



CBDC powered Smart PerFORrmance contracTs for Efficiency, Sustainable, Inclusive, Energy use

D2.5 FORTESIE services co-creation			
Report Identifier:	D2.5		
Work-package:	WP2	Task:	T2.2
Responsible Partner:	FUNDACION CTIC CENTRO TECNOLOGICO PARA EL DESARROLLO EN ASTURIAS DE LAS TECNOLOGIAS DE LA INFORMACION (CTIC)	Version Number:	1.0
Due Date	31/10/2024	Document Date	18/11/2024
Distribution Security:	PU	Deliverable Type:	R
Keywords:	Digital services; Digital components; Usage scenarios; Services' workflows; Co-creation		
Project website: https://fortesie.eu/			

Quality Control

	Organisation	Date
Editor	CTIC	30/10/2024
Peer review 1	JUST	05/11/2024
Peer review 2	INCL	06/11/2024
Authorised by (Technical Coordinator)	ED	11/11/2024
Authorised by (Quality Manager)	ED	13/11/2024
Submitted by (Project Coordinator)	ED	18/11/2024

Legal Disclaimer

FORTESIE is an EU project funded by the Horizon Europe (HORIZON) research and innovation programme under grant agreement No. 101080029. The information and views set out in this deliverable are those of the author(s) and do not necessarily reflect the official opinion of the European Union. The information in this document is provided “as is”, and no guarantee or warranty is given that the information is fit for any specific purpose. Neither the European Union institutions and bodies nor any person acting on their behalf may be held responsible for the use which may be made of the information contained therein. The FORTESIE Consortium members shall have no liability for damages of any kind including without limitation direct, special, indirect, or consequential damages that may result from the use of these materials subject to any liability which is mandatory due to applicable law.

Copyright notice

© Copyright by the FORTESIE Consortium

This document contains information that is protected by copyright. All Rights Reserved. No part of this work covered by copyright hereon may be reproduced or used in any form or by any means without the permission of the copyright holders.

Table of Contents

LIST OF FIGURES	6
LIST OF TABLES	7
ABBREVIATIONS	8
EXECUTIVE SUMMARY	9
1 INTRODUCTION	10
1.1 PROJECT INTRODUCTION	10
1.2 DELIVERABLE PURPOSE	10
1.3 STRUCTURE OF THE DOCUMENT	10
1.4 TERMINOLOGY	11
2 FORTESIE DIGITAL SERVICES AND COMPONENTS	12
2.1 SERVICES AND COMPONENTS LIST	12
2.1.1 Data Sovereignty Service	13
2.1.1.1 Update of the Data Sovereignty Service	13
2.1.2 Data Analysis Service	14
2.1.2.1 Update of the Data Analysis Service	14
2.1.3 Behaviour & Recommendation Service	14
2.1.3.1 Update of the Behaviour & Recommendation Service	14
2.1.4 User Engagement Service	15
2.1.4.1 Update of the User Engagement Service	15
2.1.5 User Profile Service	15
2.1.5.1 Update of the User Profile Service	15
2.1.6 Improvements Achieved Calculation and Green Euro Rewarding Service	15
2.1.6.1 Update of the Improvements Achieved Calculation and Green Euro Rewarding Service	15
2.1.7 One-Stop-Shop Marketplace	16
2.1.7.1 Info & Funding Service	17
2.1.7.2 Update of the Info & Funding Service	17
2.1.7.3 Matchmaking Service	18
2.1.7.4 Update of the Matchmaking Service	18
2.1.7.5 Renovation Recommendation Service	19
2.1.7.6 Knowledge Base	19
2.1.8 The Dynamic high-Resolution dEmand-side Management (DREEM) model	20
2.1.8.1 Update of the Dynamic high-Resolution dEmand-side Management (DREEM) model	20

3	CORRESPONDENCE BETWEEN THE SERVICES AND THE MODULES DEVELOPED IN THE ARCHITECTURE.....	22
4	THE PILOTS.....	25
4.1	PILOT UPDATES.....	25
4.1.1	Pilot 1 – Unleashing green cultural experience.....	25
4.1.2	Pilot 2 – Green, comfortable and sustainable home.....	25
4.1.3	Pilot 3 – Green, comfortable and sustainable home.....	25
4.1.4	Pilot 4 – Green and comfortable households through prosumer engagement in Cooperatives.....	26
4.1.5	Pilot 5 – Green, comfortable working environment.....	26
4.1.6	Pilot 6 – Comfortable and sustainable (Public) Pools.....	26
4.1.7	Pilot 7 – Comfortable, inclusive, and sustainable green Schools.....	26
4.2	ADDED VALUE.....	26
4.2.1	Data Sovereignty Service.....	26
4.2.2	Data Analysis Service.....	27
4.2.3	Behaviour & Recommendation Service, User Engagement Service and User Profile Service	27
4.2.4	Improvements Achieved Calculation and Green Euro Rewarding Service.....	27
4.2.4.1	M&V and EPC components:.....	27
4.2.4.2	Green Euro rewarding component.....	27
4.2.4.3	Green Euro wallet component.....	29
4.2.5	One Stop Shop – Marketplace Services.....	29
4.2.6	DREEM model.....	31
5	CONCLUSIONS.....	32

List of Figures

FIGURE 1 COMPONENT ARCHITECTURE: DATA SOVEREIGNTY SERVICE	14
FIGURE 2 INFO & FUNDING SERVICE	17
FIGURE 3 MATCHMAKING SERVICE	18
FIGURE 4 KNOWLEDGE BASE	20
FIGURE 5 EXPANDED ARCHITECTURE OF THE DREEM MODEL AS FURTHER DEVELOPED, MODIFIED, AND ADJUSTED IN THE CONTEXT OF THE FORTESIE PROJECT	21
FIGURE 6 PILOT 3 DIGITAL SERVICES ARCHITECTURE	26
FIGURE 7 QUIZ WORKFLOW	28
FIGURE 8 PRICE-COMFORT CHALLENGE WORKFLOW	29

List of Tables

TABLE 1 MAPPING BETWEEN FORTESIE SERVICES AND COMPONENTS OF THE ARCHITECTURE 22

Abbreviations

API	Application Programmable Interface
CBDC	Central Bank Digital Currency
CO ₂	Carbon dioxide
DREEM	Dynamic high-Resolution dEmand-side Management
EPC	Energy Performance Contract / Energy Performance Certificate
ESIE	Efficient, Sustainable and Inclusive Energy
ETSI	European Telecommunications Standards Institute
IoT	Internet of Things
NGSI-LD	Next Generation Service Interface with Linked Data
UI	User Interface
ZKP	Zero Knowledge Proof

Executive Summary

This deliverable is part of FORTESIE WP2 “Design of Combined Service Packages” and specifically, it represents the work conducted for T2.2. This deliverable relies on the content already described in D2.2, where all the services were described, and focuses on the updates that have been agreed during the last part of the task.

As a result, this document categorizes services into two types: those with revised components and those that remain unchanged. For the updated services, detailed descriptions replace previous documentation, while general descriptions suffice for services without changes.

Key services include:

- **Data Sovereignty Service:** Collects and manages IoT data with secure user access.
- **Data Analysis Service:** Delivers insights from IoT data to inform user behaviour and reward mechanisms.
- **Behaviour & Recommendation Service:** Personalizes recommendations and challenges based on user data.
- **User Engagement Service:** Engages users through analytics, visualizations, and tracking.
- **User Profile Service:** Manages user accounts and gamified recommendations.
- **Improvements Achieved Calculation and Green Euro Rewarding Service:** Monitors energy improvements for user rewards and user trust.
- **One-Stop-Shop Marketplace:** Connects stakeholders to cost-effective building renovation solutions.
- **Dynamic high-Resolution dEmand-side Management (DREEM) model:** Provides in-depth analysis of renovation measures' cost-effectiveness for energy efficiency.

