e-SAFE

DELIVERABLE REPORT

WP4 ICT infrastructure

D4.3

e-SAFE DSS - FIRST COMPLETE VERSION – ACCOMPAYNING REPORT

Due date

M15 31.12.2021

e-SAFE has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 893135

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- ☐ R - Report
- ☐ DEM - Demonstrator
- ☐ DEC Websites, patents filling, videos, etc.
- ☒ OTHER
- ☐ ETHICS – Ethics requirement
- ☐ OPRP - Open Research Data Pilot
- ☐ DATA – Data sets, microdata, etc.

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EXECUTIVE SUMMARY

This report is the accompanying document of D4.3, i.e. the **e**-SAFE Decision Support System (DSS) first complete version that will be used during the co-design stage of the real pilot in Catania.

The first complete version of **e**-DSS was released by ENG at M15. The software code is stored in the ENG Gitlab repository at https://production.eng.it/gitlab/e_safe. This is a repository hosted by ENG in order to manage and optimize the software delivery lifecycle, including all the development activities that are under ENG responsibility. The Gitlab project that was created for **e**-SAFE is compliant to a specific access policy aimed to prevent unauthorised users from gaining access to the software code; indeed, only ENG employees working on **e**-SAFE project have access to the **e**-SAFE project on Gitlab and this is compliant to the ENG policy.

Focusing on the implementation aspect, the **e**-DSS is a web application using Node.js as API back-end and Vue.js as a front-end. Moreover, the **e**-DSS refers to the Renovation space representational model that is conceived as the **e**-DSS data model, described in Deliverable D4.2. The **e**-DSS data base relies on MySQL as database relational management system, and Express framework is used to implement the interaction between the Client and the Server side of the **e**-DSS tool. Indeed, the **e**-DSS was designed as an online tool (accessible from the user browser by entering a specific URL) rather than as an application that runs stand-alone in a desktop or laptop computer. For this reason, the **e**-DSS is installed and configured in a server of ENG server farm in order to be exploited by **e**-SAFE partners.

It is important to underline that the **e**-DSS publication on ENG server is subject to a security assessment under responsibility of the Cyber Security ENG Department. Indeed, in accordance with ENG policy, this assessment is needed to identify and address possible **e**-DSS security vulnerabilities such as unauthorized access to data. The **e**-DSS as online tool will be accessible from **e**-DSS users once the security assessment will be completed.

In the meantime, this accompanying document is released with the aim of explaining the main functionalities implemented in the first version of **e**-DSS and providing a brief guideline for its usage. Some **e**-DSS screenshots are provided taking, where possible, the pilot of Catania as example.

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GLOSSARY OF TERMS

ACRONYM	DESCRIPTION
DHW	Domestic Hot Water
DSS	Decision Support System
GUI	Graphical User Interface
GPS	Global Positioning System

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1. INTRODUCTION

This is the accompanying report of D4.3, i.e. the **e**-SAFE DSS first complete version released by ENG at M15. Indeed, D4.3 is a prototype and the **e**-DSS software code is stored in the ENG Gitlab repository at https://production.eng.it/gitlab/e_safe. Therefore, this document is released to introduce the first version of the tool and provide to the Reader a brief guideline for its usage; indeed, some **e**-DSS screenshots are provided taking Catania's pilot as example. Regarding the renovation co-design process, it can be managed in different ways according to the functional specification provided in D4.2; in this document, for the sake of simplicity, the energy retrofit renovation solution is taken as example.

1.1 Intended Audience

The intended audience of the report is primarily represented by the members of the project's consortium and European Commission representatives tasked with reviewing the project and its progress towards meeting the specified milestones. Moreover, it reports relevant information for the usage of **e**-DSS tool.

1.2 Relation to other activities

This document is related to the first complete version of **e-**DSS, which corresponds to the Milestone MS4.

1.3 Document overview

The report is structured as follows:

- Section 2 provides a recap of the main functionalities supplied by the first complete version of the **e**-DSS;
- Section 3 provides a brief guideline for the **e**-DSS usage with the aid of some screenshots of **e**-DSS Graphical User Interface (GUI).

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2. e-DSS MAIN FUNCTIONALITIES

This section provides a recap of the main functionalities supplied by the first complete version of the **e**-DSS. As anticipated, D4.3 is conceived to support the co-design process of the real pilot. Regarding the use of the **e**-DSS, this process is composed of two main steps: the first one is about the energy assessment of the building in its current state (pre-renovation) and the second one is related to the possibility of managing the building renovation process (post-renovation).

The first version of the **e**-DSS is conceived to support the "**e**-DSS technician" (i.e. architect, engineer, designer, etc.) during the co-design process of the building. The exploitation of **e**-DSS from the building manager is planned to be implemented in the final version of the tool due at M30.

This first version implements the equations for the calculation of the energy needs in the building that must be renovated and the relevant algorithms for the renovation stage. Both phases of pre and post building renovations are fully supported by the tool and the technician can exploit the **e**-DSS in order to have a clear understanding of the pre and post renovation performance of the building, in terms of costs, energy savings and decarbonization potential. This kind information is relevant for the Building Manager since the **e**-DSS is also conceived as a means of communication between the technician and the building owners/residents during the co-design stage.

Deliverable D4.2 [1] provides the full list of functional requirements implemented in the first version of **e**-DSS (D4.3); as a reminder, a recap is provided in Table 1 that also resumes the main expected differences between the first and the second release of the **e-**DSS (D4.5 expected at M30).

Table 1: Main functionalities of **e**-DSS first and second release

	FIRST RELEASE	SECOND RELEASE
Deliverable	D4.3	D4.5
Due date	M15	M30
e-DSS uses cases	Technician use cases defined in D4.2	Technician and Building Manager use cases defined in D4.2
Edit **e**-DSS project	The technician can modify only the **e**-DSS projects for which the energy performance of the building in its current state (pre-renovation) was not computed yet.	The technician can modify the **e**-DSS project; previous information and results are always available.
Weather data	Assigned as from UNI 10349:2016, and valid only for Italian locations.	Extracted from PVGIS EU web-service, starting from latitude and longitude of the site, and after some simple processing by the same **e-**DSS.
Geometry input	Manual. The 3D model in the IFC file has only a graphical function.	Some geometrical data (window surfaces, opaque surfaces, height) can be read from the IFC file. If this does not work, manual input will still be possible. We will evaluate the possibility to consider some simpler representations like gbXML [2].
Duration of the heating season	Established according to Italian regulations, as a function of the national climate zones.	Based on the ratio of the monthly heat gains to the monthly heat losses, as explained in UNI 11300:1, but also with the possibility for the user to freely assign these periods.
Duration of the cooling season	Based on the ratio of the monthly heat gains to the monthly heat losses, as explained in UNI 11300:1.	As before, but also with the possibility for the user to freely assign these periods.
Status of the existing RC structure	Degradation can be described through four different levels, which determines a score.	The technician can also upload pictures representing the most degraded parts of the

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		structure, as a warning for the building manager.
e-EXOS	Implemented only in terms of feasibility checks.	Implemented also in terms of costs and time of the renovation works.
e-CLT and **e-**EXOS	Not feasible above six floors.	The maximum number of floors can be modified according to the results of the ongoing research.
U-value	The technician inserts the target U-value that the walls should reach after renovation. The **e-**DSS shows a message reporting the suggested U-value according to the Italian regulations.	Adding target U-value according to the regulations in the European Country where the building is located.
Unit costs	Determined as for December 2021 and relating to the Italian market.	Updated and extended to other European countries.
Time of renovation	They are based on the unit time of installation for **e-**CLT and **e-**PANEL.	This approach, as well as the value of these unit times, will be verified and refined.

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3. e-DSS USAGE

This section provides a brief guideline for the **e**-DSS usage, and GUI are provided to show how the **e**-DSS works and how it can be exploited by the **e**-DSS technician.

3.1 User registration and login

The first step in the use of the **e**-DSS is the user registration. The registration page (Figure 1) of **e**-DSS asks for some personal details of the user: name, surname, email, and password; moreover, it is requested to specify its role (technician or building manager). The user enters the personal details and submits the registration form.

