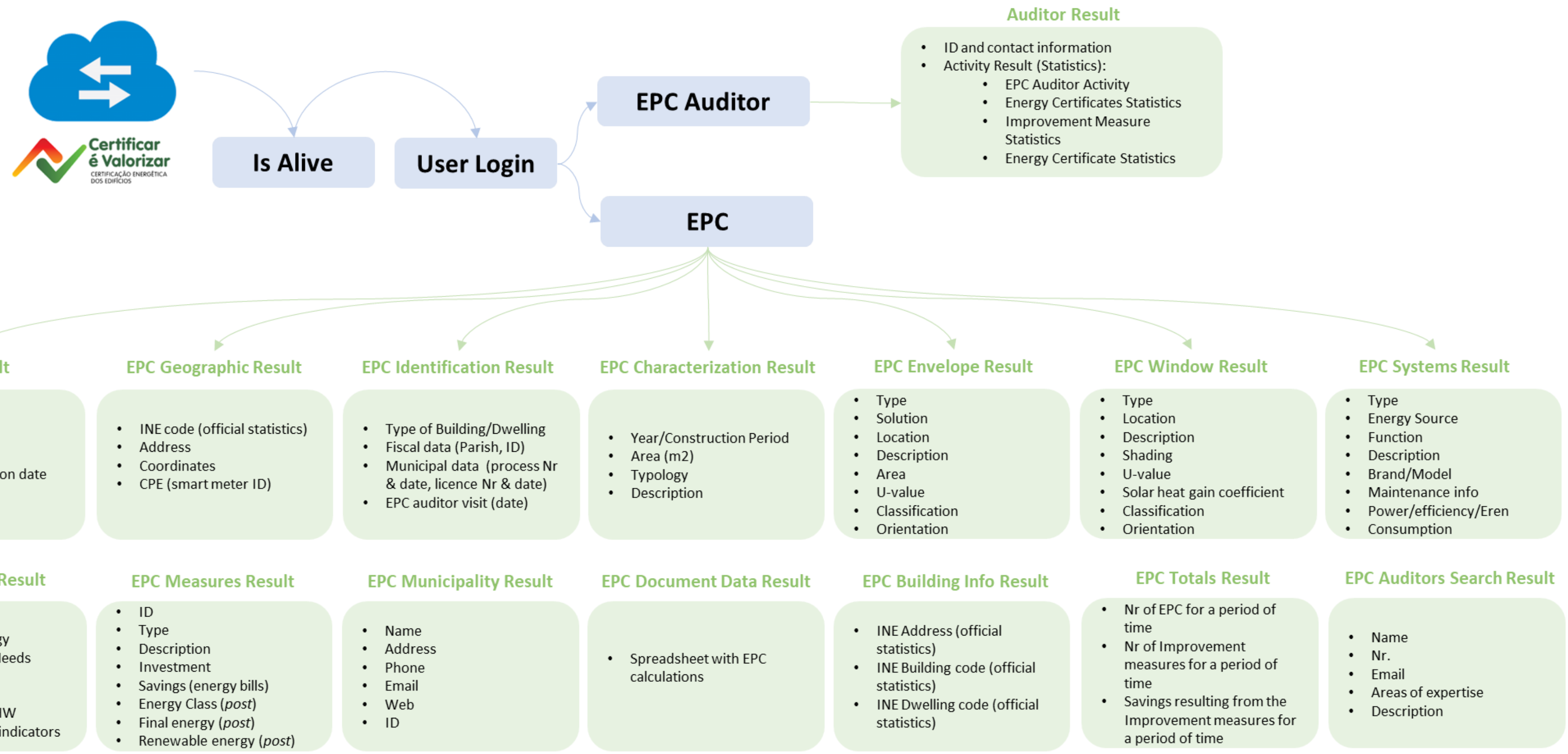

Figure 13: Webservices ADENE – SCE/casA+ Operations Results

When implementing the EPC web services, ADENE opted for using the framework WCF (Windows Communication Foundation). This framework supports communications between endpoints using HTTP Verbs (POST, GET) and with all the messages exchanged in the JSON format.

To make use of the service it is required to have a valid username and password which are mandatory to obtain a token. This uses a POST to a specific URL, providing the username and password in the request body, returning an access token that needs to be integrated in the header of the subsequent requests.

Since the first implementation of this service, more advanced technologies have surfaced and at ADENE we are starting to roll out multiple services using a RESTful approach with JWT authentication methods.

How are these data stored in the building logbook?

The data retrieved from the web services request are stores in casA+ database in PostgreSQL, one of the most supported open source databases currently available. PostgreSQL is housed in a Docker container to guarantee its scalability and extensibility as needed, being this container running on the casA+ infrastructure at DigitalOcean. At the application level, access to the database is performed via ORM[5] of the Django framework in Python. In terms of data security, casA+ database is contained in a protected environment, as the database container is only available for application containers that are on the same machine.

Regarding personal data, casA+ has available a privacy policy, identifying who is responsible for the data treatment (in this case ADENE), the data treatment legitimacy (through the informed consent given by the homeowner in the registration process), the data treated (data such as name, address, etc.), the treatment purpose (profile creation, interaction between homeowners and registered professionals such as EPC auditors, interaction between ADENE and casA+ users requests and advertising on energy efficiency, news, initiatives etc. when the user specifically gives consent on this), subcontractors and data communication to third parties, data treatment conditions and rights of data owners.

[5] Object-Relational Mapping

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