This deliverable also examines the added value that each FORTESIE service contributes to the pilot scenarios, highlighting the unique enhancements and improvements FORTESIE offers in each context. It focuses on the practical benefits and innovations these services bring, supporting the achievement of the ideal outcomes envisioned for each pilot.

Together, all the FORTESIE services aim to enhance both the project's impact and the stakeholders' decision-making capabilities for future energy investments.

1 Introduction

1.1 Project Introduction

The overall vision of FORTESIE is to design, demonstrate, validate and replicate innovative renovation packages in the building industry with Smart Performance-Based guarantees and financing, aiming at Efficient, Sustainable and Inclusive Energy (ESIE) use to accelerate the Renovation Wave in Europe. The renovation packages will combine state-of-the-art construction materials and technologies components (prefabricated facades, BIPV, heat pumps, etc.), innovative digital technologies for measurement and verification, and attractive financing (e.g. contractual frameworks for smart performance guarantees, financing mechanisms, engagement techniques, green-euros, etc.), to raise the overall EPC value proposition. The renovation packages will be tailored to specific target groups needs and optimised to improve the ESIE performance considering energy, CO₂ and comfort. Each package will be demonstrated and validated in real life use cases and customised for replication in all other partner countries for immediate market take-up.

Methodologies from Social Sciences and Humanities (SSH) will be adopted for:

- a. the creation of collaborative business models that boost the Renovation Wave by considering all stakeholders' value and revenue streams,
- b. novel incentivisation and behavioural change models that aim to stimulate long term engagement with focused interactions to adopt green behaviour
- c. the incorporation of a digital currency, green-euro, (€G) for financing, rewarding and creating an inclusive / collective narrative in the fight against climate change
- d. the collection of feedback for recommendations to policy and business stakeholders,
- e. Mapping and understanding the complex interplay between the different stakeholders to deliver an engagement strategy across the value chain.

These demonstrations will potentially constitute the green-euro as a retail Central Bank Digital Currency (CBDC), hence revolutionising the financing of renovation approaches. An online marketplace, will be offering first level advice, directing consumers through the value chain of stakeholders and facilitating access to these “packaged” renovation services.

1.2 Deliverable Purpose

The main goals of this deliverable are the following:

- To review the services and pilots' description in D2.2 and to evaluate if their description continues to be accurate.
- To update all the content that needed to be changed during the development phase.
- To describe the added value of the services provided to the pilots.

1.3 Structure of the Document

This deliverable is structured as follows:

- Section 1 provides the introduction of the deliverable.
- Section 2 describes the FORTESIE digital services and components, focusing on the updates from D2.2.
- Section 3 maps the correspondence between the services and the components of the architecture.
- Section 4 explains the pilot updates and the added value of the components for the pilots.
- Finally, Section 5 shows the main conclusions.

1.4 Terminology

To facilitate analysis, design, organisation and delimit the various parts of the FORTESIE Digital Architecture, a specific terminology was established. In the relevant section the Service and Component description is included.

Service: An end-to-end functionality that is composed of multiple components, working together to provide a complete and integrated solution to a business need. (Process and store IoT data, data analysis, calculate green euros, etc.)

Component: A standalone object that performs a specific function such as a database, backend, UI etc.

A component refers to an object that performs a specific function of a specific service.

2 FORTESIE digital services and components

The FORTESIE project includes a range of digital services that consist of several components. These are designed to support the renovation and digitalisation of pilot buildings, along with the engagement of the users towards more sustainable energy behaviours, their rewarding with green euros and other mechanisms.

2.1 Services and Components List

The digital services and components of FORTESIE have been already described in detail in D2.2. Next, a list with the all the services and their corresponding components is detailed.

- Data Sovereignty Service
 - Data collection component
 - Data filtering & pre-process component
 - Data storage component
 - Data serving component
 - Security component
- Data Analysis Service
 - Data processing and analysis component
 - Data visualisation component
 - Data querying and data serving component
 - Data storage component
 - Security component
- Behaviour & Recommendation Service
 - Data processing and analysis component
 - Data querying and data serving component
 - Data storage component
 - Security component
 - Recommendations component
 - Gamified mobile application
- User Engagement Service
 - Data querying and data serving component
 - Data storage component
 - Data processing and analysis component
 - Notification component
 - Data visualisation component
 - Security component
 - Gamified mobile application
- User Profile Service
 - User profile UI component
 - Gamified mobile application
 - Security component
 - Data storage component
- Improvements Achieved Calculation and Green Euro Rewarding Service
 - Data storage component
 - Data querying and data serving component
 - M&V component
 - EPC component
 - Green Euro rewarding component
 - Green Euro wallet component
 - Security components

- One Stop Shop – Marketplace Services
 - Match-Making Service
 - Info & Funding Service
 - Renovation Recommendation Service
 - Knowledge Base Service
- DREEM model

In the following sections each of the services is described. There are two kinds of services:

- Services in which **some components have changed** in their scope or in some details: the list of components in them is described in depth, and this description should be considered to replace the one which appeared on D2.2.
- Services **that did not need an update**: in this case, in this document only a general description of the service is described. The details of each component or the diagrams that should be considered as finals are the ones that appeared on D2.2.

2.1.1 Data Sovereignty Service

The Data Sovereignty Service is supported through the relevant components. More specifically, a data collection component that is responsible for capturing, collecting, and forwarding data from IoT sensor devices to the data storage component. A Data serving component uses a NGSI-LD compatible temporal API for other services to have access to the data. Additionally, the service includes a security component for user identification and access management purposes.

2.1.1.1 Update of the Data Sovereignty Service

Some of the components have been slightly modified from D2.2 and a “data serving component” is included to expose the stored data. As a result, the complete and updated service component list is the following:

Service components list:

- **Data collection component:** The data collection component is responsible for capturing, collecting, and forwarding data from IoT sensor devices to the data filtering & pre-process component.
- **Data filtering & pre-process component:** This component pre-processes and homogenises data collected from the data collection Component.
- **Data storage component:** This component is designed to store and index data in a structured format for easy retrieval and analysis. It can store and manage large amounts of data collected from the IoT sensor devices, to be provided to the other components that need to use the data, such as for analytics or for deciding on the recommendations.
- **Data serving component:** This component is designed to expose the stored data from the Data storage component using the ETSI NGSI-LD temporal API. With the use of the NGSI-LD temporal API the FORTESIE services can query and access the historical data from all IoT sensor devices that have sent data to the Data collection component.
- **Security component:** The security component is responsible for user or entity identification and access management purposes, ensuring that only authorised personnel has access to the data. This is valid for any user (by mobile app) or entity which requests them like the analytics or the recommendation engine.