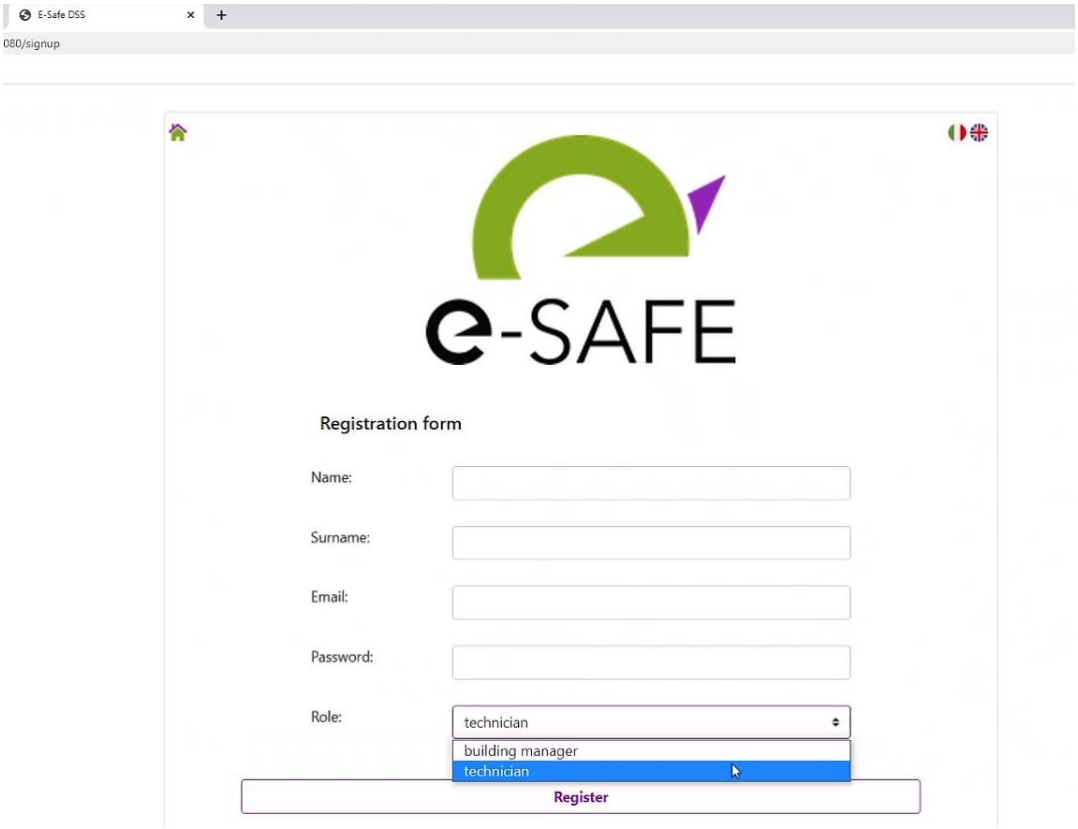

Figure 1: **e**-DSS User registration

After being registered, the user can proceed with the login (Figure 2).

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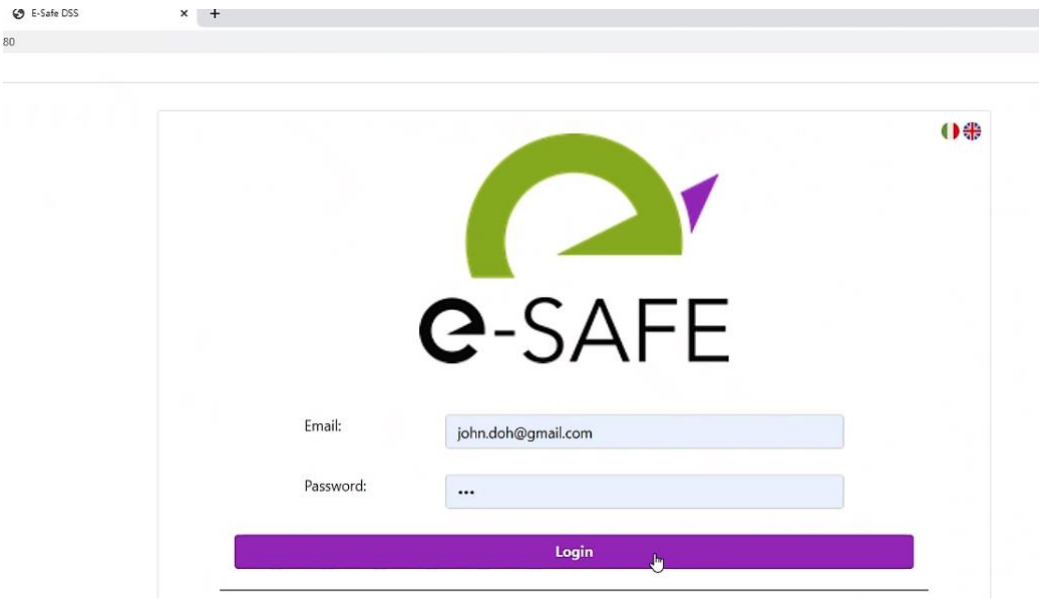

Figure 2: User login

After the login, the user is redirected to the **e**-DSS home page (Figure 3).

3.2 Project management

The **e**-DSS home page (Figure 3) shows the list of **e**-DSS renovation projects managed by the user, and the related information: project name, creation date and a short description of the renovation solution.

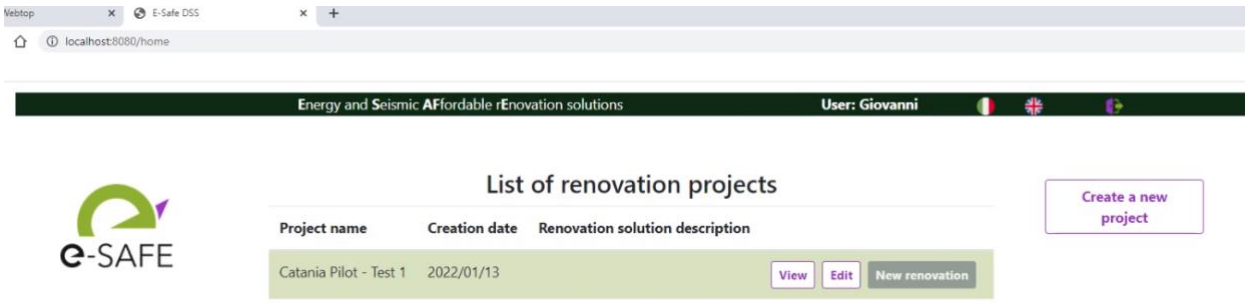

Figure 3: List of renovation projects

Through this page, the technician can:

1. create a new **e**-DSS project;
2. view or edit the **e**-DSS projects that he/she has previously created;
3. add a new renovation solution for the building.

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Clicking on the "Create a new project" button, the technician is redirected to the **e**-DSS page shown in Figure 4.

