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

D2.2 FORTESIE services co-creation			
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Abbreviations

AHU	Air Handling Unit
BIPV	Building Integrated Photovoltaics
CBDC	Central Bank Digital Currency
CIM	Common Impact Model
Dx.y	Deliverable x.y
EPC	Engineering, Procurement, and Construction
ESCO	Energy Service COmpany
ESIE	Efficient, Sustainable and Inclusive Energy
IoT	Internet of Things
IPMVP	International Performance Measurement and Verification Protocol
M&V	Measurement and Verification
ML	Machine Learning
NFT	Non-Fungible Token
NGO	Non-Governmental Organisation
OSS	One-Stop-Shop
PV	PhotoVoltaic
SSH	Social Sciences and Humanities
Tx.y	Task x.y
UI	User Interface
€G	Green Euro

Executive Summary

Deliverable **D2.2 "FORTESIE services co-creation"** constitutes a cardinal step in the FORTESIE value chain. Building on deliverable D2.1 "End-user and pilot requirements and use cases description", and following an SSH-oriented co-creation approach, D2.2 results feed: i) the FORTESIE technical activities (e.g., D2.3 "Reference architecture and components functionality M9", D3.1 "Components' functional design"); ii) the FORTESIE piloting activities (e.g., D4.1 "Pilots preparation, baseline analysis and planning"); and iii) the FORTESIE exploitation activities (e.g., D2.4 "Business models analysis for each service M9").

Towards effectively and efficiently realising the necessary work, **a 5-steps methodology** was developed and followed: Step 1. Collaborative Pilot Information Gathering; Step 2. Deriving Usage Scenarios; Step 3. Digital Components and Services Definition and Workflow; Step 4. Sessions with Pilot Teams – Validation and Fine-tuning; Step 5. FORTESIE Digital Components and Services.

Following the aforementioned methodology, the specific needs/ expectations/ requirements of each pilot were reported and studied, **8 detailed end-to-end usage scenarios** were derived and validated by the respective pilot teams.

By reverse engineering the validated usage scenarios, the **ecosystem of FORTESIE digital services**, as well as their **underlying components** was designed. Specifically, **6 digital services** were identified (namely "Data Sovereignty Service", "Data Analysis Service", "Behaviour & Recommendation Service", "User Engagement Service", "User Profile Service", "Improvements Achieved Calculation and €G Rewarding Service"), plus the "**One-Stop-Shop Marketplace Service**" which includes **4 (sub-) services** (namely "Renovation Recommendation Service", "Info & Funding Service", "Match-making Service", "Knowledge Base"). More than **15 individual components** have been prescribed.

The last step towards completing the FORTESIE digital services' ecosystem was the integration of individual digital services into pilot-specific service workflows; as not all pilots will use every FORTESIE digital service, it is only reasonable and meaningful to create service workflows that best fit each FORTESIE pilot's needs. Thus, **7 pilot-specific service workflows** were designed, communicated to, and validated by the FORTESIE pilot teams.

It must be mentioned that task T2.2 "Value-added services design and specification based on SSH-approach (co-creation)" will deliver on **M25 an updated version** of the document at hand (i.e., deliverable D2.5 "FORTESIE services co-creation M25"), as it follows the dynamic and iterative approach of FORTESIE.

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 (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), 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, CO_2, 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 €G 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 deliverable at hand reports on the first-round results of Task 2.2 "Value-added services design and specification based on SSH-approach (co-creation)". The deliverable reports on the detailed specifications of the FORTESIE digital services, following an SSH (co-creation) approach. The overview of the methodology followed is presented, focusing on the value-adding activities that result to the FORTESIE digital services and usage scenarios. The connection to the previous and follow-up deliverables and project activities (e.g., development, integration, deployment, and validation) is also documented.

The objectives related to this deliverable have been achieved in full and as scheduled.

1.3 Deliverable Structure

This deliverable is structured as follows:

- Section 1 provides the introduction of the deliverable.
- Section 2 describes the methodology used to design the value-adding services and specifications based on the SSH-approach.
- Section 3 provides a synopsis of the work performed for the first step of the methodology analysed in Section 2.

- Section 4 presents the FORTESIE digital services and the underlying components.
- Sections 5 presents and analyses the usage scenario and digital services' workflow for each FORTESIE pilot case.
- Section 6 sums up the FORTESIE digital services' ecosystem.
- Section 7 provides the deliverable's conclusions and discusses the next steps.

1.4 Terminology

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

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 Methodology

This chapter describes the methodology used to design the value-adding services and specifications based on the SSH-approach.

The methodology consists of the following steps:

- **Step 1 – Collaborative Pilot Information Gathering**
  This step involved the first information acquisition phase, where each pilot was interviewed (in the context of the collaborative requirements' elicitation sessions) towards gathering the initial inputs for detailing the pilot usage scenarios. The main focus of this step was to gain a better understanding of the pilot's needs, expectations, and requirements.
- **Step 2 – Deriving Usage Scenarios**
  This step involved a thorough analysis of the reported pilots' requirements (deliverable D2.1 "End-user and pilot requirements and use cases description") towards deriving one detailed end-to-end usage scenario per FORTESIE pilot. The usage scenarios were complemented (when needed) by the information gathered in the previous step (Step 1 - Collaborative Pilot Information Gathering).
- **Step 3 - Digital Components and Services Definition and Workflow**
  Based on the detailed end-to-end usage scenarios, the needs for appropriate digital components were identified for each FORTESIE pilot case.
  As a next step, similarities/commonalities among the identified digital components were recognised, leading to a grouping of the latter, towards defining parent digital services. These digital services embed two or more digital components, providing a complete and integrated solution to a business need.
  Subsequently, the aforementioned digital services (and components) were integrated in a logical workflow that aims to fully serve each usage scenario.
- **Step 4 - Sessions with Pilot Teams – Validation and Fine-tuning**
  After the completion of Step 3, a two-way channel was established with each of the FORTESIE pilot teams, taking advantage of the co-creation potential of the FORTESIE SSH approach. The usage scenarios and the digital services' definitions and workflows were sent to each pilot team, towards either validating the realised work, or correcting/completing/fine-tuning it.
- **Step 5 - FORTESIE Digital Components and Services**
  With the validated usage scenarios and digital services workflows at hand, the final taxonomy of the FORTESIE digital services and underlying components was designed.
  As the main output of T2.2, it will be used as input for tasks T2.3 "Reference architecture tailored to renovation technologies for increased performance", T2.4 "Novel market structures and business models for renovation services" and T3.1 "Digital components development and adaptation".

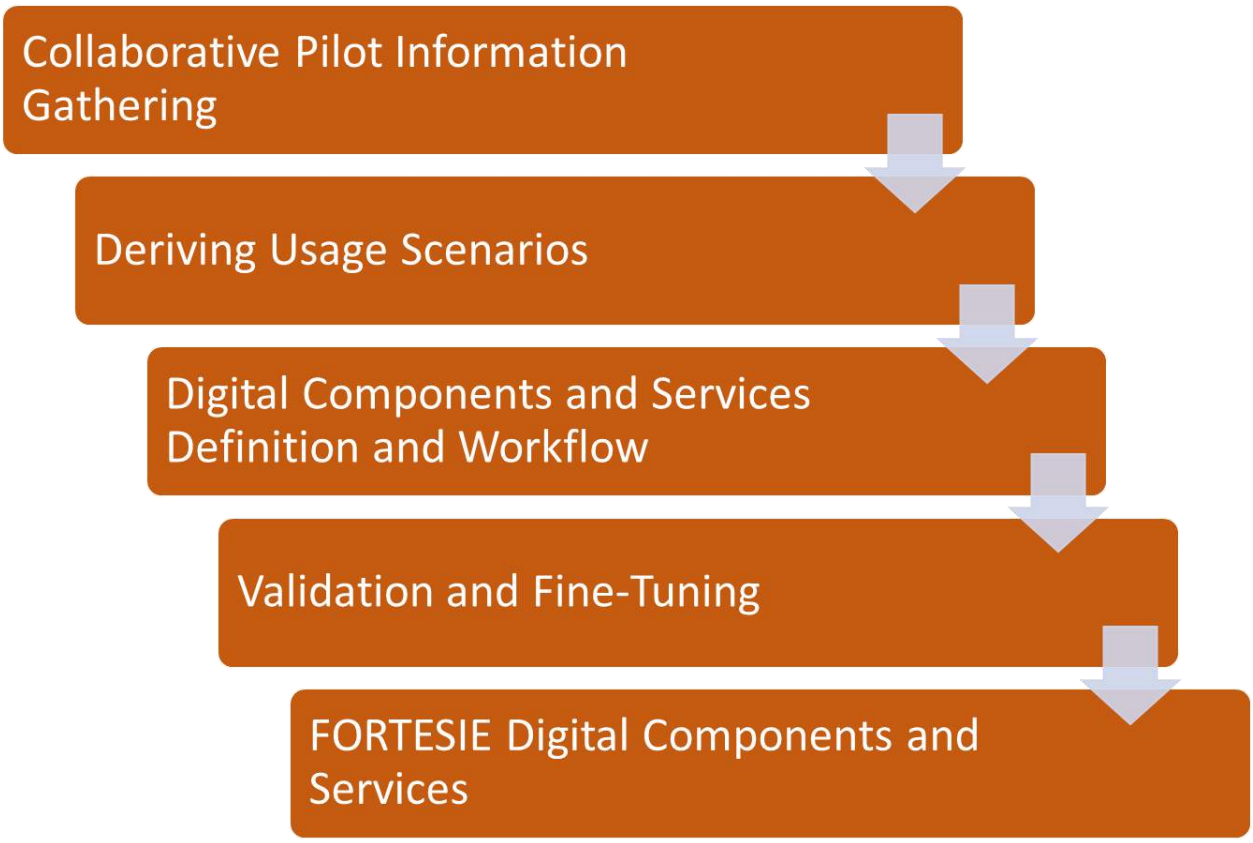

Figure 1 FORTESIE Digital Services' Co-creation Methodology

3 Wrap-up of Target Groups and Pilots' Requirements

The purpose of this section is to provide a synopsis of the work performed for the first step of the methodology analysed in Section 2 and bridge this work with the next methodological steps.

Deliverable D2.1 “End-user and pilot requirements and use cases description” outlined the methodology used to extract end user and pilot requirements. The CIM (Common Impact Model) methodology was employed to understand strategic needs and limitations related to existing ESIE and renovation technologies. Additional specific methodologies were utilised to capture the current situation and stakeholders' requirements. These methodologies were tailored to each pilot, considering the differences in building types, renovation plans, user profiles, and expectations.

The pilots provided valuable information, including the description of pilot sites, analysis of the current situation, and examination of end user and stakeholder requirements using terms like "use cases," "personas," and "user stories." After completing the analysis, the gathered information from all pilots was consolidated to extract the requirements for FORTESIE. This resulted in various target groups per pilot and a total of 13 functional and 16 non-functional requirements.

The following target groups have been identified per pilot:

- Pilot 1: owners and administrators; employees (cashier, guide); visitors.
- Pilot 2: inhabitants; homeowners.
- Pilot 3: energy poor families.
- Pilot 4: prosumer members of Coopérnico.
- Pilot 5: employees.
- Pilot 6: internal users; visitors.
- Pilot 7: building owner; building occupants (teachers, pupils, technical staff, facility staff).

In addition, each of the functional and non-functional requirements address several user stories from different personas. Indicatively: a) The FORTESIE solution shall be able to compare the before and after energy consumption or demand of the building; b) The FORTESIE solution shall be able to provide a trusted method for guaranteeing that the information stored (which is needed for the calculation of the Energy Performance Contract) is not altered. etc.

By thoroughly studying the pilot requirements and the pilot cases as they are presented in the Grant Agreement as well as the finalised version of D2.1, an end-to-end usage scenario was created per pilot (with the exception of pilot 2 that is comprised by two usage scenarios). These scenarios represent how the user would leverage the solution and the services that are going to be designed, for their benefit. These usage scenarios offer a practical glimpse into how the FORTESIE solution will be seamlessly integrated into the daily operations of various stakeholders. They demonstrate the step-by-step interactions between users and the solution, showcasing how it will address their specific needs and cater to their unique roles within the pilot settings.

By developing these usage scenarios, the project gains valuable insights into the practical utility of the solution and the services to be designed. It ensures that the development process aligns closely with the identified target groups and their requirements.

4 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.

4.1 Services and Components List

To help illustrate the scope and functionality of the FORTESIE digital services, this section provides a comprehensive list of each identified service and the components included within it. For each service, a brief description of the components is also included, outlining their role in the service and how they contribute to the overall goal of the project.

1. Data Sovereignty Service
    - Data harvesting component
    - Data filtering & pre-process component
    - Data storage component
    - Security component
2. Data Analysis Service
    - Data processing and analysis component
    - Data visualisation component
    - Data querying and data serving component
    - Data storage component
    - Security component
3. Behaviour & Recommendation Service
    - Data processing and analysis component
    - Data querying and data serving component
    - Data storage component
    - Security component
    - Recommendations component
    - Gamified mobile application
4. 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
5. User Profile Service
    - User profile UI component
    - Gamified mobile application
    - Security component
    - Data storage component
6. 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

4.1.1 Data Sovereignty Service

The Data Sovereignty Service consists of a data harvesting component that is responsible for capturing, collecting, and forwarding data from IoT sensor devices to the data filtering & pre-process component. The data filtering & pre-process component pre-processes and homogenises the data, which is then stored and indexed in a structured format for easy retrieval and analysis. Additionally, the service includes a security component for user identification and access management purposes.

Service components list:

1. **Data harvesting component**: The data harvesting component is responsible for capturing, collecting, and forwarding data from IoT sensor devices to the data filtering & pre-process component.
2. **Data filtering & pre-process component:** This component pre-processes and homogenises data collected from the data harvesting Component.
3. **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.
4. **Security component**: The security component is responsible for user or entity identification and access management purposes, ensuring that only authorised personnel have 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.

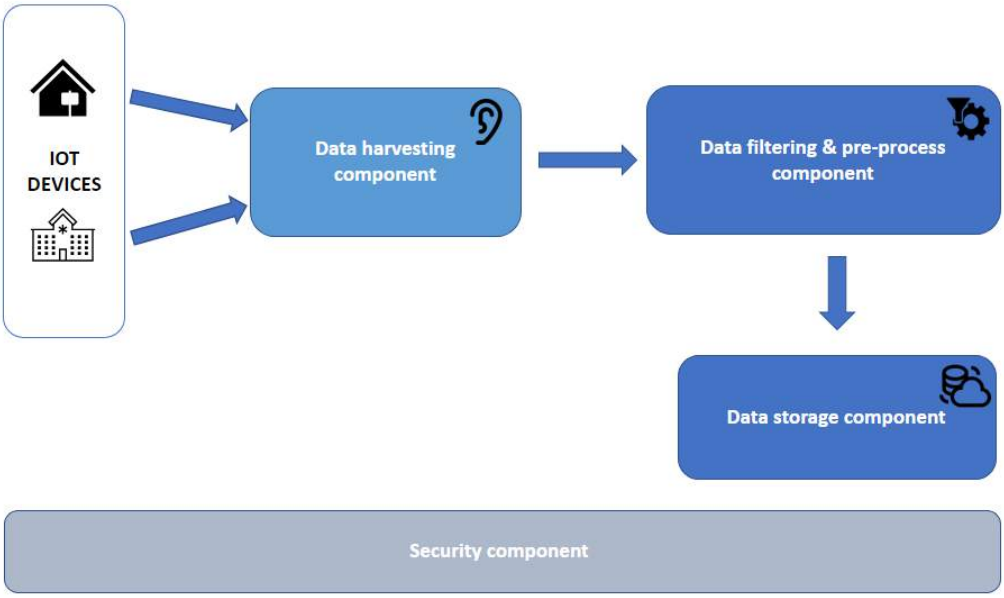

Figure 2 Component Architecture: Data Sovereignty Service

4.1.2 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.