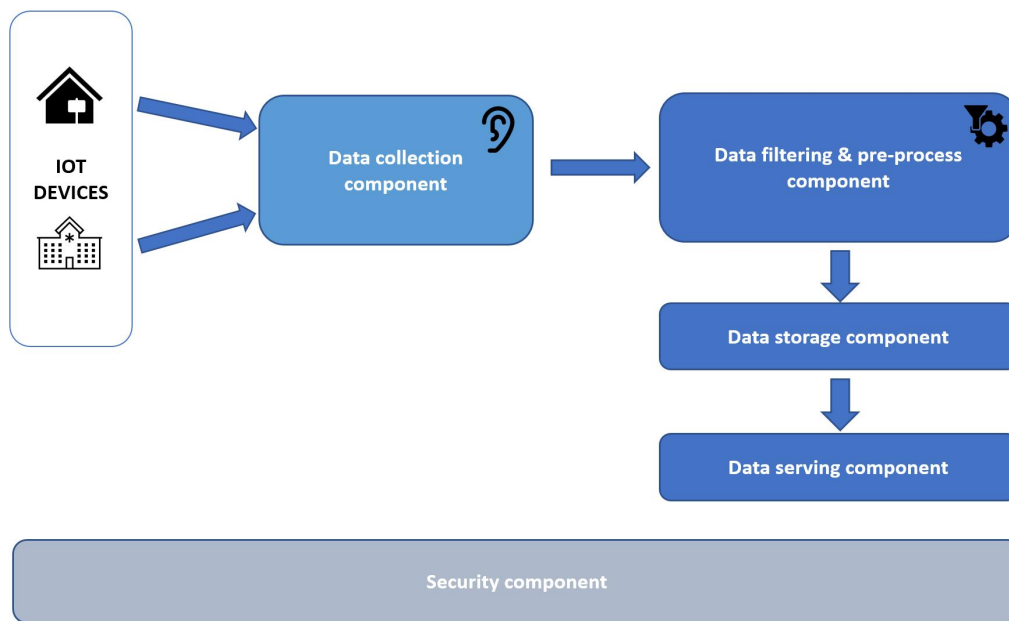


Figure 1 Component Architecture: Data Sovereignty Service

2.1.2 Data Analysis Service

The Data Analysis Service plays a crucial role in our system by providing in-depth insights and continuous analysis of the data collected from IoT devices among others. After the analytical procedures the service's generated output is forwarded to the Behavioural & Recommendation Service and to the Improvements Achieved Calculation and Green Euro Rewarding Service.

The Data Analysis Service consists of a data querying and data serving component that combines data from different databases based on specific queries and processes. Then, it feeds the data processing and analysis component which analyses and extracts insights from the data. The analysed data are stored and indexed in a structured format. It also includes a data visualisation component to create user friendly visualisations, charts, and reports. Additionally, it has automated tasks that execute data processing and analytical jobs at specific timeslots. Finally, the service includes a security component for user identification and access management purposes.

2.1.2.1 Update of the Data Analysis Service

There are no updates regarding the Data Analysis Service.

2.1.3 Behaviour & Recommendation Service

The Behaviour & Recommendation Service consists of the data processing and analysis component, as well as a recommendation component that provides personalised recommendations and challenges to the user. These results are stored in the data storage component and used at the next steps for further analysis that will lead to the calculation of the achieved improvements. Additionally, the service includes a security component for user identification and access management purposes.

2.1.3.1 Update of the Behaviour & Recommendation Service

In this service, the description of the scope of each component remains the same as D2.2. However, the Recommendation component has been updated according to the following description:

- **Recommendation component:** This component generates personalised recommendations to the user for the optimisation of the usage and energy consumption of the (IoT) devices. As of

M25, new energy and renovation recommendation content has been developed for residential (e.g. homeowners) and professional users (e.g. pool and museum staff). This content has been written to specifically support the quiz and gamified challenges related to energy baselines and 'comfort factor' parameters. Bilateral workshops have also been completed with each pilot to allow for further tailoring of the recommendation content to the unique context of each demo.

2.1.4 User Engagement Service

The User Engagement Service consists of a data querying and serving component, which combines data from different databases based on specific queries that are in turn leveraged for analytics, tracking and notifications. This service also has the mobile application as data visualisation component where users can view (through various visualisations) all the available system insights.

2.1.4.1 Update of the User Engagement Service

The mobile application introduces the concept of the "comfort price" or "comfort factor" to enhance user engagement. It is a metric that quantifies the financial impact of maintaining specific indoor comfort levels. This metric informs users of the cost implications of adjustments to their home environment, such as heating or cooling, thereby raising awareness of the financial and energy demands associated with their comfort. The comfort price metric also allows users to understand potential cost savings achievable through energy-efficient renovations. By providing this quantitative insight, the application promotes informed decision-making, encouraging users to consider the economic and environmental impact of their comfort choices

2.1.5 User Profile Service

The User Profile Service includes a UI component for registering, signing up, logging in, and gathering user information. A data storage component is used to store user engagement data and user information. Furthermore, the mobile application will provide the personalised recommendations and challenges to the users' mobile phones in a gamified way.

2.1.5.1 Update of the User Profile Service

There are no updates regarding User Profile Service.

2.1.6 Improvements Achieved Calculation and Green Euro Rewarding Service

The Improvements Achieved Calculation and Green Euro Rewarding Service uses a data querying and serving component that provides the necessary insights to the M&V component, which in turn facilitates the IPMVP standard. The M&V component provides a layer of measurements and verifications to ensure the accuracy and credibility of the energy improvements achieved by the users. Finally, if the achieved improvements meet the requirements outlined in the Energy Performance Contract (EPC) ESCO applies EPC terms of contract (bonus for some contracts). If the achieved improvements meet the requirements outlined in the challenges or recommendation engine, the Green Euro rewarding component rewards the users with monetary compensation in the form of €G into their digital wallets.

2.1.6.1 Update of the Improvements Achieved Calculation and Green Euro Rewarding Service

Some of the components have been slightly modified from D2.2 so the service list is updated.

Service components list:

- **M&V (Measurement and Verification) component:** The M&V and the EPC components are closely related. Both of the developments have seen significant improvements since their inception in order to adapt them to the requirements of the partners and the relationship with other components. The M&V component comprises a central component in the architecture that reads and implements the rules of the energy performance contracts. This helps to have a neutral calculation layer that gives the consumer and other components a secure way to consume this information. As described both in the architecture and in the last description of this service, this is crucial to ensure the credibility of the measurements. The process of developing this component has encountered several key obstacles that had to be overcome. The first one is the variety of different processes followed by the companies to implement energy performance contracts. Although it follows international protocols this process is followed by companies (ESCOs) by their own rules, often implemented in excel sheets. During the project we have worked closely with the energy companies to adapt their process to a neutral layer and although it presented some difficulties it has proven that the component and the platform are necessary to shed some light to the consumers and other actors about the calculation processes and the measurements.
- **EPC (Energy Performance Contract):** The EPC component is centred in the use of blockchain technology in conjunction with the M&V developments to improve on the capabilities of transparency of the platform. As such for the development of this component a wide research has been done to find the best approach to apply this technology in the context of energy performance contracts. Always having in mind that the end objective is to give more transparency and trustworthiness to the overall platform in a way that doesn't interfere with its functioning and designed taking into account the scalability of the final solution. This is very important in the field of electrical consumption, as there are many use cases that develop platforms that later cannot handle the volume of transactions required. After the research we have chosen to use Zero Knowledge Proof technology in combination with Blockchain to assure that the EPCs are being enforced correctly. To put in simple terms ZKPs allow us to check if a statement or calculation is true without revealing it. This way we can issue and record in a blockchain the proof, in this case the proof that a EPC has been calculated correctly and revealing (thus certifying) the savings. This feature for us is key in translating the benefits of the technology to the platform, because it doesn't impose any downside or extra steps in the functioning of the platform, but it has a lot of versatility, especially considering the possibility of collaboration with authorities, regulatory bodies or other platforms. All without revealing information on customers. The main challenge in this development has been the use of novel technologies and libraries, but the results are very promising and scalable.
- **Green Euro rewarding component:** The €G rewarding component is closely related to the M&V component as the €G rewarding components takes input from the M&V component. The process of developing this component encountered several obstacles that lead to the concept of "price-comfort" factor. This factor is a constant factor that will serve as a baseline as it does not need to be changed according to Degree Days for each month. This new concept is explained in detail in D2.6.
- **Green Euro wallet component:** Since the past reports describing the introduction of the new technology to code the €G wallet component, no further improvements were made. Those technologies, and the UX work performed for the €G wallet and the CCO2 App have been transferred and applied to the FORTESIE App, resulting in the 2 potential scenarios described in the figures in section 4.2.4.2.