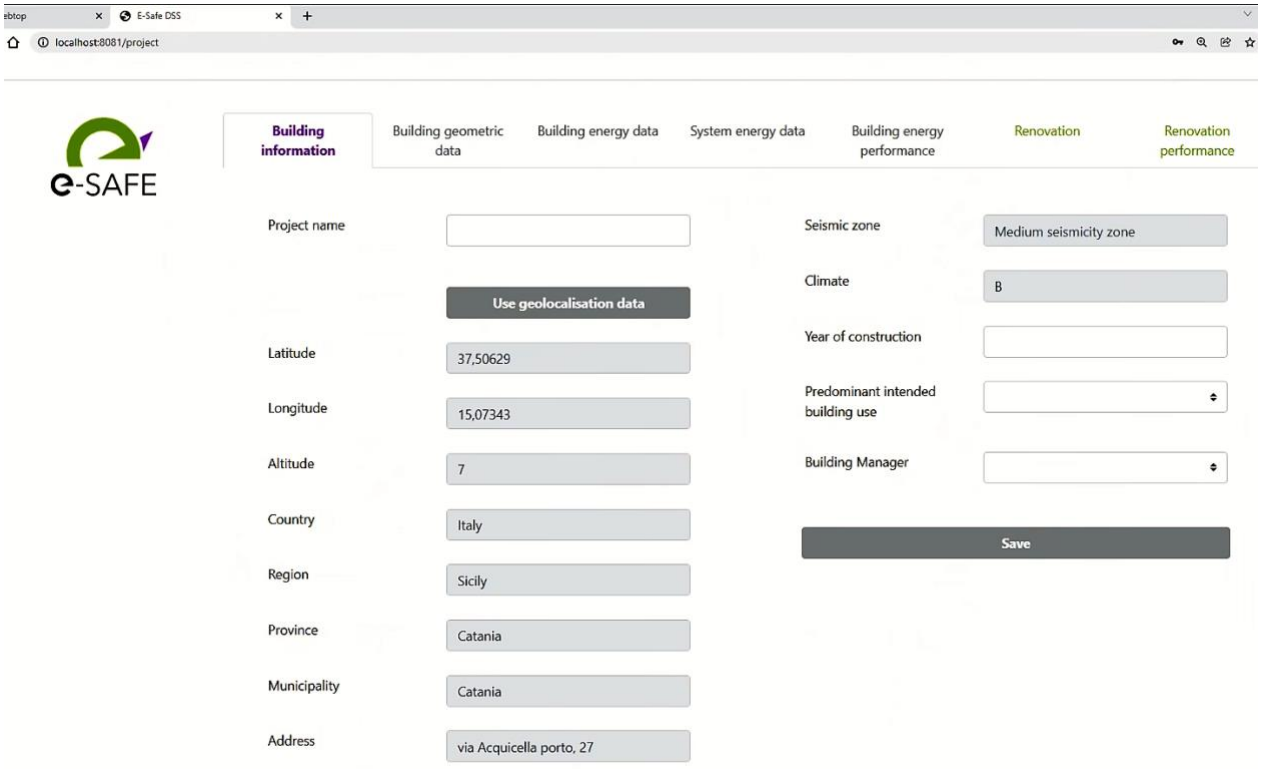

Figure 4: **e**-DSS menu

The page is composed by different tabs according to the relevant information that the technician has to provide:

- *Building information* allows inserting the building general information such as the year of construction and the predominant use.
- *Building geometric data* is used to provide information about the building geometry such as the building height and the gross surface of the ground floors. Moreover, by using this tab it is possible to insert information about the building's dwellings.
- *Building energy data* is used to insert information such as the colour of the external finish and the type of external wall. In this case the data entry phase is facilitated by drop-down menus suggesting the possible choices.
- *System energy data* is used to provide information about the features of the energy systems available in the building, such as the efficiency of the heat generators and the type of emission systems that are installed.

Moreover, there are 3 tabs related to the co-design process of the building:

- *Building energy performance* aims to show the energy performance of the building in its current state (pre-renovation), and provides results such as the annual energy demand for space heating and heating and the monthly/annual net electric energy consumption.
- *Renovation* allows starting the building renovation process.
- *Renovation performance* is responsible for showing the energy performance of the building pre and post renovation.

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3.3 Building management

Clicking on *Building information* tab (see Figure 5), the technician can fill in the information required by the **e**-DSS about the current state of the building such as the Project name, the year of construction and the predominant intended building use that he/she can select from a drop-down menu. This first version of **e**-DSS is conceived to support the Catania real pilot, and for this reason some information such as the building GPS coordinates, the building address and the seismic zone are known and they are set as predefined values. However, by clicking on "Use geolocalisation data" it is possible to select other localities if needed.

The same approach is followed for the weather data (e.g., the mean daily global solar irradiation on horizontal and vertical surfaces) that are related to the Catania pilot and are stored in the **e**-DSS database. As reported in Table 1, the final release of **e-**DSS will allow the extraction of weather data from PVGIS EU web-service [3]. An example of *Building information* tab is shown in Figure 5 where some information has been already provided in case of Catania's pilot.

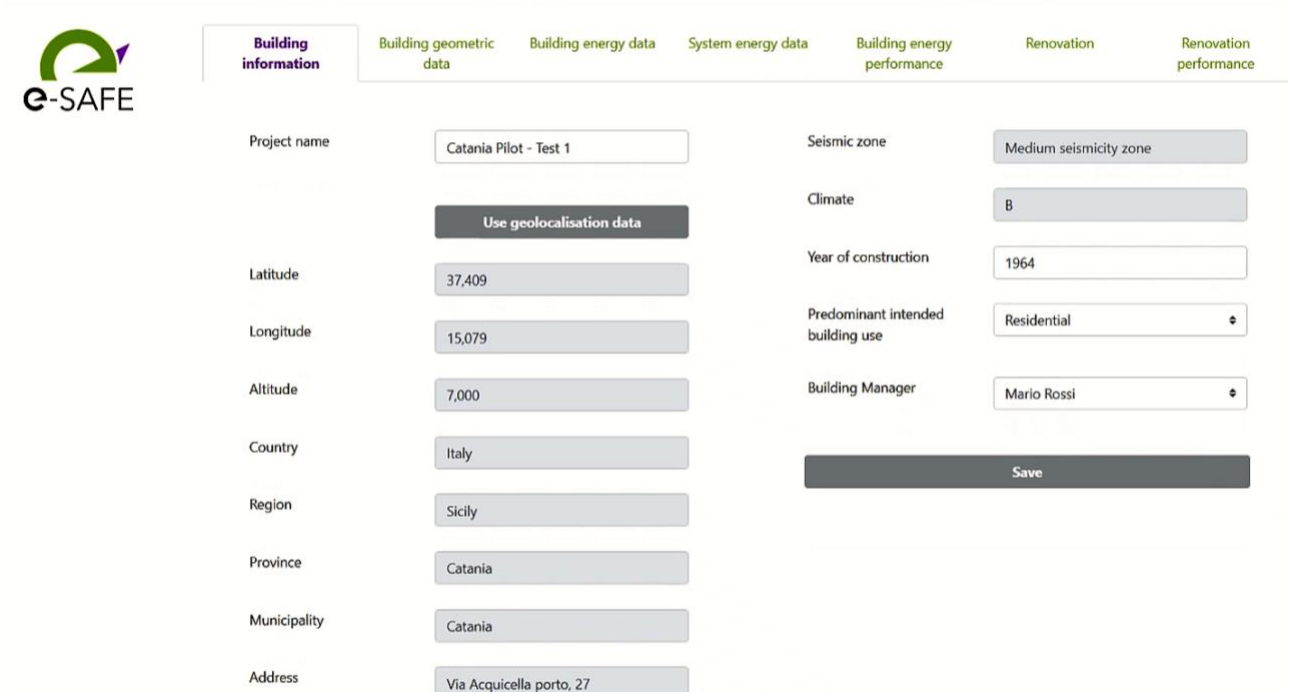

Figure 5: **e**-DSS Building information – Catania's pilot

The technician then clicks on the "Save" button to store the information in the **e-**DSS data base. After that, the *Building geometric data* tab is automatically enabled (the colour of the text changes from green to violet), so that the technician can provide the requested information. This phase – in which the technician has to provide relevant building information – can be done step by step, and the technician is guided in this process by the tool itself. Indeed, he/she can access to the *Building geometric data* tab only after having completed the information requested in the *Building information* tab. The same approach is applied for the *Building energy data* and the *System energy data* tabs.

So, clicking on the *Building geometric data* the technician can import the building IFC file and see the 3D model of the building. As anticipated, in this first version of the tool, the geometric input can be provided only manually. Figure 6 and Figure 7 show the screenshots of **e**-DSS *Building geometric data* tab that was split in more images for the sake of readability. Also in this case, geometric data of Catania's pilot are used by way of example.