Service components list:

1. **Data querying and data serving component:** This component combines data coming from different databases based on specific queries.
2. **Data processing and analysis component**: The heart of this component is an algorithm that will be responsible for processing, analysing, and extracting insights from the data collected by the Data Sovereignty Service. Additionally, this component will also incorporate an automation mechanism that triggers the execution of data processing and analysis tasks at specific timeslots.
3. **Data storage component**: This component stores and indexes the analysed data in a structured format for easy retrieval and further future analysis.
4. **Data visualisation component**: This component generates visualisations, charts, and reports that help to communicate the insights and findings from the data analysis.

5. **Security component:** The Security component is responsible for user identification and access management purposes, ensuring that only authorised personnel have access to the data.

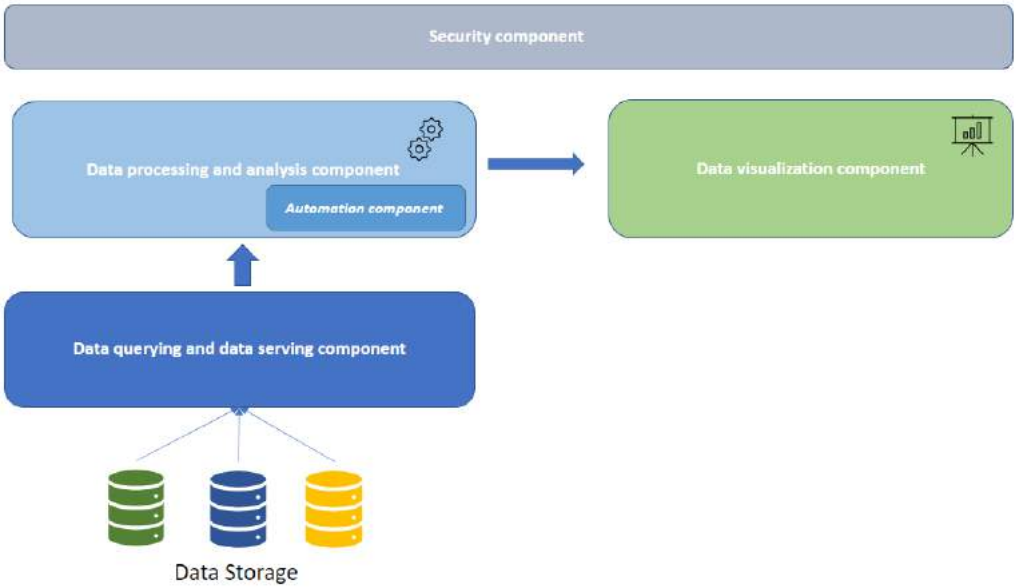

Figure 3 Component Architecture: Data Analysis Service

4.1.3 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.

Service components list:

1. **Data querying and data serving component:** This component combines data coming from different databases based on specific queries.
2. **Data processing and analysis component**: This component will be responsible for processing and analysing the collected data that will lead, among others, to the generation of recommendations from the recommendation component.
3. **Data storage component**: This component stores and indexes the analysed data in a structured format for easy retrieval and further future analysis.
4. **Recommendation component:** This component generates personalised recommendations to the user for the optimisation of the usage and energy consumption of the (IoT) devices.
5. **Security component:** The security component is responsible for user identification and access management, ensuring that only authorised personnel can have access to the data.
6. **Gamified mobile application:** The application provides the generated personalised recommendations and challenges to the users' mobile phones. Moreover, the application provides users with the ability to visualise their energy savings as well as their progress through their mobile phones.

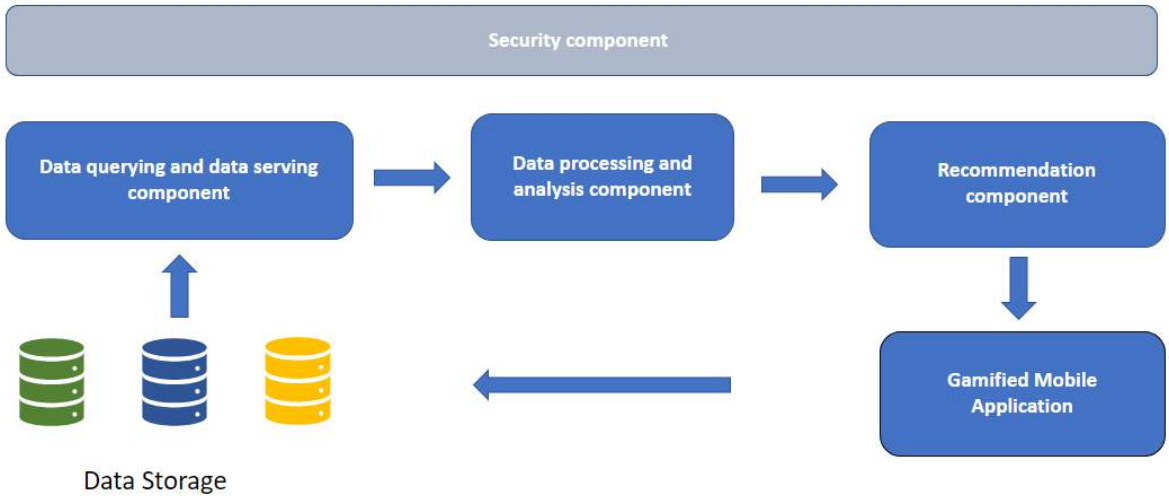

Figure 4 Component Architecture: Behaviour & Recommendation Service

4.1.4 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 a data visualisation component where users can view (through various visualisations) all the available system insights.

Service components list:

1. **Data storage component:** This component is used for storing and indexing the analysed data in a structured format for easy retrieval and further future analysis.
2. **Data querying and data serving component:** This component combines data coming from different databases based on specific predefined queries.
3. **Data processing and analysis component:** The User Engagement Service will leverage this component for analysing user behaviour and tracking engagement levels.
4. **Notification component**: This component is responsible for creating notifications and/or messages to users, such as push notifications, and emails (e.g., when they have managed to achieve high energy savings).
5. **Data visualisation component**: This component will display pertinent visualisations to the users and will allow them to interact with the building environmental data.
6. **Security component:** The security component is responsible for user identification and access management, ensuring that only authorised personnel can have access to the data.
7. **Gamified mobile application:** The application provides the generated personalised recommendations and challenges to the users' mobile phones. Moreover, it enables users to visualise their energy savings and track their progress through their mobile devices.

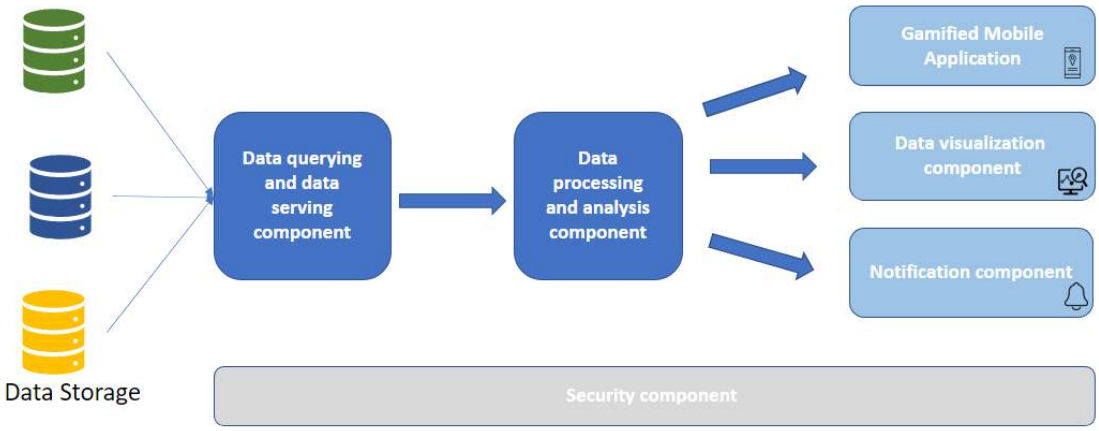

Figure 5 Component Architecture: User Engagement Service

4.1.5 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.

Service components list:

1. **User profile UI component:** This component is used for registration, sign up, login, and gathering user info.
2. **Data storage component**: This component is used to store user engagement data and user info data.
3. **Security component:** The security component is responsible for user identification and access management, ensuring that only authorised personnel can have access to the data.
4. **Gamified mobile application:** The application provides the generated personalised recommendations and challenges to the users' mobile phones. Moreover, it enables users to visualise their energy savings and track their progress through their mobile devices.

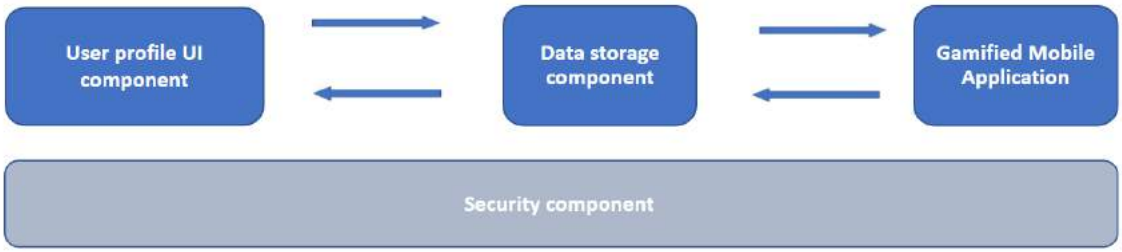

Figure 6 Component Architecture: User Profile Service

4.1.6 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 the Green Euro rewarding component rewards the users with monetary compensation in the form of €G into their digital wallets.

Service components list:

1. **Data storage:** This component is used to store analysed data related to energy consumption, improvements achieved, and other relevant information. It ensures the availability and integrity of the data for further processing and analysis.
2. **Data querying and data serving component:** This component combines data coming from different databases based on specific predefined queries and serves the resulting datasets to the next services in the workflow.
3. **M&V (Measurement and Verification) component:** The M&V component ensures the accuracy and credibility of the energy improvements achieved by the users.
4. **EPC (Energy Performance Contract):** The EPC component outlines the requirements and goals for energy performance improvements. It serves as a contractual agreement between the service provider and the users, specifying the targets that need to be met to qualify for rewards.
5. **Green Euro rewarding component**: This component is responsible for rewarding the users with €G. Based on the achieved improvements and compliance with the EPC, the component calculates and distributes the rewards to the users' wallets.
6. **Green Euro wallet component:** This component is a digital wallet where the rewards in the form of Green Euros are stored. Users can view their balance and make transactions on their digital wallets.
7. **Security component:** The security component is responsible for user identification and access management purposes, ensuring that only authorised personnel have access to the data.

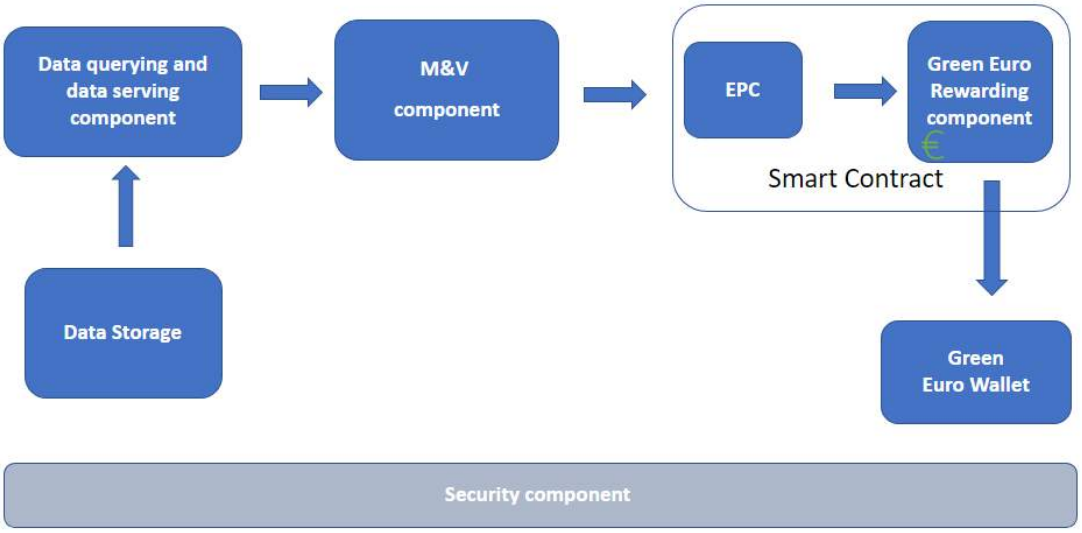

Figure 7 Component Architecture: Improvements Achieved Calculation and Green Euro Rewarding Service

4.2 One-Stop-Shop Marketplace

The primary objective of the OSS Marketplace is to provide a stakeholder-centric implementation model that enables different stakeholders, such as building owners, designers, policy makers, ESCOs, and renovation companies to interact with the market, demonstrate how the platform can help collect information around a specific building, and propose cost-effective solutions for building renovations.

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.

4.2.1 Renovation Recommendation Service

The Renovation Recommendation Service will suggest cost-effective solutions for building renovations and thus assist users in making informed decisions regarding energy-efficient building renovations. The service works as follows:

Firstly, data concerning existing renovation investments, subsidies, and user input such as building information about age, location, etc. will be collected.

Following that, data analytics will be employed to analyse the aforementioned data and provide the user through a user-friendly web interface with recommendations regarding the building in question. Forecasts about energy savings and the impact of different renovation scenarios on energy efficiency

over time are also provided from predictive models that are integraded inside the analysis component.

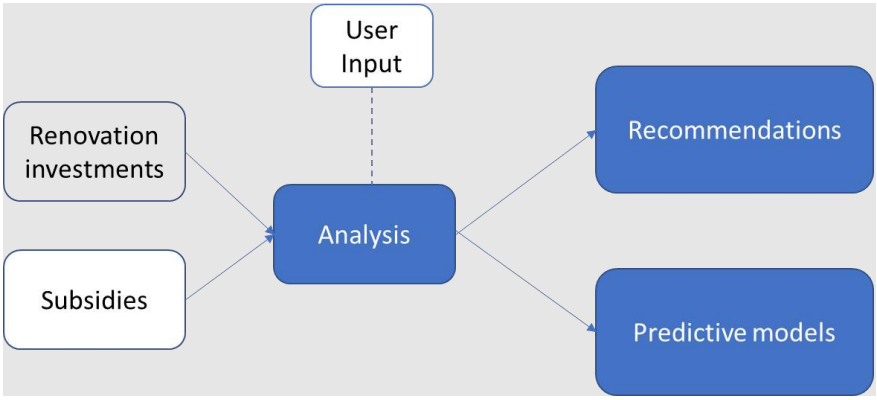

Figure 8 Renovation Recommendation Service

4.2.2 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.

