D6.4
Pilots Demonstration & Evaluation

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D6.4
SmartLivingEPC Pilots Demonstration & Evaluation

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Executive Summary

Deliverable D6.4 provides a comprehensive overview of the implementation, demonstration, and evaluation of the SmartLivingEPC scheme across pilot buildings located in Greece, Cyprus, Estonia, and Spain and complex building pilot in Spain. The aim is to validate the functionality and impact of the SmartLivingEPC Web Platform, which integrates advanced methodologies for asset and operational rating through real-time data, BIM modelling, and AI-driven analytics.

The document is structured around three main phases: baseline activities, implementation and validation of Architectural Use Cases (UCs), and demonstration activities.

Baseline activities include preparing BIM models, installing IoT devices, and ensuring data communication with the CIEM (Common Information Exchange Model) platform. The BIM models serve as foundational digital representations containing both static and dynamic data, critical for accurate performance assessments.

IoT installation varied among pilots. Some sites (e.g., DS1–DS3) had existing infrastructure, while others (DS4–DS9 in Leitza) required full setup. These installations enabled dynamic data collection—such as energy use, IAQ, and comfort parameters—essential for operational evaluation.

Communication between IoT systems and the CIEM platform was standardized via REST APIs and Rabbit MQ queues. Despite some initial integration challenges—especially in existing buildings—most pilots achieved successful, continuous data sharing. Key lessons highlighted the importance of collaboration with QUE (the CIEM developer) and the need to accommodate internal cybersecurity restrictions in some institutions.

Use Case Implementation: 25 Architectural Use Cases were successfully validated. These Use Cases tested the SmartLivingEPC platform's core services—such as energy and resource analysis, SRI calculation, LCA, asset and operational rating, and digital logbook functionality—within real buildings.

The Architectural Use Cases related to the Building Complex assessment have also been successfully validated for both asset and operational ratings. Key lessons learned highlight the importance of coordination with stakeholders to efficiently define boundaries and support effective KPI development. Consequently, the proposed improvements focus on this direction, including the development of participatory tools to enhance citizen empowerment and engagement.

Demonstration Activities**:** Two main workshops were organized—one for EPC assessors and another for end-users in Leitza. These sessions gathered direct feedback on usability and usefulness. Results showed general satisfaction but also highlighted areas for improvement, especially in data visibility, system integration, and user guidance.

The evaluation confirmed that SmartLivingEPC is technically viable and ready for deployment**,** but also revealed important lessons: the need for standardized BIM modelling**,** more resilient IoT setups**,** and better tools for scaling in existing buildings**.**

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List of Acronyms and Abbreviations

Term	Description
API	**Application Programming Interface**
BIM	**Building Information Modelling**
CIEM	**Common Information Exchange Model**
DHW	**Domestic Hot Water**
DS	**Demo Site**
EPC	**Energy Performance Certificate**
IAQ	**Indoor Air Quality**
IoT	**Internet of Things**
LCA	**Life Cycle Assessment**
LCC	**Life Cycle Cost**
SLEPC	**SmartLivingEPC**
RES	**Renewable Energy Sources**
SRI	**Smart Readiness Indicator**
UC	**Use Case**

1 Introduction

1.1 Scope and objectives of the deliverable

This deliverable presents the results of the implementation, demonstration, and evaluation of the SmartLivingEPC concepts in the pilot projects.

To this end, the deliverable first presents the foundations of the methodology followed in the pilots: it begins with a description of the baseline tasks that serve as prerequisites for the implementation of the SmartLivingEPC concepts and solutions developed in previous WPs. It also outlines the validation methodology for the implementation of the Architectural Use Cases and the approach used for the demonstration workshops, aimed at assessing, validating, and evaluating the actual performance of SmartLivingEPC.

The deliverable then describes the operational steps taken in the pilots to implement all the developed concepts. Finally, it presents the results of the evaluation.

1.2 Structure of the deliverable

This deliverable is structured in 7 main sections. Section 1 is the introductory part of the document, presenting the objective, scope, and connections with other deliverables and tasks within the project. Section 2 explains the overview of the methodology followed to carry out the deployment activities of SmartLivingEPC and its validation in the pilot projects. Sections 3, 4, and 5 explore into each phase of the methodology — Baseline activities, Architectural Use Cases implementation, and Demonstration workshops — in the corresponding order. Section 6 presents the results, experiences, and lessons learned from the tasks carried out in each pilot. Finally, Section 7 presents the results of the evaluation of the demonstration activities and workshops.

1.3 Relation to Other Tasks and Deliverables

The work carried out in Tasks T6.4 and T6.5, documented in this Deliverable D6.4, is directly connected to many other tasks and deliverables within the project, as outlined below:

- Task 6.4 focuses on the implementation of all concepts developed within the project in real-life pilot scenarios. As such, it is directly connected to WP2 and WP3, where the theoretical and methodological foundations of asset rating and operational rating were established.
- Additionally, Task 6.4 is responsible for validating the SmartLivingEPC Web Platform prototype, which integrates the methodologies developed in WP2 and WP3, along with the digital services created under WP4 and WP5.
- The Architectural Use Cases implemented and evaluated in Task 6.4 were originally defined in Deliverable D1.3, as part of the architectural framework of the SmartLivingEPC Scheme.
- As part of the baseline activities, Task 6.4 also addressed the installation of IoT devices in the pilot buildings. This was based on the minimum requirements and installation plan established in Task 6.2 and detailed in Deliverable D6.2.
- Tasks T6.4, T6.5, and the present Deliverable D6.4 are also strongly interlinked with Task T6.1. Specifically, Deliverable D6.5 provides the user manual for the SmartLivingEPC Web Platform, representing the practical implementation of the entire SmartLivingEPC scheme. It also outlines the strategy for training sessions and workshops, which are applied in Task 6.4, assessed in Task 6.5, and documented here. This relationship is visually represented in the methodological diagram included in Section 2.

- Finally, Deliverable D6.3 laid out the methodological framework and actions required to assess the SmartLivingEPC project's technical, environmental, economic, and social impacts. This assessment has been carried out in Task 6.5, and its results are presented in this deliverable.

2 SmartLivingEPC deployment methodology in Pilots.

SmartLivingEPC deployment methodology consists of successful validation of the SmartLivingEPC Web Platform performance. To this end, the workflow has been structured into three phases, as shown in the diagram below (Figure 1) and detailed thereafter.

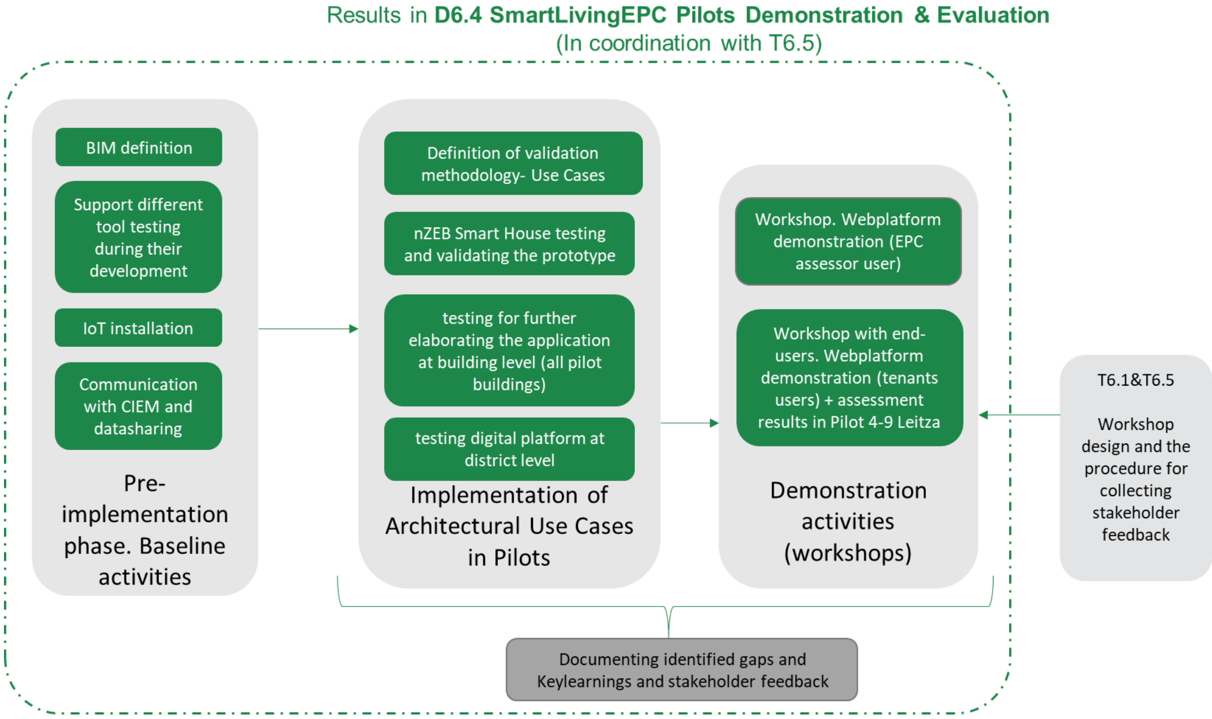


Figure 1. SmartLivingEPC deployment workflow in Pilots

This validation has been carried out across the project's pilot sites listed below, whose descriptions can be found in Deliverable D1.3.

- DS1 nZEB Smart House DIH, Mixed-use, Thessaloniki Greece
- DS2 Frederick University Main Building, Limassol, Cyprus
- DS3 Ehituse Mäemaja, Tallin University of Technology (Taltech), Tallin Estonia

Building Complex pilot in Leitza Spain:

- DS4 Single Family House
- DS5 Private flat
- DS6 Mixed-use building
- DS7 Town Hall
- DS8 School Building
- DS9 Sports Centre

From month 19 of the project until the integration of all SLEPC functionalities into the Web Platform, the pre-implementation phase was carried out. This phase consisted of conducting the baseline activities required to meet the SmartLivingEPC scheme requirements:

- Definition of the BIM models for the pilot buildings.
- During the development of SmartLivingEPC methodologies and tools, support was provided to the developers with data and real-life insights from the pilot buildings (data availability, needs, technical feasibility).
- Although some pilot sites already had IoT devices installed, others required the installation of additional or entirely new IoT systems.
- Finally, once the monitoring systems were installed, communication with the project's CIEM platform was established, and data transmission began.

As the SmartLivingEPC functionalities have been progressively integrated into the Web Platform, validations of the Architectural Use Cases—previously defined in deliverable D1.3—have been carried out. This phase includes the internal validation of the SmartLivingEPC Web Platform. This process was initially planned to be conducted at the prototype level in DS1, followed by the rest of the pilot buildings, and finally in the complex building.

For the external validation, two types of demonstration workshops were conducted. On the one hand, an open online workshop was held for EPC assessors. On the other hand, a workshop was organized with the end-user representatives from the Leitza pilot sites (DS4–DS9). In relation to this activity, the design and planning of the workshop deployment were carried out under Task 6.1, while the design of the evaluation surveys distributed after the workshops were developed under Task 6.5.

The feedback and the results obtained in these 3 phases are collected in this deliverable.

3 Definition of baseline activities

The definition of the baseline activities represents the first step toward the validation of the SmartLivingEPC prototype, as it ensures that the minimum requirements necessary for validation have been met. Carrying out these activities involves establishing the essential preconditions to support the majority of the Architectural Use Cases defined in deliverable D1.3.

The operation and evaluation within the SmartLivingEPC Web Platform rely primarily on data extracted from the buildings' BIM models. This includes both static information related to the building's characteristics and operational data collected through the installed IoT devices. For this reason, it is essential not only to install the IoT devices in accordance with the criteria set out in deliverable D6.2 but also to ensure their proper communication with the CIEM platform and effective data sharing.

The development of the methodologies in WP2 (asset rating methodology) and WP3 (operational rating methodology) established the requirements related to the BIM models and the parameters to be measured. In this context, the development and validation of these methodologies have been supported by real data obtained from the pilot buildings, with the aim of verifying their technical feasibility and evaluating their applicability based on the actual availability of data in real-world cases. This has been another key baseline activity during this preparatory phase prior to validation.

3.1 BIM file definition

Building Information Modelling (BIM) serves as a comprehensive digital representation of a building's physical and functional characteristics, acting as a reliable repository of the data required for SmartLivingEPC evaluations. Ultimately, BIM functions as a centralized data source that has the potential to optimize and enhance the SmartLivingEPC assessment process.

The BIM modelling of pilot buildings aims to ensure the delivery of a complete and well-structured data model within the BIM files. BIM data requirements are critical for the accurate computation of both asset and operational performance indicators, as they contain both static and dynamic building data.

Static Data

The static information provided by the BIM models includes:

- General Building Information: Such as building type and location, which is used to determine climatic conditions (e.g., outdoor temperature, solar radiation).
- Data for Energy Demand Calculations: Includes surface areas, geometry, orientation, and the building envelope. This involves all relevant attributes of construction elements (opaque and transparent, internal and external), thermal characteristics of materials, and U-values of walls, windows, and roofs.
- Data for Non-Energy Indicators: Includes information required for Indoor Air Quality (IAQ) assessment, ventilation systems, operational schedules, and lighting system characteristics.
- Data for Sustainability Indicators: this includes materials used in envelope construction, their quantities, and associated environmental impact factors.
- Technical Systems for Domestic Hot Water (DHW), Heating, and Ventilation: Includes location, capacity, efficiency, distribution system, and configuration.
- For SRI (Smart Readiness Indicator) Calculation: In addition to the above, data on the level of automation and control of these systems is required.
- For Building Complex Evaluations: Includes the assessment area and other relevant parameters (illuminated area, pedestrian area, waste generated in the area, building units with RES, total building units with smart meters, total units with BEMs, etc.)

Operational Data

Dynamic data in the BIM models include:

- Thermal Zoning: Based on the building's operational characteristics.
- IAQ Sensors and Energy Meters: Installed devices that provide real-time monitoring data.
- Operational Costs: Specific to the energy carriers used in each case, necessary for the LCC (Life Cycle Cost) indicator.

The extraction and verification of all these data elements from the BIM files constitute the first criterion for the successful demonstration of architectural use cases. However, in certain cases, missing information may be manually supplemented by an auditor.

All digital building model data are transmitted to the CIEM database for storage. These models can be accessed and managed through the BIM Management Dashboard on the SmartLivingEPC platform. From this interface, the "Edit BIM" functionality allows users to modify and enrich BIM models—for instance, by integrating data from technical building audits.

All changes made to the BIM models are logged and recorded in the BIM Digital Logbook, which is also accessible via the BIM Management Dashboard.

Each pilot manager is responsible for the development of the BIM model for their respective pilot. These models must contain sufficient detail to meet the evaluation requirements of SmartLivingEPC and should be designed specifically for this purpose. Including excessive, non-relevant data may lead to inconsistencies or errors in the assessment process.

3.2 IoT installation

Another baseline requirement, in this case for conducting the operational assessment of the building, is to obtain dynamic data on energy consumption and indoor air quality and comfort parameters for a minimum period of one year.

The basis for this was set out in D6.2. The main objective of D6.2 is to present the planning and setup activities carried out in the pilot buildings, including detailed tables on existing metering equipment, future installation plans, and the status of communication with the Common Information Exchange Model (CIEM). It also defines a methodology and timeline for device deployment and data collection in the nine pilots, in alignment with the integrated solution described in D5.1 and the SmartLivingEPC methodology established in WP3.

DS1, DS2, and DS3 already had sensors and meters installed prior to the start of the project. In contrast, DS4, DS5, DS6, DS7, DS8, and DS9 had no IoT devices in place, and the installation work had to be carried out from the ground up.

Once all devices are installed, they must be connected to the CIEM platform and subsequently initiate and ensure the continuous data sharing, with the objective of collecting and storing all data within the platform.

3.3 Communication with CIEM and data sharing

This baseline requirement involves establishing communication between the IoT devices of each pilot building (operated by third-party service providers) and the CIEM platform. CIEM platform does not communicate with the edge devices of each pilot, instead an integration layer was needed with each pilot site that would be available to send or let the CIEM platform to fetch those data.

The SmartLivingEPC Common Information Exchange Model (CIEM) is responsible for managing and integrating various types of data relevant to building performance and sustainability. CIEM functions as a comprehensive system for data collection, management, and sharing. It incorporates a robust data model, management strategies, and a multi-layered architecture supported by a defined technology stack. Additionally, it specifies the connections to the pilot sites.

The communication is carried out following the guidelines defined in deliverable D4.1 and a specific document shared by partner QUE with the respective pilot managers, which outlined the requirements for intercommunication.

The communication is categorized into three types:

- **Static information:** This refers to fixed, unchanging data related to the IoT infrastructure. The transfer of this information should be carried out via RESTful APIs.
- **Data Acquisition:** In this category, connected devices transmit real-time values (on change) or historical time-series data. This is done using direct exchange or topic exchange mechanisms. A direct exchange delivers messages to queues based on a specific routing key, while topic exchanges route messages to one or multiple queues based on a pattern-matching process between the routing key and the binding pattern.

  The document provided by QUE also includes an example of the required data format for continuous data sharing, which must be sent to the appropriate RabbitMQ queue.

```
{
  "item": "M00000SAMPLE001_sensor_1_space_1_sensorTemperature",
  "source": "device",
  "value": "27.5",
  "timestamp": "2021-05-25T13:33:33.000Z"
}
```

Figure 2. Sample message for temperature measurement

- **Acquisition of connection status updates:** For this communication category, direct exchange is used. Specifically, every time the connection status of any connected device changes, a message is published to a predefined queue indicating its current connection status.

  The document shared by partner QUE also includes an example of the required data format for continuous data sharing, which must be published to the corresponding RabbitMQ queue.

```
{
  "serial": "00000SAMPLE001",
  "thingUID": "00000SAMPLE001_sensor_1",
  "status": "OFFLINE",
  "description": "Communication Error",
  "timestamp": "2021-05-25T13:33:33.000Z"
}
```

Figure 3. Sample Connection Status Message

4 Implementation and validation of Architectural Use Cases in Pilots

This section defines the procedure for applying and validating SmartLivingEPC Architectural Use Cases in the pilot projects and collecting their results. At the first stage of the project, the functional requirements of the SmartLivingEPC product were defined in the form of Architectural Use Cases (D1.3).

As for the Use Cases defined in D1.3, one have been eliminated in this validation phase because there were clear duplications with other Use Cases:

- UC5.1 Provide (near) real-time building energy performance information

And a new one has been added that was not identified at the beginning of the project:

- UC5.4 Generate Physics-based baseline building energy profiles for the building

The procedure for each architectural Use Case is presented in standardized manner and include the following information:

General Information: This table presents the basic information of the Use Case (Name, Use Case description and Related Use Cases, Expected Results, Successful criteria, Fail Criteria).

Use Case Execution: This part of the table provides the sequence of actions to be carried out, the main responsible party for executing them, and the pilots in which they have been implemented.

Use Case Validation: In this section, the expected results when executing the Use Case are defined, along with the criteria to determine whether each Use Case is validated or not. If the successful criteria are met, the result will be “Pass”; otherwise, if the failure criteria apply, the result will be “Fail.”

A procedure for collecting the results has been defined. For this purpose, an excel table will be used for each UC, which is attached in Annex I.

The results of each pilot are reported in Section 6.

4.1 UC1.1 Retrieve and validate building information from BIM

Table 1. UC1.1 Retrieve and validate building information from BIM

Use case #	UC1.1
GENERAL INFORMATION	
Name	Retrieve and validate data from BIM
Description	Building Owners /Real estate agents/ provide EPC assessors with access to the examined building’s BIM file. The assessor logs into the SmartLivingEPC Web- Platform and uploads the BIM file. The file is validated, and, in the case of missing fields, incorrect information, or data inconsistencies, the assessor is notified to correct the requested fields. It is then transferred to the CIEM component, where it is stored and converted to the SmartLivingEPC’s data model. Finally, a message in the Web-Platform informs the assessor about successful completion of this process.
Related Use Cases	All Use Cases corresponding to BS1, BS3, BS4, BS6, BS7
USE CASE EXECUTION	

Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	CERTH
Execution steps	1. The BIM file is uploaded to the SmartLivingEPC Web Platform. 2. The file is validated against invalid and/or missing information. Any issues are communicated to the user, either via appropriate error notifications or by displaying an input data request form, respectively. 3. Upon successful completion of the validation process, the BIM file is transferred to the CIEM component for storage. 4. The information retrieved from the BIM file is checked for accuracy and completeness.
USE CASE VALIDATION	
Expected Results	Retrieved BIM file information is available for the SmartLivingEPC tools and services.
Successful criteria	• Successful upload and validation of the BIM file • Extraction of information related to building geometry, thermal performance and underlying technical systems
Fail Criteria	Failed upload/validation of the BIM file or insufficient extracted information

4.2 UC1.2 Collect and extract data from additional building documentation sources

Table 2. UC1.2 Collect and extract data from additional building documentation sources

Use Case #	**UC1.2**
GENERAL INFORMATION	
Name	Collect and extract additional data from external building documentation
Description	The Building Owners / Real estate agents provide the EPC assessor with access to the corresponding documentation. The assessor logs in to the SmartLivingEPC Web- Platform, where they are prompted to insert the additional building data where necessary, in order to complete the assessment process or modify the existing building parameters. The data is then transferred to the CIEM component, where they are stored and linked to the original building data. Finally, a message on the Web-Platform informs the assessor about the successful data insertion.

Related Use Cases	BS3, BS4, BS5, BS6, BS7
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	GOIENER S.COOP will act as the general responsible, while the other pilot managers (CERTH, FRC, TALTECH) will be in charge of steps 1, 2, and 3.
Execution steps	1. The EPC assessor requests the required building documentation from the building owner 2. The EPC assessor may also gather documentation from other sources, such as the municipal archive, cadastre, and similar entities. 3. Once collected, The EPC assessor uploads the building asset data to the SmartLivingEPC Web Platform. 4. The SmartLivingEPC Web Platform conducts validation checks on the uploaded data. 5. If the validation process fails, an "invalid input data" message is sent to the EPC Assessor. In such case, the EPC Assessor may request additional information, make the necessary corrections, and re-upload the updated data to the SmartLivingEPC Web Platform. 6. If the validation is successful,the information is transmitted and stored in the CIEM. 7. The SmartLivingEPC Web Platform then sends a confirmation message, and the asset information becomes available for visualization.
USE CASE VALIDATION	
Expected Results	Gather all the required data and successful validation process
Successful criteria	Visualization of the building asset information on the Web Platform
Fail Criteria	Lack of information

4.3 UC2.1 Inspection and installation of IoT equipment on the building

Table 3. UC2.1 Inspection and installation of IoT equipment on the building

Test Case #	**UC2.1**
GENERAL INFORMATION	
Name	Inspection and installation of IoT equipment on the building

Description	The EPC assessor inspects the existing metering/sensing infrastructure in the building and identifies the required additional equipment to be installed. The monitoring devices are selected according to the technical requirements of SmartLivingEPC and the preferences of the involved stakeholders. Having finalized the list, they undertake the installation of the IoT equipment.
Related Use Cases	BS4, BS5, BS6
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	TALTECH will act as the general responsible, while the other pilot managers (GOIENER, CERTH, FRC) will be in charge of steps 1, 2, 3 and 4.
Execution steps	1. The EPC assessor conducts an on-site inspection to evaluate the existing metering and sensing infrastructure. 2. They identify gaps and define the additional IoT devices needed for compliance with SmartLivingEPC requirements. 3. The assessor selects the appropriate devices and collaborates with stakeholders for installation planning. 4. After installation, the functionality of all IoT equipment is verified. 5. Data streams are tested to ensure continuous and accurate monitoring, confirming that the installed IoT equipment is functioning correctly and ready for integration with the SmartLivingEPC platform.
USE CASE VALIDATION	
Expected Results	• All necessary IoT equipment is installed and operational. • Continuous, reliable data streams are verified, ensuring the IoT equipment is ready for integration with the SmartLivingEPC platform.
Successful criteria	• IoT devices are installed and operational according to technical requirements. • Data streams are accurate, continuous, and verified as ready for integration with the SmartLivingEPC platform. • Stakeholder requirements and expectations regarding IoT implementation are met.
Fail Criteria	• IoT devices are not installed or functional. • Data streams are incomplete, inaccurate, or fail to integrate with the SmartLivingEPC platform. • Stakeholder dissatisfaction with the IoT implementation.

4.4 UC 2.2 IoT integration to the SmartLivingEPC platform

Table 4. UC2.2 IoT integration to the SmartLivingEPC platform

Test Case #	**UC2.2**
GENERAL INFORMATION	
Name	IoT integration to the SmartLivingEPC platform
Description	The EPC assessor logs in to the Web-Platform and opens the examined building's device configuration page. They assign the list of sensors and meters installed in the examined building, along with additional information for the monitoring characteristics. The assigned list of IoT equipment is forwarded to CIEM, which requests the real-time measurements from the IoT devices. The transmitted data that is in line with the CIEM data model is stored in the CIEM. Finally, the information is presented to the assessor through the Web-Platform.
Related Use Cases	BS4, BS5, BS6
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	CERTH
Execution steps	1. A new IoT device (sensor/meter) is registered for a specific building or building complex. A unique ID is assigned to the device 2. CIEM receives the device configuration for each building and retrieves real-time measurements from the onsite monitoring equipment. 3. The retrieved data are stored to the CIEM repository and provided to the SmartLivingEPC tools and services.
USE CASE VALIDATION	
Expected Results	Retrieved real-time IoT data are available for the SmartLivingEPC tools and services.
Successful criteria	• The building IoT devices configuration is successfully set up and retrieved by the CIEM component • All available measurements are retrieved from the building IoT devices • The retrieved data are stored in the CIEM repository and correctly forwarded to the SmartLivingEPC tools and services.
Fail Criteria	• Malformed IoT devices configuration, • Inability to communicate properly with the building's onsite monitoring equipment

	• Inability to provide retrieved IoT data to SmartLivingEPC tools and services

4.5 UC2.3 Near-real time automated data retrieval from IoT equipment

Table 5. UC2.3 Near-real time automated data retrieval from IoT equipment

Use Case #	UC2.3
GENERAL INFORMATION	
Name	Near-real time automated data retrieval from IoT equipment
Description	The CIEM periodically retrieves data updates from all the IoT infrastructure integrated into the SmartLivingEPC platform. The retrieved data is stored in CIEM to be used for the various SmartLivingEPC services.
Related Use Cases	BS4, BS5, BS6
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	QUE
Execution steps	1A. The CIEM service periodically initiates a request for updated data from the installed IoT infrastructure. 1B. The CIEM receives event data directly from IoT infrastructure. 1. CIEM validates the received data 2. The validated data is stored in the CIEM's repository 3. CIEM updates BIM with the new IoT data. These may be available on the SmartLivingEPC platform.
USE CASE VALIDATION	
Expected Results	Data storing and management, Sharing of static and dynamic related information
Successful criteria	Updated and stored data available to the SmartLivingEPC Platform and the SmartLivingEPC components
Fail Criteria	Unexpected value range / For not configured equipment, data are discard

4.6 UC2.4 On-demand data retrieval

Table 6. UC2.4 On-demand data retrieval

Use Case #	UC2.4
GENERAL INFORMATION	
Name	On-demand data retrieval
Description	The end-user logs into the Web-Platform and requests the retrieval of a specified data set. The request is forwarded to CIEM. The latter retrieves the requested data set. Finally, the information is presented to the end-user through the Web Platform.
Related Use Cases	BS4, BS5, BS6
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	QUE
Execution steps	1. The EPC Assessor actor requests the required dynamic data through the Web platform. 2. The request is forwarded to the CIEM platform. 3. CIEM validates the received request and collects the data from CIEM persistent data storage. 4. CIEM sends back the response data set to the Web Platform. 5. The SmartLivingEPC Web Platform receives and provides a a visualization.
USE CASE VALIDATION	
Expected Results	Data retrieval for the requested criteria and visualisation
Successful criteria	Valid request criteria for retrieving data for configured pilot sites IoT equipment.
Fail Criteria	Unexpected value range / For not configured equipment, data are not returned

4.7 UC3.1 Energy and non-energy resources analysis

Table 7. UC3.1 Energy and non-energy resources analysis

Use Case #	UC3.1
GENERAL INFORMATION	
Name	Energy and non-energy resources analysis

Description	The EPC assessor logs into the Web-Platform and requests the existing building information. The required data for the calculation of the Energy and non-energy resources analysis is retrieved from the CIEM component through the Web Platform. They confirm the information and fill in any missing fields. Then, they request the calculation of the Energy and non-energy indicators through the SmartLivingEPC Web platform. The request is transferred to the Asset Rating Engine/Energy and non-energy indicators component, which performs the analysis, and returns the results through the Web Platform to the assessor for validation. The results are stored both in the Web Platform database and in CIEM Repository. Finally, the "Energy and non-energy analysis" report is issued.
Related Use Cases	UC3.4, UC3.6
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	AIIR will act as the general responsible, while the other pilot managers (CERTH, FRC, TALTECH, GOIENER) will be in charge of step 1.
Execution steps	1. The EPC assessor introduces all the demanded data (e.g. how many zones, required temperature, destination of the zone, etc) 2. The EPC assessor can use 3D model of the building for fast extraction of surfaces 3. The SmartLivingEPC Web Platform conducts validation checks on the input data. 4. If the data are not entirely introduced a message will warn the user to submit all the necessary information 5. If the validation of inputs is successful, the information is transmitted and afterwards the calculation core is activated
USE CASE VALIDATION	
Expected Results	Gather all the input data from the user and successful calculation process
Successful criteria	Visualization of the energy and non-energy results for all declared zones and also at building level.
Fail Criteria	Lack of input data to process the calculation

4.8 UC3.2 SRI Calculation

Table 8. UC3.2 SRI Calculation

Use Case #	**UC3.2**
GENERAL INFORMATION	

Name	SRI Calculation
Description	The EPC assessor logs into the Web-Platform and requests the existing building information. The required data for the calculation of the Smart-Readiness Indicator (SRI) score from the CIEM component, through the Web platform. They confirm the information and fill in any missing fields. Then, they request the SRI calculation through the SmartLivingEPC Web platform. The request is transferred to the Asset Rating Engine/SRI component, which performs the analysis, and returns the results, through the Web Platform, to the assessor for validation. The results are stored both in the Web Platform database and in CIEM repository. Finally, the SRI report is issued.
Related Use Cases	UC1.1, UC2.4
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	REHVA will act as the general responsible, while the other pilot managers (CERTH, FRC, TALTECH, GOIENER) will be in charge of step 3.
Execution steps	1. The EPC assessor accesses the SmartLivingEPC Web Platform and selects Smart Readiness assessment, within the Asset-Rating environment. 2. The request is channelled from the SmartLivingEPC Web Platform to the CIEM, which provides the input data for the SRI assessment retrieved from a pre-existing BIM file. 3. The EPC assessor validates such information and provides additional input data to the SmartLivingEPC Web Platform. 4. The EPC assessed requests the SRI calculation. 5. The request is channelled from the SmartLivingEPC Web Platform to the Asset Rating Engine, which provides the calculation report for the SRI assessment according to Method B. 6. The EPC assessor validates such results and confirms the analysis. 7. The SmartLivingEPC Web Platform then sends a confirmation message, and the SRI report is issued and becomes available for visualization.
USE CASE VALIDATION	
Expected Results	1. Based on information automatically retrieved from BIM file (related to UC1.1). a. Maximise the number of technical domains correctly identified as applicable/non-applicable. According to the

	methodology indicated in D2.4 and published[1] the applicability of all technical domains can be checked with elements from the IFC4 schema, except for the Electric Vehicle Charging and Monitoring and Control. b. Maximise the number of smart-ready services correctly identified as applicable/non-applicable for each applicable technical domain. According to the methodology indicated in D2.4 and published[2], the applicability of the following smart-ready services can be checked with elements from the IFC4 schema: i. All within Heating, except for H-3 and H-4; ii. All within Domestic Hot Water, except for DHW-3; iii. All within Cooling, except for C-1f, C-2a, C-3 and C-4; iv. All within Ventilation, except for V-2d, V-3, and V-6; v. All within Electricity, except for E-12. Considering that V-1a, L-1a, L2, and E-12 shall always be assessed according to the technical framework defined by the European Commission. c. Maximise the number of functionality levels greater than zero correctly assigned for each applicable smart-ready service. d. Maximise the administrative information of the assessed object. 2. Considering manual data input (UC2.4), enable manual input of all the required data by the assessor. This includes the applicable technical domains and smart-ready services not automatically identified in the previous step. Also, the functionality levels, and any administrative information required for the assessment. Upon input, the information should be stored. 3. Obtain results that properly represent the Smart Readiness Indicator of the assessed object. 4. Obtain analytics on the share of input data automatically retrieved from BIM file and that manually provided by the EPC assessor.
Successful criteria	1. For BIM files that contain the information related to input data for the SRI assessment, capacity of the SmartLivingEPC Web Platform to retrieve it. 2. Enable manual input for every data item required for the SRI assessment. 3. The assessment result through the Web Platform is equal to that obtained using the SRI assessment package provided by the European Commission. 4. Visualization of the analytics on the Web Platform
Fail Criteria	1. For BIM files that contain the information related to input data for the SRI assessment, inability of the SmartLivingEPC Web Platform to retrieve it.

[1] https://doi.org/10.23919/SpliTech61897.2024.10612336

[2] https://doi.org/10.23919/SpliTech61897.2024.10612336

	2. There are missing fields for manual input for every data item required for the SRI assessment. 3. The assessment result through the Web Platform differs to that obtained using the SRI assessment package provided by the European Commission. 4. Absence of visualization of the analytics on the Web Platform

4.9 UC3.3 Environmental life-cycle assessment

Table 9. UC3.3 Environmental life-cycle assessment

Use Case #	UC3.3
GENERAL INFORMATION	
Name	Environmental life-cycle assessment
Description	The EPC assessor logs into the Web-Platform and request the LCA calculation through the SmartLivingEPC Web platform. The required data for the calculation of the LCA indicators are retrieved from the CIEM component through the Web Platform. The request is transferred to the Asset Rating Engine/LCA component, which performs the analysis, and returns the results, through the Web Platform, to the assessor for validation. The validated results are stored both in the Web Platform database and in CIEM Repository. Finally, the LCA report is issued.
Related Use Cases	UC3.4, UC3.6
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	FRC will act as the general responsible, while the other pilot managers (CERTH, FRC, TALTECH, GOIENER) will be in charge of step 1.
Execution steps	• Data Input: 1. The EPC assessor logs into the SmartLivingEPC platform. 2. Navigates to the Life-Cycle tab in the Asset Rating module. 3. Inputs or confirms material and operational data using the Complete Form button or dynamically adds missing details using the + Add option. • Data Retrieval: 1. The platform fetches required data from the CIEM component, such as materials • Validation and Processing:

	1. The assessor reviews input data and ensures completeness. 2. Initiates the LCA calculation by clicking the Calculate button. • Analysis: 1. The Asset Rating Engine processes the LCA indicators using life-cycle stages • Results Storage and Report Generation: 1. Results are validated by the assessor. 2. Once validated, results are stored in the CIEM repository and database. 3. The system generates an LCA report accessible to the user.
USE CASE VALIDATION	
Expected Results	1. Successful retrieval and processing of all required input data. 2. Accurate calculation of environmental life cycle assessment indicators. 3. Generation and storage of the Environmental Life-Cycle Assessment (LCA) report.
Successful criteria	1. Data input is complete and validated by the assessor. 2. LCA calculations are accurate and adhere to predefined benchmarks. 3. The report is generated without errors and stored securely in the CIEM repository.
Fail Criteria	1. Missing or incomplete data fields (e.g., materials or energy metrics). 2. Errors in data retrieval from CIEM or during analysis. 3. The assessor cannot validate the results due to inconsistencies. 4. Failure to generate or store the LCA report.

4.10 UC3.4 Asset Rating issuance for Building Unit

Table 10. UC3.4 Asset Rating issuance for Building Unit

Use Case #	**UC3.4**
GENERAL INFORMATION	
Name	Asset Rating issuance for Building Unit
Description	The EPC assessor logins to the Web Platform and requests the existing building information from the CIEM component through the Web Platform, as well as the results from the energy and non-energy resources analysis, the SRI and the LCA. The EPC assessor confirms the

	information and fills in any missing fields. Then, they request the asset rating calculation for a building unit through the SmartLivingEPC Web platform. The request is transferred to the Asset Rating Engine component, which performs the analysis, and returns the results, through the Web Platform, to the assessor for validation. The validated results are stored both in the Web Platform database and in CIEM repository. Finally, the asset rating calculation for a building unit report is issued.
Related Use Cases	UC3.6
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	AIIR will act as the general responsible, while the other pilot managers (CERTH, FRC, TALTECH, GOIENER) will be in charge of step 2.
Execution steps	1. TheEPC assessor logs into the SmartLivingEPC Web Platform and initiates a request for existing building documentation and relevant analysis results (energy, non-energy resources, SRI, and LCA) from the CIEM component through the platform. 2. If any data is missing, the EPC assessor collects additional information directly from the building owner or other sources 3. The EPC assessor verifies and completes the needed input data 4. The platform performs validation checks on the uploaded data to ensure accuracy and completeness. 5. If the validation fails, an "invalid input data" message is sent to the EPC assessor. 6. Once the validation succeeds, the data is transmitted to the Asset Rating Engine for analysis and calculations 7. The Asset Rating Engine performs the calculation based on the provided data and analysis results (energy and non-energy resources, SRI, and LCA). 8. The generated results are sent back to the EPC assessor for validation 9. The EPC assessor reviews and validates the results. If there are discrepancies, the assessor initiates corrections and re-requests the calculation. 10. After validation, the final results are permanently stored 11. The SmartLivingEPC Web Platform generates the Asset Rating report for the building unit, which is made available for download or visualization by the EPC assessor.
USE CASE VALIDATION	
Expected Results	A detailed and accurate asset rating report for the building unit is issued, containing energy performance indicators, non-energy resource analysis

	results, SRI score, and LCA data. Permanent storage of validated results in both the Web Platform and CIEM repository for future SmartLivingEPC assessments.
Successful criteria	Ed fields in the building unit documentation are complete, accurate, and confirmed by the EPC assessor. The Asset Rating Engine performs calculations without errors and generates a valid report. The EPC assessor validates the analysis results without discrepancies. The asset rating report is issued without errors, with all relevant sections completed and formatted according to standards. The CIEM repository and Web Platform database are successfully updated with the validated results.
Fail Criteria	Missing or incorrect fields in the building unit documentation, leading to an inability to perform the assessment. Failures in the Asset Rating Engine, such as calculation errors, incomplete integration of analysis results, or missing data. The asset rating report is not generated or contains significant inaccuracies or omissions. Failure to store results in the CIEM repository or Web Platform database correctly.

4.11 UC3.5 Asset Rating issuance for Building Complexes

Table 11. UC3.5 Asset Rating issuance for Building Complexes

Use Case #	UC3.5
GENERAL INFORMATION	
Name	Asset Rating issuance for Building Complex
Description	The EPC assessor logs in to the Web Platform and requests the existing information on the complex level from the CIEM component through the Web Platform. EPC assessor confirms the information and fill in any missing fields. Then, they request the asset rating calculation for a building complex through the SmartLivingEPC Web platform. The request is transferred to the Asset Rating Engine/ Building Complex Assessment Asset Rating, which performs the analysis and returns the results. The results are stored both in and the Web Platform database and in CIEM repository. Finally, the asset rating calculation for a building complex report is issued.
Related Use Cases	UC3.6
USE CASE EXECUTION	
Testing in Pilots	Pilot 4-9. Leitza’s Building Complex
Responsible	DEUSTO will act as the general responsible, while the building complex pilot manager (GOIENER) will be in charge of steps 1, 2, 4 and 5.

Execution steps	1. Define a contiguous area including all relevant buildings and infrastructure. 2. Gather data from cadastral records, building inspections, and technical documentation. 3. Apply KPIs such as insulation quality, renewable energy potential, and building materials efficiency. 4. Normalize data based on climatic zones, building codes, and comparable benchmarks. 5. Apply established weighting methods to compile a final asset rating score. 6. Generate an Asset Rating certificate summarizing building attributes and energy performance.
USE CASE VALIDATION	
Expected Results	1. Clear and well-defined assessment boundary 2. Accurate and detailed asset data 3. KPIs that effectively represent static asset performance 4. Consistent and comparable data 5. Weighted scoring accurately reflects asset energy performance 6. Certificate issued on time with detailed analysis and recommendations
Successful criteria	1. Comprehensive coverage of the building complex 2. Comprehensive data collection ensuring completeness and accuracy 3. KPIs align with methodology and support actionable insights 4. Effective normalization ensures fair evaluations across building types 5. Scoring system adheres to methodology and reflects stakeholder priorities 6. Certificate meets all quality and completeness standards
Fail Criteria	1. Exclusion of important buildings or components 2. Missing or incomplete data, leading to gaps in analysis 3. Irrelevant or insufficient KPIs chosen 4. Inadequate normalization leading to inconsistencies 5. Misrepresentation of performance due to inappropriate weighting 6. Delayed, incomplete, or inaccurate certificates

4.12 UC3.6 Asset rating as service

Table 12. UC3.6 Asset rating as service

Use Case #	**UC3.6**
GENERAL INFORMATION	
Name	Asset rating as service
Description	The EPC assessor using a third-party platform, requests authorization from the SmartLivingEPC Web platform in order to log in. After gaining access to the platform, they can send building information and request the calculation of the asset rating on a building unit or complex level, as well as of the services included in the SmartLivingEPC as-designed assessment (energy and non-energy resources analysis, SRI, LCA, asset rating for building unit, asset rating for building complex). The request is transferred to the specific module in the Asset Rating Engine, which sends the results back to the third-party platform.
Related Use Cases	UC3.1, UC3.2, UC3.3, UC3.4, UC3.4, UC3.5
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	CERTH
Execution steps	1. The user logs into the SmartLivingEPC Web Platform and generates a unique user API key. 2. For authorized and eligible access, the user starts making HTTP requests to asset-based assessment services (energy, non-energy, smart readiness, life-cycle, total asset rating, building complex asset rating) 3. The Web Platform API returns the requested results to the user.
USE CASE VALIDATION	
Expected Results	Valid API requests successfully provide the asset-based assessment results.
Successful criteria	• Approval of authorized user access based on appropriate user role • Successful API data retrieval
Fail Criteria	Inability to perform requests or erroneous API response

4.13 UC4.1 Operational Energy Analysis

Table 13. UC4.1 Operational Energy Analysis

Use Case #	**UC4.1**
GENERAL INFORMATION	
Name	SmartlivingEPC operational energy analysis
Description	The EPC assessor logs into the Web-Platform and requests the existing building measurements and the required building static information. The required information for the calculation of the operational energy analysis is retrieved from the CIEM component through the Web Platform. The EPC assessor confirms the information and fills in any missing fields. Then, they request the calculation of the operational energy analysis through the SmartLivingEPC Web-platform. The request is transferred to the Operational Rating Engine/Operational Level Energy Analysis component, which performs the analysis, and returns the results, through the Web Platform, to the assessor for validation. The results are stored both in the Web Platform database and in CIEM repository. Finally, the operational energy analysis report is issued.
Related Use Cases	UC4.4, UC4.6
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	FRC
Execution steps	• Data Input and IoT Retrieval: 1. The EPC assessor logs into the SmartLivingEPC platform. 2. Navigates to the Operational Rating module. 3. Requests real-time operational data (e.g., Indoor environmental quality, Energy) retrieved from IoT sensors via the CIEM component. • Data Validation: 1. The assessor reviews the retrieved data for completeness and accuracy. 2. Any missing fields or discrepancies are manually corrected using platform-provided forms. • Calculation Request: 1. The assessor submits the validated data for operational energy analysis by clicking the Calculate button. • Analysis Execution:

	1. The Operational Rating Engine processes the real-time IoT data to compute operational rating metrics • Results Validation: 1. The assessor reviews the results returned by the Operational Rating Engine. 2. Adjusts inputs or requests additional IoT data and re-runs calculations if necessary. • Report Generation and Storage: 1. Validated results are stored securely in the CIEM repository and the platform's database. 2. An operational energy analysis report is generated, providing insights into the building's performance.
USE CASE VALIDATION	
Expected Results	• Successful retrieval and integration of real-time IoT sensor data. • Accurate calculation of operational energy performance metrics. • Generation of an operational energy analysis report • Secure storage of validated results for future assessments.
Successful criteria	• IoT sensors provide accurate, complete, and real-time operational data. • Data retrieved via CIEM is validated by the assessor without errors. • Operational energy analysis calculations are completed accurately • The report is generated without issues and stored securely in the CIEM repository
Fail Criteria	• Missing, incomplete, or inconsistent IoT sensor data. • Errors during data retrieval from IoT sensors or CIEM. • Operational Rating Engine fails to process IoT data correctly. • The assessor cannot validate results due to discrepancies. • Failure to generate or securely store the operational energy analysis report.

4.14 UC4.2 IEQ performance calculation

Table 14. UC4.2 IEQ performance calculation

Use Case #	UC4.2
GENERAL INFORMATION	
Name	IEQ performance calculation
Description	The EPC assessor logs in to the Web-Platform and requests the existing building measurements and the required building static information. The required information for the calculation of the Indoor Environmental Quality (IEQ) indicators is retrieved from the CIEM component through the Web Platform. The assessor confirms the information and fills in any missing fields. Then, they request the calculation of the IEQ performance

	through the SmartLivingEPC Web platform. The request is transferred to the Operational Rating Engine/IEQ component, which performs the analysis, and returns the results, through the Web Platform, to the assessor for validation. The validated results are stored both in the Web Platform database and in CIEM Repository. Finally, the IEQ performance report is issued.
Related Use Cases	UC4.4, UC4.6
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	TALTECH
Execution steps	1. Existing building and it's IoT sensors have to be integrated to the SmartLiving EPC Web Platform 2. The EPC assessor requests the existing building measurements and static information from Web Platform. 3. The Web Platform fetches the necessary data for Indoor Environmental Quality (IEQ) indicators calculation from the CIEM component. The Web Platform will indicate missing values. 4. The assessor reviews the retrieved data and fills in any missing information directly on the Web Platform. 5. They request the calculation of the IEQ performance through the SmartLivingEPC Web platform. 6. The Web Platform sends the request to the Operational Rating Engine/IEQ component, which processes the data and returns the results to the Web Platform. 7. The assessor validates the results, whether they are reasonable for IEQ assessment scale. Results are then saved in the Web Platform database and the CIEM Repository. 8. The final IEQ performance report is generated and made available to the assessor as Web Platform view.
USE CASE VALIDATION	
Expected Results	The communication in between assessor, Web Platform, CIEM and Operational Rating Engine/IEQ component works successfully. Operational Rating Engine/IEQ component will get the data from Web Platform, calculates the result and returns it to the Web Platform.
Successful criteria	The IEQ performance report is visualized on the Web Platform.
Fail Criteria	The Operational Rating Engine/IEQ component will not give out the result to the Web Platform or it is not within reasonable values indicated in SmartLivingEPC methodology. The failure is also, when the assessor does not confirm the information or fill in the missing fields. In case of any error, the system should show the communication link, where the error occurs.

4.15 UC4.3 LCC assessment

Table 15. UC4.3 LCC assessment

Use Case #	UC4.3
GENERAL INFORMATION	
Name	LCC assessment
Description	The EPC assessor logs into the Web-Platform and requests the existing building measurements and the required building static information. The required information for the calculation of the Life Cycle Cost (LCC) assessment is retrieved from the CIEM component through the Web Platform. The EPC assessor confirms the information and fills in any missing fields. Then, they request the calculation of the LCC assessment through the SmartLivingEPC Web platform. The request is transferred to the Operational Rating Engine/ Financial Indicators component, which performs the analysis, and returns the results, through the Web Platform, to the assessor for validation. The validated results are stored both in the Web Platform database and in CIEM Repository. Finally, the LCC assessment report is issued.
Related Use Cases	UC4.4, UC4.6
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	DEMO will act as the general responsible, while the other pilot managers (CERTH, FRC, TALTECH, GOIENER) will be in charge of step 1.
Execution steps	1. The user collects energy costs information (energy bills). 2. The information is filled in the web platform. The user can choose the financial parameters from the default data on the platform or fill it in differently. 3. Per request of the user, the operational rating of the building is calculated, which includes the financial indicators.
USE CASE VALIDATION	
Expected Results	Energy costs per use and carrier, calculated and visualized per month and year.
Successful criteria	Visualization of the LCC assessment on the Web Platform
Fail Criteria	Lack of calculated results

4.16 UC4.4 Operational Rating Issuance for Building Units

Table 16. UC4.4 Operational Rating Issuance for Building Units

Use Case #	**UC4.4**
GENERAL INFORMATION	
Name	Operational Rating Issuance for Building Units
Description	The EPC assessor logs in to the Web Platform and requests the existing building measurements and the required building static information from the CIEM component through the Web Platform, as well as previous results from the operational energy analysis, IEQ and LCC. The EPC assessor confirms the information and fills in any missing fields. Then, they request the operational rating calculation for a building unit through the SmartLivingEPC Web platform. The request is transferred to the Operational Rating Engine, which returns the results, through the Web Platform, to the assessor for validation. The results are stored both in the Web Platform database and in CIEM repository. Finally, the operational rating calculation for a building unit report is issued.
Related Use Cases	UC4.4, UC4.
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	FRC
Execution steps	• Data Retrieval: 1. The EPC assessor logs into the SmartLivingEPC platform and navigates to the Operational Rating module. 2. Requests existing building measurements and static data from the CIEM component. • Retrieves results from previous analyses, including: 1. Operational Energy Analysis (UC4.1). 2. IEQ Performance Calculation (UC4.2). 3. LCC Assessment (UC4.3). • Data Validation: 1. The assessor reviews the retrieved data for completeness and consistency. • Operational Rating Request: 1. The assessor submits the validated data to the Operational Rating Engine via the platform. • Analysis Execution:

	• The Operational Rating Engine processes the input data and calculates the operational rating metrics, such as: 1. Energy efficiency. 2. Indoor environmental quality performance. 3. Life cycle cost. • Results Validation: 1. The results are returned to the assessor for review. 2. If discrepancies are found, the assessor revises the inputs and re-runs the analysis. • Report Generation and Storage: 1. Once validated, the results are stored securely in the CIEM repository and the platform database. 2. The operational rating report for the building unit is generated
USE CASE VALIDATION	
Expected Results	• Successful retrieval and integration of building measurements, static data, and prior analysis results. • Accurate calculation of operational rating metrics. • Generation of an operational rating report for the building unit, including: 1. Energy efficiency 2. IEQ performance metrics. 3. LCC summaries. • Secure storage of results in the CIEM repository.
Successful criteria	• All required data (static and dynamic) is retrieved and validated. • Previous analyses (UC4.1, UC4.2, UC4.3) have been completed and incorporated. • Operational rating calculations are accurate • The operational rating report is generated without errors and stored securely
Fail Criteria	• Missing or incomplete building data or prior analysis results. • Errors in data retrieval from the CIEM component. • Operational Rating Engine fails to process the data or returns incorrect results. • Validation of results is incomplete or inconsistent. • Failure to generate or securely store the operational rating report

4.17 UC4.5 Operational Rating Issuance for Building Complexes

Table 17. UC4.5 Operational Rating Issuance for Building Complexes

Use Case #	**UC4.5**
GENERAL INFORMATION	
Name	Operational Rating Issuance for Building Complexes
Description	The EPC assessor logs into the Web Platform and requests the existing information and measurements on the complex level from the CIEM component through the Web Platform. They confirm the information and fill in any missing fields. Then, they request the Operational Rating calculation for a building complex through the SmartLivingEPC Web platform. The request is transferred to the Operational Rating Engine/Building Complex Assessment Operational Rating component, which performs the analysis and returns the results. The results are stored both in the Web Platform database and in CIEM repository. Finally, the operational rating calculation for a building complex report is issued.
Related Use Cases	UC4.6
USE CASE EXECUTION	
Testing in Pilots	Pilot 4-9. Leitza's Building Complex
Responsible	DEUSTO will act as the general responsible, while the building complex pilot managers (GOIENER) will be in charge of steps 1, 2, and 5.
Execution steps	1. Define the area with interconnected buildings and shared infrastructure. 2. Gather data through smart meters, BEMS, sensors, and surveys. 3. Apply operational KPIs such as energy intensity, peak load, and efficiency metrics 4. Normalize data for weather conditions, occupancy rates, and usage variations. 5. Apply established weighting systems to aggregate scores. 6. Generate an Operational Rating certificate summarizing findings and actionable recommendations.
USE CASE VALIDATION	
Expected Results	1. Clear, well-documented assessment area 2. Accurate and comprehensive dataset 3. KPIs effectively reflect operational energy performance 4. Consistent and comparable data across the assessment area

	5. Weighted scoring reflects true energy performance 6. Certificate issued on time with actionable energy efficiency recommendations
Successful criteria	1. Comprehensive boundary covering all relevant components 2. All necessary data collected and verified for accuracy 3. KPIs align with methodology and provide actionable insights 4. Normalization methods ensure fair comparisons 5. Scores align with methodology and stakeholder expectations 6. Certificate issued within timeline and meets all quality standards
Fail Criteria	1. Exclusion of key components or discontinuities in the assessment area 2. Missing, incomplete, or unreliable data 3. Irrelevant or insufficient KPIs used 4. Inadequate normalization leading to biased results 5. Weighting system misrepresents performance priorities 6. Delays or issuance of incomplete/inaccurate certificates

4.18 UC4.6 Operational Rating as a Service

Table 18. UC4.6 Operational Rating as a Service

Use Case #	**UC4.6**
GENERAL INFORMATION	
Name	Operational Rating as a Service
Description	The EPC assessor using a third-party platform, requests authorization from the SmartLivingEPC Web platform in order to log in. After gaining access to the platform, they can send the dynamic and static building information and request the calculation of the operational rating on a building unit or complex level, as well as of the services included in the SmartLivingEPC as-operated assessment (operational energy analysis, LCC, IEQ, operational rating for building unit, operational rating for building complex). The request is transferred to the specific module in the Operational Rating Engine, which sends the results back to the third-party platform.
Related Use Cases	UC4.1, UC4.2, UC4.3, UC4.4, UC4.4, UC4.5
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick’s University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza’s Building Complex

Responsible	CERTH
Execution steps	1. The user logs into the SmartLivingEPC Web Platform and generates a unique user API key. 2. For authorized and eligible access, the user starts making HTTP requests to operation-based assessment services (energy, life cycle cost, indoor environmental quality, total operational rating, building complex operational rating) 3. The Web Platform API returns the requested results to the user.
USE CASE VALIDATION	
Expected Results	Valid API requests successfully provide the operation-based assessment results.
Successful criteria	• Approval of authorized user access based on appropriate user role • Successful API data retrieval
Fail Criteria	Inability to perform requests or erroneous API response

4.19 UC5.2 Building Dynamic Model Extraction

Table 19. UC5.2 Building Dynamic Model Extraction

Use Case #	**UC5.2**
GENERAL INFORMATION	
Name	Building Dynamic Model Extraction
Description	The assessor logs into the SmartLivingEPC Web-Platform and requests information regarding the building dynamic behaviour. The request is transferred to the Building Dynamic Behavior Monitoring System, which retrieves the required IoT data from CIEM. The component configures the dynamic (i.e., human presence in the building, forecasted energy consumption, occupancy profiles etc.) model and visualizes the results to the end user through the Web Platform
Related Use Cases	UC5.3
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick’s University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza’s Building Complex
Responsible	CERTH
Execution steps	• The user logs in to the Web platform and requests information regarding the building dynamic behavior from the related tab of the Web Platform. 1. The user can request information about occupancy estimation within the building

	2. The user can request predictions for energy consumption 3. The user can request alerts regarding any anomaly detection in the building • The user retrieves the outputs in various forms
USE CASE VALIDATION	
Expected Results	Occupancy estimation for 1-e week ahead, energy consumption prediction for 1-day ahead and alerts for behaviour optimization.
Successful criteria	The Web Platform returns the expected results to the end user.
Fail Criteria	Inability of the Web Platform to perform the user's request.

4.20 UC5.3 Provide the AI-driven operational analysis for improving the asset's energy performance

Table 20. UC5.3 Provide the AI-driven operational analysis for improving the asset's energy performance

Use Case #	UC5.3
GENERAL INFORMATION	
Name	Provide the AI driven operational analysis for improving the asset's energy performance
Description	The EPC Assessor logs in to the SmartLivingEPC Web Platform and accesses the operational data analysis of the interface. The user then specifies the operational data analysis they would like to undertake by choosing one of five options (Thermal Comfort Assessment, Occupancy Trends, Anomaly Detection, Disaggregation & Cost Estimation). The web-platform then calls on the Operational Data Analysis Tool module of the DT Platform. Based on the user input, the DT platform calls on the targeted AI engine which in turn accesses the CIEM to call on the most up to date IoT data available. The relevant AI engine implements its algorithm using the data and undertakes the specified operational analysis process. The output of the algorithm is recorded and transferred to the web-platform and visualised either as a KPI module on the Web Platform or displayed on the BIM/IFC viewer.
Related Use Cases	UC2.2, 2.3
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology
Responsible	IESRD

Execution steps	The AI tools process the corresponding data analysis, utilising IoT sensor data and potentially historical trends. It then generates relevant recommendations on changes that can potentially lead to better building performance. APIs and authentication methods will be part of the execution process to ensure secure access and integration.
USE CASE VALIDATION	
Expected Results	The AI tools successfully generate actionable insights for Thermal Comfort Assessment, Occupancy Trends, Anomaly Detection, Disaggregation & Cost Estimation. Recommendations will be displayed in the final Web Platform. Then, the users can obtain meaningful insights that help them to make informed decisions.
Successful criteria	The analysis results and recommendations are accurate, visualised properly in SLEPC Web Platform.
Fail Criteria	Inaccurate results due to the AI tools failing to retrieve sufficient IoT data leading to inaccurate results. Another fail criterion could be that the analysis is not visualised correctly on the Web Platform.

4.21 UC5.4 Generate Physics-based baseline building energy profiles for the building

Table 21. UC5.4 Generate Physics-based baseline building energy profiles for the building

Use Case #	UC5.4
GENERAL INFORMATION	
Name	Generate Physics-based baseline building energy profiles for the building
Description	The end-user logs in to the SmartLivingEPC Web Platform and requests a physics-based baseline for the building for a user defined time period. The request is transferred to the SmartLivingEPC Building Digital Twin component. The Digital Twin component calls on the Physics-Based Digital Twin module which retrieves up to date weather forecasts from external APIs and runs a simulation over the given time period and returns the time-series energy consumption profile for the building to the web-platform. The profile is then visualised for the user on the Web-Platform with targeted KPIs and metric cards displayed on the 3D model of the building.
Related Use Cases	BS2
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	CERTH

Execution steps	The user requests the direction to the Physics-Based Digital Twin module in the Web Platform. The module displays the results coming from the energy simulation engine which calculated the baseline energy consumption profile, and finally transmits the outputs to the Web Platform. The output is displayed with targeted KPIs and energy metrics overlaid on the 3D model of the building for two cases: the Leitza Community and the SmartHouse in Greece.
USE CASE VALIDATION	
Expected Results	A detailed, physics-based energy profile is generated, showing energy consumption trends over the specified time period.
Successful criteria	The energy profile is accurately calculated and visualised, aligning with real-world conditions and providing building performance insights for users.
Fail Criteria	The performance gap. The generated energy profile might not align with real performance due to the assumptions and input in the model.

4.22 UC6.1 Provide information on as-designed/as-operated deviations

Table 22. UC6.1 Provide information on as-designed/as-operated deviations

Use Case #	UC6.1
GENERAL INFORMATION	
Name	Provide information on as-designed/as -operated deviations
Description	The EPC assessor logs into the Web Platform and requests the issuance of the as-designed/in-operation deviations report. The request is transferred to the Nudge-ready performance benchmarking & evaluation module, which retrieves (theoretical/ design) data calculated by the EPCs and compares them with the actual operational data for the same building. The tool retrieves the required data from the Web Platform and the KPI-calculator (subcomponent of the tool) calculates the differences. The outcomes are presented in form of different metrics/ KPIs splitted to individual devices/ assets, assisting the end users to understand the behaviour of their buildings. The results are stored on the Web Platform, and the user receives the final report.
Related Use Cases	UC6.3
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	DEMO

Execution steps	The user requests the evaluation on the Web Platform. The Web Platform namely nudges the tool, which requests the ass and operational results from the Web Platform. It compares and calculates the differences, and sends the results to the Web Platform.
USE CASE VALIDATION	
Expected Results	Comparison of total asset and operational rating scores, in addition to two categories of indicators in detail; IAQ and Energy indicators.
Successful criteria	Visualization of comparison of asset and operational rating, in form of charts.
Fail Criteria	Lack of visualized results

4.23 UC6.2 Benchmark the building's performance

Table 23. UC6.2 Benchmark the building's performance

Use Case #	UC6.2
GENERAL INFORMATION	
Name	Benchmark the building's performance
Description	The EPC assessor logs in to the Web-Platform and requests the issuance of a benchmarking report. The request is transferred to the Nudge-ready performance benchmarking & evaluation module, which collects and normalizes data from all available buildings to create a repository that, will be used for benchmarking purposes. The tool retrieves the as-designed and as-operated assessments from the Web Platform. The KPI calculator (subcomponent of the tool) calculates the differences. The tool retrieves the related assessment according to the classification of the building from the pre-calculated benchmarking KPIs repository. The tool compares the building assessment with the benchmarking KPIs. The functionalities will help building occupants/ managers to verify the performance of their buildings as well as to compare different building characteristics, encouraging them to adopt the positive ones (e.g. specific insulation, shadings, etc.) as well as energy efficiency-friendly behaviour. The outcome is stored in the Web Platform database. Finally, the report is presented through the Web Platform to the assessor.
Related Use Cases	UC6.3
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	CERTH
Execution steps	1. The user logs into the platform and requests a benchmarking report for the under-study building 2. The Web Platform returns:

	a. Deviations regarding as-designed and as-operated performance assessments b. Benchmarking report by comparing the under-study building with other buildings c. Recommendations for building performance upgrades
USE CASE VALIDATION	
Expected Results	Gaps between design expectations and actual operations, comparison with similar buildings to identify improvement areas and strategies for energy efficiency and operational improvements.
Successful criteria	The Web Platform successfully returns the requested information to the end user.
Fail Criteria	Inability of the Web Platform to perform the user's request.

4.24 UC6.3 Provide recommendations for energy efficiency practices

Table 24. UC6.3 Provide recommendations for energy efficiency practices

Use Case #	UC6.3
GENERAL INFORMATION	
Name	Provide recommendations for energy efficiency practices
Description	The EPC assessor logs into the Web Platform and requests recommendations for energy efficiency practices. The tool calculates the deviations according to UC6.1. The tool calculates the benchmarking results according to UC6.2 and then reads relevant static and dynamic information from the DBL through the Web Platform. The data is sent to the recommendation engine that produces the recommendations. The recommendations are presented to the assessor through the Web Platform.
Related Use Cases	UC6.2
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	DEMO
Execution steps	The user requests to receive recommendations on the Web Platform, which nudges the tool. The tool calculates EPC improvement by improving indicators. It calculates EPC improvement based on the energy consumption of replacement of technical systems. It calculates the LCC for new technical system.
USE CASE VALIDATION	

Expected Results	Recommendations on EPC improvement, by calculation of indicator and total EPC score. Recommendations on technical system upgrade with estimation of EPC improvement LCC information connected to the technical system upgrade.
Successful criteria	Calculated results provided and visualized in the Web Platform. Notifications in case of lack of information required for calculation.
Fail Criteria	Lack of notifications and results

4.25 UC7.1 Provide building's Record through Digital Logbooks

Table 25. UC7.1 Provide building's Record through Digital Logbooks

Use Case #	UC7.1
GENERAL INFORMATION	
Name	Provide building's Record through Digital Logbooks
Description	The EPC assessor logs into the Web-Platform and requests the building's record. The request is forwarded to the Digital Building Logbook module, which retrieves the existing building documentation from the Web Platform database. The end user is able to access in chronological order the main events that took place throughout the building's lifecycle, along with the related building information.
Related Use Cases	None
USE CASE EXECUTION	
Testing in Pilots	Pilot 1. nZEB Smarthouse Pilot 2. Frederick's University Main Building Pilot 3. Ehituse Mäemaja, Tallin University of Technology Pilot 4-9. Leitza's Building Complex
Responsible	CERTH
Execution steps	After each action executed by the user that is related to a building, the Web Platform keeps a chronological record of the changes. If the user modifies the BIM file, logs of the modifications are maintained, as well as when the end user performs an assessment.
USE CASE VALIDATION	
Expected Results	Visual representation of the executed actions recordings
Successful criteria	The actions and selected assessment outputs are demonstrated to the end user in a chronological order
Fail Criteria	Missing actions from the recording.

5 Demonstration activities: Workshops with stakeholders

5.1 Definition of the workshops

The description of the approaches for gathering feedback from stakeholders concerning potential improvements of the SmartLivingEPC Web Platform is described in detail in section 4 of D6.5. The step-by-step plan is described below:

1. Internal Validation and Testing with Consortium Partners
2. Pilot Ecosystem Validation
3. Public Validation Workshop
4. Documentation and Refinement of Workshop Procedures
5. Full Roll-out of Workshops in All Pilot Ecosystems
6. Consolidation and Analysis of Feedback
7. Next Steps for Tool Improvement and Final Validation

5.1.1 Description and Contents

5.1.1.1 SmartLivingEPC validation workshop- EPC assessor users

The SmartLivingEPC public validation workshop was held as an online event on May 21, 2025. It aimed to present the SmartlivngEPC Web Platform, one of the key outcomes of the project, and to gather user feedback for validation purposes. The consortium was represented by partners from REHVA (overall coordination), FRC (project overview), CERTH (Web Platform demonstration) and DEUSTO (feedback collection).

The workshop agenda adhered to the following structure:

A short introduction to the event was performed by REHVA.

An overview of the SmartlivingEPC project was detailed by FRC, highlighting its main concept, key objectives and methodological approach, its work plan and its expected impacts.

A live demonstration walkthrough of the Web Platform was delivered by CERTH, focusing on the parametrization of the various tools and the interpretation of the results by an EPC assessor

Feedback was requested in the form of answers to short questionnaires by DEUSTO, as explained in detail in Section 7.

Following the end of the workshop, the demonstration user account and example building was provided to the participants through email for further familiarization and provision of additional feedback, if needed.

The event was also recorded and is publicly available[3] in the project's YouTube channel.

[3] https://www.youtube.com/watch?v=uEge0qwDN5c

Figure 4. Screenshot of the Public Validation Workshop of the SmartLivingEPC Web Platform

5.1.1.2 SmartLivingEPC workshop with end users in pilots- Tenants users

The workshop was held on June 9th in Leitza, at the Mimukai Coworking Centre, and lasted an hour and a half.

Goiener and Deusto attended on behalf of the SmartLivingEPC consortium, and each pilot building was represented, except for DS6, which did not express interest in attending the workshop.

Figure 5. Workshop with end-users in Leitza pilots.

The content was structured as follows:

- First, a brief summary was given about the project objectives and the roles of Goiener and the pilot buildings within the SmartLivingEPC project.

- Goiener then provided an assessment based on the experience with the pilots, covering aspects such as project timelines, data collection in buildings and documentation, challenges encountered, IoT installation and data gathering, and the quality of the measured data.
- The third and most time-consuming part was the demonstration of the platform. The platform was presented while also sharing the evaluation results for each pilot. To facilitate understanding, participants were provided with a printed guide tailored to their building's specific case, enabling them to follow along during the platform demonstration.

This third part was interactive and highly participatory. Attendees discussed their results, asked questions, and showed genuine interest.

Finally, the evaluation survey questions were also explained to them point by point, as there were technical terms they were not familiar with.

Caffè scientifico Ordine Ing/Arch e SmartLivingEPC (event with EPC assessors)

The event was held on June 18 in Pavia. It was organised by R2M in collaboration with the Ordine degli Ingegneri e degli Architetti of Pavia. The Ordine is the organisation that brings together engineers and architects for collaboration and upskilling. Hence, this training was to illustrate to practitioners the future of EPC and the impact that the latest EPBD will have in practice, several critical questions were raised, mainly concerning the fact that the EPC may not be the right tool, at least in Italy for an assessment related to dynamic aspects, SRI etc. It loses its purpose. The main reason can be explained by a comparison with the class of the car. A car that is EURO4-5 cannot circulate anymore in city centres and in some cities because it consumes more than the most recent cars. Hence, its value is less. In Italy, the EPC says that a house has less value because it is in energy label G instead of A, for example. Another comment was that the dynamic aspect can heavily impact the energy label, because you can have class A thanks to technologies but if you open the windows with the heating open, everything goes in the garbage. Hence, what is the right EPC, the most objective one?

5.1.2 Methodology for collecting feedback

In accordance with the objectives established in Task 6.3, the feedback collection methodology was designed to evaluate the performance, usability, and acceptance of the SmartLivingEPC rating by both professional evaluators and end-users. The feedback process was structured around the defined KPIs and the evaluation framework developed in Deliverable D6.3, with a dual focus on technical performance and user-centered validation. This chapter describes the feedback collection methodology, the tools used, the stakeholders involved, and their alignment with the project's overall evaluation strategy.

5.1.2.1 Objectives and Scope

The primary objective of the feedback collection activities was to validate the evaluation indicators proposed in D6.3 and ensure that the SmartLivingEPC concept adequately meets the needs, expectations, and usability criteria defined for both professional and non-professional users. The proposed methodology was based on the following objectives:

- To assess the relevance, clarity, and feasibility of the proposed KPIs, especially those related to user experience, system performance, and stakeholder engagement.
- To understand the level of acceptance of SmartLivingEPC among professional EPC evaluators and non-technical end-users (tenants and institutional stakeholders).
- To identify usability barriers, information gaps, or functional deficiencies that may affect the adoption of SmartLivingEPC in real-world operational environments.
- To validate the platform's modular components and functionalities through guided demonstrations and structured feedback tools.

These objectives envision a SmartLivingEPC concept validation process based on testing and appropriate KPIs to assess the impact on the established objectives. These objectives were articulated around the design of surveys aimed at assessing stakeholder acceptance before project completion.

5.1.2.2 Activities and Target Groups

Two main feedback gathering activities were implemented, each targeting a specific interest group:

- SmartLivingEPC Validation Workshop – EPC User Assessors

  This online session, aimed at professional EPC evaluators from several countries, had a total of 25 participants and 6 completed responses. The workshop's objective was to present the SmartLivingEPC platform in detail and obtain structured feedback on its features, usability, data accuracy, and suitability for current assessment practices.

- SmartLivingEPC Workshop with End Users – Tenants and Institutional Stakeholders

  This workshop focused on actual end users of the Leitza pilot, including tenants and local stakeholders such as the municipality, school representatives, and the rural village. Its objective was to gather feedback from non-technical users on the accessibility, usability, and understanding of SmartLivingEPC functionalities from the perspective of everyday users.

5.1.2.3 Feedback Instruments and Procedure

Both workshops used structured questionnaires, designed and implemented using Google Forms, to ensure consistency and ease of participation across all user profiles, in English and Spanish. The feedback instruments were developed internally by the project team, based on the KPIs defined in D6.3, and refined through a pre-validation process with a closed group of 10 researchers. This step helped identify ambiguities, logical inconsistencies, and technical language issues, thus improving clarity and usability.