2.1.7 One-Stop-Shop Marketplace

The primary objective of the OSS Marketplace is to deliver a stakeholder-centered model, allowing diverse participants—such as building owners, designers, policymakers, ESCOs, and renovation firms—to engage with the market. It demonstrates how the platform gathers detailed information on

specific buildings and offers cost-effective renovation solutions. To maximise accessibility, the OSS Marketplace will be available in seven languages: English, Greek, French, Spanish, Portuguese, Latvian, and Polish, ensuring broad usability and effective communication across regions.

The OSS platform consists of four digital services:

- Matchmaking Service
- Info & Funding Service
- Renovation Recommendation Service
- Knowledge Base

These services are designed to support the various stakeholder through value-adding functionalities.

2.1.7.1 Info & Funding Service

The Info & funding Service will provide information about funding opportunities for building renovation projects. It will help stakeholders to identify the most suitable funding schemas and sources for their projects and provide them with information about the application process, eligibility criteria, and funding requirements.

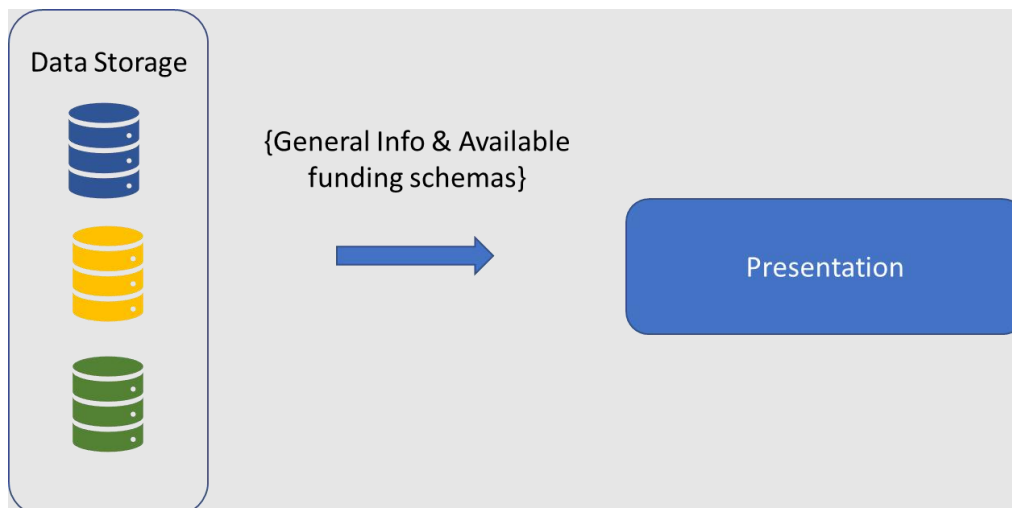


Figure 2 Info & Funding Service

2.1.7.2 Update of the Info & Funding Service

The Info & Funding Service on the Marketplace is a comprehensive resource to guide stakeholders through the maze of available funding opportunities and EU policies relevant to building renovations. This service is divided into two main sections: Policies and Financing Options. Each section is designed to support building owners, project managers, and other stakeholders in understanding how they can maximise financial support for sustainable building upgrades.

Service Overview

The Info & Funding Service aims to:

- Provide in-depth information on EU and national policies supporting energy-efficient renovations.
- Help users identify suitable funding schemes and understand eligibility requirements, application processes, and funding criteria.
- Empower users to make informed decisions on sustainable renovation projects, benefiting both the environment and their finances.

Info & Funding Service Details

1. ESIE Section

The ESIE section offers an interactive Q&A section where users can find answers to common questions about energy-efficient solutions for industry. This section aims to clarify best practices, offer guidance on compliance, and provide tips on integrating sustainable technologies into business operations. It's designed as a knowledge-sharing space, helping users understand the platform's tools and resources for improving energy usage. Users can access this Q&A to explore tailored solutions and better navigate the platform's offerings for sustainable practices.

2. Policies Section

This section covers key EU policies driving the transition toward energy-efficient buildings. It educates users about the European Green Deal, the Energy Efficiency Directive (EED), and other policies that make energy-efficient renovations attractive and feasible.

3. Financing Options Section

This section provides detailed information on innovative and alternative financing options available for renovation projects. It helps users find ways to fund renovations through grants, loans, tax breaks, and other financing mechanisms tailored to support energy efficiency and sustainability.

2.1.7.3 Matchmaking Service

The Matchmaking Service on the FORTESIE Marketplace enables stakeholders to connect for renovation projects by matching them based on skills, expertise, and project needs. This process is facilitated through a searchable catalogue of suppliers and products, where users can browse and identify suitable matches. Additionally, registered partners can post collaboration requests, allowing them to specify project details and seek partnerships directly. This dual approach streamlines connections, making it easier to find compatible partners and resources for successful, energy-efficient project outcomes.

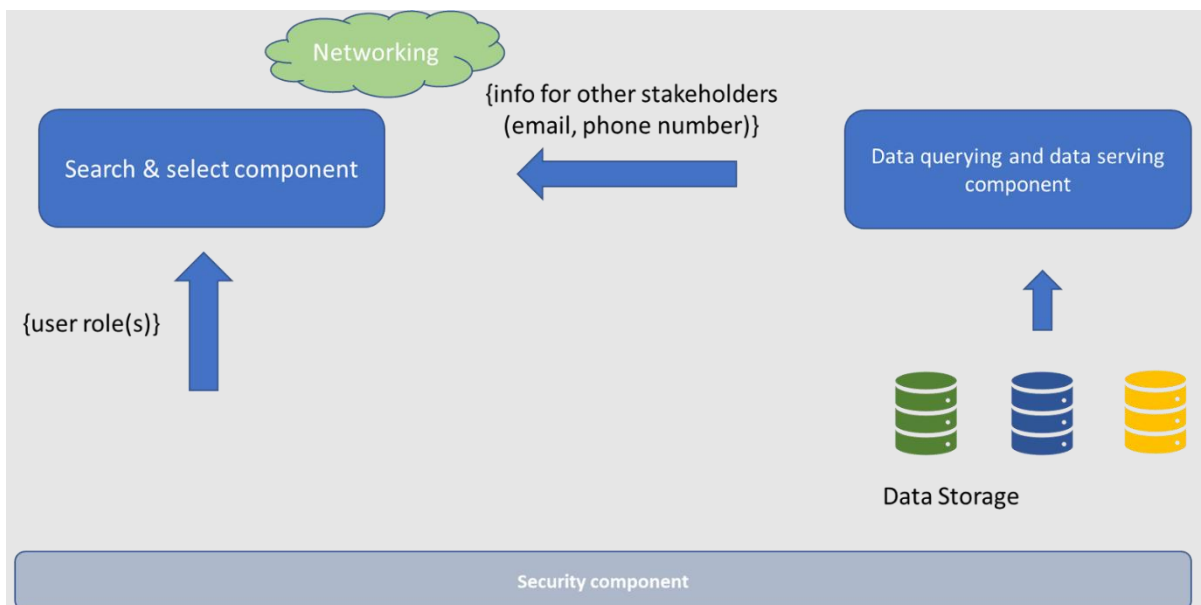


Figure 3 Matchmaking Service

2.1.7.4 Update of the Matchmaking Service

The Marketplace's **Match-making service** offers a streamlined, user-friendly search page to connect users with ideal partners, services, products, and renovation packages. Designed to enhance access to renovations, the search page offers versatile filter options tailored to user needs.

Users can start their search journey through several flexible filter choices:

- **Free Text Search** - Allows users to enter keywords related to specific renovation needs, enabling personalized search results.
- **Dropdown Filters** - Users can refine their search by selecting from predefined categories, such as location, type of provider, or specific renovation products and services.

Filters provide flexibility, allowing users to apply one or multiple options to fine-tune their results. If no filters are selected, a comprehensive list of all partners, products, and services appears, ensuring maximum visibility.