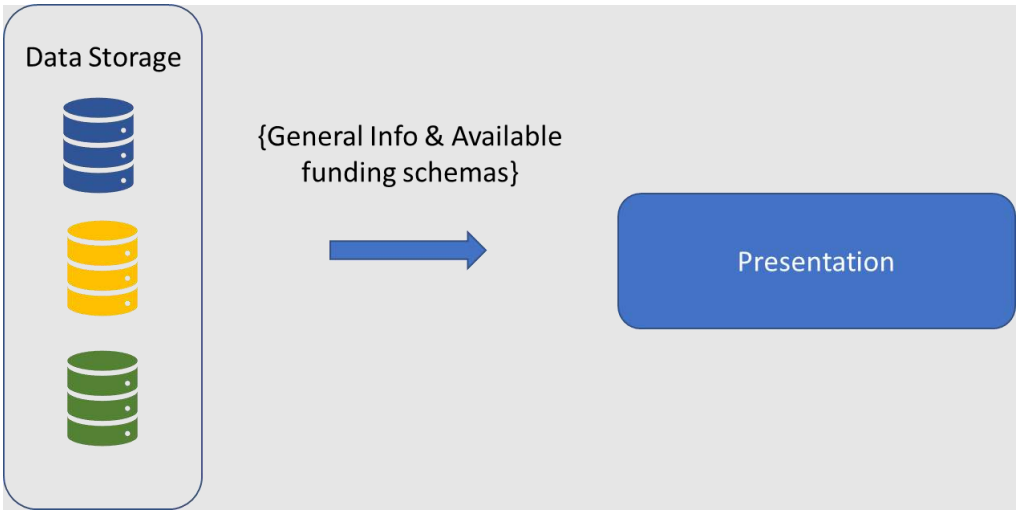

Figure 9 Info & Funding Service

4.2.3 Matchmaking Service

The Matchmaking Service will enable stakeholders to connect and collaborate on building renovation projects. The service will match stakeholders based on their skills, expertise, and project requirements, helping them to find the right partners and build successful collaborations.

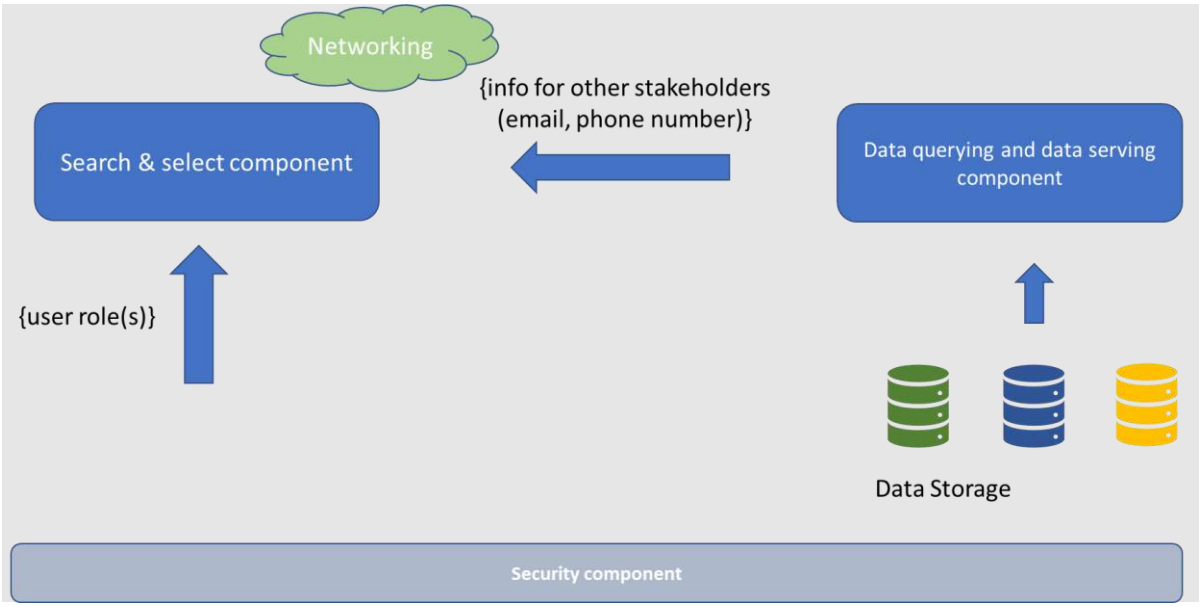

Figure 10 Match-making Service

4.2.4 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.

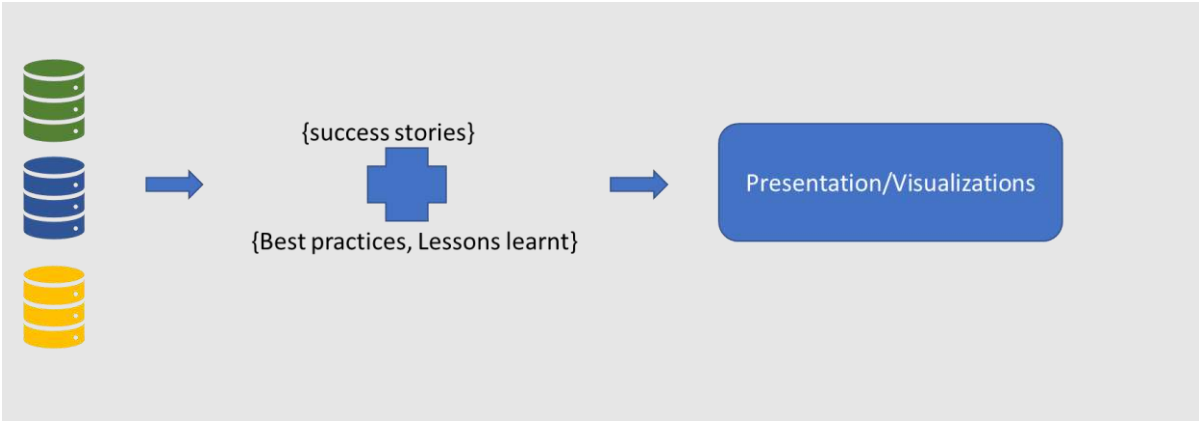

Figure 11 Knowledge Base

5 Workflow per Pilot Analysis

In response to the requirements specified in Deliverable D2.1, the following workflows have been designed for each pilot service:

5.1 Pilot 1 – Unleashing green cultural experience

5.1.1 Pilot 1 Usage Scenario

Actors
Museum employee
Alternative actors
-
Actors interested in the outcome
Employees, museum owner, visitors
Scenario
George works for a museum in the centre of Athens, Greece. The museum's visitors consist mainly of schools that visit it as part of school trips and tourists during the summer season. The administration is considering implementing ESIE measures for the improvement of the building. The building has exhibits of art, meaning that there are certain conditions inside the building that must be maintained to ensure the proper preservation of these exhibits. However, it should not be overlooked that in the same building there are some conditions related to temperature, air quality, etc. that must be observed and optimised for the workers as well as for the visitors. The current situation at the museum does not fully address the demanding requirements for the secure custody of exhibits and the comfort of the employees while also remaining energy efficient. However, the museum owner (John), being highly motivated in environmentally conscious practices and greener actions wants to perform some physical renovations that might include PVs, smart windows, air quality filters, as well as sensors and monitors (IoT) that take measurements of temperature, humidity, and other conditions in the museum. In his research, John comes across the FORTESIE project that could be the answer to his problems. He sees that FORTESIE, not only offers a digital solution with a variety of value-adding services, but also includes a renovation marketplace, where he can fill in some information about the building and his needs and receive pertinent recommendations. FORTESIE, through past experimentation and piloting in a variety of buildings has generated multiple success stories, strategies, and lessons learnt and as such, can offer performance guarantees on any renovation that takes place via the FORTESIE Marketplace. John decides to leverage the platform and finds a renovation company that can fulfil his needs concerning the museum. After the installation of all the renovations and the sensors that will draw pertinent data about consumption, temperature, comfort and so on, John also decides to connect the IoT sensors and any smart appliance with the FORTESIE technical solution. FORTESIE provides a trusted infrastructure for measurement and verification of energy savings, analytics and visualisations, a

rewarding mechanism as well as a gamification application that incentivises and rewards the users. John is quite happy with what the platform can provide him, especially because it can alleviate his uncertainty and lack of knowledge concerning some basic tasks on his side (e.g., what data he should measure, how he can know about his savings, how will his savings translate to rewards), for which in the past, he would have to consult and depend on an ESCO. In addition, he sees increased trust in the validity of metrics, savings, and rewards, among others, since to calculate savings and rewards FORTESIE will rely on official protocols (such as IPMVP) in combination with blockchain technology (which he knows is a secure and reliable solution used mostly for cryptocurrencies and NFTs) for preventing data manipulation.

To onboard his building on FORTESIE, John must set up an account for the museum on the platform. The registration requires an email, password and information about the building including the type and size of the building, the address and location, the composition of the building, the year of construction and also an optional photo upload. John has concluded that the employees can also be challenged to modify their behaviour and energy consumption patterns (provided that they agree) during their working hours in order to increase the efficiency of the museum and also be in a position to claim a reward for these changes. Finally, he informs his employees that the museum from now on is registered in the FORTESIE platform urging them to use it too.

Going back to George, the first step he must take is to create a profile in the FORTESIE gamification app. The registration process requires filling in personal information such as name, e-mail, phone number and any thermal comfort or air quality limitations from his side. George can simply select the building (museum) from a list of FORTESIE registered buildings. Additionally, George fills in some personal preferences, such as ideal temperature, thermal comfort, air quality, and willingness to participate in behavioural methods of reducing energy consumption. George must also set up his account in the neobanking application where his €G will be credited into his digital wallet. This application is linked with the FORTESIE gamification app, but it requires from George to validate his identity through a bank account. FORTESIE will reward George for sustainable behaviour actions either with financial incentives (i.e., €G) or with non-financial incentives.

After George sets up his accounts, he can start benefitting from this process. The Data Analysis Service retrieves data coming from his profile and the Data Sovereignty Service (data from sensors and monitors in the museum) to be analysed. The results from this analysis will define behavioural changes that are suggested for George to do. These types of changes can be, accepting a temperature drop in his working space, taking the stairs instead of using the elevator, driving a bicycle, or taking mass transportation to get to work instead of using a car etc. These behavioural changes along with his energy performance results from the M&V that are stored in the blockchain, in the long run, will help him earn €G which will be added to his digital wallet. From this point and after, George can start using his €G he amassed as normal digital currency or keep supporting the creation and development of a green ecosystem and use them for discounts in his home electricity bills as well as for the renovation of his dwelling.

On the other hand, John, one year after the renovations and onboarding on the FORTESIE technical solution sees that his employees have started employing greener behaviours, the museum conditions have been optimised for employees, visitors, and the exhibits, and the energy savings and performance guarantees that were promised to him by FORTESIE have been achieved.

Benefits

- Improved sustainability and energy efficiency in the museum.
- Increased productivity due to optimised conditions.

• Increased trust and ability to verify energy measurements, recorded savings, and rewards. • Establishment of a more horizontal green behaviour through analytics and recommendations. • €G earned. • Create a state-of-art green museum and promote it as a showcase museum active for the green deal. • Optimal indoor environmental conditions for the art collection.
Challenges
• Developing effective and accurate formulas to calculate energy/CO_2 savings stemming from behavioural modifications. • Employees' continuous engagement. • Employees' training on sustainable actions and on using the platform. • Disgruntled employees who do not trust ESIE investments and are resistant to change. • Lack of knowledge of actions to support the new systems/services. • Lack of interest from employees/users in changing their behaviour.

5.1.2 Pilot 1 Service Workflow

The digital services and components for Pilot 1, "Unleashing Green Cultural Experience", consist of several integrated services to address the challenge of maintaining comfortable and healthy environments in museums affected by heavy CO_2 levels.

First, the Data Sovereignty Service is deployed in the Museum of the Society of Hellenism and Philhellenism to collect and process environmental data such as temperature, humidity, and CO_2 levels. The data are then fed into the Data Analysis Service, which processes and analyses them to generate insights into the air quality and climate conditions of the museum.

Next, the Behaviour & Recommendation Service uses the baseline generated by the Data Analysis Service in combination with the calculations made by its own analysis component, to make recommendations on how to improve the environmental conditions of the museum. The behaviour recommendations are provided to the museum owner and may involve adjusting the ventilation system or lowering the temperature of the museum floors.

The User Engagement Service is then used to engage with visitors of the museum, displaying information about the environmental conditions of the museum and the improvements that have been made but also possible energy optimisation pathways that may materialise if the recommended system changes are adopted by them. This is accomplished by using the data visualisation component which provides visitors with a user-friendly interface to interact with the museum's environmental data. The User Profile Service stores user data securely, including visitors' preferences and feedback on the museum's environmental conditions. This information is used to improve future recommendations and to personalise the museum experience for each visitor. Finally, the Improvements Achieved Calculation and Green Euro Rewarding Service tracks the improvements made to the environmental conditions of the museum and rewards the museum owner, employees, and the visitors with Green Euros for engaging in environmentally friendly behaviours.

Overall, this integrated suite of digital services and components helps museums in areas with heavy CO_2 levels to maintain high environmental standards, improve the visitor experience, and reduce their

carbon footprint while awarding the museum owner for adopting recommended energy improvements.

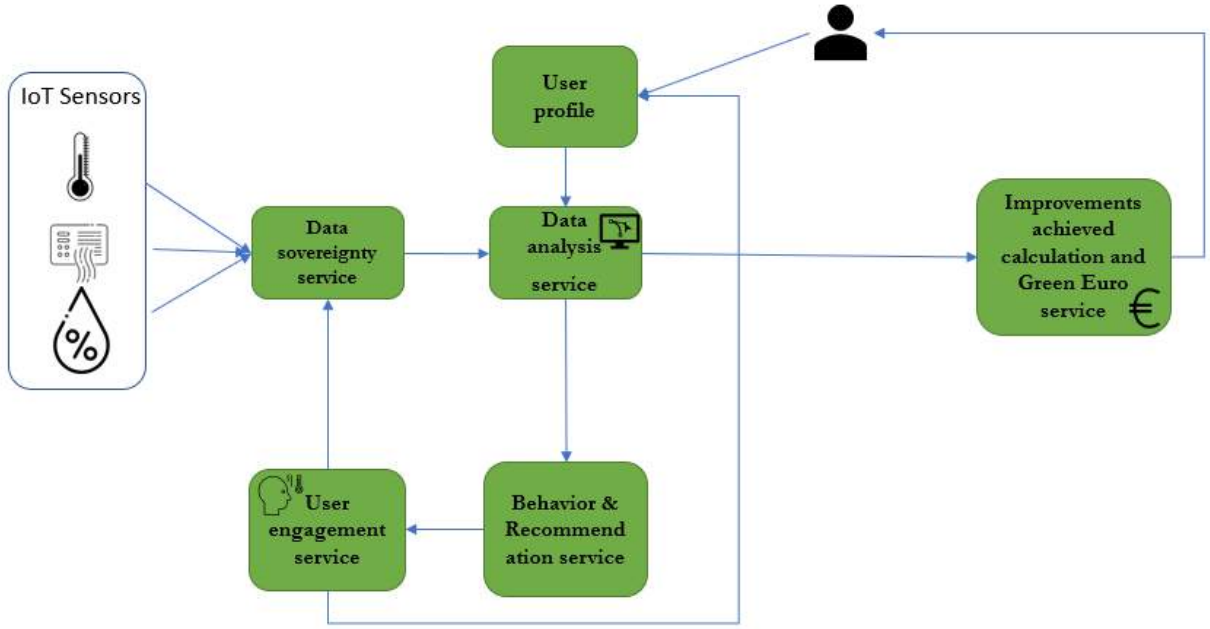

Figure 12 Pilot 1 Digital Services Architecture

5.2 Pilot 2 – Green, comfortable and sustainable home

5.2.1 Pilot 2 Usage Scenario 1

Actors
City council (or neighbourhood association)
Alternative actors
-
Actors interested in the outcome
Municipality residents, city council (or neighbourhood association), ESCO.
Scenario
Chris is a member of a city council (or neighbourhood association) in a borough that is over 50 years old, with significant deficiencies and/or construction pathologies in the buildings that make up the area. The city council (or neighbourhood association) is interested in fostering the collective rehabilitation of the residential environment and FORTESIE is an ideal project for achieving this. He sees that FORTESIE, not only offers a digital solution with a variety of value-adding services,

but also includes a renovation marketplace, where he can fill in some information about the building and his needs and receive recommendations. FORTESIE, through past experimentation and piloting in a variety of buildings has generated multiple success stories, strategies, and lessons learnt and as such, can offer performance guarantees on any renovation that takes place via the FORTESIE Marketplace. John decides to leverage the platform and finds a renovation company that can fulfil the city council's (or neighbourhood association's) needs concerning the buildings. FORTESIE provides a trusted infrastructure for measurement and verification of energy savings, analytics and visualisations, a rewarding mechanism as well as a gamification application that incentivises and rewards the users. They see increased trust in the validity of metrics, savings, and rewards, among others, since to calculate savings and rewards FORTESIE will rely on official protocols (such as IPMVP) in combination with blockchain technology (which they know is a secure and reliable solution used mostly for cryptocurrencies and NFTs) for preventing data manipulation. The first step is to create profiles for the buildings they oversee by registering with an email and password, while regarding the buildings, they have to provide previous electricity consumption data, type and size of the buildings, the addresses and locations, the composition of the buildings, the year of construction, and an optional photo upload. In addition, they urge rehabilitation agents to list their details on the market so that residents of the municipality/city council/neighbourhood associations are aware of their work and can reach them more easily. For each building, a rehabilitation agent is selected based on their expertise and understanding of the sector and financing mechanisms. This agent also consults the FORTESIE Marketplace for funding information to explore various financing schemes, evaluate them, and choose the best option or a combination of them. What follows is the formation of an Energy Performance Contract based on the agreements between parties (improvement in the energy rating letter, etc.). Once the monitors and smart meters are installed, the baseline assessment begins, and the data are stored. After the implementation of the renovations, through the M&V Service, the energy performance is validated and stored in the blockchain so that it cannot be changed, ensuring that the specified improvement targets are achieved according to legally applicable calculation programmes.
Benefits
• Improved energy efficiency in buildings. • Improved living conditions. • Reduction of utility bill costs. • Increased knowledge that the ESCO has about the facility it manages. • Encourages other neighbourhood associations to benefit from these services.
Challenges
• Efficient renovations. • ESCO's limited knowledge about some of the facilities it manages. • Prioritisation of buildings/neighbourhoods in need of renovation.