5.1.2.4 Questionnaire Structure – Assessors

The evaluator feedback process was organized into three thematic modules, each followed by a dedicated questionnaire section. The dynamics were carried out during the online workshop. Each survey section was scheduled to be presented immediately after the demonstration of the corresponding platform module, giving participants 5 minutes to respond. The modules were structured in the following order of content:

- Module 1: Building Data Entry and EPC Generation Process

  Section 1: https://forms.gle/yMtSvAp15DZrZMiz9

- Module 2: Use of Smart Data and Interoperability Features

  Section 2: https://forms.gle/T5uACTeFvP5fQNKMA

- Module 3: Recommendations, Performance Evaluation, and Reporting

  Section 3: https://forms.gle/RdGkRitQJgo9p6eM6

5.1.2.5 Questionnaire Structure – End Users

A similar structure was adapted for the end-user group, focusing on accessibility, content comprehension, interaction flow, and perceived usefulness of the platform. The form, adapted for non-technical participants, is available here:

End-Users Questionnaire:

https://docs.google.com/forms/d/e/1FAIpQLSdxlmZvxfjzihzakyQPJ87PPLxQhZaYJZvyQfGxGW_0x6Jx7A/viewform?usp=dialog

The questions for end users were simplified, prioritizing the visual and practical aspects of the platform. The goal was to understand how users interact with the information provided and whether it could contribute to better awareness and decision-making regarding energy efficiency in their homes.

5.1.2.6 Demonstration and Facilitation

For the advisor workshop, the project's technical team conducted an online demonstration of the SmartLivingEPC platform. Each of the three functional modules was presented sequentially, accompanied by live navigation and explanations. The session was recorded for documentation purposes.

As mentioned above, for the end-user workshop, an in-person session was planned and delivered in Leitza, with demonstrations and direct interaction with the platform. This approach facilitated immediate clarification of doubts and more engaging participation, especially among tenants with limited digital skills.

Both workshops emphasized interaction, allowing participants to ask questions, share observations, and suggest improvements during and after the demonstrations. The combination of remote and in-person formats also facilitated inclusive participation from different user groups.

6 Results of SmartLivingEPC deployment and demonstration activities in Pilots

6.1 Demo Site 1 - nZEB Smart House DIH

6.1.1 Deployment timeline

As Demo site 1 constitutes a real-life testbed for various research activities of CERTH, including the ones within the SmartlivingEPC project, the initial pilot setup steps were not needed. Pilot data (structure, included systems, EPC results etc.) and a detailed BIM file were available from the project's initiation, while the installation of additional IoT devices was considered unnecessary, as the preexisting IoT infrastructure fulfilled the project's requirements already. Thus, historical measurements were also available quite early in the project and the building was the first pilot to be integrated into the Web Platform, in order to act as a base validation case for all the features that were gradually being integrated. The following table demonstrates the deployment timeline actions within the project's lifespan.

Table 26. Timeline of the main activities in pilots

	M1	M12	M24	M36
Measurements- Operational data collection				
Web Platform integration				
Pilot demonstration				

6.1.2 Baseline activities

1.1.2.1 BIM file definition

The preexisting BIM file already satisfied the Web Platform requirements, thus no further actions were taken.

1.1.2.2 IoT installation

The already existing IoT installation and data storage covered all assessment aspects, thus no further devices were installed.

1.1.2.3 Communication with CIEM and data sharing

Communication with CIEM was also established soon after the integration of the demo site into the Web Platform. The communication is based on the already existing RESTful API of the Smart House IoT Platform, which exposes all the available historical and real-time measurements.

6.1.3 Results of architectural use cases implementation

6.1.3.1 UC1.1 Retrieve and validate building information from BIM

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot): Results of the BIM logbook entry for DS1 showing the information extraction from the BIM file.

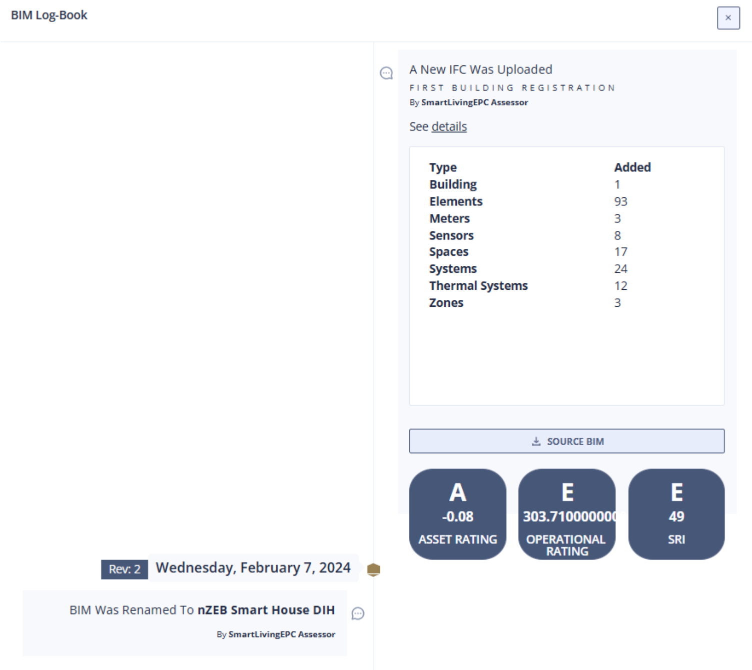


Figure 6. BIM logbook screenshot in DS1

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.2 UC1.2 Collect and extract data from additional building documentation sources

- **Result:** N/A (no additional data required for this demo site)
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot): N/A
- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.3 UC2.1 Inspection and installation of IoT equipment on the building

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Operational Rating/Energy indicators results calculated using actual building measurements.

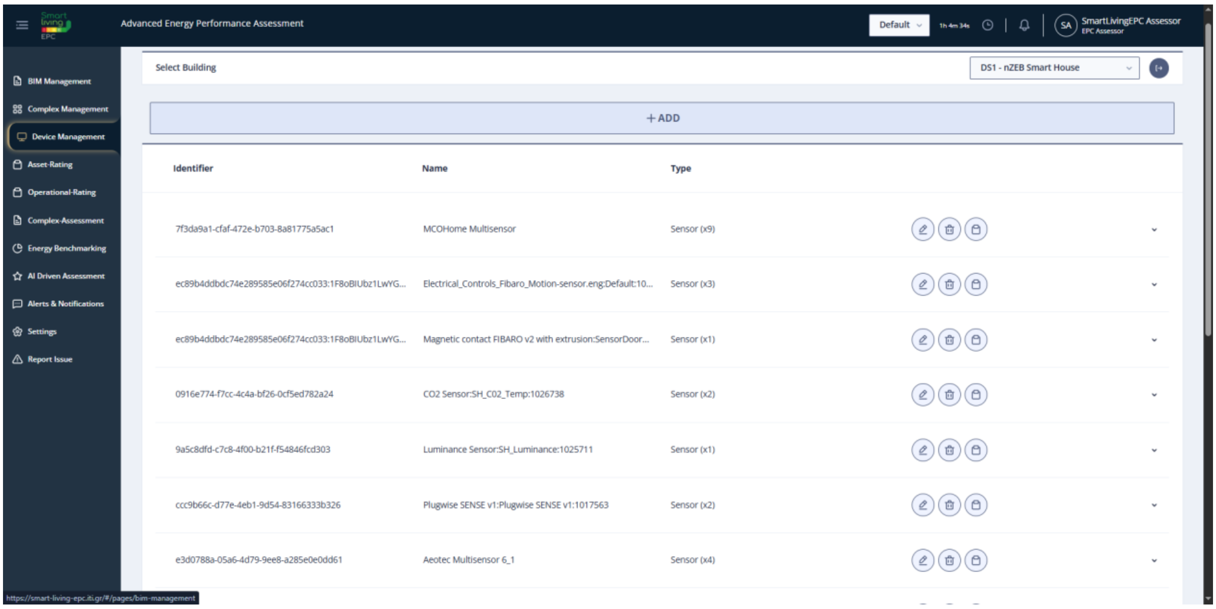


Figure 7. Device Management screenshot in DS1

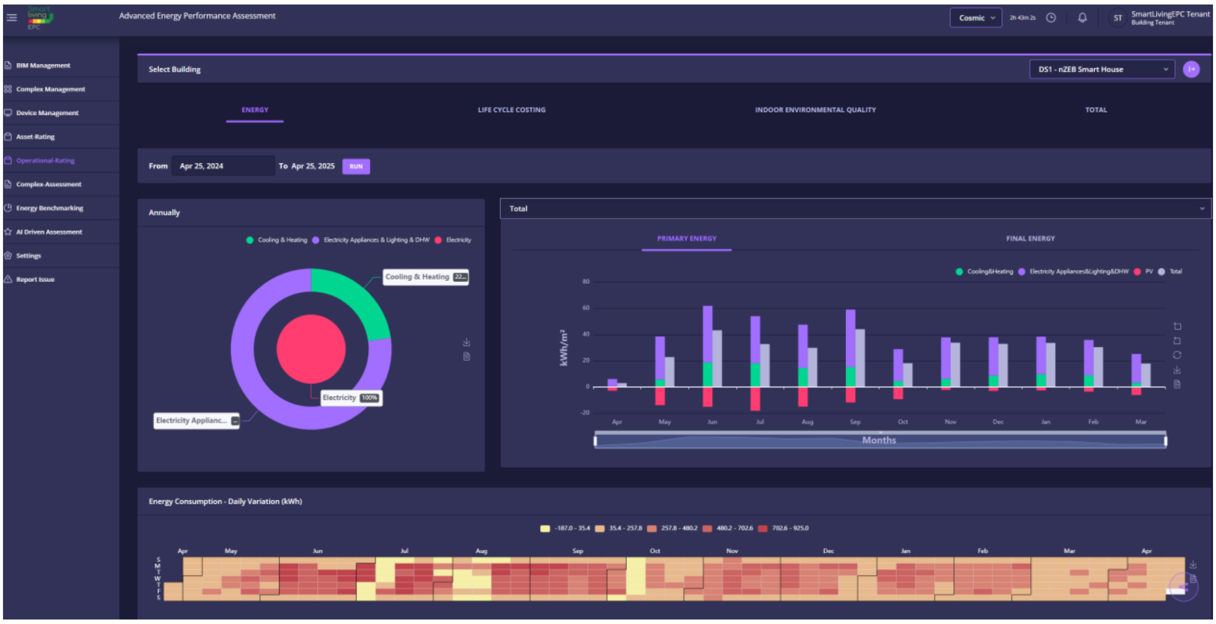


Figure 8. Operational Energy analysis in DS1

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.4 UC2.2 IoT integration to the SmartLivingEPC platform

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

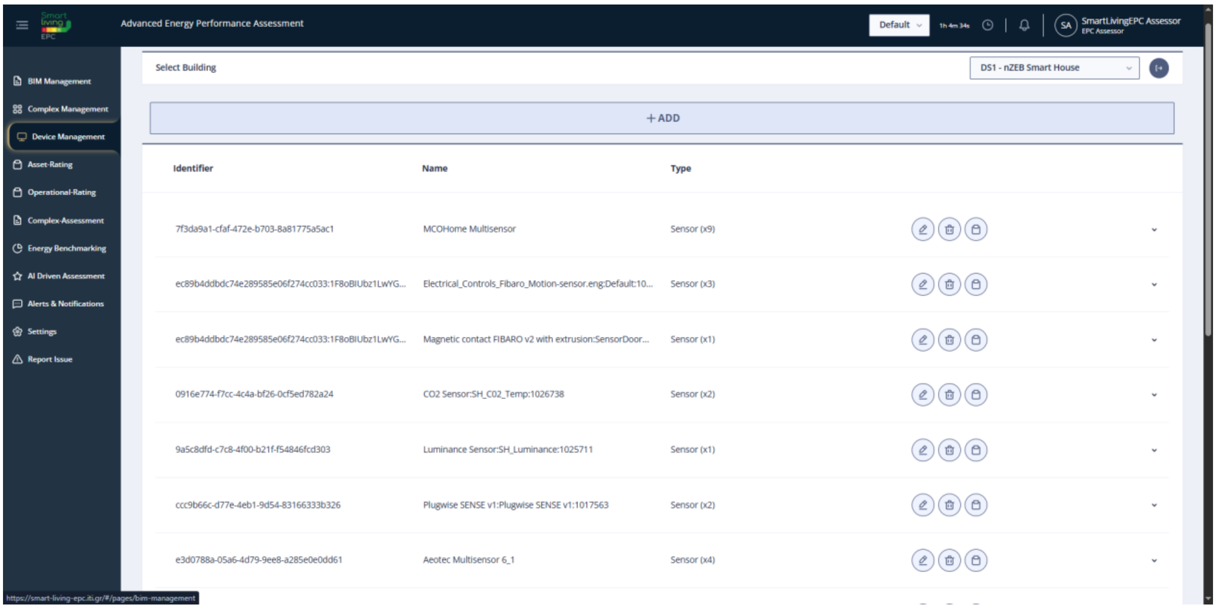


Figure 9. IoT device configuration in DS1

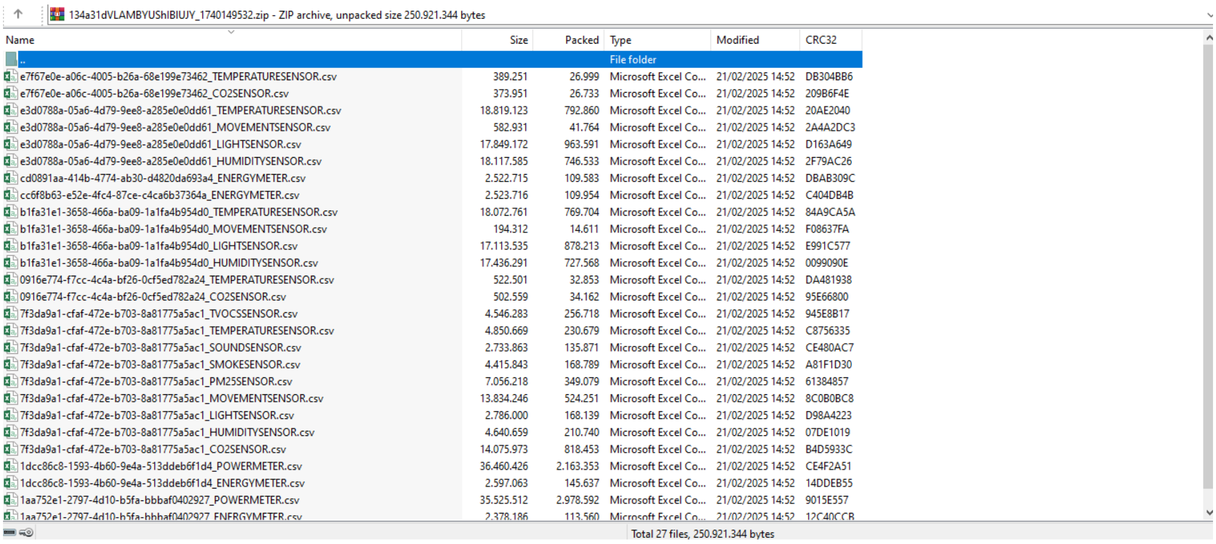


Figure 10. Download of monitoring data

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.5 UC2.3 Near-real time automated data retrieval from IoT equipment

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

API call results to fetch Demo Site 1 measurements from CIEM database.

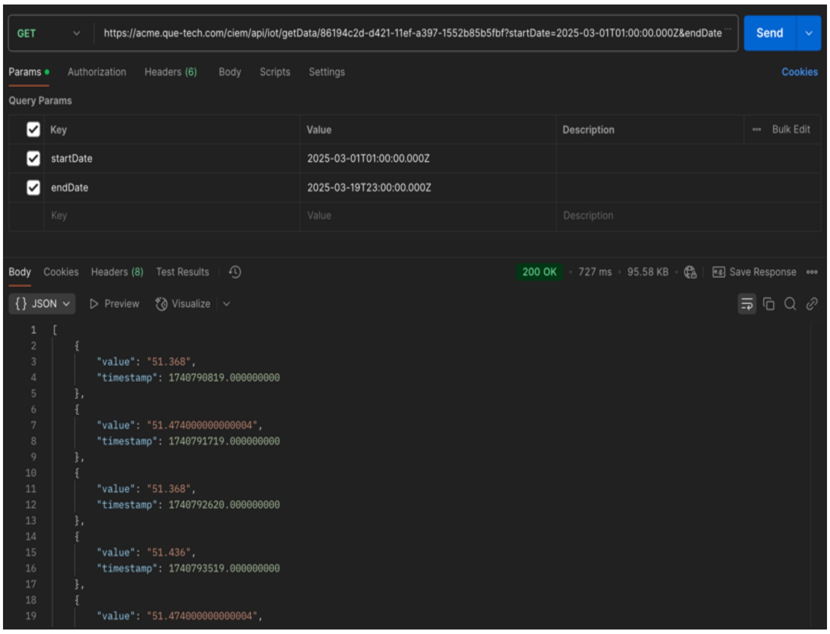


Figure 11. API call results to fetch DS1 measurements from CIEM database

- **Lessons learned:** Due to the different data models that the pilot provided, we learnt how to be flexible and deal with various cases.
- **Proposed improvements:** Optimization in case of big data storage

6.1.3.6 UC2.4 On-demand data retrieval

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Historical data from Demo Site 1 as provided by specific requests.

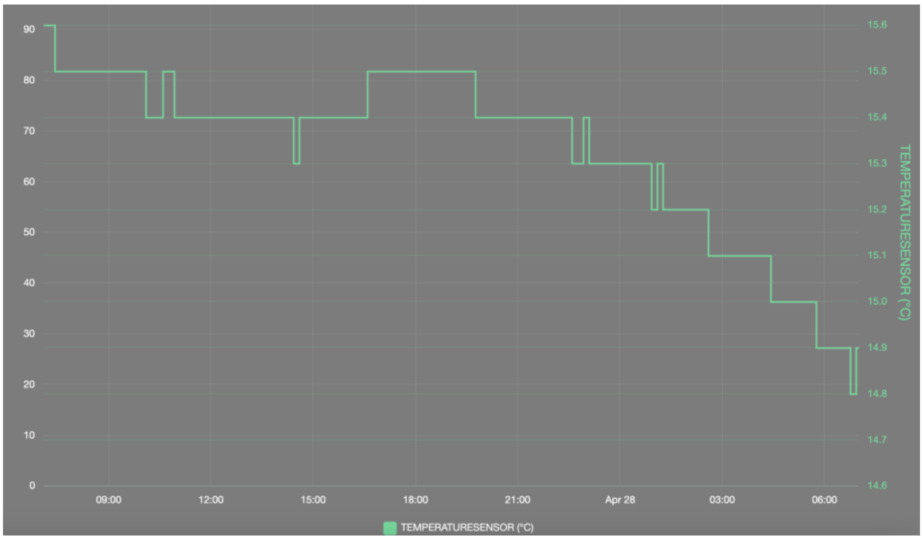


Figure 12. Historical data in DS1

- **Lessons learned:** N/A

- **Proposed improvements:** N/A

6.1.3.7 UC3.1 Energy and non-energy resources analysis

- **Result:** Pass
  The integration of assessments into the platform has been validated.
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

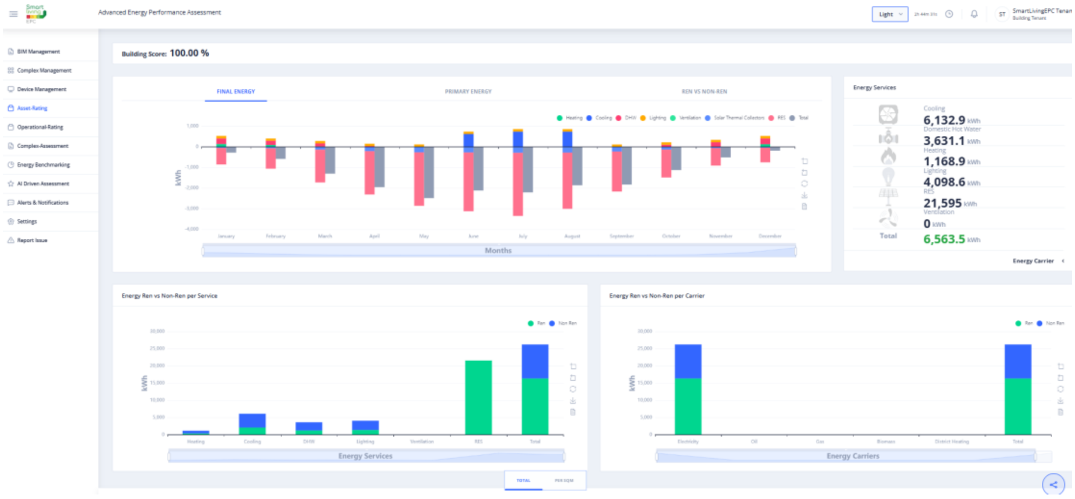


Figure 13. Energy Analysis in Asset rating assessment for DS1

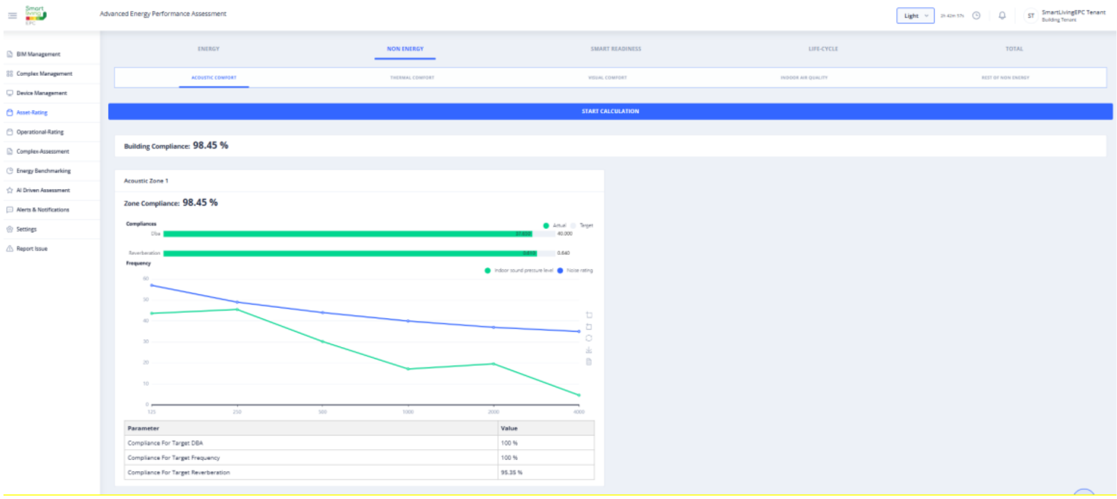


Figure 14. Non- Energy analysis. Acoustic Comfort Assessment for DS1

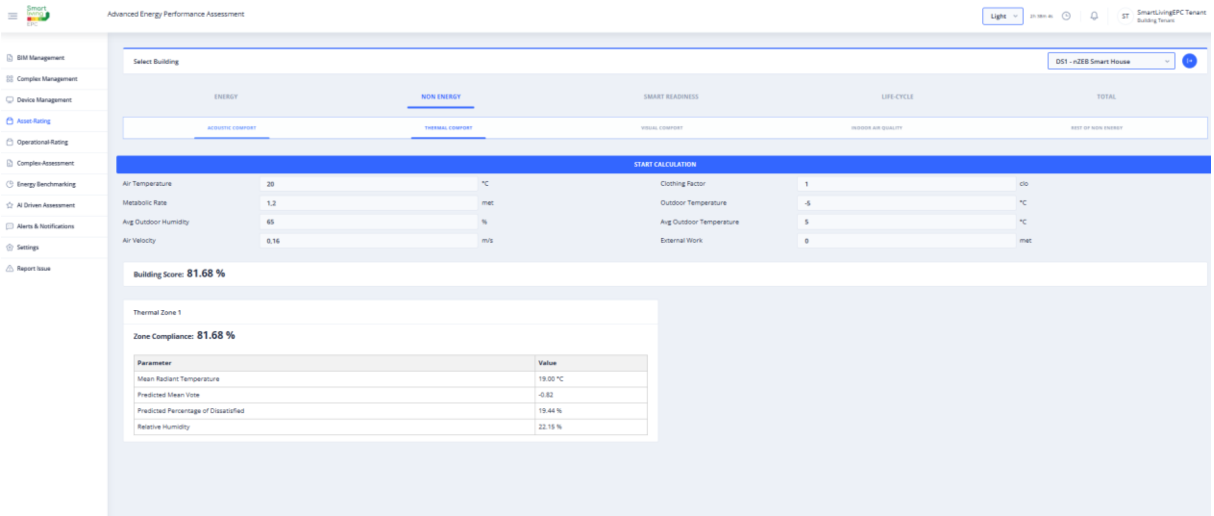


Figure 15. Non - Energy analysis. Thermal Comfort Assessment for DS1

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.8 UC3.2 SRI Calculation

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

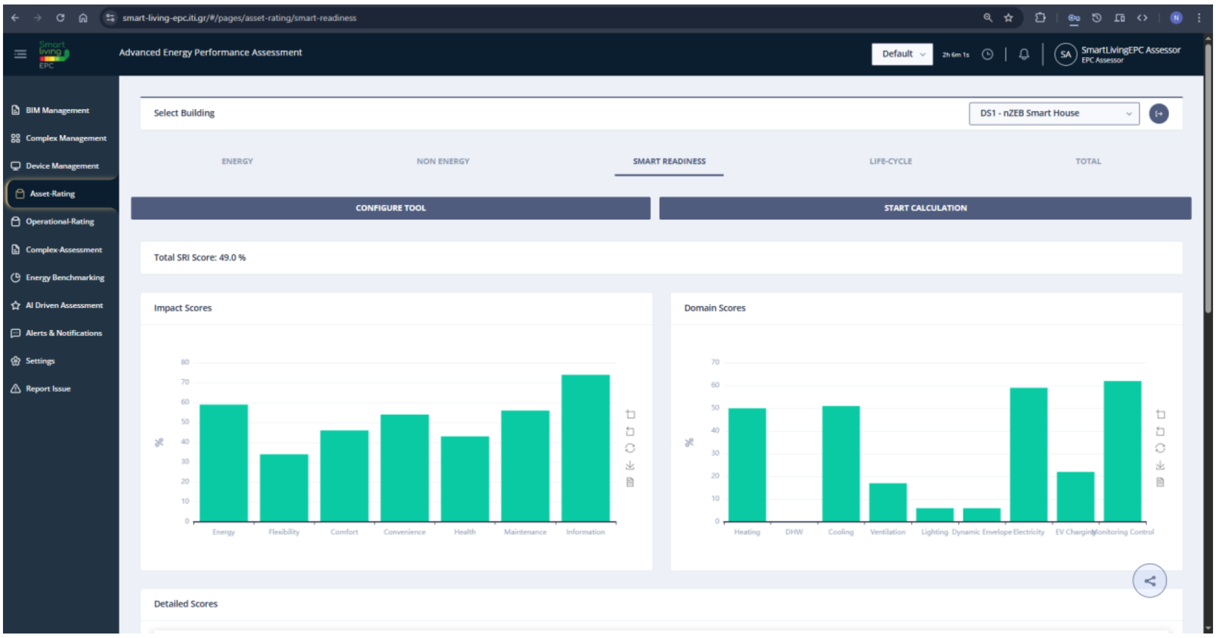


Figure 16. SRI calculation results in DS1

- **Lessons learned:** The assignment of "This domain is absent and not mandatory" and "This domain is absent but mandatory" is misleading for the assessor, as this will be something to be defined by the national EPBD implementing bodies
- **Proposed improvements:**

An indication ought to be included to inform the assessor that all the inputs should be revised to avoid that the assessor performs an assessment with inadequate input data.

All absent technical domains shall be set to "This domain is absent but mandatory" by default to avoid confusion. This shall be modifiable by the assessor

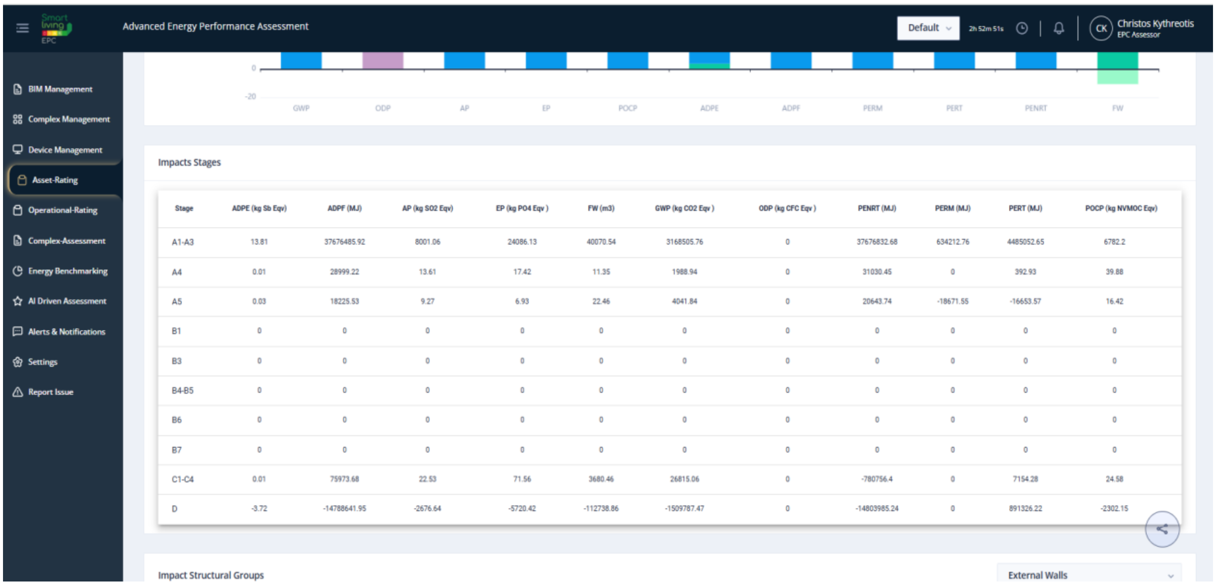
There are technical domains and smart-ready services that shall always be considered present/applicable.

When a technical domain is not present, its related smart-ready services shall be automatically set as not applicable to avoid confusion

6.1.3.9 UC3.3 Environmental life-cycle assessment

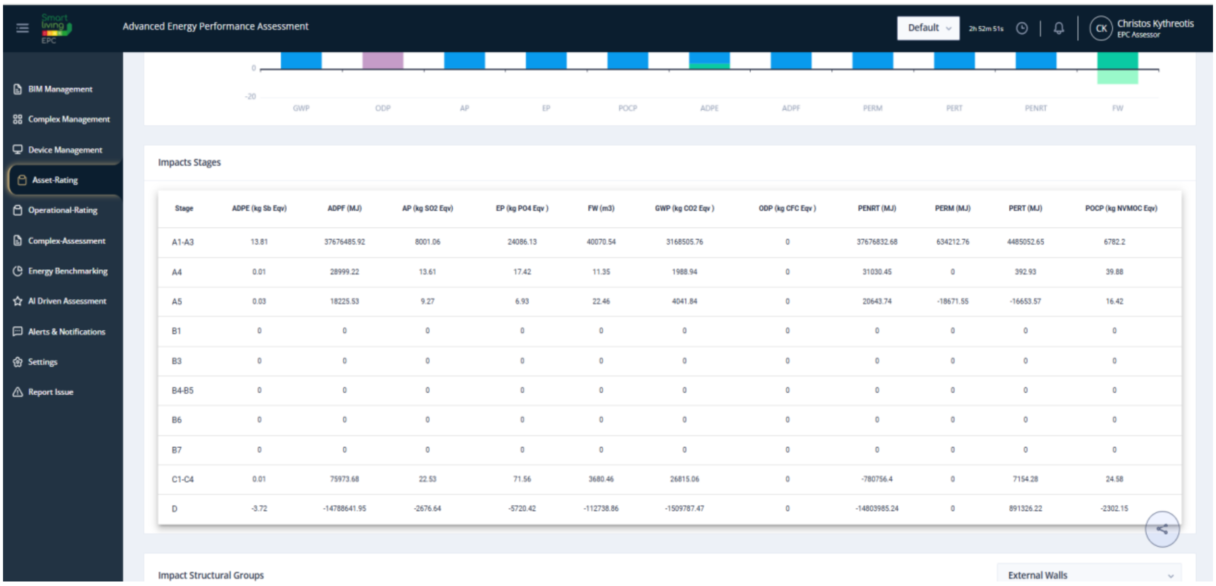
- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Material extraction from BIM and calculation of the LCA indicators for DS1.



Stage	ADPE (kg Sb Eqv)	ADPF (MJ)	AP (kg SO2 Eqv)	EP (kg PO4 Eqv)	FW (m3)	GWP (kg CO2 Eqv)	ODP (kg CFC Eqv)	PENRT (MJ)	PERM (MJ)	PERT (MJ)	POCP (kg NVMOC Eqv)
A1-A3	13.81	37676485.92	8001.06	24086.13	40070.54	3168505.76	0	37676832.68	634212.76	4485052.65	6782.2
A4	0.01	28999.22	13.61	17.42	11.35	1988.94	0	31030.45	0	392.93	39.88
A5	0.03	18225.53	9.27	6.93	22.46	4041.84	0	20643.74	-18671.55	-16653.57	16.42
B1	0	0	0	0	0	0	0	0	0	0	0
B3	0	0	0	0	0	0	0	0	0	0	0
B4-B5	0	0	0	0	0	0	0	0	0	0	0
B6	0	0	0	0	0	0	0	0	0	0	0
B7	0	0	0	0	0	0	0	0	0	0	0
C1-C4	0.01	75973.68	22.53	71.56	3680.46	26815.06	0	-780756.4	0	7154.28	24.58
D	-3.72	-14788641.95	-2676.64	-5720.42	-112738.86	-1509787.47	0	-14803985.24	0	891326.22	-2302.15

Figure 17. Material data extraction for LCA assessment (1)



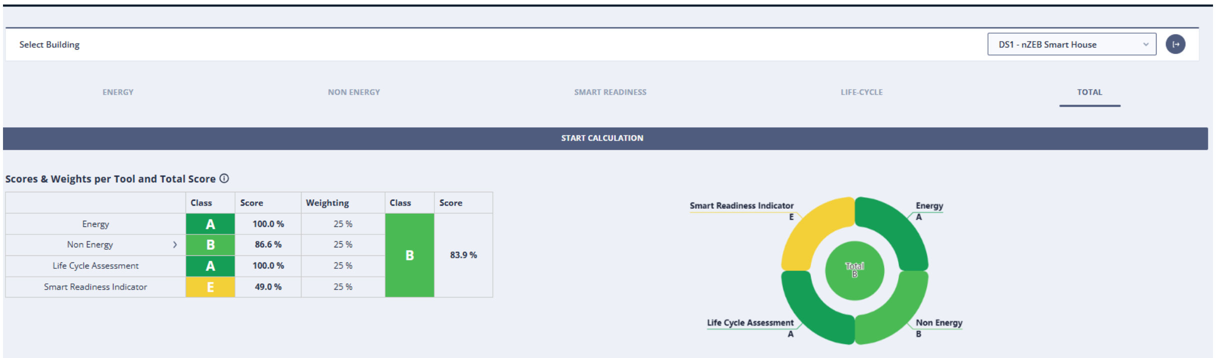
Stage	ADPE (kg Sb Eqv)	ADPF (MJ)	AP (kg SO2 Eqv)	EP (kg PO4 Eqv)	FW (m3)	GWP (kg CO2 Eqv)	ODP (kg CFC Eqv)	PENRT (MJ)	PERM (MJ)	PERT (MJ)	POCP (kg NVMOC Eqv)
A1-A3	13.81	37676485.92	8001.06	24086.13	40070.54	3168505.76	0	37676832.68	634212.76	4485052.65	6782.2
A4	0.01	28999.22	13.61	17.42	11.35	1988.94	0	31030.45	0	392.93	39.88
A5	0.03	18225.53	9.27	6.93	22.46	4041.84	0	20643.74	-18671.55	-16653.57	16.42
B1	0	0	0	0	0	0	0	0	0	0	0
B3	0	0	0	0	0	0	0	0	0	0	0
B4-B5	0	0	0	0	0	0	0	0	0	0	0
B6	0	0	0	0	0	0	0	0	0	0	0
B7	0	0	0	0	0	0	0	0	0	0	0
C1-C4	0.01	75973.68	22.53	71.56	3680.46	26815.06	0	-780756.4	0	7154.28	24.58
D	-3.72	-14788641.95	-2676.64	-5720.42	-112738.86	-1509787.47	0	-14803985.24	0	891326.22	-2302.15

Figure 18. Material data extraction for LCA assessment (2)

- Lessons learned: The validation confirmed the alignment between data input procedures and system expectations, supporting potential implementation.
- Proposed improvements: There could be an enhancement of the visibility and accessibility of validation benchmarks through a shared repository with clearly annotated reference results.

6.1.3.10 UC3.4 Asset Rating issuance for Building Unit

- **Result: Pass**
- **Incidence/Impact** (in case of fail):
- **Evidence** (numerical or screenshot)



	Class	Score	Weighting	Class	Score
Energy	A	100.0 %	25 %	B	83.9 %
Non Energy	B	86.6 %	25 %		
Life Cycle Assessment	A	100.0 %	25 %		
Smart Readiness Indicator	E	49.0 %	25 %		

Figure 19. Asset rating issuance for DS1

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.11 UC3.5 Asset Rating issuance for Building Complexes- N/A

6.1.3.12 UC3.6 Asset rating as service

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Asset rating service API call response.

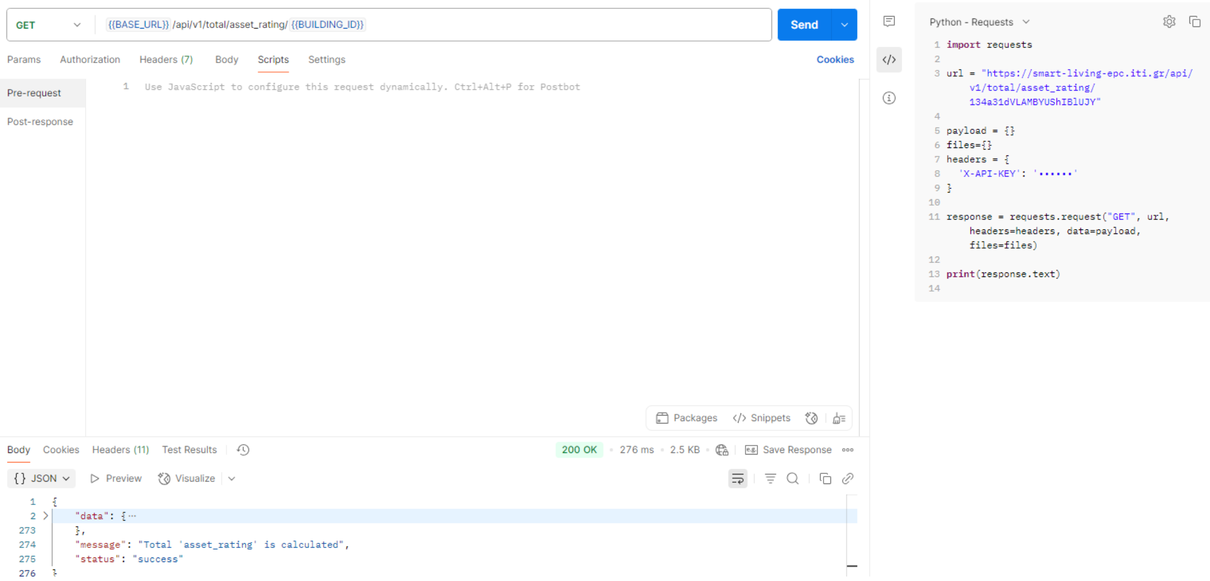


Figure 20. Asset rating service API call response in DS1

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.13 UC4.1 Operational Energy Analysis

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Results of the operational energy analysis for DS1.

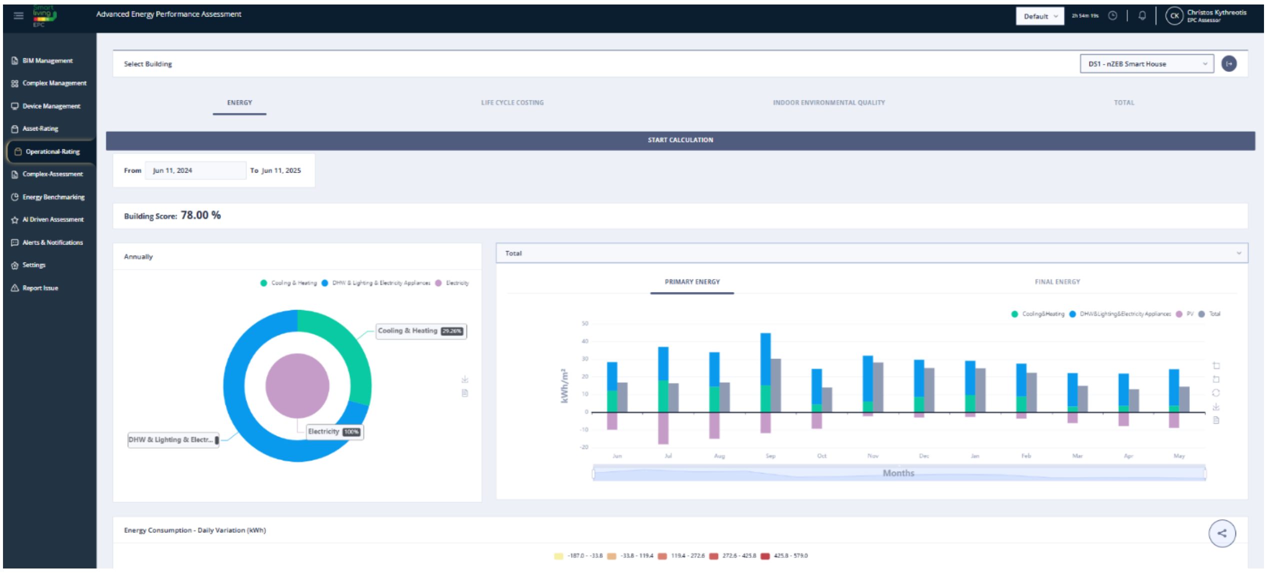


Figure 21. Results for the operational energy analysis in DS1

- **Lessons learned:** Early deployment of IoT sensors across key building zones contributes significantly to the reliability of CIEM-integrated monitoring.
- **Proposed improvements**: There could be a consideration of expanding CIEM export formats to include CSV/JSON summaries directly from the validation interface.

6.1.3.14 UC4.2 IEQ performance calculation

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Numerical calculations agree with output of the Web Platform for DS1.

- **Lessons learned:** The transparency of the platform inputs (e.g. explanations or if hard coded input, then visible) and maybe even some calculations could be relevant as the assessor final will be responsible of the result. In this case we handled well, but it will be more fluent to test the platform functioning, if the calculation method is written as for platform development and testing - exact definition of inputs and algorithm logic in the same document - the method developer and platform developer will generate the manual for testing in collaboration.
- **Proposed improvements:**

Occupancy hours could be also visualized while calculated from sensor data, because then the assessor can validate the sensor data and if needed, overwrite the sensor data with validated occupancy time.

There could be an example or description of the input value, so the assessor or pilot manager can understand what is asked.

If the calculation was not done (e.g. for the virus risk for Space type Other), then it should be communicated in platfrom.

Each room space category will indicate the percentages in space class. It would be more reasonable to show, what is the percentage in this specific class or in better categories (e.g. if class is C, then in A to C there is 95%). Or vice versa - what is the percentage in this specific class or above (e.g. if class is C, then in D to OUT there is 5% of time).

6.1.3.15 UC4.3 LCC assessment

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

LCC results for DS1.

Figure 22. LCC results for DS1

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.16 UC4.4 Operational Rating issuance for Building Units

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Results of the total operational rating assessment for DS1.

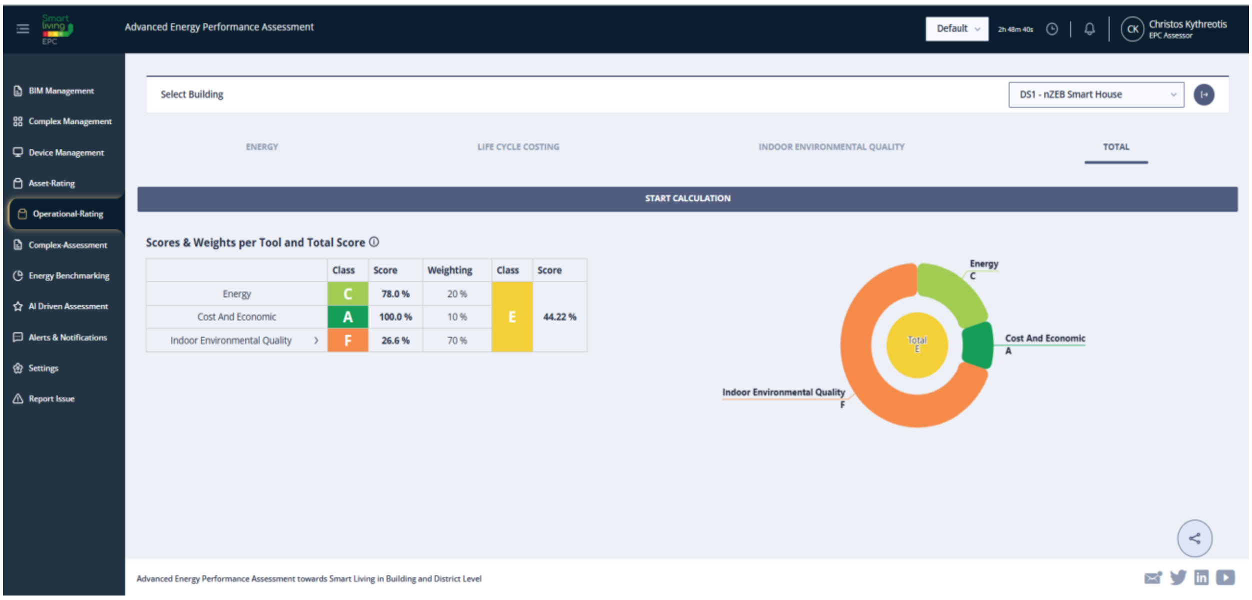


Figure 23. Total operational rating assessment for DS1

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.17 UC4.5 Operational Rating issuance for Building Complexes

- **Result:** N/A
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot): N/A
- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.18 UC4.6 Operational Rating as a service

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Operational Rating API call response

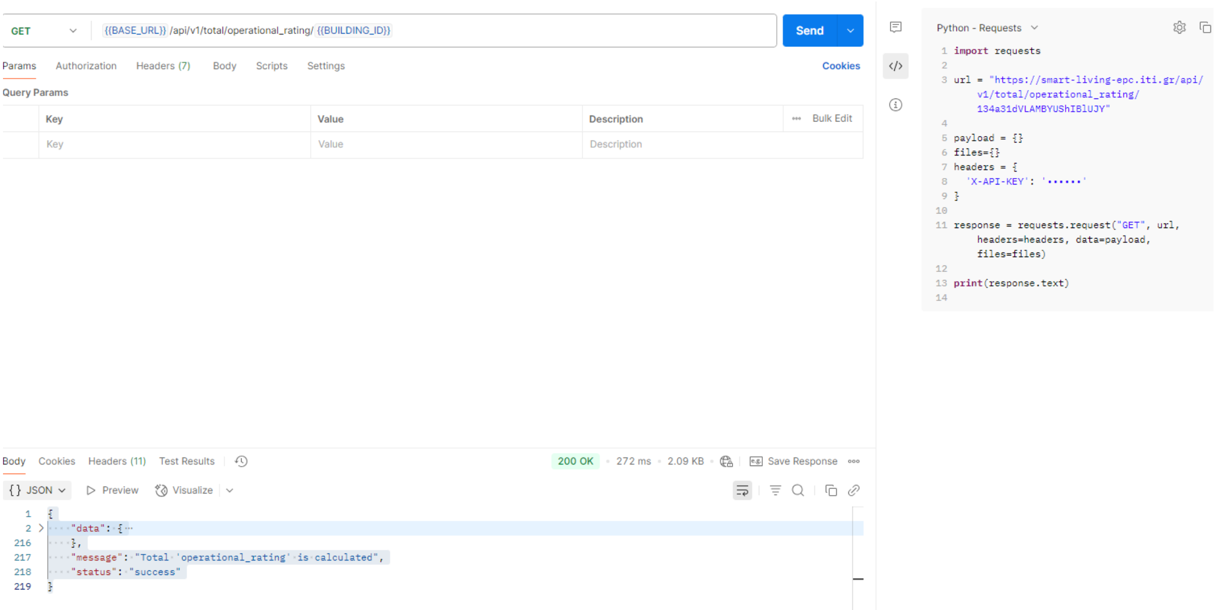


Figure 24. Operational Rating API call response in DS1

- **Lessons learned**: N/A
- **Proposed improvements:** N/A

6.1.3.19 UC5.2 Building Dynamic Model Extraction

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Results of the energy forecasting and the occupancy estimation tools.

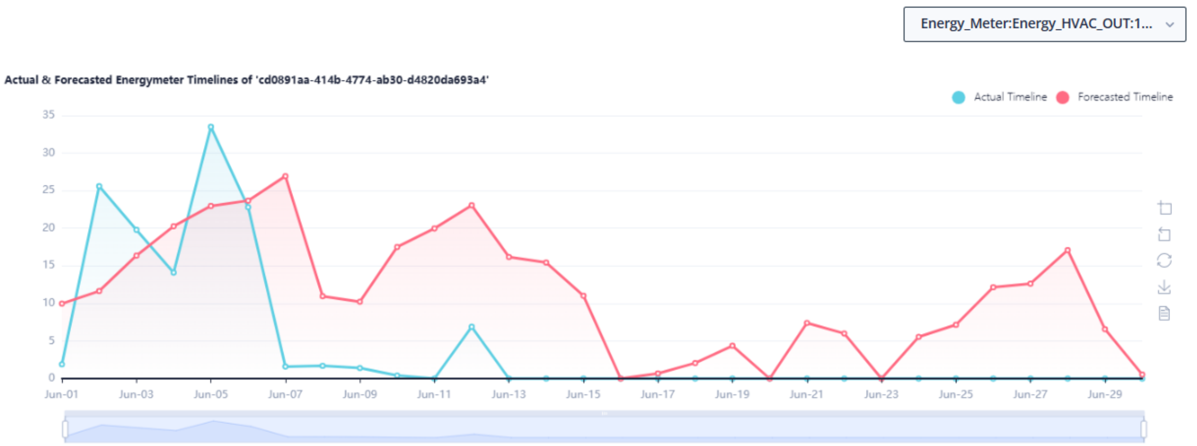


Figure 25. Results of the energy forecasting and the occupancy estimation tool for DS1

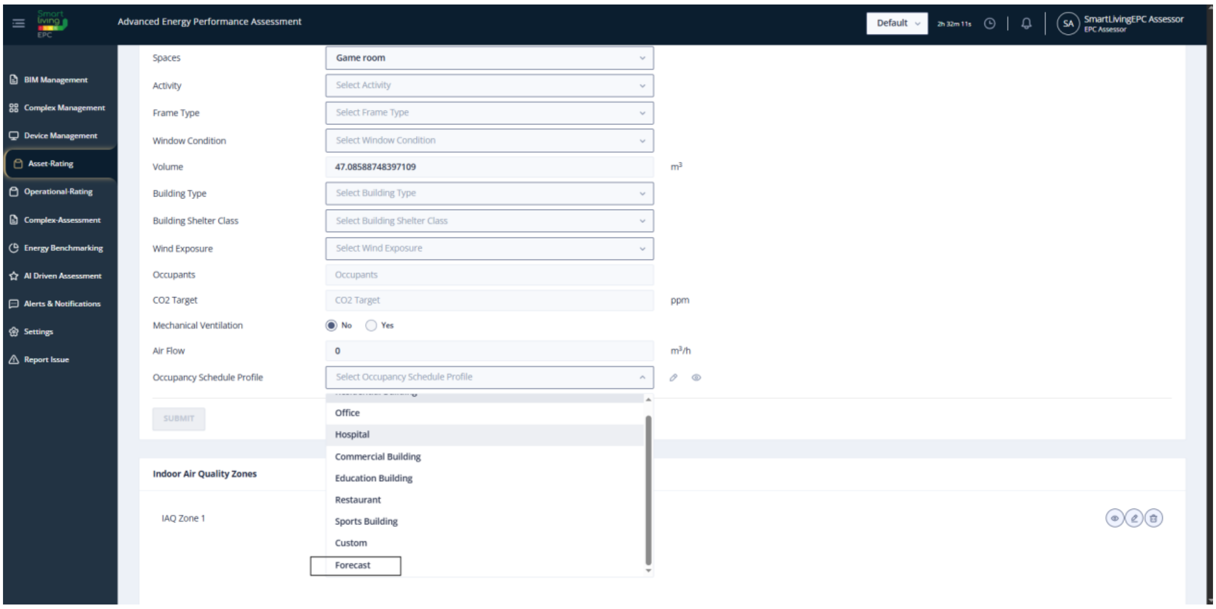


Figure 26. Web Platform interface for request energy forecasting and the occupancy estimation

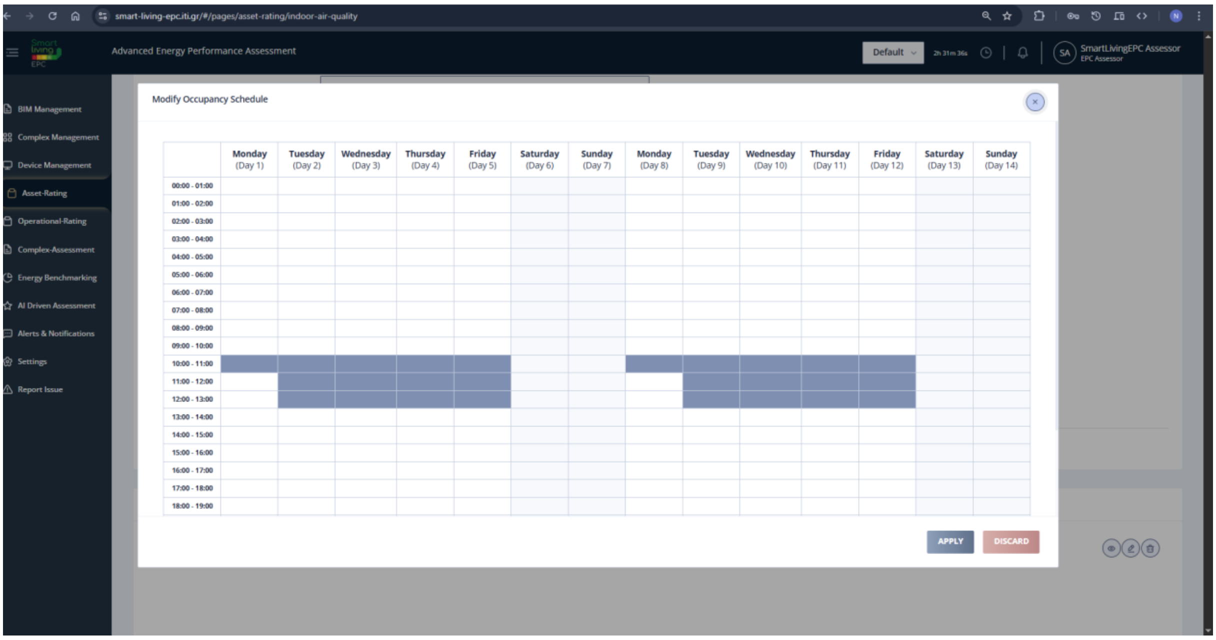


Figure 27. Occupancy profile in DS1

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.20 UC5.3 Provide the AI-driven operational analysis for improving the building's energy performance

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot): All relevant information can be found in deliverable 5.2 SmartLivingEPC Digital Platform v2 Components development, Integration and Acceptance Tests
- **Lessons learned:**

Accurate thermal comfort prediction depends heavily on the availability and quality of sensor data.

Interpreting behavioral patterns at scale requires standardizing data collection and ensuring consent mechanisms are well integrated.

The output values generated by the disaggregation engine included large numerical results which needed to be clearly presented and contextualized to support better understanding and usability.

The accuracy of the anomaly detection depends heavily on high-quality input data and appropriate threshold settings to avoid false positives or missed events

Unexpected zero outputs from the cost estimation engine highlight the need for thorough validation of input handling and internal calculation logic

- **Proposed improvements:**

User feedback would improve the validation of predictions and model relevance. Consistent feedback integration across all pilot studies would enhance model accuracy and applicability. Additionally, further tuning of the ML model will be essential to boost performance and reliability.

Incorporate user feedback to validate activity predictions and improve model relevance. Enable direct connection to time series data sources to eliminate the need for manual uploads and support real-time forecasting

Incorporate user feedback to validate activity predictions and improve model relevance. Enable direct connection to time series data sources to eliminate the need for manual uploads and support real-time forecasting

Improve Missing Data Handling: Implement robust strategies for managing missing or incomplete time-series data, including advanced imputation techniques, to maintain detection accuracy even when data gaps occur.

Enhance Rule Management: Refine the system's ability to manage and apply complex user-defined rules, ensuring accurate execution and minimizing the risk of false positives or rule conflicts.

Ensure Scalability: Optimize the engine's performance to handle large-scale datasets efficiently, enabling real-time analysis and anomaly detection across high-volume sensor inputs.

Incorporate user feedback to validate activity predictions and improve model relevance. Enable direct connection to time series data sources to eliminate the need for manual uploads and support real-time forecasting

6.1.3.21 UC5.4 Generate Physics-based baseline building energy profiles for the building

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

3D model and energy profiles for DS1.

Figure 28. 3D model for DS1

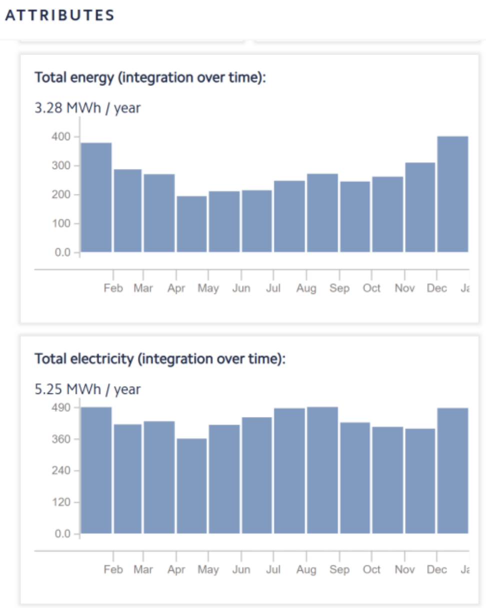


Figure 29. Energy profiles for DS1

- **Lessons learned:** A key lesson learned is that interoperability issues between BIM files and thermal energy analysis have proven challenging to address. To resolve this, a detailed mapping of attributes would be necessary to ensure seamless integration and accurate data transfer between systems.
- **Proposed improvements:** It would be beneficial to display actual measured energy data alongside simulated results within the same platform, enabling easier comparison and validation. Additionally, incorporating the country-specific EPC (Energy Performance Certificate) benchmark would provide valuable context for performance assessment.

6.1.3.22 UC6.1 Provide information on as-designed/as-operated deviations

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Results of the KPI evaluation tool yield the same results as manual calculations.

Select Building — DS1 - nZEB Smart House

PEER COMPARISON | KPI EVALUATION | KPI OPTIMIZATION | COST ANALYSIS & PLANNING

Name	As Designed	As Operated	Comparison
Energy	100.00 %	78.00 %	-22.00 %
CO2	54.00 %	71.00 %	31.48 %
Thermal Comfort	82.00 %	14.00 %	-82.93 %
Total	83.95 %	44.22 %	-47.33 %

Figure 30. Results of KPI evaluation tool for DS1

- **Lessons learned:** N/A
- **Proposed improvements:**

  To provide a notification that if an indicator (asset or operational) has not been calculated, to avoid fault comparison.

6.1.3.23 UC6.2 Benchmark the asset's performance

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Energy benchmarking (peer-comparison, KPI evaluation and KPI optimization tools)

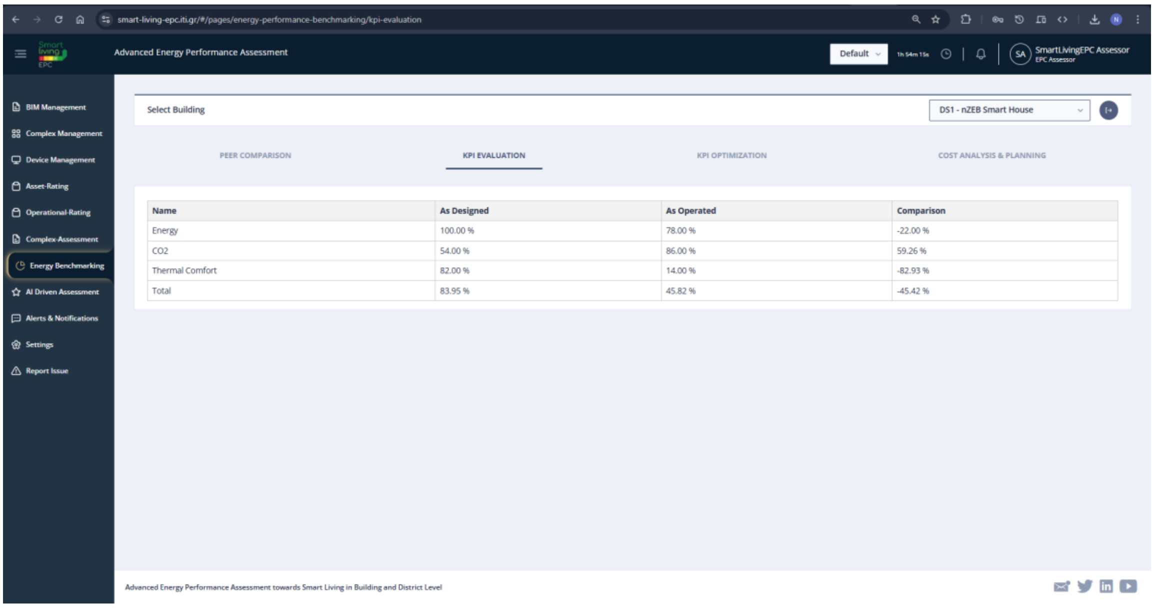


Figure 31. KPI evaluation and optimization

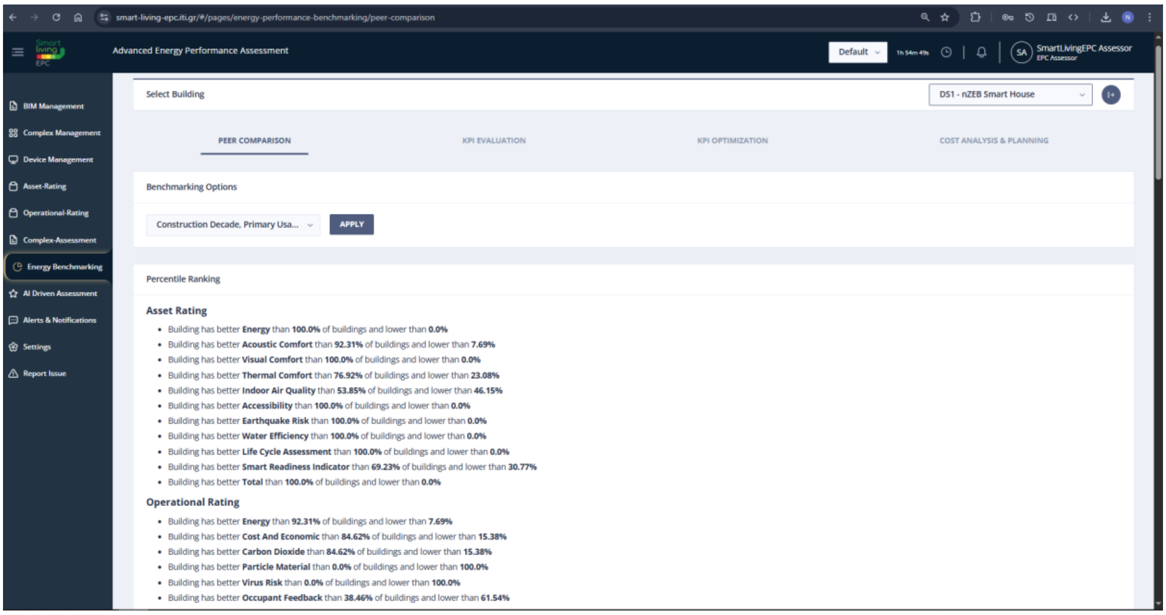


Figure 32. Benchmarking for DS1

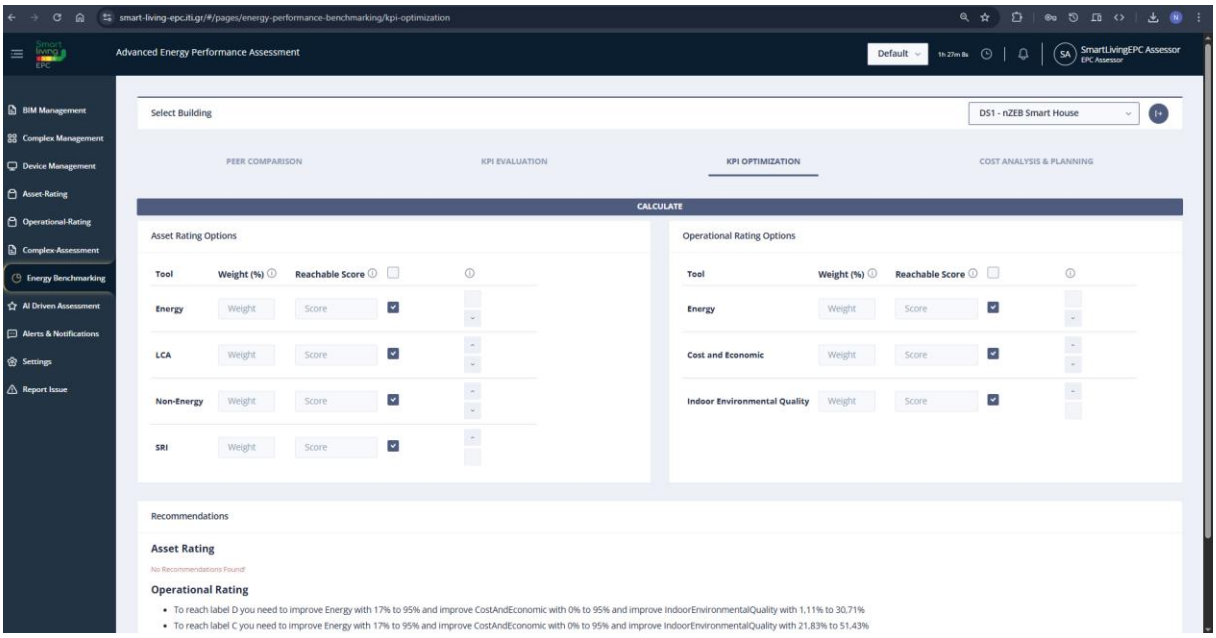


Figure 33. KPI optimization tool for DS1

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.1.3.24 UC6.3 Provide recommendations for energy efficiency practices

- **Result:** Pass
- **Incidence/Impact (**in case of fail): N/A
- **Evidence** (numerical or screenshot):

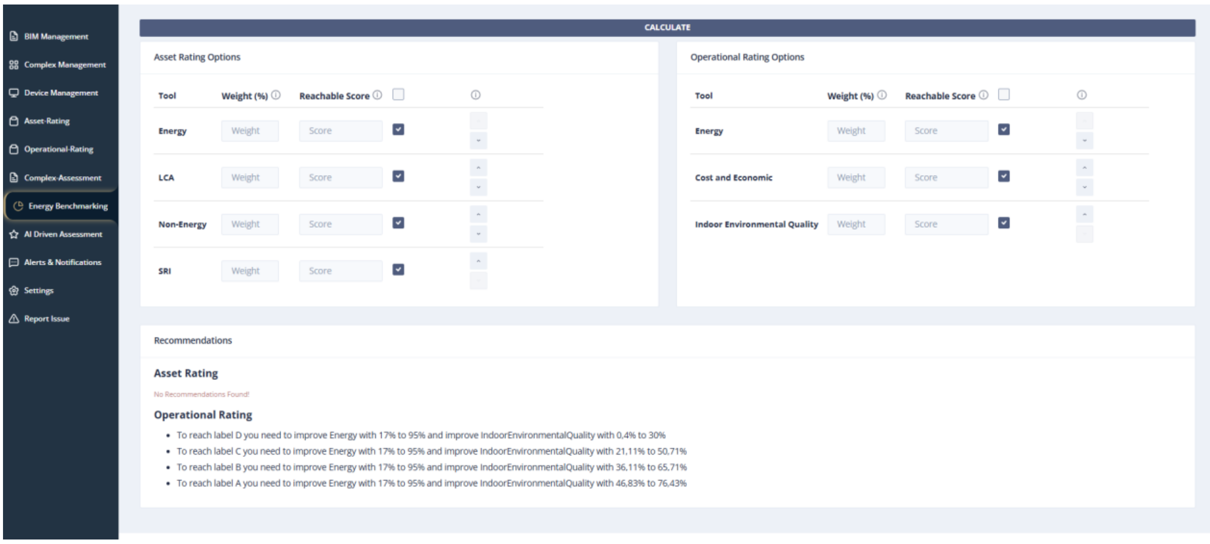


Figure 34. Recommendations provision for energy efficiency improvements in DS1

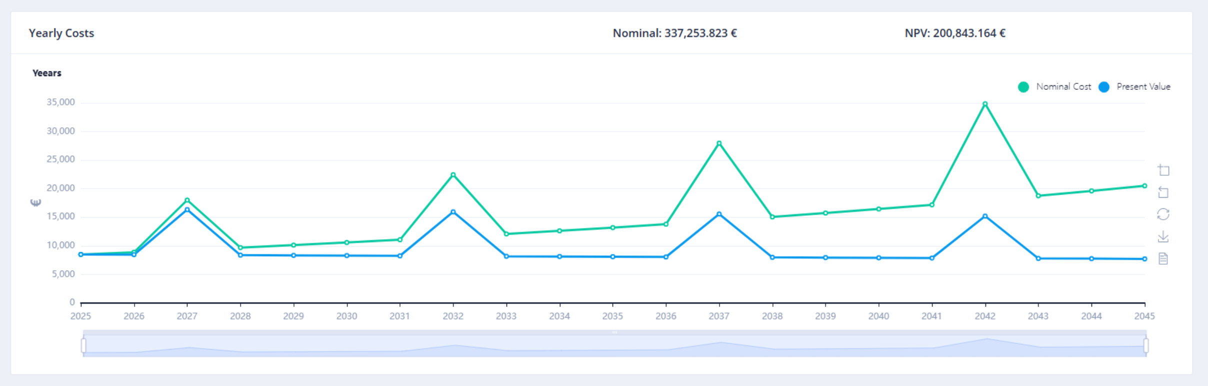


Figure 35. Cost analysis for a replacement system in DS1

- **Lessons learned:**
- **Proposed improvements:**
  To include estimations of EPC improvements for replacement systems.

6.1.3.25 UC7.1 Provide Building Records through Digital Logbooks

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

BIM logbook entry fro DS1.