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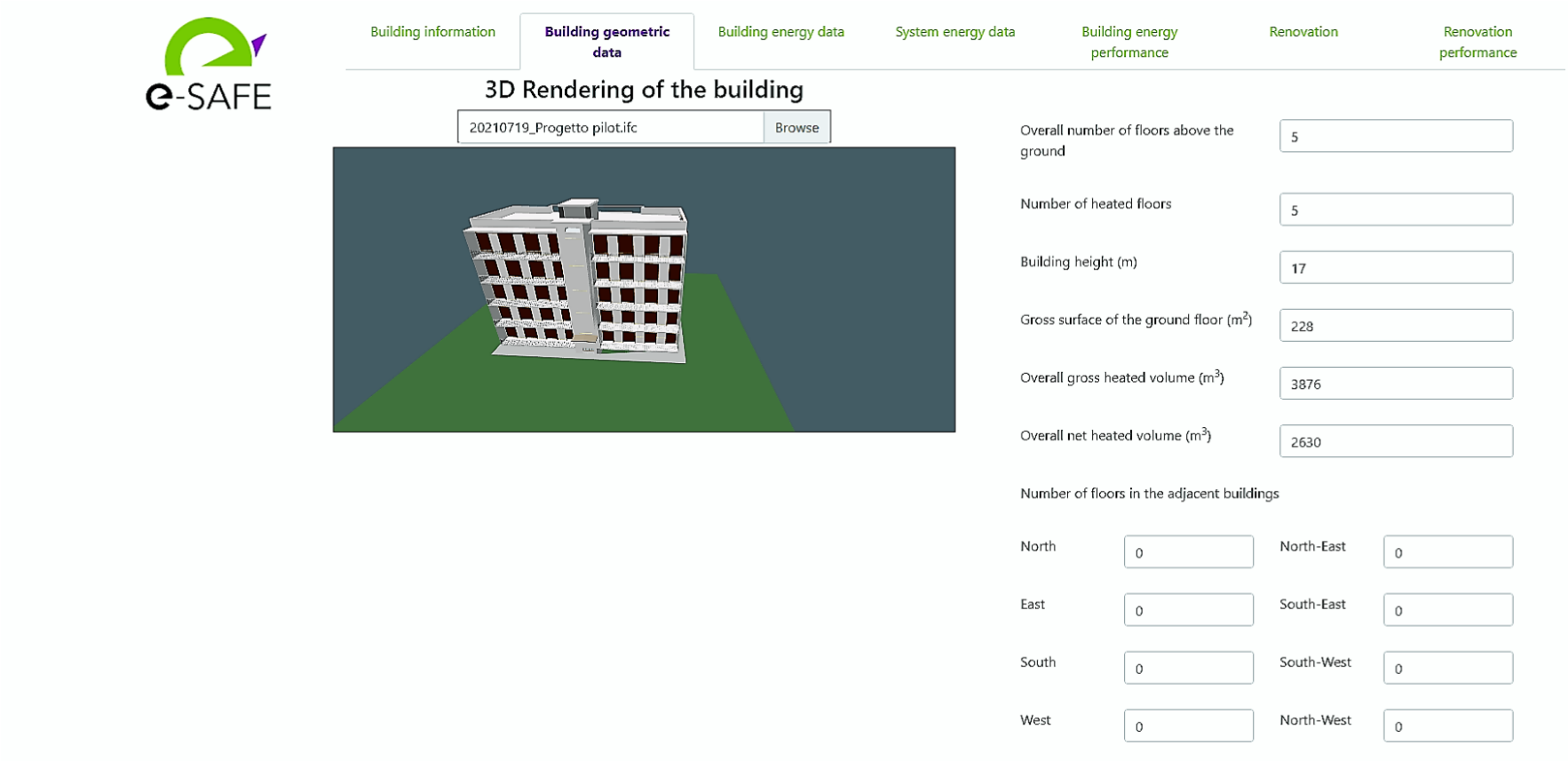

Figure 6: Building geometric data – Catania's pilot -1

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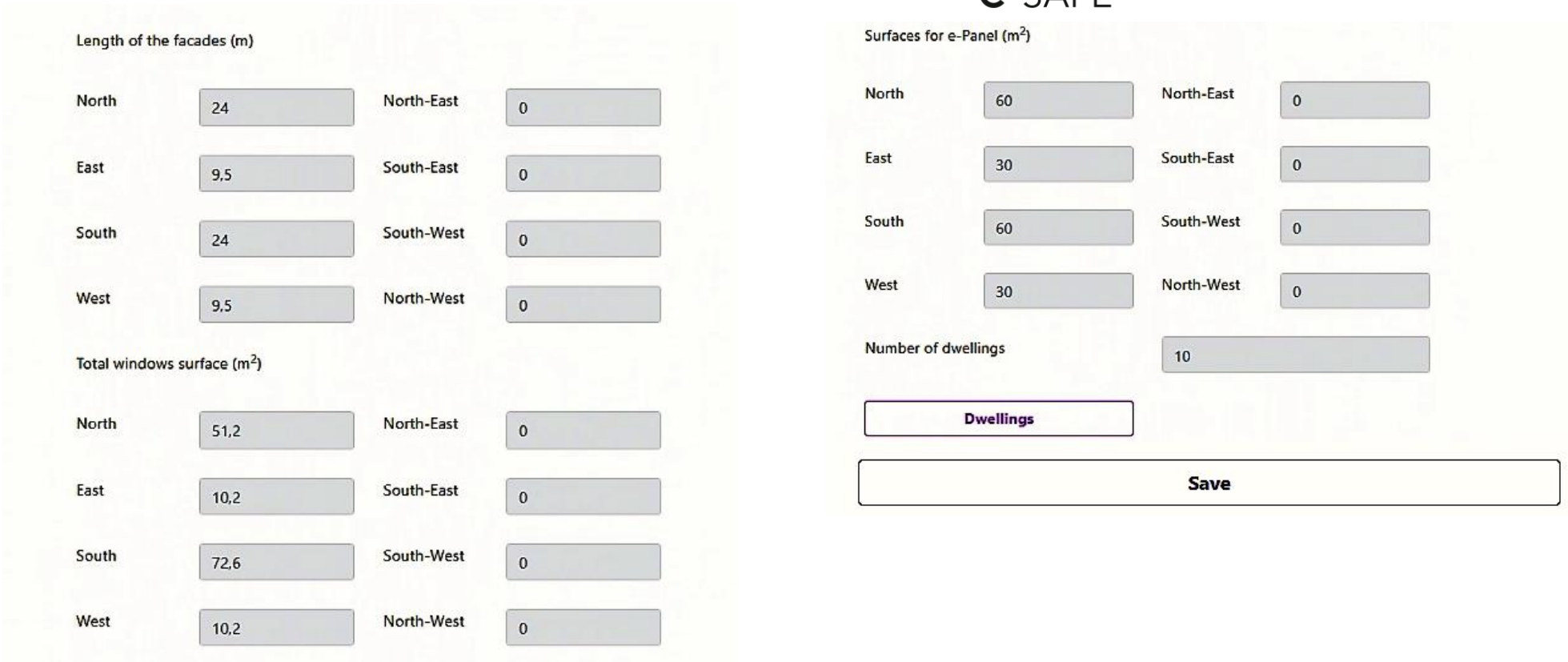

Figure 7: Building geometric data – Catania's pilot -2

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By clicking on the "Dwellings" button, the technician can then add the information for each dwelling of the building. As shown in Figure 8, he/she can provide a short description, the net surface of the dwelling and the owner information. The field "number of dwelling" of Figure 7 is automatically updated by the tool once the technician has completed to add the dwellings information.