5.2.2 Pilot 2 Usage Scenario 2

Actors
Homeowner

Alternative actors
Community of homeowners in multi-dwelling buildings with predominantly residential use
Actors interested in the outcome
Homeowner, ESCO, Renovation company.
Scenario
George is a homeowner in Spain. He lives in an apartment in a building which, like many other buildings in the area and in the country in general, is ageing. Climate change and the energy crisis are forcing George into taking actions considering the apartment's condition such as temperature, humidity, air quality etc. Unfortunately, the financial situation of George and his family does not allow them to proceed with all the necessary renovations of his house. However, he is highly motivated to change the current situation and is trying to learn more about the things that he can do to achieve that. This fact drives him to research ways to mitigate the situation until he comes across the FORTESIE platform and approach which he heard discussed by some of his friends who used it and benefitted from it. He sees that FORTESIE not only offers a digital solution with a variety of value-adding services, but also includes a renovation marketplace, where he can fill in some information about the building and his needs and receive recommendations. FORTESIE, through past experimentation and piloting in a variety of buildings has generated multiple success stories, strategies, and lessons learnt and as such, can offer performance guarantees on any renovation that takes place via the FORTESIE Marketplace. He then informs the building owner, John, about the FORTESIE platform so that he can address the building's issues. The building shows issues such as detached façade coatings, water leakage into the interior of dwellings and condensation. Eventually, both decide to use it. First, George creates a profile in the FORTESIE platform. He then visits the Marketplace to fill in information about his home and receive recommendations about potential renovations, associated technologies, grants, financing schemes etc. He can also see good practices and success stories of past completed projects. Furthermore, if he wants, he can connect with a renovation company to receive information about potential renovations. He can follow the same procedure to connect with an ESCO. This step is followed by the selection and installation of the renovations and the connection of his smart sensors to the FORTESIE platform so that he can leverage M&V, incentives, and rewarding. George is quite happy with what the platform can provide him, especially because it can alleviate his uncertainty and lack of knowledge concerning some basic tasks on his side (e.g., what data he should measure, how he can know about his savings, how will his savings translate to rewards), for which in the past, he would have to consult and depend on an ESCO. In addition, he sees increased trust in the validity of metrics, savings, and rewards, among others, since to calculate savings and rewards, FORTESIE will rely on official protocols (such as IPMVP) in combination with blockchain technology (which he knows is a secure and reliable solution used mostly for cryptocurrencies and NFTs) for preventing data manipulation. George also creates a profile in the FORTESIE gamification app. The registration process requires filling in personal information such as name, e-mail/e-mail verification, phone number and thermal comfort. Moreover, some additional information to complete includes the characteristics of the building that this profile is linked to and some personal preferences. Regarding the building,

information required includes previous electricity consumption data, type of heating, type and size of the building, the address and location, the composition of the building, the year of dwelling/construction and an optional photo upload. Personal preferences to be filled in include ideal temperature, thermal comfort, air quality, and willingness to participate in behavioural methods. George must also set up his account in the neobanking application where his G€ will be credited into his digital wallet. This application is linked with the FORTESIE gamification app, but it requires George to validate his identity through a bank account.

Now that the current house conditions and George's habits are submitted, George decides to appeal to an ESCO. George makes the decision about the renovations that he wants based on the recommendations from FORTESIE and maybe the ESCO companies. After the successful installation of the renovations and his onboarding to the FORTESIE Platform, he can now see the benefits in his reduced electricity bill cost and in the increase of the thermal comfort. The Data Analysis Service combines his new electricity bill information, sensors indications, and thermal comfort levels with his profile information and formats behavioural changes that are suggested for George to do. These types of changes can be, accepting a temperature drop in his apartment, using the night tariff for some activities, etc. Engaging in these behavioural changes, in the long run, will earn him €G which will be added to his digital wallet. When his energy performance is confirmed with the M&V and based on his EPC, he starts to earn rewards (e.g., gamified rewards, €G credited to his digital wallet). From this point on, George can start using the €G he amassed for discounts in his home electricity bills or to finance any new renovation needs that may occur in the future.

On the other hand, John signs up in the Marketplace with an email and password and for the buildings he owns, he enters the information that John had been asked to enter as well. He uses the Marketplace to search for funding resources with the Info-Funding Service and to find out more about ESIE, EPCs, and renovation technologies. Via the Renovation Recommendation Service, he receives personalised renovation recommendations, such as passive and active measures, tailored to the situation of each building he owns. Passive measures include façade envelope, insulation beneath the roof, insulation of lower floor slabs, replacement of windows, replacement of enclosed balconies, installation of low-emissivity glass etc., while active measures include boiler renovation, installation of Renewable Energy Systems etc. The Marketplace's Knowledge Base Service provides information of success stories, best practises and lessons learnt.

One year after the renovations and onboarding on the FORTESIE technical solution, George's living conditions have greatly improved and both George and John saw that the energy savings and performance guarantees that were promised to them by FORTESIE have been achieved.

Benefits

- Improved energy efficiency in the apartment.
- €G earned.
- Improved living conditions.
- Reduced electricity bill costs.
- Increased knowledge that the ESCO has about the facility it manages.
- Encourages other homeowners to benefit from these services.
- Evidence and financial tools help minimise risks and initial costs and provide concrete forecast of the projected savings.
- Increased trust and ability to verify energy measurements, recorded savings, and rewards.

Challenges

- Identifying and selecting efficient renovations.
- Calculation accuracy of the number of €G that should be earned.
- Difficulties to ensure the homeowners' engagement.
- ESCO's limited knowledge about some of the facilities it manages.
- Reluctance to make the initial investment without a concrete forecast of the savings they will make.

5.2.3 Pilot 2 Service Workflow

The digital services and components for Pilot 2, "Green, Comfortable and Sustainable Home," consist of several integrated services to address the challenge of maintaining comfortable and healthy environments in households while reducing the greenhouse gas emissions they indirectly produce.

Firstly, the Data Sovereignty Service will be installed in every single house to collect, filter and pre-process environmental data such as temperature, energy consumption, humidity, CO_2 levels, etc. The data will then be forwarded into the Data Analysis Service, which processes and analyses them to generate insights correlated to the collected data of the house.

Afterwards, the Behaviour & Recommendation Service uses the insights from the Data Analysis Service in combination with the calculations made by its own analysis component, to make recommendations on how to improve the environmental conditions or minimise the total house energy consumption. The behavioural recommendations are provided to the house owner through the User Engagement Service, and may, for example, involve turning off energy demanding devices or adjusting the temperature of the integrated heating system.

Furthermore, through the User Engagement Service, the householder can engage with the system. They can also see insights about the environmental conditions and the improvements that have been made but also possible projected energy reductions if they adopt the recommended system changes. This is accomplished by using the data visualisation component, which provides a user-friendly interface to interact with the house environmental data.

The User Profile Service stores user data securely, including preferences and the comfort level of the householder. This information is used to improve future recommendations and to optimise the householder's experience. Finally, the Improvements Achieved Calculation and Green Euro Rewarding Service, based on the achieved energy improvements rewards the householder with Green Euros for engaging in environmentally friendly behaviours. At this stage, before the rewarding, the IPMVP standard provides a layer of measurement and verification in combination with the blockchain to ensure the accuracy and credibility of the energy improvements achieved by the householder.

Overall, this integrated suite of digital services and components helps householders maintain high environmental standards, improve their living experience, and reduce their carbon footprint while awarding the owners for adopting the recommended energy improvements.

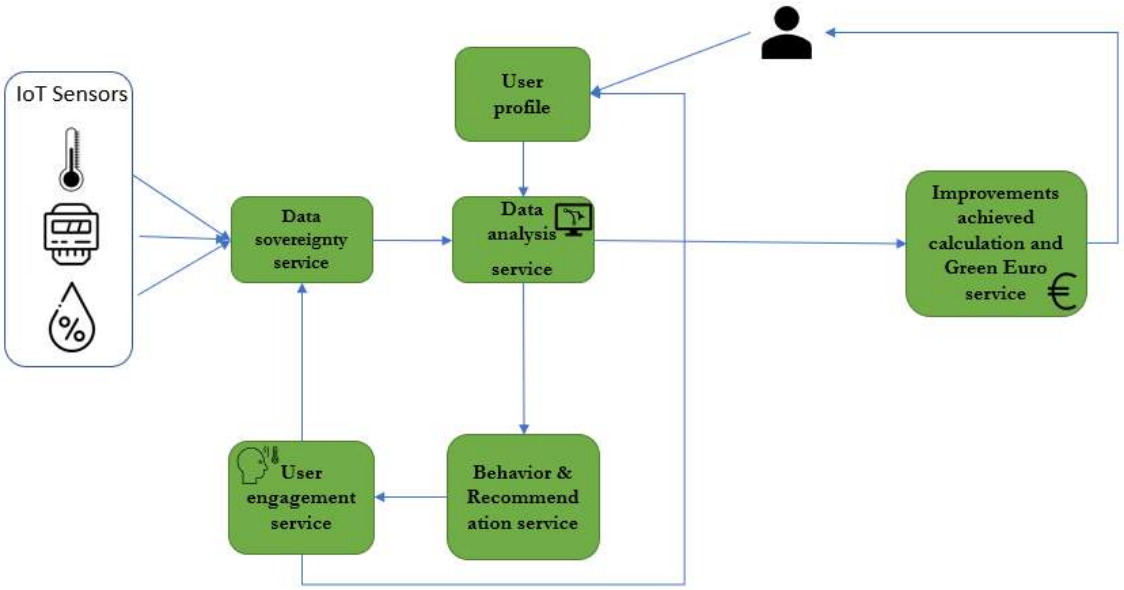

Figure 13 Pilot 2 Digital Services Architecture

5.3 Pilot 3 – Green, comfortable and sustainable home

5.3.1 Pilot 3 Usage Scenario

Actors
Energy poverty Homeowner in Portugal
Alternative actors
-
Actors interested in the outcome
Homeowner, ESCO, Voluntary operated Renovation company.
Scenario
George is a homeowner in Portugal. He lives in a house which, like many other houses in the area and in the country in general, is ageing and lacks necessary features to offer minimum comfortable living conditions. Climate change and the energy crisis are forcing George into taking actions considering the apartment's condition such as temperature, humidity, air quality etc. George lives in housing deprivation and energy poverty, with no means to renovate/improve his dwelling. He is a socially excluded and isolated person, with an underlying condition (addiction, mental disease, etc). He has

no technology knowledge or proficiency. He is accompanied by social services, who know and follow his social case, providing support in key areas of his daily life (such as meals support).

Just a Change is an NGO renovating poverty homes such as George's. His case was flagged by the city hall's social services. Just a Change will of course provide support and guide George through each step. Jose, a Go Parity (GOP supports financing by an innovative business model which collects funds through crowdfunding and directs them under specific conditions to targeted ESIE and renovation projects) representative who has been assigned to support George, recommends that he leverages the FORTESIE project, since it not only offers a digital solution with a variety of value-adding services, but also includes a renovation marketplace, where he can fill in some information about the building and his needs and receive recommendations. FORTESIE, through past experimentation and piloting in a variety of buildings, has generated multiple success stories, strategies, and lessons learnt and as such, can offer performance guarantees on any renovation that takes place via the FORTESIE Marketplace.

George's lack of necessary means and skills (a computer with internet access, etc.) prevents him from using FORTESIE. For this reason, he appoints an agent (John) from Just a Change as his representative who will carry out the necessary procedures to register George's information to the platform. Signing up to the FORTESIE Marketplace requires an email and password (and a verification of those). Moreover, some additional information for him to complete include the characteristics of the building that his profile is linked to and some personal preferences. Regarding the building, information to be filled in include any previous electricity consumption data, type of heating, type and size of the building, address and location, composition of the building, year of dwelling/construction and an optional photo upload. As for personal preferences, the required information includes ideal temperature, thermal comfort, air quality, and willingness to participate in behavioural methods of reducing energy consumption, among others. All data are entered by John in consultation with George, and after receiving his validation.

In the FORTESIE Marketplace, they can now access the Info-Funding Service to find funding sources for the renovations that the Renovation Recommendation Service suggests to George and a rich knowledge base of various information about ESIE, EPC, renovation technologies, available grants, etc. In addition, John can network with a renovation company offering volunteers to help them with the renovation work, via the Match-Making Service and inquire about their services since he has previous expertise in the field and is working towards George's best interests. John can also view the success stories from FORTESIE, using the Knowledge Base Service, to evaluate the usefulness of the platform and its associated renovation projects. All these features convince John to use the FORTESIE platform and leverage its services to proceed with the renovations for George's case. In the months following the renovations, John periodically checks the living conditions of George via sensors to ensure that his needs have been met.

Benefits

- Offers important gathered knowledge, success stories, and successful practices.
- Contributes to people having a dignified home, living conditions, access to piped water, energetic efficiency means and appliances.
- New/Better equipment to install in each household.
- Innovative financing model for high impact needs.
- Access to broader community of investors and of projects to be financed.
- Insights on impact assessment of energy efficiency projects.

Challenges

- Suitable personal recommendations for stakeholders living in energy poverty.
- Undignified living conditions. Leaky roofs, no piped water, no sanitations, sometimes no electricity, etc.
- Difficulty to measure and improve energetic efficiency in each renovation.

5.3.2 Pilot 3 Service Workflow

The digital services and components for Pilot 3, "Green, Comfortable and Sustainable Home," consist of several integrated services to address the challenge of maintaining comfortable and healthy environments in energy poverty households while reducing the greenhouse gas emissions they indirectly produce.

The architecture workflow starts with data gathering via portable measuring devices from every single house before and after the renovation actions. These are gathered at a specific time period in order to be comparable and could include energy consumption, humidity, CO_2 levels, etc. Data is then stored into the Data Storage and afterwards processed and analysed by the Data Analysis Service to generate and visualise insights from the achieved energy and living quality improvements.