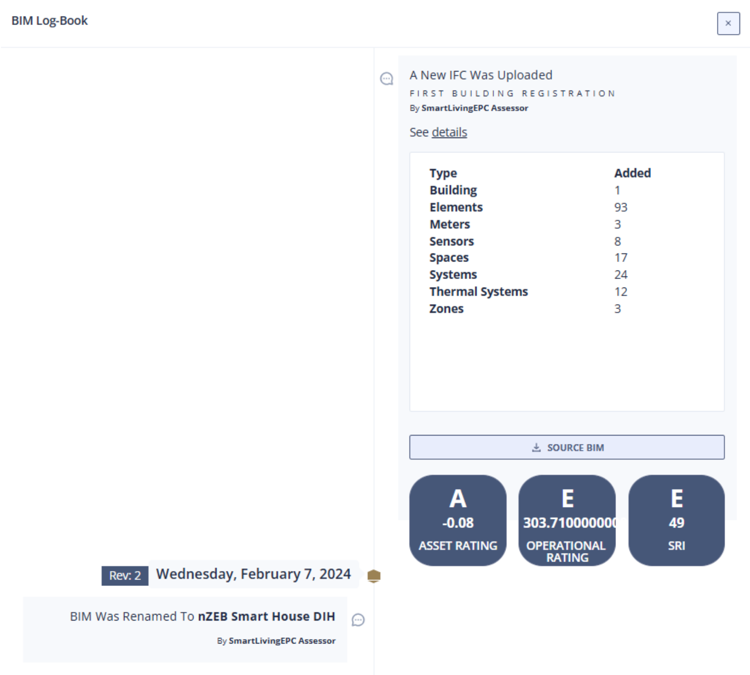


Figure 36. BIM logbook entry for DS1

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.2 DemoSite 2 - Frederick's University Main Building

6.2.1 Deployment timeline

The pilot building at Frederick University in Limassol is a multifunctional educational facility comprising teaching spaces, laboratories, administrative offices, and student service areas. Constructed in 1996 and significantly renovated in 2021, the building was updated both structurally and digitally, including the development of a comprehensive Building Information Model (BIM).

This BIM, created during the renovation phase, covered multiple disciplines such as architecture, structural and electrical engineering, HVAC systems, and interior spatial design. Within the SmartLivingEPC project, the BIM model served as a crucial asset for simulation and analysis tasks. In order to ensure compatibility with the SmartLivingEPC web-based platform, the model underwent a transformation process to convert it into IFC format. This conversion was carried out in coordination with FRC and CERTH, focusing on cleaning up metadata, refining the structure, and aligning it with the operational rating methodology requirements.

6.2.2 Baseline activities

1.2.2.1 IoT installation

The building is not equipped with a centralized Building Management System (BMS). However, as a result of previous energy efficiency initiatives and research activities, it includes a variety of stand-alone monitoring systems and sensors that have been made available for the SmartLivingEPC project. This allowed the project team to utilize existing infrastructure without the need to install new sensors. Available sensor categories in the building include room-level measurements for temperature, relative humidity, and CO_2; HVAC-related sensors such as supply and return air temperature, airflow rates, and fan speed; smart meters monitoring electricity, cooling, and heating energy consumption; water consumption meters; occupancy detection via motion or CO_2-based control; and data related to PV generation and electrical subsystems. Monitoring is handled via a combination of local dashboards and equipment-level interfaces, enabling access to both real-time values and historical trends. While these systems are not integrated under a unified BMS, they provide sufficient coverage for the data acquisition needs of the SmartLivingEPC operational rating methodology.

1.2.2.2 Communication with CIEM and data sharing

While the building is not originally equipped with a centralized Building Management System (BMS), a wide range of sensors and monitoring devices were installed during the major renovation completed in 2021.

The infrastructure includes room-level measurements for temperature, relative humidity, and CO_2; HVAC-related sensors such as airflow, supply and return air temperatures, and fan speed; energy meters for electricity, heating, and cooling; water consumption meters; motion-based or CO_2-triggered occupancy sensors; and data on PV generation and electrical subsystem performance. Although these systems operate independently and are not integrated under a unified BMS, they provide sufficient resolution and reliability for the purposes of operational performance assessment.

In terms of data sharing, a significant step forward was achieved in coordination with project partner QUE. Since early 2024, data transfer from the pilot site to the CIEM platform has been active using a secure RESTful API approach. The system continuously retrieves selected variables from the existing monitoring infrastructure, formats them according to SmartLivingEPC specifications, and transmits them at regular intervals. This method has ensured consistent, real-time data availability while maintaining compliance with institutional data management policies.

6.2.3 Results of architectural use cases implementation

6.2.3.1 UC1.1 Retrieve and validate building information from BIM

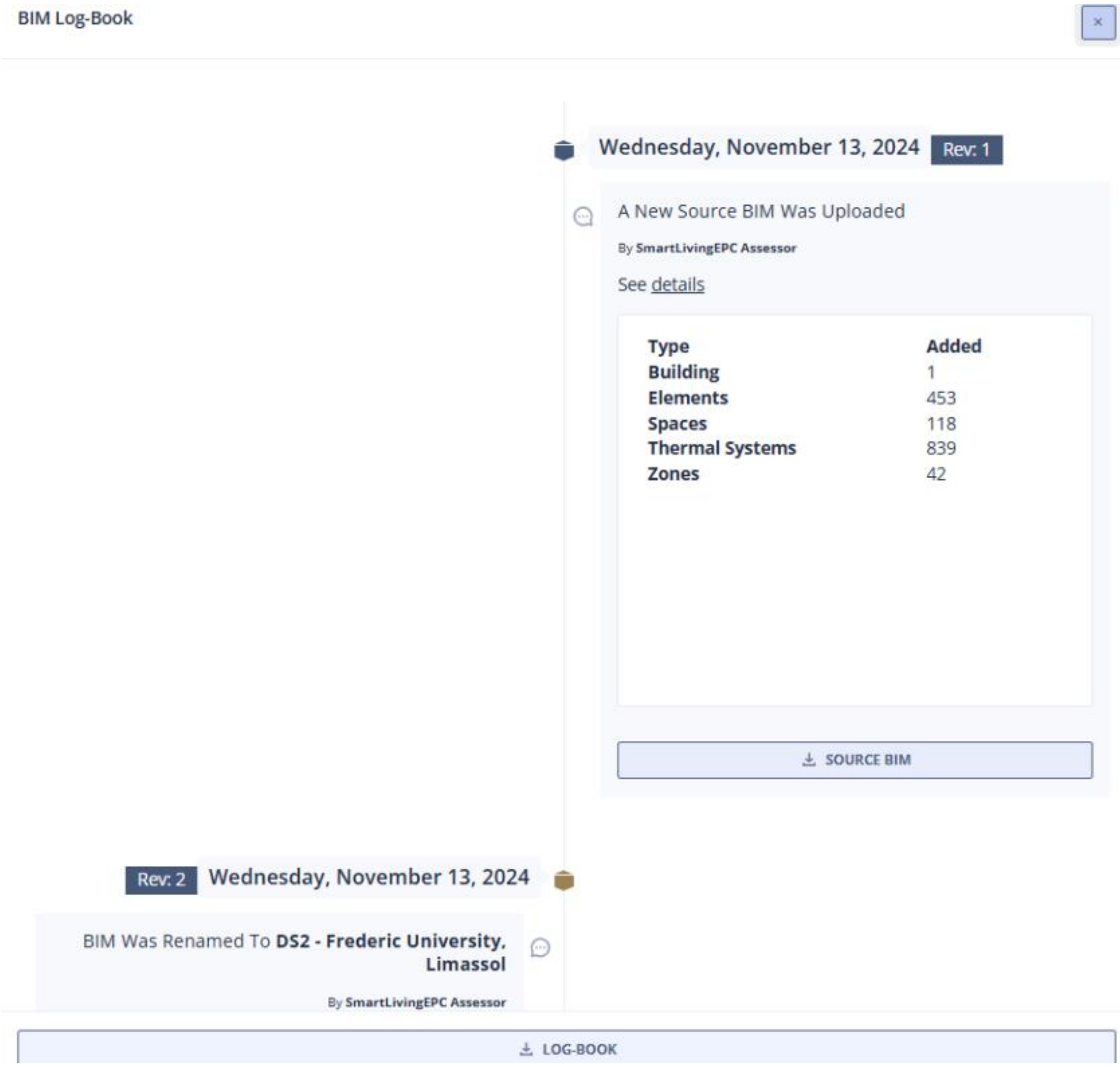


Figure 37. BIM Log-Book entry showing the upload and registration of the source BIM model for the Frederick University pilot (DS2 – Limassol)

- **Result:** PASS
- **Incidence/Impact** (in case of fail):
  N/A – The BIM file was successfully uploaded and validated. Information related to building geometry, thermal performance, and technical systems was extracted.
- **Evidence** (numerical or screenshot):
  Screenshot showing the BIM logbook interface with extracted information (building: 1, elements: 453, spaces: 118, thermal systems: 839, zones: 42), following the first upload on November 13, 2024.
- **Lessons learned:**
  As in DS1, successful extraction depends on proper structuring and metadata cleanliness. Despite the absence of national BIM guidelines in Cyprus, the IFC export was interpreted correctly by the platform.
- **Proposed improvements:**
  None required at this stage; process considered effective. However, routine cross-checks with native Revit data could be beneficial for identifying any hidden inconsistencies before upload.

6.2.3.2 UC1.2 Collect and extract data from additional building documentation sources

- **Result:**
  PASS
- **Incidence/Impact** (in case of fail):
  N/A – The visualization of the building asset information on the Web Platform was successful.
- **Evidence** (numerical or screenshot):
  Interactive display of model elements, systems, and spaces was visible via the SmartLivingEPC Web Platform interface after IFC upload and processing.
- **Lessons learned:**
  The presence of well-structured IFC metadata directly influenced the visibility and navigability of asset layers in the platform. Lack of classification in some components reduced semantic search efficiency.
- **Proposed improvements:**
  Encourage enhanced IFC authoring practices in upstream BIM environments, including enriched property sets and asset categorization aligned with EU standards.

6.2.3.3 *UC2.1 Inspection and installation of IoT equipment on the building*

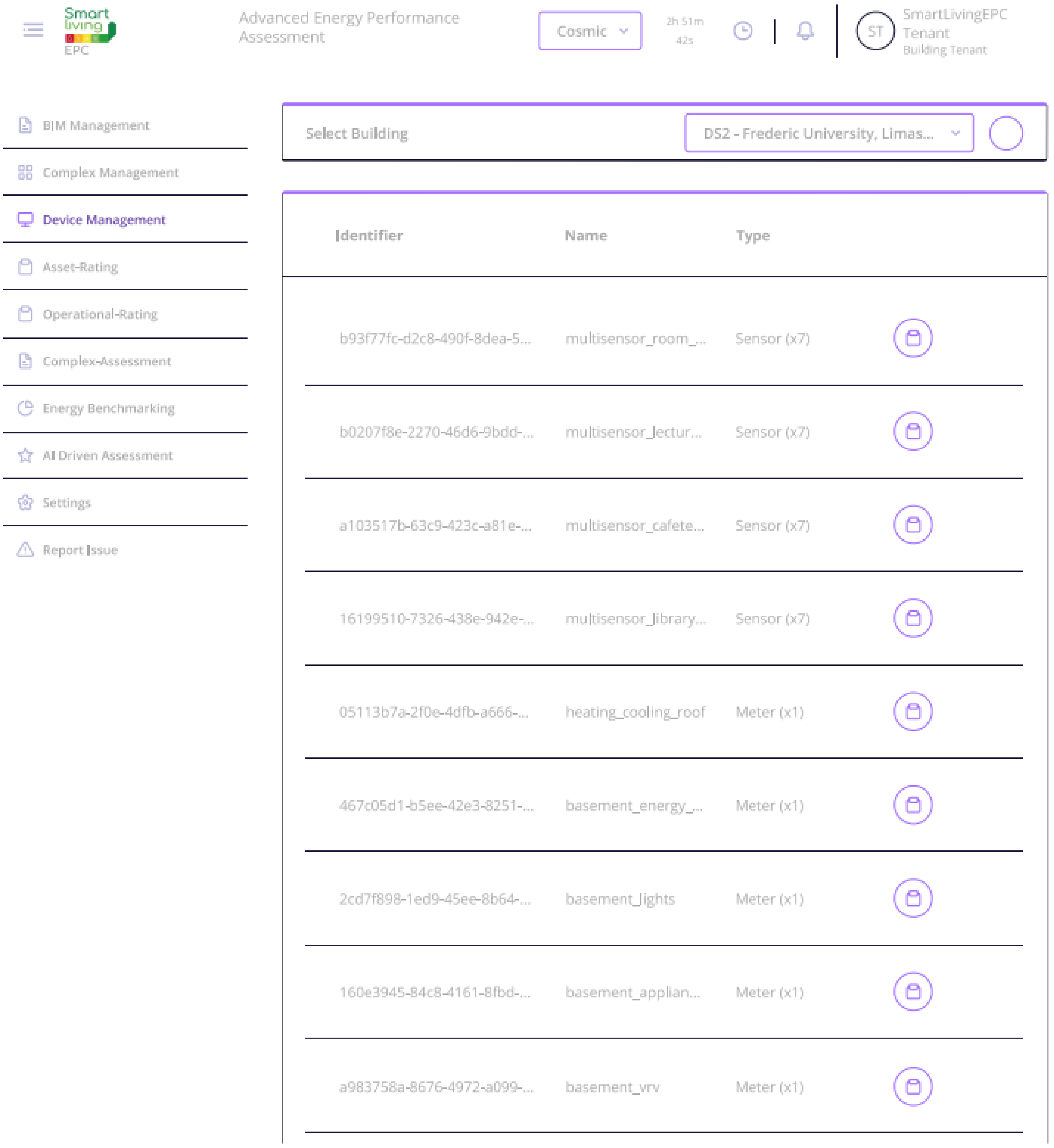
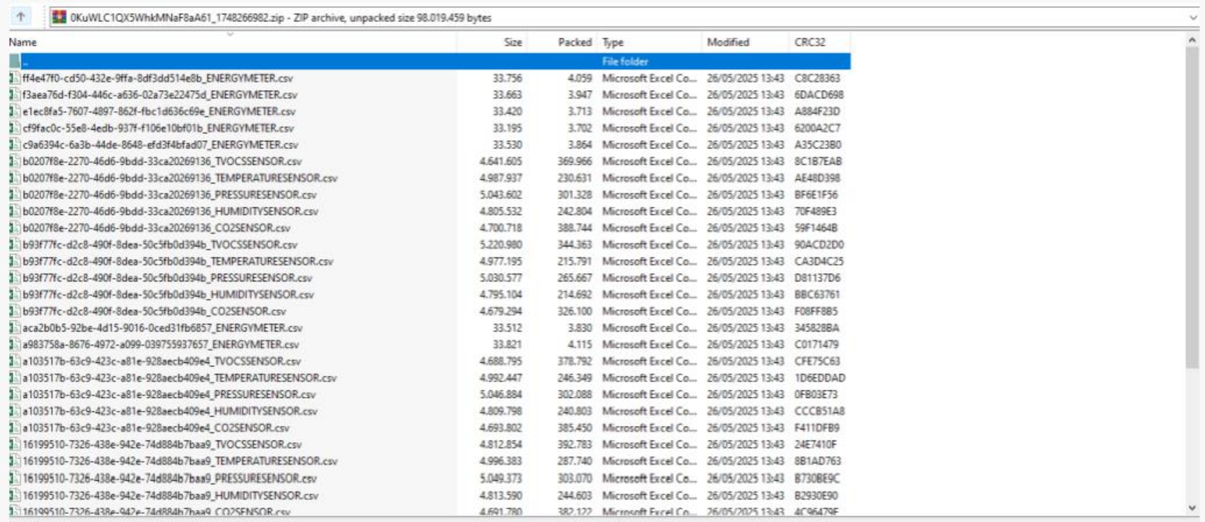


Figure 38. Device Management interface for Demo Site 2 – Frederick University, Limassol, as displayed in the SmartLivingEPC platform.

- **Result:**
  PASS
- **Incidence/Impact (in case of fail):**
  N/A – IoT devices were properly installed and functional, and data streams met all integration requirements.
- **Evidence (numerical or screenshot):**
  Platform screenshot from the Device Management tab showing registered multisensors and metering devices linked to various spaces and systems in the building.
- **Lessons learned:**
  Early consideration of SmartLivingEPC data requirements during renovation planning helped ensure full compatibility without requiring additional hardware. The reuse of existing infrastructure proved both efficient and cost-effective.
- **Proposed improvements:**
  To support long-term data integrity, periodic audits and backup procedures should be implemented to ensure continued synchronization with the CIEM and redundancy in case of network disruptions.

6.2.3.4 UC2.2 IoT integration to the SmartLivingEPC platform



0KuWLC1QX5WhkMNaF8aA61_1748266982.zip - ZIP archive, unpacked size 98.019.459 bytes

Name	Size	Packed	Type	Modified	CRC32
..			File folder		
ff4e47f0-cd50-432e-9ffa-8df3dd514e8b_ENERGYMETER.csv	33.756	4.059	Microsoft Excel Co...	26/05/2025 13:43	C8C28363
f3aea76d-f304-446c-a636-02a73e22475d_ENERGYMETER.csv	33.663	3.947	Microsoft Excel Co...	26/05/2025 13:43	6DACD698
e1ec8fa5-7607-4897-862f-fbc1d636c69e_ENERGYMETER.csv	33.420	3.713	Microsoft Excel Co...	26/05/2025 13:43	A884F23D
cf9fac0c-55e8-4edb-937f-f106e10bf01b_ENERGYMETER.csv	33.195	3.702	Microsoft Excel Co...	26/05/2025 13:43	6200A2C7
c9a6394c-6a3b-44de-8648-efd3f4bfad07_ENERGYMETER.csv	33.530	3.864	Microsoft Excel Co...	26/05/2025 13:43	A35C23B0
b0207f8e-2270-46d6-9bdd-33ca20269136_TVOCSSENSOR.csv	4.641.605	369.966	Microsoft Excel Co...	26/05/2025 13:43	8C1B7EAB
b0207f8e-2270-46d6-9bdd-33ca20269136_TEMPERATURESENSOR.csv	4.987.937	230.631	Microsoft Excel Co...	26/05/2025 13:43	AE48D398
b0207f8e-2270-46d6-9bdd-33ca20269136_PRESSURESENSOR.csv	5.043.602	301.328	Microsoft Excel Co...	26/05/2025 13:43	BF6E1F56
b0207f8e-2270-46d6-9bdd-33ca20269136_HUMIDITYSENSOR.csv	4.805.532	242.804	Microsoft Excel Co...	26/05/2025 13:43	70F489E3
b0207f8e-2270-46d6-9bdd-33ca20269136_CO2SENSOR.csv	4.700.718	388.744	Microsoft Excel Co...	26/05/2025 13:43	59F1464B
b93f77fc-d2c8-490f-8dea-50c5fb0d394b_TVOCSSENSOR.csv	5.220.980	344.363	Microsoft Excel Co...	26/05/2025 13:43	90ACD2D0
b93f77fc-d2c8-490f-8dea-50c5fb0d394b_TEMPERATURESENSOR.csv	4.977.195	215.791	Microsoft Excel Co...	26/05/2025 13:43	CA3D4C25
b93f77fc-d2c8-490f-8dea-50c5fb0d394b_PRESSURESENSOR.csv	5.030.577	265.667	Microsoft Excel Co...	26/05/2025 13:43	D81137D6
b93f77fc-d2c8-490f-8dea-50c5fb0d394b_HUMIDITYSENSOR.csv	4.795.104	214.692	Microsoft Excel Co...	26/05/2025 13:43	BBC63761
b93f77fc-d2c8-490f-8dea-50c5fb0d394b_CO2SENSOR.csv	4.679.294	326.100	Microsoft Excel Co...	26/05/2025 13:43	F08FF8B5
aca2b0b5-92be-4d15-9016-0ced31fb6857_ENERGYMETER.csv	33.512	3.830	Microsoft Excel Co...	26/05/2025 13:43	345828BA
a983758a-8676-4972-a099-039755937657_ENERGYMETER.csv	33.821	4.115	Microsoft Excel Co...	26/05/2025 13:43	C0171479
a103517b-63c9-423c-a81e-928aecb409e4_TVOCSSENSOR.csv	4.688.795	378.792	Microsoft Excel Co...	26/05/2025 13:43	CFE75C63
a103517b-63c9-423c-a81e-928aecb409e4_TEMPERATURESENSOR.csv	4.992.447	246.349	Microsoft Excel Co...	26/05/2025 13:43	1D6EDDAD
a103517b-63c9-423c-a81e-928aecb409e4_PRESSURESENSOR.csv	5.046.884	302.088	Microsoft Excel Co...	26/05/2025 13:43	0FB03E73
a103517b-63c9-423c-a81e-928aecb409e4_HUMIDITYSENSOR.csv	4.809.798	240.803	Microsoft Excel Co...	26/05/2025 13:43	CCCB51A8
a103517b-63c9-423c-a81e-928aecb409e4_CO2SENSOR.csv	4.693.802	385.450	Microsoft Excel Co...	26/05/2025 13:43	F411DFB9
16199510-7326-438e-942e-74d884b7baa9_TVOCSSENSOR.csv	4.812.854	392.783	Microsoft Excel Co...	26/05/2025 13:43	24E7410F
16199510-7326-438e-942e-74d884b7baa9_TEMPERATURESENSOR.csv	4.996.383	287.740	Microsoft Excel Co...	26/05/2025 13:43	8B1AD763
16199510-7326-438e-942e-74d884b7baa9_PRESSURESENSOR.csv	5.049.373	303.070	Microsoft Excel Co...	26/05/2025 13:43	B730BE9C
16199510-7326-438e-942e-74d884b7baa9_HUMIDITYSENSOR.csv	4.813.590	244.603	Microsoft Excel Co...	26/05/2025 13:43	B2930E90
16199510-7326-438e-942e-74d884b7baa9_CO2SENSOR.csv	4.691.780	382.122	Microsoft Excel Co...	26/05/2025 13:43	4C96479F

Figure 39. Contents of the CIEM archive for Demo Site 2 – Frederick University, Limassol. The ZIP archive includes time-series CSV files for multiple IoT devices

- **Result:**
  PASS
- **Incidence/Impact** (in case of fail):
  N/A – The IoT configuration was properly set up and fully integrated with the CIEM component. All available measurements were successfully retrieved and processed.
- **Evidence** (numerical or screenshot):
  CIEM backend confirmed proper ingestion of structured data from the building's devices, including room sensors and meters. Successful forwarding to SmartLivingEPC services was verified through log records and dashboard output.
- **Lessons learned:**
  Direct coordination between the building's IT administrators and the CIEM integrators was essential to streamline access and formatting of data. Alignment on variable naming and timestamp handling reduced risks during initial onboarding.

6.2.3.5 UC2.3 Near-real time automated data retrieval from IoT equipment

- Result:
  PASS
- **Incidence/Impact** (in case of fail):
  N/A – All unexpected or non-configured values were discarded by design. The system remained stable and operational.
- **Evidence** (numerical or screenshot):
  Screenshot from Postman showing successful JSON-based data posting to the CIEM API. Payloads confirm structured data ingestion, including timestamped sensor values and associated metadata.
- **Lessons learned:**
  The integration process revealed the importance of flexible backend design, as pilot sites often provide datasets with differing formats, granularity, and frequency. Consistent parsing logic across varying data structures was key to ensuring interoperability.
- **Proposed improvements:**
  Future scaling scenarios would benefit from enhanced data storage strategies to handle high-volume influxes efficiently. Optimization practices for big data streams should be embedded in early deployment phases.

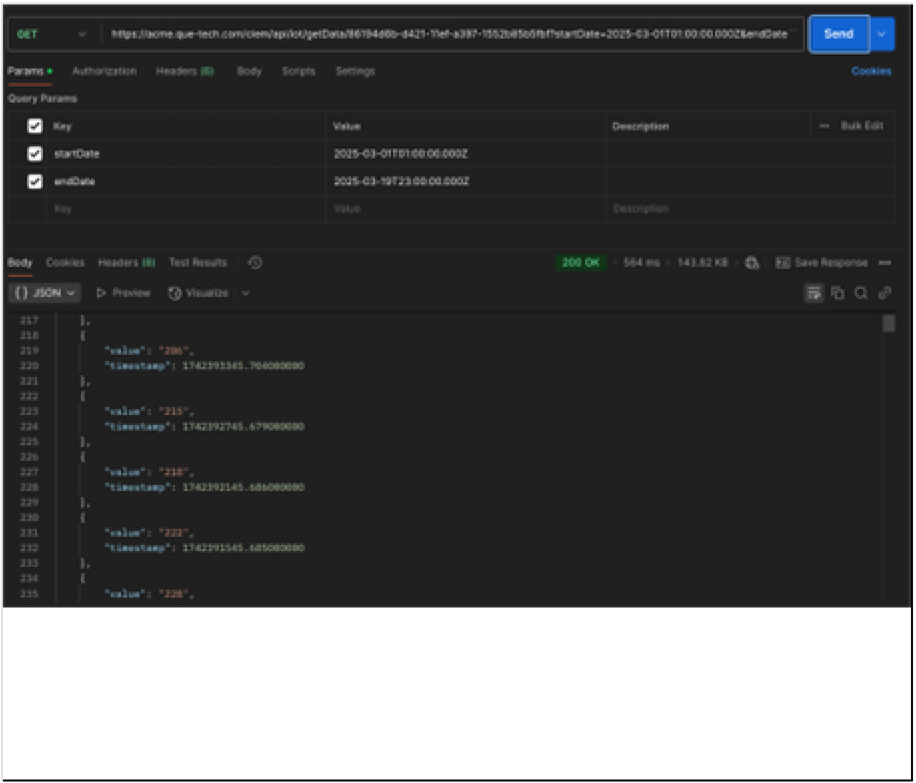


Figure 40. GET request from the CIEM API endpoint for Demo Site 2 – Frederick University, Limassol

6.2.3.6 UC2.4 On-demand data retrieval

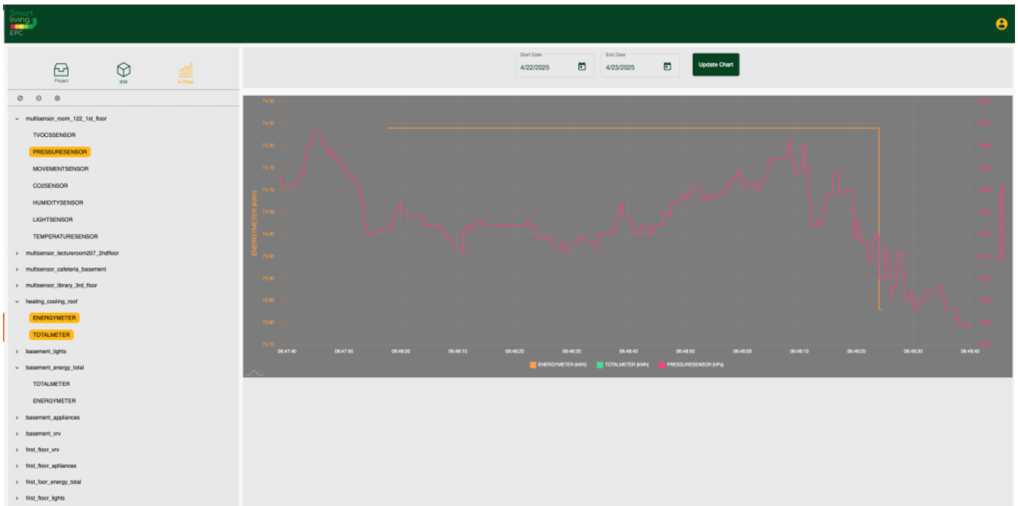


Figure 41. On-Demand Data Retrieval Interface for Frederick University Pilot

- **Result:**
  PASS
- **Incidence/Impact** (in case of fail):
  Not applicable – data from non-configured equipment is excluded automatically from retrieval routines, ensuring no unexpected values are presented.
- **Evidence** (numerical or screenshot):
  Screenshot from the SmartLivingEPC platform interface showing successful data query execution.

Timestamped sensor values are shown for a selected timeframe, confirming that the retrieval engine delivers expected outputs based on available configuration.

- **Lessons learned:**
  On-demand retrieval through the platform allows assessors to validate the live status of connected equipment without relying on fixed-time queries or external APIs. This approach provides flexibility during both setup and monitoring phases and reduces integration complexity for non-developer users

6.2.3.7 UC3.1 Energy and non-energy resources analysis

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence:** Input data successfully entered and validated for all declared thermal zones using the 3D BIM model within the SmartLivingEPC platform. The system confirmed data completeness and activated the calculation core.

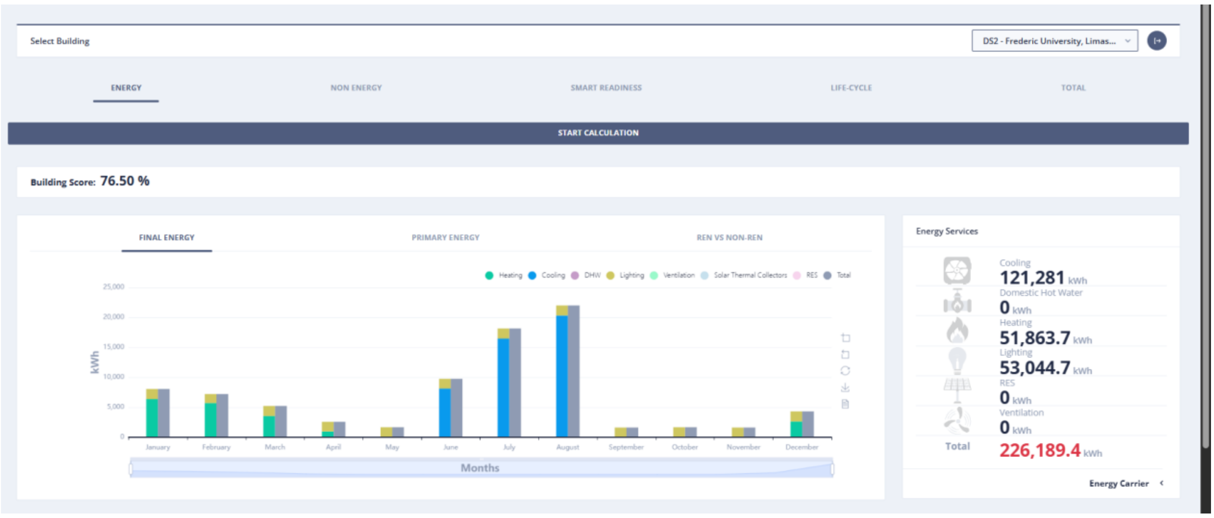


Figure 42. Energy assessment results for DS2

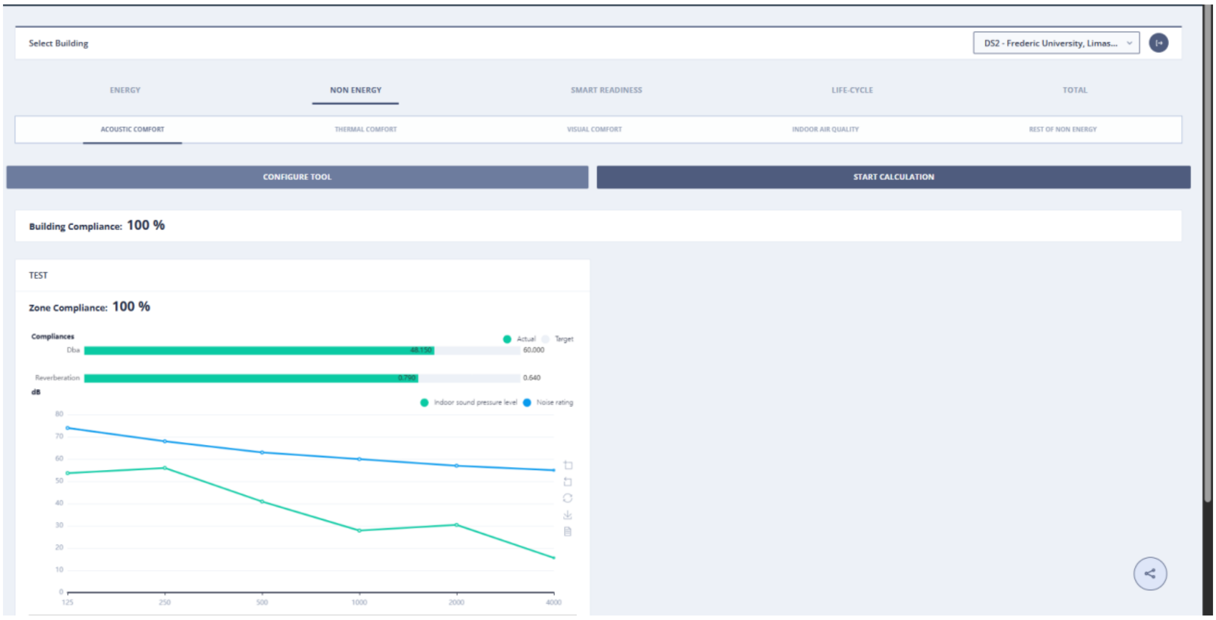


Figure 43. Non energy/acoustic comfort assessment results for DS2

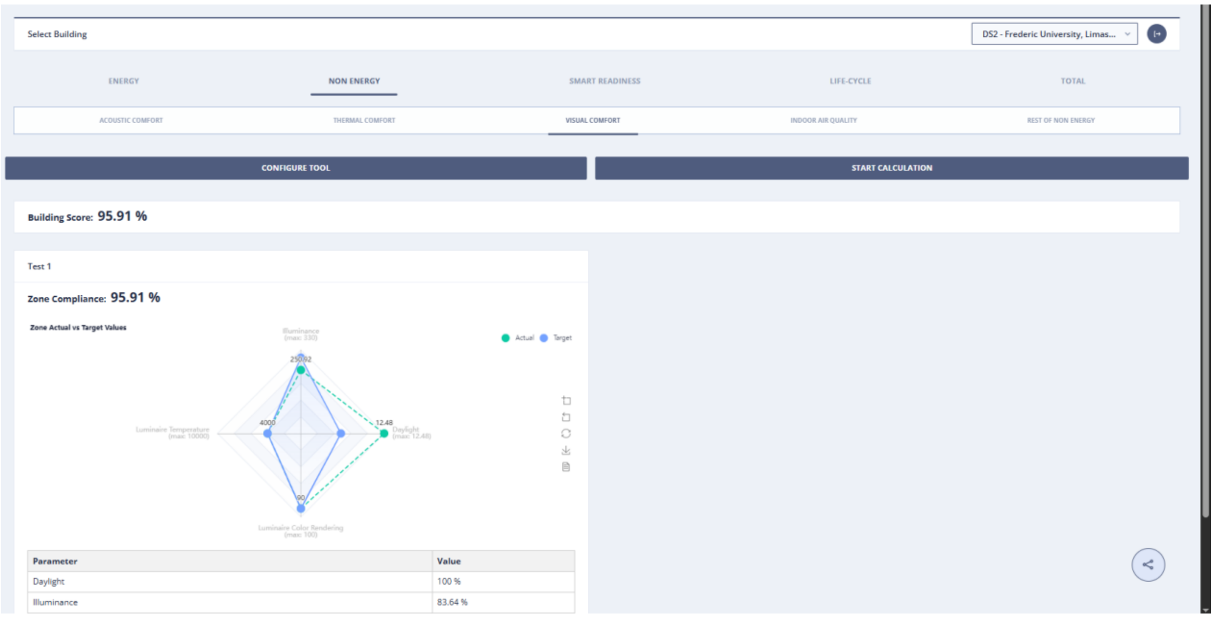


Figure 44. Non energy/visual comfort assessment results for DS2

6.2.3.8 UC3.2 SRI Calculation

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

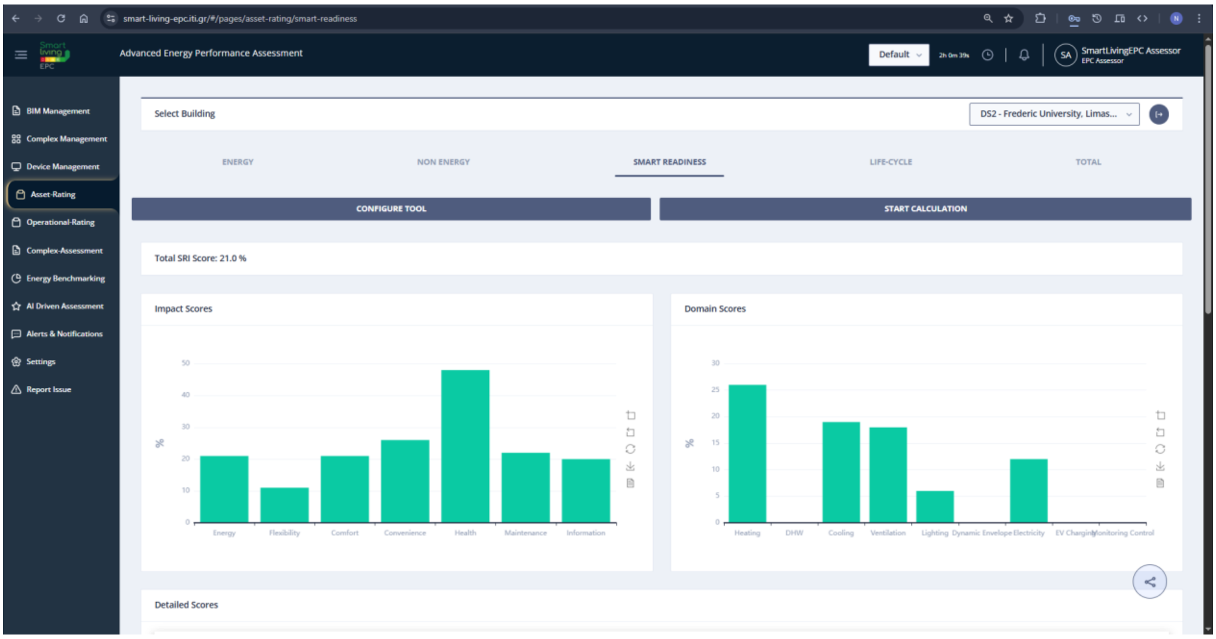


Figure 45. SRI Calculation results in DS2

- **Lessons learned:** Same as in DS1
- **Proposed improvements:** Same as in DS1

Add an explanation in the interface that a domain might be "absent but not mandatory" and clarify when user input is required.
Improve BIM parsing logic for EPBD-related domains (especially for ventilation and control systems) to better align with national conventions.

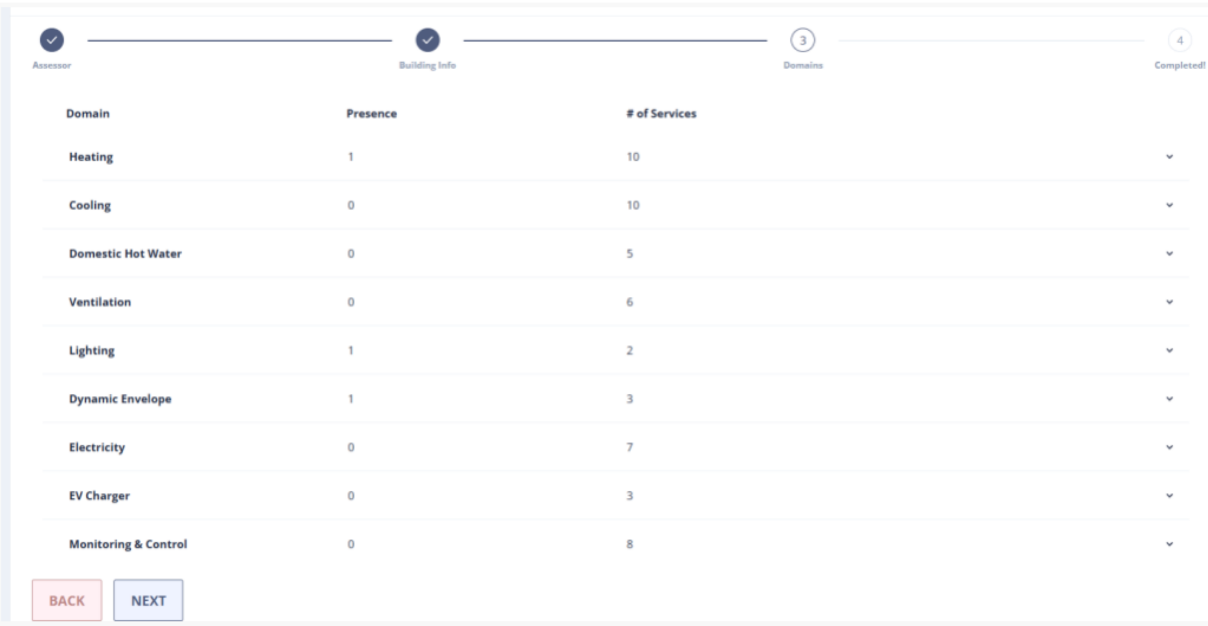


Figure 46. Smart Readiness Assessment – Domain Presence Interface (Demo Site 2: Frederick University Main Building)

6.2.3.9 UC3.3 Environmental life-cycle assessment

Validation Step 1:

- **Input:**
  Data input is complete and validated by the assessor.
- **Failure Mode:**
  Missing or incomplete data fields (e.g., materials or energy metrics).
  Errors in data retrieval from CIEM or during analysis.
- **Status:**
  Pass
- **System Behavior:**
  No operational inconsistencies were recorded during execution.
  The validation was completed in alignment with predefined procedures.

Screenshot:

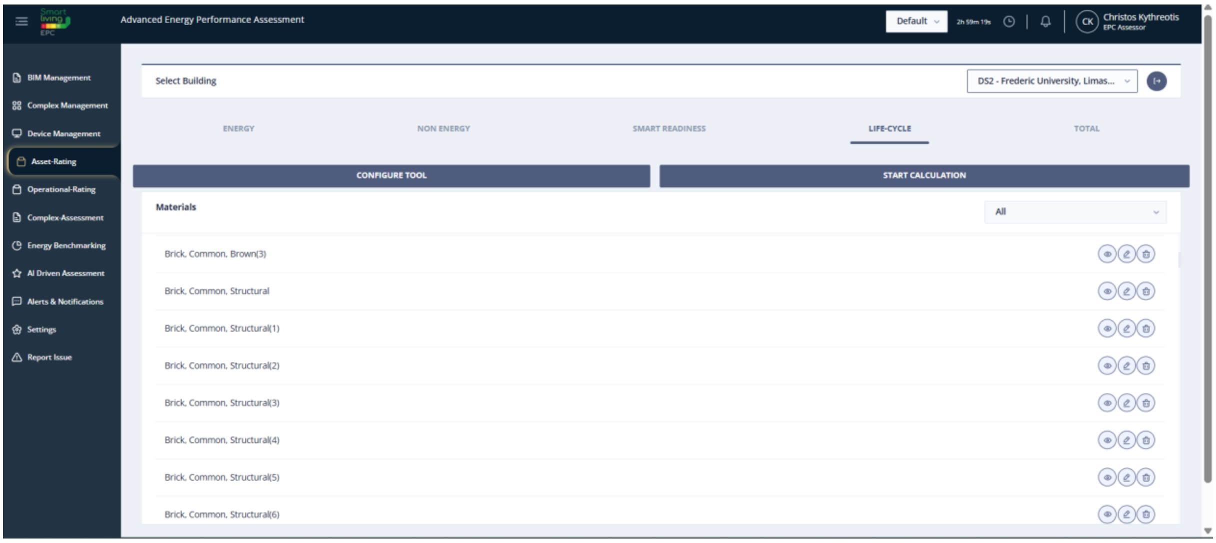


Figure 47. SmartLivingEPC platform interface displaying the Life-Cycle Assessment (LCA) material input screen for Demo Site 2: Frederick's University, Limassol.

Comment:
The validation confirmed the alignment between data input procedures and system expectations, supporting the implementation.

Validation Step 2:

- **Input:**
  LCA calculations are accurate and adhere to predefined benchmarks.
  The report is generated without errors and stored securely in the CIEM repository.
- **Failure Mode:**
  The assessor cannot validate the results due to inconsistencies.
  Failure to generate or store the LCA report.
- **Status:**
  Pass
- **System Behavior:**
  LCA results are calculated

Screenshot:

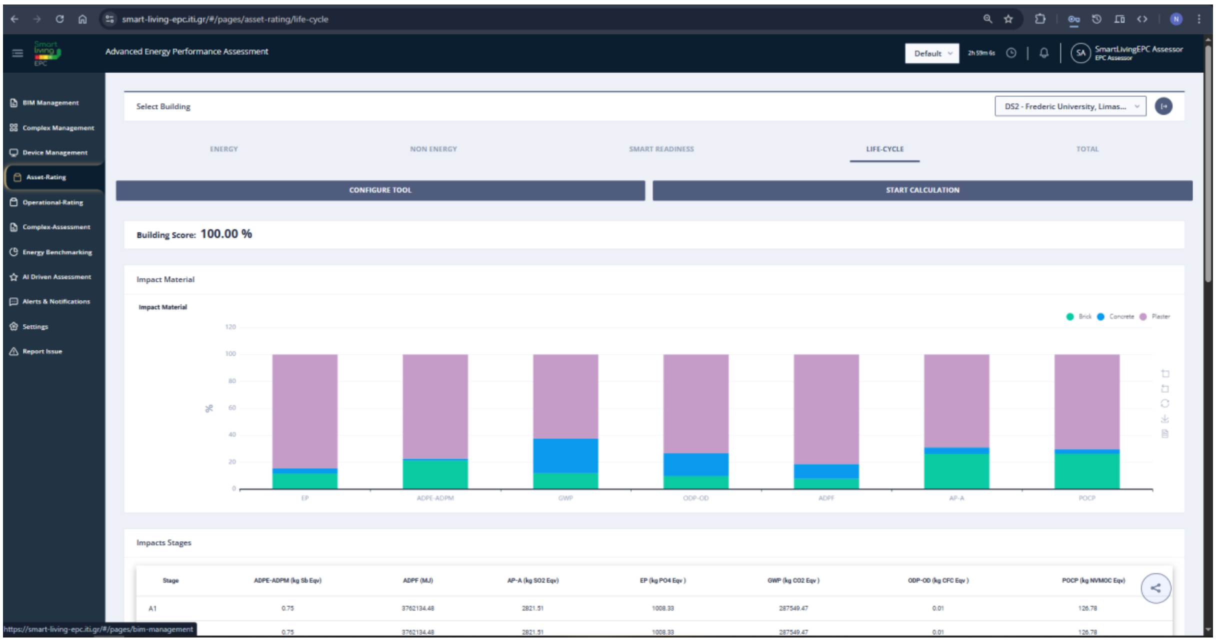


Figure 48. Life-Cycle Assessment (LCA) Results for Demo Site 2: Frederick's University, Limassol.

6.2.3.10 UC3.4 Asset Rating issuance for Building Unit

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

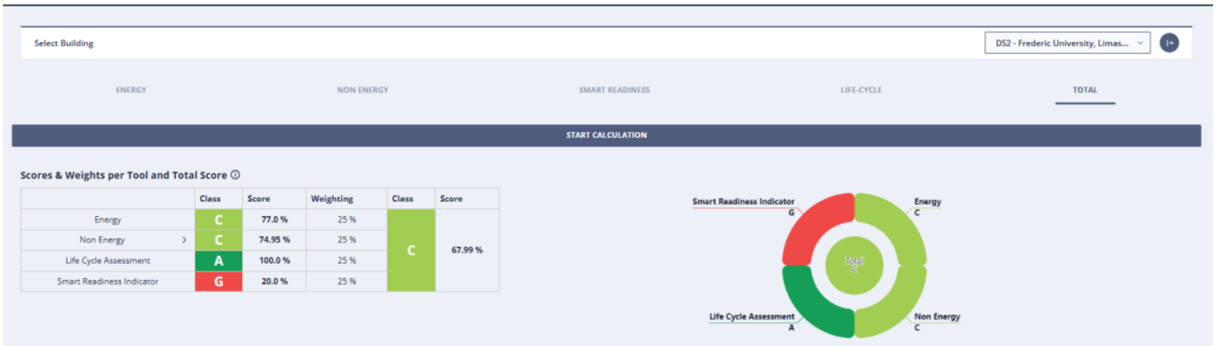


Figure 49. Asset rating issuance for DS2

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.2.3.11 UC3.6 Asset rating as service

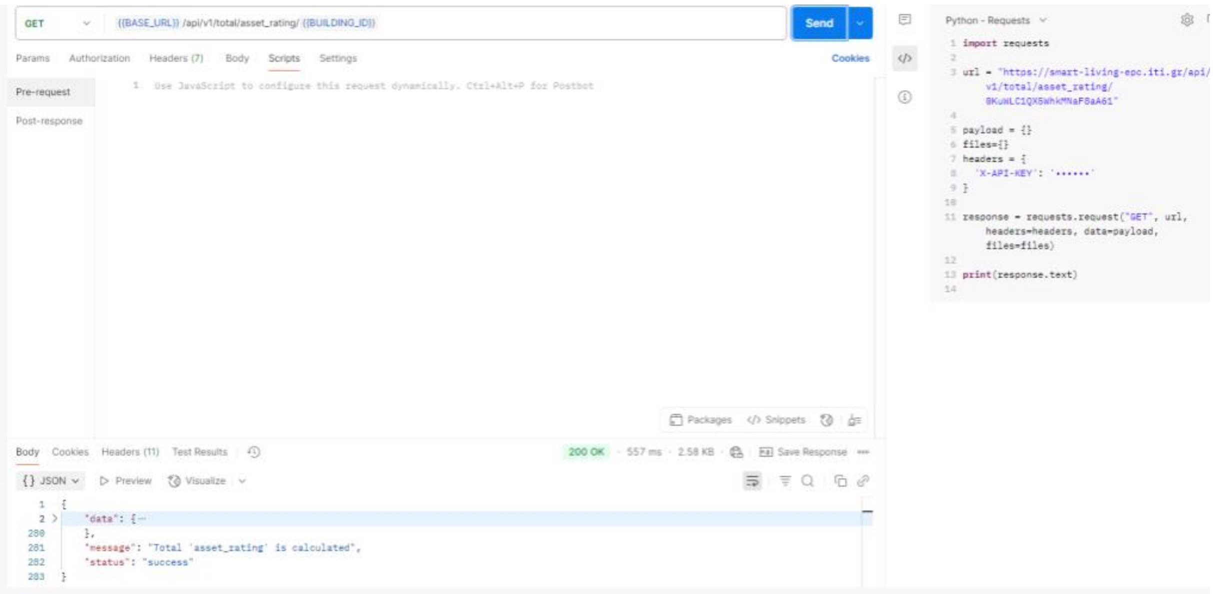


Figure 50. Retrieval of Total Asset Rating Calculation

- **Result**: PASS
- **Incidence/Impact**: Not applicable (data flow is functional)
- **Evidence**: Internal platform logs and successful API response sequences confirmed via Postman
- **Proposed improvements**: Consider implementing detailed API logging with visual indicators to assist assessors in diagnosing configuration errors faster during onboarding

6.2.3.12 UC4.1 Operational Energy Analysis

- **Result:**
  Pass
- **Incidence/Impact** (in case of fail):
  The assessor is able to verify the integrity and completeness of retrieved data through the platform's validation dashboard.
- **Evidence** (numerical or screenshot):

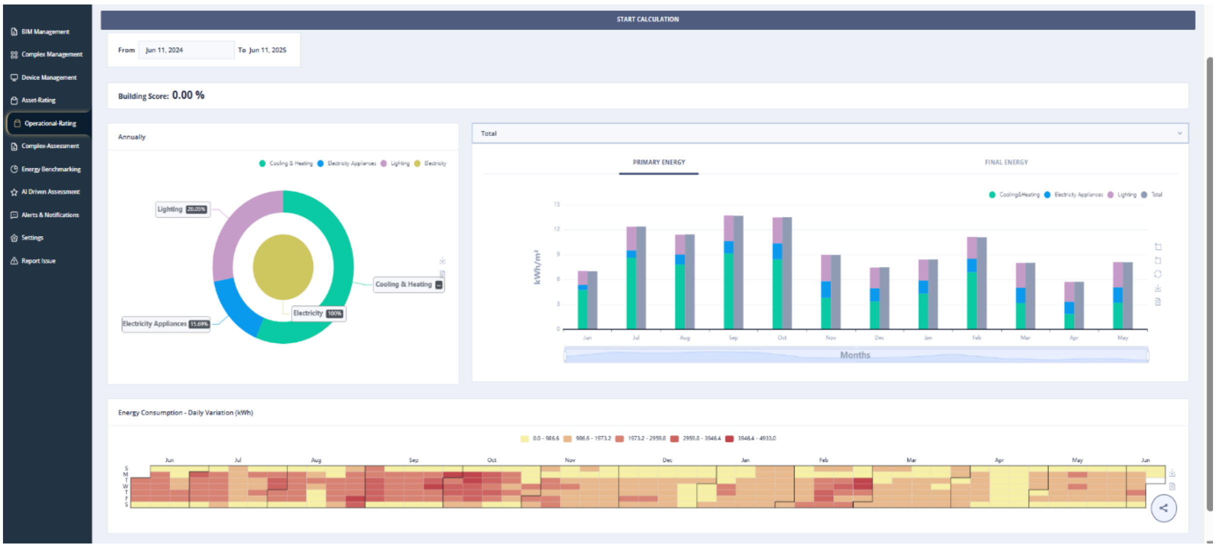


Figure 51. SmartLivingEPC operational energy dashboard for Demo Site 2: Frederick's University Main Building

- **Lessons learned:**
  Early deployment of IoT sensors across key building zones contributes significantly to the reliability of CIEM-integrated monitoring.
- **Numerical result evidence:**
  Although historical energy records are present in some cases, differences in measurement scope, resolution, or contextual data prevent a numerical comparison at this stage.
  Alignment of reference conditions might be required for validation.

6.2.3.13 UC4.2 IEQ performance calculation

- **Result**: PASS, however the error occurs
- **Incidence/Impact**: (in case of fail) An error could occur while inserting wrong spaces
- **Evidence (numerical or screenshot)**: In case of fail, a red error message will be shown during space insertion.
- **Proposed improvements:** Occupancy hours could be visualized and validated through sensor data.

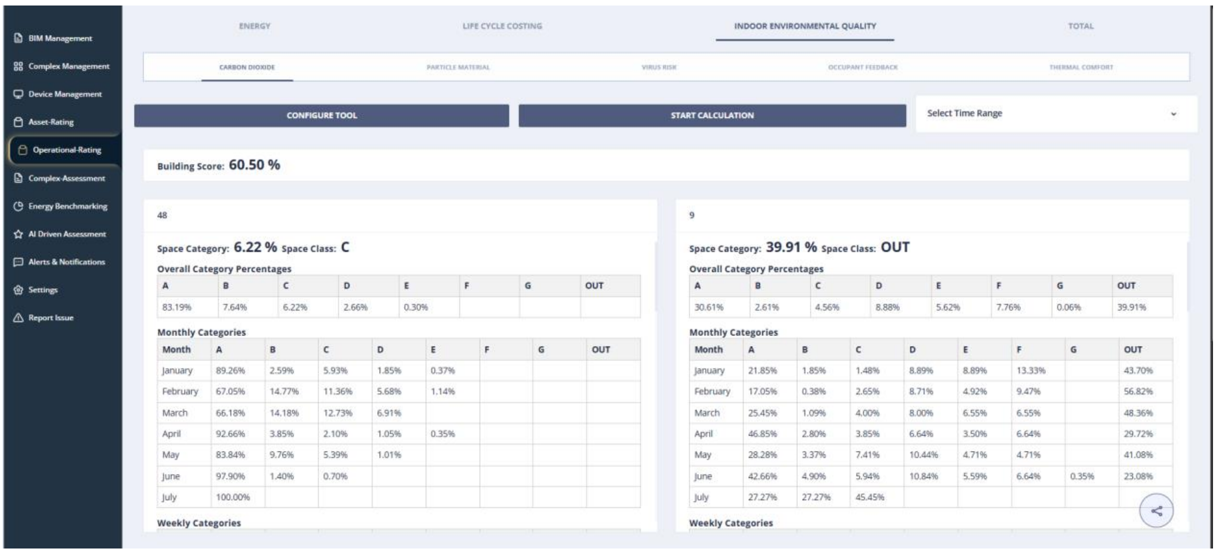


Figure 52. The SmartLivingEPC platform displays IEQ performance calculation for DS2

6.2.3.14 UC4.3 LCC assessment

Figure 53. Graphs of LCC assessment results on the platform

- **Result:** Pass
- **Incidence/Impact:** No error occurred.
- **Evidence** (numerical or screenshot): Link to visual interface provided (marked "Link")

6.2.3.15 UC4.4 Operational Rating issuance for Building Units

- **Result:**
  Pass
- **Incidence/Impact** (in case of fail):
  The data retrieval phase was completed without observable irregularities. Sensor feeds were active and accessible through the CIEM interface.
- **Evidence** (numerical or screenshot):

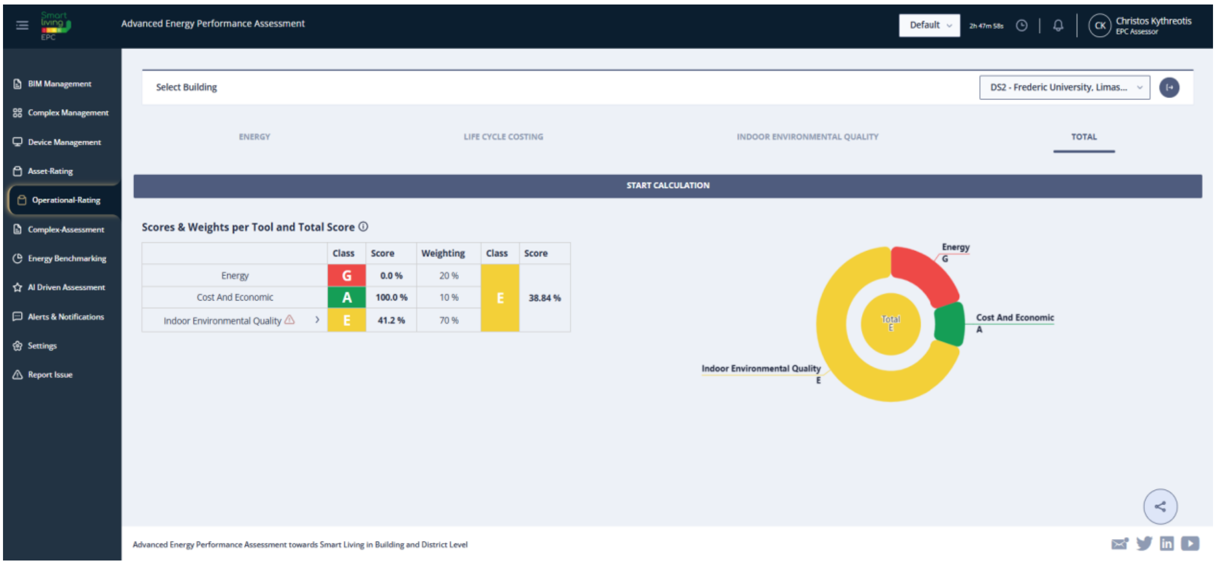


Figure 54. SmartLivingEPC operational rating issuance dashboard for Demo Site 2: Frederick's University Main Building.

- **Lessons learned:**
  It was not applicable in this instance due to timing constraints and the need to prioritize structural and procedural verification according to the validation criteria.
- **Proposed improvements:**
  Using a visual confirmation interface for upstream status could improve assessor confidence in proceeding with final issuance.

6.2.3.16 UC4.6 Operational Rating as a service

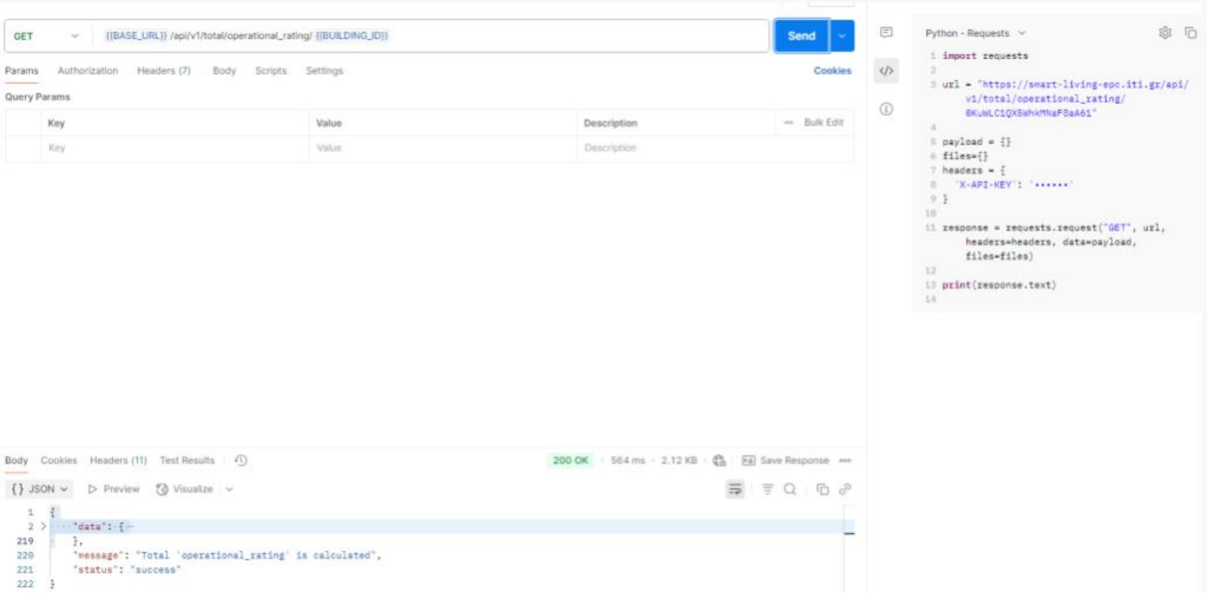


Figure 55. DemoSite 2: Frederick's University Main Building server response

- **Result:** Pass
- **Incidence/Impact:** No errors occurred. The API request returned valid operational assessment data when executed with authorized user credentials.
- **Lessons Learned:** The test confirmed that proper user authentication and role-based access control are functioning as intended.
- **Proposed Improvements:** None required at this stage, as the API is stable and responses were valid.

6.2.3.17 UC5.2 Building Dynamic Model Extraction

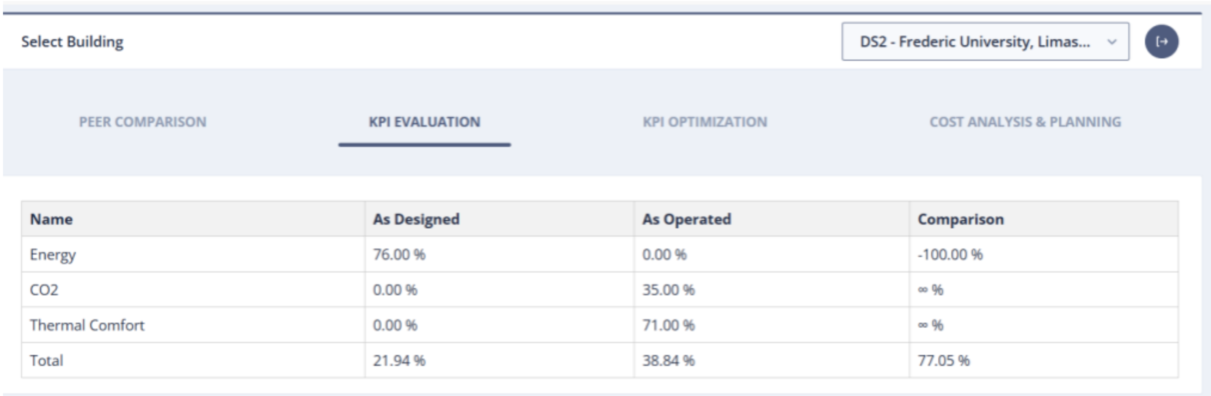
Figure 56. Energy Forecasting Timeline for DS2 – Frederick University Main Building

- **Result:** PASS (Only energy forecasting)
- **Incidence/Impact (in case of fail):** Occupancy-related services not applicable, as the building has no configured occupancy data.
- **Evidence (numerical or screenshot):** Results of the energy forecasting timeline are presented via screenshot (actual vs forecasted energy usage).
- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.2.3.18 UC5.3 Provide the AI-driven operational analysis for improving the building's energy performance

- **Result:** PASS for all modules (COMFORT, ACTIVITY, DISAGGREGATION, ANOMALIES DETECTION, COST ESTIMATION ENGINE).
- **Incidence/Impact (in case of fail):** Manual data uploads are currently required, which can introduce delays and inconsistencies in analysis. This limits the platform's real-time capabilities and affects the practical feasibility of the engines in live settings.
- **Evidence (numerical or screenshot):** All AI engine outputs are visualized in the DS2 interface. Results from modules such as comfort detection, activity patterns, energy disaggregation, anomaly detection, and cost estimation were successfully rendered and tested within the Web Platform.
- **Lessons learned:** Accurate analysis output depends heavily on sensor data quality and availability. Gaps, noise, or manual uploads may lead to deviations in disaggregation and comfort assessments. Manual validation is still necessary in some areas, especially for cost estimation and comfort modules.
- **Proposed improvements:** Integrate real-time data sourcing to eliminate the need for manual uploads. Incorporate user feedback to validate AI outputs and improve reliability. Implement robust data preprocessing (e.g., imputation for missing or incomplete entries) and support real-time forecasting and anomaly detection even with data irregularities.

6.2.3.19 UC6.1 Provide information on as-designed/as-operated deviations



Name	As Designed	As Operated	Comparison
Energy	76.00 %	0.00 %	-100.00 %
CO2	0.00 %	35.00 %	∞ %
Thermal Comfort	0.00 %	71.00 %	∞ %
Total	21.94 %	38.84 %	77.05 %

Figure 57. KPI evaluation in DS2

- **Result:**
  PASS — KPI evaluation results were successfully displayed on the platform.
- **Incidence/Impact** (in case of fail):
  N/A — All KPI values were rendered without interruption.
- **Evidence** (numerical or screenshot):

  Energy (As Designed): 76.00%, (As Operated): 0.00%, Comparison: -100.00%

  CO_2 (As Designed): 0.00%, (As Operated): 35.00%, Comparison: ∞%

Thermal Comfort (As Designed): 0.00%, (As Operated): 71.00%, Comparison: ∞%

Total KPI Score: (As Designed): 21.94%, (As Operated): 38.84%, Comparison: 77.05%

6.2.3.20 UC6.2 Benchmark the asset's performance

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

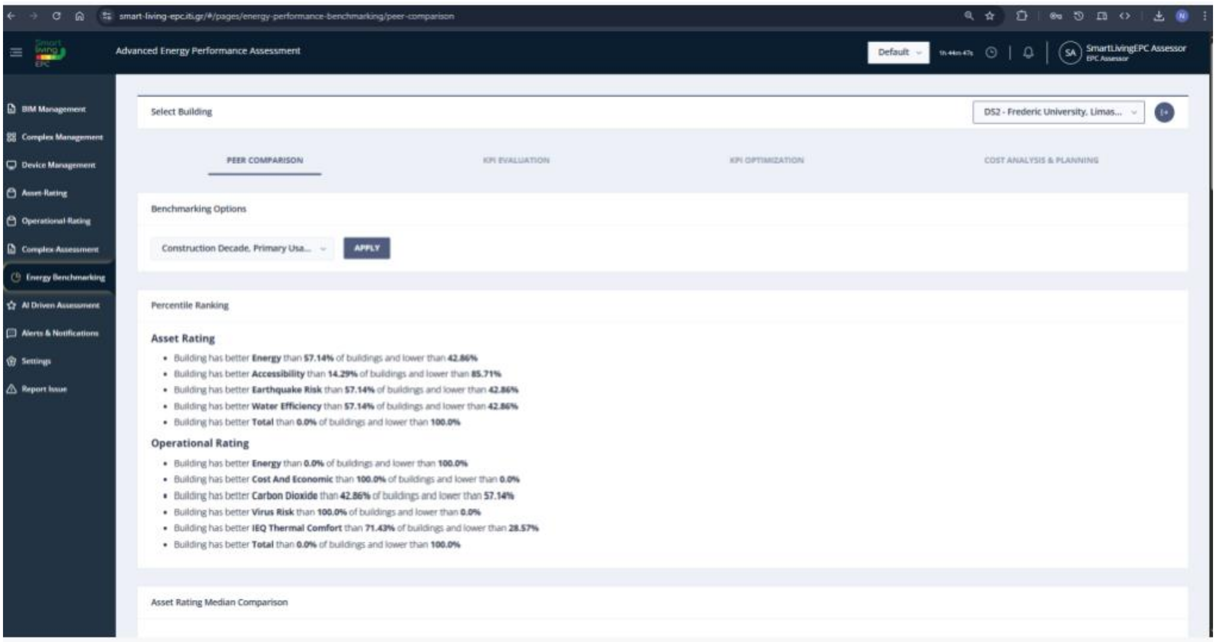


Figure 58. Benchmarking of Demo Site 2: Frederick University, Limassol

6.2.3.21 UC6.3 Provide recommendations for energy efficiency practices

- **Result:** Pass
- **Incidence/Impact (**in case of fail): N/A
- **Evidence** (numerical or screenshot):

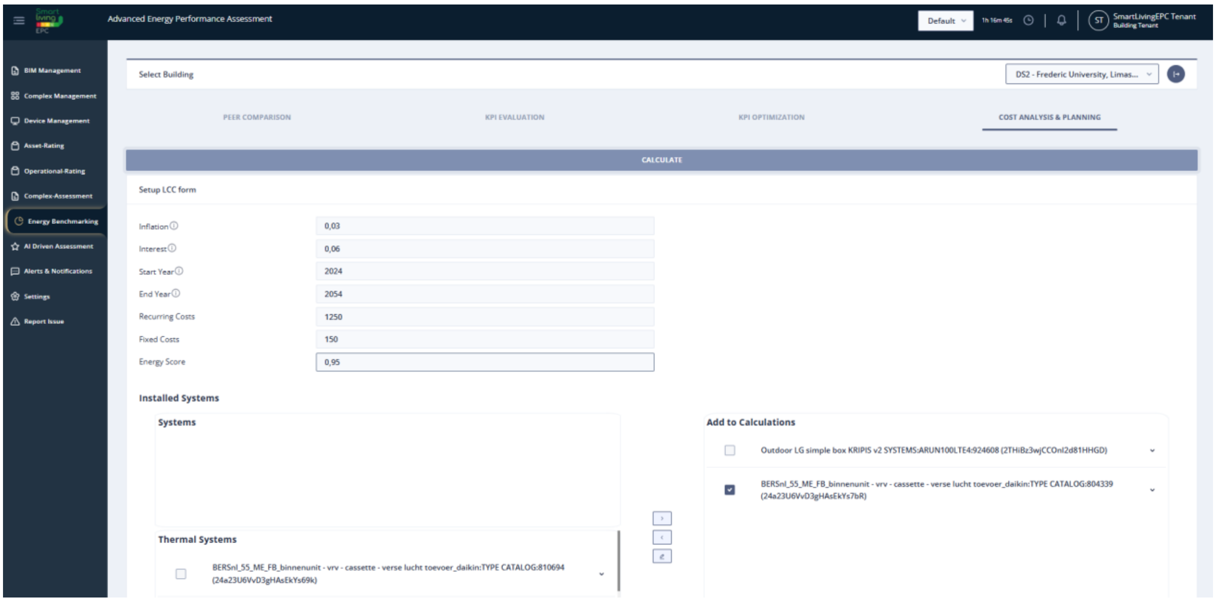


Figure 59. Replacement system input in DS2

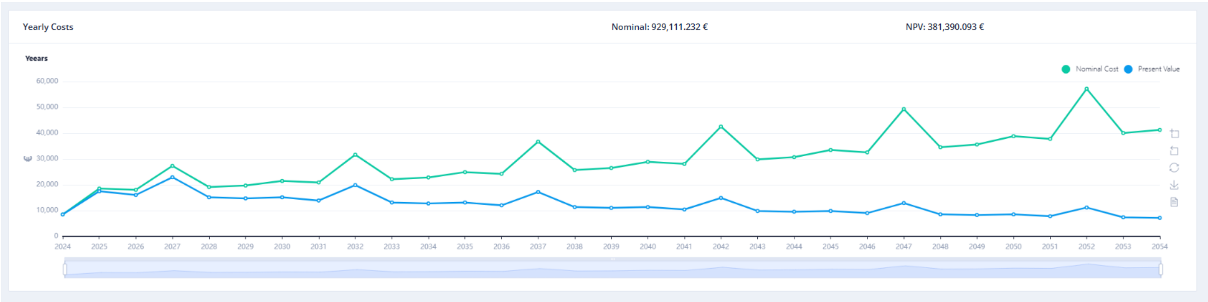


Figure 60. Cost analysis for a replacement system in DS2

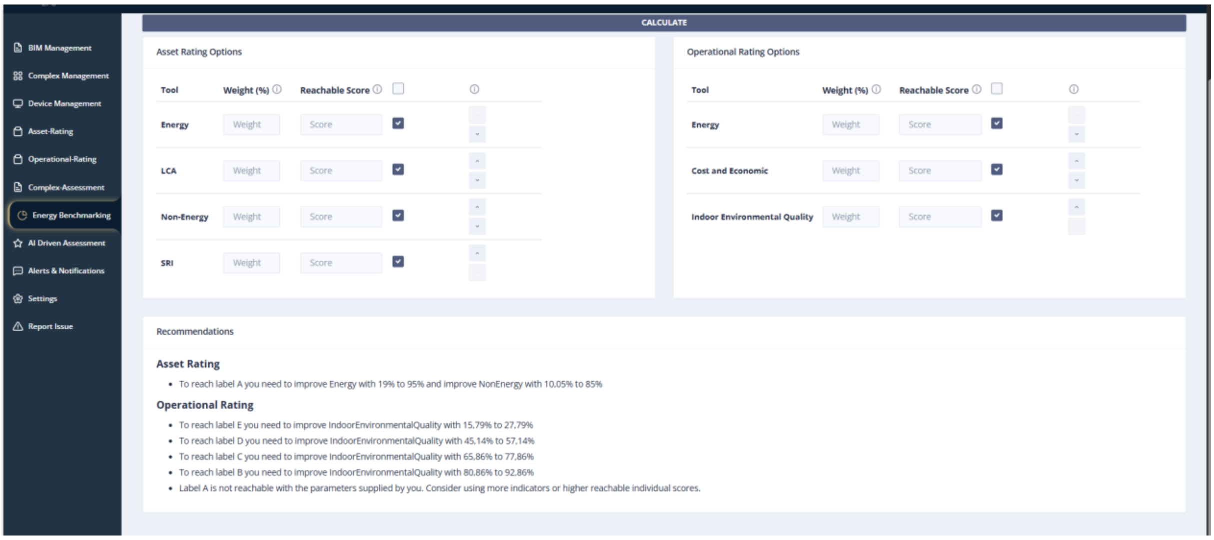


Figure 61: Recommendations for energy efficiency improvements

- **Lessons learned: N/A**

- **Proposed improvements:**
  To include estimations of EPC improvements for replacement systems.