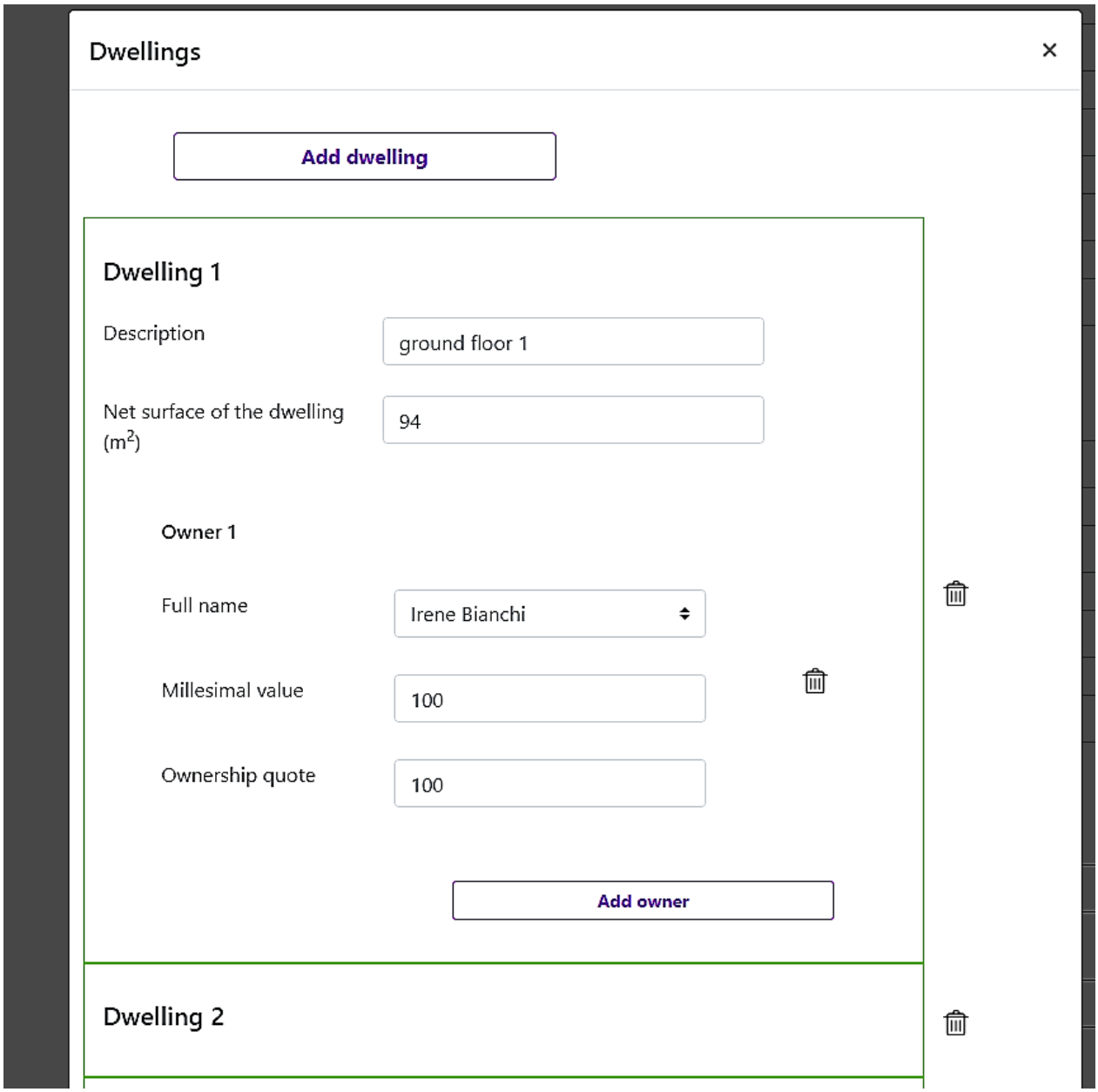

Figure 8: Add dwelling function

The technician clicks the "Save" button and he/she can move forward filling in the *Building energy data*. This kind of information is needed to calculate the equations used for describing the energy and cost performance of the building before the renovation. Figure 9 shows the screenshot of *Building energy data* tab where the filled in information is related to the Catania pilot that also in this case is used as example.

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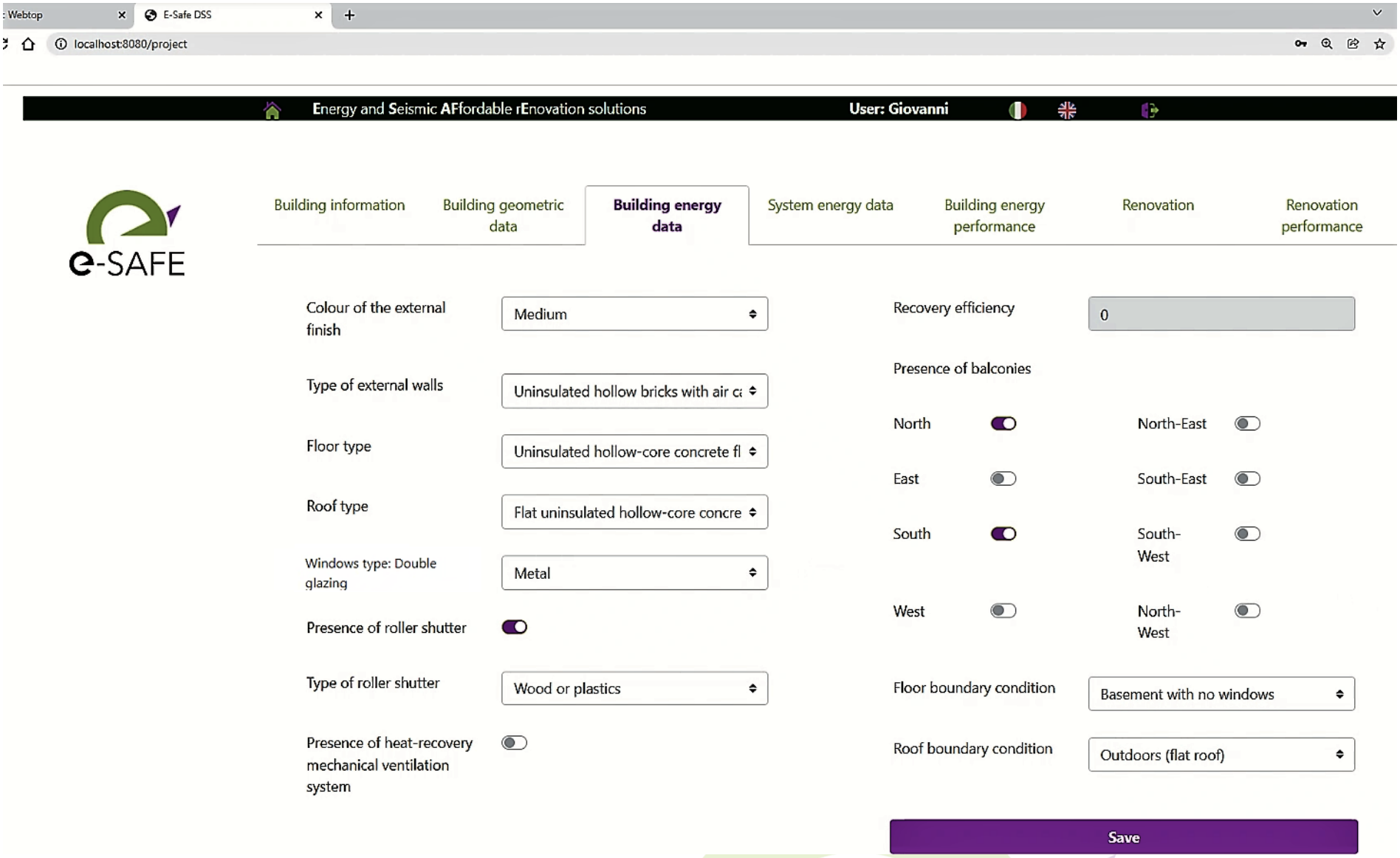

Figure 9: building energy data - Catania

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The technician clicks the "Save" button and the *System energy data* tab is enabled so that he/she can insert the information about the features of the energy systems available in the building. Figure 10, Figure 11, Figure 12 and Figure 13 show the screenshot of *System energy data* tab filled with information related to the Catania pilot; the content of *System energy data* tab is split in more images for the sake of readability. The technician can see the overall content of the tab using the vertical scrolling.

The checkbox (one for each energy system) allows indicating the presence of energy systems in the building like DHW and Space heating system; the further specification of details of each energy system is simplified by a series of drop-down menu. Moreover, the system efficiency parameters are suggested by the tool as default value that the technician can manually update.