Overall, this architecture combines data from portable measuring devices and the installed PV systems and after a robust comparative analysis extracts insights to prove the effectiveness of the renovation technologies to the householders that are directly related with a healthier living, lower energy consumption, and carbon footprint reduction.

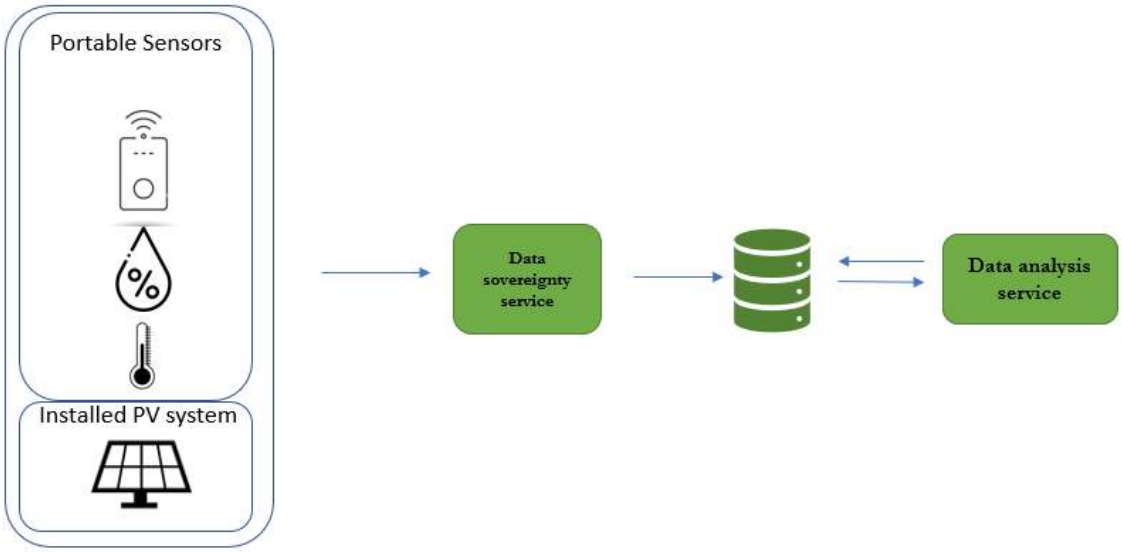

Figure 14 Pilot 3 Digital Services Architecture

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

5.4.1 Pilot 4 Usage Scenario

Actors
Homeowner/ prosumer
Alternative actors
-
Actors interested in the outcome
Renewable energy Cooperative, Crowdlending organisation, investors.
Scenario
George is a homeowner in Portugal. He lives in a house, and is a Residential Prosumer, meaning he is a member in Coopérnico and very enthusiastic about renewable energy and energy transition. As such, he has installed his own PV system for self-consumption. Unfortunately, even though he has his own PV system for self-consumption, he is struggling to keep thermal comfort at adequate levels in his house and also take full advantage of the peak energy timeslots, as well as reduce his electricity bills, mainly due to the lack of adequate and relevant information, successful practices, and so on. However, he is highly motivated to change the current situation and is trying to learn more about the things that he can do to achieve that. George turns to his energy community which will help him with the renovations as well as with the financial issue of paying for them. Members of his community referred him to find information about the FORTESIE project since some of them had benefited from it. He sees that FORTESIE, not only offers a digital solution with a variety of value-adding services, but also includes a renovation marketplace, where he can fill in some information about the building and his needs and receive recommendations. FORTESIE, through past experimentation and piloting in a variety of buildings has generated multiple success stories, strategies, and lessons learnt and as such, can offer performance guarantees on any renovation that takes place via the FORTESIE Marketplace. George decides to leverage the platform and finds a renovation company that can fulfil his needs concerning his house. He signs up on the FORTESIE platform and uses its Marketplace to find out about more funding resources via the Info-Funding Service and about personalised renovation recommendations via the Renovation Recommendation Service. The resources and recommendations that he finds out about are tailored to the situation of his household. He decides that the best choice for him is to take a loan with zero interest rate which will be repaid from his energy savings based on his energy performance. George first creates a profile in the FORTESIE gamification app. The registration process requires filling in personal information such as name, e-mail and password, and an optional phone number, among others. Moreover, there is some additional information to complete which includes the characteristics of the building that this profile is linked to and some personal preferences. Regarding the building, required information includes previous electricity consumption data, type of heating, type and size of the building, address and location, composition of the building, year of

dwelling/construction and an optional photo upload. As for personal preferences, these include ideal temperature, thermal comfort, air quality, and willingness to participate in behavioural methods of reducing energy consumption, among others. George must also set up his account in the neobanking application where his €G will be credited into his digital wallet. This application is linked with the FORTESIE gamification app, but it requires George to validate his identity through a bank account. Now that the current house conditions, data, and George's habits are submitted, George along with COOP can begin the renovation procedures that include insulation, more solar panels (if needed), ventilation, etc.

After the installation of all the renovations and the sensors that will draw pertinent data about consumption, temperature, comfort, and so on, John also decides to connect the IoT sensors and any smart appliance with the FORTESIE technical solution. He can now see the benefits of the renovation, seen in the reduced electricity bill cost and the increased thermal comfort. The Data Analysis Service combines his new electricity consumption data, sensors' indications, and thermal comfort levels with his profile information and formats behavioural changes that are suggested for George to do. These types of changes can be, accepting a temperature drop in his apartment, using the night tariff for some activities, etc. Engaging in these behavioural changes, in the long run, he will be rewarded (e.g., via gamified rewards, €G credited to his digital wallet). FORTESIE provides a trusted infrastructure for measurement and verification of energy savings, analytics and visualisations, a rewarding mechanism as well as a gamification application that incentivises and rewards the users. George is quite happy with what the platform can provide him, especially because it can alleviate his uncertainty and lack of knowledge concerning some basic tasks on his side (e.g., what data he should measure, how he can know about his savings, how will his savings translate to rewards), for which in the past, he would have to consult and depend on an ESCO. In addition, he sees increased trust in the validity of metrics, savings, and rewards, among others, since to calculate savings and rewards FORTESIE will rely on official protocols (such as IPMVP) in combination with blockchain technology (which he knows is a secure and reliable solution used mostly for cryptocurrencies and NFTs) for preventing data manipulation. From this point on, George can start using the €G he amassed for discounts in his home electricity bills. Moreover, George can now repay the instalment for the loan he had received or invest his €G earnings in his energy community.

Benefits

- Improved energy efficiency in the apartment.
- €G earned.
- Improved living conditions.
- Reduce electricity bill costs.
- Improved knowledge regarding energy efficiency measures in the households.
- Knowledge regarding which renovation techniques and financial ways one should invest in.
- Increased trust and ability to verify energy measurements, recorded savings, and rewards.

Challenges

- Difficulties in finding efficient renovations.
- Calculation accuracy of the number of €G that should be earned.
- Lack of knowledge or financial capacity to invest in energy renovation techniques.
- Lack of knowledge regarding when to use heating in the house.
- Lack of access to the best energy efficiency renovation methods.
- Distrust to acquire alternative financing schemes.

- Raising funds efficiently for projects of lower financial returns (even with high impact).
- Limited resources to assess, measure, and monitor impact indicators and metrics related to energy efficiency projects' implementation.

5.4.2 Pilot 4 Service Workflow

The digitisation package for Pilot 4, "Green and comfortable households through prosumer engagement in Cooperatives" consist of several integrated services to address the pilot's challenges.

Firstly, the Data Sovereignty Service will be responsible for collecting and pre-processing data input streams from the photovoltaic system and IoT devices. Following that, the Data Analysis Service will process and analyse the collected data to generate insights correlated to the consumption, environmental and living conditions of the household. In addition to the entire digitisation package and explicitly for the Residential Prosumers, this service will also facilitate the optimisation of the produced energy, by adopting flexible demand and response mechanisms such as energy matching, peak demand management, and optimisation of self-consumption.

Using the analytics calculated by the Data Analysis Service, the Behaviour & Recommendation Service will make recommendations on how to improve the environmental conditions or minimise total household energy consumption.

The User Engagement Service will allow the householder to engage with the system and receive recommendations from the Behaviour & Recommendation Service. Furthermore, through the User Engagement Service, the householder can engage with the system. He can also see information about the environmental conditions and the improvements that have been achieved so far but also potential projected energy reductions if he/she adopts the recommended system changes. This is accomplished by using the data visualisation component, which provides a user-friendly interface to interact with the house environmental data.

Additionally, the User Profile Service stores user data securely, including all the preferences, habits, and the comfort level of the householder. This information is used to improve future recommendations and to optimise the total experience. Finally, the Improvements Achieved Calculation and Green Euro Rewarding Service serves as a mechanism to incentivise environmentally friendly behaviours, rewarding householders with Green Euros for their efforts in achieving energy improvements. Prior to the rewarding process, the IPMVP standard, in conjunction with the blockchain, establishes a robust layer of measurement and verification. This approach ensures high accuracy and credibility when assessing the energy improvements accomplished by the householder. Also, it incentivises the distribution of the generated savings from PVs in the community of COOP.

Overall, these digital services will help COOP members maintain high environmental standards, improve their living experience, and reduce their carbon footprint while awarding them for adopting recommended energy improvements.

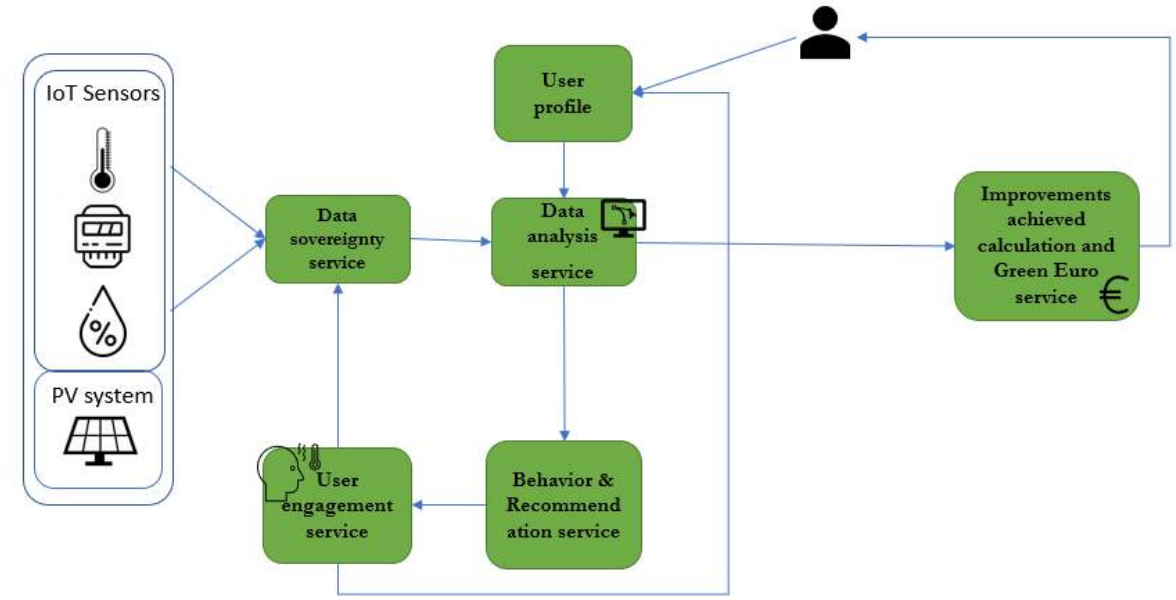

Figure 15 Pilot 4 Digital Services Architecture

5.5 Pilot 5 – Green, comfortable working environment

5.5.1 Pilot 5 Usage Scenario

Actors
Employee in Office building
Alternative actors
-
Actors interested in the outcome
Employee, Building owner.
Scenario
George is an employee in the office of the "General Secretariat of Information Systems for Public Administrations" located in Athens. For most commercial buildings' owners, energy efficiency is not the main reason to invest in a sustainable solution; most of the time the main motivation is the reduction of cost. Besides, there is a lack of knowledge of economic incentives and actual benefits to invest in such projects, as well as a lack of expertise and know-how for fast deployment of novel renovation

technologies. In addition, the employees who do not pay the bill are usually not interested in changing their behaviour.

However, both the owner of the building (Claire) and the employees in the GSIS building are highly motivated to change the existing situation. Claire found out about the FORTESIE project at a seminar for ESIE technologies in the building sector. Claire is convinced to try the FORTESIE's services and creates an account in the FORTESIE Marketplace. She sees that FORTESIE, not only offers a digital solution with a variety of value-adding services, but also includes a renovation marketplace, where she can fill in some information about the building and her needs and receive recommendations. FORTESIE, through past experimentation and piloting in a variety of buildings has generated multiple success stories, strategies, and lessons learnt and as such, can offer performance guarantees on any renovation that takes place via the FORTESIE Marketplace. Claire decides to leverage the platform and finds a renovation company that can fulfil her needs concerning the building. She signs up with an email and a password and registers her building characteristics, including the type and size of the building, the address and location, the composition of the building, the year of construction and also an optional photo upload. Based on her input, she can use the knowledge base and access previous success stories with similar characteristics. Using the Info-Funding Service and Match-Making Services, she can respectively, find available grants and various funding pathways and also get in contact with ESCOs or renovation companies. The renovations that the owner decides to proceed with are automated control of the temperature for maximum comfort, building-integrated PV installation, HVAC control and air quality.

After the renovations have been installed, and the smart sensors connected with the FORTESIE platform that can offer measurement and verification, visual analytics, etc., the workers, including George are incentivised to create a profile. Claire also decides to connect the IoT sensors and any smart appliance with the FORTESIE technical solution. FORTESIE provides a trusted infrastructure for measurement and verification of energy savings, analytics and visualisations, a rewarding mechanism as well as a gamification application that incentivises and rewards the users. Claire is quite happy with what the platform can provide her, especially because it can alleviate her uncertainty and lack of knowledge concerning some basic tasks on her side (e.g., what data she should measure, how can she know about her savings, how will her savings translate to rewards), for which in the past, she would have to consult and depend on an ESCO. In addition, she sees increased trust in the validity of metrics, savings, and rewards, among others, since to calculate savings and rewards FORTESIE will rely on official protocols (such as IPMVP) in combination with blockchain technology (which she knows is a secure and reliable solution used mostly for cryptocurrencies and NFTs) for preventing data manipulation.

Going back to George, the first step he must take is to create a profile in the FORTESIE gamification app. The registration process requires filling in personal information such as name, e-mail/e-mail verification, and optionally a phone number. Some additional information to complete include the characteristics of the building that this profile is linked to and some personal preferences. Regarding the building, the required information includes the type and size of the building, the address and location, the composition of the building, the year of construction and also an optional photo upload. As for the personal preferences, ideal temperature, thermal comfort, air quality, and willingness to participate in behavioural methods of reducing energy consumption are required. George must also set his account in the neobanking application where his G€ will be credited into his digital wallet. This application is linked with the FORTESIE gamification app, but it requires from George to validate his identity through a bank account.

After George sets up his accounts, he can start benefitting from this process. The Data Analysis Service retrieves data coming from his profile, from his colleagues' profiles and the Data Sovereignty Service (data from sensors, monitors in the building) to be analysed. The results from this analysis will define behavioural changes that are suggested for George to do. These types of changes can include accepting a temperature drop in his working space, taking the stairs instead of using the elevator etc. The choice to engage or not is up to him and if he decides to follow these behavioural changes (also based on his energy performance results from the M&V that are stored in the blockchain), in the long run, he will be rewarded (e.g., via gamified rewards, €G credited to his digital wallet). From this point on, George can start using the €G he amassed and use them for discounts in his home electricity bills and also in renovations of his dwelling.
Benefits
• Improved energy efficiency in the building. • €G earned. • To learn about the financial and environmental benefits of the application of new technologies and to inform their colleagues. • To learn and follow the procedure for the optimisation of the building performance and ensure that those systems also contribute to their wellbeing. • To increase the sense of social responsibility. • Increased trust and ability to verify energy measurements, recorded savings, and rewards.
Challenges
• Calculation accuracy of the number of €G an employee should earn from behavioural changes. • Ensuring employees' engagement. • Lack of owners' trust concerning ESIE measures' implementations, and their performance improvements guarantees. • The hesitation of owners to invest restricts market penetration. • Evidence and knowhow in ESIE activities needs enhancement.