6.2.3.22 UC7.1 Provide Building Records through Digital Logbooks

- **Result:**
  PASS — The assessment outputs and actions were visualized in the expected chronological sequence for the end user.
- **Incidence:** N/A
- **Evidence:**
  See reference to **UC1.1 validation**. Screenshots and logs validate the execution timeline and result visualization.
- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.3 Demo Site 3 - Ehituse Mäemaja, Tallin University of Technology, Tallin, Estonia

6.3.1 Baseline activities

1.3.1.1 BIM file definition

The pilot building at TalTech is a recently completed near-zero energy office and laboratory building, with its construction finalized in 2021. As part of the original design and construction process, a comprehensive set of BIM models was created and made readily available, facilitating data access and integration for the SmartLivingEPC project.

Specifically, the following discipline-specific sub-models were available in Revit format:

- Architectural/structural
- Electrical systems
- Technical systems (heating, ventilation, and cooling)
- Interior architecture
- Water and sewage

To meet the specific requirements of the SmartLivingEPC project, a simplified and reduced version of the original BIM model was iteratively developed in collaboration with project partners (notably CERTH and DEMO). These adjustments were necessary to ensure compatibility with the web-based SmartLivingEPC platform, where the model was exported and uploaded in .IFC format.

Due to the lack of standardized national BIM implementation guidelines in Estonia, the available data was not fully harmonized with common European BIM conventions. Consequently, some information relevant to the project was missing or presented in non-standard ways, while other parts of the model contained an abundance of detail not needed for the operational evaluation methodology. These factors necessitated cleaning, filtering, and restructuring the model to optimize usability for simulation, analysis, and visualization in the SmartLivingEPC project.

1.3.1.2 IoT installation

The IoT installation phase at the Estonian pilot site benefited from the fact that the building was recently constructed (completed in 2021) with extensive built-in monitoring capabilities and a modern building management system. Given TalTech's involvement in the design of the building, it was anticipated from the outset that the necessary energy, indoor climate, and occupancy data would be available through the existing infrastructure.

This building already functions as a research object, hosting numerous laboratories, instrumentation, and monitoring solutions across its different spaces. As such, no new physical sensors were installed for the SmartLivingEPC project. Instead, the focus was placed on identifying and extracting relevant data streams from the existing system.

Sensor categories already available in the building include:

- Room-level indoor temperature, humidity, and CO_2 sensors
- Air handling unit sensors (flow, temperature, pressure, valve position, fan speed)
- Energy meters for heating, cooling, electricity, and water
- Room occupancy detection (via CO_2 control or presence sensors)
- PV production and central system status values

Monitoring and visualization are handled via Schneider Electric's Building Operation Workstation, a centralized system that covers the entire campus. For the pilot site, a local subset of this system is used to access real-time values and historical trends for all relevant variables.

1.3.1.3 Communication with CIEM and data sharing

Although the internal infrastructure was well-equipped for monitoring, the primary challenge lay in securely extracting and forwarding the data to the CIEM platform used in the SmartLivingEPC project. Due to internal data governance and cybersecurity restrictions at the university level, direct external access to the building's BMS was not permitted. However, access to a localized subset of the system corresponding to the pilot site was negotiated and approved.To avoid delays from cross-department coordination, a custom data acquisition and transmission pipeline was implemented. This solution includes:

- A cloud server that queries internal APIs from the building's automation server to fetch selected SmartLivingEPC variables.
- A second API connection to a third-party provider hosting data from three PM2.5 sensors, which had been installed previously as part of another EU project. These IAQ sensors are not integrated into the main BMS and require a separate API key to access.
- Data from both sources is retrieved, parsed, and processed into the format required by the SmartLivingEPC platform.
- The data is pushed to CIEM every 15 minutes via RabbitMQ.
- Simultaneously, a redundant cloud storage receives the same data for backup and local access purposes.

This approach has allowed continuous data sharing for the project while ensuring compliance with university IT policies and maintaining data integrity and redundancy.

6.3.2 Results of architectural use cases implementation

6.3.2.1 UC1.1 Retrieve and validate building information from BIM

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot): Screenshot showing all files upload to the platform successfully. Screenshot showing the BIM logbook interface with the extracted information following the first upload

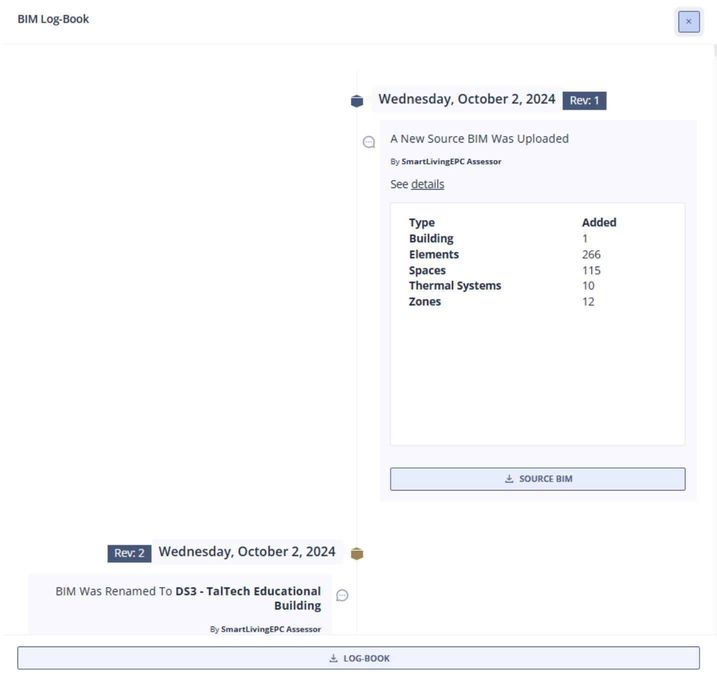


Figure 62. Screenshoot showing the BIM Logbook interface

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.3.2.2 UC1.2 Collect and extract data from additional building documentation sources

- **Result:** PASS
- **Incidence/Impact** (in case of fail):
  N/A – The visualization of the building asset information on the Web Platform was successful.
- **Evidence** (numerical or screenshot):
  Interactive display of model elements, systems, and spaces was visible via the SmartLivingEPC Web Platform interface after IFC upload and processing.
- **Lessons learned:**
  The presence of well-structured IFC metadata directly influenced the visibility and navigability of asset layers in the platform. Lack of classification in some components reduced semantic search efficiency.
- **Proposed improvements:**
  Encourage enhanced IFC authoring practices in upstream BIM environments, including enriched property sets and asset categorization aligned with EU standards.

6.3.2.3 UC2.1 Inspection and installation of IoT equipment on the building

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot): The installed IoT devices that appear in CIEM static configuration (Figure 64), and the data streams are accurate (Figure 63).

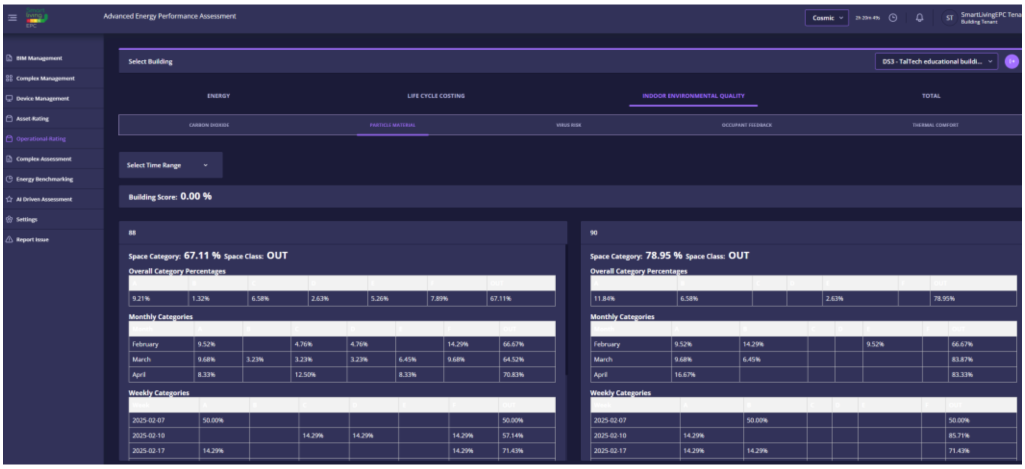


Figure 63. The PM2.5 rating is calculated in the platform

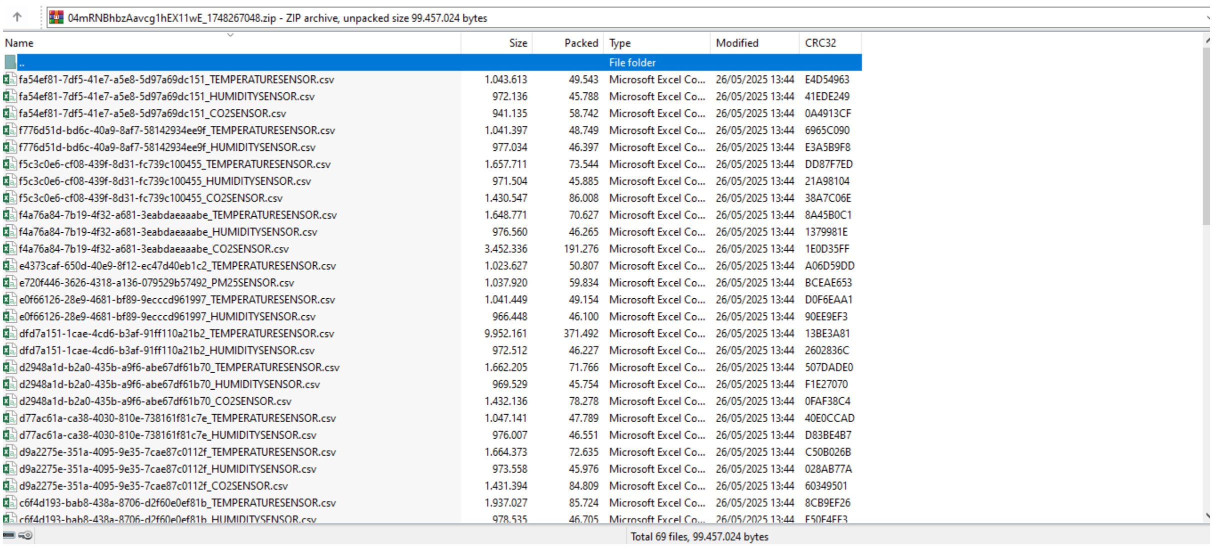
-

Figure 64. The devices existing in the platform for DS3

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.3.2.4 UC2.2 IoT integration to the SmartLivingEPC platform

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot): Screenshot showing device configuration in the Web Platform (Figure 64). Screenshot showing data downloaded from the platform (thus already collected and available to the SmartLivingEPC tools) (Figure 65)



04mRNBhbzAavcg1hEX11wE_1748267048.zip - ZIP archive, unpacked size 99.457.024 bytes

Name	Size	Packed	Type	Modified	CRC32
..			File folder		
fa54ef81-7df5-41e7-a5e8-5d97a69dc151_TEMPERATURESENSOR.csv	1.043.613	49.543	Microsoft Excel Co...	26/05/2025 13:44	E4D54963
fa54ef81-7df5-41e7-a5e8-5d97a69dc151_HUMIDITYSENSOR.csv	972.136	45.788	Microsoft Excel Co...	26/05/2025 13:44	41EDE249
fa54ef81-7df5-41e7-a5e8-5d97a69dc151_CO2SENSOR.csv	941.135	58.742	Microsoft Excel Co...	26/05/2025 13:44	0A4913CF
f776d51d-bd6c-40a9-8af7-58142934ee9f_TEMPERATURESENSOR.csv	1.041.397	48.749	Microsoft Excel Co...	26/05/2025 13:44	6965C090
f776d51d-bd6c-40a9-8af7-58142934ee9f_HUMIDITYSENSOR.csv	977.034	46.397	Microsoft Excel Co...	26/05/2025 13:44	E3A5B9F8
f5c3c0e6-cf08-439f-8d31-fc739c100455_TEMPERATURESENSOR.csv	1.657.711	73.544	Microsoft Excel Co...	26/05/2025 13:44	DD87F7ED
f5c3c0e6-cf08-439f-8d31-fc739c100455_HUMIDITYSENSOR.csv	971.504	45.885	Microsoft Excel Co...	26/05/2025 13:44	21A98104
f5c3c0e6-cf08-439f-8d31-fc739c100455_CO2SENSOR.csv	1.430.547	86.008	Microsoft Excel Co...	26/05/2025 13:44	38A7C06E
f4a76a84-7b19-4f32-a681-3eabdaeaaabe_TEMPERATURESENSOR.csv	1.648.771	70.627	Microsoft Excel Co...	26/05/2025 13:44	8A45B0C1
f4a76a84-7b19-4f32-a681-3eabdaeaaabe_HUMIDITYSENSOR.csv	976.560	46.265	Microsoft Excel Co...	26/05/2025 13:44	1379981E
f4a76a84-7b19-4f32-a681-3eabdaeaaabe_CO2SENSOR.csv	3.452.336	191.276	Microsoft Excel Co...	26/05/2025 13:44	1E0D35FF
e4373caf-650d-40e9-8f12-ec47d40eb1c2_TEMPERATURESENSOR.csv	1.023.627	50.807	Microsoft Excel Co...	26/05/2025 13:44	A06D59DD
e720f446-3626-4318-a136-079529b57492_PM25SENSOR.csv	1.037.920	59.834	Microsoft Excel Co...	26/05/2025 13:44	BCEAE653
e0f66126-28e9-4681-bf89-9ecccd961997_TEMPERATURESENSOR.csv	1.041.449	49.154	Microsoft Excel Co...	26/05/2025 13:44	D0F6EAA1
e0f66126-28e9-4681-bf89-9ecccd961997_HUMIDITYSENSOR.csv	966.448	46.100	Microsoft Excel Co...	26/05/2025 13:44	90EE9EF3
dfd7a151-1cae-4cd6-b3af-91ff110a21b2_TEMPERATURESENSOR.csv	9.952.161	371.492	Microsoft Excel Co...	26/05/2025 13:44	13BE3A81
dfd7a151-1cae-4cd6-b3af-91ff110a21b2_HUMIDITYSENSOR.csv	972.512	46.227	Microsoft Excel Co...	26/05/2025 13:44	2602836C
d2948a1d-b2a0-435b-a9f6-abe67df61b70_TEMPERATURESENSOR.csv	1.662.205	71.766	Microsoft Excel Co...	26/05/2025 13:44	507DADE0
d2948a1d-b2a0-435b-a9f6-abe67df61b70_HUMIDITYSENSOR.csv	969.529	45.754	Microsoft Excel Co...	26/05/2025 13:44	F1E27070
d2948a1d-b2a0-435b-a9f6-abe67df61b70_CO2SENSOR.csv	1.432.136	78.278	Microsoft Excel Co...	26/05/2025 13:44	0FAF38C4
d77ac61a-ca38-4030-810e-738161f81c7e_TEMPERATURESENSOR.csv	1.047.141	47.789	Microsoft Excel Co...	26/05/2025 13:44	40E0CCAD
d77ac61a-ca38-4030-810e-738161f81c7e_HUMIDITYSENSOR.csv	976.007	46.551	Microsoft Excel Co...	26/05/2025 13:44	D83BE4B7
d9a2275e-351a-4095-9e35-7cae87c0112f_TEMPERATURESENSOR.csv	1.664.373	72.635	Microsoft Excel Co...	26/05/2025 13:44	C50B026B
d9a2275e-351a-4095-9e35-7cae87c0112f_HUMIDITYSENSOR.csv	973.558	45.976	Microsoft Excel Co...	26/05/2025 13:44	028AB77A
d9a2275e-351a-4095-9e35-7cae87c0112f_CO2SENSOR.csv	1.431.394	84.809	Microsoft Excel Co...	26/05/2025 13:44	60349501
c6f4d193-bab8-438a-8706-d2f60e0ef81b_TEMPERATURESENSOR.csv	1.937.027	85.724	Microsoft Excel Co...	26/05/2025 13:44	8CB9EF26
c6f4d193-bab8-438a-8706-d2f60e0ef81b_HUMIDITYSENSOR.csv	978.535	46.705	Microsoft Excel Co...	26/05/2025 13:44	F50F4FF3

Total 69 files, 99.457.024 bytes

Figure 65. Downloaded data from DS3

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.3.2.5 UC2.3 Near-real time automated data retrieval from IoT equipment

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A

- **Evidence** (numerical or screenshot): As there is no CIEM user interface, in Figure 66 there is relevant screenshot from Postman.

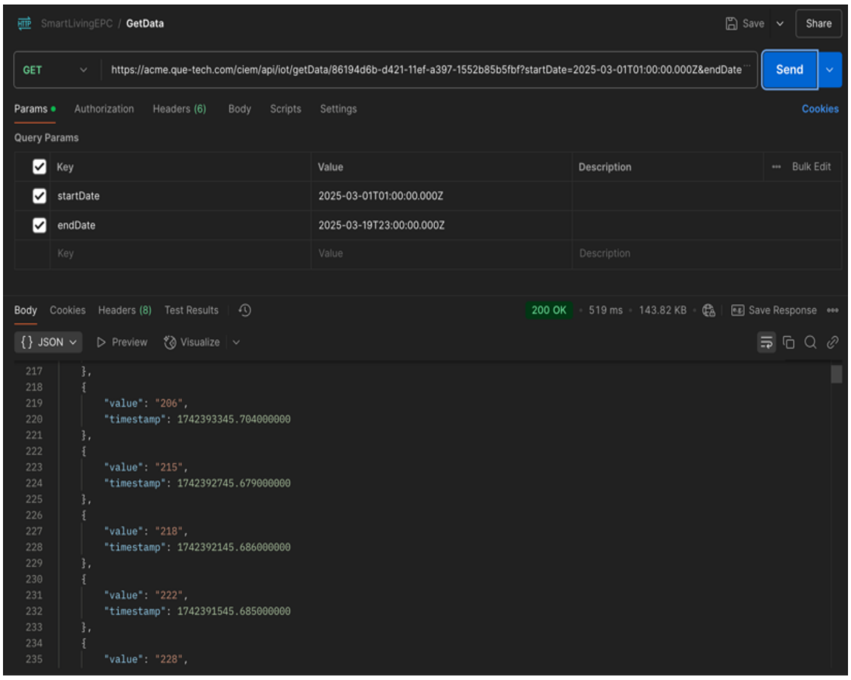


Figure 66. Screenshot of the stored data in CIEM (DS3)

- **Lessons learned:** Due to the different data models that the pilot provided, we learnt how to be flexible and deal with various cases.
- **Proposed improvements:** Optimisation in case of big data storage

6.3.2.6 UC2.4 On-demand data retrieval

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

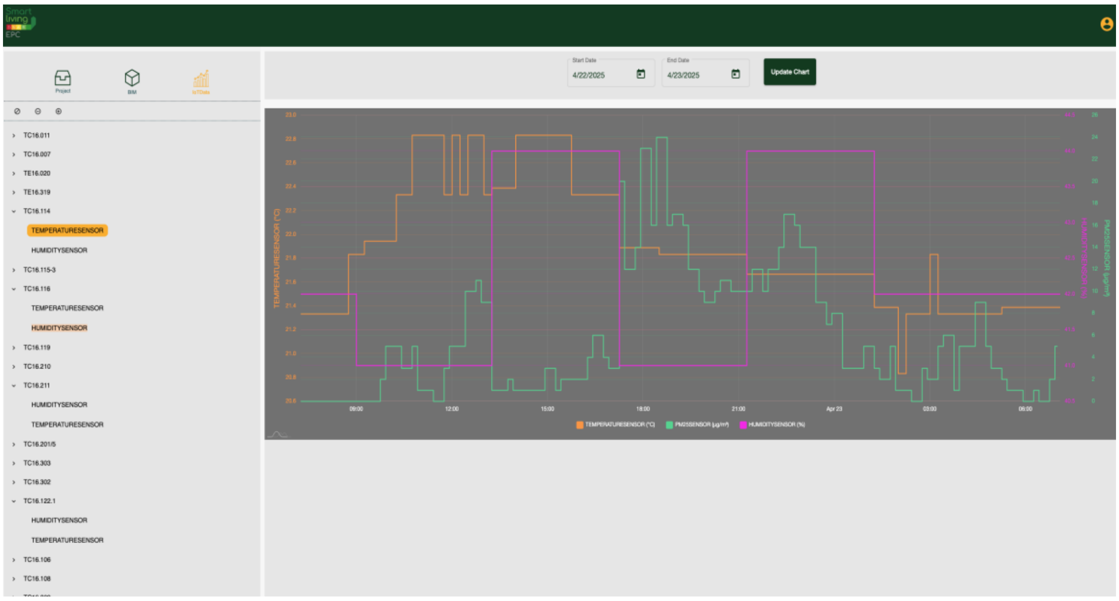


Figure 67. The data retrieved for configured DS3 IoT equipment.

- **Lessons learned:** N/A
- **Proposed improvements**: N/A

6.3.2.7 UC3.1 Energy and Non-energy resources analysis

- **Result:** Pass
  The integration of assessments into the platform has been validated.
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

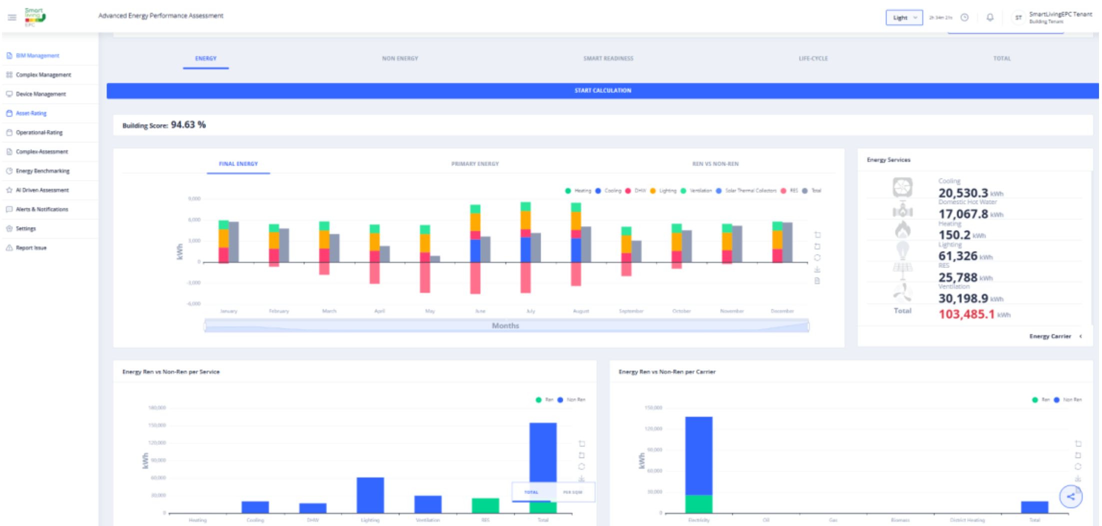


Figure 68. Energy Analysis in Asset rating assessment for DS3

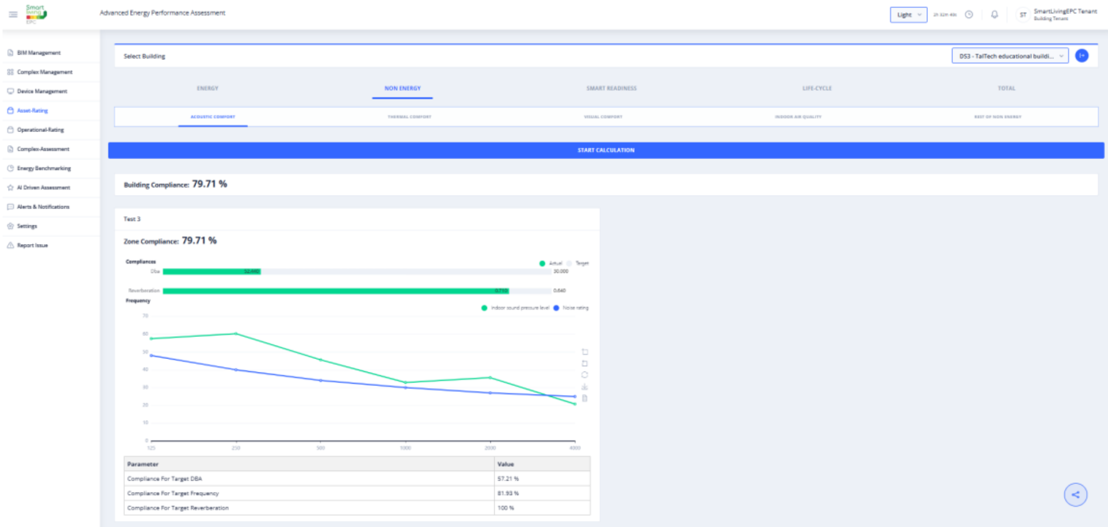


Figure 69. Non- Energy analysis. Acousting Comfort Assessment for DS3

Figure 70. Non- Energy analysis. IAQ Assessment for DS3

- **Lessons learned:**N/A
- **Proposed improvements:** Same as in DS1

6.3.2.8 UC3.2 SRI Calculation

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

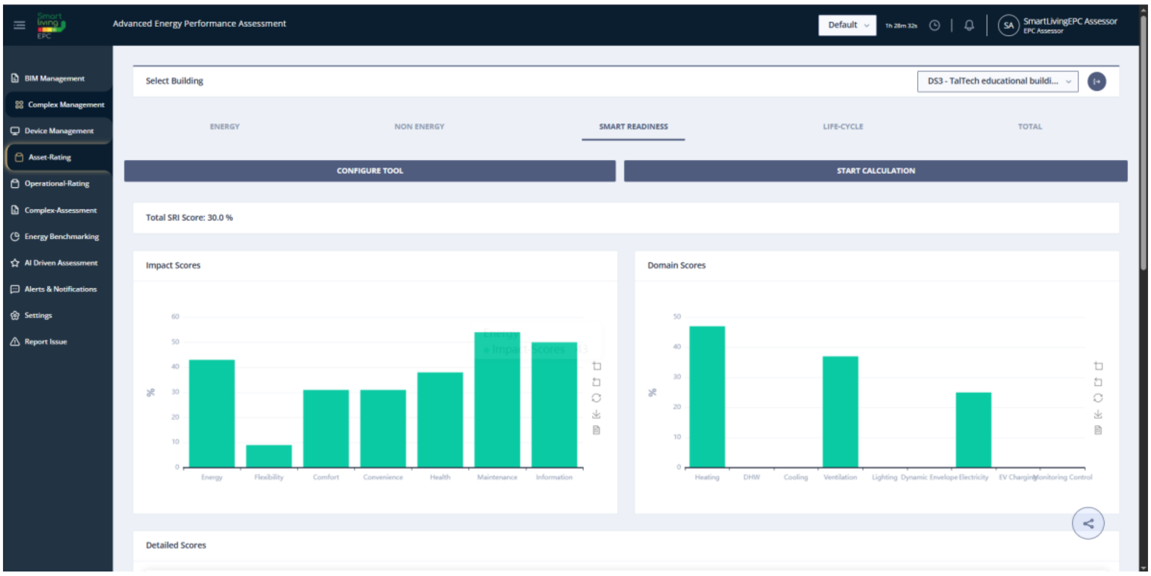


Figure 71. SRI assessment results in DS3

- **Lessons learned:** Same as in DS1
- **Proposed improvements:** Same as in DS1

6.3.2.9 UC3.3 Environmental life-cycle assessment

- **Result:**

  PASS: Data input is complete and validated by the assessor
  PASS: LCA indicators results are calculated

- **Incidence/Impact** (in case of fail): Failure to execute the LCA calculation
- **Evidence** (numerical or screenshot)

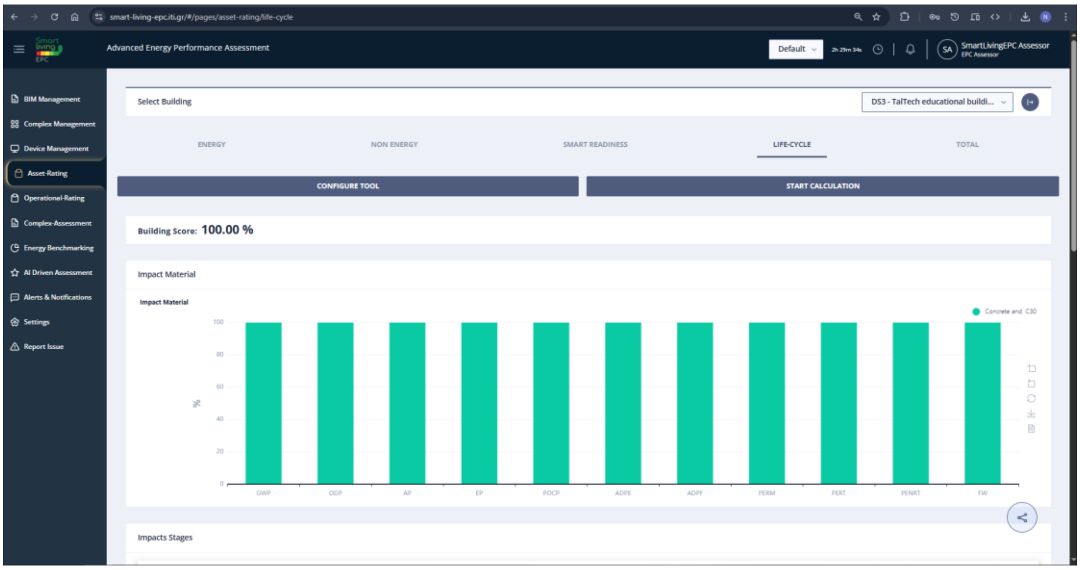


Figure 72. LCA for DS3

- **Lessons learned:** N/A

- **Proposed improvements:** N/A

6.3.2.10 UC3.4 Asset Rating issuance for Building Unit

- **Result:** Pass
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

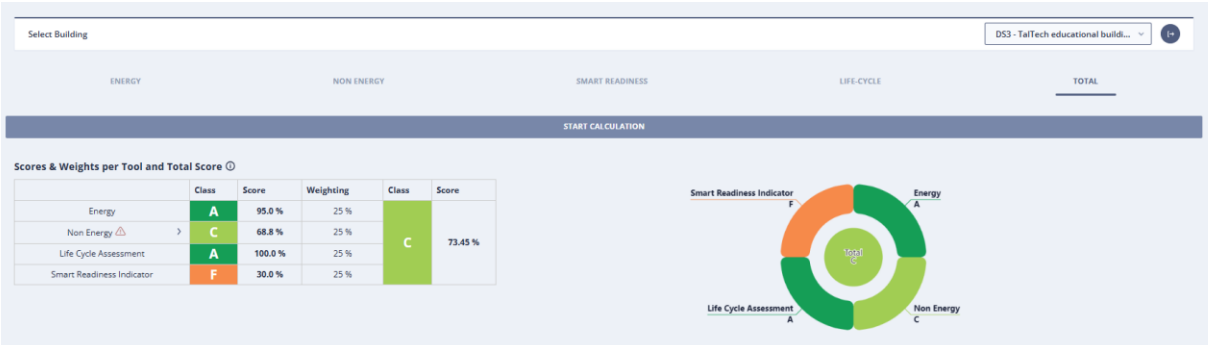


Figure 73. Asset rating issuance for DS3

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.3.2.11 UC3.5 Asset Rating issuance for Building Complexes (Not applicable for DS3)

6.3.2.12 UC3.6 Asset rating as service

- **Result:** PASS - Request performed with EPC assessor credentials returns data normally
- **Incidence/Impact** (in case of fail):
- **Evidence** (numerical or screenshot): N/A
- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.3.2.13 UC4.1 Operational Energy Analysis

- **Result:** PASS - The Operational Rating Engine successfully processed the retrieved data and generated the corresponding energy performance metrics.
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

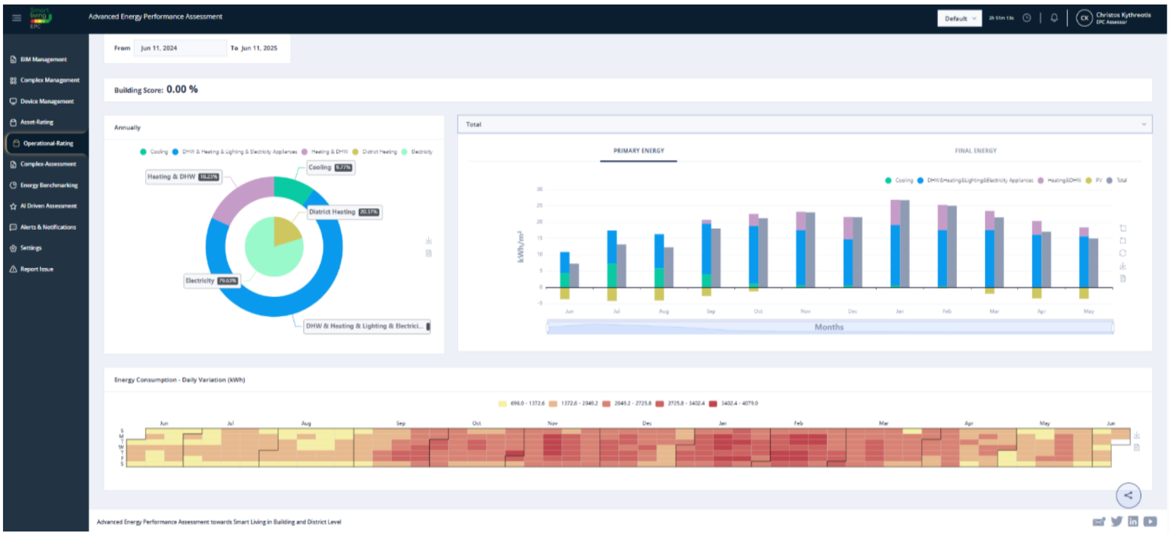


Figure 74. Operational Energy Assessment for DS3

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.3.2.14 UC4.2 IEQ performance calculation

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

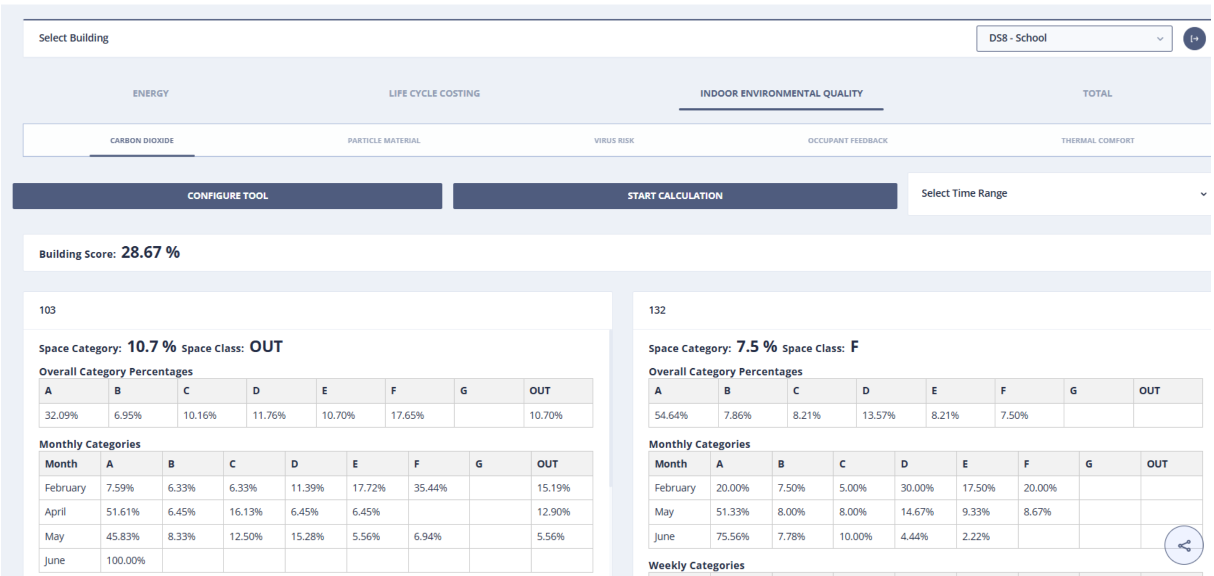


Figure 75. IEQ assessment for DS3

- **Lessons learned:** The transparency of the platform inputs (e.g. explanations or if hard coded input, then visible) and maybe even some calculations could be relevant as the assessor final will be responsible of the result. In this case we handled well, but it will be more fluent to test the platform functioning, if the calculation method is written as for platform development and testing - exact definition of inputs and algorithm logic in the same document - the method developer and platform developer will generate the manual for testing in collaboration.

- **Proposed improvements:**

Occupancy hours could be also visualized while calculated from sensor data, because then the assessor can validate the sensor data and if needed, overwrite the sensor data with validated occupancy time.
There could be an example or description of the input value, so the assessor or pilot manager can understand what is asked.
if the calculation was not done (e.g. for the virus risk for Space type Other), then it should be communicated in platform
Each room space category will indicate the percentages in space class. In my point of view, more reasonable would be to show, what is the percentage in this specific class or in better categories (e.g. if class is C, then in A to C there is 95%). Or vice versa - what is the percentage in this specific class or above (e.g. if class is C, then in D to OUT there is 5% of time).

6.3.2.15 UC4.3 LCC assessment

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence (numerical or screenshot):**

Figure 76. LCC assessment for DS3

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.3.2.16 UC4.4 Operational Rating issuance for Building Units

- **Result:** The Operational Rating tool itself works well. The red flag indicates that one component in IEQ assessment is missing. However, as it is Occupancy Feedback that is not inserted, the problem is not related to platform, but rather the missing input from assessor. The result will be pass, if the assessor will insert the occupancy feedback results.
- **Incidence/Impact** (in case of fail):
- **Evidence** (numerical or screenshot)

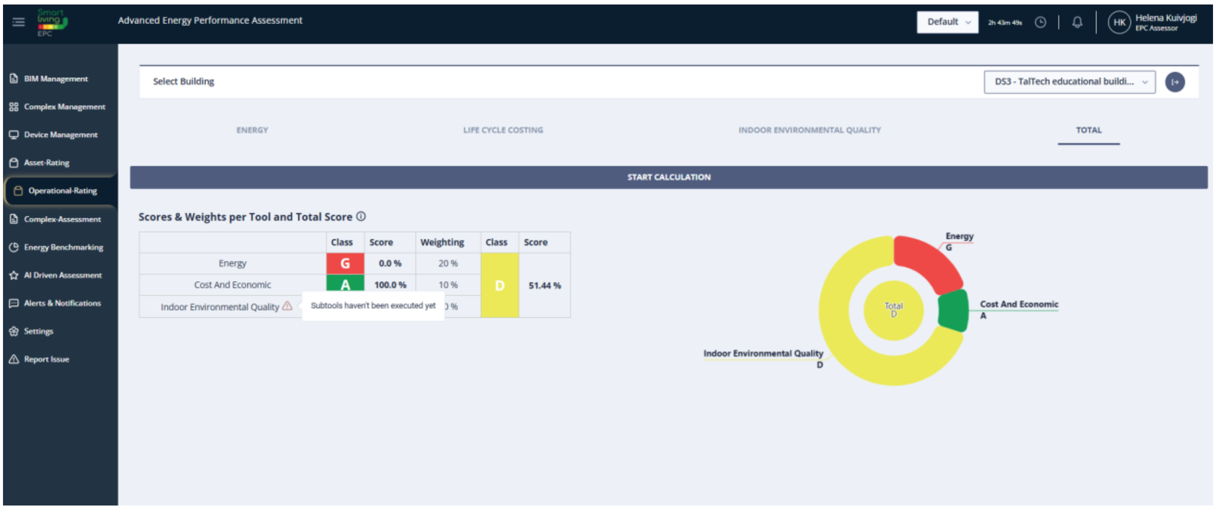


Figure 77. Total operational rating for DS3

- **Lessons learned:** N/A
- **Proposed improvements:** There could be a potential to integrate automated flags when any prior analysis result is missing or has expired validation.

6.3.2.17 UC4.5 Operational Rating issuance for Building Complexes (Not applicable for DS3)

6.3.2.18 UC4.6 Operational Rating as a service

- **Result:** PASS - Request performed with EPC assessor credentials returns data normally
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)
- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.3.2.19 UC5.2 Building Dynamic Model Extraction

- **Result:** PASS (Only energy forecasting)
- **Incidence/Impact** (in case of fail): Occupancy-related services not applicable, as the building has no occupancy sensors
- **Evidence** (numerical or screenshot) Results of the energy prediction service as screenshot

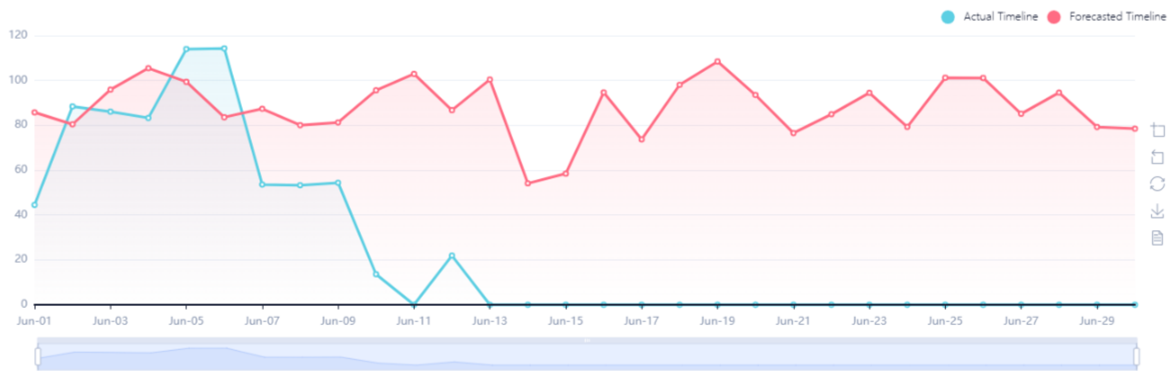


Figure 78. Energy consumption prediction for DS3

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.3.2.20 UC5.3 Provide the AI-driven operational analysis for improving the building's energy performance

- **Result:** PASS - The analysis results and recommendations are accurate, visualized properly in SLEPC Web Platform. The comfort, activity, disaggregation, anomalies detection, cost estimation engine passed.
- **Incidence/Impact** (in case of fail): Currently, users must manually upload data, which can lead to delays and inconsistencies in analysis. This limits real-time capabilities and reduces the practical scalability of the engine in live environments.
- **Evidence** (numerical or screenshot): All details available in D5.2
- **Lessons learned and Proposed improvements:**

Table 27. Lessons learned and proposed improvements in UC5.3 validation

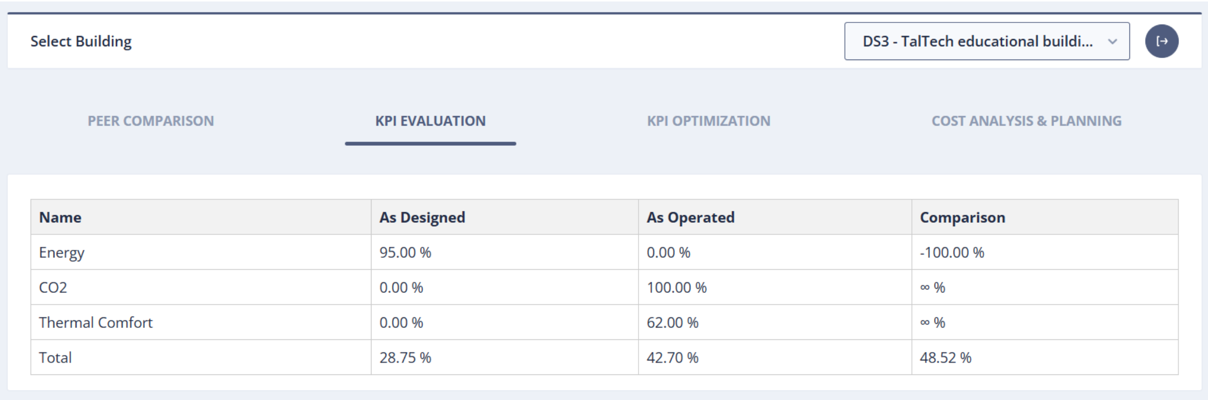
Component	Lessons learned	Proposed improvement
COMFORT Engine. Pass	Accurate thermal comfort prediction depends heavily on the availability and quality of sensor data.	User feedback would improve the validation of predictions and model relevance. Consistent feedback integration across all pilot studies would enhance model accuracy and applicability. Additionally, further tuning of the ML model will be essential to boost performance and reliability.
ACTIVITY. Pass	Interpreting behavioral patterns at scale requires standardizing data collection and ensuring consent mechanisms are well integrated.	Incorporate user feedback to validate activity predictions and improve model relevance. Enable direct connection to time series data sources to eliminate the need for manual uploads and support real-time forecasting
DISAGGREGATION. Pass	The output values generated by the disaggregation engine included large numerical results which needed to be clearly presented and contextualized to support better understanding and usability.	Incorporate user feedback to validate activity predictions and improve model relevance. Enable direct connection to time series data sources to eliminate the need for manual uploads and support real-time forecasting
ANOMALIES DETECTION. Pass	The accuracy of the anomaly detection depends heavily on high-quality input data and appropriate threshold settings to avoid false positives or missed events	1. Improve Missing Data Handling: Implement robust strategies for managing missing or incomplete time-series data, including advanced imputation techniques, to maintain detection accuracy even when data gaps occur. 2. Enhance Rule Management: Refine the system's ability to manage and apply complex user-defined rules, ensuring accurate execution and minimizing the risk of false positives or rule conflicts. 3. Ensure Scalability: Optimize the engine's performance to handle large-scale datasets efficiently, enabling real-time analysis and anomaly detection across high-volume sensor inputs.

COST ESTIMATION ENGINE. Pass	Unexpected zero outputs from the cost estimation engine highlight the need for thorough validation of input handling and internal calculation logic	Incorporate user feedback to validate activity predictions and improve model relevance. Enable direct connection to time series data sources to eliminate the need for manual uploads and support real-time forecasting

6.3.2.21 UC5.4 Generate Physics-based baseline building energy profiles for the building (Not applicable for DS3)

6.3.2.22 UC6.1 Provide information on as-designed/as-operated deviations

- **Result:** PASS - Visualization of comparison of asset and operational rating, in form of charts.
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot) (figure below)
  example: Energy as operated - Energy as designed = 0 - 95 = - 95. Comparison: -95 / 95 = - 100%
- **Lessons learned: -**
- **Proposed improvements:** to provide a notification that if an indicator (asset or operational) has not been calculated, to avoid fault comparison.



Name	As Designed	As Operated	Comparison
Energy	95.00 %	0.00 %	-100.00 %
CO2	0.00 %	100.00 %	∞ %
Thermal Comfort	0.00 %	62.00 %	∞ %
Total	28.75 %	42.70 %	48.52 %

Figure 79. KPI results (as Designed vs As Operated)

6.3.2.23 UC6.2 Benchmark the asset's performance

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot): Figure 80; Figure 81; Figure 82
- **Lessons learned:** N/A
- **Proposed improvements:** N/A

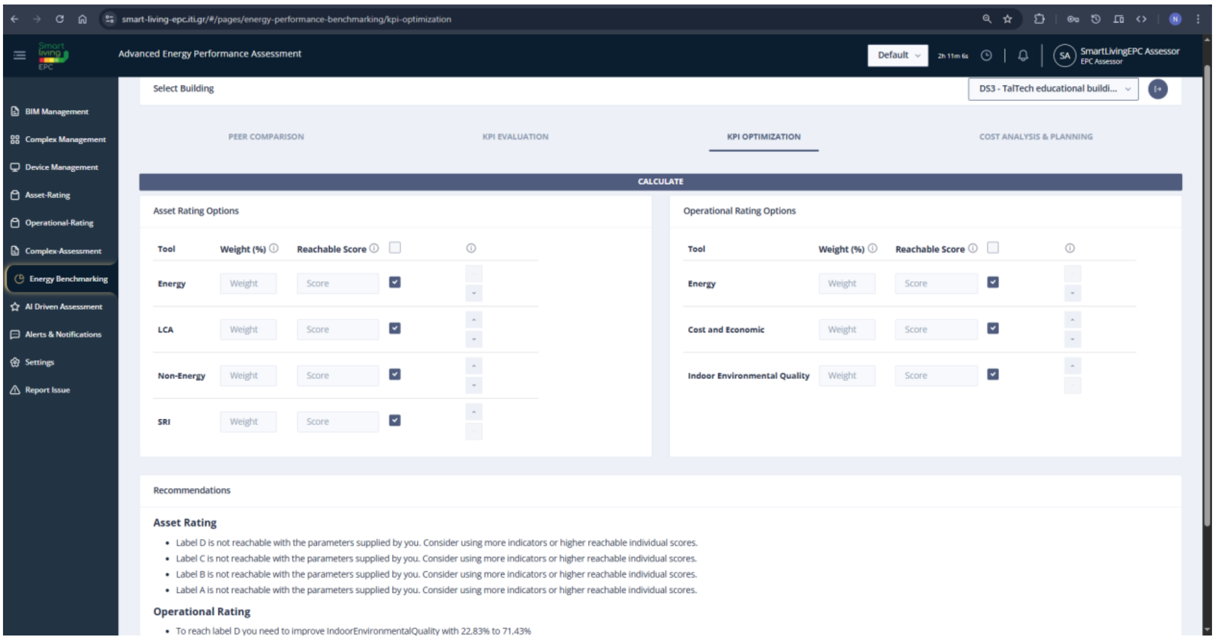


Figure 80. The KPI optimization of DS3 Energy Benchmarking

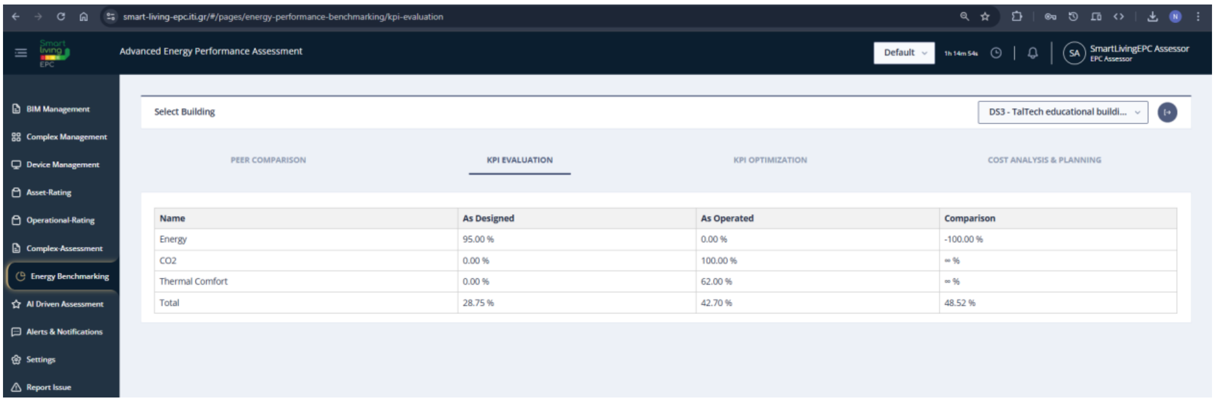


Figure 81. The KPI evaluation of DS3 Energy Benchmarking - as designed as operated comparison

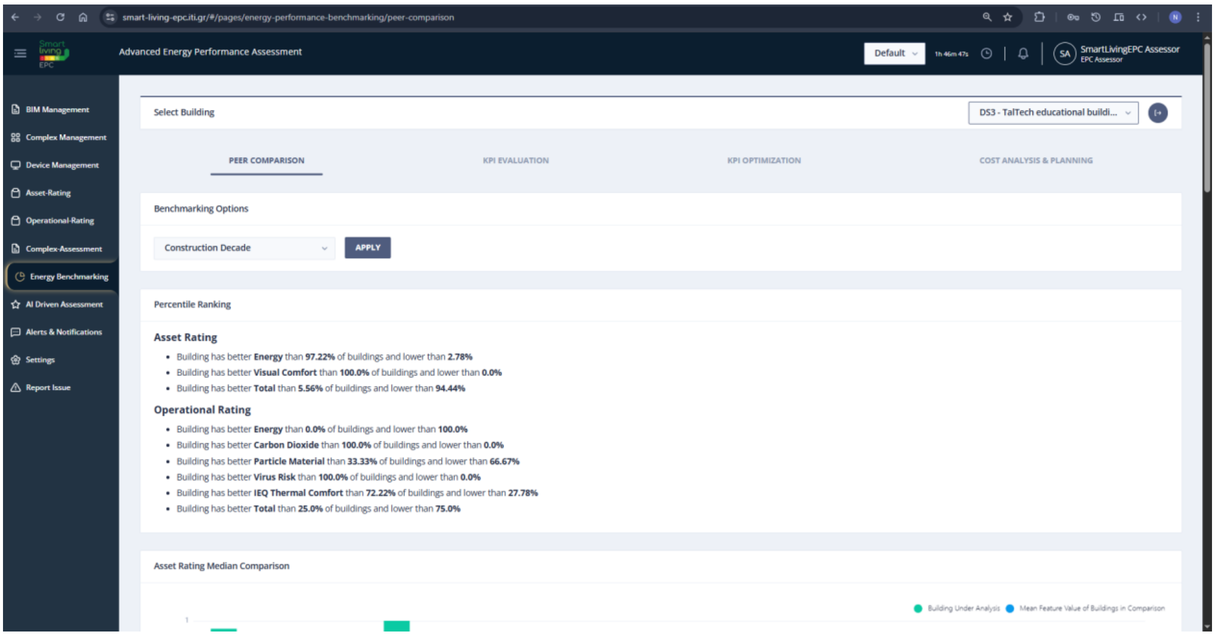


Figure 82. The Peer comparison of DS3 Energy Benchmarking

6.3.2.24 UC6.3 Provide recommendations for energy efficiency practices

- **Result:** Pass
- **Incidence/Impact (**in case of fail):
  The assessment provide the LCC information connected to the technical system upgrade
  Evidence (numerical or screenshot):

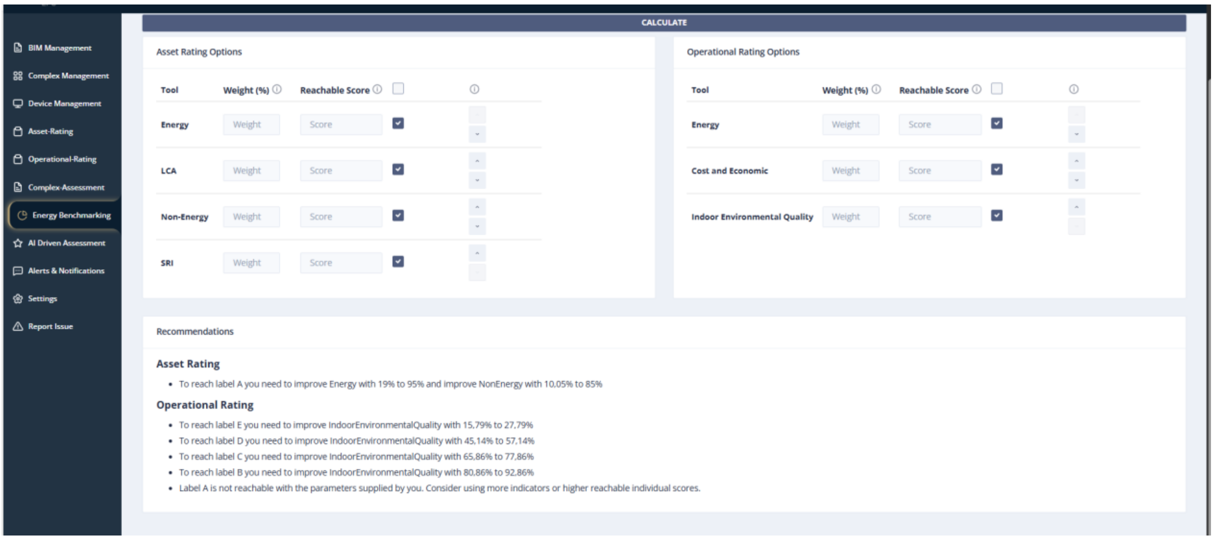


Figure 83. Energy efficiency recommendations

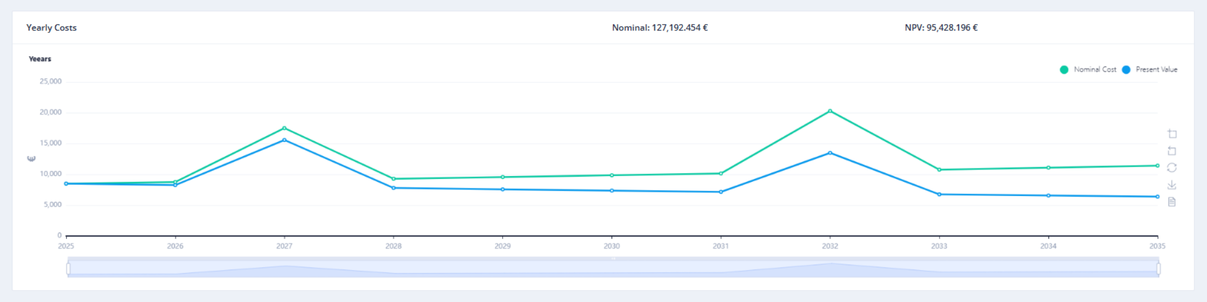


Figure 84. Cost analysis for a replacement system in DS3

- **Lessons learned:**
- **Proposed improvements:** N/A

6.3.2.25 UC7.1 Provide Building Records through Digital Logbooks

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot). See UC1.1 validation
- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.4 DemoSite 4 - Complex building in Leitza

6.4.1 Deployment timeline

The main activities in the pilots, listed below in the table, have been implemented during the time of the project as presented in the following table.

Table 28. Timeline of the main activities in pilots

	M1											M12												M24												M36
Pilot data collection	■	■	■	■	■	■	■	■	■																											
BIM definition				■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■												
definition of the criteria for IoT installation																■	■	■	■	■	■															
IoT installation																						■	■	■												
Measurements- Operational data collection																								■	■	■	■	■	■	■	■	■	■	■	■	■
Web Platform integration																								■	■	■	■	■	■	■	■	■	■	■	■	
Pilot demonstration																																			■	■

6.4.2 Baseline activities

1.4.2.1 BIM file definition

The pilot buildings in Leitza were constructed in different periods, with the most recent one built in 2004. Therefore, at the start of the SmartLivingEPC project, BIM models from the original design of these buildings were not available.

Based on the initial data collection (from non-digitized documentary and graphic sources), we created BIM models for each building with the aim of developing models containing the necessary data for energy analysis.

Goiener used IFCbuilder by CYPE, which is designed for use with the energy calculation software Cypetherm HEPlus. However, the software had limitations when it came to inputting certain types of data required to meet the project's specifications. To ensure compatibility with the web-based SmartLivingEPC platform, the model needed adjustments before being exported and uploaded in .IFC format.

Due to interoperability issues with other IFC editing programs, it was not possible to fully complete the models with all the necessary data. As a result, the BIM models had to be rebuilt from scratch using REVIT software by CERTH with the collaboration of Goiener.

Overall, we can conclude that there have been significant challenges in defining models that meet the requirements of the SmartLivingEPC project. These difficulties stem from several factors:

- The task demanded a high level of technical expertise from a professional BIM modeller to carry out the necessary model adaptations—expertise which Goiener does not currently have in-house.
- In addition, interoperability issues between different BIM software tools created obstacles when working with the same model across multiple platforms, making the adaptation process even more complex.

1.4.2.2 IoT installation

This section outlines the activities undertaken at the Leitza pilot site to ensure the availability of operational data required for testing the SmartLivingEPC methodology. The scope of work includes:

- Definition of sensor types
- Selection of suppliers
- Determination of sensor locations
- Installation of equipment

Unlike other pilot sites, which consist of newly constructed or fully equipped demonstration buildings, the Leitza pilot presents the challenges of a real-life scenario. At the outset, no sensors or meters had been installed, and limited access to homes and the availability of homeowners introduced additional complexities to the deployment process.

Initial Planning and Supplier Selection

The process began with the identification of suitable sensor suppliers. Although Task 6.4 officially commenced in Month 19 (M19), preliminary contact with suppliers was initiated in December 2023 to expedite procurement, given the need for multiple sensors and monitoring systems. A draft list of required sensors was distributed early to allow suppliers adequate time to prepare their proposals.

On 18 January 2024, a Task 6.4 kick-off meeting was held with relevant project partners to align the monitoring plan with Task 6.2 requirements (refer to MoM 11Jan24.docx). During the meeting, it was agreed to proceed with the installation phase despite the pending deliverables of Task 6.2, as the monitoring requirements were already well-defined. The required sensors were confirmed, and subsequent steps were planned.

Goiener selected Stechome as the supplier, given their experience in building monitoring for the Basque Government. The initial proposal included IAQ sensors, gas meters, thermal energy meters, and window switches. The first list of proposed sensors was submitted on 23 January 2024.

Progress During Q1 2024

The proposed sensor list and measurement strategy were presented during the consortium's second online meeting on 30 January. Integration requirements for CIEM were also shared and discussed with Stechome.

Following this, a decision was made to remove window switches from the list and include sensors capable of measuring 2.5 ppm, which would yield more relevant data for the methodology being tested. This update was communicated to Stechome on 15 February, and a revised proposal was subsequently submitted.

Regular communication with homeowners was maintained throughout, addressing various concerns including installation logistics, sensor dimensions, drilling requirements, and timing preferences (e.g., morning vs. afternoon appointments).

Technical integration details with CIEM were also clarified after an exchange of emails between QUE and Stechome. It was established that CIEM required an API to receive data from a centralized platform, as it could not interface directly with individual sensors.

An on-site inspection was conducted with the supplier on 12 March. During this visit, installation challenges and limitations were identified, prompting a revision of the initial proposal.

At the first project review meeting held on 26 March, the outcomes of the site visit were presented, and the necessary modifications to the monitoring plan were approved. A revised sensor deployment list incorporating these changes was submitted, and the final proposal from Stechome was received in April.

Installed system and data traceability

The system for data traceability operates as an interdependent chain of steps. It begins with comfort sensors and energy consumption meters (e.g., electricity or gas). These devices transmit data wirelessly via LoRa technology, chosen due to the lack of existing communication infrastructure in the buildings. The signal is received by a hub, which acts as a bridge to a 4G router, sending the data to a central database. To ensure data integrity, each value must include a unique device ID, a timestamp, and pass a validation check for errors or duplicates. Finally, the data is displayed on a visualization platform for analysis, monitoring, and decision-making.

However, experience has shown that, as the monitoring system functions as a fully interdependent chain, any failure in one of its components—whether in data capture, transmission, or processing—can compromise the overall value of the process.

Due to the absence of pre-existing wired or data networks in the participating buildings, a dedicated short- and medium-range wireless network based on LoRa (Long Range) technology had to be implemented. However, this technology has notable limitations: it is sensitive to physical interference, offers low transmission speeds, and in some cases only allows one-way communication, preventing confirmation of successful data delivery. This fragility has generated a significant risk to the continuity of data flow.

Installation and Initial Data Collection

A purchase order for Stechome was issued on 15 April 2024. Delivery and installation were scheduled over a six-week period to enable data collection beginning in June 2024, with the goal of obtaining a full year’s worth of data for analysis.

Sensor installation commenced on 22 May. Signal concentrators, IAQ sensors, and gas meters were installed at various locations, including the town hall, a single-family home, a private apartment, and a mixed-use building. During installation, an unanticipated need for IAQ sensor power supply caused some inconvenience to homeowners. Calibration requirements for IAQ sensors were also identified for subsequent visits.

On 4 and 6 June, hydraulic installations for energy metering were completed at the single-family house, the sports center, and the mixed-use building. Remaining IAQ and gas sensors were also installed, except the outdoor weather station, which was not yet available.

A coordination meeting between QUE, Stechome, and Goiener was held on 26 June to finalize communication protocols between the sensor data platform and CIEM. Despite sensors being operational, various communication issues arose. Technicians visited the pilot site on 12 and 18 June, and again on 2 and 4 July to address these issues. A new signal concentrator was required to resolve persistent problems.

The proposed site for the outdoor weather station was rejected by the town hall due to location constraints. An alternative site was identified, and the weather station was successfully installed on the terrace of Demosite 5 on 12 July. Additionally, a new concentrator was deployed at Demosite 5 to facilitate data collection from Demosites 4, 5, and 6.

Reconfigurations and Adjustments

On 18 July, reconfiguration and additional installations were carried out, including:
DS4: Adjustment of the lighting electricity measurement
DS5: Replacement of gas meter and reconfiguration of lighting, electricity measurement
DS6 (Shop): Reconfiguration of three separate electricity measurements (lighting, heat pump, DHW heater)
DS6: Replacement of biomass boiler meters
DS7: Replacement of gas meter
DS8: Replacement of two gas meters
DS9: Installation of a repeater to facilitate data transmission

Despite these interventions, some issues persisted. On 2 August, the DS7 concentrator was relocated to the inverter room. The signal transmitter for the DS8 school kitchen gas meter was moved outdoors, and a damaged IAQ meter cable in DS9's gym was replaced. Warning labels were also affixed to prevent disconnection. A faulty component on the DS4 lighting electricity meter was removed to restore data transmission.

Post-Summer Issues and Resolutions

Upon returning from the summer break (2 September), further issues were identified:

- **Devices not transmitting data**:
    1. DS4: Lighting electricity consumption
    2. DS8: Kitchen gas meter
- **Devices that had stopped transmitting**:
    1. DS4: Gas meter (since 20 August)
    2. DS8: Boiler gas meter (since 2 August)
    3. DS8: IAQ sensor 1 (since 2 August)
    4. DS8: IAQ sensor 2 (since 26 August)
- **Devices with unclear consumption readings**:
    1. DS6: Biomass boilers (usage patterns need clarification by household)
    2. DS7: Gas meter and inverters
    3. DS9: Diesel oil consumption

On 17 September, a homeowner at DS6 reported a temperature spike in the biomass boiler, suspected to be linked to meter installation. Stechome claimed that the installation was not the cause. The relationship with this homeowner was damaged after this event.

Technicians returned on 18 and 25 September to resolve communication issues. A new concentrator was installed in the school, and data transmissions for the sports center, school, and Demo sites 4–6 were reconfigured. Suspect clamps measuring DS4 lighting consumption were also replaced. From 26 September onwards, data transmission was reported to be stable.

Final Activities and Recent Developments

In February 2025, data sharing with CIEM officially began.

However, in early May, a communication loss affecting some sensors was observed. This was traced to a nationwide electrical outage in Spain on 28 April, which impacted the IoT infrastructure. On 7 May, a technician from Stechome visited the site and successfully resolved the identified issues.

During May 2025, raw data collected from June 2024 to April 2025 was sent by the provider. Communication problems during the data collection campaign have resulted in 60% of the data being available for comfort sensors, but only 30% for energy meters. Consequently, the heating season has been lost without relevant data to facilitate an operational evaluation. Data from gas/diesel invoices have been gathered to make the evaluation.

A meeting with Stechome was held on the 17th of June, IA will be used starting with the real consumption from the invoices and historical data profiles, for having an estimation on the thermal energy consumption. Further explanation on the situations that have affected the data gathering campaign can be found in the Annex II.

Figure 85. Energy meters installation in DS4&DS8 in March 12th, 2024.

Figure 86. HVAC systems in DS9, May 22th 2024.