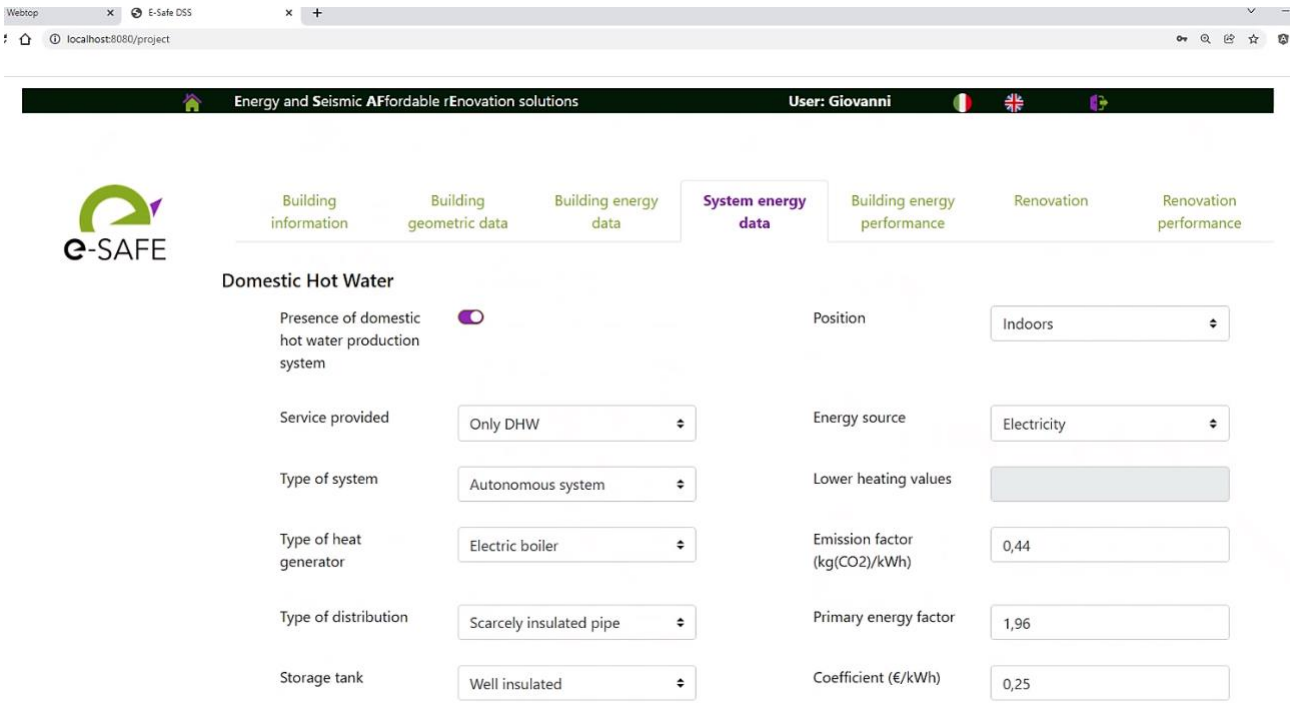

Figure 10: System energy data – DHW - Catania

If an energy system is not available in the building, the related fields are not editable by the user, as it is shown in Figure 11, Figure 12 and Figure 13 reflecting the scenario of Catania's pilot.

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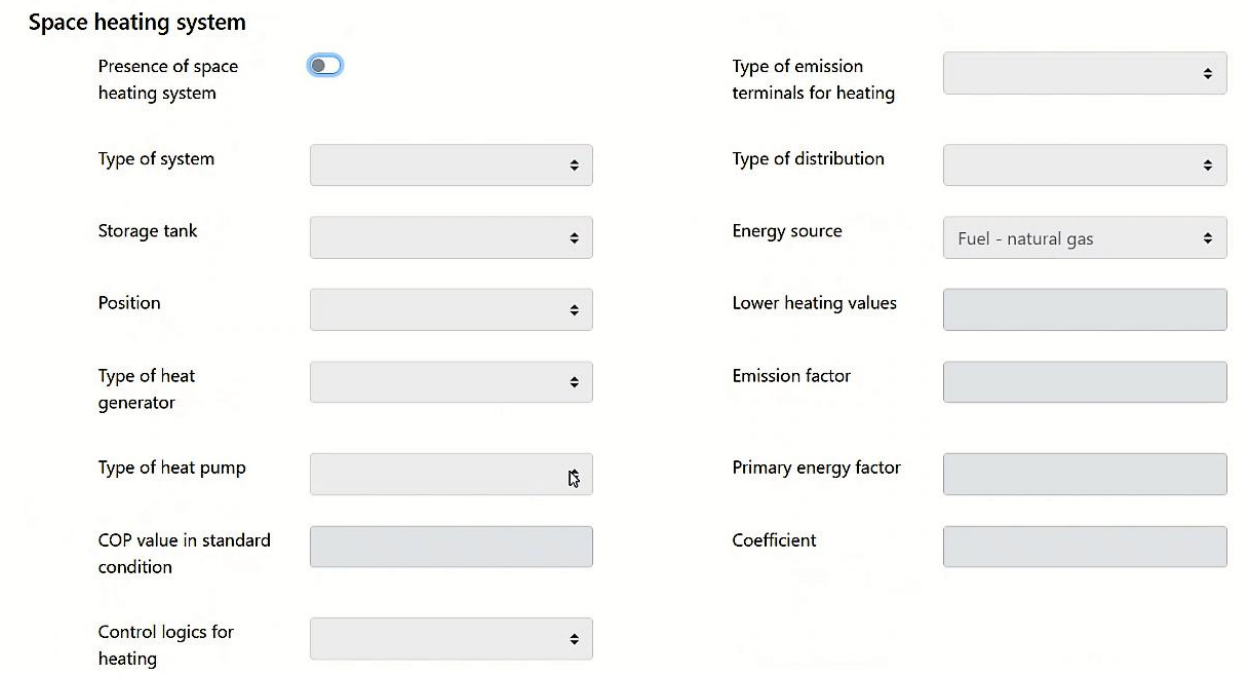