5.5.2 Pilot 5 Service Workflow

The digitisation package for Pilot 5, "Green, comfortable working environment" consists of several integrated services to address the challenge of maintaining a green and comfortable working environment at a public administration building in Greece.

The architecture workflow starts with data gathering from IoT devices inside the building by the Data Sovereignty Service. These data such as air quality and temperatures are stored in the Data Storage and later are queried by the Data Analysis Service, which will process and analyse them to generate insights correlated to the offices and more generally for the building.

Afterwards, the Behaviour & Recommendation Service uses the insights generated by the Data Analysis Service to provide energy saving recommendations. The behavioural recommendations are provided to the employees through the User Engagement Service, and may, for example, involve adjusting the temperature of the heating/cooling office system to minimise a portion of the total building energy consumption. Furthermore, through the User Engagement Service, the employees can engage with the system, become informed not only about the environmental conditions and the improvements that they achieved but also the potential projected energy reductions if they adopt the

recommended system energy improvements. This is accomplished by using data visualisations that are provided through the mobile application.

Following that, user data are stored securely in the User Profile Service and include preferences such as the comfort level of each employee for generating pertinent recommendations. Finally, the Improvements Achieved Calculation and Green Euro Rewarding Service serves as a mechanism to incentivise environmentally friendly behaviours, and for rewarding workers with Green Euros for their efforts in achieving energy improvements. Prior to the rewarding process, the IPMVP standard, in conjunction with blockchain technology, establishes a robust layer of measurement and verification. This approach ensures high accuracy and credibility when assessing the energy improvements accomplished by the workers. Overall, the integrated suite of digital services will help building workers to maintain high environmental standards and reduce their carbon footprint while being awarded for adopting the recommended energy improvements.

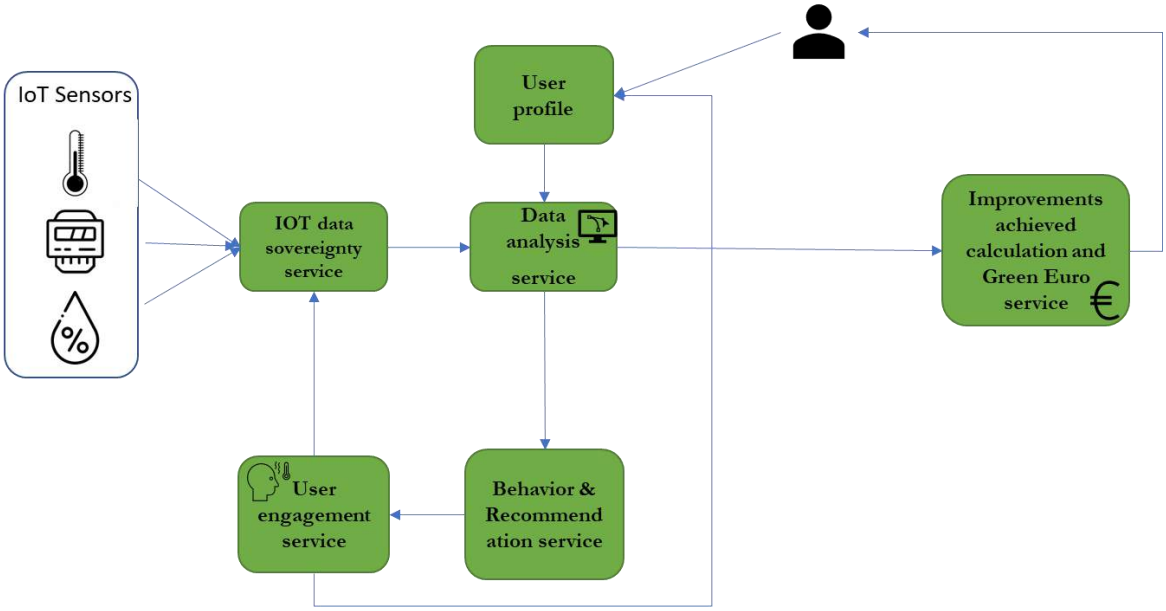

Figure 16 Pilot 5 Digital Services Architecture

5.6 Pilot 6 – Comfortable and sustainable (Public) Pools

5.6.1 Pilot 6 Usage Scenario

Actors
Municipality
Alternative actors
-
Actors interested in the outcome

Municipality, citizens & other users-visitors (swimmers), renovation company.
Overview
Scenario
George is the mayor of a municipality in Central Poland. The municipality owns among other facilities, a public pool that is popular during the summer months, but its operational costs are quite high due to the energy consumption required to maintain the pool's temperature and air quality. Indoor swimming pools are among the most energy and water consuming building types due to the need to provide suitable thermal comfort for the occupants and to counterbalance losses. The municipality wants to increase the pool's energy efficiency to reduce its operational costs and also increase attendance by promoting a more comfortable pool environment. George becomes informed of FORTESIE, which not only offers a digital solution with a variety of value-adding services, but also includes a renovation marketplace, where he can fill in some information about the building and his needs and receive recommendations. FORTESIE, through past experimentation and piloting in a variety of buildings has generated multiple success stories, strategies, and lessons learnt and as such, can offer performance guarantees on any renovation that takes place via the FORTESIE Marketplace. George decides to leverage the platform and finds a renovation company that can fulfil his needs concerning the pool's operation. George signs up in FORTESIE's Marketplace to find out more about ESIE technologies, EPCs, etc. using an email and a password. The Marketplace also provides the Match-Making Service with a variety of renovation companies and ESCOs that can be consulted for the implementation of the necessary actions. George oversees the completion of the public procurement process which includes: a) contact with a consultant who recommends a company that has experience in this type of renovation and who will provide these green performance / ecological solutions, b) set out the rules on what the budget framework is (there are different budget rules for different municipalities) – either a tender or a single source, depending on the amount of money required, etc. The renovation company, that is selected, is aware about the benefits that the new renovation technologies can provide to its business, in terms of efficient, sustainable, inclusive energy use for the relevant facilities. The renovation technologies include integrated thermal and energy modernisation along a tailored ventilation system with smart heat recovery, supported by a system of efficient heat exchangers for pool water and further PV installation. The municipality decides to use the FORTESIE platform so that the pool operator can monitor and control the indoor environmental conditions and the pool's temperature. The first step is to create user profiles for the pool building, its staff members, and visitors. The pool's profile includes previous electricity consumption data, type of heating, type and size of the building, the address and location, the composition of the building, the year of construction, an optional photo upload and the dimensions and temperature of the pool, as well as whether it is located indoor or outdoor. The staff members and visitors can access the FORTESIE services via the FORTESIE gamification app. The registration process requires filling in personal information such as name, e-mail/e-mail verification, optionally a phone number, information about ideal conditions including temperature, thermal comfort, and air quality, frequency of using the pool's facilities and willingness to participate in behavioural methods (indicatively via polling actions that will in turn

provide recommendations based on the majority voting concerning the pool's conditions) of reducing energy consumption, along with measurement of their satisfaction.

They will also need to create an account in the neobanking application where their €G will be credited into their digital wallet. This application is linked with the FORTESIE gamification app, but it requires them to validate their identity through a bank account.

The tool uses IoT devices to collect data on the pool's energy consumption, including data on the temperature of the pool water and the air temperature in the pool area. It generates personalised recommendations for staff members and visitors, based on their individual profiles and preferences (Behaviour & Recommendation Service). Based on those recommendations and also the general overview of the pool's conditions by the pool operators, the latter will then shape certain sustainable packages of conditions to be kept, taking into account what is realistic and practical from a technical standpoint. User groups will then be exposed with these packages, express their preferences towards particular packages through the gamification app and give majority suggestions to the pool administrators. Following that, the pool administrators (through the FORTESIE services) will be able to manage pool conditions accordingly based on the user group that is using the facilities each time. Other than voting actions, the packages prepared by the pool operators could include more horizontal actions such as the drop of the pool's temperature on certain days along with some promotional rewards for the users (e.g., lower temperatures on Fridays and rewarding of users who visit the pool on Fridays) or alternatively some more vertical and personalised actions that concern each individual user (e.g., not using the drier after using the pool to save energy) and will be accompanied by an appropriate reward.

If staff members and pool users decide to engage in their suggested behavioural changes, they will be rewarded (e.g., via gamified rewards, €G credited to their digital wallet).

Either way, through the measurement and verification results, if the EPC's terms are met then they can start earning €G and thus George's municipality can evaluate the success of the renovation through the new operational costs. As a result of using the tool, the municipality is able to significantly reduce the pool's energy consumption and operational costs, while also improving the pool's comfort and cleanliness. This leads to increased attendance and greater satisfaction among visitors, helping to promote the pool as a desirable destination all year.

Benefits

- Lower operational costs.
- A tool to manage and monitor the energy consumption in the pool building.
- Involve and motivate users to support the programmes of the energy consumption reduction.
- Educate the pool operators about their role in the process.
- Increase the building sustainability by improving the heating and ventilation system.
- Introduce innovative ways of heating the air and water inside the pool.

Challenges

- Difficulties convincing everyone regarding a potential lower pool temperature.
- Inefficiency of the heating and ventilation system.
- Inconsistency of the pool workers to achieve the best possible results of the heating and ventilation system.
- Lack of adaptability of the heating and ventilation system to the predictable occupancy of the pool.

- Lack of flexibility of the system to adapt towards the pool operator needs.
- Lack of knowledge on how to improve the efficiency of the system.

5.6.2 Pilot 6 Service Workflow

The digitisation package for Pilot 6, "Comfortable and sustainable (Public) Pools" consists of several integrated services to address the challenge of maintaining green and sustainable pool.

The architecture workflow starts with data gathering from IoT devices from the pool by the Data Sovereignty Service. The data will then be stored to the data storage and queried by the Data Analysis Service, which will process and analyse them to generate insights about the pool and provide the required input for the next service in the workflow chain.

Afterwards, the Behaviour & Recommendation Service uses the insights generated by the Data Analysis Service to provide energy saving recommendations. The behavioural recommendations are provided to the pool users through the User Engagement Service, and may, for example, involve the recommendation to accept lower pool temperatures to minimise a portion of the total energy consumption. Furthermore, through the User Engagement Service, the pool users can engage with the system by becoming informed about the possible improvements that they achieved but also the possible projected energy reductions if they adopt the recommended system energy improvements. This is accomplished by the Data Analysis Service that gathers and analyses the feedback responses from the pool users through the mobile application and combines them with the operators' commands for the optimal outcome.

The User Profile Service stores the pool users' data securely, including preferences about the comfort levels, which are useful for future exploitation and recommendations generation. Finally, the Improvements Achieved Calculation and Green Euro Rewarding Service serves as a mechanism to incentivise environmentally friendly behaviours, rewarding pool users with Green Euros for their efforts in achieving energy improvements. Prior to the rewarding process, the IPMVP standard, in conjunction with blockchain technology, establishes a layer of measurement and verification. This approach ensures the accuracy and credibility when assessing the energy improvements accomplished by the pool users. Overall, the integrated suite of digital services will help both the pool owners in a sustainable way and the pool users to indirectly control the pool temperatures and lead to high energy savings.

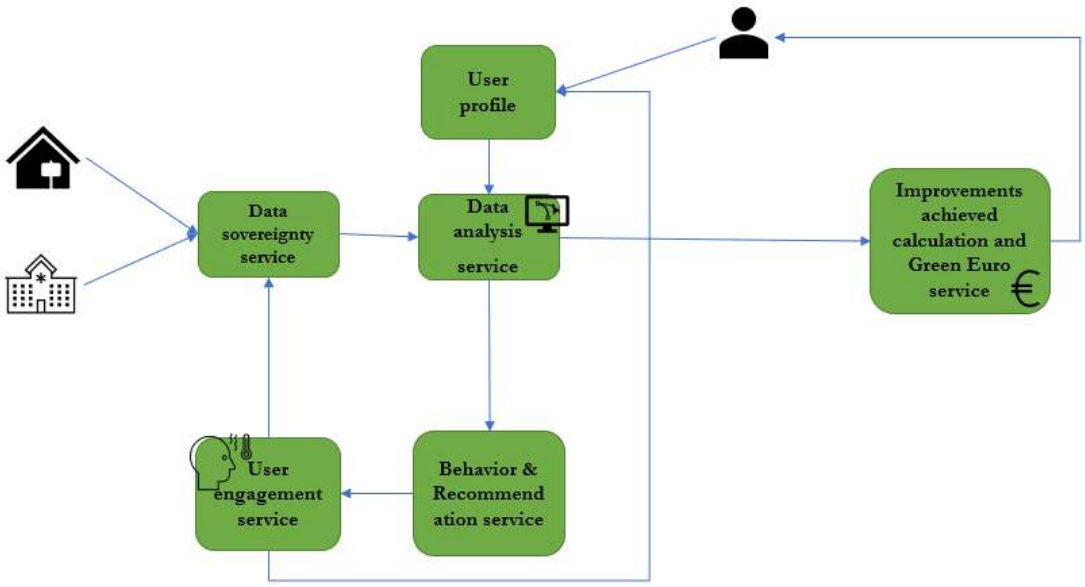

Figure 17 Pilot 6 Digital Services Architecture

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

5.7.1 Pilot 7 Usage Scenario

Actors
School dean
Alternative actors
-
Actors interested in the outcome
Teachers, students, school dean, municipality, ESCO.
Scenario
Johanna is a school dean at a public school in Riga. The people who are in the school and are directly affected by its conditions are students, teachers, secretarial staff, and maintenance staff such as cleaners, canteen operators and so on. The majority of the school's population consists of students whose health would be vulnerable in non-optimal indoor conditions, such as bad air quality and low temperature. Additionally, it should not be overlooked that in the same building the necessary climatic working conditions must be observed for the workers as well. The school, as a public building is a place that does not generate

money, which makes it essential that it operates in the best indoor conditions while also considering energy efficiency.

The current situation at the school does not fully address the above requirements. However, the dean is highly motivated and in contact with the municipality to fix the situation. The municipality managers inform Johanna about the FORTESIE project, which they have previously leveraged for other buildings they oversee with positive results. FORTESIE offers a digital solution with a variety of value-adding services, and also includes a renovation marketplace, where Johanna can fill in some information about the building and its needs and receive recommendations. FORTESIE, through past experimentation and piloting in a variety of buildings has generated multiple success stories, strategies, and lessons learnt and as such, can offer performance guarantees on any renovation that takes place via the FORTESIE Marketplace. Johanna decides to leverage the platform and finds a renovation company that can fulfil her needs concerning the school.

First, she creates an account for the school which contains the building's information (previous electricity consumption data, type of heating, type and size of the building, the address and location, the composition of the building, the year of construction and an optional photo upload). Johanna via the FORTESIE Marketplace can be informed about previous success stories on similar buildings (Knowledge Base Service), to choose through a range of proposed renovations that can be implemented based on the characteristics of the building (Renovation Recommendation Service), available grants (Info-Funding Service), and also finds ESCOs which have experience in this field (Match-Making Service). In cooperation with an ESCO, they decide to proceed with various renovations and finally apply them. The renovation includes new heating and ventilation systems, new pipe heating systems and AHUs for mechanical air handling, remote electronic controllers for all heating and air handling elements, and connection of heating elements with AHUs to maintain energy regulation based on demand. However, Johanna needs to ensure that these actions are going to be successful and result in a healthier and more comfortable learning environment for the students and staff. To achieve this, she uses the FORTESIE platform to monitor the school's indoor environment.