Figure 87. Gas Meters in DS4&DS5, May 22th 2024.

Figure 88. Sensors in DS4, DS5, DS7&DS8, May 22th 2024.

Figure 89. Concentrator for data reception in DS7. May 22th 2024.

Figure 90. Fuel oil meters in boiler and HVAC system in DS9. June 4th 2024.

Figure 91. Electricity meters in DS9. June 6th 2024.

Figure 92. Concentrator for data reception in DS9. June 6th 2024.

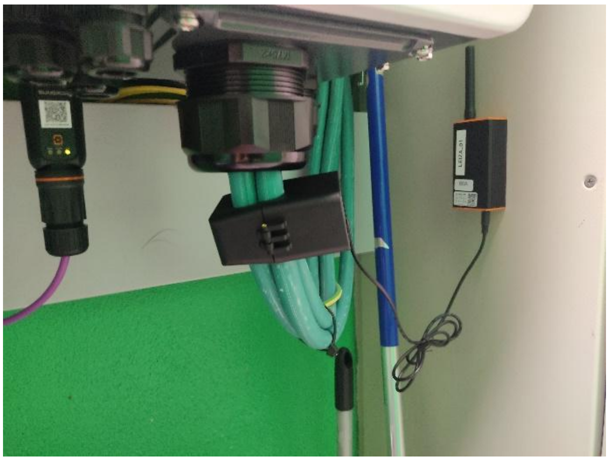


Figure 93. Measurement of the output of the collective PV system at the inverter in DS9. June 6th 2024.

Figure 94. Energy meters in DS4, DS5&DS6. June 6th 2024.

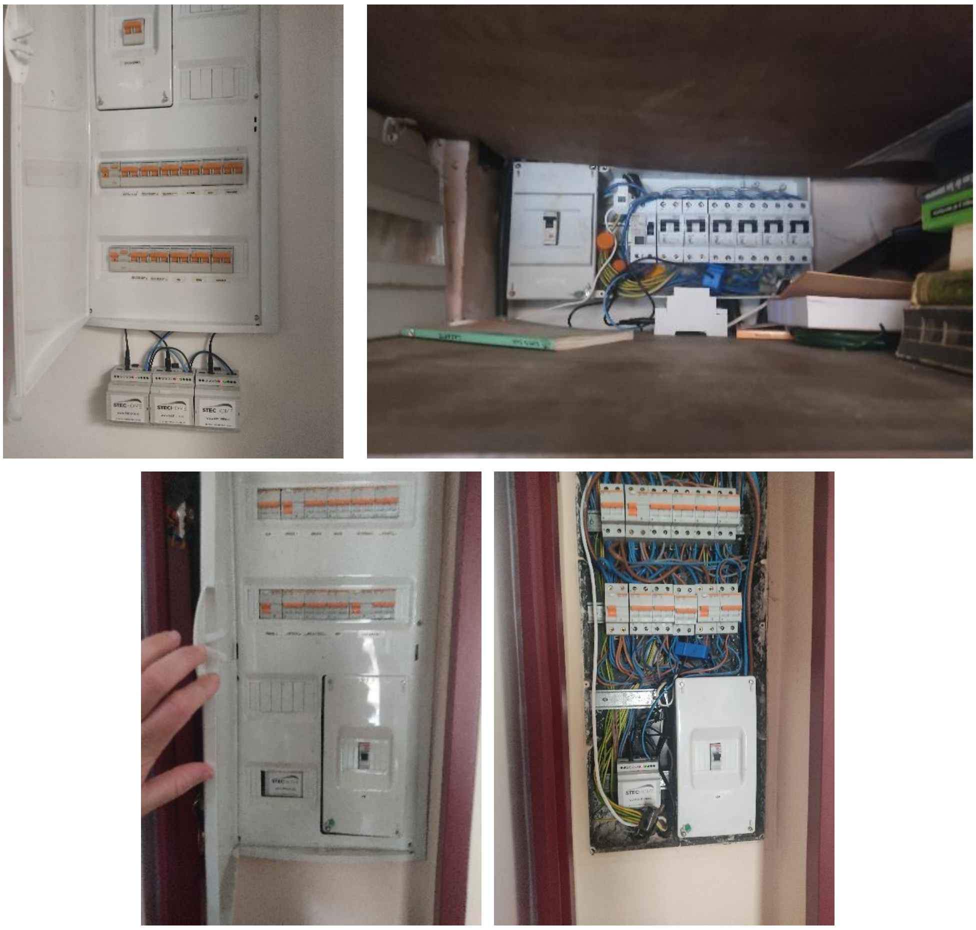


Figure 95. Electricity meters in DS4, DS5&DS6. June 6th 2024.

Figure 96. Measurement of the output of the PV system at the inverter in DS7. June 6th 2024.

Figure 97. Gas meters in DS7&DS8. June 6th 2024.

Figure 98. Installation of a new concentrator for data reception in DS7. August 2nd 2024.

Figure 99. Gas meter in the kitchen ofDS8. August 2nd 2024.

Figure 100. Failure detected in the power supply of a sensor in DS9 due to user intervention. August 2nd 2024.

1.4.2.3 Communication with CIEM and data sharing

Communication with the CIEM platform and data sharing have been carried out smoothly.

Collaboration between QUE and Stechome has been key for this work as several tests were needed until communication was stablished.

First, device configuration was completed by defining the identification and measurement units for each device. Based on these configurations, communication was stablished via an API. Several tests were conducted successfully, verifying the proper data flow. Following this, continuous data transmission to the CIEM platform was initiated.

6.4.3 Results of architectural use cases implementation

As the SmartLivingEPC functionalities were progressively integrated into the Web Platform, the validation of the Architectural Use Cases was carried out following the methodology defined in Section 3. Although the initial plan was to conduct these validations first at the prototype level in DS1, then in the other pilot buildings, and finally in the complex building, in practice, the Use Cases were tested incrementally as the functionalities became available on the platform.

6.4.3.1 UC1.1 Retrieve and validate building information from BIM

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

  Screenshot showing all files upload to the platform successfully.

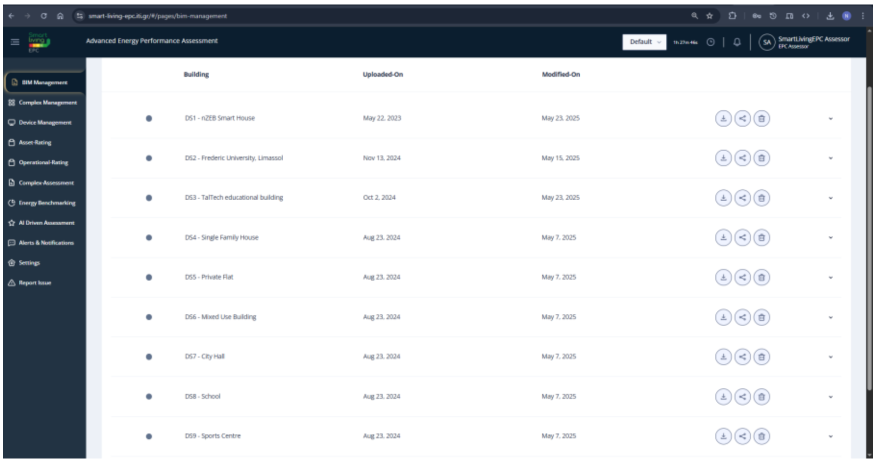
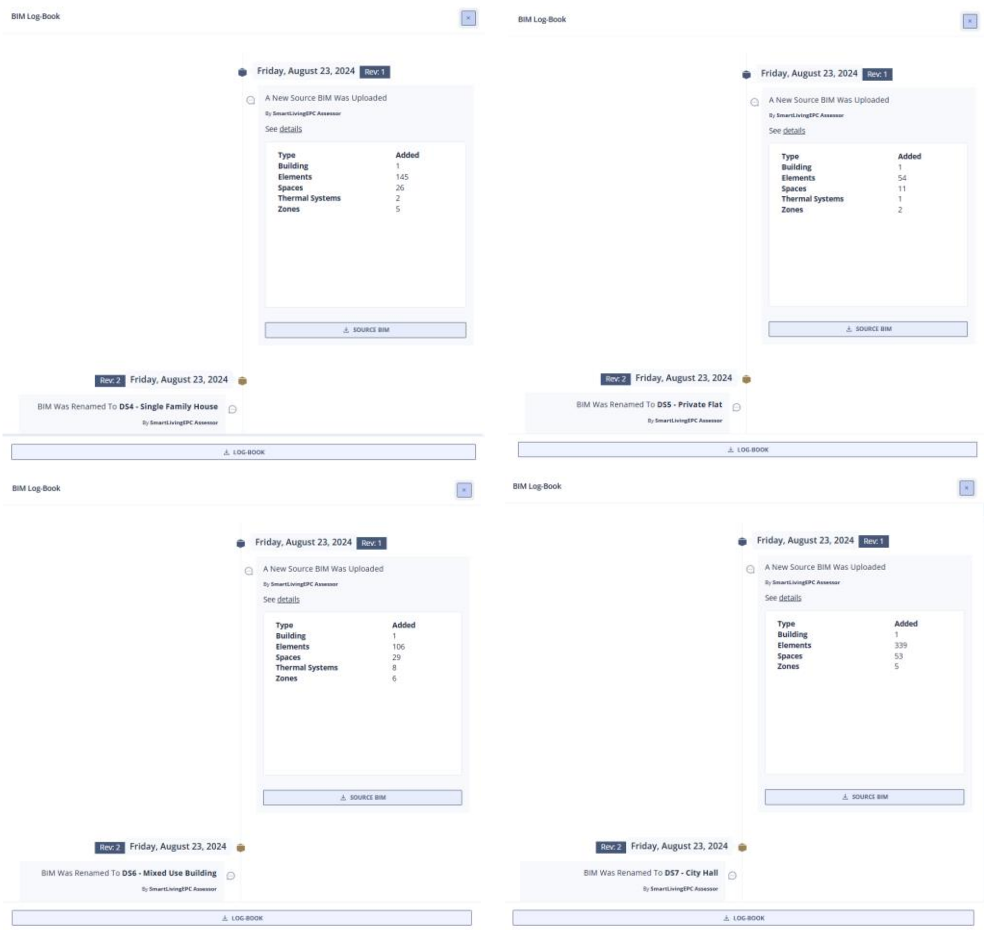


Figure 101. Screenshot showing BIM files of DS4-DS9 buildings

Screenshot showing the BIM logbook interface with the extracted information following the first upload (DS4, DS5, DS6, DS7, DS8 & DS9).



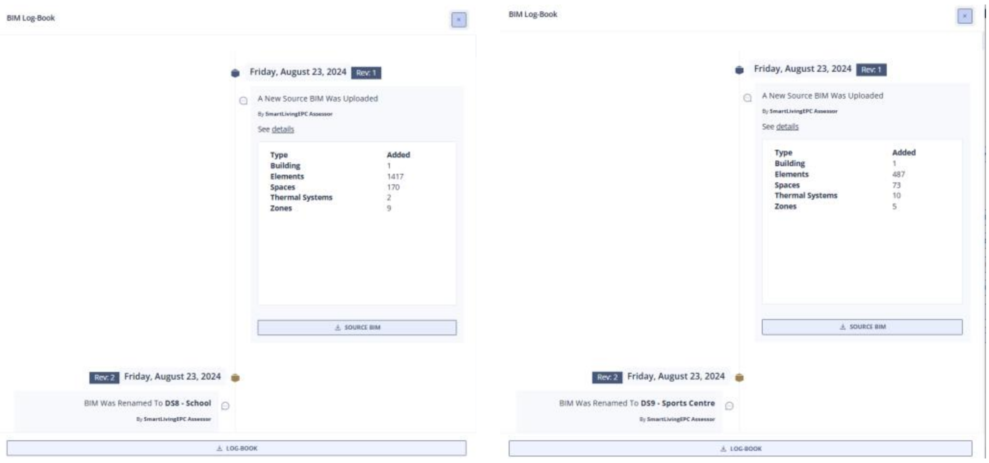
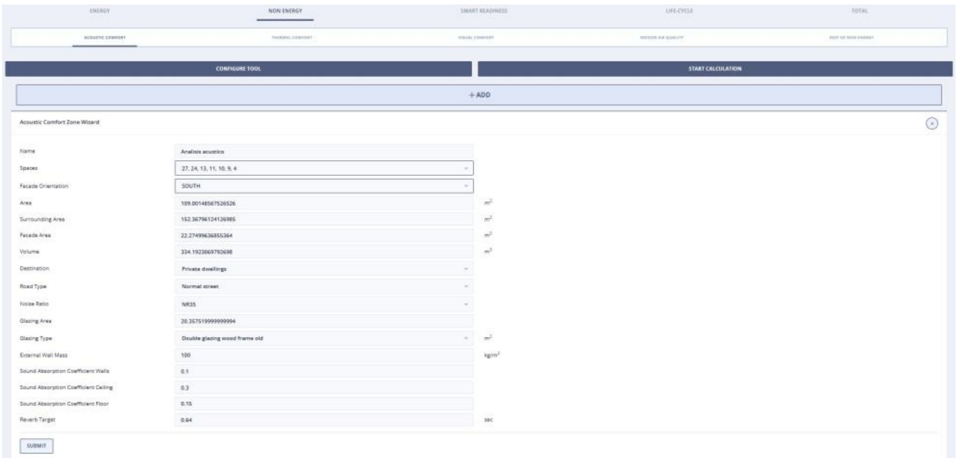


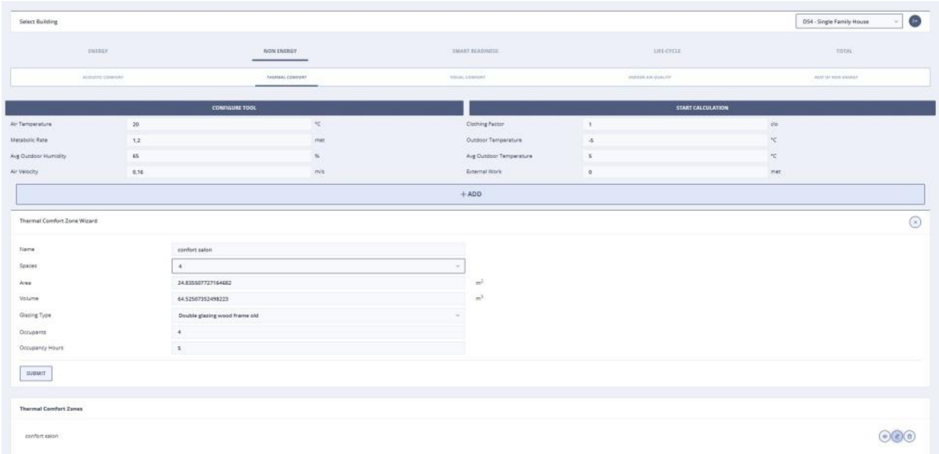
Figure 102. BIM logbook interface in DS4-DS9-

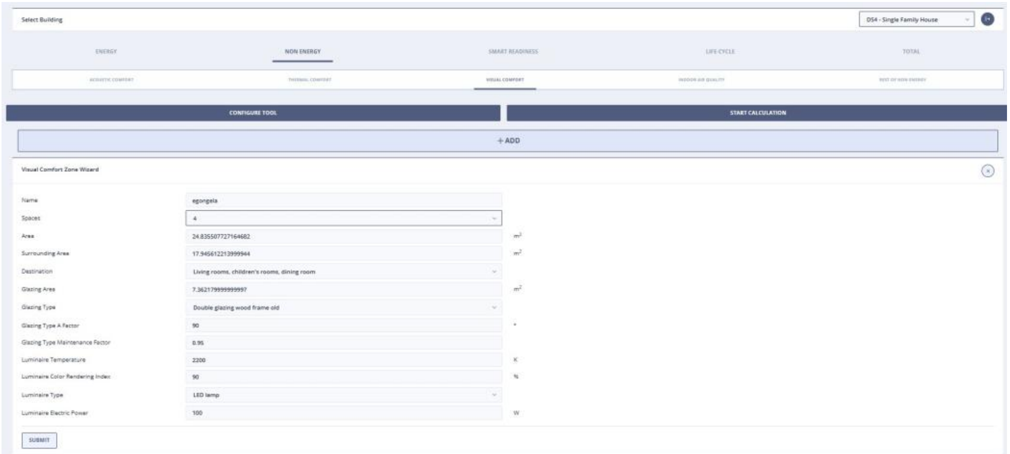
- **Lessons learned:** N/A
- **Proposed improvements:** Changes regarding to the thermal systems parsing in IFC files were implemented in the BIM Parser subcomponent

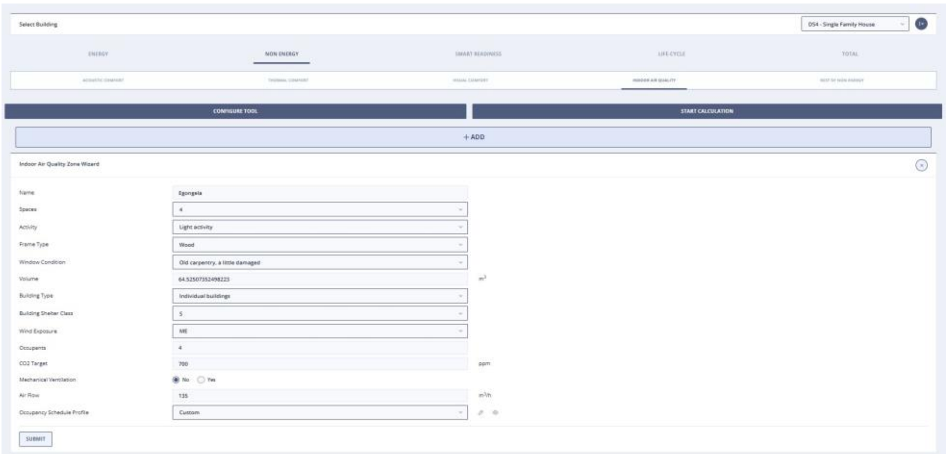
6.4.3.2 UC1.2 Collect and extract data from additional building documentation sources

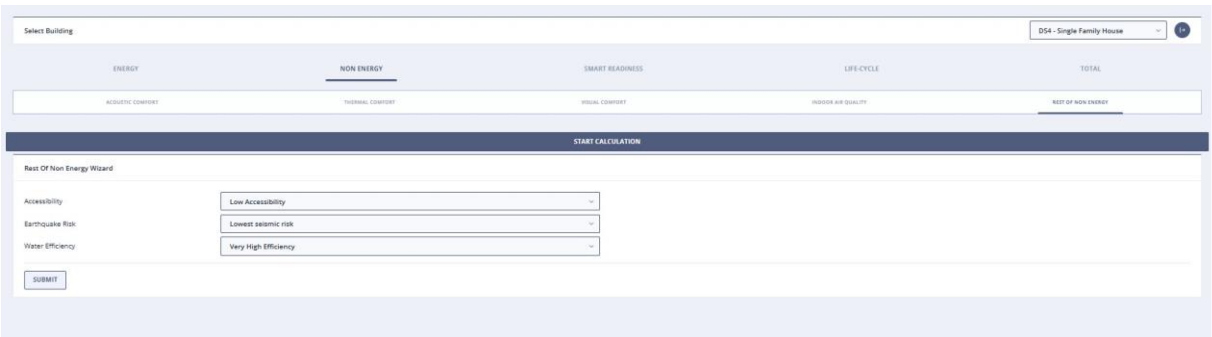
- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot): Screenshots illustrating the input data used in the Asset Rating assessment for DS4, as an example.




Select Building
D54 - Single Family House
ENERGY
NON ENERGY
SMART READINESS
LIFE-CYCLE
TOTAL
ACOUSTIC COMFORT
THERMAL COMFORT
VISUAL COMFORT
INDOOR AIR QUALITY
REST OF NON ENERGY
CONFIGURE TOOL
START CALCULATION
Air Temperature
20
°C
Metabolic Rate
1.2
met
Avg Outdoor Humidity
65
%
Air Velocity
0.16
m/s
Clothing Factor
1
clo
Outdoor Temperature
-5
°C
Avg Outdoor Temperature
5
°C
External Work
0
met
+ ADD
Thermal Comfort Zone Wizard
Name
confort salon
Spaces
4
Area
24.835507727164682
Volume
64.52507352498223
Glazing Type
Double glazing wood frame old
Occupants
4
Occupancy Hours
5
SUBMIT
Thermal Comfort Zones
confort salon


Select Building
D54 - Single Family House
ENERGY
NON ENERGY
SMART READINESS
LIFE-CYCLE
TOTAL
ACOUSTIC COMFORT
THERMAL COMFORT
VISUAL COMFORT
INDOOR AIR QUALITY
REST OF NON ENERGY
CONFIGURE TOOL
START CALCULATION
+ ADD
Visual Comfort Zone Wizard
Name
egongela
Spaces
4
Area
24.835507727164682
Surrounding Area
17.945612213999944
Destination
Living rooms, children's rooms, dining room
Glazing Area
7.362179999999997
Glazing Type
Double glazing wood frame old
Glazing Type A Factor
90
Glazing Type Maintenance Factor
0.95
Luminaire Temperature
2200
K
Luminaire Color Rendering Index
90
%
Luminaire Type
LED lamp
Luminaire Electric Power
100
W
SUBMIT


Select Building
D54 - Single Family House
ENERGY
NON ENERGY
SMART READINESS
LIFE-CYCLE
TOTAL
ACOUSTIC COMFORT
THERMAL COMFORT
VISUAL COMFORT
INDOOR AIR QUALITY
REST OF NON ENERGY
CONFIGURE TOOL
START CALCULATION
+ ADD
Indoor Air Quality Zone Wizard
Name
Egongela
Spaces
4
Activity
Light activity
Frame Type
Wood
Window Condition
Old carpentry, a little damaged
Volume
64.52507352498223
Building Type
Individual buildings
Building Shelter Class
5
Wind Exposure
ME
Occupants
4
CO2 Target
700
ppm
Mechanical Ventilation
No
Yes
Air Flow
135
Occupancy Schedule Profile
Custom
SUBMIT


Select Building
D54 - Single Family House
ENERGY
NON ENERGY
SMART READINESS
LIFE-CYCLE
TOTAL
ACOUSTIC COMFORT
THERMAL COMFORT
VISUAL COMFORT
INDOOR AIR QUALITY
REST OF NON ENERGY
START CALCULATION
Rest Of Non Energy Wizard
Accessibility
Low Accessibility
Earthquake Risk
Lowest seismic risk
Water Efficiency
Very High Efficiency
SUBMIT

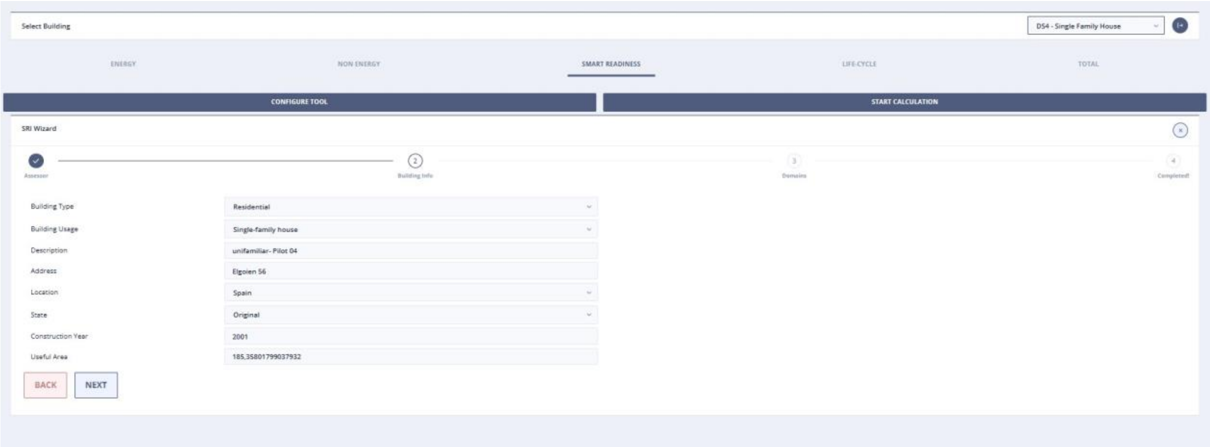


Figure 103. Screenshots of DS4 asset input data

- **Lessons learned:** N/A
- **Proposed improvements:**

To specify input data units in all cases where manual input is required

to introduce the possibility of giving names to the spaces, instead of numbers. Or visually view the building and the selected space to make the data entry process more agile and intuitive.

6.4.3.3 UC2.1 Inspection and installation of IoT equipment on the building

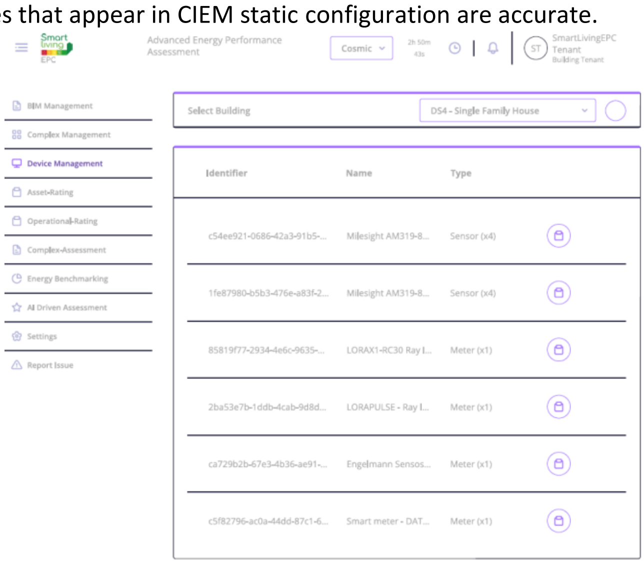
- **Result:** PASS

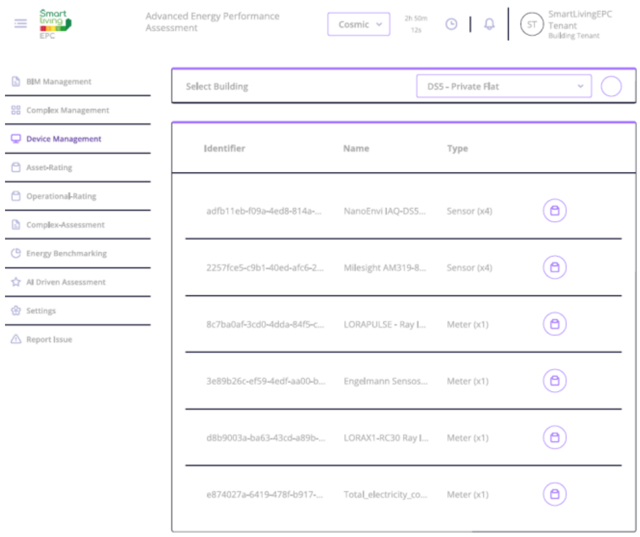
All necessary IoT equipment is installed and operational.

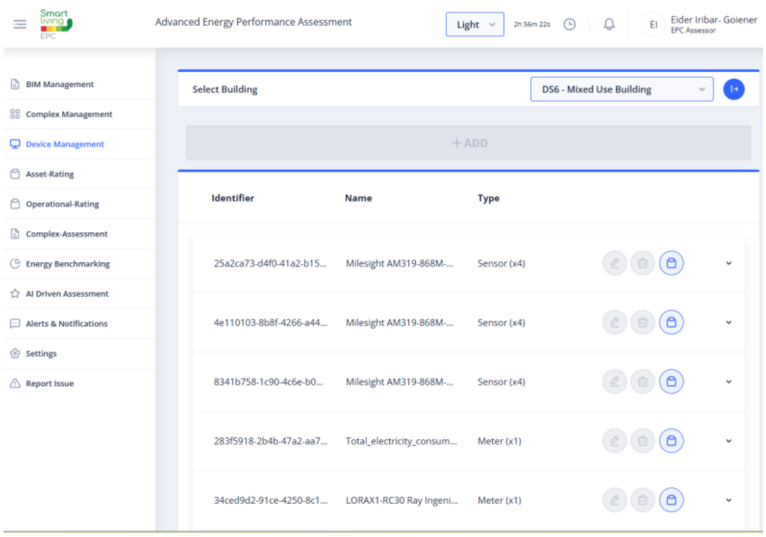
Continuous, reliable data streams are verified, ensuring the IoT equipment is ready for integration with the SmartLivingEPC platform.

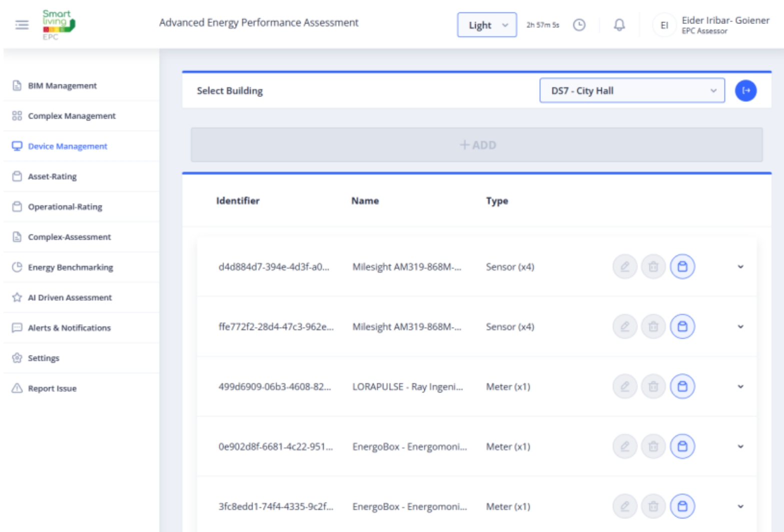
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

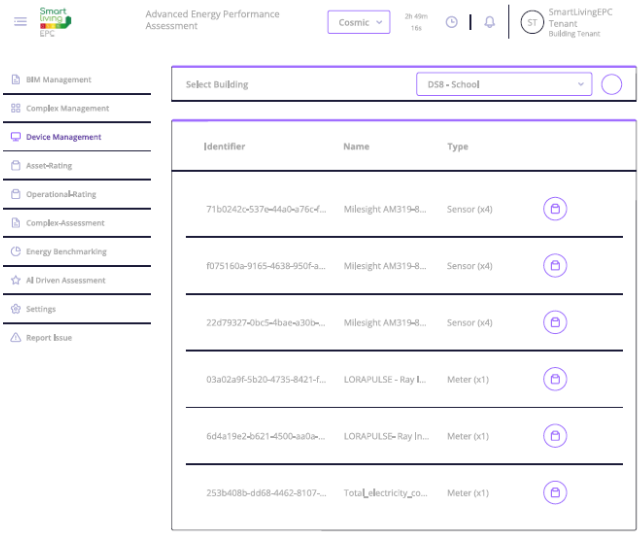
The installed IoT devices that appear in CIEM static configuration are accurate.




Advanced Energy Performance Assessment
Cosmic
SmartLivingEPC Tenant
Building Tenant
BIM Management
Complex Management
Device Management
Asset-Rating
Operational-Rating
Complex-Assessment
Energy Benchmarking
AI Driven Assessment
Settings
Report Issue
Select Building
DS5 - Private Flat
Identifier
Name
Type
adfb11eb-f09a-4ed8-814a-...
NanoEnvi IAQ-DS5...
Sensor (x4)
2257fce5-c9b1-40ed-afc6-2...
Milesight AM319-8...
Sensor (x4)
8c7ba0af-3cd0-4dda-84f5-c...
LORAPULSE - Ray I...
Meter (x1)
3e89b26c-ef59-4edf-aa00-b...
Engelmann Sensos...
Meter (x1)
d8b9003a-ba63-43cd-a89b-...
LORAX1-RC30 Ray I...
Meter (x1)
e874027a-6419-478f-b917-...
Total_electricity_co...
Meter (x1)


Advanced Energy Performance Assessment
Light
2h 56m 22s
Eider Iribar- Goiener
EPC Assessor
BIM Management
Complex Management
Device Management
Asset-Rating
Operational-Rating
Complex-Assessment
Energy Benchmarking
AI Driven Assessment
Alerts & Notifications
Settings
Report Issue
Select Building
DS6 - Mixed Use Building
+ ADD
Identifier
Name
Type
25a2ca73-d4f0-41a2-b15...
Milesight AM319-868M-...
Sensor (x4)
4e110103-8b8f-4266-a44...
Milesight AM319-868M-...
Sensor (x4)
8341b758-1c90-4c6e-b0...
Milesight AM319-868M-...
Sensor (x4)
283f5918-2b4b-47a2-aa7...
Total_electricity_consum...
Meter (x1)
34ced9d2-91ce-4250-8c1...
LORAX1-RC30 Ray Ingeni...
Meter (x1)


Advanced Energy Performance Assessment
Light
2h 57m 5s
Eider Iribar- Goiener
EPC Assessor
BIM Management
Complex Management
Device Management
Asset-Rating
Operational-Rating
Complex-Assessment
Energy Benchmarking
AI Driven Assessment
Alerts & Notifications
Settings
Report Issue
Select Building
DS7 - City Hall
+ ADD
Identifier
Name
Type
d4d884d7-394e-4d3f-a0...
Milesight AM319-868M-...
Sensor (x4)
ffe772f2-28d4-47c3-962e...
Milesight AM319-868M-...
Sensor (x4)
499d6909-06b3-4608-82...
LORAPULSE - Ray Ingeni...
Meter (x1)
0e902d8f-6681-4c22-951...
EnergoBox - Energomoni...
Meter (x1)
3fc8edd1-74f4-4335-9c2f...
EnergoBox - Energomoni...
Meter (x1)



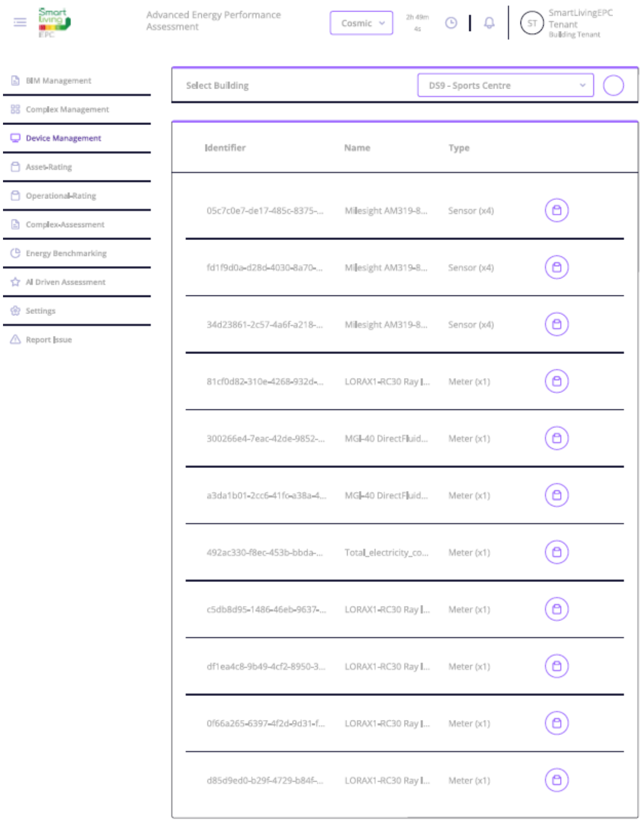
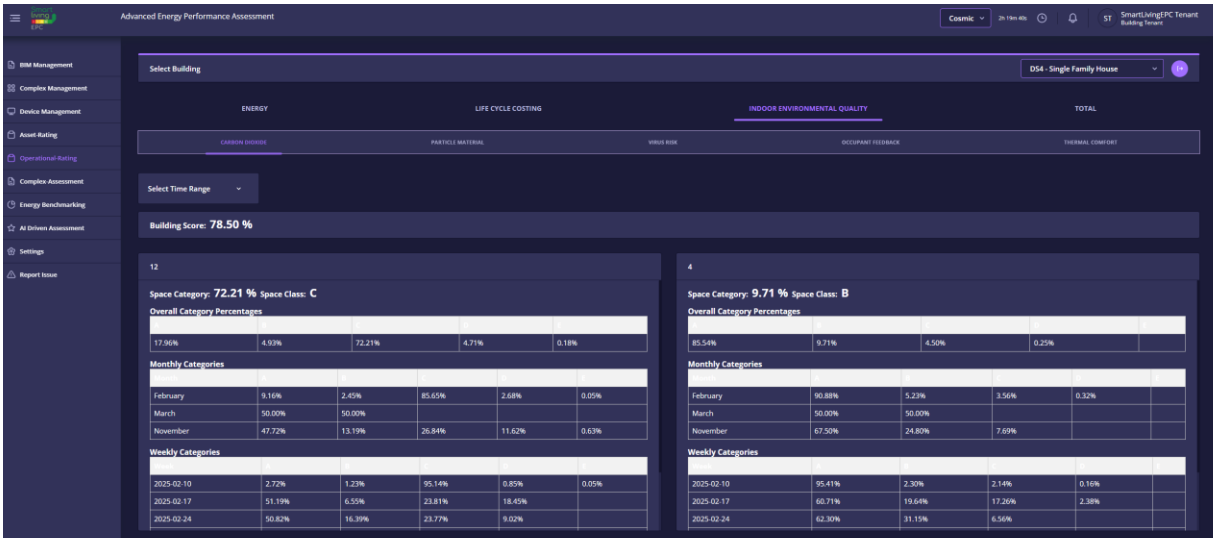
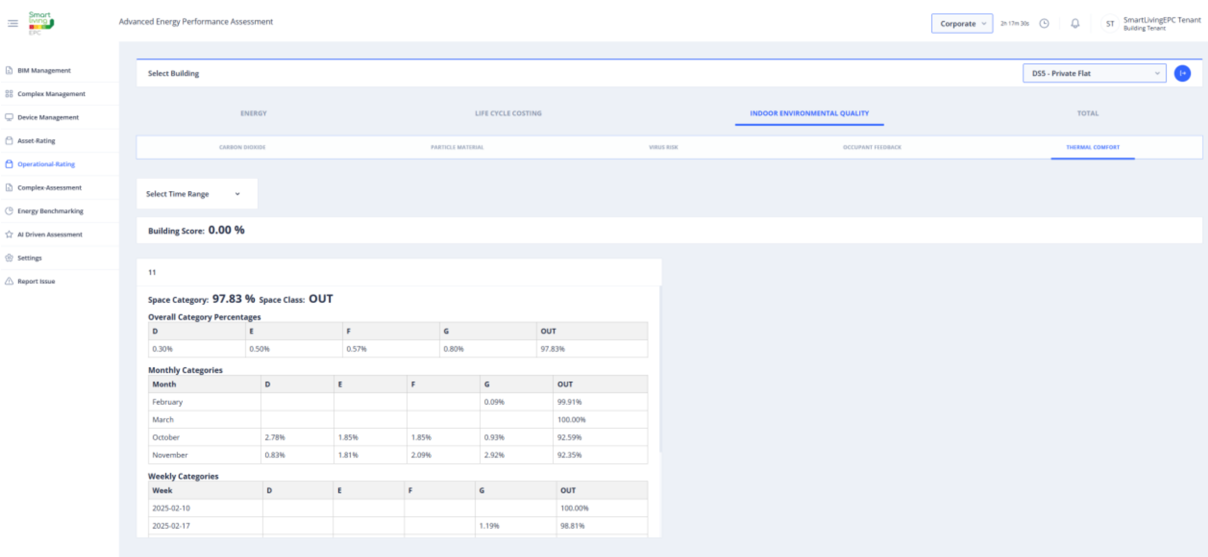
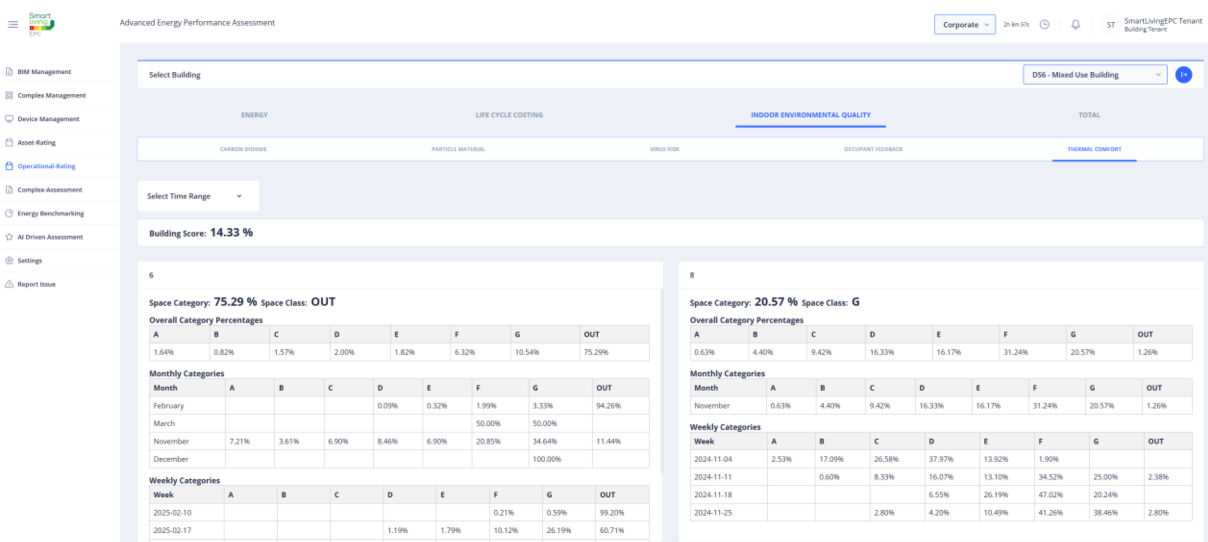


Figure 104. IoT devices in DS4-DS9


Advanced Energy Performance Assessment
Select Building
DS4 - Single Family House
ENERGY
LIFE CYCLE COSTING
INDOOR ENVIRONMENTAL QUALITY
TOTAL
Select Time Range
Building Score: 78.50 %
Space Category: 72.21 % Space Class: C
Space Category: 9.71 % Space Class: B
Overall Category Percentages
Monthly Categories
Weekly Categories


Advanced Energy Performance Assessment
Select Building
DS5 - Private Flat
ENERGY
LIFE CYCLE COSTING
INDOOR ENVIRONMENTAL QUALITY
TOTAL
Select Time Range
Building Score: 0.00 %
Space Category: 97.83 % Space Class: OUT
Overall Category Percentages
Monthly Categories
Weekly Categories


Advanced Energy Performance Assessment
Select Building
DS6 - Mixed Use Building
ENERGY
LIFE CYCLE COSTING
INDOOR ENVIRONMENTAL QUALITY
TOTAL
Select Time Range
Building Score: 14.33 %
Space Category: 75.29 % Space Class: OUT
Space Category: 20.57 % Space Class: G
Overall Category Percentages
Monthly Categories
Weekly Categories

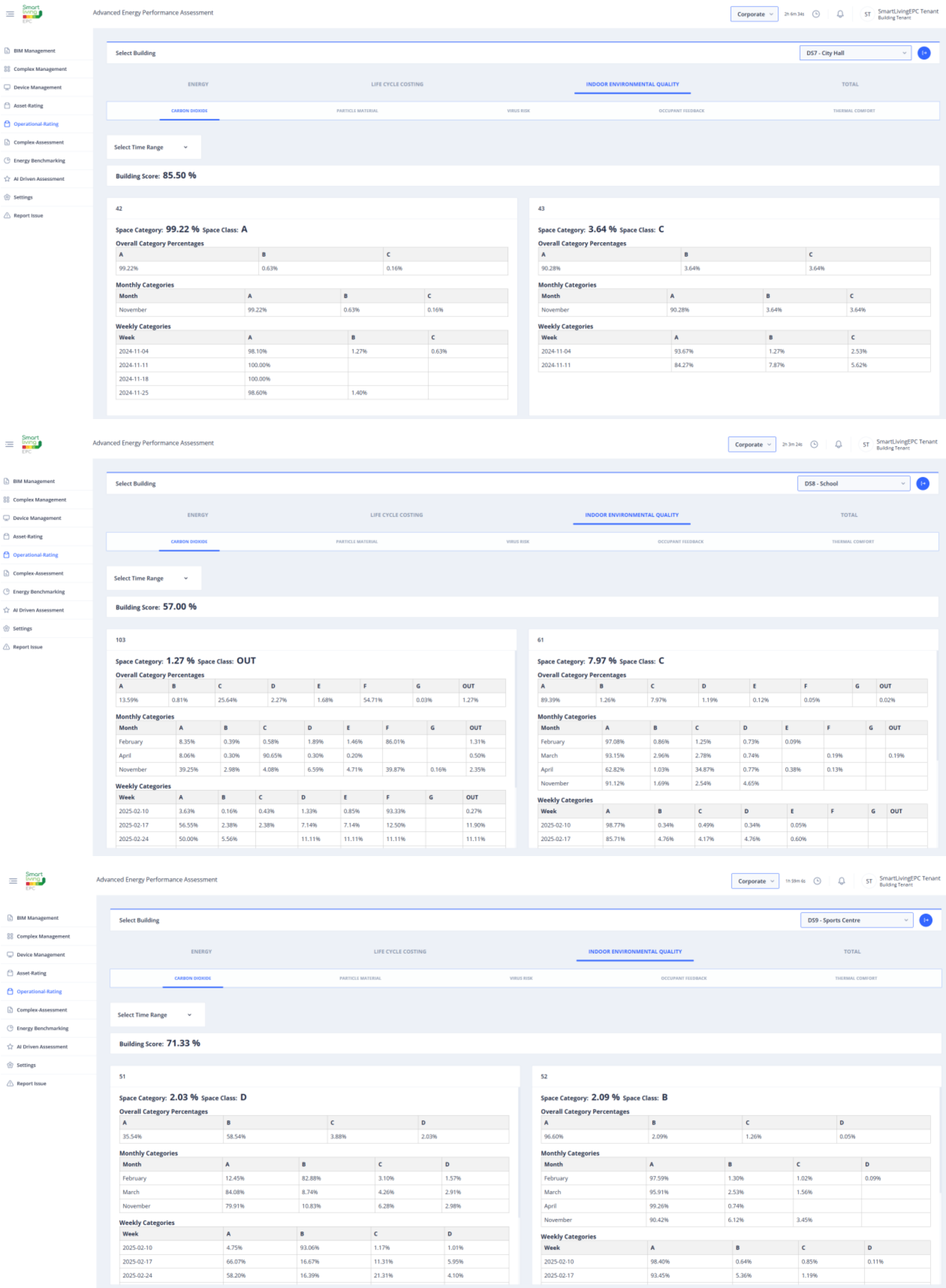


Figure 105. Accuracy of IEQ data measurements in DS4-DS9

- Lessons learned: N/A

- **Proposed improvements:** N/A

6.4.3.4 UC2.2 IoT integration to the SmartLivingEPC platform

- **Result:** PASS
  Retrieved real-time IoT data are available for the SmartLivingEPC tools and services.
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

Screenshot showing device configuration in the Web Platform. Devices corresponding to DS5 as example

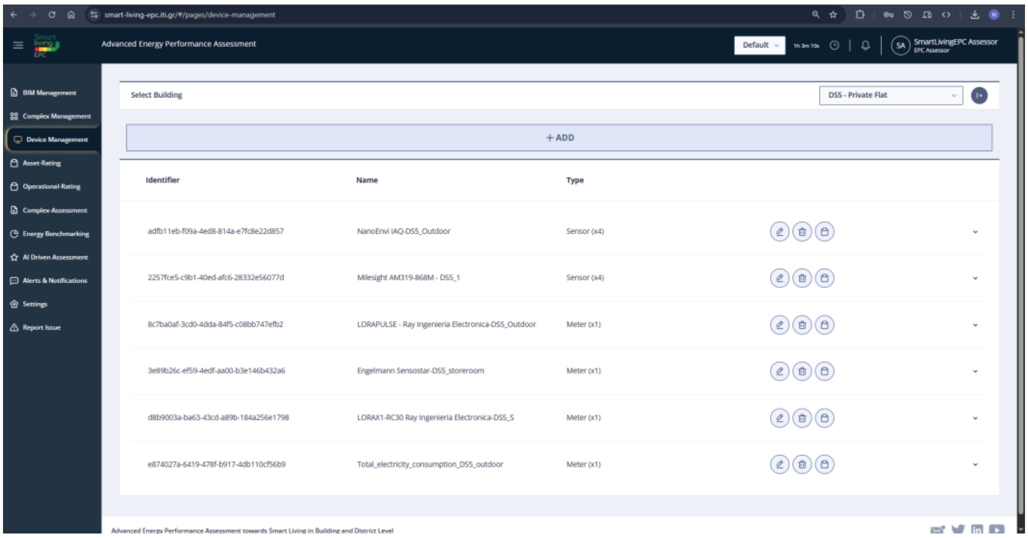


Figure 106. DS5 IoT device configuration in the Web Platform.

Screenshot showing data downloaded from the platform (thus already collected and available to the SmartLivingEPC tools). Data corresponding to DS5 as example:

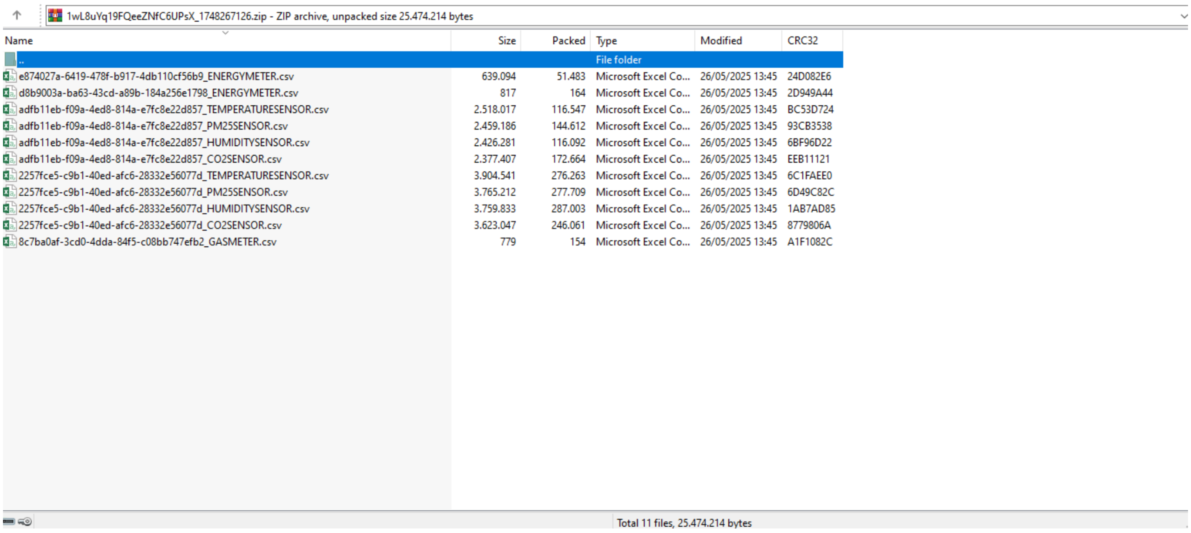


Figure 107. Data downloaded from the platform

- **Lessons learned:** N/A

- **Proposed improvements:** N/A

6.4.3.5 UC2.3 Near-real time automated data retrieval from IoT equipment

- **Result:** PASS
  Data storing and management, Sharing of static and dynamic related information
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

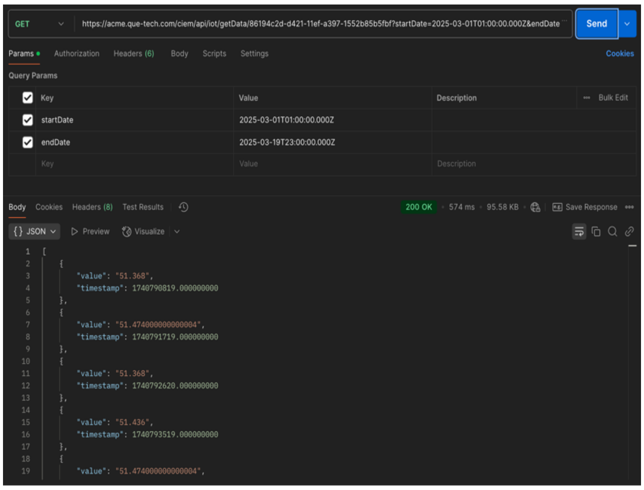


Figure 108. Results of Data call by API

- **Lessons learned:** Due to the different data models that the pilot provided, we learnt how to be flexible and deal with various cases.
- **Proposed improvements:** Optimisation in case of big data storage

6.4.3.6 UC2.4 On-demand data retrieval

- **Result:** PASS
  Data retrieval for the requested criteria and visualisation
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

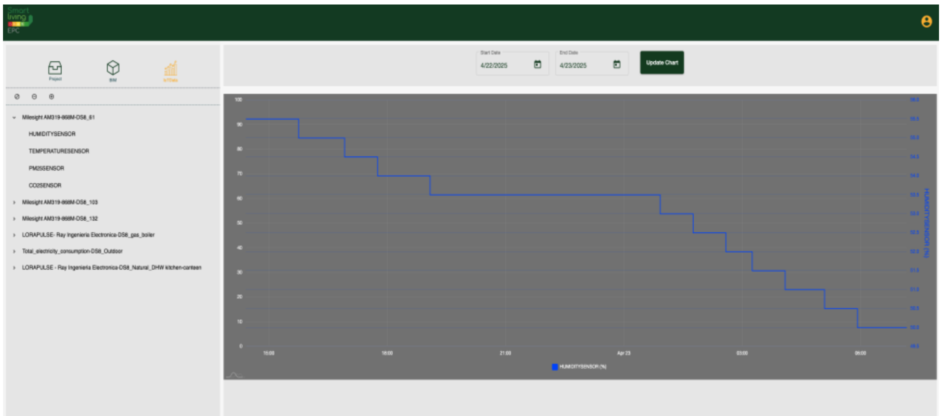


Figure 109. Historical data from sensors in a DS of Leitza

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.4.3.7 UC3.1 Energy and non-energy resources analysis

- **Result:** Pass
  The integration of assessments into the platform has been validated.
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

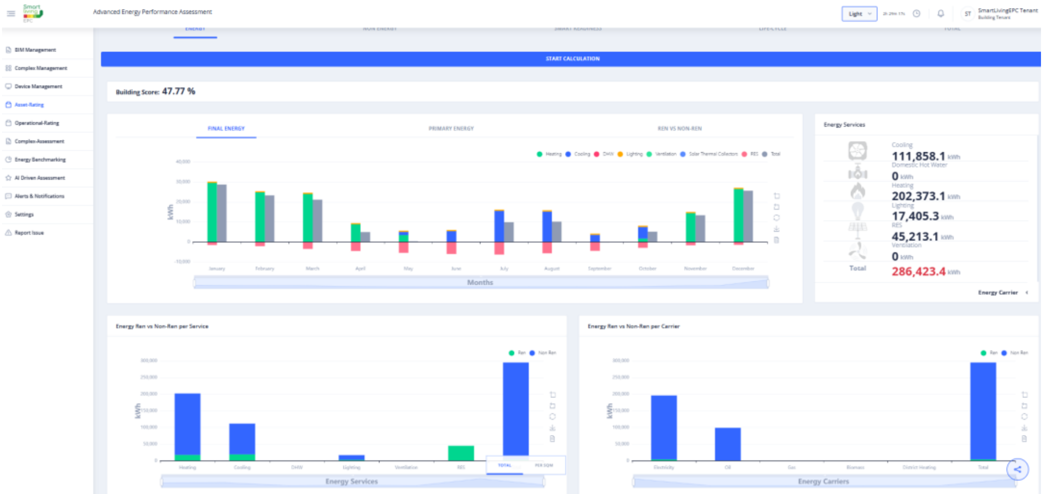


Figure 110. Energy Analysis in Asset rating assessment for DS9

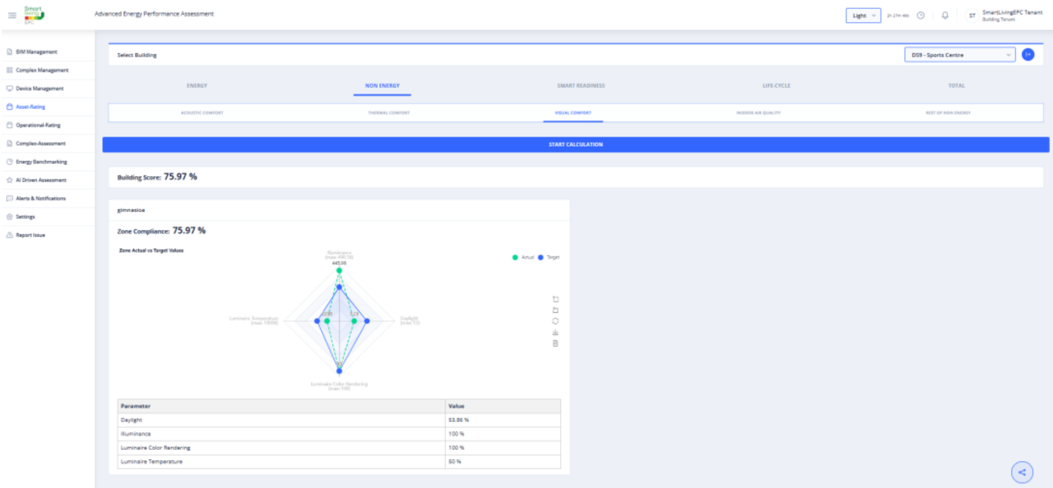


Figure 111. Non- Energy analysis. Visual Comfort Assessment for DS9

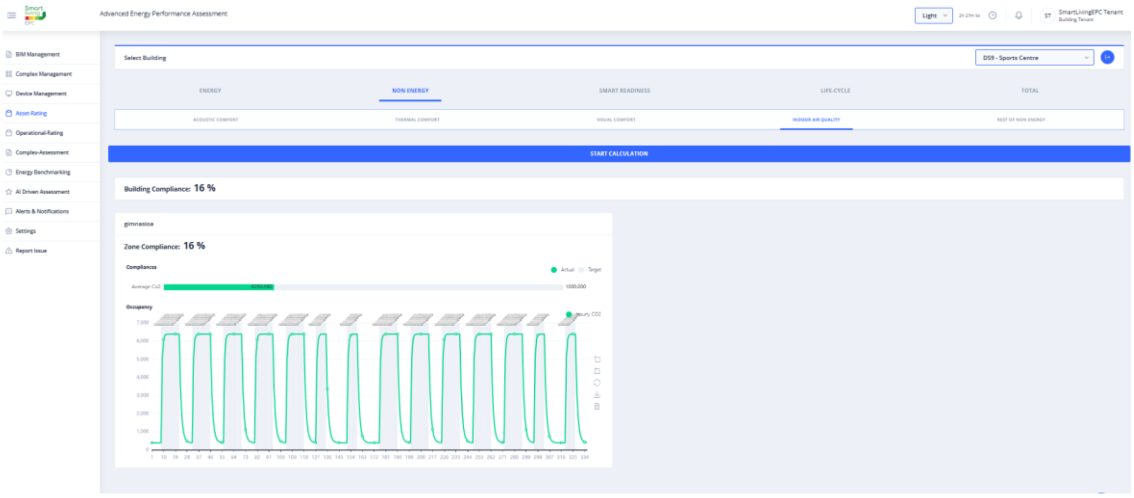


Figure 112. Non- Energy analysis. IAQ Assessment for DS9

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.4.3.8 UC3.2 SRI Calculation

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

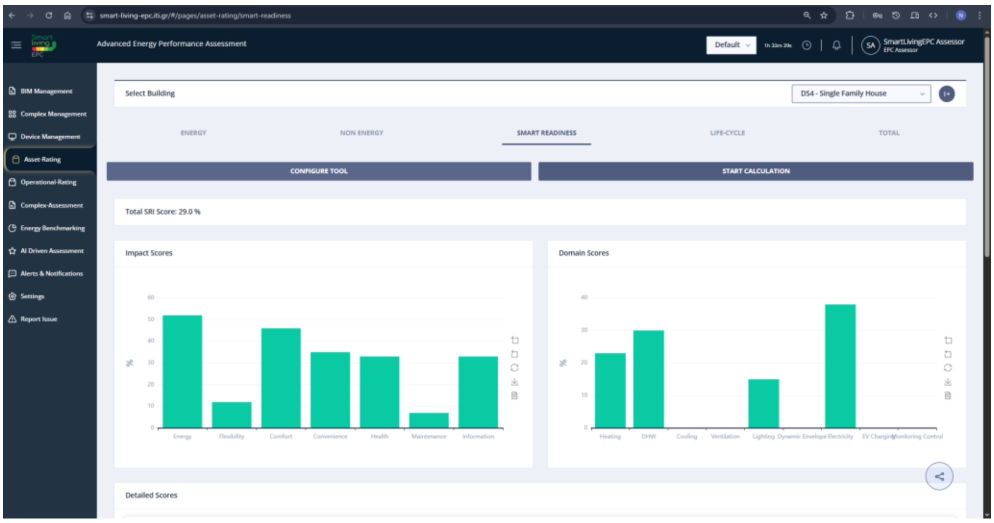


Figure 113. SRI assessment results in DS4

- **Lessons learned:** Same as in DS1
- **Proposed improvements:** Same As in DS1

6.4.3.9 UC3.3 Environmental life-cycle assessment

- **Result:** PASS
- **Incidence/Impact** (in case of fail): the result reflects a successful processing of the BIM materials. LCA results are calculated, based on minimal input parameters for materials.
- **Evidence (**numerical or screenshot)

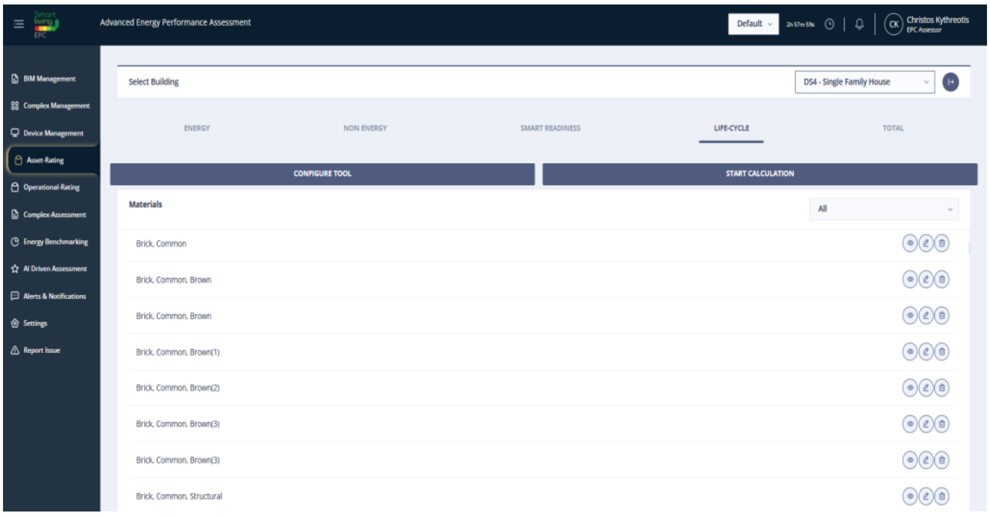


Figure 114. Material data for LCA assessment in DS4

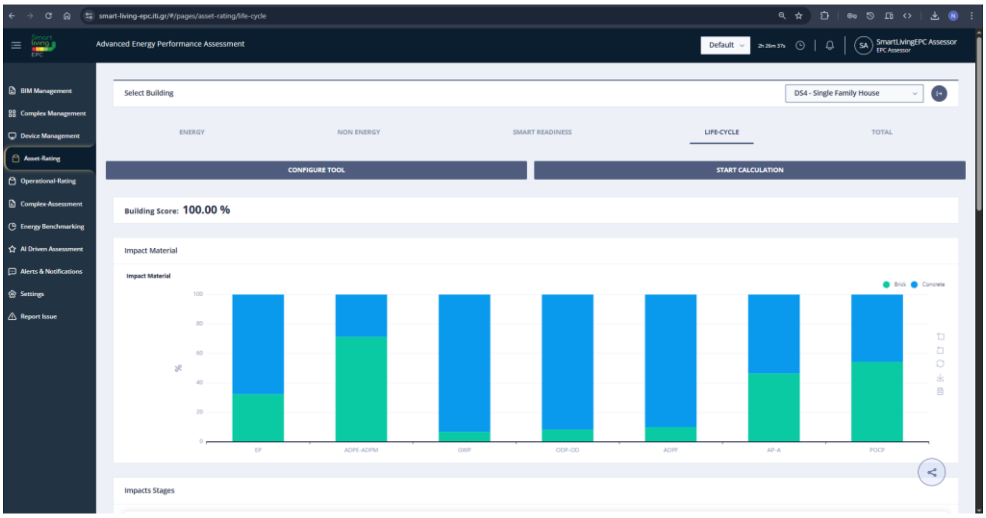


Figure 115. LCA assessment results in DS4

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.4.3.10 UC3.4 Asset Rating issuance for Building Unit

- **Result:** Pass

- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

Figure 116. Asset rating issuance for DS4 (same for DS5-DS9)

- **Lessons learned: -**
- **Proposed improvements: -**

6.4.3.11 UC3.5 Asset Rating issuance for Building Complexes

- **Result:** PASS

The assessment boundary is clear and well-defined. Comprehensive coverage of the building complex.
Accurate and detailed asset data
KPIs that effectively represent static asset performance
Consistent and comparable data
Weighted scoring accurately reflects asset energy performance
Certificate issued on time with detailed analysis and recommendations

- **Impact:**

The implemented method to define neighborhood boundaries through participatory action dynamics promotes neighborhood cohesion and strengths cultural identity.
The multi-source integration methodology facilitates a holistic assessment of the neighborhood.
The proposed set of indicators contains diverse KPIs, allowing for evaluation of aspects ranging from purely technical to social metrics.
All KPI units were normalized to percentages so that their incidence is measurable and comparable for all possible application cases.
Residents' choice of weights reflects their end-user preferences, as well as their culture, identity, and aspirations, avoiding gentrification effects and double penalties.
The SmartLiving EPC Web Platform includes the timely certificate, along with detailed analysis and recommendations, meeting all quality and integrity standards.

- **Evidence** (numerical or screenshot)

Figure 117. The assessment boundary

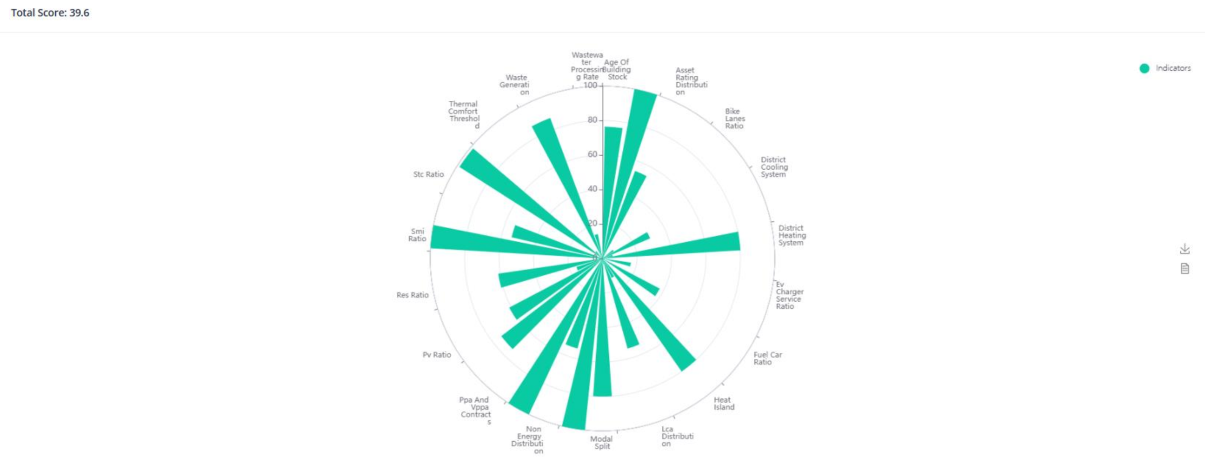


Figure 118. Building Complex asset rating in Leitza

Numerical result evidence: Total KPIs selected: 37; Technical KPIs: 26; Sociocultural KPIs: 11

- **Lessons learned:**

Early identification and coordination with stakeholders is essential to streamline the boundary definition

Cross-validation of data sources significantly reduces errors; close collaboration with government and various

The co-development and multidisciplinary review of the proposed KPIs ensures their alignment with project objectives and avoids methodological bases.

Normalizing KPI units to percentages makes them easier and more understandable for technicians, reducing the barrier to entry and the learning curve for the methodology.

Residents' choice of weights reflects their end-user preferences, as well as their culture, identity, and aspirations, avoiding gentrification effects and double penalties.

- **Proposed improvements:**

Develop a set of participatory dynamics tools, adaptable to different sociocultural contexts.
A data repository could be created with the information required for each neighborhood assessment.
Update the validity of the developed KPIs every 5 years
The inclusion of neighbors in this central aspect of the methodology reinforces the sense of community and promotes empowerment among neighborhood.

6.4.3.12 UC3.6 Asset rating as service

- **Result:** PASS
  Valid API requests successfully provide the asset-based assessment results.
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):
  Request performed with EPC assessor credentials returns data normally

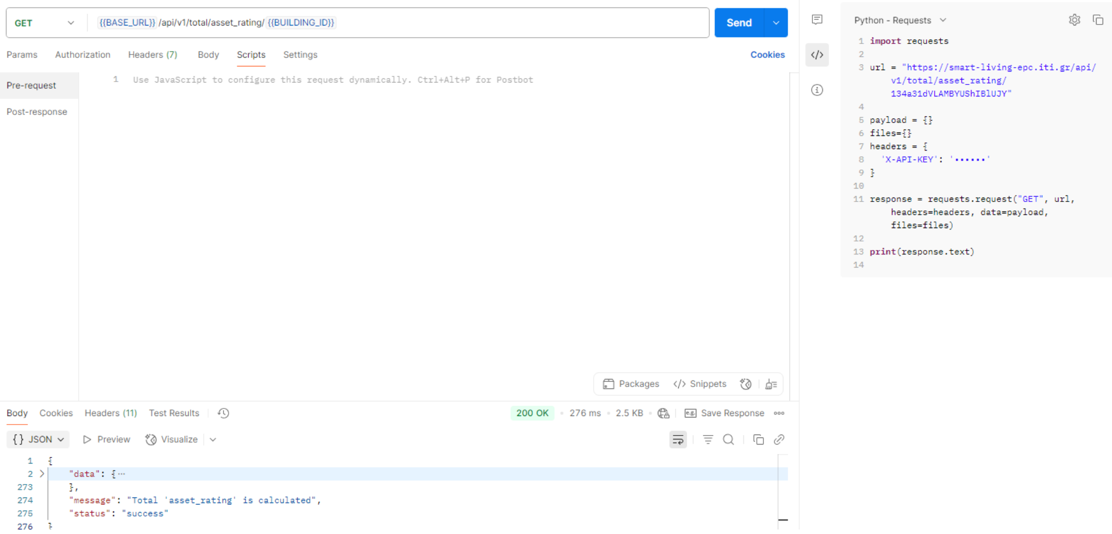


Figure 119. Request performed with EPC assessor credentials returns data

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.4.3.13 UC4.1 Operational Energy Analysis

- **Result:** PASS
  The result is dependent on the energy consumption measurements in the pilot sites. As explained in the previous section, there have been issues with some measurements in the buildings in Leitza, except for electricity consumption. The calculations only rely on electrical energy measurements, thus not providing a result adhering to reality. In the case of DS7, DS8, and DS9, the issue was resolved using historical data on natural gas and fuel oil consumption.
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

  Results in DS4, DS5, DS6 only relying on electrical energy consumption

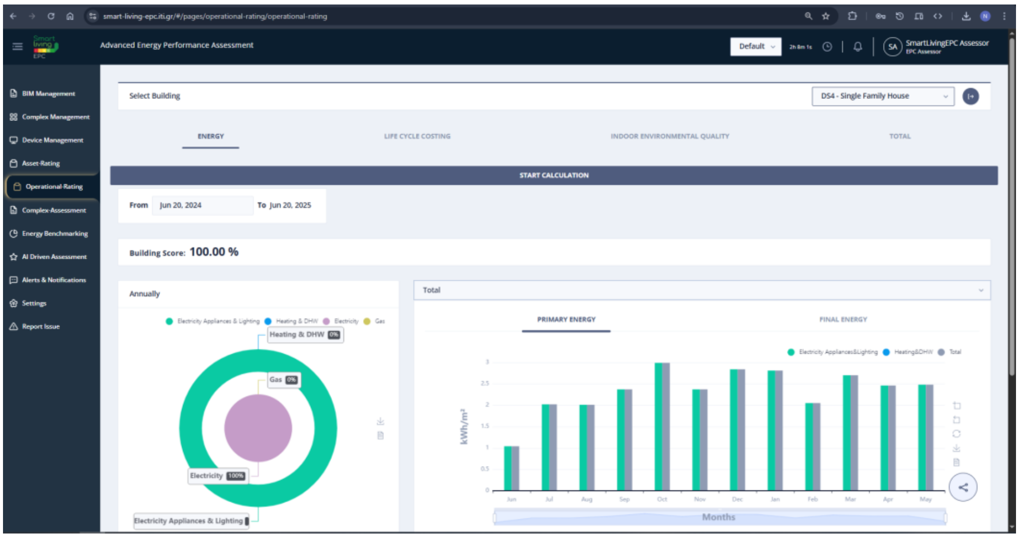


Figure 120. Operational Energy Analysis in DS4

In DS7, DS8, and DS9, the results are based on historical consumption data obtained from invoices.