Filter Options Include:

- **Location** - Select countries across Europe.
- **Renovation Products** - Specific items like Smart Windows, Heat Pumps, or HVAC systems.
- **Service Packages** - To be determined.
- **Type of Provider** - Options include ESCOs, Design Professionals, Digital Solution Providers, and more.

Tailored Search Results: When using “Find a Service” or “Find a Product,” users receive a list of partners that offer the selected items, ensuring the results align closely with their needs. This targeted approach enables efficient identification of collaborators whose offerings match the user's specific requirements.

Partner Profile Overview: Upon selecting a partner, users are directed to a detailed profile showcasing essential partner information, including:

- **Logo and Company Name** - Branding and easy identification.
- **Short Description** - A brief overview of the partner's core offerings.
- **Location** - Partner's geographic area to facilitate local connections.
- **Type of Organization** - Specifies public, private, or other structures.
- **Website Link** - Directs to the partner's site for further information.
- **Products and Services Provided** - Detailed lists to inform decision-making.
- **Expertise** - Highlights specialized services and areas of expertise.
- **Past Work** - Displays previous projects with descriptions and visuals, showcasing capabilities.
- **Contact Options** - Members can directly message partners, while non-members are prompted to join for communication access.

This **Find a Partner** feature enables users to navigate the Marketplace with ease, fostering collaborations and simplifying the path to securing trusted partners for renovations.

2.1.7.5 Renovation Recommendation Service

The Renovation Recommendation Service will use data analytics to provide users with tailored renovation suggestions. By inputting details like building size, users receive examples of past renovations that are similar to their own cases. The tool shows what actions were taken in these previous examples, detailing the methods and materials used, and highlights the resulting benefits. This comparative approach helps users make informed decisions on effective renovation strategies based on real-world outcomes.

2.1.7.6 Knowledge Base

The Knowledge base is designed to serve as a repository of information about building renovation projects. It will provide stakeholders with access to relevant data, reports, case studies, and best practices, helping them to make informed decisions about their projects.

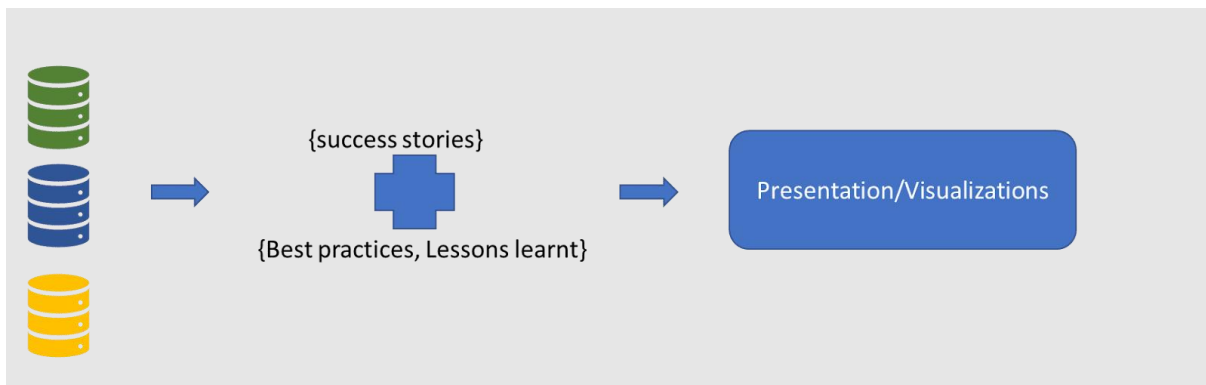


Figure 4 Knowledge Base

2.1.8 The Dynamic high-Resolution dEmand-side Management (DREEM) model

The primary objective of applying the Dynamic high-Resolution dEmand-side Management (DREEM) model is to provide actionable outcomes and recommendations for end-users (consumers/citizens) and other stakeholders. This aims to empower their active participation in the energy transition by raising awareness of the benefits of investing in new products and services. While the necessary technological infrastructure is often in place, innovations in business models and regulatory frameworks are required to maximise the value of these products and services. In addition, monetisation strategies are needed to ensure end-users are adequately compensated for their investments.

In the context of FORTESIE, DREEM plays a critical role in evaluating the cost-effectiveness of different portfolios of ESIE improvement measures. These portfolios are analysed in conjunction with various financing schemes that are tailored in the different socioeconomic contexts related to the project's pilots, which may vary in scale, technology, and location. The model integrates a wide range of factors including energy savings, investment costs, operational efficiency, and financial incentives, to provide a comprehensive assessment of potential interventions.

By using the DREEM model, decision-makers can compare long-term impacts of different energy efficiency renovation packages. The model also incorporates risk a technoeconomic analysis using key indicators such as Net Present Value, Levelised Cost of Saved Energy, and Payback Periods, ensuring that the chosen portfolios not only enhance energy efficiency but also align with the project's overall objectives. The ultimate goal is to aid stakeholders, including project developers, policymakers, and investors, in making informed decisions about the optimal financing and implementation of energy efficiency interventions, ensuring that both economic viability and sustainability targets are met.

2.1.8.1 Update of the Dynamic high-Resolution dEmand-side Management (DREEM) model

The methodology underpinning the application of the DREEM model in the FORTESIE project has been comprehensively outlined in project deliverables (e.g., Deliverable 2.2, Deliverable 3.1). Building on this foundation, this section outlines the necessary expansion of the model's original architecture and capabilities, as first introduced by Stavrakas & Flamos, 2020, to meet the specific modelling requirements of the FORTESIE project.

The updated modelling structure of DREEM is presented in Figure 2.

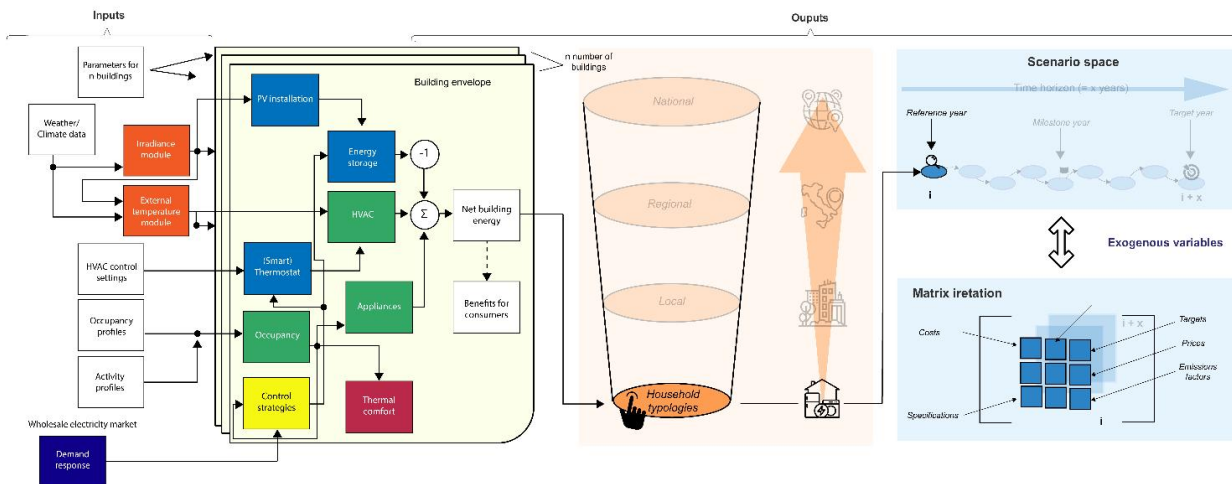


Figure 5 Expanded architecture of the DREEM model as further developed, modified, and adjusted in the context of the FORTESIE project

Below, we provide a description of the components and respective modules that have been further developed and integrated into the original model's structure, along with the components and modules that have been used for the application at hand.