She logs in to the tool's dashboard with the school's credentials (email, password) and accesses the Data Analysis Service, which gathers information from IoT devices installed in the school's classrooms and other spaces. The system provides real-time information about temperature, humidity, CO_2 levels, and other important indicators of indoor air quality which allow the building's administrator to keep track of the system's operation. Johanna can now set the right temperature and air quality indoors which may differ in some places based on the specific conditions required by students, teachers, and school workers.

The data from sensors, radiators and the profiles of the people in the building are analysed in the Data Analysis Service. The outputs are exported in the Behaviour and Recommendation Service, which in turn suggests actions to implement. The baseline assessment and the results from the Data Analysis Service are validated via the blockchain (M&V Service), which tracks energy consumption and verifies any changes in energy use that are a result of the renovation actions. When the school's energy performance is confirmed with the M&V and stored in the blockchain, it starts to earn €G which can be used on other renovations that are needed. Johanna is quite happy with what the platform can provide her, especially because it can alleviate her uncertainty and lack of knowledge concerning some basic tasks on her side (e.g., what data she should measure, how can she know about her savings, how will her savings translate to rewards), for which in the past, she would have to consult and depend on an ESCO. In addition, she sees increased trust in the validity of metrics, savings, and rewards, among others, since to calculate savings and rewards FORTESIE will rely on official protocols (such as IPMVP) in combination with blockchain

technology (which she knows is a secure and reliable solution used mostly for cryptocurrencies and NFT) for preventing data manipulation. This allows Johanna to see the actual impact of the renovations on the school's energy consumption and carbon footprint. As a result, the municipality managed to reduce the school's operational costs, the ESCO has data for the renovations in order to assess their success and most importantly, the students and staff have a place with the ideal thermal comfort and air quality.
Benefits
• Reduced operational costs. • Increased indoor environmental conditions and climate. • Translate energy savings into economic rewards and ensure the investment terms and their recovery. • Increased trust and ability to verify energy measurements, recorded savings, and rewards.
Challenges
• Figuring out the most suitable indoor conditions in each classroom of the school. • Facility quality and environmental quality is difficult to control due to the multitude of different classrooms and parameters that need to be controlled and optimised.

5.7.2 Pilot 7 Service Workflow

The digitisation package for Pilot 7, "Comfortable, inclusive and sustainable green schools" consists of several integrated services to address the challenge of maintaining green and sustainable schools.

The architecture workflow starts with data gathering from installed IoT devices by the Data Sovereignty Service. The data will then be stored to the Data Storage and queried by the Data Analysis Service, which will process and analyse them to generate insights about the school and each class individually.

The next service in the workflow is the Behaviour & Recommendation Service which uses the insights generated by the Data Analysis Service to provide energy saving recommendations for each user. The behaviour recommendations are provided to students and teachers about their class through the mobile app and may involve the recommendation to accept lower temperatures to minimise a portion of the total energy consumption. Furthermore, through the User Engagement Service, the students and teachers can engage with the system by getting informed about the improvements that they have achieved but also about further energy optimisation pathways that will materialise if they adopt the recommended system's energy improvements. This is accomplished in the Data Analysis service by gathering and analysing the feedback responses through the mobile application.

The User Profile Service stores data securely, including preferences about the comfort levels, which are useful for future exploitation and recommendations generation. Finally, the Improvements Achieved Calculation and Green Euro Rewarding Service serves as a mechanism to incentivise environmentally friendly behaviours, by rewarding the students and teachers with Green Euros for their efforts in achieving energy improvements. Prior to the rewarding process, the IPMVP standard, in conjunction with blockchain technology, establishes a robust layer of measurement and verification. This approach ensures the utmost accuracy and credibility when assessing the energy improvements accomplished by the digital services users.

Overall, the integrated suite of digital services will help increase the school's energy sustainability and will lead to energy savings and better indoor conditions for the students.

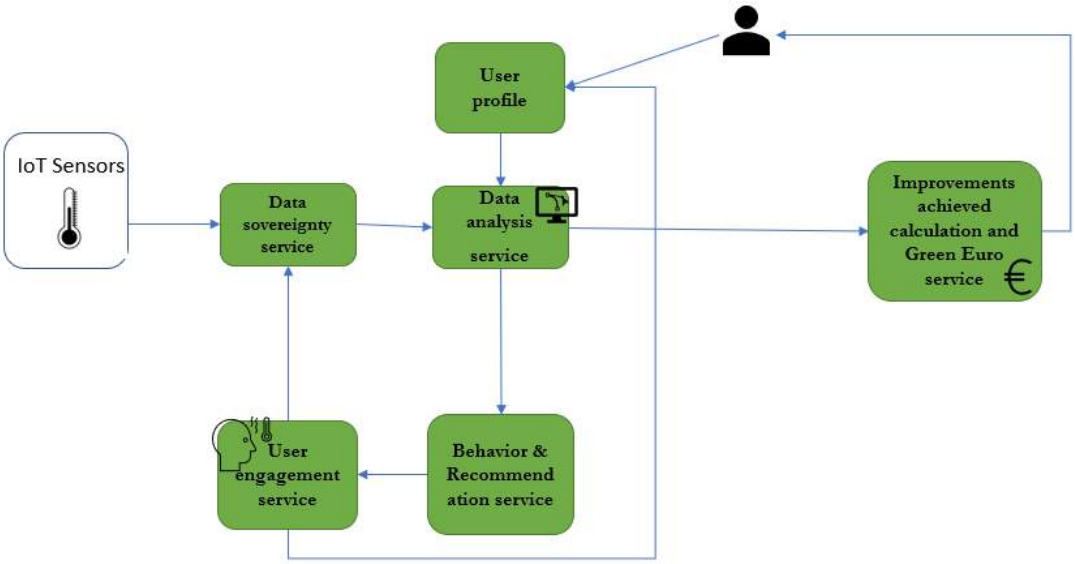

Figure 18 Pilot 7 Digital Services Architecture

6 FORTESIE Digital Services' Ecosystem

In the previous chapters, the FORTESIE Digital Services, which were designed specifically to cater to the needs of the FORTESIE pilots, were presented and analysed in detail. These services, along with their components, will be deployed in several pilots, thus creating an intricate yet complex network.

This complex network constitutes the FORTESIE Digital Services' Ecosystem, and it is of added value to be presented in a clear and comprehensive way. To facilitate this visualisation, the kumu.io tool[1] was used, and three views were created providing different functionalities and information about the pilots, the services, the components, and their relations.

In the figure below, the FORTESIE Digital Services' Ecosystem is depicted. The pilots are marked with orange circles, while the services are depicted using octagons. The One-Stop-Shop Marketplace is represented in green, with the remaining services in yellow. Components are shown as diamonds, with the Marketplace's sub-services in dark green and components of other services in blue.

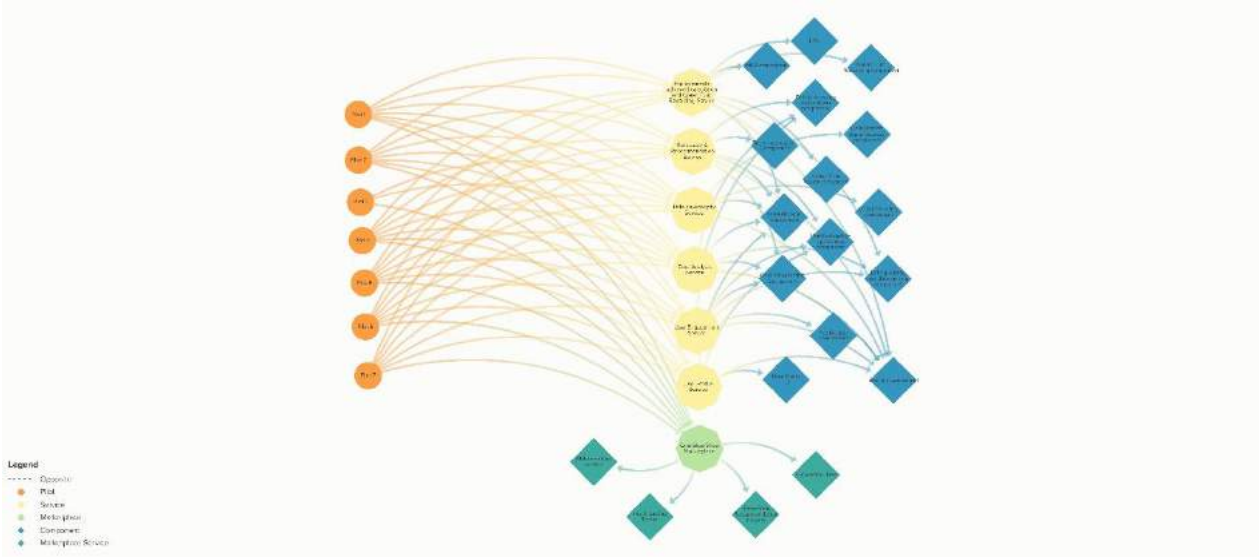

Figure 19 FORTESIE Digital Service's Ecosystem

The link for the view containing all the pilots, services and components can be found here: https://kumu.io/epuntua/fortesie-services-ecosystem#fortesie-ecosystem.

However, this complex graph may pose a challenge for a user who attempts to comprehend all available information. Therefore, for the sake of simplicity, we have placed all the pilots on the left side of the window, services are in the centre and the components on the right. Moreover, kumu.io provides the feature to focus on a specific object for a user to be able to examine its relations and to collect more information (type, brief description) about the selected node.

In the figure below, the Data Sovereignty Management Service has been selected. On the left side of the screen, the title as well as the type of the selected object along with a brief description are presented. On the right side of the screen, the nodes that are connected with the selected node are depicted.

[1] https://kumu.io/

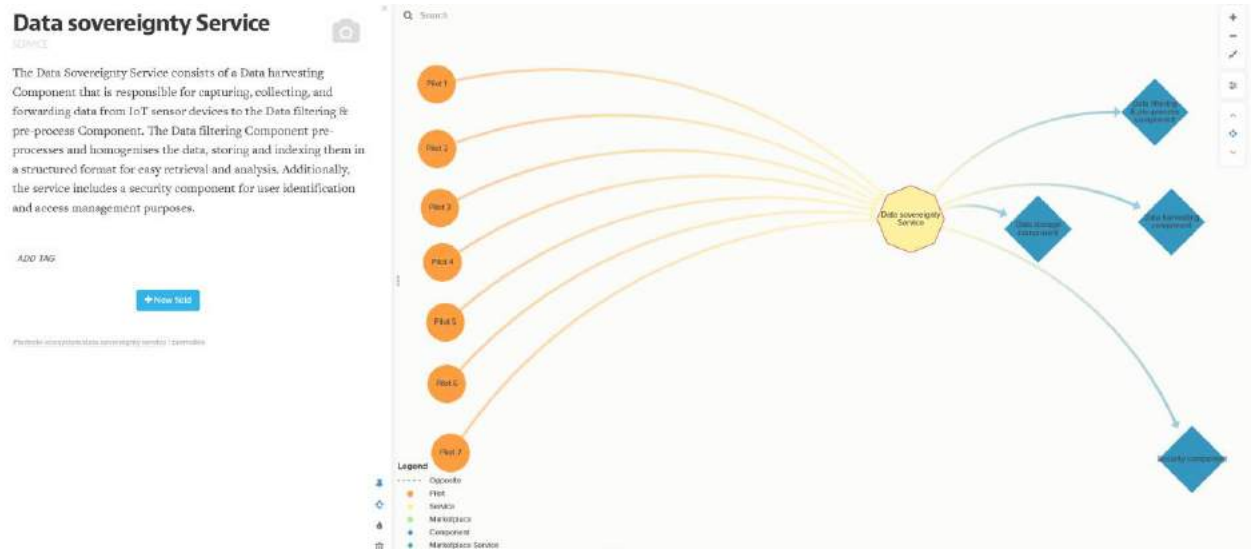

Figure 20 Focus on Data Sovereignty Service

The second view depicts only the pilots and the services of the FORTESIE Digital Services' Ecosystem (the components are hidden). This view helps the reader to understand and focus on the high-level functionalities needed for a pilot. The link for that view can be found here:

https://kumu.io/epuntua/fortesie-services-ecosystem#fortesie-ecosystem/pilots-services.

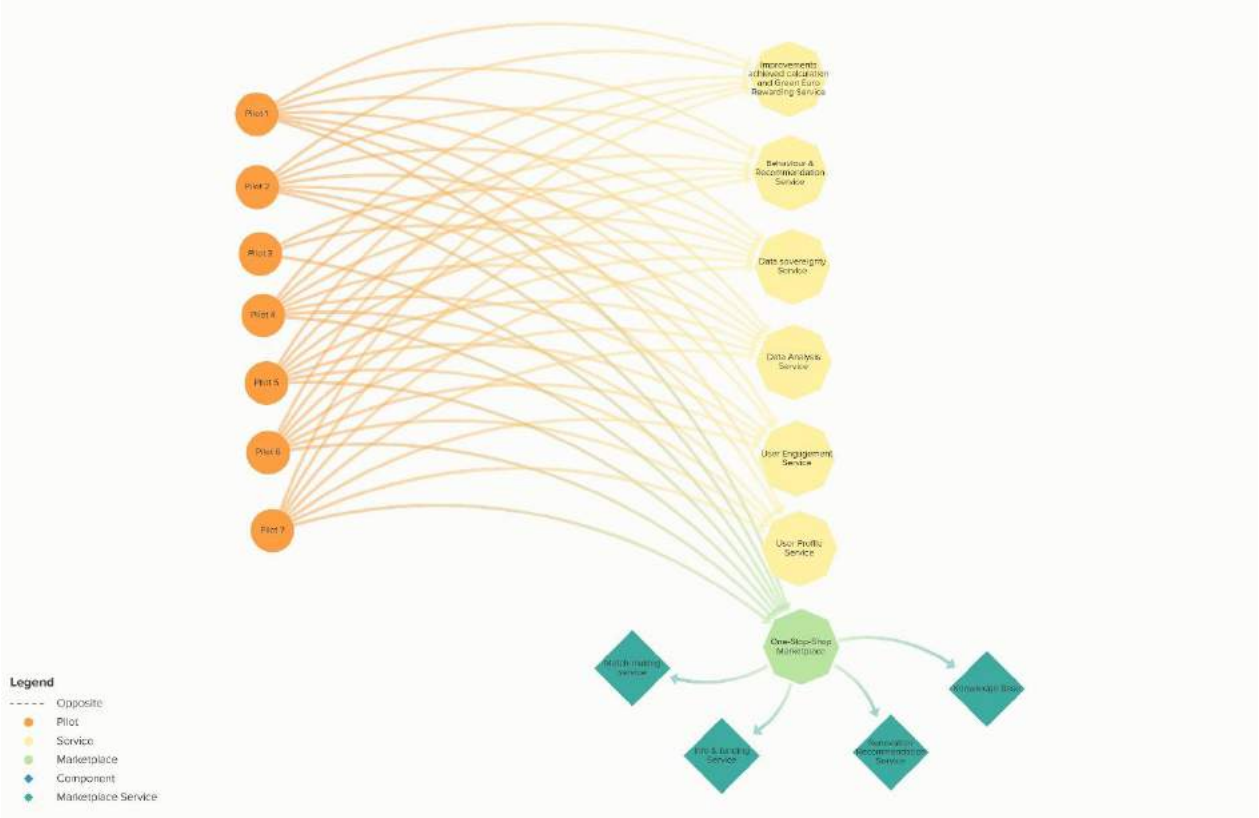

Figure 21 Pilots and Services

The third view is similar to the first one with the difference that the focus functionality has been modified. To be more specific, in "expand focus mode" only the nodes that are associated with directed connection (direction: from selected to others) are presented. In that view, as depicted below, the reader can understand the services as well as the components that are needed for a specific pilot. The link to that view can be found here: https://kumu.io/epuntua/fortesie-services-ecosystem#fortesie-ecosystem/pilots-services-components-focus.