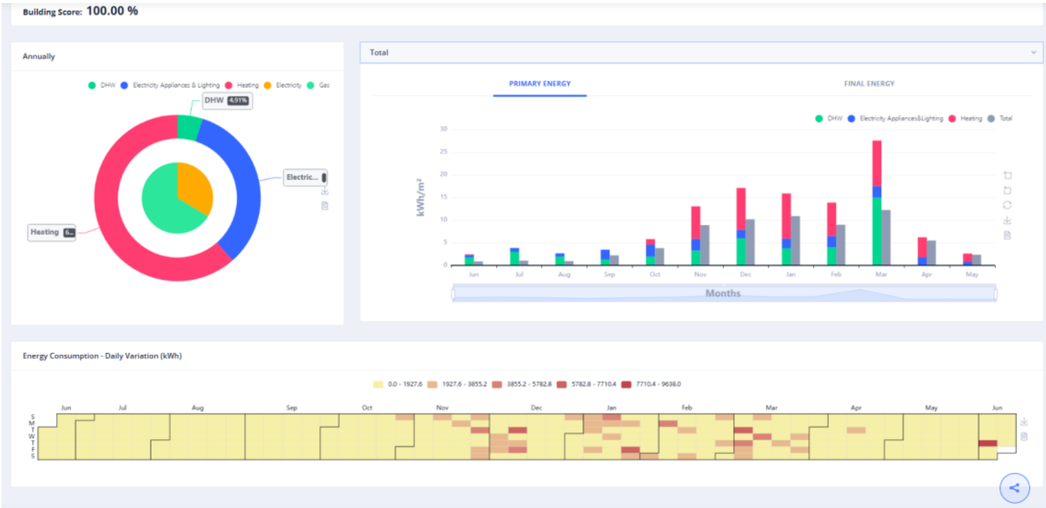


Figure 121. Operational energy analysis in DS8

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.4.3.14 UC4.2 IEQ performance calculation

- **Result:** PASS
- **Incidence/Impact:** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

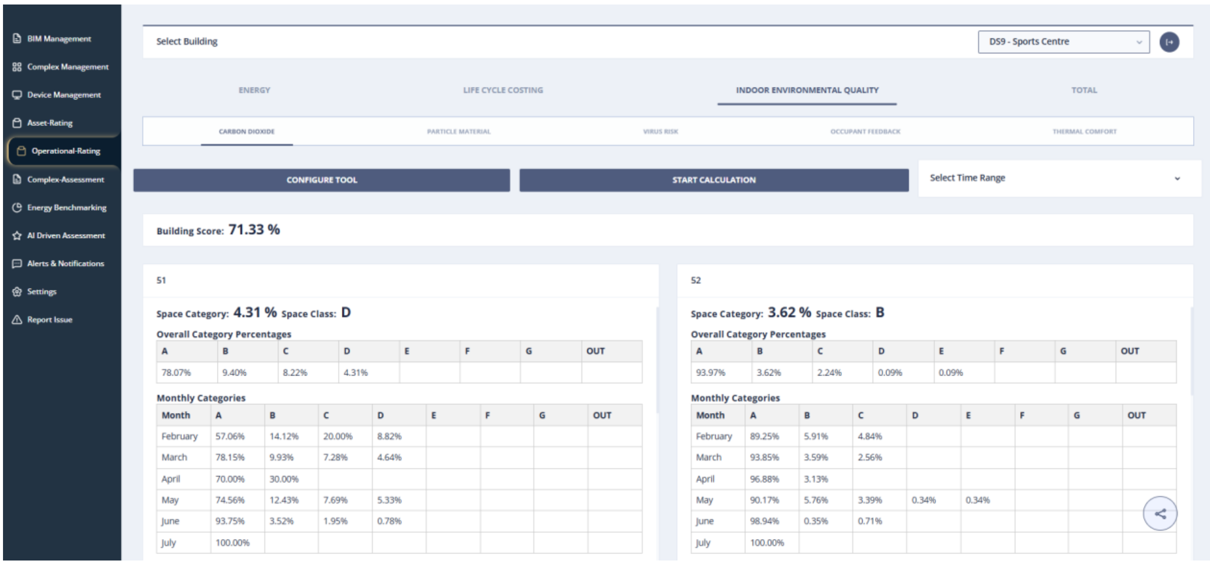


Figure 122. IEQ results for DS9 – Sports Centre

- **Lessons learned: N/A**
- **Proposed improvements:**
    1. Occupancy hours could be also visualized while calculated from sensor data, because then the assessor can validate the sensor data and if needed, overwrite the sensor data with validated occupancy time.
    2. There could be an example or description of the input value.

6.4.3.15 UC4.3 LCC assessment

Results for all UCs have been calculated.

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

Example results from various DS's:

Figure 123. LCC assessment in various DS of Leitza

- **Lessons learned**: N/A
- **Proposed improvements:** N/A

6.4.3.16 UC4.4 Operational Rating issuance for Building Units

- **Result:** PASS (with reservations)
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot)

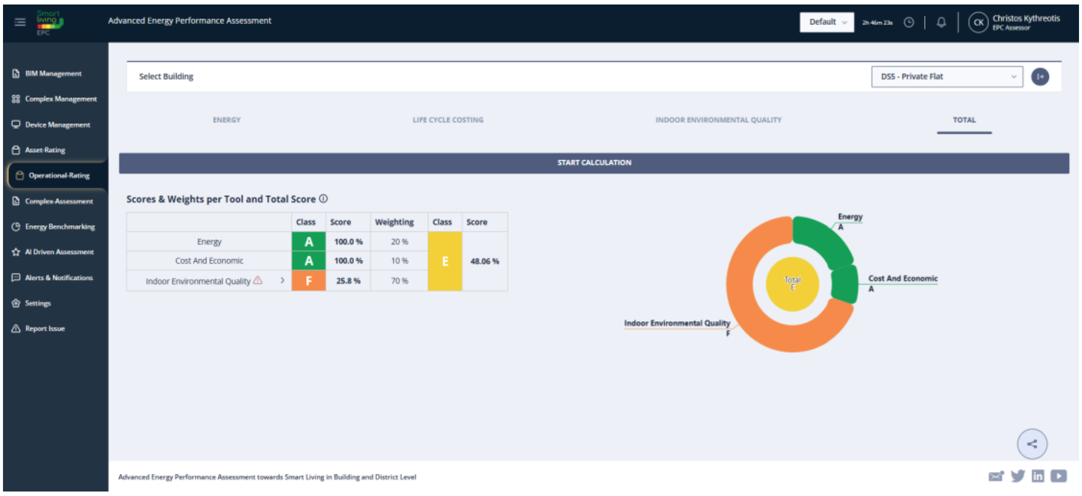


Figure 124. Operational rating in DS5

- **Lessons learned:** The experience highlighted how procedural completeness, even when data gaps exist, contributes to overall workflow maturity.
- **Proposed improvements:** N/A

6.4.3.17 UC4.5 Operational Rating issuance for Building Complexes

- **Result:** PASS
- **Incidence/Impact** (in case of fail):

  The implemented method to define neighborhood boundaries through participatory action dynamics promotes neighborhood cohesion and strengths cultural identity.

  The proposed set of KPIs includes Neighbourhood services, Renewable Energies and Neighbourhood´s Building Functioning indicators.

  All KPI units were normalized to percentages so that their incidence is measurable and comparable for all possible application cases.

- **Evidence** (numerical or screenshot)

Figure 125. Assessment boundary

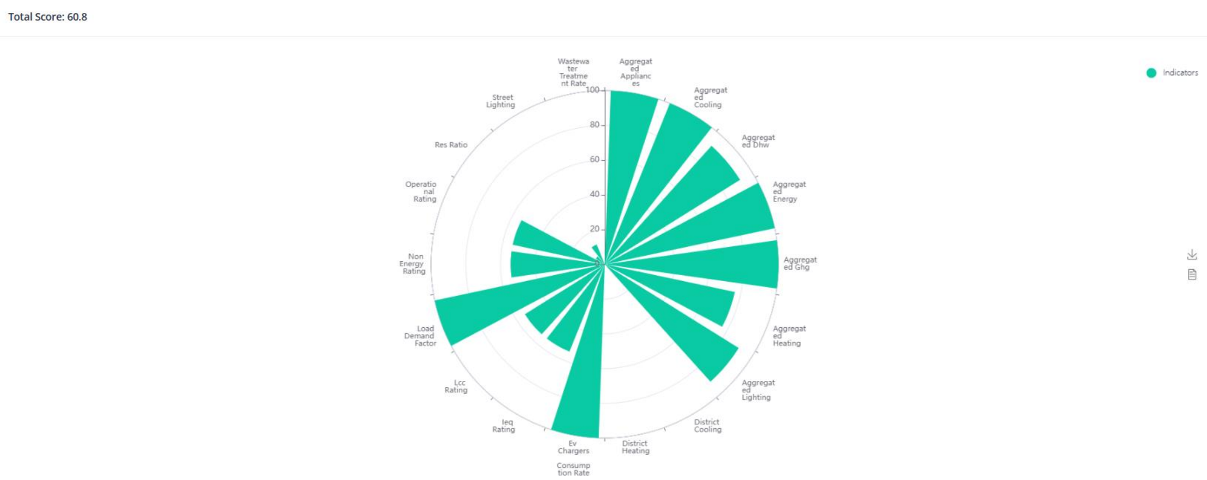


Figure 126. Buidling Complex operational rating

- **Lessons learned:**

  Early identification and coordination with stakeholders is essential to streamline the boundary definition process.

  The co-development and multidisciplinary review of the proposed KPIs ensures their alignment with project objectives and avoids methodological bases.

- **Proposed improvements:**

  Develop a set of participatory dynamics tools, adaptable to different sociocultural contexts.

6.4.3.18 UC4.6 Operational Rating as a service

- **Result:** PASS
  Request performed with EPC assessor credentials returns data normally.

- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):

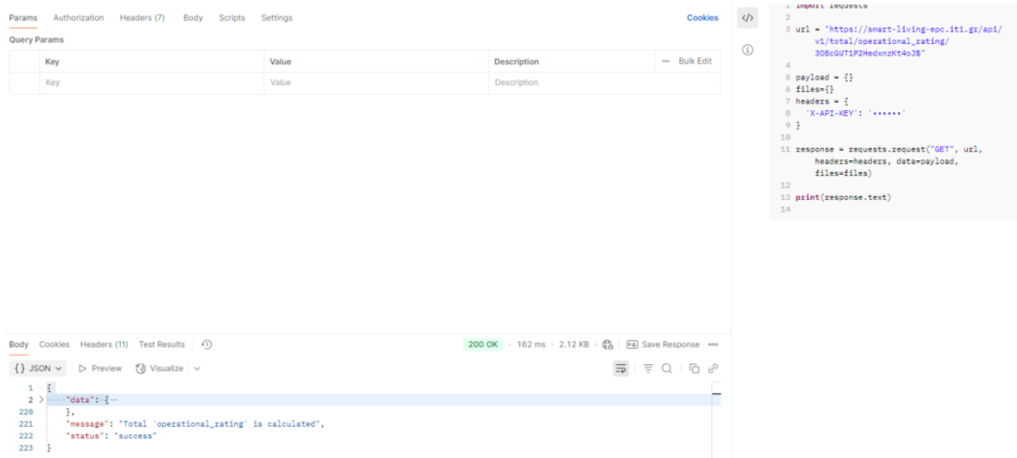


Figure 127. Request performed with EPC assessor credentials returns data

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.4.3.19 UC5.2 Building Dynamic Model Extraction

- **Result:** PASS (only energy forecasting)
  Occupancy estimation for 1-e week ahead, energy consumption prediction for 1-day ahead and alerts for behaviour optimization.
- **Incidence/Impact (in case o):** Occupancy-related services not applicable, as the building has no occupancy sensors
- **Evidence** (numerical or screenshot):

Results of the energy prediction service as screenshots (Only DS4 for simplicity)

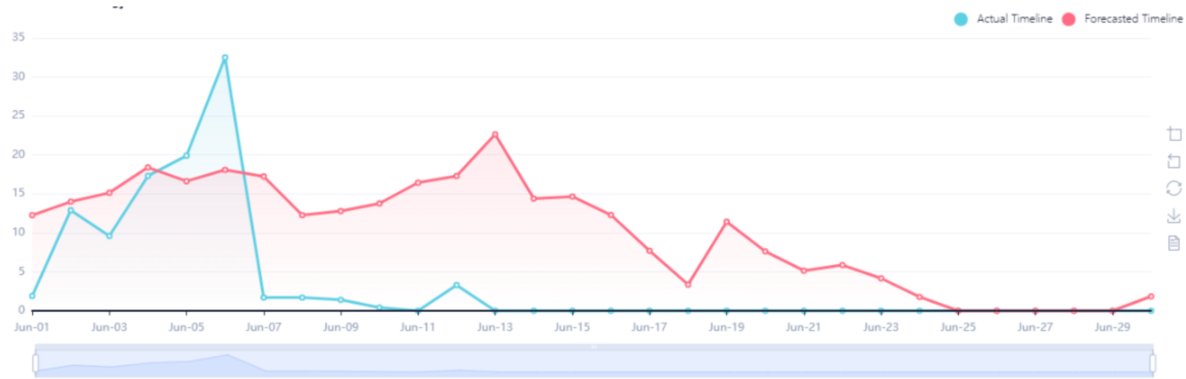


Figure 128. Energy Prediction in DS4

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.4.3.20 UC5.3 Provide the AI-driven operational analysis for improving the building's energy performance

Does not apply to Leitza pilots (DS4, DS5, DS6, DS7, DS8&DS9)

6.4.3.21 UC5.4 Generate Physics-based baseline building energy profiles for the building

- **Result:** Pass.

The tool displays the 3D models for the 6 buldings and the energy profile coming from the energy simulation engine.

The entire community has been validated for accuracy puprose with actual metered consumption was given for the validation process.

- **Incidence/Impact** (in case of fail): N/A
- **Evidence (numerical or screenshot):**

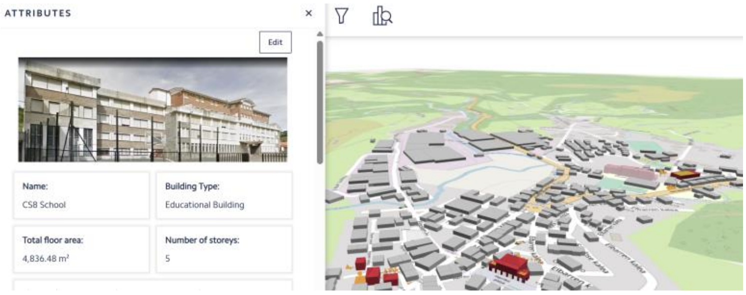


Figure 129. Complex Building Digital Twin and general data of DS8

Results and further details can be found in D4.2 SmartLiving Building Digital Twin and Digital Logbook

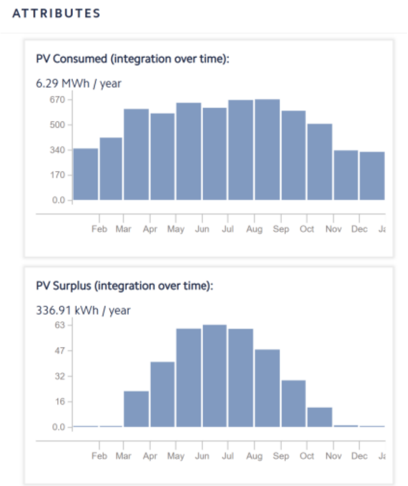


Figure 130. Energy profiles of collective PV installation in DS9

- **Lessons learned:**

A key lesson learned is that a more robust user experience (UX) design process early in development could have helped identify the existing issues related to the PV network community feature.

- **Proposed improvements:**

It would be beneficial to display actual measured energy data alongside simulated results within the same platform, enabling easier comparison and validation. Additionally, incorporating the country-specific EPC (Energy Performance Certificate) benchmark would provide valuable context for performance assessment

6.4.3.22 UC6.1 Provide information on as-designed/as-operated deviations

- **Result:** PASS

Successful visualization of comparison of asset and operational rating, in form of charts.

- **Incidence/Impact (**in case of fail): N/A
- **Evidence** (numerical or screenshot):

Screenshot with KPI evaluation results (example DS4)

Name	As Designed	As Operated	Comparison
Energy	62.00 %	100.00 %	61.29 %
CO2	16.00 %	50.00 %	212.50 %
Thermal Comfort	78.00 %	0.00 %	-100.00 %
Total	40.45 %	27.00 %	-33.25 %

Figure 131. KPI evaluation results in DS4

- **Lessons learned:**
- **Proposed improvements:** to provide a notification that if an indicator (asset or opertaional) has not been calculated, to avoid fault comparison.

6.4.3.23 UC6.2 Benchmark the asset's performance

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot):
  Results from the three energy benchmarking services as screenshots (Only DS4 for simplicity)

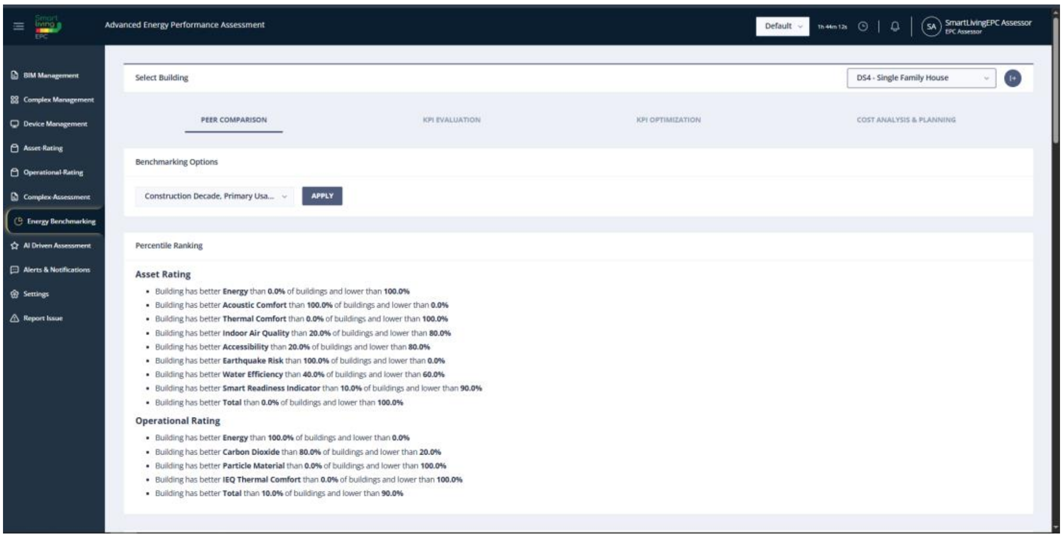


Figure 132. Energy Benchmarking in DS4

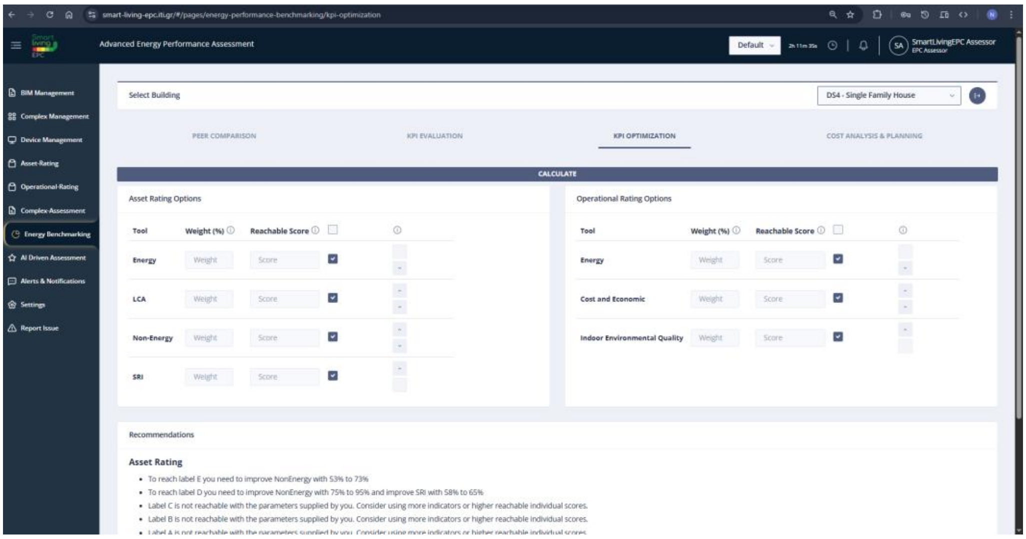


Figure 133. KPI optimization tool for DS4

- **Lessons learned:** N/A
- **Proposed improvements:** N/A

6.4.3.24 UC6.3 Provide recommendations for energy efficiency practices

- **Result:** Pass
- **Incidence/Impact (**incase of fail):
  The assessment provide the LCC information connected to the technical system upgrade. But does not provide estimation of EPC improvement.
- **Evidence** (numerical or screenshot):

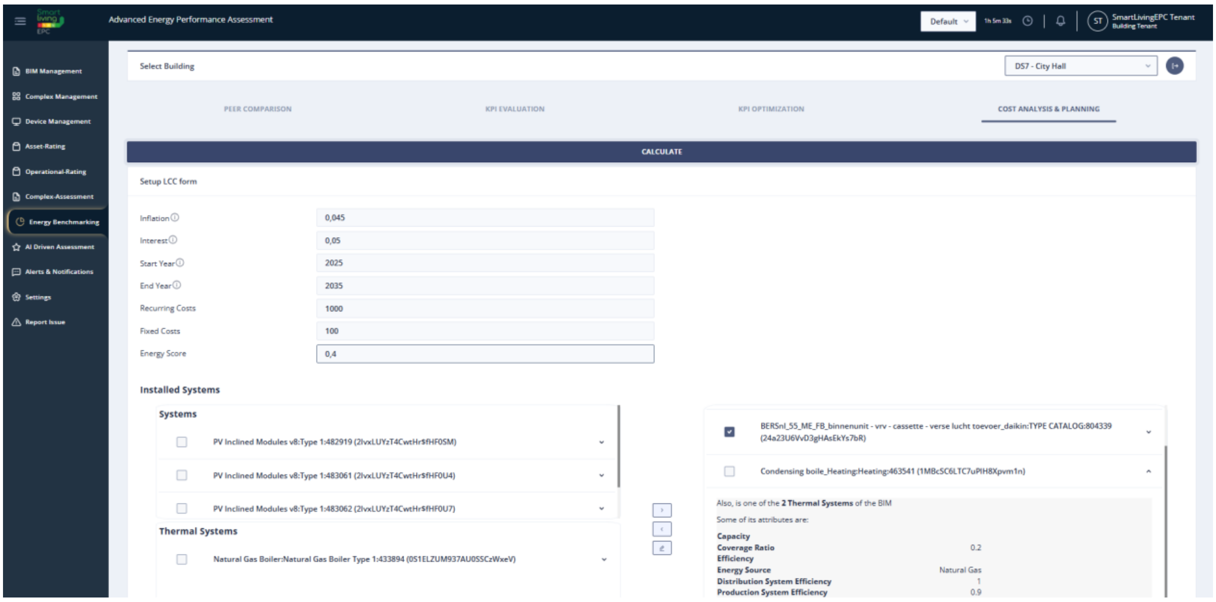


Figure 134. Replacement system input in DS7 (1 DS for simplifying)

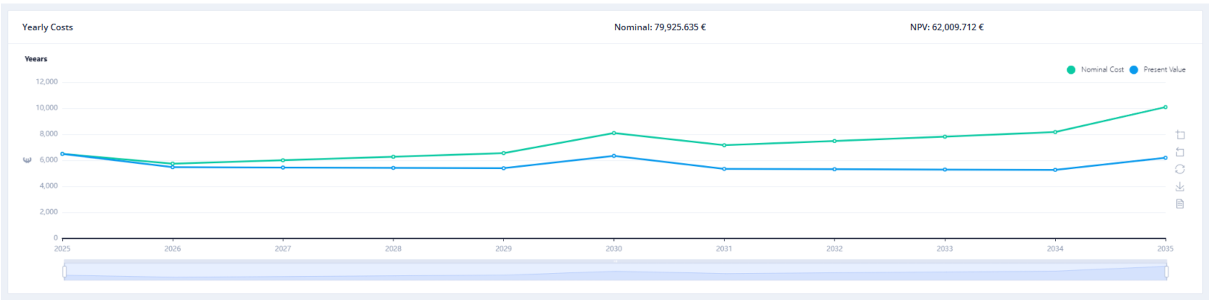


Figure 135. Cost analysis for a replacement system in DS7 (1 DS for simplifying)

- **Lessons learned:**
- **Proposed improvements:**
  To include estimations of EPC improvements for replacement systems.

6.4.3.25 UC7.1 Provide Building Records through Digital Logbooks

- **Result:** PASS
- **Incidence/Impact** (in case of fail): N/A
- **Evidence** (numerical or screenshot). See UC1.1 validation
- **Lessons learned:** N/A
- **Proposed improvements:** N/A

7 Results of SmartLiving EPC Evaluation Framework

Below are the results of the survey conducted to evaluate and monitor the performance of the SmartLivingEPC project concept. The survey questions were organized around the platform's various components to assess stakeholder acceptance.

The components were identified as:

- Digital Building Logbooks integration to EPC assessment: This dimension evaluates the functionalities of existing digital logbook initiatives (functional requirements, data interoperability, and stakeholder privacy) and evaluates the requirements for EPC certification.
- Technical systems audits integration to EPC assessment: This dimension focuses on enhancing the accuracy and reliability of EPCs by including detailed evaluations of building technical systems, such as HVAC, and aligning the ratings with real-world energy usage.
- Human comfort integration into EPC assessment: This dimension aims to evaluate the application of SmartLivingEPC IEQ (Indoor Environmental Quality) assessment in the pilot projects.
- SRI integration into SmartLivingEPC assessment: This dimension aims to estimate the degree of coordination of the SRI with complementary asset assessments through the SmartLivingEPC platform.
- Upgrade of operational EPC rating process: This dimension evaluates the integration and effectiveness of digital technologies, and the feedback mechanisms from users and assessors, focusing on their impact on the SmartLivingEPC's accuracy, comprehensibility, and energy efficiency improvements.
- Resident Perception of the Neighborhood Rating Scheme: This dimension gauges user perception of the SmartLivingEPC's new neighborhood scale rating system (NSLE). It focuses on four key aspects: the perceived usefulness, this is, the degree to which users believe the SLEPC offers valuable insights, the perceived ease of use, through which it is expected to evaluate the level of intuitiveness and clarity of SmartLivingEPC for users of various technical knowledge, the intention to use, gauging residents' willingness to regularly integrate the SLEPC into their decision-making processes, and the privacy of personal data, assessing user comfort with how the SLEPC collects and utilizes their personal data.
- Building Stock Enhancement: This dimension evaluates the effectiveness and understanding of the SmartLivingEPC certificate in facilitating decision-making for building improvements.
- Overall evaluation of the Tool: Up to this point, you've provided feedback on the various components of the SmartLivingEPC certificate. In this section, we'll ask you to provide feedback on the tool as a whole.

7.1 Assessors SmartLivingEPC assessment

7.1.1 Digital Building Logbooks integration to EPC assessment

The graphs below show the results of different aspects based on the assessors' perception after using the SmartLivingEPC platform. Digital Building Logbooks integration to EPC assessment dimension evaluates the functionalities of existing digital logbook initiatives (functional requirements, data interoperability, and stakeholder privacy) and evaluate the requirements for EPC certification. A total of eight assessors with technical expertise in Energy Performance Certificates participated in the evaluation of the SmartLivingEPC platform.

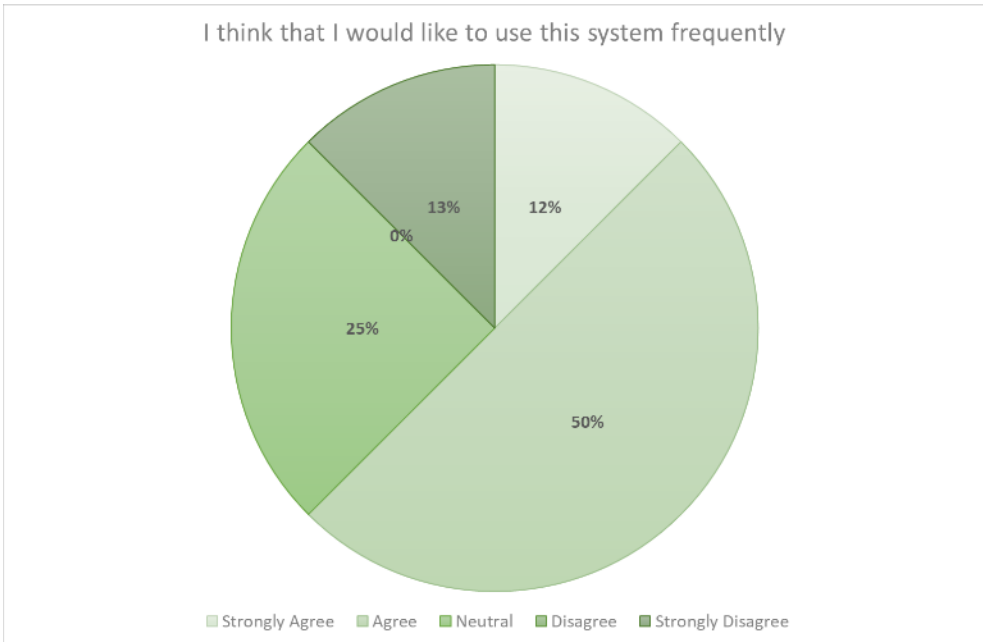


Figure 136. Frequent System Use

The results of the first dimension reveal a high level of willingness among assessors to adopt the system in their routine work. 75% percent expressed interest in using the SmartLivingEPC platform frequently, a strong indication of acceptance and validation success. A small proportion of neutral (13%) and negative (12%) responses suggest minimal reservations, likely linked to individual preferences or operational contexts.

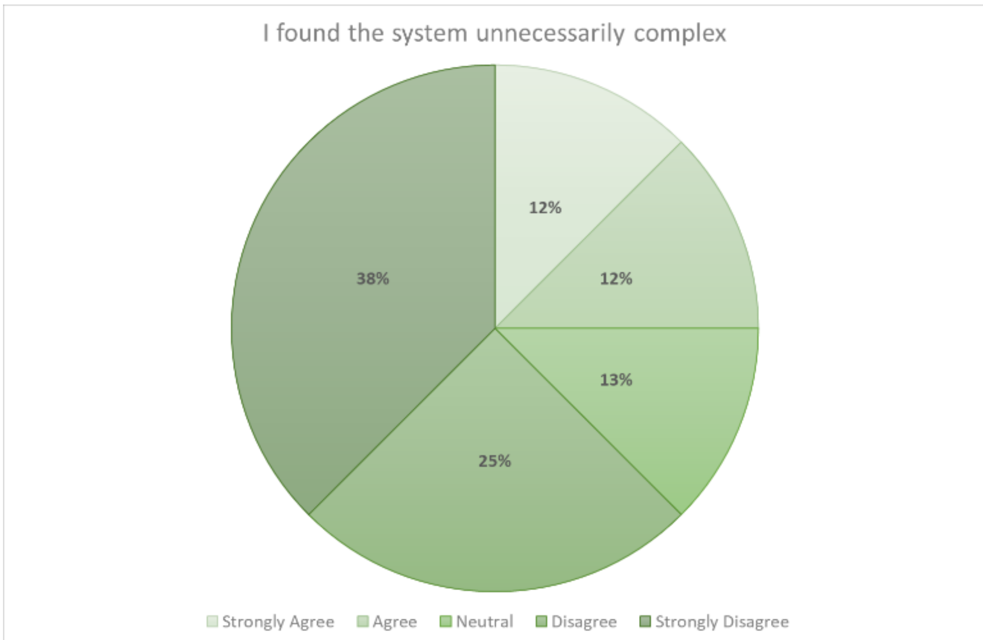


Figure 137. Unnecessary Complexity

Regarding the complexity, the majority of assessors (63%) disagreed with the notion that the platform is unnecessarily complex. This reflects a generally manageable level of complexity across use cases. Nonetheless, 24% of respondents did perceive the system as complex. Coincidentally, in terms of ease of use, 62% of assessors reported that the system was intuitive and easy to navigate. This perception reinforces the success of the platform's user interface design. However, 26% did not find the system easy to use, signaling inconsistencies in the user experience. These variations may stem from differing levels of technical familiarity or task-specific interactions, suggesting that further refinements are needed to ensure uniform ease of use.

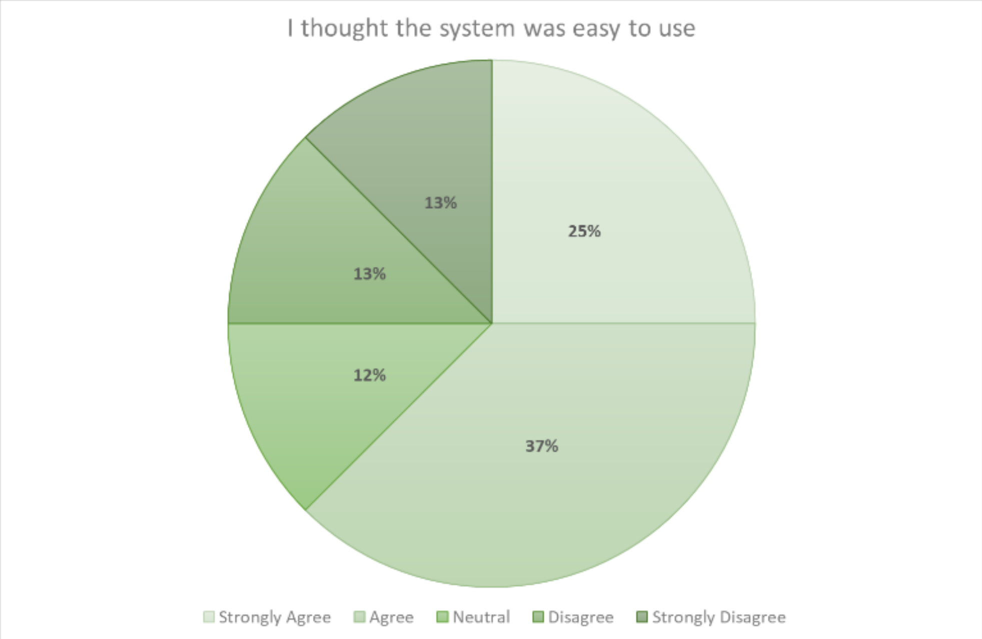


Figure 138. Ease of Use

With regard to learnability, 62% of assessors believed that most users would be able to learn the system quickly. This perception underscores the platform's suitability for professional environments, particularly among technically proficient users. However, the 25% who expressed uncertainty indicate that targeted training resources could enhance adoption and reduce variability in onboarding experiences. Maybe this was the reason for diverged opinions regarding the need for technical support.

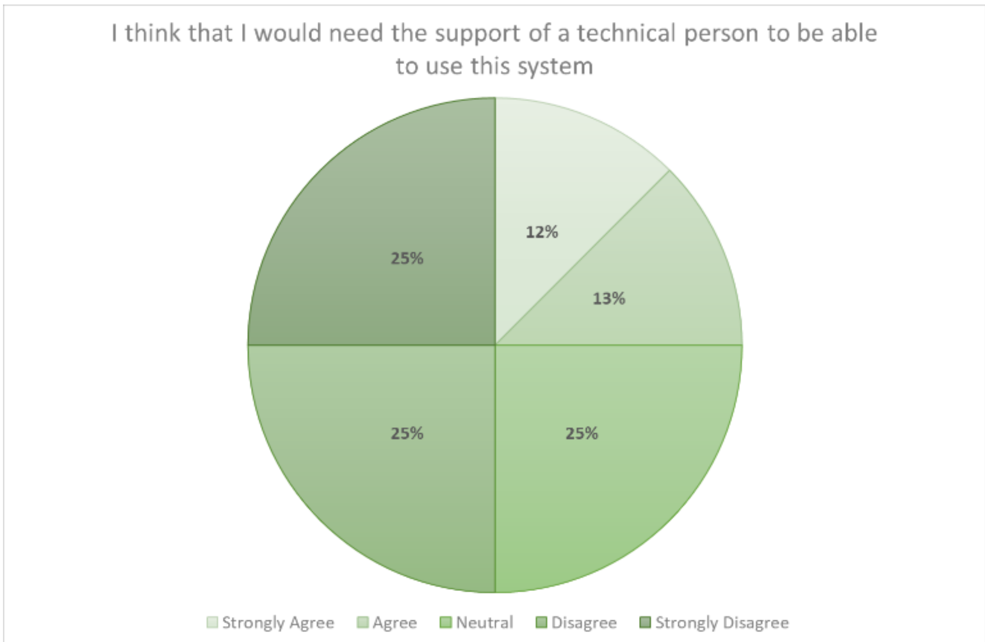


Figure 139. Need for Technical Support

While 38% felt confident navigating the system without assistance, 37% anticipated requiring support, and 25% were undecided. This distribution highlights the importance of providing robust onboarding processes and user-friendly support materials to bridge the gap between autonomous users and those requiring guidance. It is necessary to highlight that, when asked about the level of initial learning required to begin using the platform, 62% of assessors disagreed that significant effort was needed. This reinforces the conclusion that the platform supports efficient user onboarding. However, 25% of assessors reported experiencing a steeper learning curve, pointing to a need for enhanced introductory resources and potentially interactive tutorials to support early adoption.

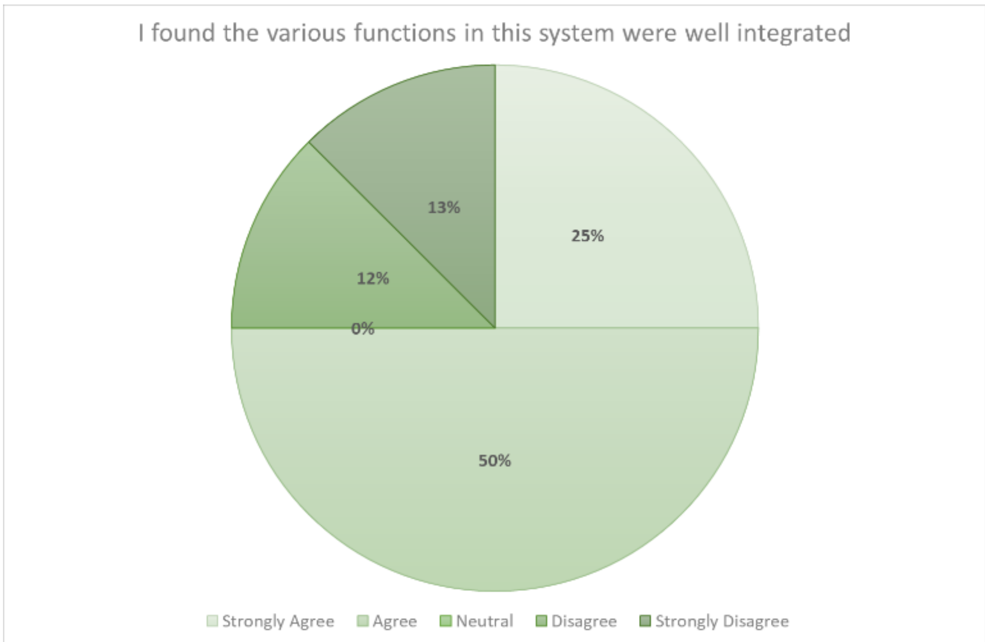


Figure 140. Function Integration

Regarding the SmartLivingEPC functional integration, three-quarters of the assessors agreed that the platform's components are well-integrated, contributing to a smooth and coherent user experience. Only a small percentage (13%) identified integration issues, suggesting isolated incidents rather than systemic flaws.

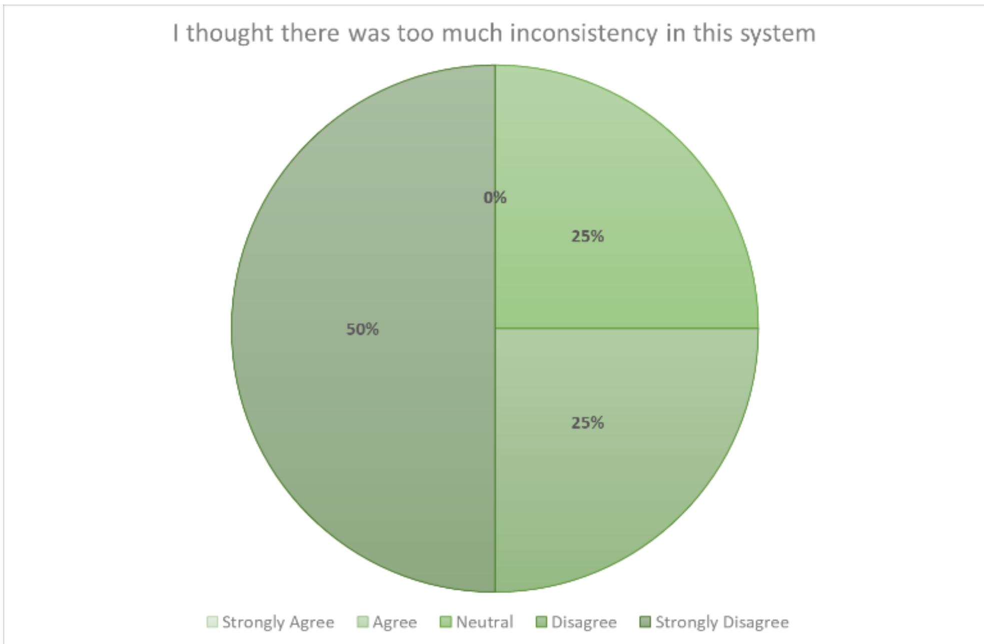


Figure 141. System Inconsistency

The effectiveness of the underlying architecture was validated by 75% of assessors, who reported that the platform behaved reliably during use. Nevertheless, 25% of respondents perceived inconsistencies, which merit further technical review to ensure uniform behavior across diverse usage scenarios.

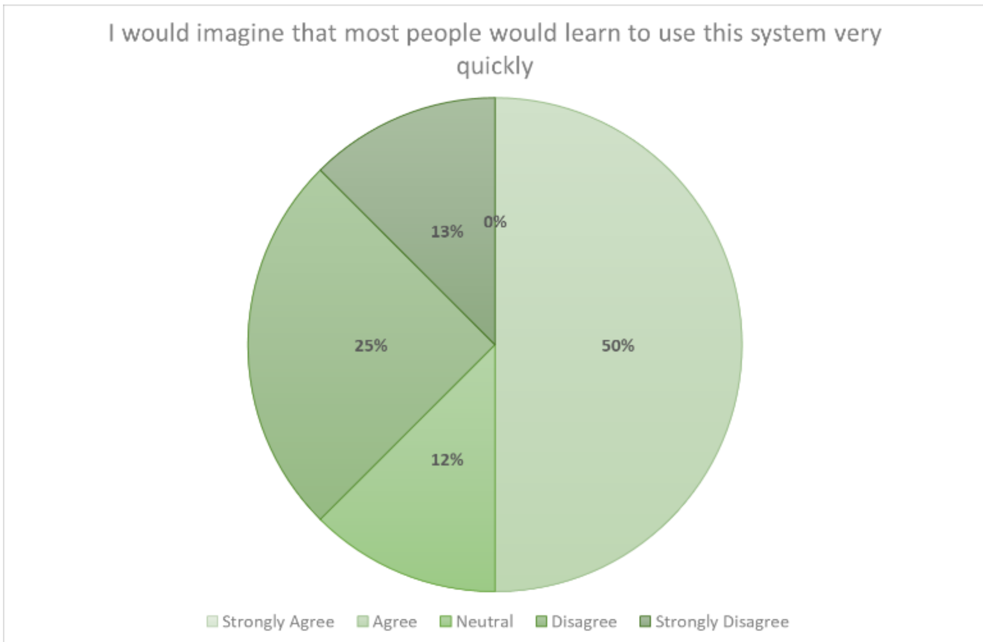


Figure 142. Learning Curve

A combined 75% of respondents expressed confidence that most people would learn to use the system quickly (50% strongly agreed and 25% agreed). This suggests a generally positive view of the system's intuitiveness and user-friendliness. Meanwhile, 12% remained neutral, possibly needing more exposure to the system to form a firm opinion. Only 13% disagreed, and no respondents strongly disagreed, indicating that negative perceptions are limited.

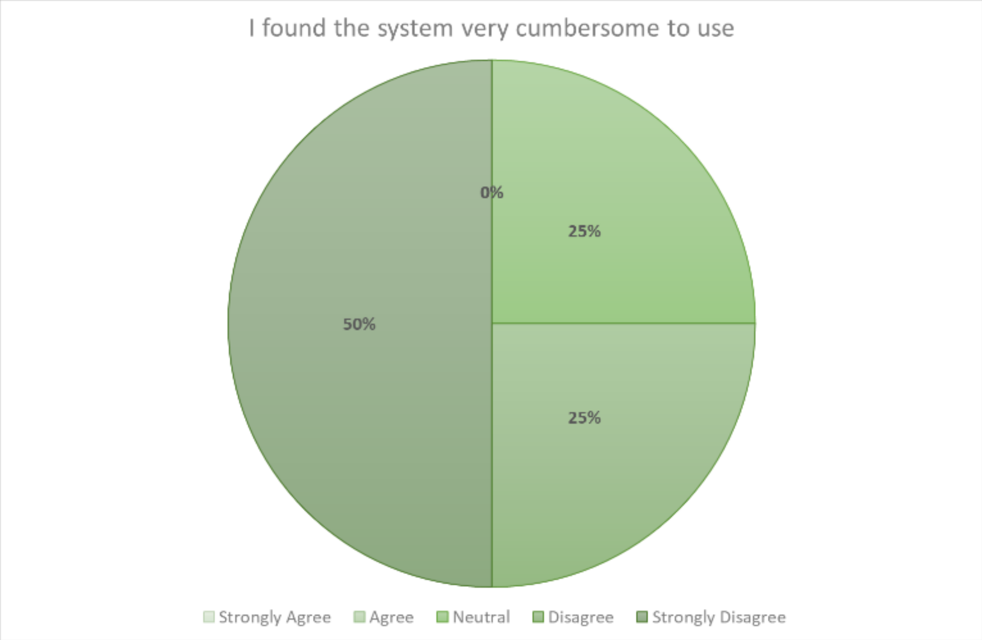


Figure 143. System Cumbersomeness

Perceptions of operational cumbersomeness shows 75% of assessors disagreeing that the system is cumbersome. This finding supports the view that the workflow design is generally efficient. Still, 25% of respondents felt the system was cumbersome, suggesting that specific interactions or features might benefit from streamlining.

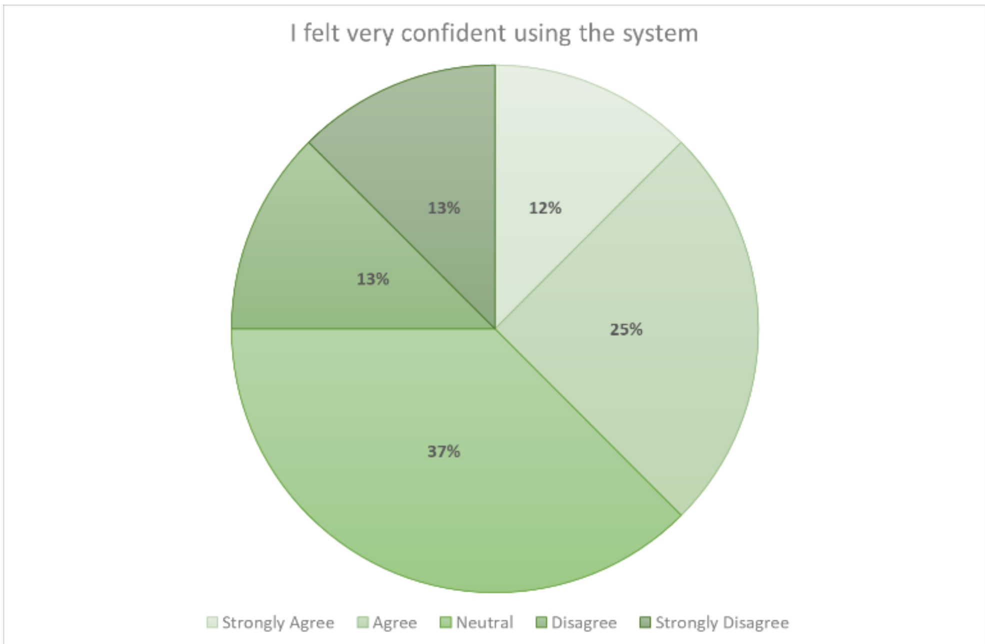


Figure 144. User Confidence

Confidence in using the system was reported by 62% of assessors, reflecting an overall sense of control and clarity when interacting with the platform. At the same time, 26% of participants expressed lower levels of confidence, which could be mitigated through improved interface feedback, more accessible documentation, and clearer task flows.

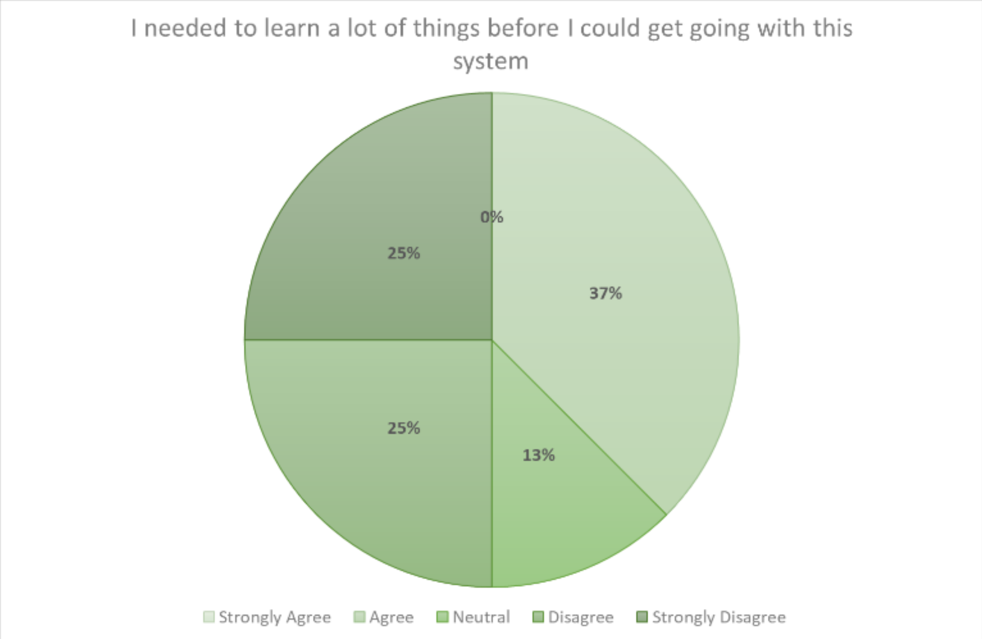


Figure 145. Initial Learning Requirements

The analysis reveals a positive correlation between the willingness to frequently use the system and the perception of ease of use and manageable complexity. Assessors who considered the platform intuitive and not overly complex were markedly more inclined to report frequent use, highlighting the critical role of usability in fostering acceptance. Conversely, a clear link emerges between the perceived need for technical support and the experience of complexity and cumbersomeness. Respondents who identified the system as unnecessarily complex or operationally cumbersome were also more likely to anticipate requiring technical assistance, suggesting that perceived usability barriers directly influence expectations for support.

Confidence in using the system is similarly intertwined with perceptions of ease of use and learnability. Assessors who expressed confidence typically found the platform easy to use and believed that users would learn to operate it quickly. On the other hand, those with lower confidence often reported encountering challenges during initial interactions, underscoring the value of targeted training and onboarding resources. A comparable alignment is observed between the perceived integration of system functions and the consistency of system behavior. Assessors who found functionalities well integrated were also those who did not report inconsistencies, suggesting that coherent architecture and seamless interface design contribute significantly to perceptions of system reliability.

Additionally, there is a relationship between the level of initial learning required and the perception of complexity and cumbersomeness. Assessors who indicated that minimal learning was necessary to begin using the platform were generally those who did not find the system complex or cumbersome. In contrast, respondents who reported higher initial learning needs often coincided with those identifying complexity and cumbersome features, pointing to the importance of accessible and well-structured guidance in supporting early engagement.

These patterns collectively demonstrate that the platform’s usability dimensions are mutually reinforcing. Ease of use, low complexity, quick learnability, and system confidence are positively associated, forming a foundation for stakeholder satisfaction and operational efficiency. In contrast, the perception of barriers in one area—such as complexity or inconsistency—can cascade into increased reliance on support mechanisms and reduced confidence. Therefore, strategic investments in usability improvements, streamlined workflows, introductory resources, and responsive support services are essential to consolidating assessor engagement and enhancing the overall validation performance of the SmartLivingEPC system.

7.1.2 Technical systems audit integration to EPC assessment

This dimension focuses on enhancing the accuracy and reliability of EPCs by including detailed evaluations of building technical systems, such as HVAC, and aligning the ratings with real-world energy usage

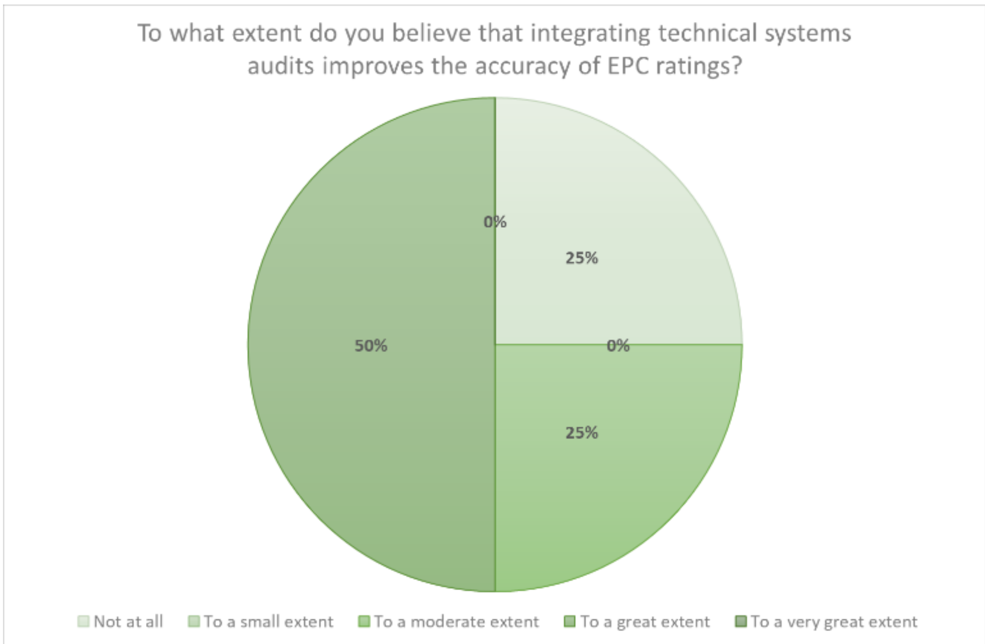


Figure 146. Accuracy Impact

The analysis of the Technical systems audits integration to EPC assessment dimension indicates a generally favorable perception among evaluators regarding the added value of incorporating technical systems audits into the EPC assessments. Across the four survey questions, a moderate to high support for the role of technical audits in improving the accuracy, diagnostic capacity, and relevance of EPCs is showing.

First, regarding the accuracy of EPC ratings, a combined 75% of respondents believe that technical systems audits contribute either “to a moderate extent” (25%) or “to a very great extent” (50%), with no respondents indicating that audits do not help at all.

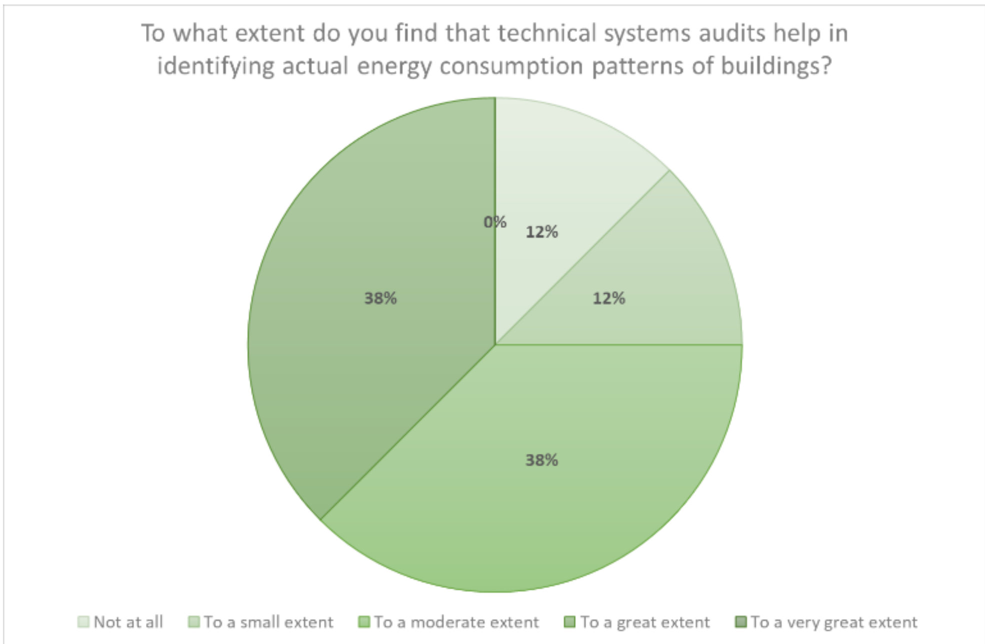


Figure 147. Consumption Insights

Second, when asked whether technical audits help identify actual energy consumption patterns, 76% of assessors responded positively, split equally between "to a great extent" and "to a moderate extent." Only 24% expressed limited or minimal agreement, suggesting that technical audits are perceived as a reliable method to align certification results with real-world performance.

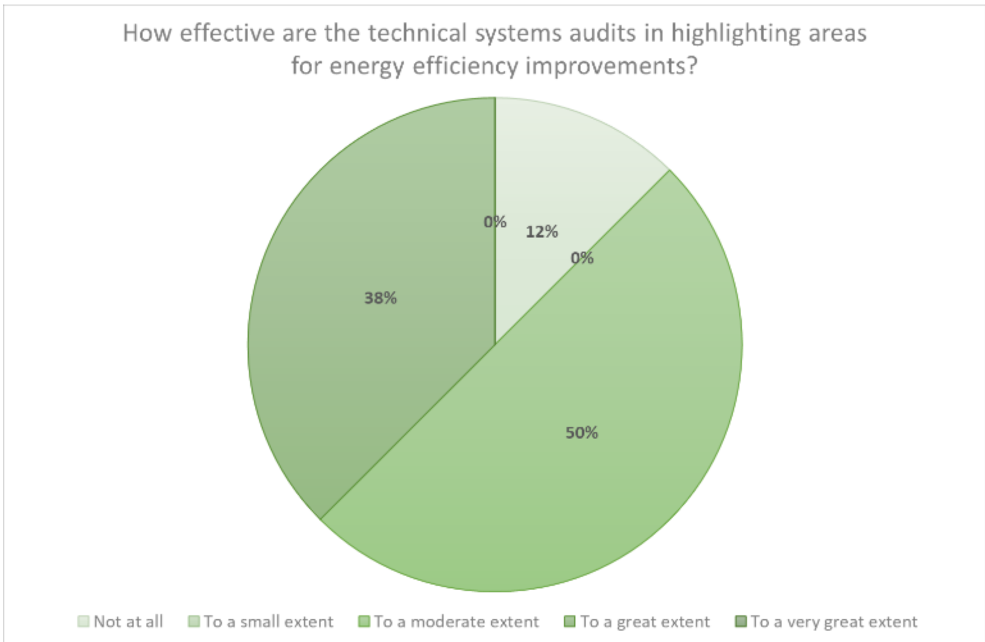


Figure 148. Efficiency Guidance

Third, the chart shows that 50% of respondents rated technical systems audits as "to a great extent" effective and 38% as "to a moderate extent," for a total of 88% positive responses. Only 12% considered audits to be "to a small extent" effective, and no participants selected "not at all" or "to a great extent.".

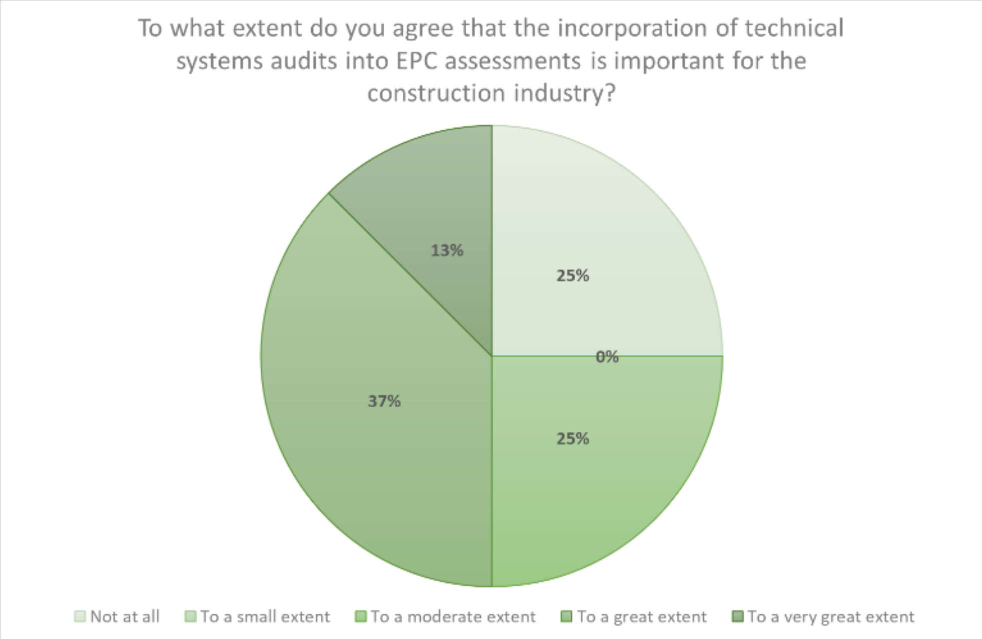


Figure 149. Industry Relevance

Finally, when evaluating the importance of audit integration for the construction industry at large, responses shows more variations. A total of 62% support the idea to at least a moderate extent, while 25% remain neutral and 13% see limited value. This reveal a need for continued advocacy or clearer demonstration of long-term benefits, especially among more skeptical stakeholders.

It is noteworthy that there is a strong consensus between those who consider technical audits effective in improving the accuracy of EPC ratings and those who value their ability to identify real energy consumption patterns. In both cases, more than 75% of respondents expressed at least moderate agreement. This could be because evaluators who trust audits' ability to increase rating accuracy also recognize their diagnostic potential to reflect actual energy consumption, reinforcing the conceptual link between accuracy and empirical relevance. Similarly, a parallel emerges between the identification of consumption patterns and the perceived usefulness of audits in recommending energy efficiency improvements. In this case, the majority of responses fell within the moderate to high range, confirming that evaluators perceived a natural progression from data collection to practical recommendations. This indicates a consistent view among respondents that effective diagnostics support strategic interventions, implying that audits would serve not only to describe conditions but also to guide improvements. Despite this agreement on functional value, the level of confidence in the broader institutional integration of audits is comparatively lower. While evaluators show support for audits' achievements at the assessment level, they are less enthusiastic about their importance for the construction sector as a whole. With 25% of responses neutral and 13% moderately supportive, this discrepancy may be due to some stakeholders' distinction between technical effectiveness and sectoral feasibility. Possible reasons for this caution include concerns about implementation costs, the complexity of standardizing procedures, or resistance to change within the construction sector. This leads to a broader cross-cutting perspective: while evaluators show great confidence in the value that audits can bring (such as increased rating accuracy, energy diagnoses, and specific efficiency recommendations), they are less certain about the feasibility of their systematic adoption across the sector. This difference in perception between functional outcomes and practical adoption implies a gap between technical merit and institutional integration.

7.1.3 Human comfort integration into EPC assessment

This dimension aims to evaluate the application of SmartLivingEPC IEQ (Indoor Environmental Quality) assessment in the pilot projects.

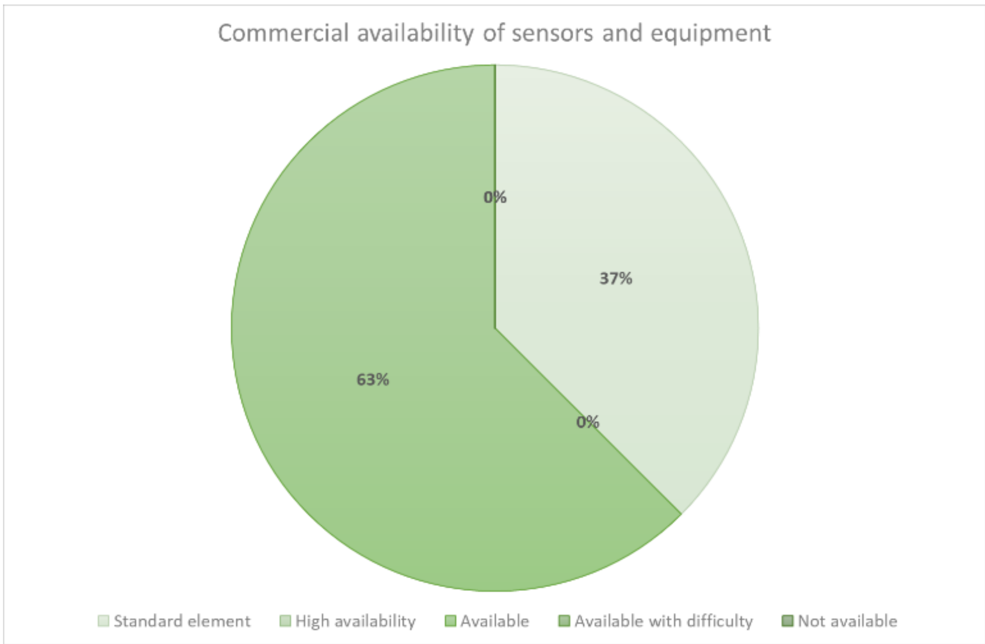


Figure 150. Sensor Availability

The responses collected suggest that integrating Indoor Environmental Quality (IEQ) elements into EPC assessments appears to be widely viable from both a commercial and technical perspective. Regarding the commercial availability of sensors and equipment, the majority of respondents (63%) consider the required technologies to be "highly available," while the remaining 37% identify them as "standard elements." Notably, no respondents reported difficulties with availability or unavailability, suggesting that IQ-related equipment is readily accessible in all settings.

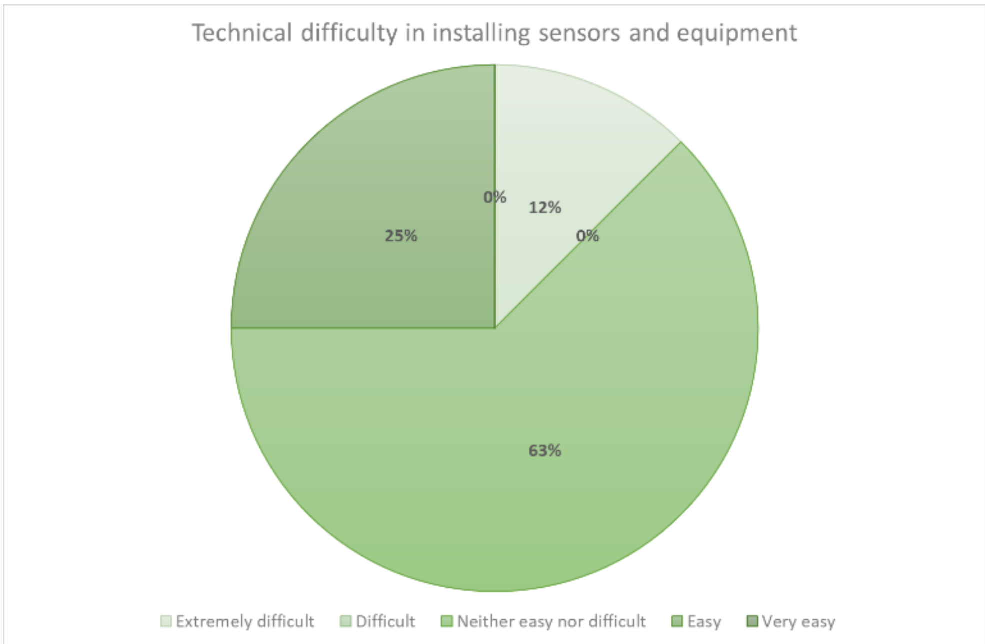


Figure 151. Ease of Installation

From a technical perspective, 88% of evaluators described the installation process as "easy" (63%) or "very easy" (25%), while no respondents described it as "difficult" or "extremely difficult." Only a small minority (12%) considered it neutral in terms of difficulty, demonstrating that implementation does not present significant barriers at the hardware level. Similarly, the data collection and storage processes are perceived as relatively straightforward. Half of respondents rated this aspect as "easy," and an additional 25% rated it as "very easy." While a small percentage indicated difficulty (13%) or neutrality (12%), overall trust in data management appears strong.