- **C₂: Building envelope** (further developed, Modelica-Python): responsible for modelling different building typologies with the corresponding characteristics, properties, and heat conduction elements.
- **C₄: Thermal comfort** (further developed, Modelica - Python): responsible for determining, based on international standards, appropriate conditions and temperature ranges that result in occupants' thermal satisfaction.
- **C₉: Transition matrix** (further developed, Python)
 - **C₉M₁: Scenario space**: responsible for designing the scenario space (in terms of different transition pathways and the respective exogenous variables) based on each socioeconomic context, relevant policy documents' specifications and practical experts' feedback.
 - **C₉M₂: Matrix iteration**: responsible for initialising the transition matrix and updating it at each time interval (i.e., iteration), following the scenario space's specifications (i.e., targets and constraints) derived from the "C₉M₁: Scenario space" module.

3 Correspondence between the services and the modules developed in the Architecture

The current document manages the services defined to carry out all the functionalities needed for FORTESIE. However, as each service is formed by a group of components, these components usually are part of different elements of the architecture. As the architecture is the key to develop the implementation of the digital components, in the rest of the technical deliverables from WP2 and WP3 (e.g. D2.3, D2.6, D3.1, D3.2), we usually refer to the components in the architecture. But each component of the architecture can be allocated to different services. In order to clarify the correspondence between the services and the components described in the architecture, the following table shows the mapping between them.

Table 1 Mapping between FORTESIE Services and components of the architecture

Service	Component	Correspondence in Architecture
Data Sovereignty Service	Data collection component	Data Sovereignty Component
	Data filtering & pre-process component	Data Sovereignty Component
	Data storage component	Data Sovereignty Component
	Data serving component	Data Sovereignty Component
	Security component	Data Sovereignty Component
Data Analysis Service	Data processing and analysis component	Data Analysis Component
	Data visualisation component	Mobile application
	Data querying and data serving component	Data Analysis Component
	Data storage component	Data Sovereignty Component
	Security component	Data Analysis Component
Behaviour & Recommendation Service	Data processing and analysis component	Data Analysis Component
	Data querying and data serving component	Data Analysis Component
	Data storage component	Data Sovereignty Component
	Security component	Security by design implemented in: - Data Sovereignty Component - Mobile application - Data Analysis Component
	Recommendations component	Behavioural model and recommendation engine

Service	Component	Correspondence in Architecture
	Gamified mobile application	Mobile application
User Engagement Service	Data querying and data serving component	Data Analysis Component
	Data storage component	Data Sovereignty Component
	Data processing and analysis component	Data Analysis Component
	Notification component	Mobile application
	Data visualisation component	Mobile application
	Security component	Security by design implemented in: - Data Sovereignty Component - Mobile application
	Gamified mobile application	Mobile application
User Profile Service	User profile UI component	Mobile application
	Gamified mobile application	Mobile application
	Security component	Security by design implemented in: - Data Sovereignty Component - Mobile application
	Data storage component	Data Sovereignty Component
Improvements Achieved Calculation and Green Euro Rewarding Service	Data storage component	Data Sovereignty Component
	Data querying and data serving component	Data Analysis Component
	M&V component	M&V and EPC components
	EPC component	M&V and EPC components
	Green Euro rewarding component	Green-Euro Application
	Green Euro wallet component	Green-Euro Application
	Security component	Security by design implemented in: - Data Sovereignty Component - M&V and EPC components - Green-Euro Application
One Stop Shop –	Match-Making Service	Marketplace

Service	Component	Correspondence in Architecture
Marketplace Services	Info & Funding Service	Marketplace
	Renovation Recommendation Service	Marketplace
	Knowledge Base Service	Marketplace
DREEM model	DREEM model services	DREEM model

4 The pilots

In D2.2 each pilot outlined a comprehensive usage scenario. This included a detailed description of the primary actors involved, any alternative actors who might also participate, as well as those particularly interested in the outcome of the scenario. Each scenario section provided an overview of the setting, identifying the potential benefits and challenges associated with it. Additionally, a specific workflow for the pilot was described, mapping out the sequence of activities and interactions among actors to achieve the intended results of the scenario.

Therefore, these scenarios were defined as the "ideal" scenario for FORTESIE. This envisioned scenario represents the optimal deployment of FORTESIE, set to take place after the project has concluded, where all technical components are fully operational, and the product is available on the market. This perspective offers a long-term vision, presenting FORTESIE's intended impact and function under ideal conditions.

In addition to these scenarios described in D2.2, the pilots continued to work during WP4 in the pilots definition and implementation. In contrast, the WP4 description of the pilots focuses on the present realities of testing and validation. Its objective is to assess and refine the technology to ensure readiness by the project's end. WP4 acknowledges the current state of development, emphasising practical evaluations over idealised outcomes to address any limitations, enabling FORTESIE to achieve the intended level of maturity for future market deployment.

Therefore, the scope of the pilots during the last phase of the project is part of WP4. However, in D2.5 the definition of the pilot scenario is maintained in its view of an envisioned scenario that could be possible after the project ends. As a result, the content of D2.2 from each pilot has been reviewed and, in a similar way to the services description, only relevant updates are reported in D2.5.

4.1 Pilot updates

4.1.1 Pilot 1 – Unleashing green cultural experience

The only relevant update that needs to be reported is regarding CO₂ measurements. In D2.2 it is explained that CO₂ levels will be measured, but instead of this, what is measured is air quality, using Particulate Matter (PM_{2.5}) levels.

4.1.2 Pilot 2 – Green, comfortable and sustainable home

There are no relevant updates in this pilot, but a clarification needs to be made. In this pilot, there are two usage scenarios without specifying to which specific sub-pilot they are related to:

“Pilot 2 Usage Scenario 1” represents the pilots in which a community of owners is the decision maker, so the community of owners is the entity that will search for and do the contract for FORTESIE. In Pilot 2 this represents the VEO and GAR sub-pilots.

“Pilot 2 Usage scenario 2” represents the pilots in which the owner is the decision maker. In Pilot 2 this represents the OKT sub-pilot.

4.1.3 Pilot 3 – Green, comfortable and sustainable home

The description of the usage scenario specified in D2.2 continues to be valid. However, when D2.2 was delivered, no final decision was made related to the sensors to be used in this specific pilot. Finally, the sensors that will be used are similar to those used in the rest of the services, which are based on IoT. As a result, the following image represents an update in the service workflow for Pilot 3.



Figure 6 Pilot 3 Digital Services Architecture

4.1.4 Pilot 4 – Green and comfortable households through prosumer engagement in Cooperatives

No relevant updates have been found for Pilot 4.

4.1.5 Pilot 5 – Green, comfortable working environment

No relevant updates have been found for Pilot 5.

4.1.6 Pilot 6 – Comfortable and sustainable (Public) Pools

No relevant updates have been found for Pilot 6.

4.1.7 Pilot 7 – Comfortable, inclusive, and sustainable green Schools

No relevant updates have been found for Pilot 7.

4.2 Added value

This section provides an analysis of the added value that each of the FORTESIE services bring to each pilot scenario, trying to illustrate the unique contributions and improvements introduced by FORTESIE in each context, emphasising the practical advantages and innovations that the services offer in achieving the ideal scenario envisioned for each pilot.

4.2.1 Data Sovereignty Service

The integration of a Data Sovereignty Service within the FORTESIE project adds significant value by ensuring compliance with European data protection regulations like GDPR, enhancing data security and privacy through secure communication protocols such as mutual TLS. It maintains data ownership and control for stakeholders, fostering trust and transparency in data handling. By adhering to the FORTESIE Data Model and NGSI-LD standards, the service homogenises and standardises data from multiple sources, facilitating seamless integration and analysis. It supports temporal data

representation for robust historical tracking, essential for monitoring trends over time. The use of open-source components and sharing of tools like esthesis and various IoT Agents promote collaboration, interoperability, and innovation within the European digital ecosystem.