Figure 11: System energy data – Space heating system - Catania

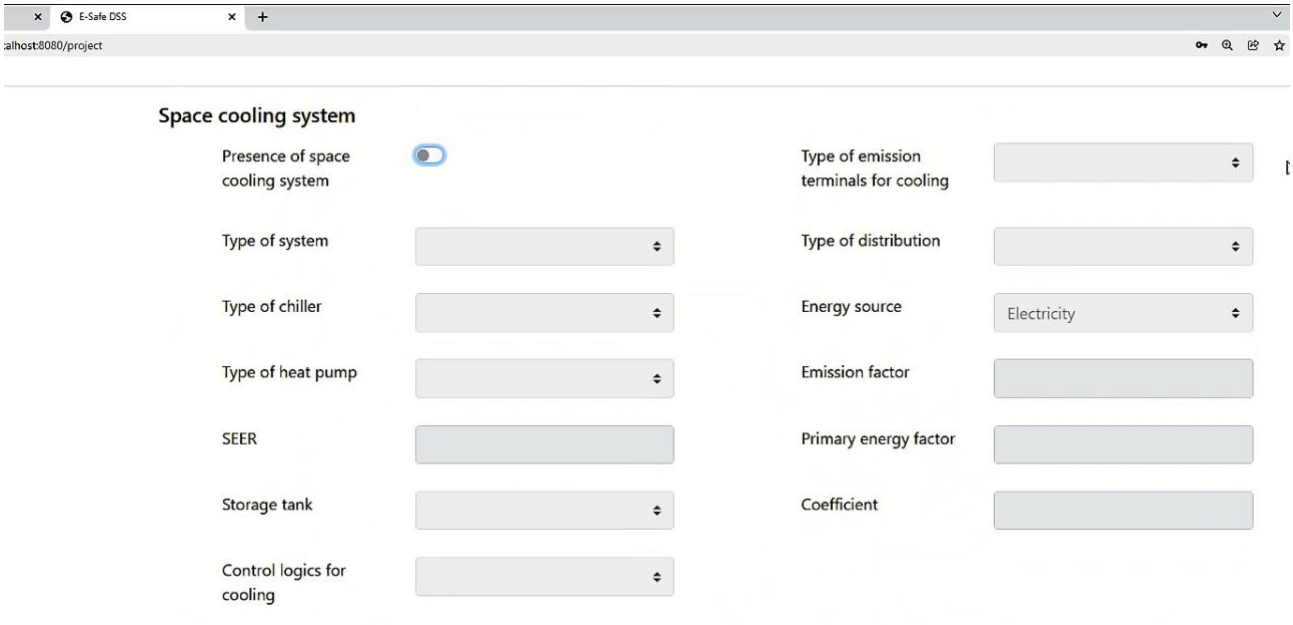

Figure 12: System energy data – Space cooling system - Catania

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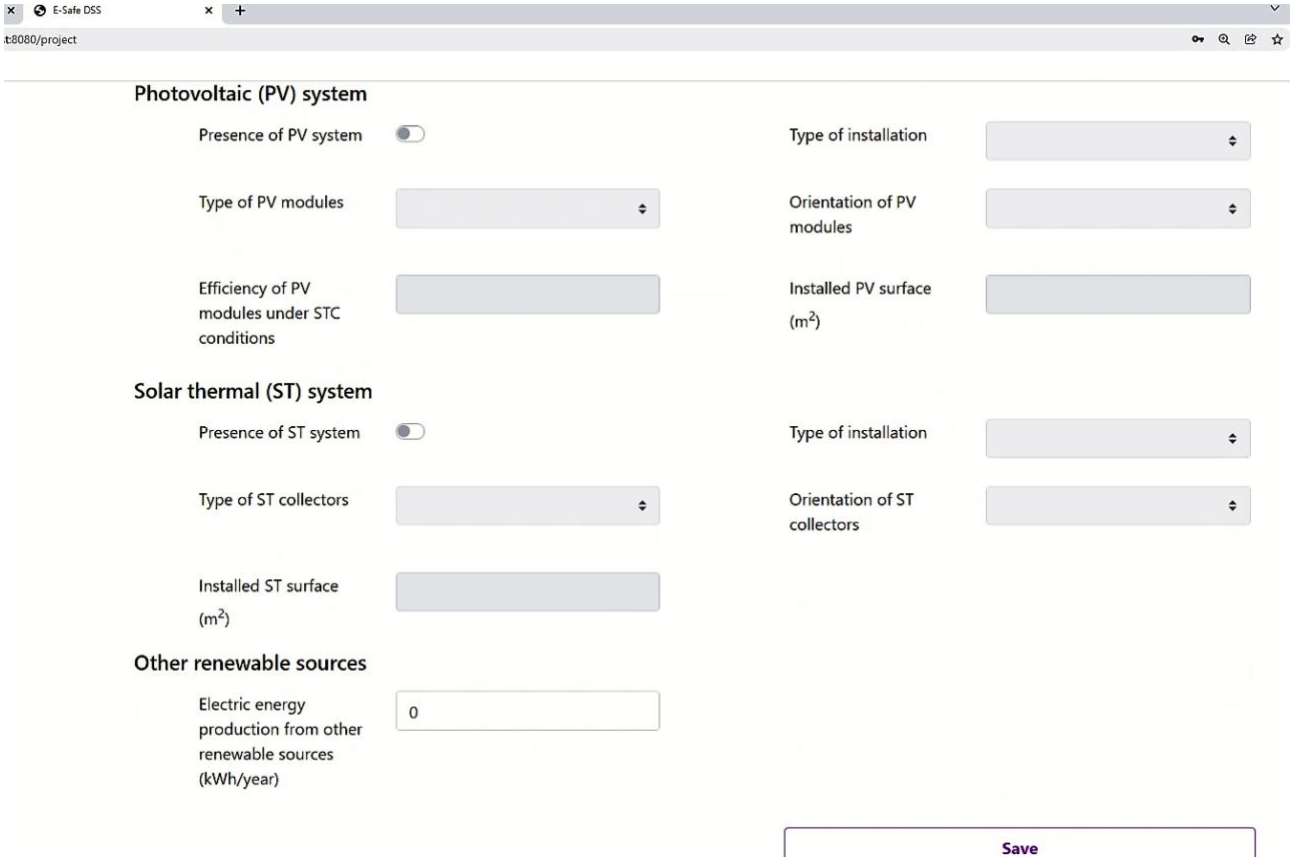

Figure 13: System energy data – PV, ST and other renewable sources system - Catania

After that the technician has provided information about the general building data, the building geometric data, the building energy data and the system energy data, he/she can know the energy performance of the building in its current state. He/she goes to the *Building energy performance* tab, clicks the "Calculate energy performance "button, the **e**-DSS runs the algorithms for the calculation of energy needs that are shown to the technician (see Figure 14)

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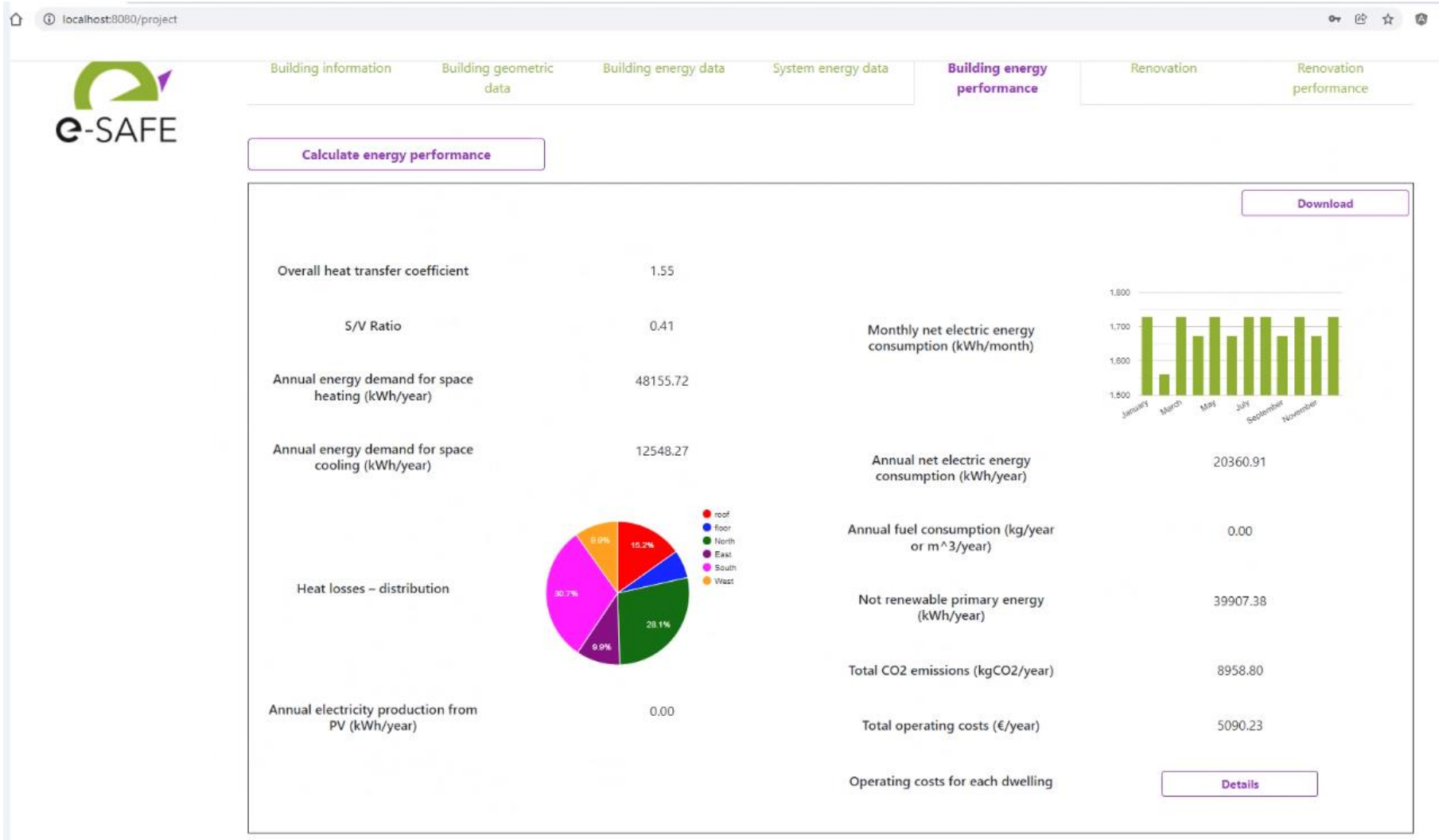

Figure 14: Catania building energy performance

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3.4 Building Renovation Management

This section describes the usage of **e**-DSS for the building renovation co-design process. The technician is directly involved in this process and different alternatives are possible according to the choices and selection he/she can perform using the tool. Some screenshots are included as an example of **e**-DSS exploitation (energy retrofit scenario); a detailed description of the usage of **e**-DSS for the building renovation co-design process is provided in D4.2 (section 2.2.1.3 Building Renovation Management).

As it is shown in Figure 15, first of all the technician has to indicate the type of retrofit he/she wants to perform. He/she can choose between two alternatives: energy retrofit or combined seismic and energy retrofit. Moreover, the tool retrieves the seismic zone of the building and it notifies to the technician if the building is in high/average or low seismicity zone. The technician makes his choice clicking one of the two available buttons "energy retrofit" or "Combined seismic and energy retrofit".

Figure 16 is related to the energy retrofit selection; some questions are shown to the technician in order to understand if the e-PANEL solution can be applied to the building. Moreover, the **e**-DSS asks the technician to define the opaque building envelope (Figure 17) and he/she is guided through the selection process for the new windows (Figure 18), the possibility to refurbish the roof and to replace the technical system. In the example shown in Figure 18, the technician doesn't want to refurbish the exiting roof and he/she doesn't want to replace the technical system.