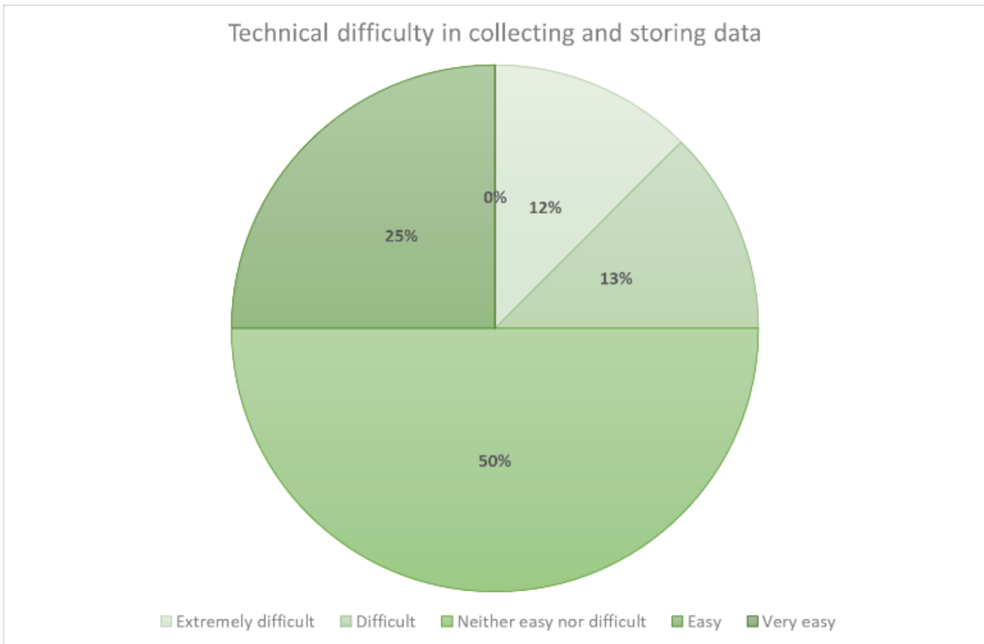


Figure 152. Ease of Data Handling

Half of the respondents (50%) found the process of collecting and storing data to be easy, and an additional 25% rated it as very easy, indicating that 75% did not encounter significant difficulties. A minority of respondents rated the task as neither easy nor difficult (13%) or difficult (12%), while none rated it as extremely difficult.

Overall, these results suggest that the technical infrastructure and interface for data handling in the system are largely user-friendly and accessible.

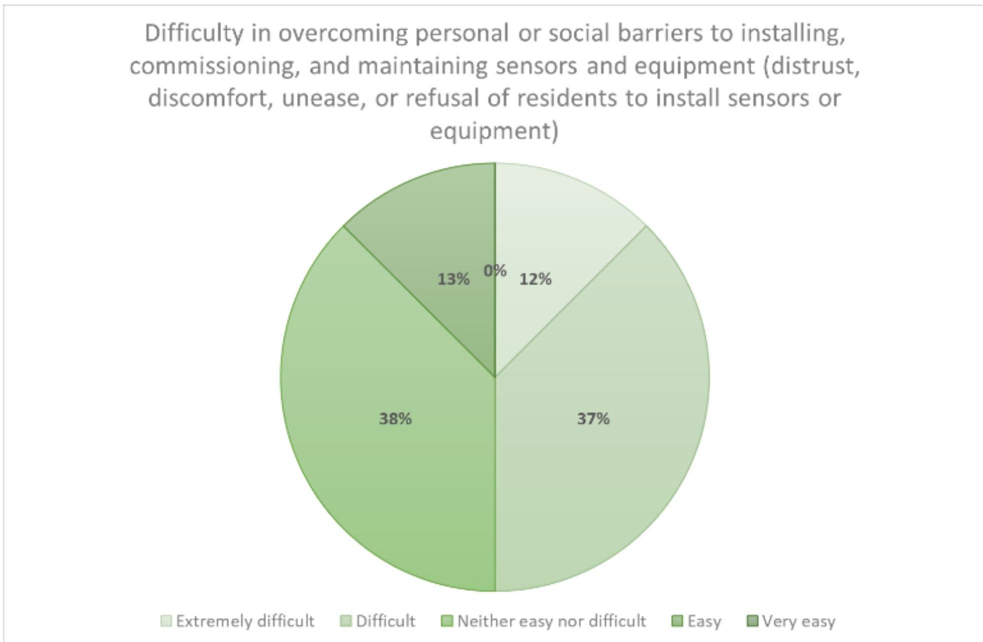


Figure 153. Social Acceptance Barriers

The challenges in this dimension appear to be related to factors of personal and social acceptance. While 38% of evaluators considered overcoming user discomfort or mistrust "neither easy nor difficult," and 37% rated it as "easy," 13% still described these barriers as "difficult." This indicates that social aspects, such as residents' resistance to the presence of sensors or concerns about data privacy, can pose difficult obstacles to overcome, even when technical conditions are favorable.

7.1.4 SRI integration into SmartLivingEPC assessment

This component aims to estimate the degree of coordination of the SRI with complementary asset assessments through the SmartLivingEPC platform.

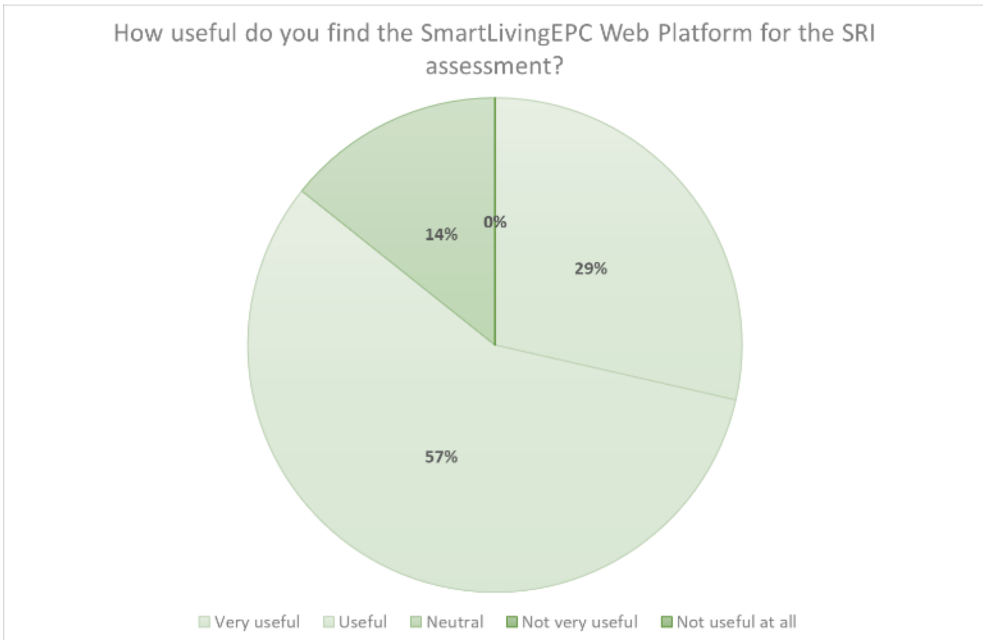


Figure 154. Web Platform Usefulness for SRI

Regarding the usefulness of the SmartLivingEPC Web Platform for SRI assessment, 57% of respondents described it as "useful" and 29% as "very useful." Only a minority (14%) were neutral, and no respondents rated the platform negatively. This indicates a high degree of acceptance and perceived value in the platform's current features that support the SRI process.

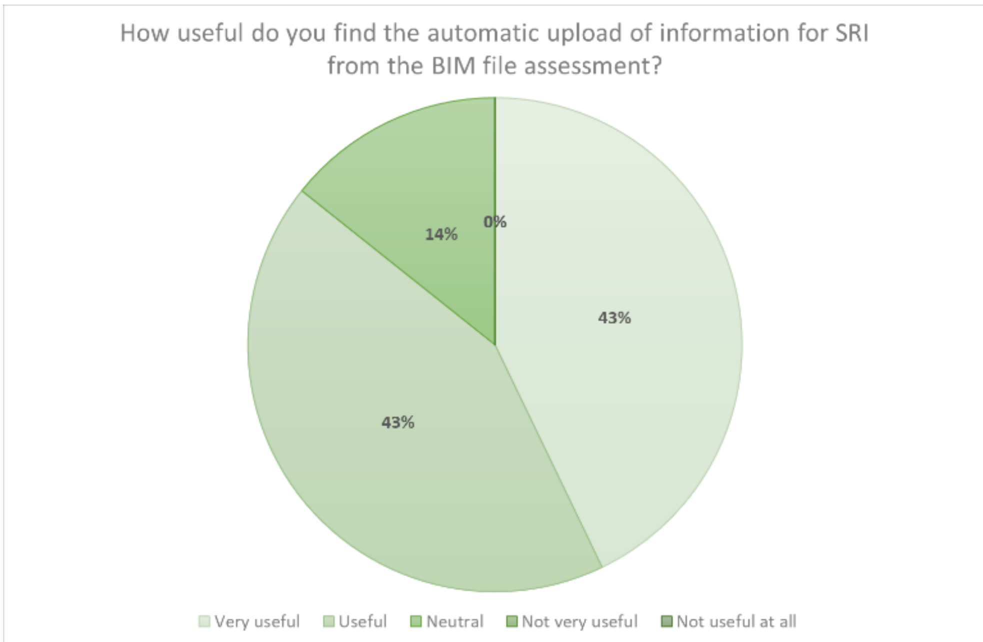


Figure 155. BIM automatic upload Usefulness

Secondly, the evaluation of the automatic upload of information from BIM files for SRI purposes also showed favorable results, with 86% of participants considering this feature "very useful" (43%) or "useful" (43%). This reinforces the idea that automation and interoperability between systems are necessary improvements. Again, only 14% rated this feature neutrally, and no negative comments were recorded, suggesting that it is an appropriate solution for the experts' needs.

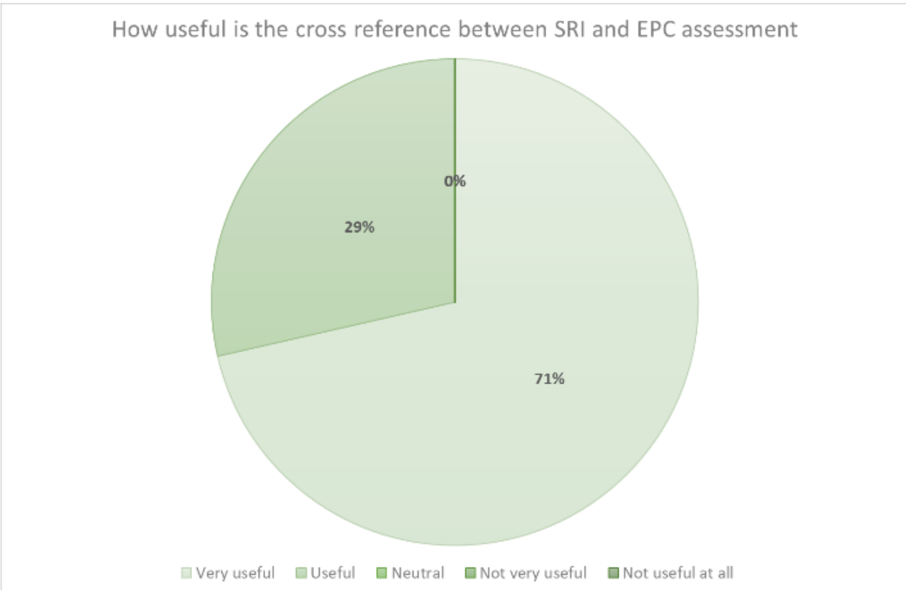


Figure 156. SRI–EPC Link Usefulness

The most highly rated aspect of this dimension was the ability to cross-reference SRI and EPC assessments. Seventy-one percent of respondents rated this feature as "very useful," while the remaining 29% described it as "useful." This assessment reflects a strong demand for integrated tools that enable consistent and optimized multi-metric assessments in the field of building performance.

7.1.5 Upgrade of operational EPC rating process

This dimension evaluates the integration and effectiveness of digital technologies, and the feedback mechanisms from users and assessors, focusing on their impact on the SmartLivingEPC's accuracy, comprehensibility, and energy efficiency improvements.

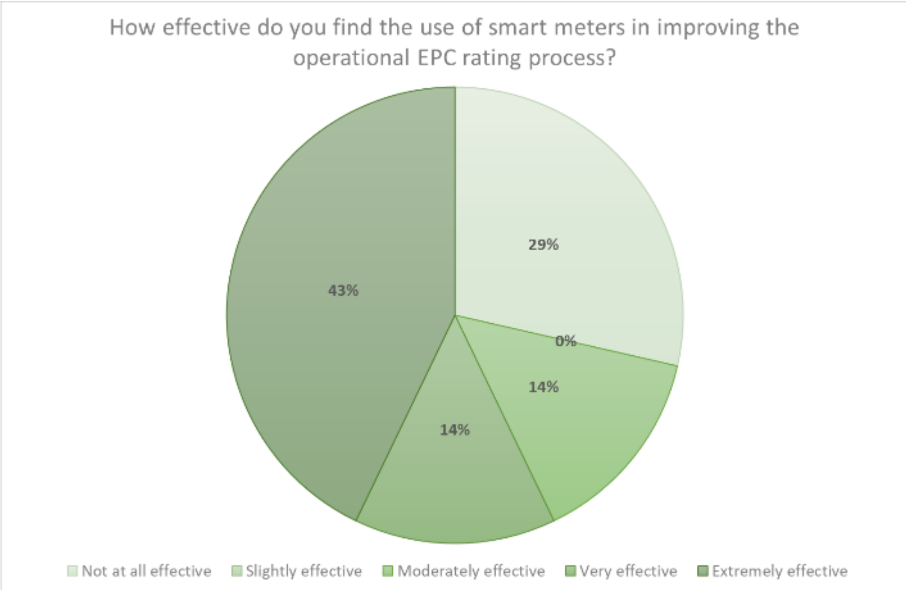


Figure 157. Smart Meter Effectiveness in EPC Rating

Feedback on the "Improving the EPC qualification operational process" dimension revealed a gap in opinions regarding the integration of digital technologies into certification. The greatest discrepancy is observed in responses regarding the effectiveness of smart meters in improving the EPC qualification process. While 43% rated the devices as extremely effective, another 29% considered them not at all effective, and the remainder were slightly to moderately effective. This polarization may be related to different levels of familiarity or experience with smart meter integration in different contexts.

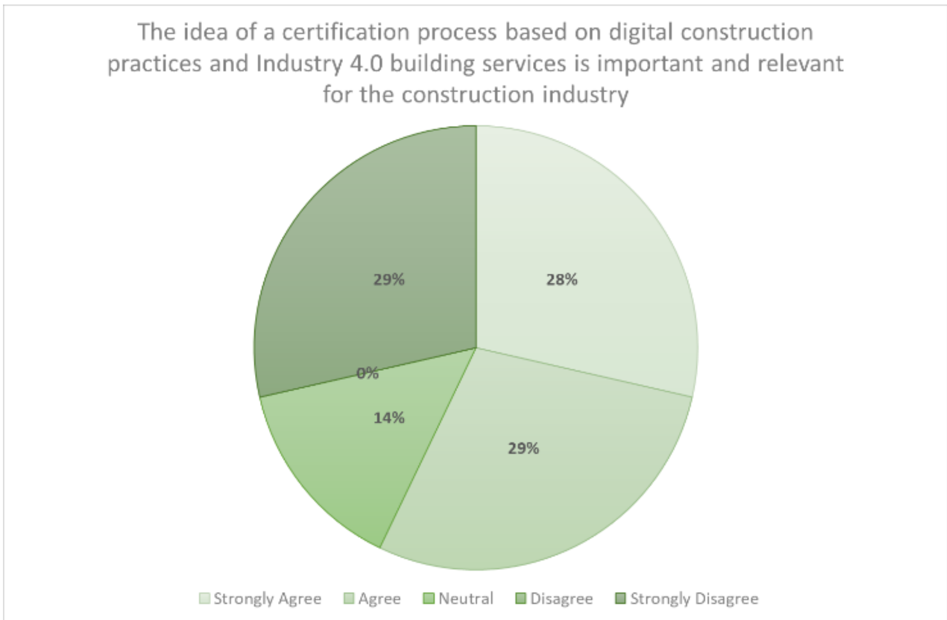


Figure 158. Relevance of Industry 4.0 Certification

When asked about the relevance of a certification process based on digital construction practices and Industry 4.0 construction services, feedback showed that 57% of respondents strongly agreed or agreed with its importance for the construction industry, while 29% disagreed.

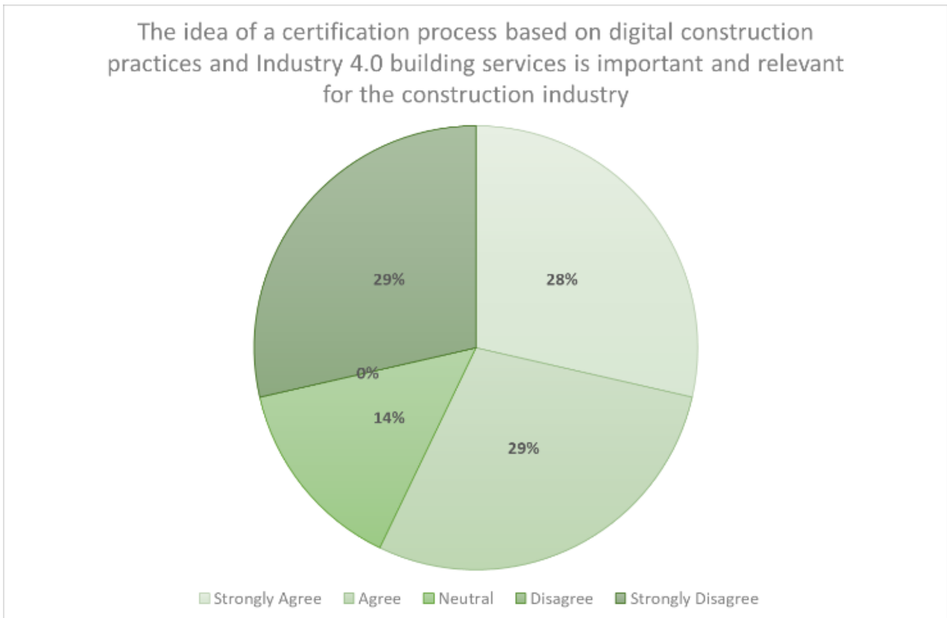


Figure 159. Value of BIM-Compatible, Performance-Based Certification

Finally, the proposal for a certification system compatible with BIM, smart meters, and digital twins received support from 43% of respondents who strongly agreed and an additional 14% who agreed, with fewer respondents expressing disagreement.

7.1.6 Resident Perception of the Neighbourhood Rating Scheme

This dimension gauges user perception of the SmartLivingEPC's new neighborhood scale rating system (NSLE). It focuses on four key aspects: the perceived usefulness, this is, the degree to which users believe the SLEPC offers valuable insights, the perceived ease of use, through which it is expected to evaluate the level of intuitiveness and clarity of SmartLivingEPC for users of various technical knowledge, the intention to use, gauging residents' willingness to regularly integrate the SLEPC into their decision-making processes, and the privacy of personal data, assessing user comfort with how the SLEPC collects and utilizes their personal data.

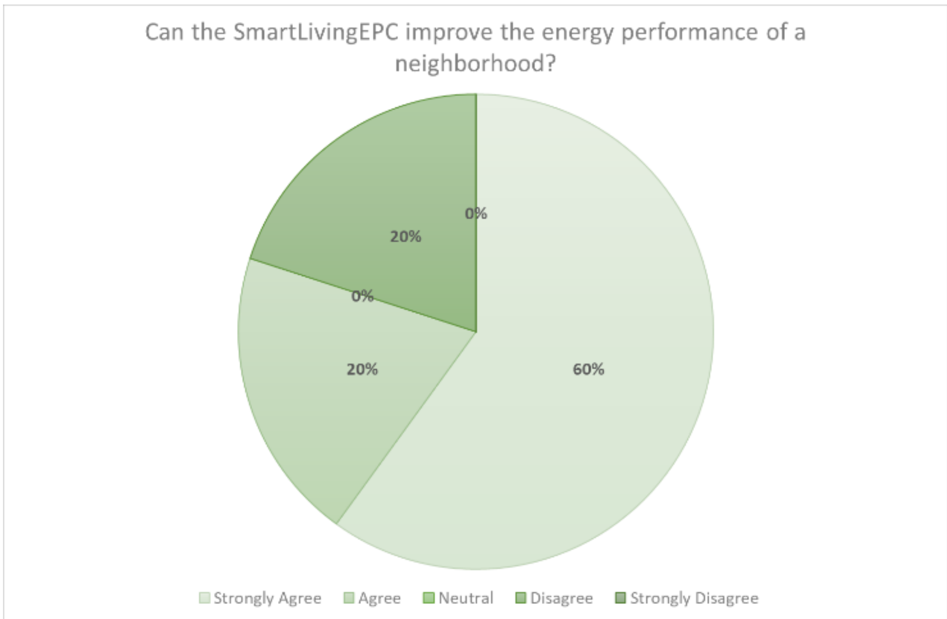


Figure 160. Energy Performance Improvement

In the case of the SmartLivingEPC Neighborhood Rating System, 80% of respondents agreed or strongly agreed when asked whether the system could improve their neighborhood's energy performance. Furthermore, 80% of users also indicated they would consider integrating SmartLivingEPC into their work. This direct relationship between perceived value and future usage intention is an encouraging result for the tool's adoption.

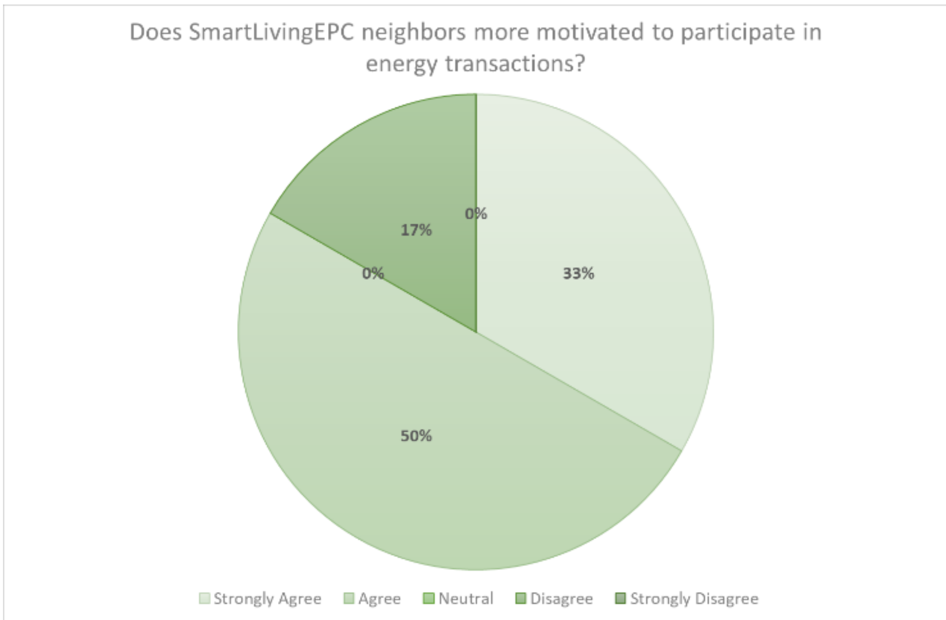


Figure 161. Promote Energy Transactions

Another important aspect evaluated was the system's ability to foster community engagement. In this case, more than 80% of respondents agreed that SmartLivingEPC increases their motivation to participate in energy transactions with their neighbors. This confirms that the neighborhood approach proposed by the methodology not only promotes individual action aimed at sustainability and energy savings, but also fosters collective awareness and cooperation as the basis for an energy and ecological transition leveraged by social transformation.

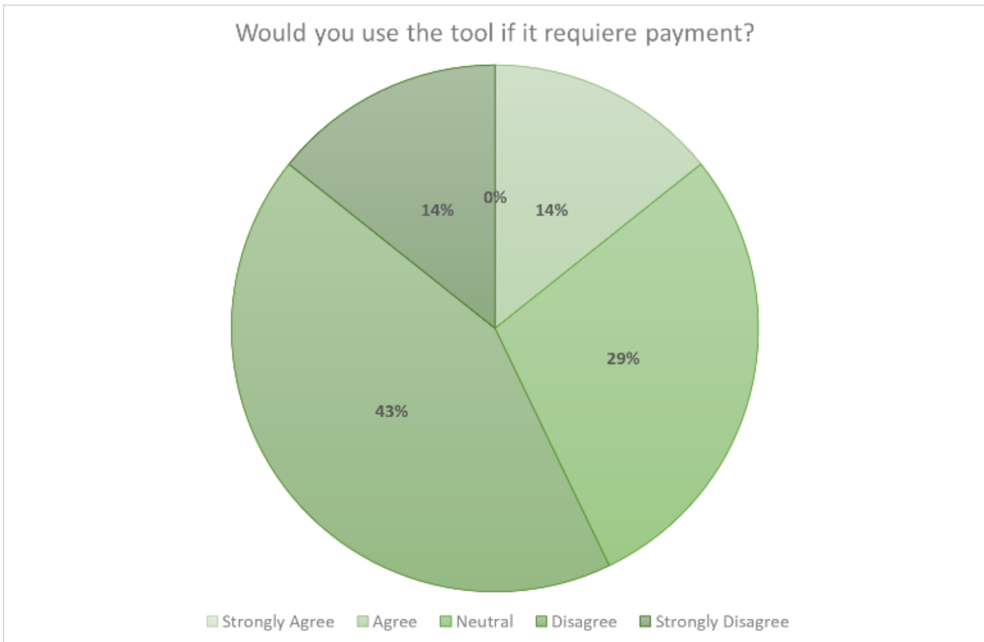


Figure 162. Willingness to Pay

Despite these results, the responses also revealed some barriers to SLEPC adoption. Among them, it was determined that only 43% of users would be willing to use the system if it were paid, while the rest were unsure or outright refused to pay (Figure 162).

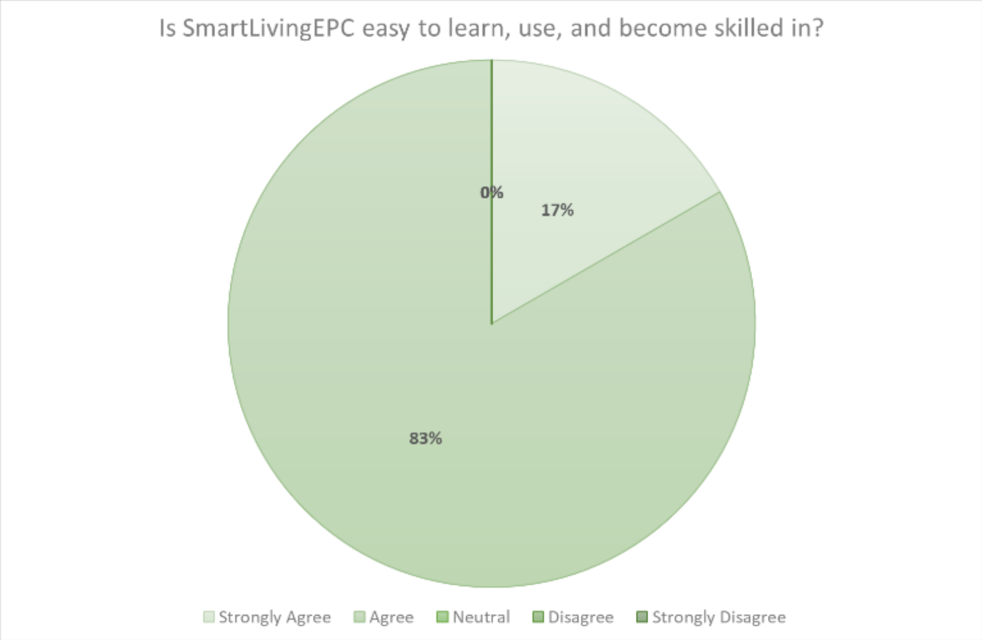


Figure 163. Ease of Use

83% strongly agree that SmartLivingEPC is easy to learn, use, and become skilled in. The remaining 17% expressed a neutral stance, while no respondents disagreed or strongly disagreed. These results reflect a high level of perceived usability and intuitive design, indicating that the tool successfully supports onboarding and user engagement without steep learning curve.

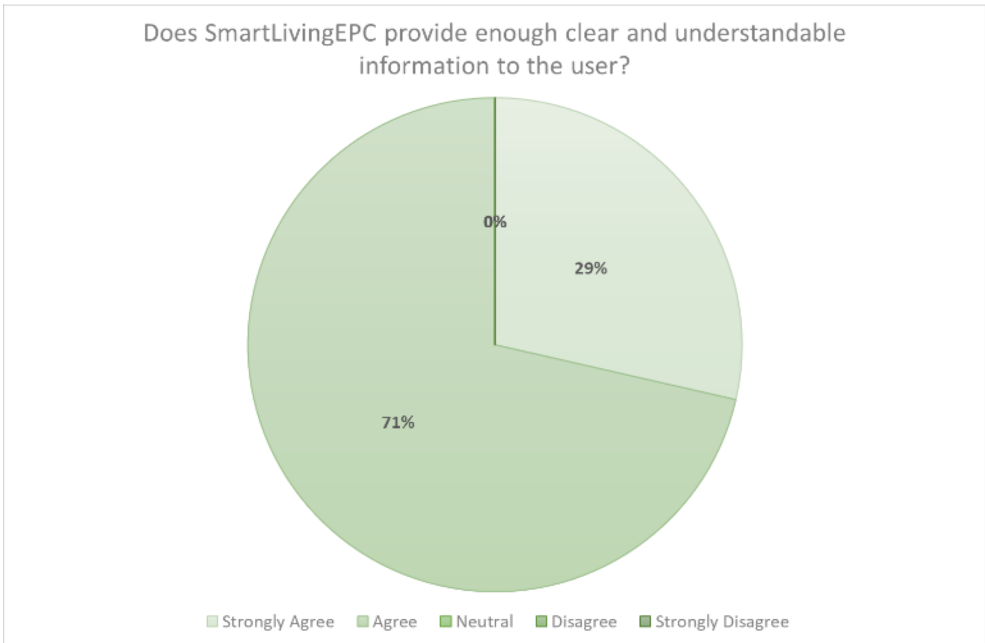


Figure 164. Clarity of Information

Figure 164 shows 71% strongly agreed and 29% agreed with the question. Also, no users expressed neutrality or disagreement, indicating a unanimous positive perception of the system's communicative clarity. It is worth noting that the tool's configurability to meet specific needs also received positive ratings, which, for adoption, would allow for the development of a user base with diverse profiles (Figure 165).

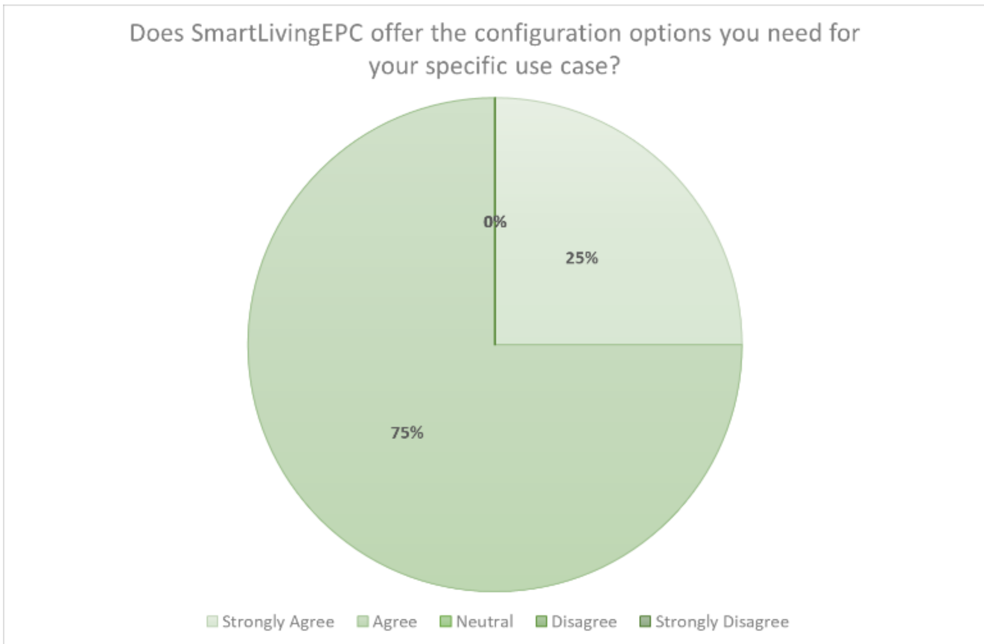


Figure 165. Configuration Options

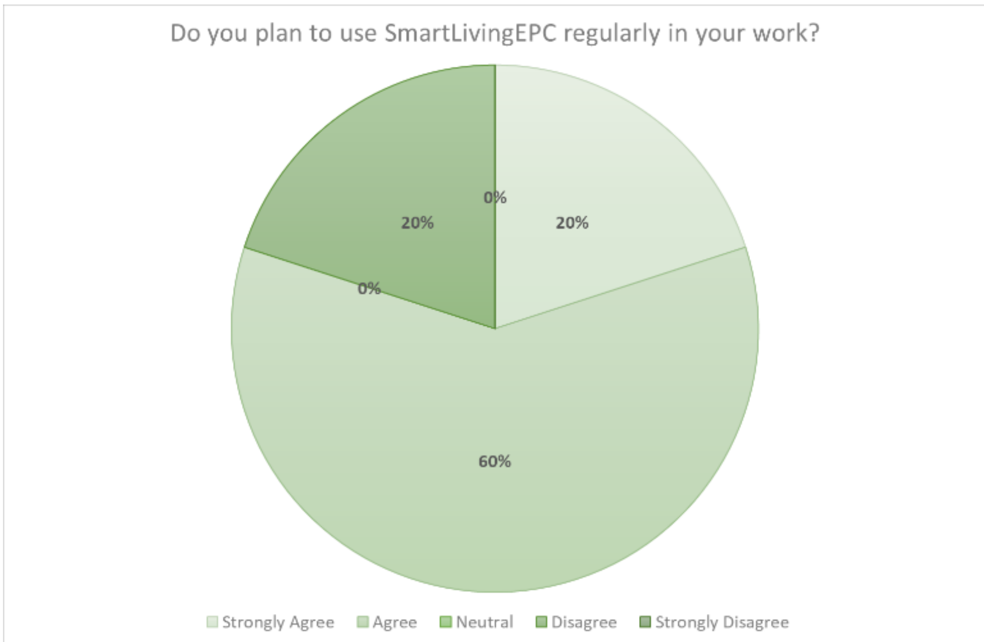


Figure 166. Intention of Use in Work

The majority of respondents expressed a clear intention to integrate SmartLivingEPC into their regular work routines. 60% strongly agreed and 20% agreed, indicating 80% overall positive intent. An additional 20% remained neutral, suggesting some users may still be evaluating its relevance or awaiting further experience with the tool. Importantly, no participants disagreed, reinforcing a strong initial acceptance and perceived usefulness of SmartLivingEPC among professionals.

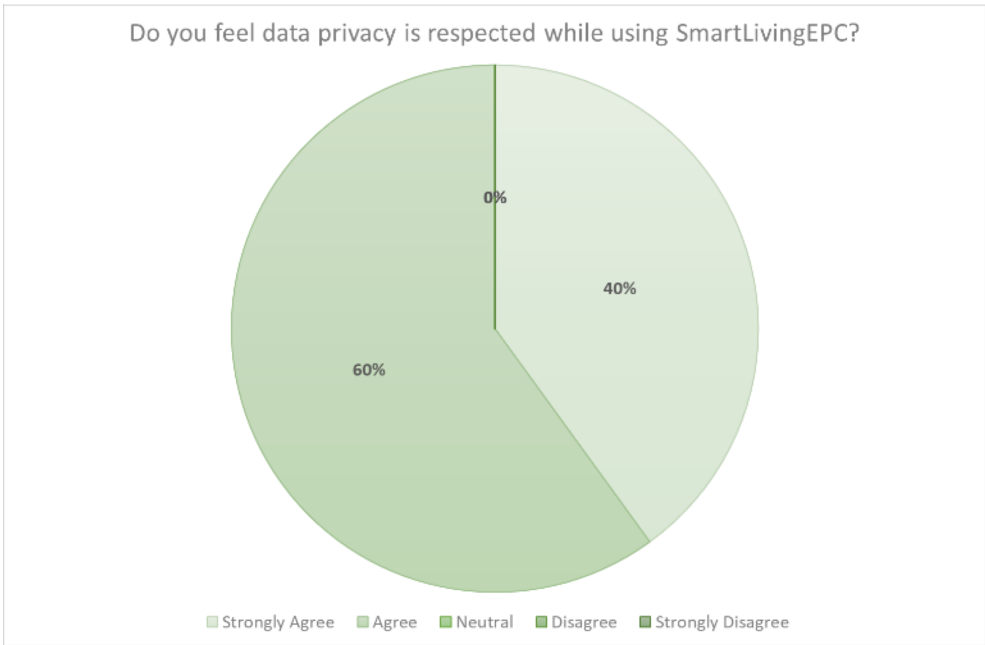


Figure 167. Perceived Data Privacy

It's important to note that users stated that using the platform does not pose a risk to their data privacy. However, this does not appear to be linked to the frequency of use of the tool. In this sense, once adequate protection of user data is ensured, frequent and sustained access to the SmartLivingEPC platform is likely linked to the integration of the tool into daily routines or workflows.

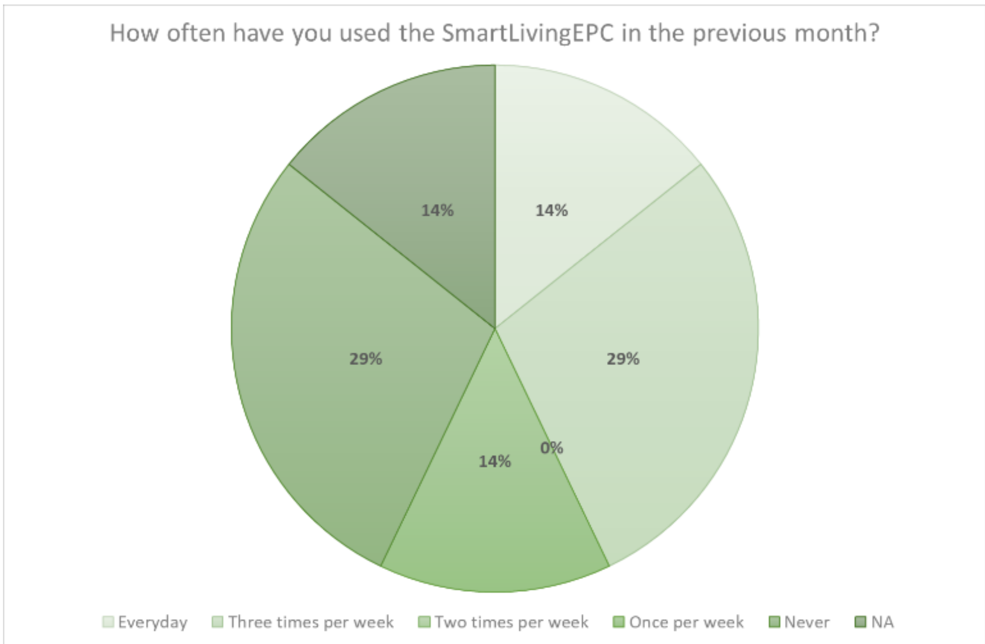


Figure 168. Frequency of Use

The strong stated intention to use the tool regularly is partially reflected in actual usage patterns over the previous month: 57% reported using the tool at least once or twice a week, and 14% used it daily. However, 14% reported not using it at all, indicating that a subset of users may still be in an exploratory phase or encounter barriers to regular integration, possibly due to onboarding, technical limitations, or contextual relevance.

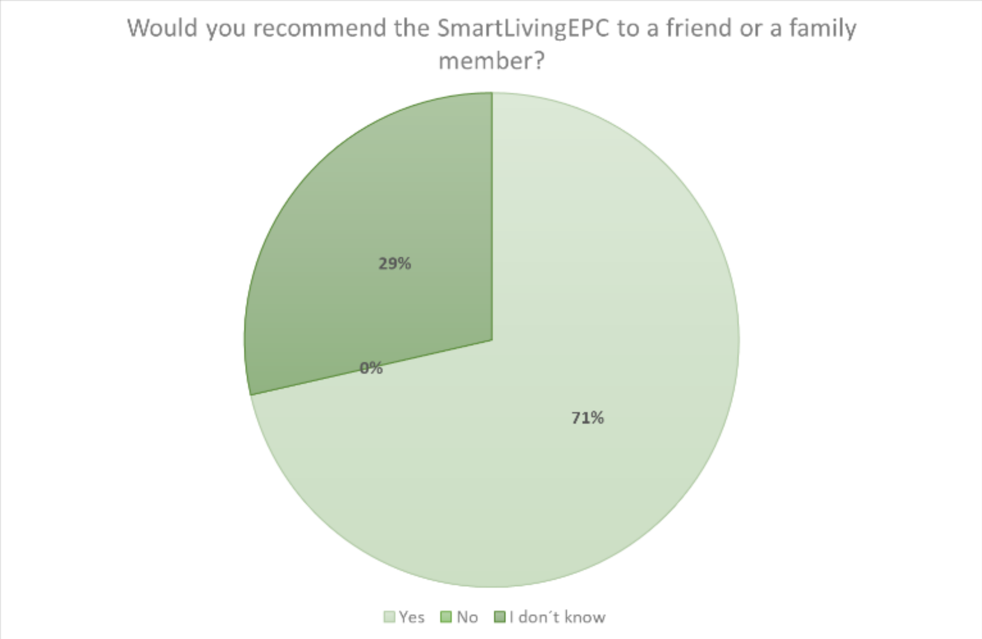


Figure 169. Likelihood of Recommendation

Reinforcing this trend, 71% of respondents stated they would recommend SmartLivingEPC to a friend or family member, demonstrating a high level of user satisfaction and potential for peer dissemination (Figure 169). However, it seems necessary to investigate what areas of improvement need to be addressed to achieve acceptance by the 29% of respondents who remained undecided about recommending the tool.

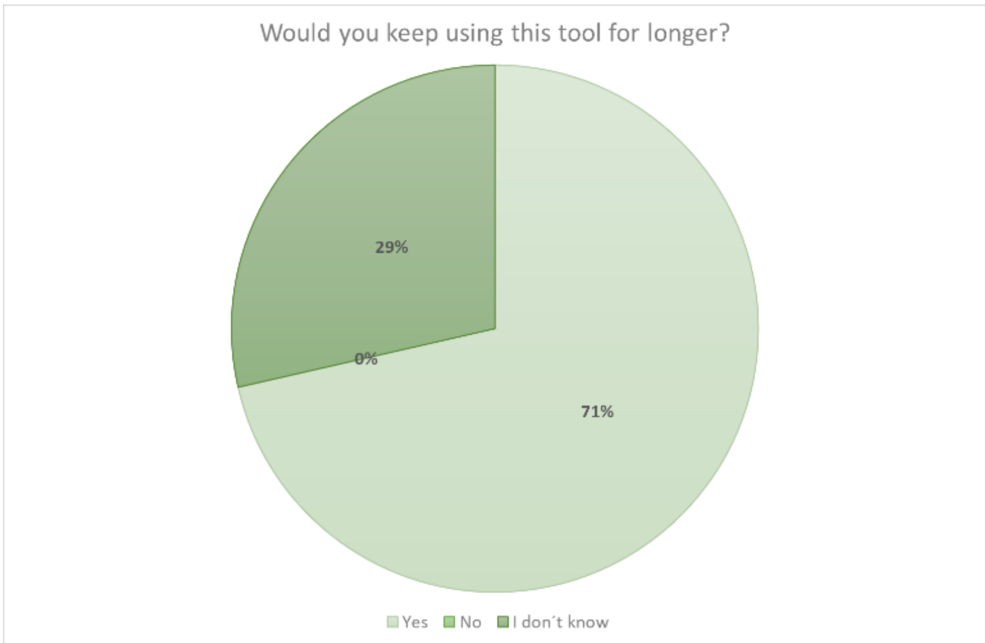


Figure 170. Willingness to Continue Using the Tool

A significant majority of users (71%) expressed their willingness to continue using SmartLivingEPC in the future, suggesting a high level of user satisfaction and perceived value. Meanwhile, 29% indicated uncertainty, highlighting a potential need for ongoing support, updates, or demonstration of long-term benefits. Notably, no respondents rejected continued use, reinforcing a generally positive user experience.

7.1.7 Building Stock Enhancement

This dimension evaluates the effectiveness and understanding of the SmartLivingEPC certificate in facilitating decision-making for building improvements.

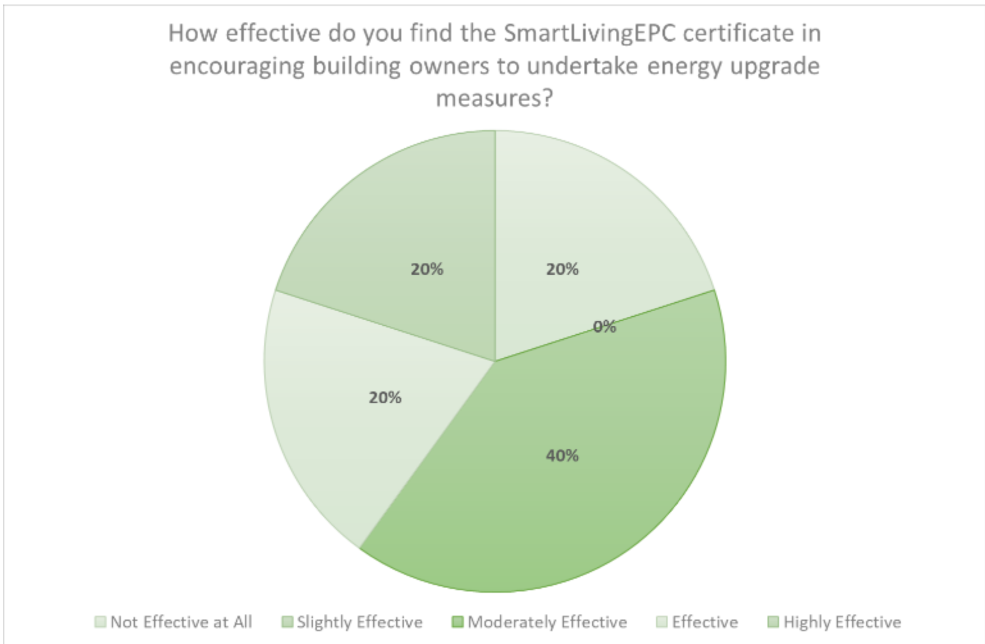


Figure 171. Upgrade Encouragement Effectiveness

When asked about the effectiveness of the SmartLivingEPC certification in encouraging building owners to implement energy improvement measures, responses revealed that while 40% of evaluators rated it as "Effective" and another 20% as "Moderately Effective," 40% considered it "Somewhat Effective" or "Not at All Effective." Notably, none of the respondents selected "Very Effective." This distribution suggests that some value is recognized in the certification in motivating energy improvements, but it is not yet entirely convincing. It would be interesting to explore these findings further through surveys of owners and compare the results with the high acceptance of the methodology as a driver of community and neighborhood processes.

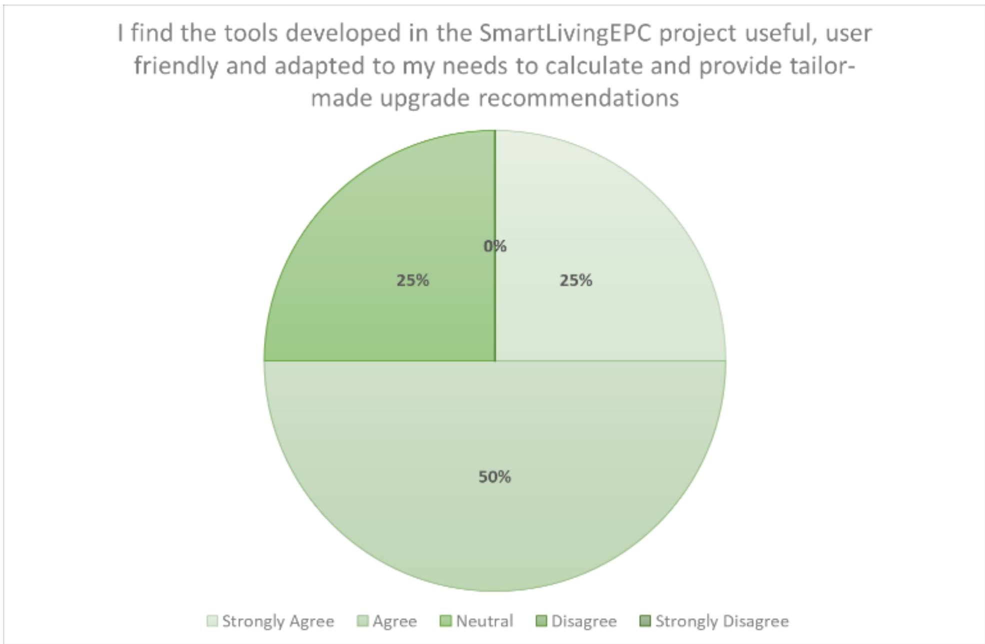


Figure 172. Tool Usefulness and Adaptation

Regarding the SmartLivingEPC platform's ability to generate improvement recommendations, 75% of evaluators "Agreed" or "Strongly Agreed" that the tools were useful, easy to use, and tailored to their professional needs. The remaining 25% remained neutral, with no disagreement recorded.

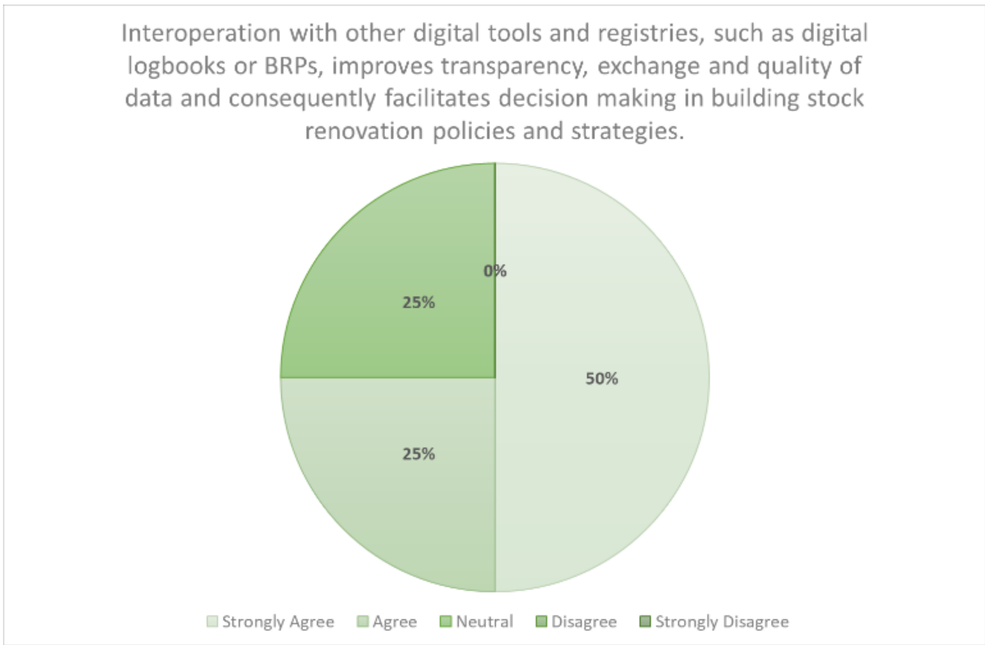


Figure 173. Impact of Interoperability

Furthermore, evaluators were asked about the perceived value of interoperability between SmartLivingEPC and other digital infrastructures, such as Building Renovation Passports (BRPs) or digital logbooks. In this case, 75% of evaluators supported the idea that such integration improves transparency, data quality, and decision-making in renovation strategies, while another 25% remained neutral. This could be due to different levels of familiarity with such tools or the state of ongoing integration in their respective national contexts.

7.1.8 Overall evaluation of the Tool

Up to this point, you've provided feedback on the various components of the SmartLivingEPC certificate. In this section, we'll ask you to provide feedback on the tool as a whole.

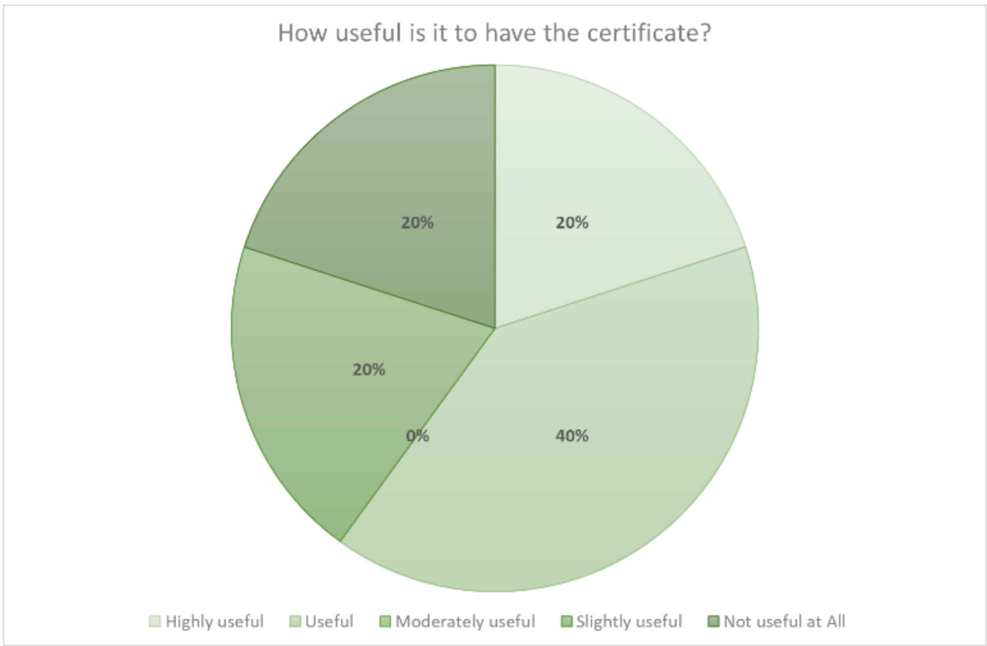


Figure 174. Perceived Usefulness of the Certificate

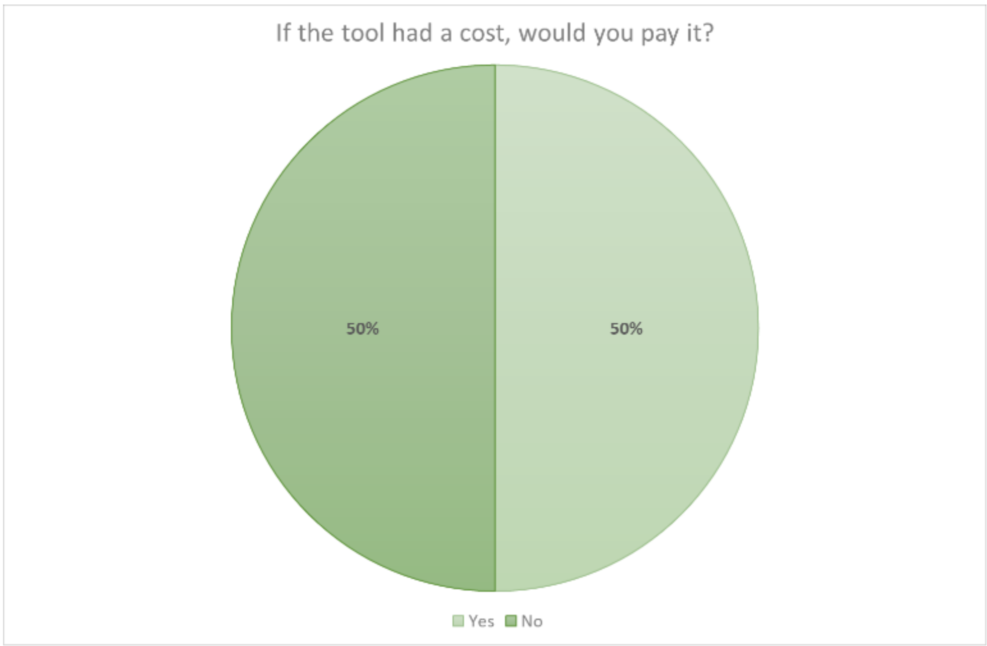


Figure 175. Paying for the Tool

When asked about the certificate's overall usefulness, 60% of respondents found it "useful" or "very useful," indicating that the majority of evaluators recognize its value. However, this positive opinion is tempered by a segment of responses (40%) that rated the tool only "moderately useful" or "not at all useful." Further research is needed to investigate which aspects of the tool are most and least valued, in order to evaluate the inclusion of modifications or strategies for communicating unperceived benefits (Figure 174).

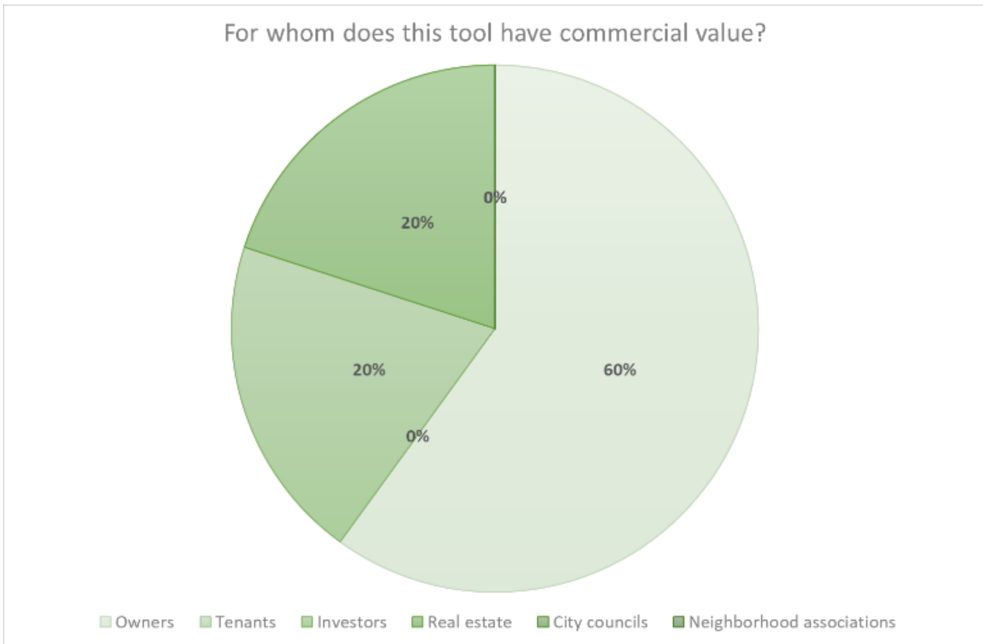


Figure 176. Target Market Identification

Regarding the question "For whom does this tool have commercial value?", the tool is primarily perceived as beneficial for "individual homeowners" (60%), while a smaller percentage identifies value for investors and renters (20% each). In no case was any potential commercial relevance mentioned for city councils, real estate agencies, or neighborhood associations, indicating a current gap in participation or perceived usefulness between institutional and intermediary stakeholders (Figure 176). However, from the assessors' perspective, willingness to pay for the tool showed that 50% of assessors would be willing to pay for it, while the remaining 50% indicated they would not. This focuses future actions on the importance of carefully positioning the tool's value proposition and highlights price sensitivity as a decisive factor for its future adoption (Figure 176).

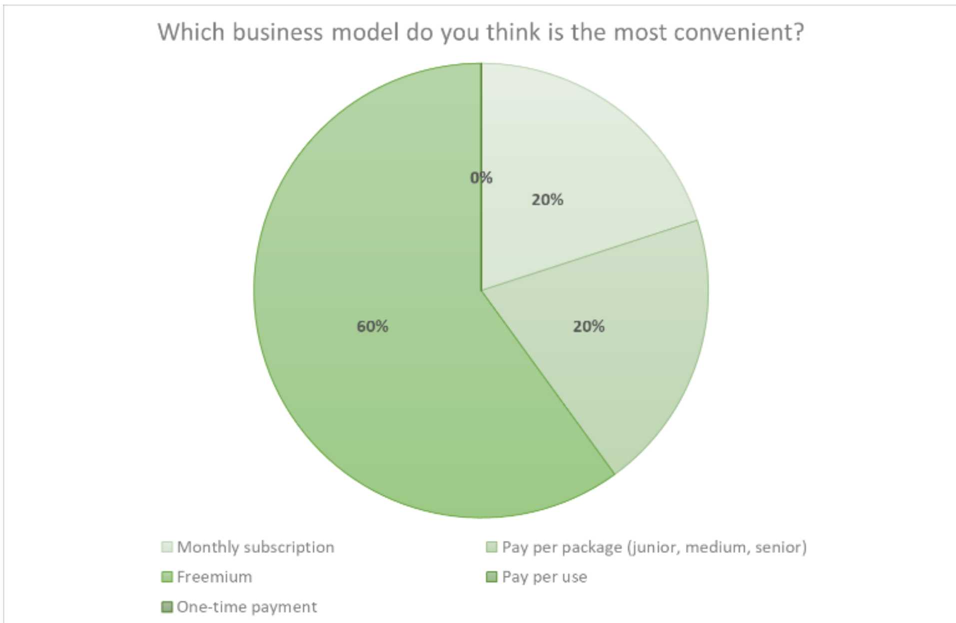


Figure 177. Preferred Business Model

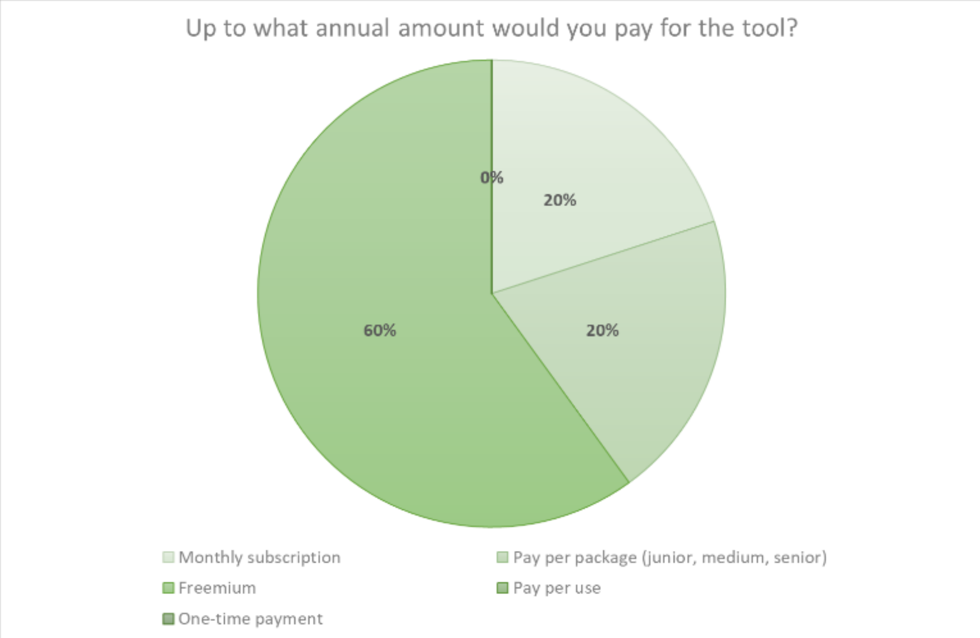


Figure 178. Annual Budget for the Tool

Regarding the business models most appropriate for the type of tool proposed, it was observed that 60% of assessors favored a one-time payment option, while others were more open to accepting freemium or pay-as-you-go models (Figure 177). This is closely linked to the price range considered acceptable for the tool. The majority (60%) of respondents indicated they would pay up to €50 per year (Figure 178), while another 40% were willing to pay between €50 and €300. No participants selected higher price ranges, confirming the need for a cost-effective offering to ensure adoption.

7.2 End-Users SmartLivingEPC assessment

The analysis of SmartLivingEPC end-user outcomes was conducted using a descriptive mixed-methods approach, focusing on extracting meaningful insights from a focused data set of 13 responses. These results were collected from based on 15 responses from Demo sites. Given the limited sample size, the methodology sought to ensure internal validity through careful question design, consistent data processing, and triangulation of indicators.

To this end, the survey was designed to assess specific aspects of the SmartLivingEPC user experience and perceived value, based on established models such as the System Usability Scale (SUS), the Technology Acceptance Model (TAM), and contextualized indicators. It included Likert-scale questions in the following dimensions:

- Understandability and clarity of information
- Perceived usefulness and decision support
- Ease of use and complexity of the system
- Willingness to use and pay
- Perceived commercial value and price preferences

A frequency distribution analysis was applied to all closed-ended questions, which were represented using pie charts that allow the proportion of responses by category to be visualized. This enables the following:

- Quickly identify consensus or divergence.
- Comparatively evaluate indicators (e.g., contrast between perceived complexity and ease of use).
- Detect outliers or contradictory perceptions.

It was decided to use percentage-based visualizations to normalize the results, allowing comparison between indicators even with a small cohort. To further the interpretation, a cross-tabulation logic was qualitatively applied, examining how certain responses correlate across different questions. For example:

Information clarity (100% positive) was compared with ease of use (82% agree/strongly agree) and need for support (27% agree) to infer whether technical clarity translates into operational autonomy.

Perceived usefulness (certificate, decision-making, energy savings) was correlated with willingness to pay and preferred pricing models, providing robust insight into perceived market value.

These relationships, while not statistical due to sample size, support preliminary hypotheses for future scaling tests and inform strategic adjustments.

7.2.1 Limitations of the Analysis and Contextual Framing

While the limited number of responses prevents statistical generalization, the selection of respondents from two real-life implementation contexts (CERTH and Leitza) provides ethnographic validity. These participants interacted with the SmartLivingEPC tool in real-life buildings or community contexts, meaning their assessments are based on experience and not hypothetical. To acknowledge the limitations of the sample:

No attempt was made to extrapolate to broader populations.

Results were presented as indicative patterns rather than definitive findings.

Interpretations were qualified, prioritizing internal consistency over external representativeness.

7.2.2 Building Stock Enhancement

This dimension evaluates the effectiveness and understanding of the SmartLivingEPC certificate in facilitating decision-making for building improvements.

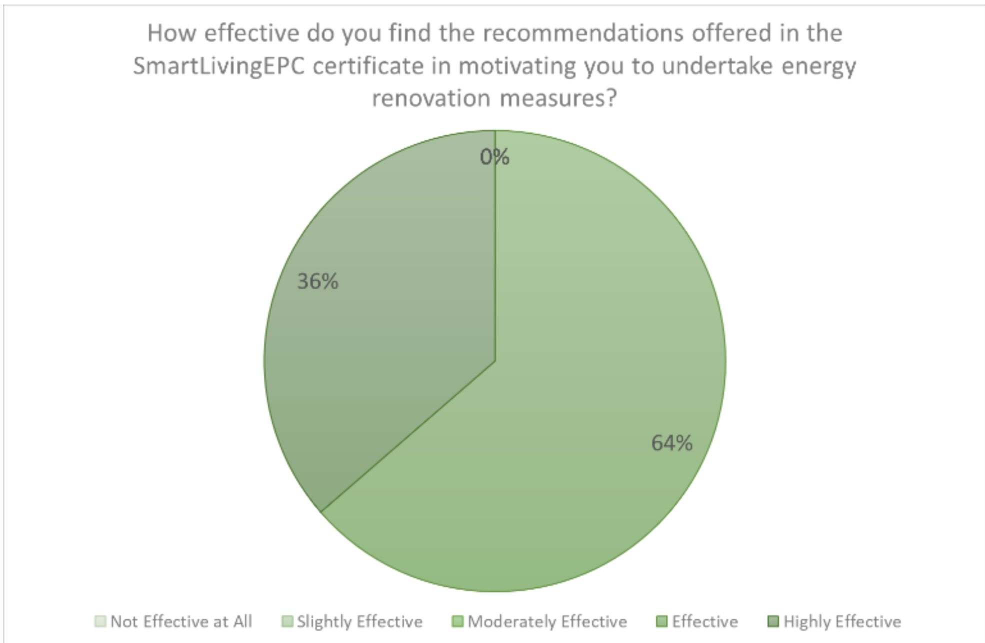


Figure 179. Upgrade Encouragement Effectiveness

The survey results indicate that the certificate's recommendations are generally well received: 64% of respondents consider them moderately effective, and 36% rate them as effective. Notably, no participants rated the recommendations as ineffective or slightly effective. However, the lack of responses indicating high effectiveness of the recommendations implies that, while useful, they may not be compelling enough to drive immediate or ambitious renovation actions.

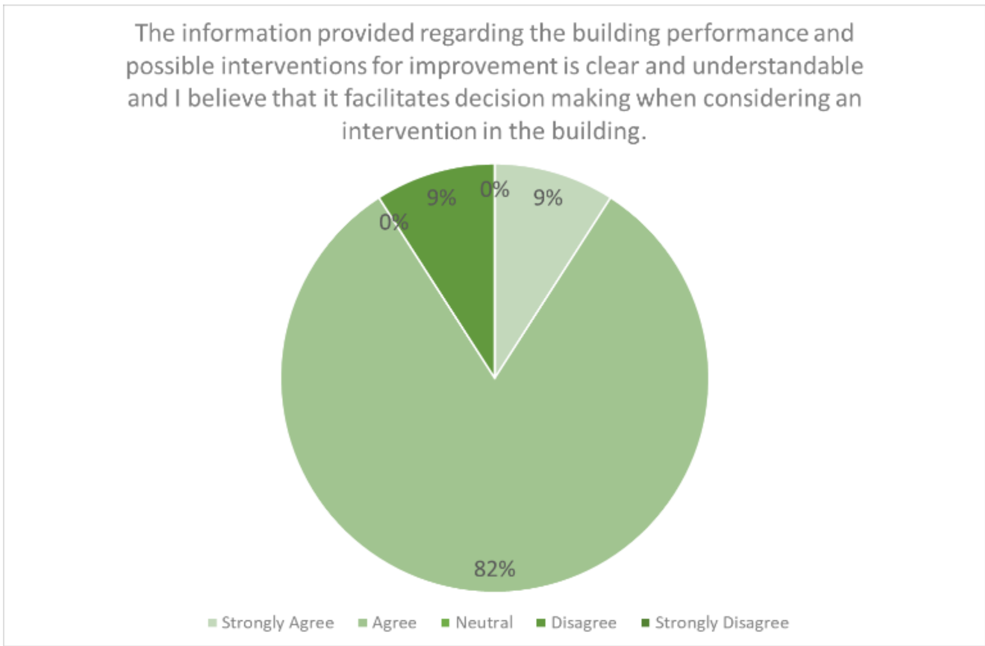


Figure 180. Clarity and usefulness of Building Information

In parallel, the second element of the survey revealed very strong support for the clarity and usefulness of the information provided by the SmartLivingEPC solution. 91% of respondents agreed or strongly agreed that the information is clear, understandable, and facilitates decision-making regarding building interventions. Only 9% remained neutral, and no respondents disagreed with this statement.