4.2.2 Data Analysis Service

The Data Analysis Service provides valuable insights across all project demos by processing the stored data in the Data Sovereignty component. It offers functionalities such as fetching data from Data Sovereignty, performing hourly aggregations, calculating heating and cooling degree days, and running fault detection tests. These functions are not only available on demand but also run periodically, with heating and cooling degree days calculated daily as this information is essential for other processes, such as determining baseline consumption. Additionally, fault detection tests are conducted daily to ensure the integrity of sensor data. The Data Analytics component performs predefined analyses on the stored data, which are visualised by the Mobile Application. Other digital components, such as the M&V and Recommendation Engine, also leverage the outputs from Data Analytics. The added value of the Data Analytics component is demonstrated indirectly through other components that visualise its results or rely on its outputs for further calculations or validations.

4.2.3 Behaviour & Recommendation Service, User Engagement Service and User Profile Service

The Behaviour & Recommendation Service provides tailored, user centric content designed to support intentional behavioural changes. The Recommendation Engine offers functionalities such as interactive quizzes designed to increase user knowledge and understanding of concepts (e.g. energy baselines and comfort factor indicators) as well as gamified challenges such as the 'slow heating challenge' designed to incentive lowering room temperature, and the 'baseline energy challenges' designed to promote monthly improvement to energy consumption levels. Each of these content categories are coupled with complimentary tips, advice, and recommendations designed to provide tailored support to users as they navigate new home energy and renovation information.

The Behaviour & Recommendation Service relies on the user engagement service and user profile service to manage user interaction, so these services set the basics for the behaviour and recommendation service's added value.

4.2.4 Improvements Achieved Calculation and Green Euro Rewarding Service

4.2.4.1 M&V and EPC components:

The main added value of this component is the ability to verify energy measurements for the user, which increases the trust. In addition, as mentioned in the update of the M&V and EPC components, the methods used by the ESCOs to calculate the rewards are based on the IPMVP, but they do not follow all the same rules. As such, having a way to see the results and experiment them with all the explanations is a great way to compare different opportunities and also be trustful of their implementation. This would be possible by the use of blockchain technology.

The M&V and EPC components allow users to be involved by giving them more options and confidence in the whole system. With these components, the users can see their energy contract being enforced on a neutral platform. Also, with the capabilities of the ZKP, we have laid the foundations as to the users being able to compare and share the information of their contract without compromising privacy in a novel way.

4.2.4.2 Green Euro rewarding component

The implementation of quizzes, challenges and recommendations (including DREEM model options) that are pushed to the user have been analysed and the following 2 scenarios presented in the

following pictures are currently considered. Further discussions with all partners involved will determine which options will be retained.

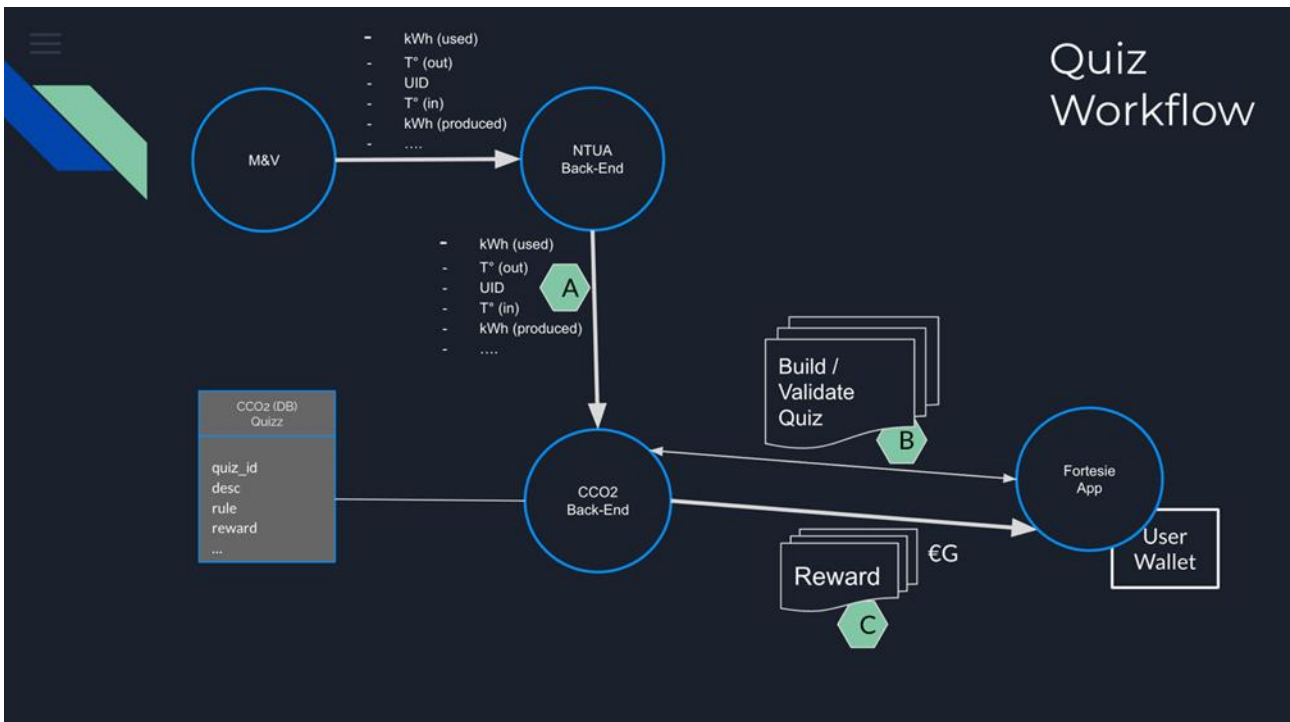


Figure 7 Quiz workflow

Figure 7 represents the Quiz workflow. All the quizzes reward and logic will be handled directly on the CCO2 side. Nevertheless, generating the quiz for the user requires some data from the Analytics back-end. Example - "Your current comfort price is <VALUE>. To get a better comfort and a lower energy invoice you need to:". Thus, endpoints will be needed from Analytics back-end (A step) to be able to properly handle the quizzes.