An example of the third view is depicted below. Here, "Pilot 2" has been selected, thus only displaying the services and components that are related to this chosen pilot.

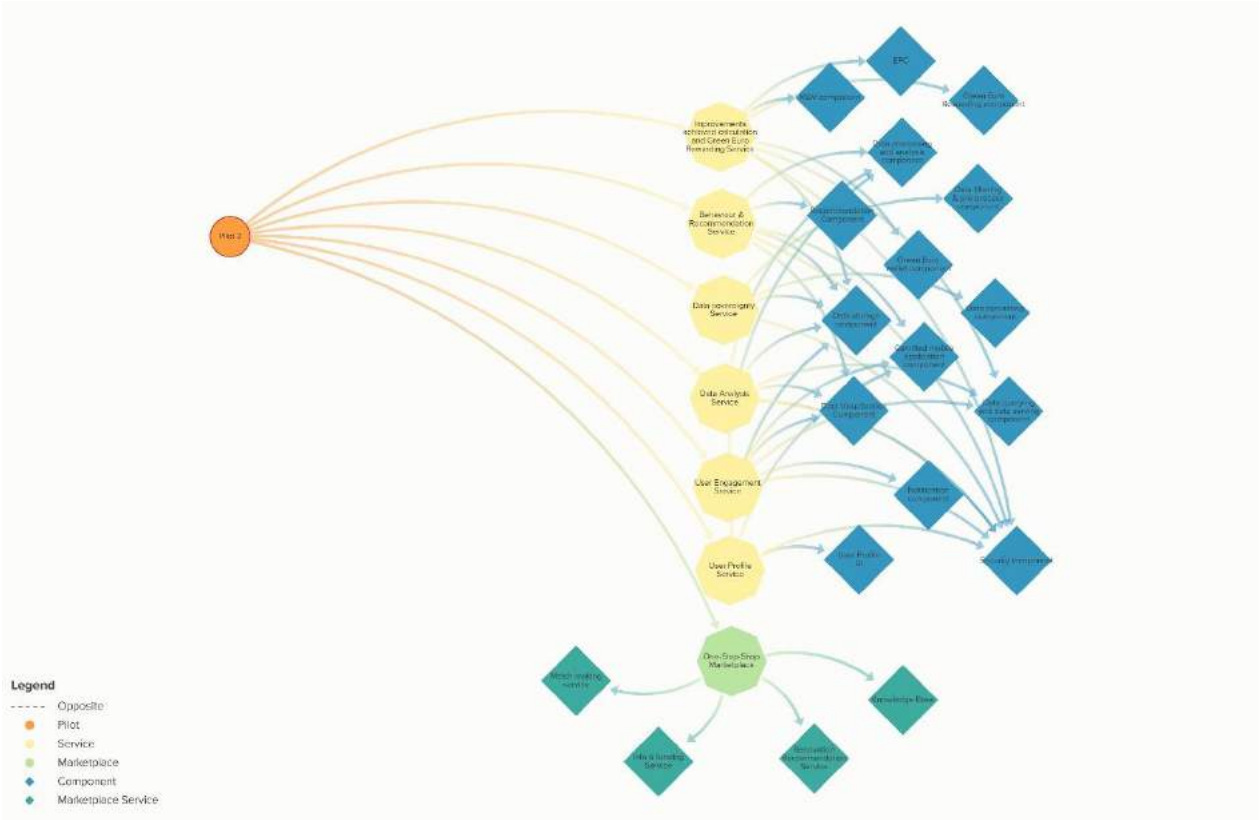

Figure 22 Services and Components designed for Pilot 2

To conclude, the FORTESIE Digital Services' Ecosystem was visualised through kumu.io enabling users to better comprehend the pilots, the designed services, and components, as well as their interrelations. By using this tool, the user may navigate through the graph and find information about the designed services and components. This could play a vital role in better understanding the pilots' needs.

After visualising the FORTESIE Digital Services' Ecosystem, it would be valuable to understand how the Functional Requirements, presented within the context of Deliverable 2.1, will be addressed by the designed services and components.

For this purpose, we have constructed a table that includes the Functional Requirement identifier (originating from D2.1), its title, related user stories (originating from D2.1), as well as the corresponding FORTESIE Digital services or components. This table is presented below.

Table 1 Mapping between FORTESIE Requirements and Services

Requirement	Requirement ID	User Story ID	Service
The FORTESIE solution shall be able to allow the definition of a smart Energy Performance Contract based on ESIE measures.	**F1**	**1.2.2, 2A.2.1, 2A.5.2, 2A.6.3, 2B.1.3, 2B.7.1, 2B.7.2, 4.3.2, 5.2.1, 5.2.2**	*Smart Contract*
The FORTESIE solution shall be able to store the relevant data needed for the Energy Performance Contract.	**F2**	**4.3.2, 5.2.1, 7.1.1, 7.1.2, 7.3.2**	*Data sovereignty Service/User profile component/ Improvements Achieved Calculation Service and Green Euro Rewarding Service/ Smart Contract*
The FORTESIE solution shall be able to provide a trusted method for guaranteeing that the information stored (which is needed for the calculation of the Energy Performance Contract) is not altered.	**F3**	**1.1.3, 1.2.2, 1.7.2, 1.8.2, 1.9.1, 1.9.3, 2A.1.2, 2A.1.3, 2A.4.1, 2A.4.2, 2A.8.1, 2B.2.1, 2B.3.1, 2B.4.1, 2B.7.1, 2D.1.1, 2D.2.2, 4.3.2, 5.1.2, 5.3.2, 5.8.1, 6.10.1, 7.3.2**	*Improvements Achieved Calculation Service and Green Euro Rewarding a Data Sovereignty*
The FORTESIE solution shall be able to provide a means for the final user to consult the information related to the Energy Performance Contract stored and calculated in it (only the relevant information for that user).	**F4**	**11.3.1, 1.3.2, 2A.1.2, 2A.3.1, 2A.4.1, 2A.4.2, 2A.5.1, 2A.5.2, 2B.5.1, 5.5.2, 5.4.1, 5.4.2, 5.6.1, 6.4.1, 6.5.3, 6.6.1, 6.6.2, 6.7.1**	*Knowledge Base/Info & funding/ Gamified mobile application/ Data Sovereignty/ Improvements Achieved Calculation Service and Green Euro Rewarding*
The FORTESIE solution shall be able to provide a means for the relevant stakeholders (e.g ESCOs, renovation companies, potential investors) to consult the information related to the Energy Performance Contract stored and calculated in it.	**F5**	**1.2.1, 1.2.3, 1.7.1, 1.8.1, 1.8.4, 1.9.2, .1.9.4, 2A.1.3, 2A.2.1, 2A.2.2, 2A.3.1, 2A.3.2, 2A.4.2, 2A.5.1, 2A.6.1, 2A.6.2, 2A.7.1, 2A.7.2, 2B.1.3, 2B.2.3, 2B.3.3, 2B.6.1, 2B.6.2, 2B.7.2, 2C.4.2, 2C.4.3, 2D.1.3, 2D.2.3, 2D.2.4, 2D.3.1, 2D.3.2, 2D.3.3, 2D.3.4, 2D.4.1, 2D.4.2, 3.2.1, 3.2.2, 3.2.3, 3.5.1, 3.6.1, 4.1.2, 4.1.3, 4.2.2, 4.4.1, 4.4.2, 4.4.3, 4.5.2, 4.6.1, 4.7.1, 5.1.2, 5.3.2, 5.7.1, 5.7.2, 5.9.2, 6.8.4, 6.10.2, 6.10.3, 6.10.4, 6.11.1, 6.11.2, 6.11.3, 6.12.1, 6.13.1, 7.1.3, 7.1.4, 7.2.1, 7.2.2, 7.2.3, 7.3.1, 7.4.3, 7.6.1, 7.6.2, 7.7.1, 7.7.2, 7.7.3, 7.8.1, 7.8.2, 7.8.3**	*Knowledge Base/Info & funding/ Data Sovereignty*
The FORTESIE solution shall be able to compare the before and after energy consumption or demand of the building.	**F6**	**2A.1.1, 2A.2.3, 2B.1.2, 2D.1.4, 3.3.2, 3.4.2, 4.1.1, 4.2.1, 4.3.1, 5.1.1, 5.2.1, 5.2.2, 6.3.1, 6.5.1, 6.8.1, 6.8.2, 6.9.1**	*Data Analysis/ Data Sovereignty/ Gamified mobile application / Improvements Achieved*

			Calculation Service and Green Euro Rewarding
The FORTESIE solution shall be able to provide a comparative of performance of buildings from an energy and sustainability perspective.	**F7**	**1.1.6, 1.2.4, 1.5.2, 1.6.1, 1.8.3, 2A.1.1, 2A.1.2, 2A.2.3, 2A.3.3, 2B.1.1, 2B.1.2, 2B.1.4, 2B.2.1, 2B.3.2, 2B.4.2, 2D.1.2, 2D.1.4, 2D.2.1, 3.1.1, 3.1.2, 3.3.1, 3.4.1, 3.7.1, 3.7.2, 4.2.2, 4.5.1, 5.1.1, 5.2.1, 5.5.1, 5.8.2, 5.9.1, 6.1.2, 6.2.1, 6.1.1, 6.2.2, 6.8.2, 6.8.3, 6.8.5, 7.4.1, 7.4.2, 7.5.2, 7.5.3**	*Data Analysis/ Gamified mobile application*
The FORTESIE solution shall be able to provide personalised feedback to consumers regarding their progress in achieving energy savings.	**F8**	**1.3.1, 1.3.2, 1.5.3, 1.6.3, 2A.1.4, 2B.2.2, 2D.2.2, 6.1.4, 6.3.3**	*Improvements Achieved Calculation Service and Green Euro Rewarding/ Data analysis Service/ User profile service/ User Engagement Service/ Behaviour & Recommendation service/ Gamified mobile application*
The FORTESIE solution shall be able to offer personalised challenges to the consumers related to their energy consumption.	**F9**	**1.1.4, 1.3.1, 1.4.1, 1.5.1, 1.5.2. 1.6.1, 1.6.2, 4.1.2, 6.5.2, 6.9.2, 6.9.3**	*Behaviour & Recommendation Service/ Data Analysis Service/ User Engagement Service/ Gamified mobile Application*
The FORTESIE solution shall be able to generate personalised recommendations and rewards to guide the consumers towards a more energy efficient behaviour.	**F10**	**1.1.2, 1.1.4, 1.3.1, 1.4.1, 1.4.2, 1.5.1, 1.5.3, 1.6.3, 5.3.1, 5.6.2, 6.3.4, 6.4.2, 6.4.3, 6.6.3, 6.7.2**	*Behaviour & Recommendation Service/ Data Analysis service/ User Engagement Service/ Improvements Achieved Calculation Service and Green Euro Rewarding Service/ Gamified mobile Application*
The FORTESIE solution may be able to integrate non-economical rewards (e.g., badges) and/or economical rewards (e.g., Green euro).	**F11**	**1.3.3, 1.5.3, 1.6.3, 1.8.5, 4.3.2, 5.6.3, 6.3.4, 6.5.4, 7.5.1**	*Behaviour model& recommendation service /User Engagement Service / Improvements Achieved Calculation Service and Green Euro Rewarding*
The FORTESIE solution shall be able to offer a OSS that provides presential and online services, via a marketplace.	**F12**	**1.8.6, 1.9.2, 1.9.4, 2A.8.2, 2B.2.3, 2C.1.1, 2C.1.2, 2C.1.3, 2C.1.4, 2C.2.1, 2C.2.2, 2C.2.3, 2C.2.4, 2C.3.1, 2C.3.2, 2C.3.3, 2C.3.4, 2C.4.1, 2C.4.2, 2C.4.3, 2C.4.4, 2C.5.1, , 2C.5.2, 2C.5.3, 2C.5.4, 2C.6.1,**	*One-Stop-Shop Marketplace*

		2C.6.2, 2C.7.1, 2C.7.2, 2D.2.4, 2D.3.2, 6.5.5, 6.6.4, 6.7.3, 6.8.6, 6.10.5	

7 Conclusions and Next Steps

As D2.2 "FORTESIE services co-creation" constitutes an important step towards a successful FORTESIE services' implementation and realisation, a dedicated methodology was designed for its needs. The methodology consisted of five steps that ensured a collaborative and iterative approach towards advancing the collected (in the context of T2.1 "Analysis of end user requirements and definition of services") pilot requirements, deriving usage scenarios, leading to a reference ecosystem of digital services and underlying components; constantly validating and fine-tuning the ongoing work following a collaborative, SSH-oriented, approach. The aforementioned methodology proved to be effective in achieving its goals.

Diving in more detail, the first step involved a collaborative pilot information gathering through interviews (realised in the frames of the T2.1 interviews), which provided initial inputs for detailing the pilot usage scenarios. This was crucial in understanding the specific needs, expectations, and requirements of each pilot.

Building on the information gathered, and always taking into account the requirements documented in the previous deliverable (D2.1), the second step focused on deriving detailed end-to-end usage scenarios for each FORTESIE pilot. Thus, 8 usage scenarios were detailed, fine-tuned, and lastly validated by the pilots.

In the third step, the goal was to design the FORTESIE digital services, as well as the underlying components, based on the derived usage scenarios. The identification of commonalities in the pilot usage scenarios and requirements, led to the design of 6 digital services. These services practically constitute grouping of components (i.e., standalone objects that perform a specific function) into parent services. In addition, the "One-Stop-Shop Marketplace Service" which includes 4 (sub-) services was identified and designed. The next step was the design of a high-level integration schema that addresses each pilot's digital service needs. A tailored service workflow was created for each pilot to guide the future implementation of these digital services, ensuring an end-to-end approach serving each usage scenario effectively.

The fourth step of the methodology involved the final fine-tuning and validation cycle of the aforementioned results through collaborative sessions with the pilot teams, leveraging the FORTESIE SSH orientation. All relevant teams were actively engaged in reviewing and providing feedback on the usage scenarios, digital service definitions, and workflows. This feedback ensured that the work in previous steps was adherent to the pilots' requirements, and any necessary corrections, updates or improvements were effectively addressed.

Finally, the validated usage scenarios and digital service workflows were used to design the final classification of FORTESIE digital services and their underlying components.

7.1 Next Steps

As also mentioned earlier in the document at hand, D2.2 constitutes an important milestone towards a successful FORTESIE services' implementation and realisation. The results reported in D2.2 are already being fed in three other key tasks.

Firstly, in T2.3 "Reference architecture tailored to renovation technologies for increased performance" which aims to define a reference architecture tailored to renovation technologies, taking into account the usage scenarios and service designs reported in the current deliverable. This modular architecture will prioritise extensibility, independence, and interoperability with existing systems while considering privacy by design and data protection requirements.

Moreover, T3.1 “Digital components development and adaptation” will proceed with the development and adaptation of digital components based on the reference architecture and the methodology specified in Task 2.2, ensuring the required functionality, integration, and extensibility of these components.

Furthermore, T2.4 “Novel market structures and business models for renovation services” will focus on developing novel market structures and business models for renovation services, aligning them with the stakeholders and services identified in Task 2.2 and reported in the deliverable at hand. This will involve identifying exploitation assets, studying innovative business models, and developing detailed business plans for market launch.

Finally, T2.2 will deliver on M25 an updated version of the document at hand (i.e., D2.5 “FORTESIE services co-creation M25”, as it follows the dynamic and iterative approach of FORTESIE.