7.2.3 Upgrade of operational EPC rating process

This dimension evaluates the integration and effectiveness of digital technologies, and the feedback mechanisms from users and assessors, focusing on their impact on the SmartLivingEPC's accuracy, comprehensibility, and energy efficiency improvements.

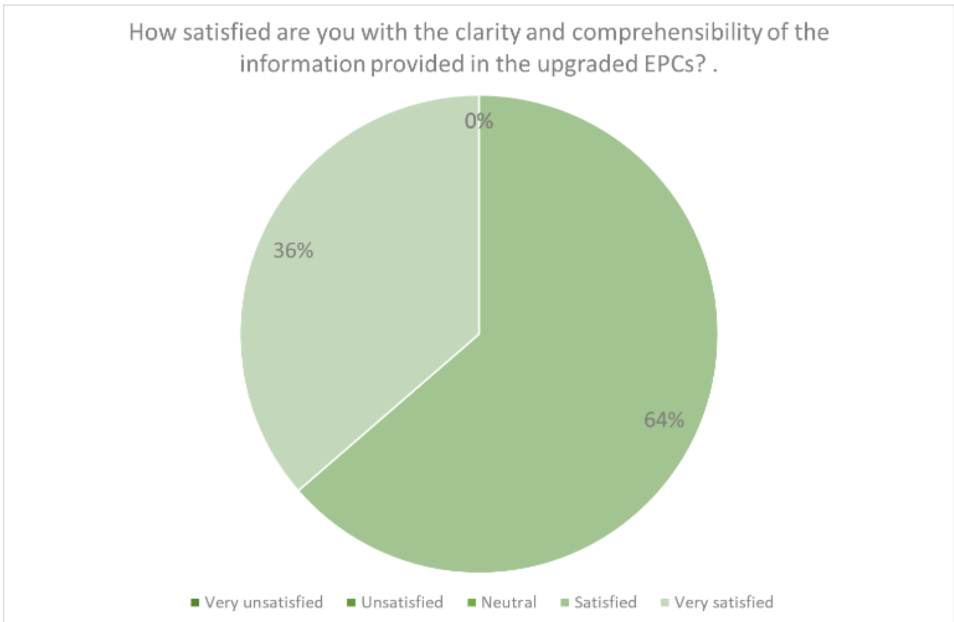


Figure 181. Satisfaction with EPC Information Clarity

The first indicator shows that 64% of users are satisfied and 36% are very satisfied with the clarity and understandability of Energy Efficiency Certificates. No dissatisfied or neutral responses were observed, indicating good performance in communicating technical information, making it more accessible and practical for end users.

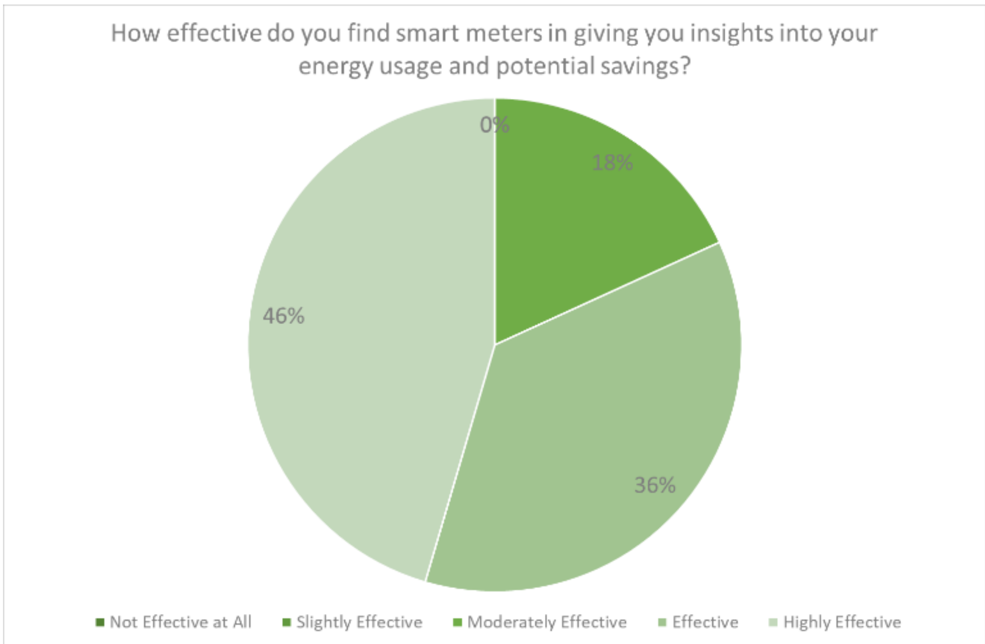


Figure 182. Smart Meters' effectiveness for Energy Insights

The second question assesses the perceived effectiveness of smart meters in providing information on energy consumption and potential savings. In this case, the responses were more varied: 46% of respondents considered them moderately effective, 36% rated them as effective, and 18% perceived them as somewhat effective. The absence of extreme responses could indicate that smart meters are highly valued, but their potential has not yet been fully leveraged or communicated.

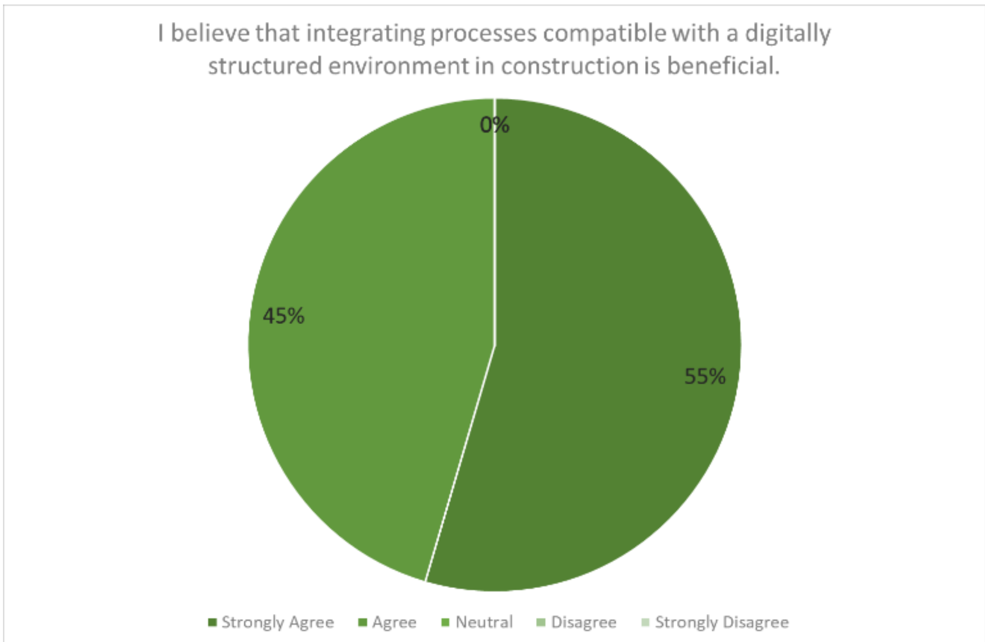


Figure 183. Benefit of Digital Integration

The last graph shows the acceptance of digital integration in construction. The responses were unanimously positive: 55% of users strongly agreed, and 45% agreed that integrating digitalized processes into construction is beneficial. No neutral or negative responses were recorded. This finding validates the project's focus on integrating BIM, IoT, and data-driven tools into the energy performance assessment ecosystem.

7.2.4 Building sustainability synergies, Level(s) update

This dimension evaluates the integration of sustainability indicators with the aim to promote a life cycle approach by incorporating relevant instruments and components that improve the quality and depth of information available to users.

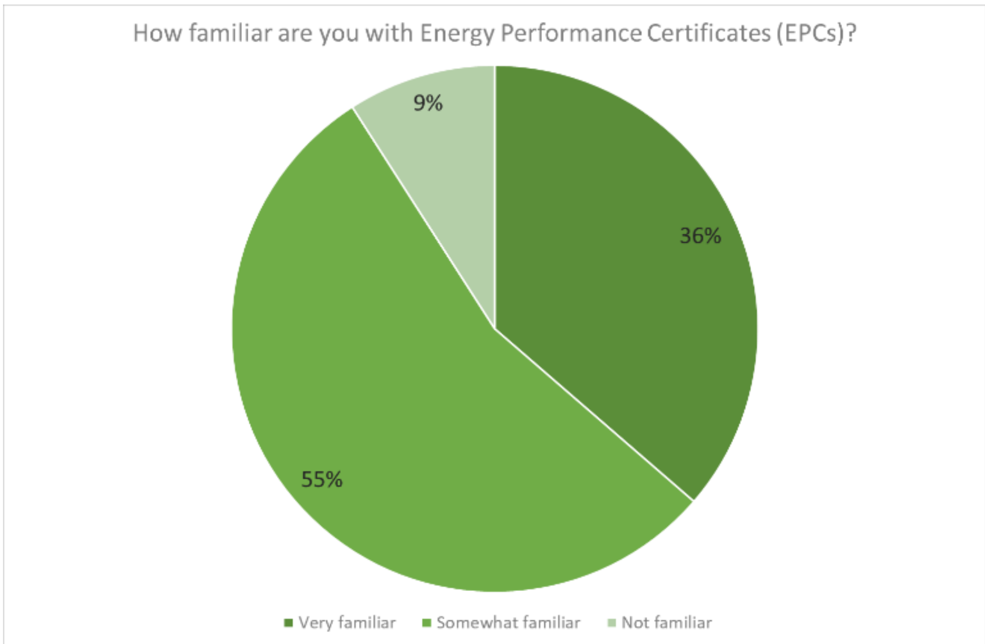


Figure 184. Familiarity with EPCs

55% percent of respondents stated they were very familiar and 36% somewhat familiar with EPCs. Only 9% identified themselves as unfamiliar. This good basic understanding of EPCs likely influenced their interaction with the updated SmartLivingEPC framework.

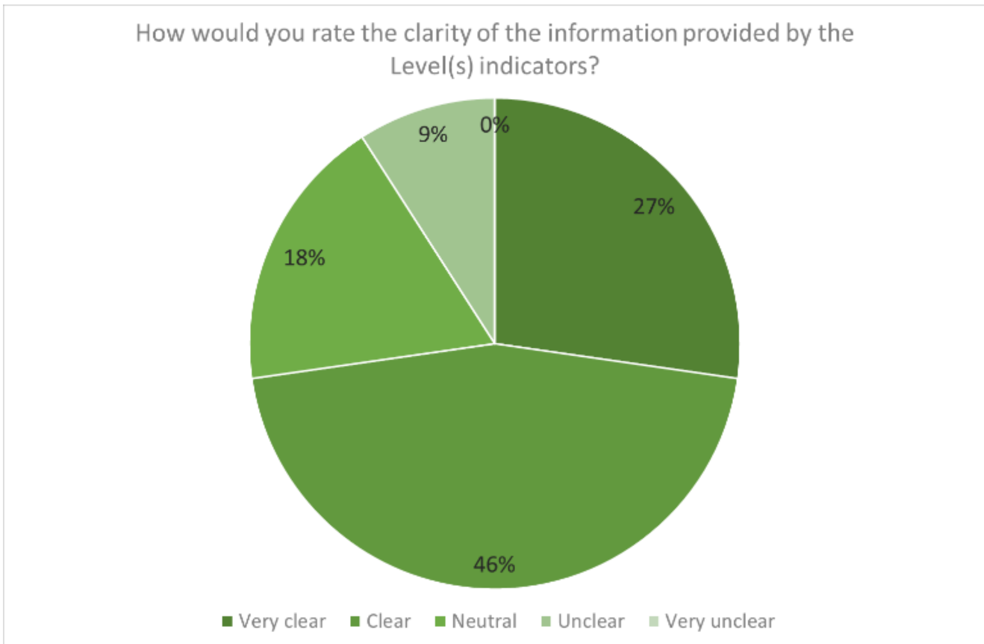


Figure 185. Clarity of the Level(s) indicators

The results regarding the clarity of the information provided by the Level(s) indicators were divergent. Forty-six percent of respondents rated it as clear and 27% as very clear; only 9% remained neutral, and 18% indicated that the content was unclear. This shows that there is still a challenge in guiding end-users in reading the data.

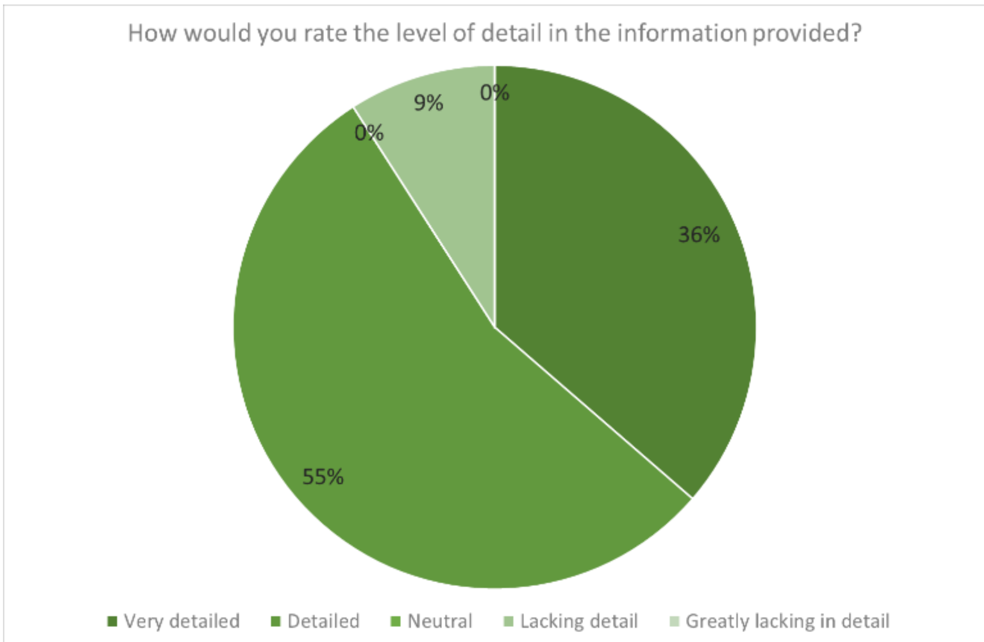


Figure 186. Detail Level in Provided Information

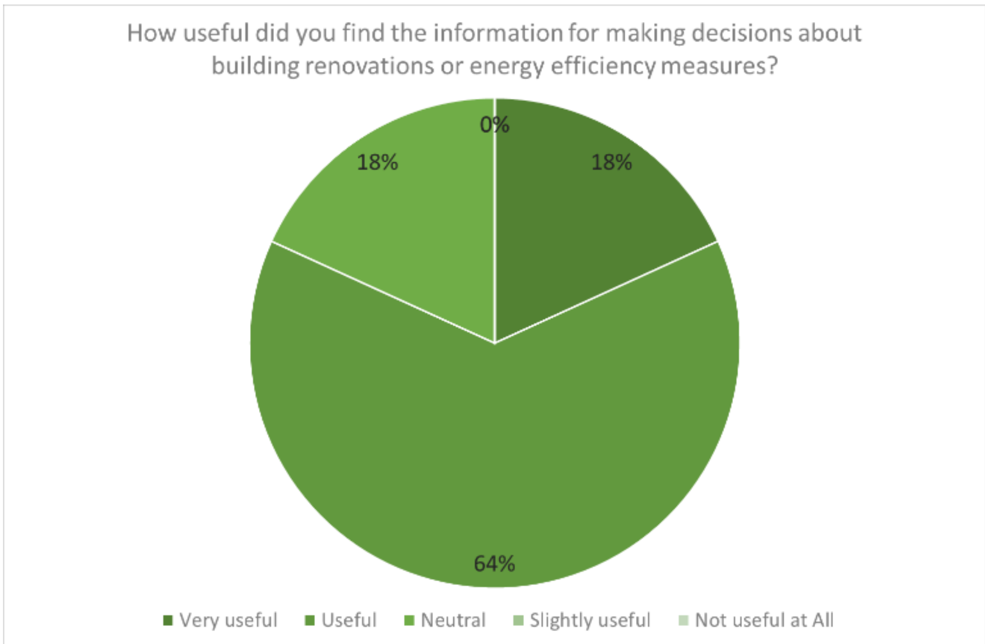


Figure 187. Usefulness of the information for making decision

The assessment of the level of detail of the information, however, was very favorable. 91% of users rated the content as detailed (36%) or very detailed (55%), with only 9% stating that it was neutral and no respondents suggesting that the content lacked detail (Figure 185). This perception of informational richness is also valued for its usefulness, as 64% found the information provided by the certificate useful and 18% very useful. Only 18% remained neutral, and none rated it as not very useful.

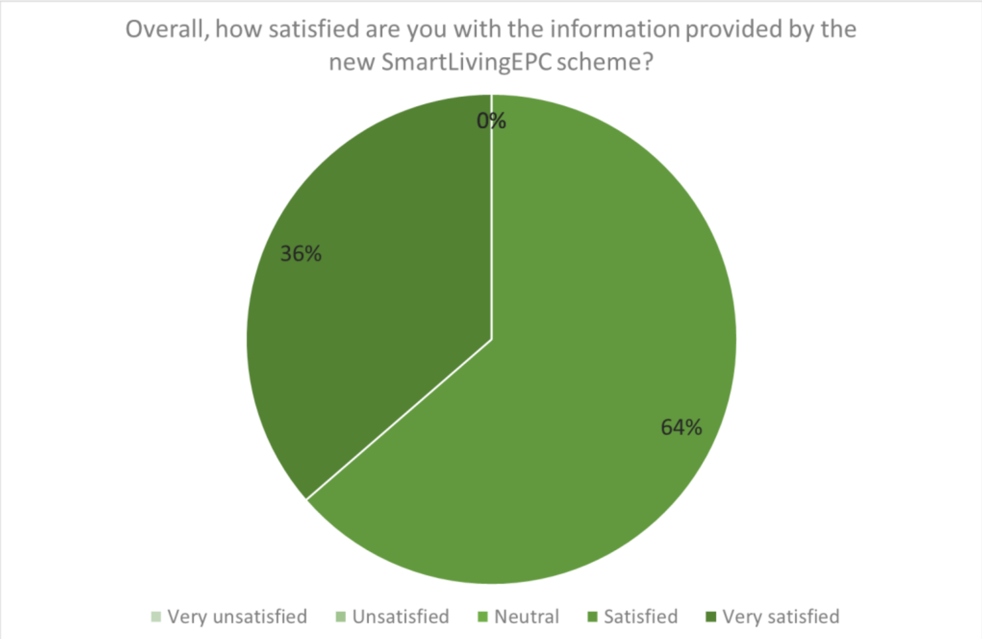


Figure 188. Overall Satisfaction with SmartLivingEPC

Finally, overall satisfaction with the SmartLivingEPC platform was remarkably high: 64% declared themselves satisfied and 36% very satisfied. No respondents expressed dissatisfaction or neutrality. Taken together, these findings validate the decision to incorporate the lifecycle approach and holistic indicators into the EPC framework, although improvements in communication clarity are required to further boost user engagement.

7.2.5 Technical systems audit integration to EPC assessment

This KPI focuses on enhancing the accuracy and reliability of EPCs by including detailed evaluations of building technical systems and aligning the ratings with real-world energy usage.

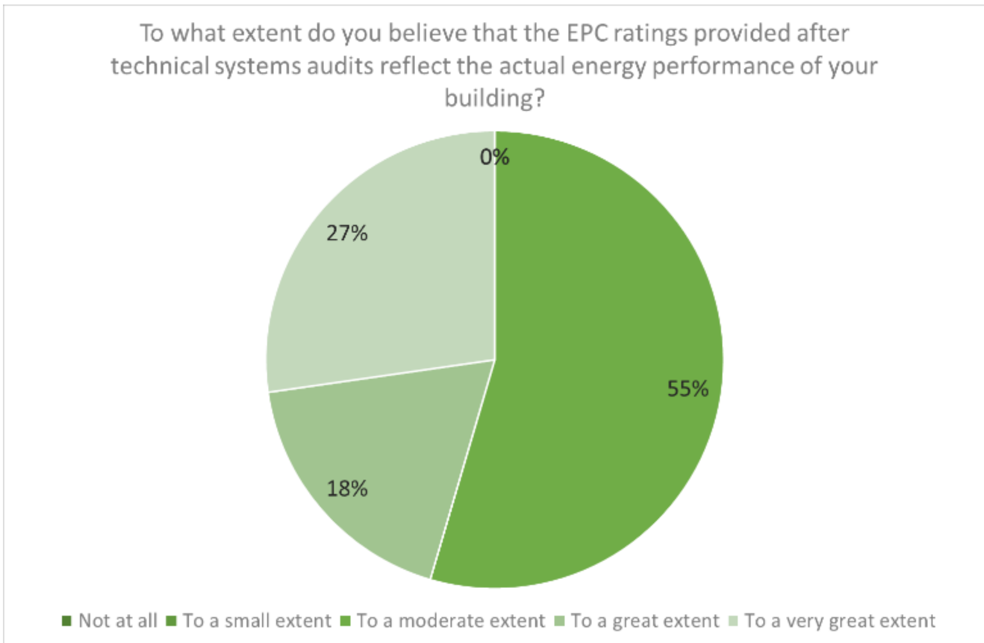


Figure 189. Accuracy EPC rating

According to the results, the majority of respondents (55%) consider that the EPC ratings reflect their building's actual energy performance "to a great extent," with an additional 18% indicating "to a moderate extent." Notably, no respondents selected "not at all" or "to a small extent," which suggests that users generally trust the enhanced methodology. Meanwhile, 27% selected "to a very great extent," signaling a smaller group that perceives a very strong correlation between technical audit-informed ratings and real performance outcomes.

7.2.6 Digital Building Logbooks integration to EPC assessment

This KPI evaluates the functionalities of existing digital logbook initiatives (functional requirements, data interoperability, and stakeholder privacy) and evaluate the requirements for EPC certification.

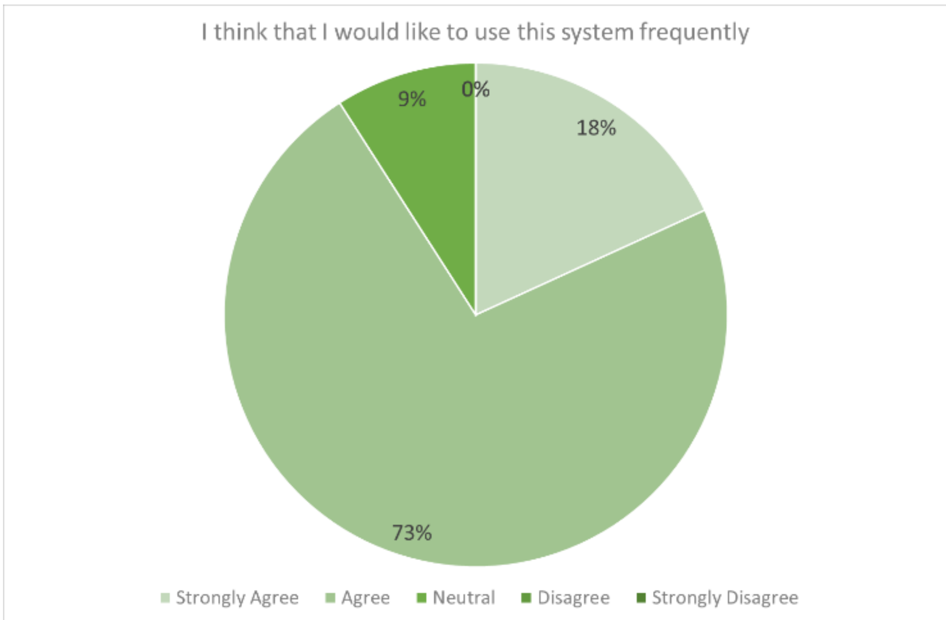


Figure 190. Willingness to Use System Frequently

The responses reveal a generally favorable perception, with 91% of respondents expressing a clear intention to use the SmartLivingEPC platform frequently. However, when assessing the system's complexity, the data paint a more nuanced picture: while nearly half of users (46%) did not find the system unnecessarily complex, 36% remained neutral, and 18% agreed with the statement about its complexity. This combination suggests that while the system is generally attractive and functionally valuable, some users may still encounter barriers related to interface navigation or technical knowledge.

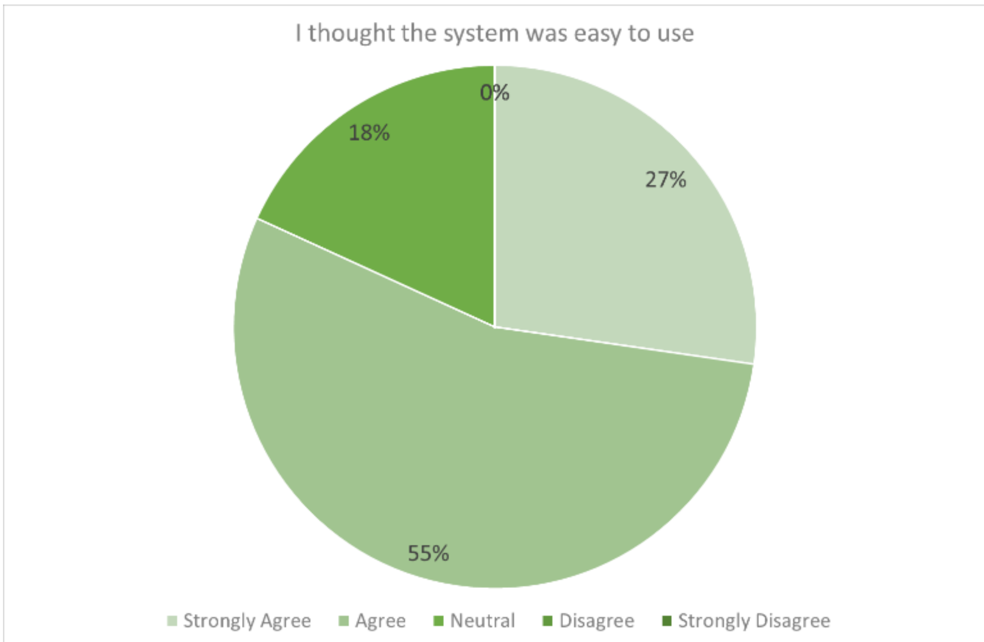


Figure 191: Ease of Use Perception

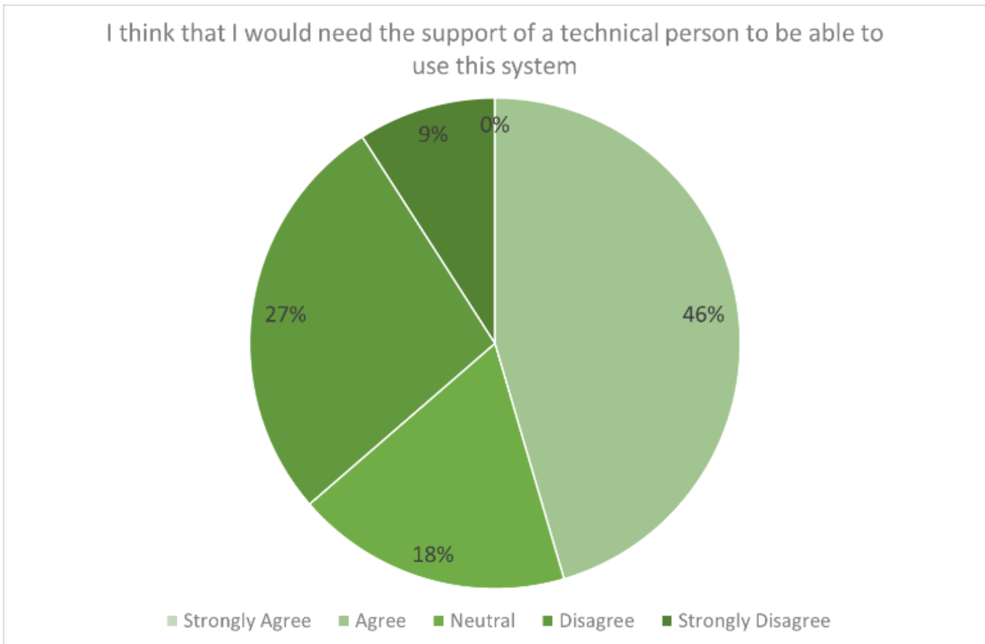


Figure 192. Need for Technical Support

Figure 191 and Figure 192 show an apparent contradiction regarding the platform's usability. While a clear majority of participants (73%) perceived the system as easy to use (related to an intuitive interface), more than 60% simultaneously indicated that they would need the assistance of a technician to operate it effectively. This discrepancy suggests that ease of use alone does not completely eliminate perceived barriers to independent operation. The relatively high proportion of neutral responses (27%) in both questions may indicate uncertainty or lack of confidence, especially among users with less digital or technical proficiency.

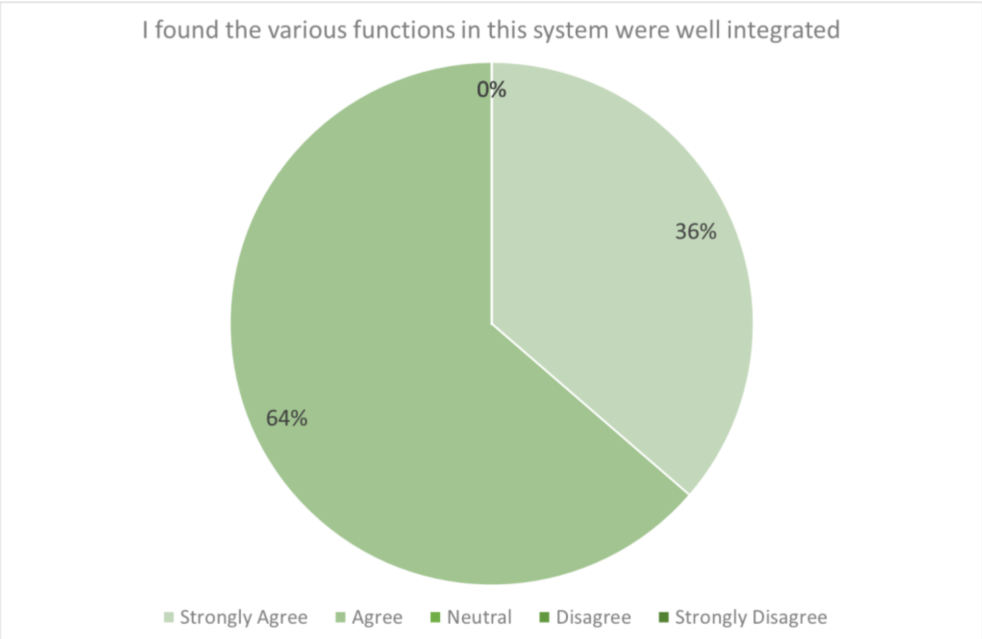


Figure 193. System Integration Quality

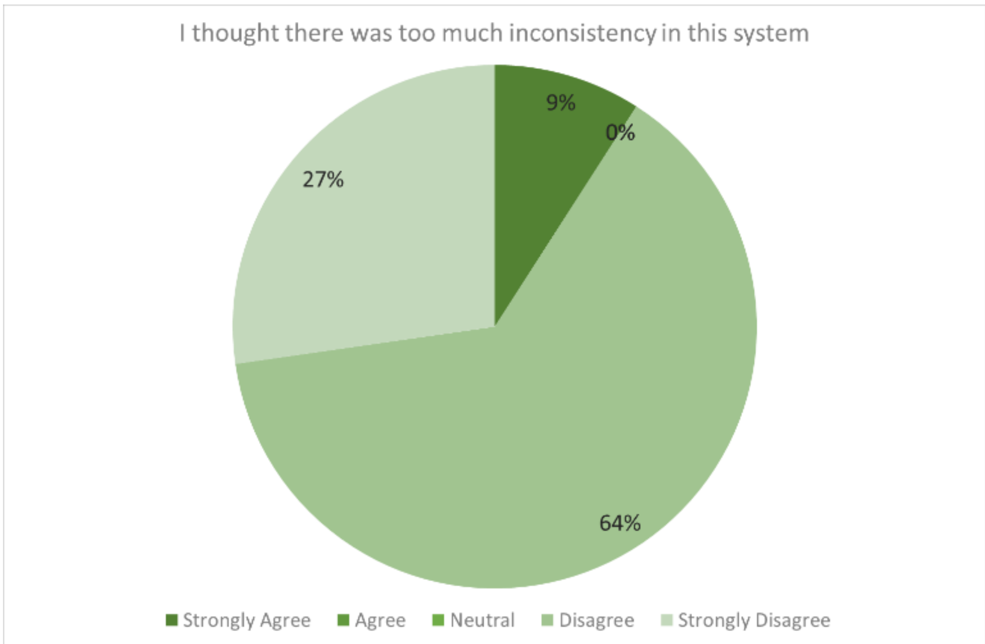


Figure 194. Perceived System Inconsistency

Regarding the perception of internal coherence and structural soundness of the system, the majority of respondents acknowledged that the platform's functions are well integrated, with 64% agreeing and 36% strongly agreeing. Furthermore, 64% of users explicitly disagreed with the idea that the system is inconsistent, and only a small minority (9%) expressed concern about this. The 27% of neutral responses suggest some isolated or context-specific cases where users might have encountered minor inconsistencies.

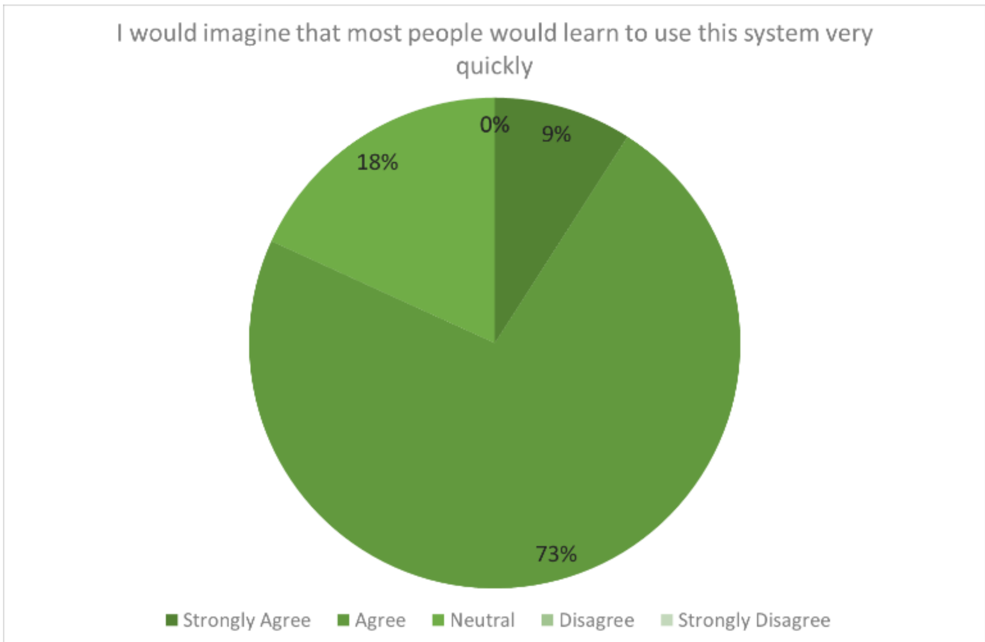


Figure 195. Ease of Learning for New Users

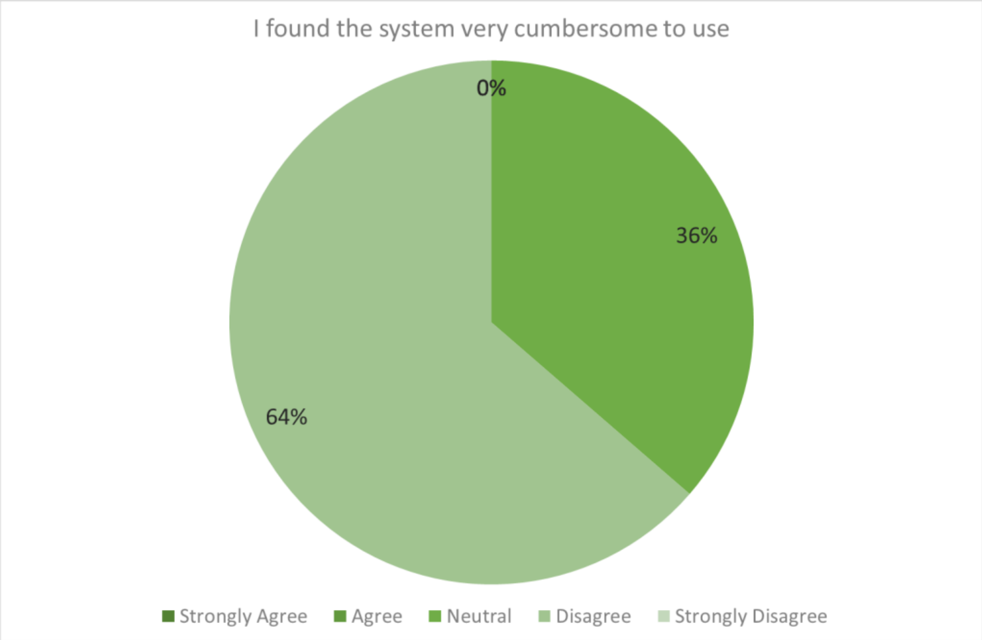


Figure 196. Perceived System Cumbersomeness

In this case, 91% of respondents expressed confidence that most people could learn to use the system quickly, indicating a strong perception of accessibility and a smooth learning curve—key attributes for ensuring widespread adoption of the Digital Building Record Book (DBL) integrated into the EPC workflow. In parallel, 64% of users explicitly rejected the idea that the system is cumbersome, and no respondents agreed with this negative assessment. However, the 36% who remained neutral on this last point could indicate that certain features could be further optimized in terms of usability or interface fluidity.

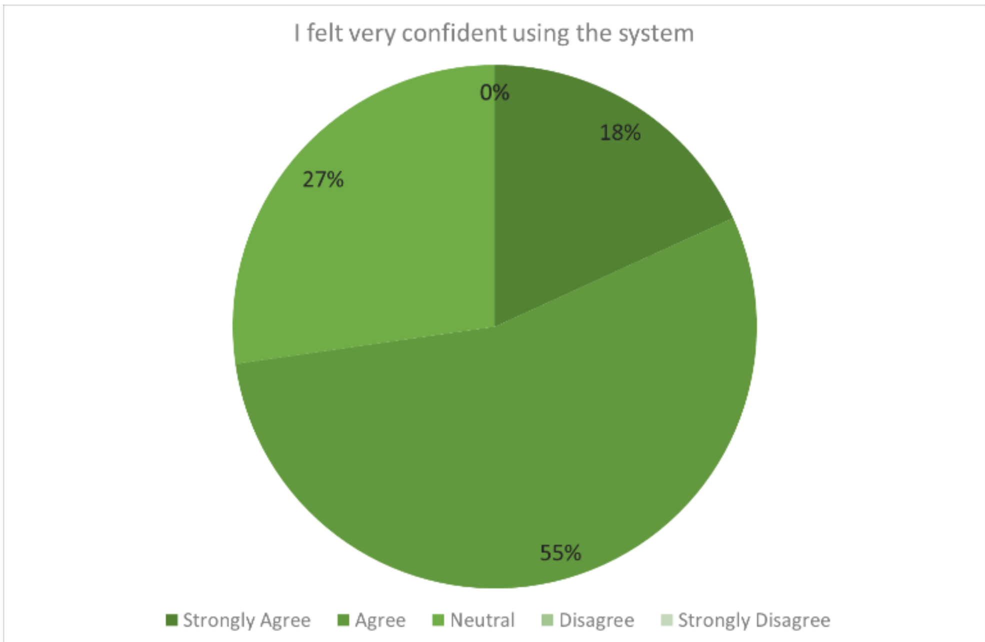


Figure 197. User Confidence in System Use

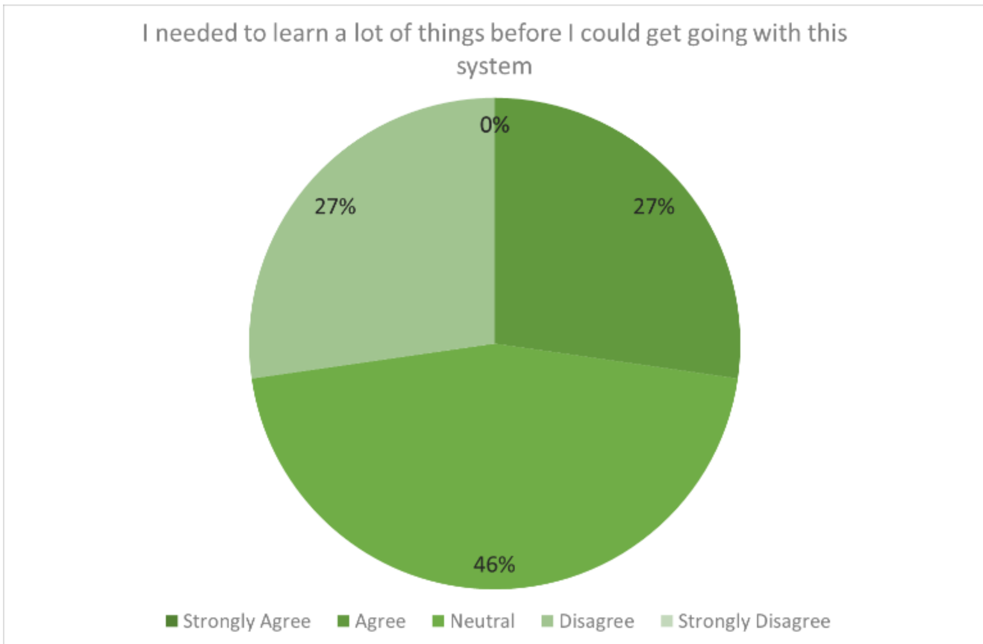


Figure 198. Learning Curve Required

While 73% of respondents said they felt confident using the system, 73% also acknowledged the need for significant learning before they could begin operating it effectively (Figure 197 and Figure 198). This suggests that, while the system fosters a strong sense of control and competence once users become familiar with its functions, it presents a considerable initial learning curve. The presence of 27% neutral responses on both items reinforces the idea that not all users transition smoothly from onboarding to safe use. It is worthwhile to provide structured training resources to facilitate the adoption of the Digital Building Logbooks within the EPC assessment framework.

7.2.7 Resident Perception of the Neighbourhood Rating Scheme

This dimension gauges user perception of the SmartLivingEPC's new neighborhood scale rating system (NSLE).

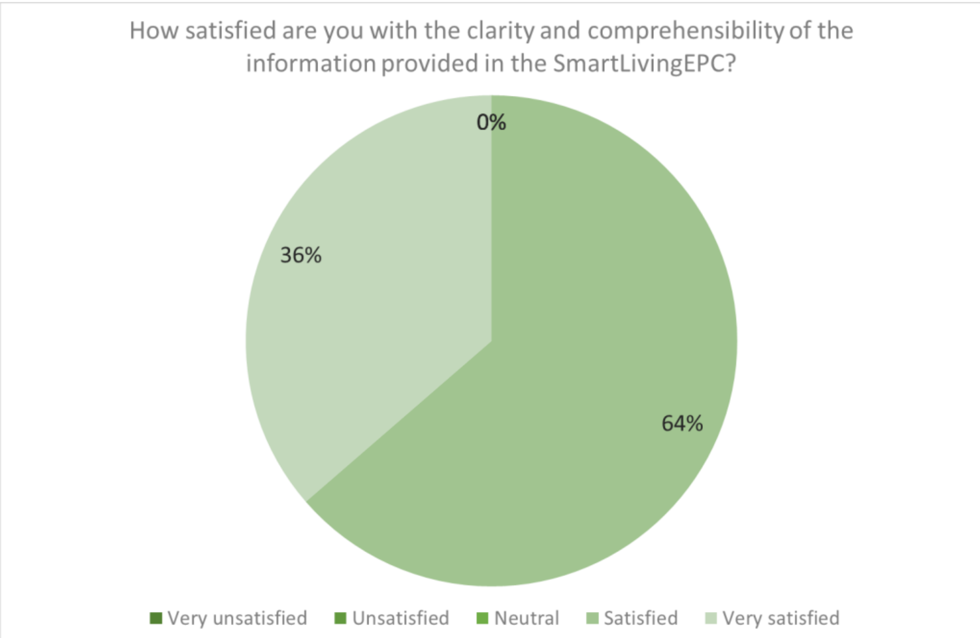


Figure 199. Satisfaction with Clarity of SmartLivingEPC Info

This KPI focuses on four key aspects: the perceived usefulness, this is, the degree to which users believe the SLEPC offers valuable insights, the perceived ease of use, through which it is expected to evaluate the level of intuitiveness and clarity of SmartLivingEPC for users of various technical knowledge, the intention to use, gauging residents' willingness to regularly integrate the SLEPC into their decision-making processes, and the privacy of personal data, assessing user comfort with how the SLEPC collects and utilizes their personal data.

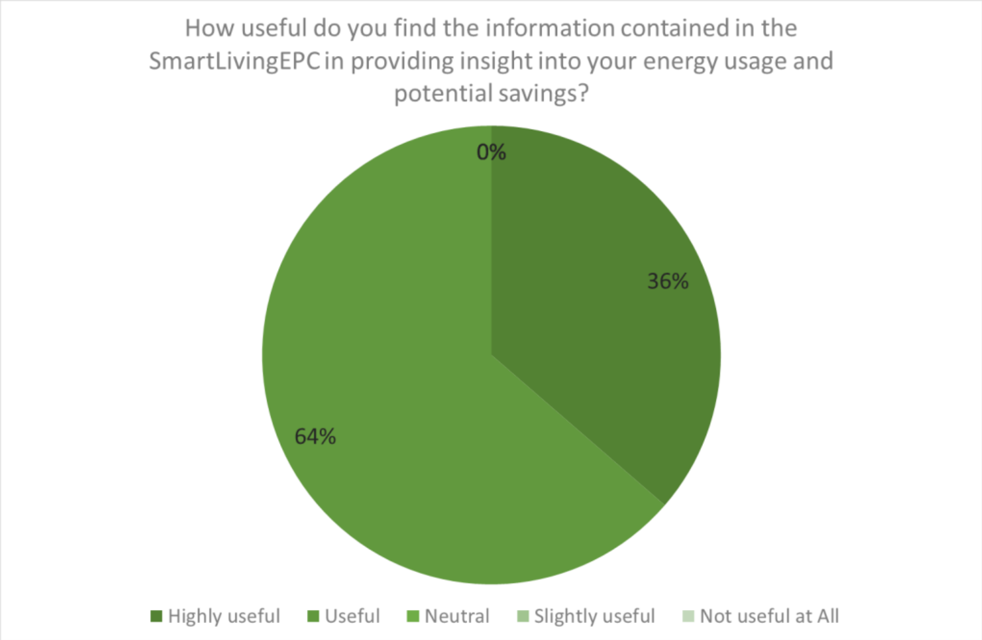


Figure 200. Usefulness of SmartLivingEPC for Energy Insights

A clear correlation was found between the quality of the platform's information and its perceived value to users. The fact that 100% of respondents expressed satisfaction with the clarity and understandability of the information (64% satisfied and 36% very satisfied) demonstrates that the platform communicates technical content in an accessible manner (Figure 199). Similarly, the reported usefulness of the information on energy and potential savings was rated as very useful by 64% of users and useful by the remaining 36%, with no neutral or negative responses.

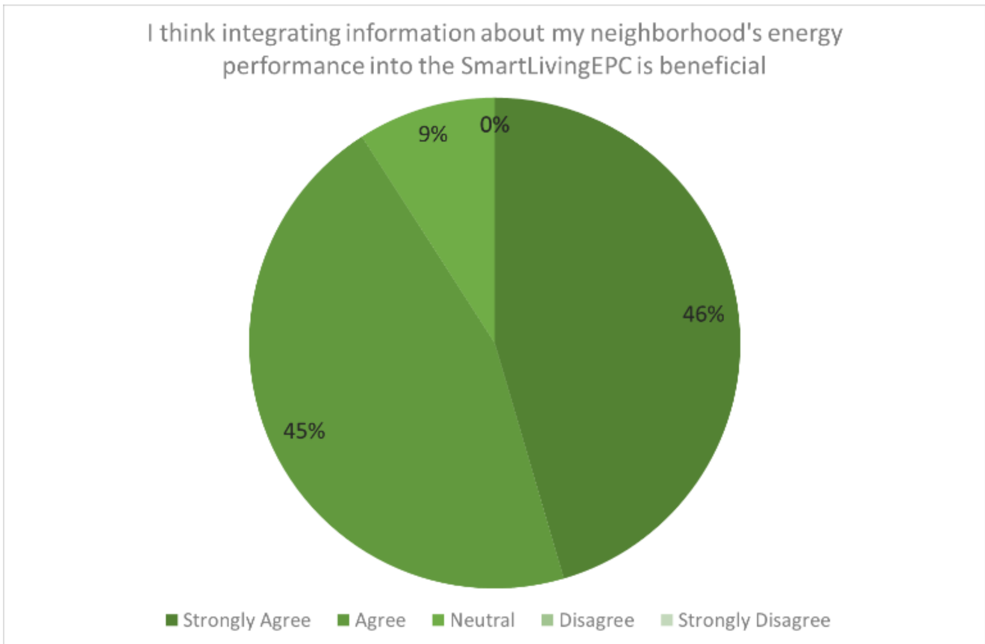


Figure 201. Value of Including Neighborhood Energy Data

A large majority of respondents recognize the value of including neighborhood-level data in the EPC framework. Specifically, 46% "Strongly Agree" and 45% "Agree" that integrating neighborhood-level energy performance information is beneficial. Only 9% were neutral, and none disagreed. This response confirms user support for a more comprehensive and community-based approach to energy certification systems.

7.2.8 Overall evaluation of the Tool

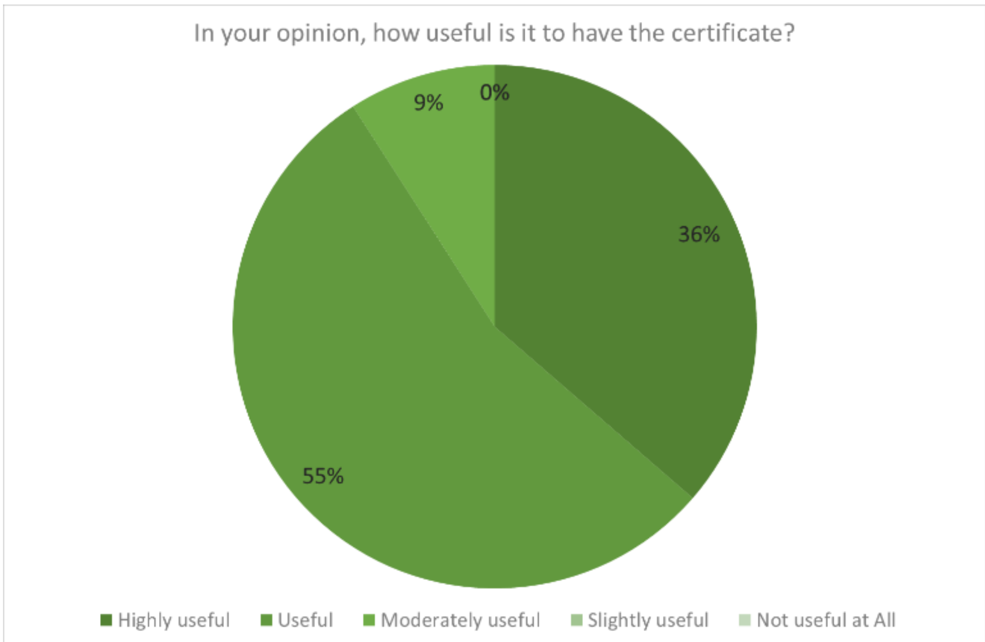


Figure 202. Perceived Usefulness of the Certificate

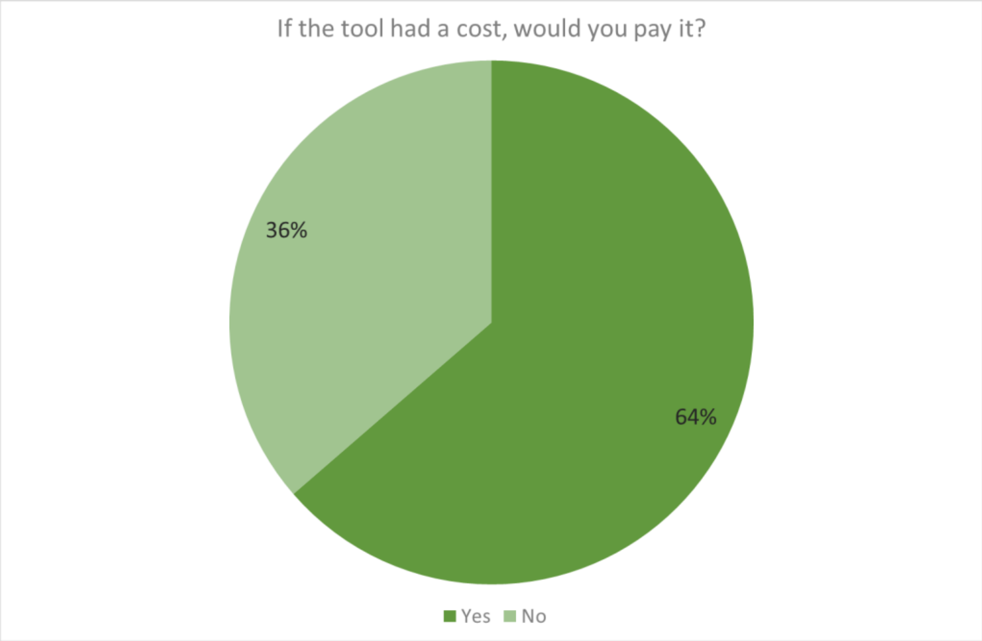


Figure 203. Willingness to Pay for the Tool

The results of the overall evaluation of the SmartLivingEPC by its users show that 91% of respondents rate it as "Very Useful" or "Useful," positioning it as a reliable tool to support informed energy decision-making. This perceived value is reflected in the finding that 64% of users would be willing to pay for access to the tool. However, the 36% who indicated they would not pay highlights a certain price sensitivity among end-users.

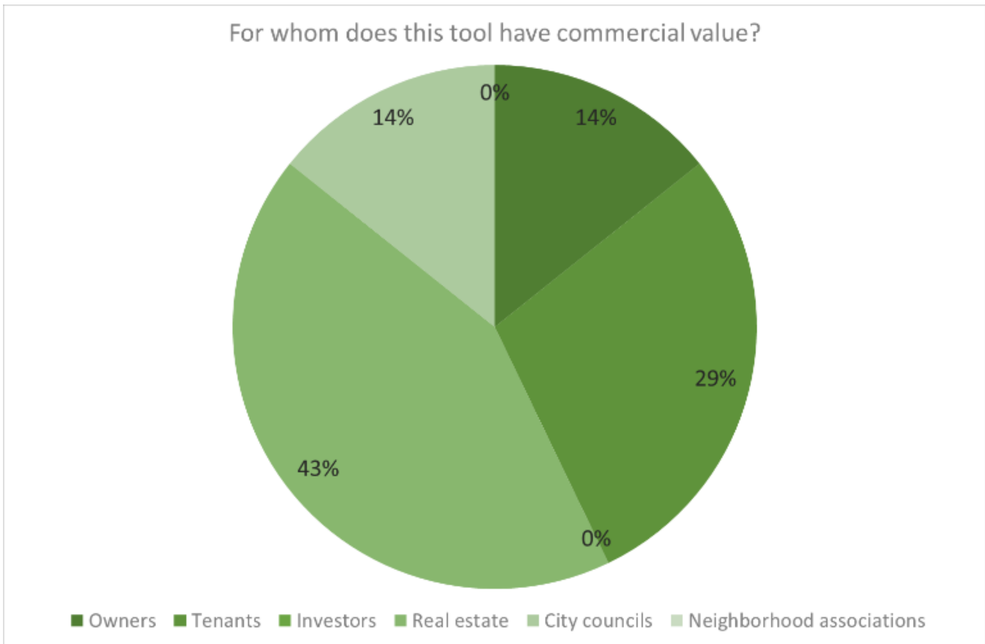


Figure 204. Perceived Commercial Value of the Tool

Among end users, the perception was that professional and investment-oriented sectors, particularly the real estate sector (43%) and private investors (29%), were likely to find the platform most commercially attractive. This could represent potential as a B2B (business-to-business) solution tailored to stakeholders who derive direct financial benefits from real estate performance optimization. In contrast, segments such as property owners, tenants, and neighborhood associations showed moderate recognition of its value, and city councils were not identified as a target at all.

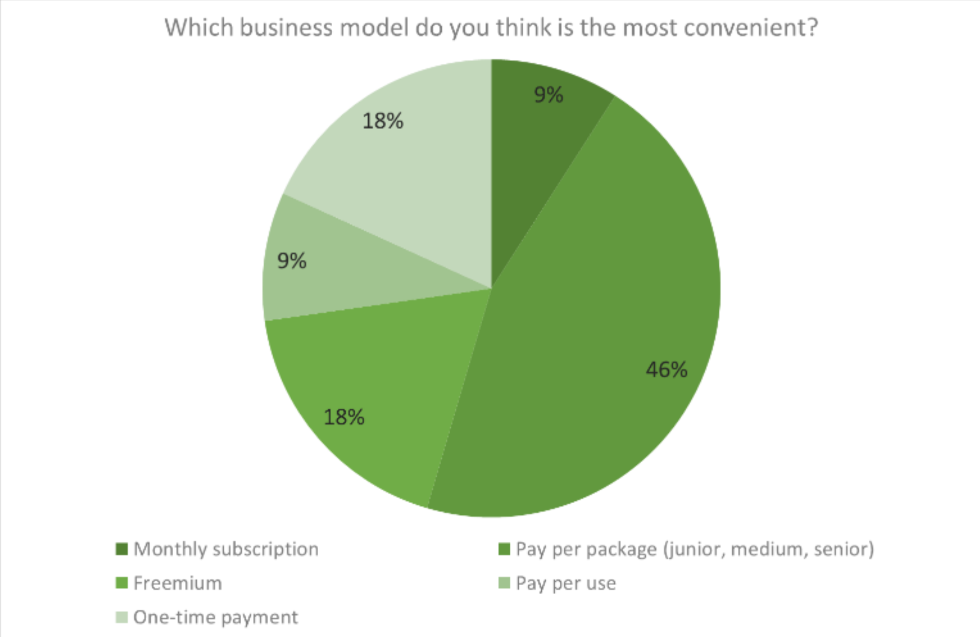


Figure 205. Preferred Business Model

Regarding business model preferences, the predominant choice was a tiered package payment approach (46%) and the "Freemium" and "Pay-as-you-go" models (18% each). Support for the "One-time Payment" (9%) or "Monthly Subscription" (9%) options is marginal, further highlighting the preference for scalable, usage-based models. These preferences are reflected in respondents' willingness to pay. Although some users are willing to invest in the tool, especially in the ranges of €0–€50/year (28%) and €100–€300/year (27%), a significant 27% would pay nothing, and no participants indicated they were willing to spend more than €300/year.

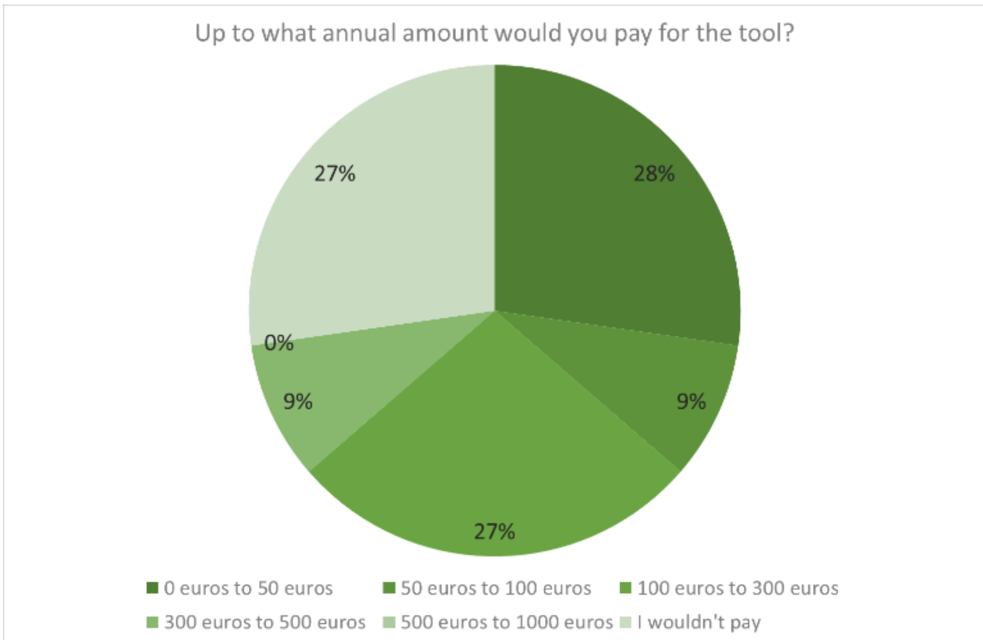


Figure 206. Willingness to Pay: Annual Amount

The pie chart illustrates respondents' willingness to pay an annual fee for the tool. A clear majority is willing to make modest contributions:

28% would pay up to €50, and
27% would pay between €50 and €100.

These two groups together represent 55%, indicating that more than half of respondents are willing to pay a low price. Furthermore, 9% are willing to pay between €100 and €300, and another 9% would pay between €500 and €1,000, suggesting that a small segment sees greater value in the tool.

It is worth noting that no respondents were willing to pay between €300 and €500, and 27% indicated they would not pay, reflecting a discrepancy between their perception of the assigned price and the tool's value. Finally, it should be noted that in the open-ended question "If you opt for a one-time payment for a lifetime license, what amount in euros would you be willing to pay?", the majority of respondents indicated a willingness to pay between €30 and €250, suggesting that a one-time payment model could be viable if kept in a low-to-medium price range. There were also some outliers (e.g., €1,500 and €7,000), suggesting that some users (likely those with significant commercial or institutional interest) perceive high value.

8 Conclusions

8.1 BIM Model Development and Challenges Across Pilots

In the absence of standardized BIM guidelines at the start of the project, each pilot either developed its own BIM model or relied on existing models previously created for earlier building projects. However, these models later had to be modified to align with the requirements of the SmartLivingEPC project. In some cases, this involved cleaning, filtering, and restructuring the models to optimize their usability, while in others, it was necessary to complete missing or incomplete information.

In one case, some information relevant to the project was missing or presented in non-standard formats, while other parts of the model contained an excessive level of detail that was not required by the evaluation methodology.

In another case, the model underwent a transformation process to convert it into IFC format. This conversion was carried out in collaboration with FRC and CERTH, focusing on cleaning up metadata and refining the overall model structure.

In contrast, for the Leitza pilot buildings, there were no pre-existing BIM models available from design or construction phases. The models had to be developed from scratch. Initially, they were created using a tool focused on energy performance analysis, but the resulting. ifc models lacked the necessary information to meet the SmartLivingEPC requirements. Due to incompatibility with other BIM tools and the absence of standardization, the buildings had to be re-modeled a second time using tools that fulfilled all technical and methodological criteria.

In all three cases, BIM expertise was essential. The collaboration with CERTH, who provided technical support and quality assurance, was key to producing BIM models that met the conditions required under the SmartLivingEPC scheme.

These experiences highlight **the critical need for clear, standardized BIM modelling guidelines to ensure scalability and interoperability. Furthermore, the involvement of a qualified BIM manager or modeler is essential to ensure the models are properly structured and aligned with the project's requirements**.

8.2 Monitoring Setup Challenges in Existing Buildings

There are generally no significant issues when the monitoring infrastructure has been designed with research purposes in mind**,** particularly in new or recently constructed buildings where monitoring systems were integrated into the design phase. This is the case in pilots such as DS3 and DS1**,** which are equipped with Building Management Systems (BMS), and DS2, which—despite not having a BMS—already had a consolidated monitoring system established before the project, driven by energy efficiency initiatives and prior research projects.

In contrast, existing buildings (DS4-DS9) present a number of complexities. As described in Section 6.4.2, working with pre-existing installations often requires technical interventions, which may introduce additional risks and limitations:

- Human interference: Monitoring devices are more exposed to accidental disconnections, power supply interruptions, or broken connections.
- The need for some devices to be permanently powered by mains electricity limited their deployment in dwellings with physical, aesthetic or occupancy restrictions.
- In existing buildings there are mechanical and analogue installations such as gas meters. These devices are not ready for digitalisation and their integration is a challenge
- In diesel and biomass thermal generation systems, in many cases there were no physical meters installed, which made it necessary to incorporate retrofit solutions and required interventions.
- The data acquisition process in real-world environments relies on a complex and fragile technical chain, where each link represents a potential critical point.

- Limitations of LORA: sensitivity to physical interference, low transmission speed, and the fact that, in some cases, the communication is unidirectional
- Absence of local storage systems in devices, which means that if they lose connection to the real-time transmission system, the data generated is lost without any possibility of recovery.
- Dependence on mobile coverage in rural or semi-urban environments, which is not always stable or continuous.

To address the lack of reliable data from energy meters in the Leitza pilots, a workaround has been implemented. Consumption profiles are being estimated using AI-based applications, which rely on outdoor conditions and monthly historical billing data. This solution enables the operational evaluation of buildings even in the absence of complete real-time data.

If the installed devices had the ability to store the measured data locally, we would have also had the option to recover data that was lost due to connection or data acquisition issues. It is important to mention that devices on the market that support wireless systems for real-time communication do not have internal data backup and storage systems.

The experience has shown that scaling up the monitorization for operational assessment in existing buildings is challenging. To ensure stability, reliability and traceability of measurements in the future, it is essential:

- Incorporate devices with local storage and robust forwarding protocols.
- Establish network and device health monitoring systems.
- Implement redundant or failover systems.
- Ensure complete metadata recording (origin, date, quality) to guarantee traceability and validity in decision-making processes.

8.3 Communication of IoT devices with CIEM platform

Overall, there have been no issues that prevented successful communication with the CIEM platform. However, two key learnings can be highlighted:

- In all cases, continuous collaboration and communication with QUE, the developer of CIEM, was essential. Direct coordination between pilot managers and the CIEM integrators played a crucial role in facilitating data access and ensuring correct data formatting.
- In one case (DS3), complications emerge due to internal data governance and cybersecurity restrictions. Certain adaptations had to be made in order to meet the project requirements while also complying with the university's IT policies.

8.4 Validation of Architectural Use Cases

Overall, 25 Use Cases have been validated in at least one pilot building.

During the validation process, several key learnings and possible future improvements were identified:

- BIM Integration: The BIM file was successfully uploaded and validated. Information related to building geometry, thermal performance, and technical systems was properly extracted.
- For the Indoor Environmental Quality (IEQ) and operational rating calculations, having clear explanations for inputs and making hardcoded or calculated data visible to users would enhance trust and validation of results.
- Inspection and Reliability of IoT Equipment: To ensure long-term integrity of measured data, periodic audits and backup procedures are recommended. These would support continued synchronization with the CIEM platform and provide redundancy in the event of network disruptions.
- Automated Near-Real-Time Data Retrieval: The integration process highlighted the importance of a flexible backend architecture, as pilot sites often deliver data in different formats, granularity, and frequency. A consistent parsing logic was essential to guarantee interoperability across pilots. For future scaling, enhanced data storage strategies will be needed to manage high-volume data flows efficiently. Big data optimization techniques should be integrated from the early deployment stages.

AI-Driven Operational Analysis: The accuracy of AI-based analysis is highly dependent on the quality and availability of sensor data. Data gaps, noise, or reliance on manual uploads can lead to deviations in disaggregation results and comfort assessments. Manual validation remains necessary in certain modules, particularly for cost estimation and comfort evaluation.

These findings provide valuable insight into the current challenges and considerations that must be addressed to ensure the robustness and scalability of the SmartLivingEPC framework in future deployments.

8.5 Building Complex Assessment

The building complex assessment was successfully completed for both asset and operational ratings and integrated into the SmartLivingEPC platform. Key lessons learned include the need for early coordination with stakeholders to define boundaries efficiently, the value of cross-validating data sources to minimize errors, and the importance of multidisciplinary KPI development to ensure alignment with project goals. Normalizing KPIs into percentages improved usability for technical users, while involving residents in weighting helped reflect local values and avoid social risks. Suggested improvements include creating participatory tools adaptable to different sociocultural contexts, establishing a centralized data repository, reviewing KPIs every five years, and increasing resident involvement to foster community empowerment.

8.6 Evaluation methodology of SmartLivingEPC framework

The SmartLivingEPC platform was well received by evaluators, with 75% expressing a willingness to use it regularly. The interface was considered intuitive by most highlighting the need for improved training and support tools. The system's functional integration and reliability were rated in general positively. The Digital Building Log Books and BIM automation were seen as valuable for data accuracy and efficiency. Technical audits of the system were praised for improving the relevance of the EPC, but raised questions about the feasibility of widespread implementation. Indoor Environmental Quality (IEQ) integration was technically feasible, although societal acceptance (privacy concerns) remains an obstacle. The Smart Building Readiness Indicator (SRI) received high ratings in relation to the EPC assessments. The neighborhood rating system was well received for fostering collective awareness and cooperation as the basis for an energy and ecological transition leveraged by social transformation. The building improvement recommendations were considered useful, although the certificate's ability to drive such actions was rated as moderate. Finally, users preferred low-cost, one-time payment models.

Annex I

UC1.2 template as example

	Name	Execution	Responsible	Expected Results	Pilot	Successful criteria	Fail Criteria	Results (Pass/Fail)	Incidence/ Impact	Result evidence. Picture (file link)	Numerical Result evidence	Lessons Learned	Proposed improvements
UC1.2	**Collect and extract data from additional building documentation sources**	1. The EPC assessor requests the required building documentation from the building owner 2. The EPC assessor may also gather documentation from other sources, such as the municipal archive, cadastre, and similar entities. 3. Once collected, The EPC assessor uploads the building asset data to the SmartLivingEPC Web Platform. 4. The SmartLivingEPC Web Platform conducts validation checks on the uploaded data. 5. If the validation process fails, an “invalid input data” message is sent to the EPC Assessor. In such case, the EPC Assessor may request additional information, make the necessary corrections, and re-upload the updated data to the SmartLivingEPC Web Platform. 6. If the validation is successful,the information is transmitted and stored in the CIEM. 7. The SmartLivingEPC Web Platform then sends a confirmation message, and the asset information becomes available for visualization.	GOIENER S.COOP will act as the general responsible, while the other pilot managers (CERTH, FRC, TALTECH) will be in charge of steps 1, 2, and 3.	Gather all the required data and successful validation process	DemoSite 1. nZEB Smarthouse DIH	Visualization of the building asset information on the Web Platform	Lack of information						
					DemoSite 2. Frederick’s University Main Building	Visualization of the building asset information on the Web Platform	Lack of information						
					DemoSite 3. Ehituse Mäemaja, Tallin University of Technology, Tallin, Estonia	Visualization of the building asset information on the Web Platform	Lack of information						
					DemoSite 4-9. Complex building in Leitza	Visualization of the building asset information on the Web Platform	Lack of information						

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https://www.smartlivingepc.eu/en/

https://www.linkedin.com/company/smartlivingepc/

https://twitter.com/SmartLivingEPC

https://www.youtube.com/channel/UC0SKa-20tiSabuwjtYDqRrQ

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