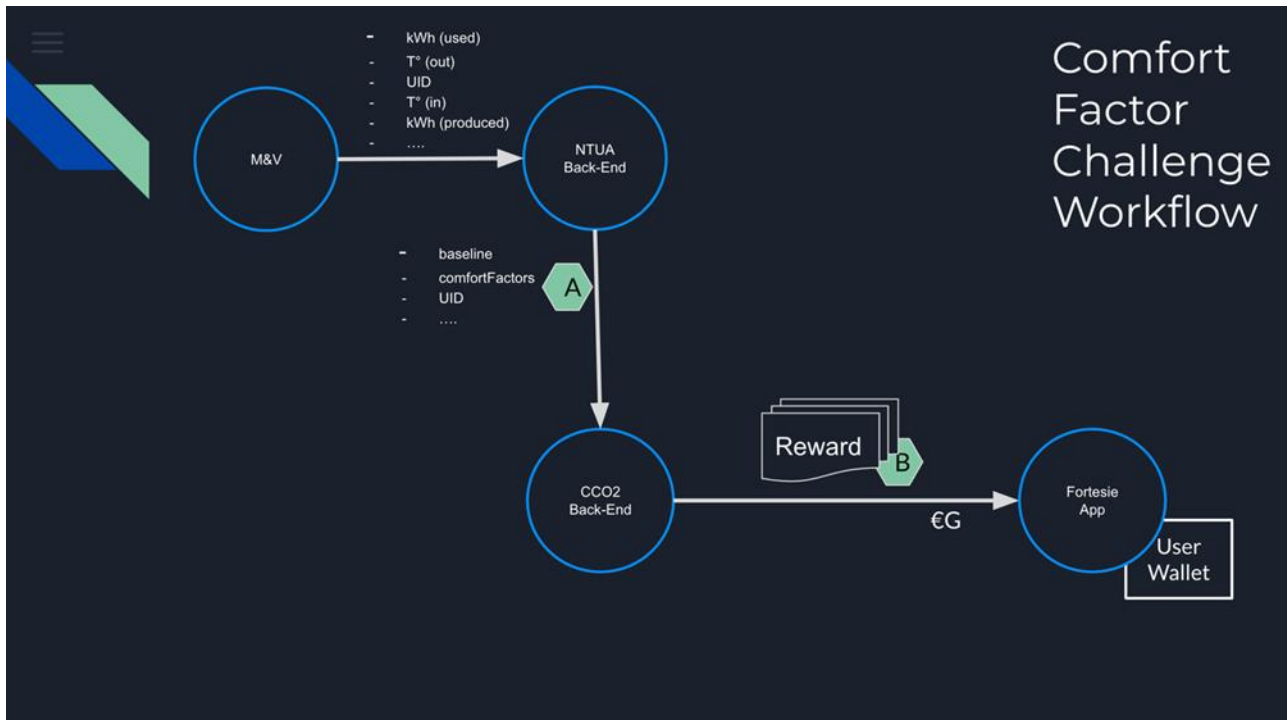


Figure 8 Price-comfort challenge workflow

Figure 8 shows the Price-comfort challenge workflow: Due to the relation between the current challenges, we consider focusing only on the comfort price. Indeed, temperature, kWh consumption and the comfort price are all depending to each other. Thus, we consider running each month only the comfort price challenge. The monthly report card will then be selected depending on a scale of results that has to be defined.

4.2.4.3 Green Euro wallet component

Since the past reports describing the introduction of the new technology to code the €G wallet component, no further improvements were made. Payments corresponding to rewards will be made to end users directly from a FORTESIE wallet held by CCO2 and will not interfere with ESCO EPC contract terms (such as bonus/malus for example). Discussion with ESCOs will continue in order to evaluate the possibility of integration of Price-Comfort concept and payments in future EPCs.

4.2.5 One Stop Shop – Marketplace Services

OSS Services Added Values

Public Buildings (Pilots Covered: 1, 5, 6, 7)

- **Match-Making Service:** Connects public building administrators, such as museum curators, school deans or municipal managers, with experienced energy renovation companies and ESCOs. This service ensures that the right expertise is provided for implementing tailored energy-efficient solutions, reducing the time and effort needed to find trusted professionals. By leveraging this service, public institutions can optimise their renovation processes, resulting in enhanced energy efficiency, comfort, and sustainability. This also streamlines the procurement process, ensuring a seamless collaboration with experts who can deliver impactful energy-saving measures.
- **Info & Funding Service:** Provides public buildings with access to a variety of financial incentives, grants, and funding schemes aimed at supporting energy-efficient renovations. This service reduces financial barriers by guiding users through available funding options, making

green renovations more financially feasible. It also offers step-by-step assistance to ensure that institutions like schools, museums, and municipal buildings can leverage these financial resources effectively, enabling cost-effective implementation of sustainable energy upgrades.

- **Renovation Recommendation Service:** Delivers personalised, data-driven renovation recommendations tailored to the specific needs of public buildings. By analysing data such as energy consumption patterns, building structure and environmental conditions, it provides actionable suggestions for energy efficiency improvements and the relevant renovation activities. This helps public institutions, including schools, museums and municipal offices to enhance indoor comfort while optimising energy use. These recommendations are geared towards achieving both sustainability goals and cost savings, ensuring that renovations align with the requirements of public spaces.
- **Knowledge Base Service:** Offers access to a comprehensive repository of best practices, success stories, and case studies from previous renovation projects. This empowers building managers and administrators to make informed, data-driven decisions regarding energy efficiency improvements. By learning from past experiences, public institutions can adopt proven strategies that increase the effectiveness of their renovations, thereby enhancing the comfort and sustainability of public spaces. This service also promotes knowledge sharing among institutions, helping them to stay up-to-date with the latest energy-saving technologies and methodologies.

Households (Pilots Covered: 2, 3, 4)

- **Match-Making Service:** Helps homeowners and prosumers connect with trusted renovation experts, including ESCOs and energy cooperatives, to address their specific energy efficiency needs. It ensures efficient and successful project execution by matching users with professionals who can deliver tailored renovation solutions, such as solar upgrades, insulation, and heating improvements. This service is particularly valuable for households in energy poverty or with limited resources, providing the necessary expertise to achieve sustainable home improvements.
- **Info & Funding Service:** Offers homeowners access to a wide range of financial schemes, such as grants, zero-interest loans and crowdlending options, making energy-efficient home renovations more affordable. This service not only reduces financial barriers but also attracts community support for energy cooperative projects, enhancing the financial sustainability of household renovations. It provides guidance on how to access and apply for these funding opportunities, helping homeowners maximise their budget for sustainable living.
- **Renovation Recommendation Service:** Provides customised renovation suggestions based on household data, helping homeowners optimise energy use and improve indoor comfort. By offering targeted advice on improvements, such as insulation, ventilation, and solar panel installations, it ensures that renovation efforts lead to significant energy savings and enhanced living conditions. The service is tailored to address the specific needs of individual homes, enabling residents to achieve greater energy efficiency and comfort in their daily routine.
- **Knowledge Base Service:** Equips homeowners with access to educational materials, best practices, and case studies on energy-efficient renovations. This empowers them to make informed decisions about their home improvements, ensuring that they can fully leverage available financial resources and adopt the most effective energy-saving strategies. For energy cooperatives, this service facilitates knowledge-sharing among members, promoting community-driven energy efficiency initiatives and sustainable living practices.

4.2.6 DREEM model

The DREEM model provides added value to the FORTESIE project pilots by enabling a comprehensive and dynamic simulation of energy demand, flexibility, and energy efficiency measures. By incorporating detailed inputs such as weather data, building characteristics, occupancy and activity profiles, HVAC ownership and use, DREEM can provide accurate energy consumption profiles for the project's real-life pilots. This allows for a thorough analysis of the "prior" (baseline) and different "to-be" (future) scenarios, facilitating the assessment of energy-saving potential and economic benefits from implementing smart and conventional energy efficiency measures and renewable energy technologies. In addition to technical assessments, DREEM also simulates behavioural changes, allowing for the quantification of impacts from setpoint adjustments in the project's real-life pilots. This means the model can assess how lowering temperature setpoints—without jeopardising thermal comfort—can lead to energy savings and improved cost efficiency for occupants.

By doing this, DREEM allows for the provision of tailored recommendations that address specific barriers to building renovation, helping to increase the capacity of decision-makers in selecting the most effective strategies. It ensures that end-users are aware of the benefits specific to their case, enabling them to choose the most cost-effective renovation options. Additionally, the model provides policymakers with valuable insights into which energy efficiency measures should be prioritised to enhance renovation efforts. DREEM also helps identify the appropriate levels of incentives and financial support required to promote the uptake of renovations, taking into account the diverse socioeconomic contexts of the project's pilot cases. This comprehensive approach ensures that technical, behavioural, and socioeconomic aspects are addressed, supporting the project's goal of fostering efficient and sustainable building upgrades.

5 Conclusions

As it has been explained throughout this document, only the relevant updates from the services and the pilots have been described in this deliverable. In specific, few changes were made, mostly on the “Data Sovereignty Service”, “Improvements Achieved Calculation and Green Euro Rewarding Service” and “Dreem model”. All the updates described are related to more detailed information concerning these services, as at the time of submitting D2.2, several aspects were not yet defined.

In a similar way, the pilots were reviewed and again few changes have been made to them, mostly for Pilots 2 and 3. In a parallel way to the services, the changes described are related to clarifications on the descriptions on D2.2. The main contributions of this deliverable to FORTESIE were the insights regarding the added value that each service brings to the project. The main conclusion of this document is that the initial proposal of services of D2.2 was quite accurate as only small updates were needed.