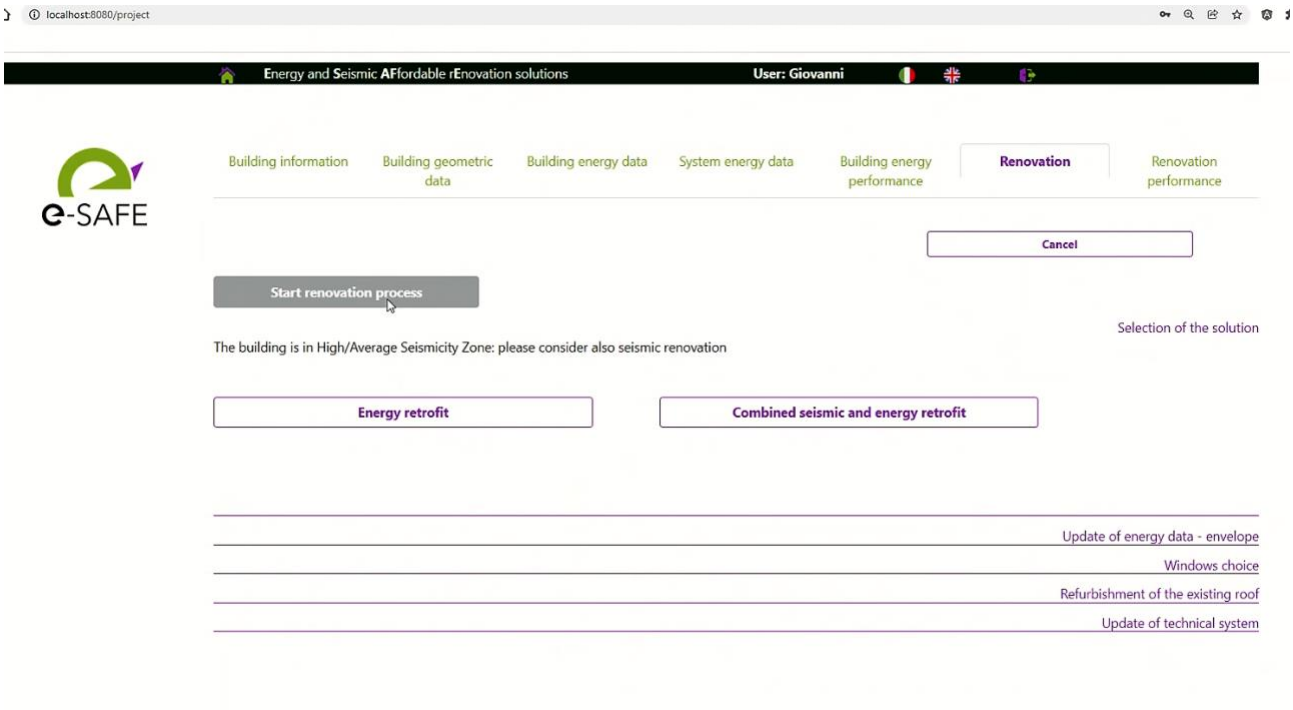

Figure 15: **e**-DSS selection of type of retrofit

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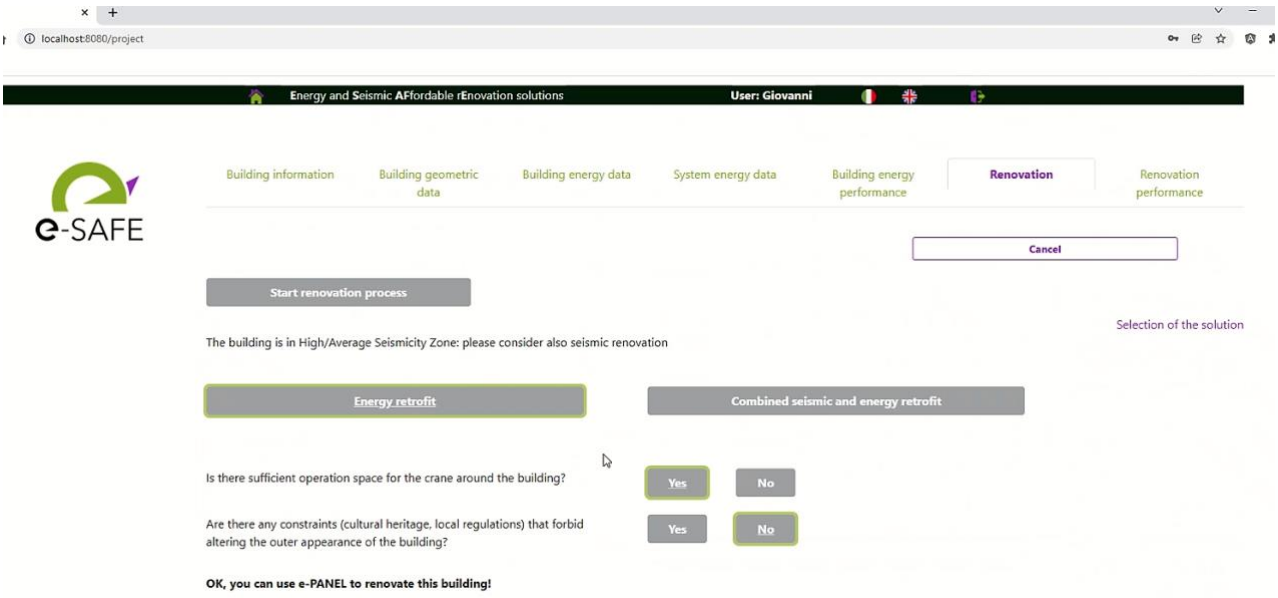

Figure 16: building energy retrofit selection

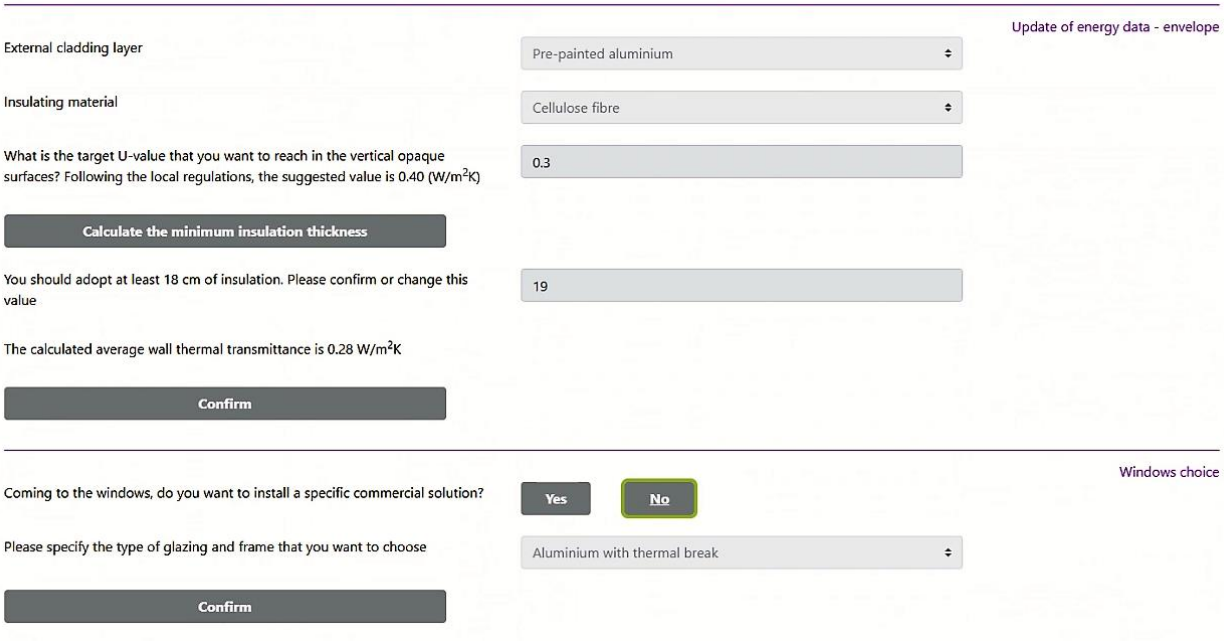

Figure 17: definition of the opaque building envelope and selection of new windows

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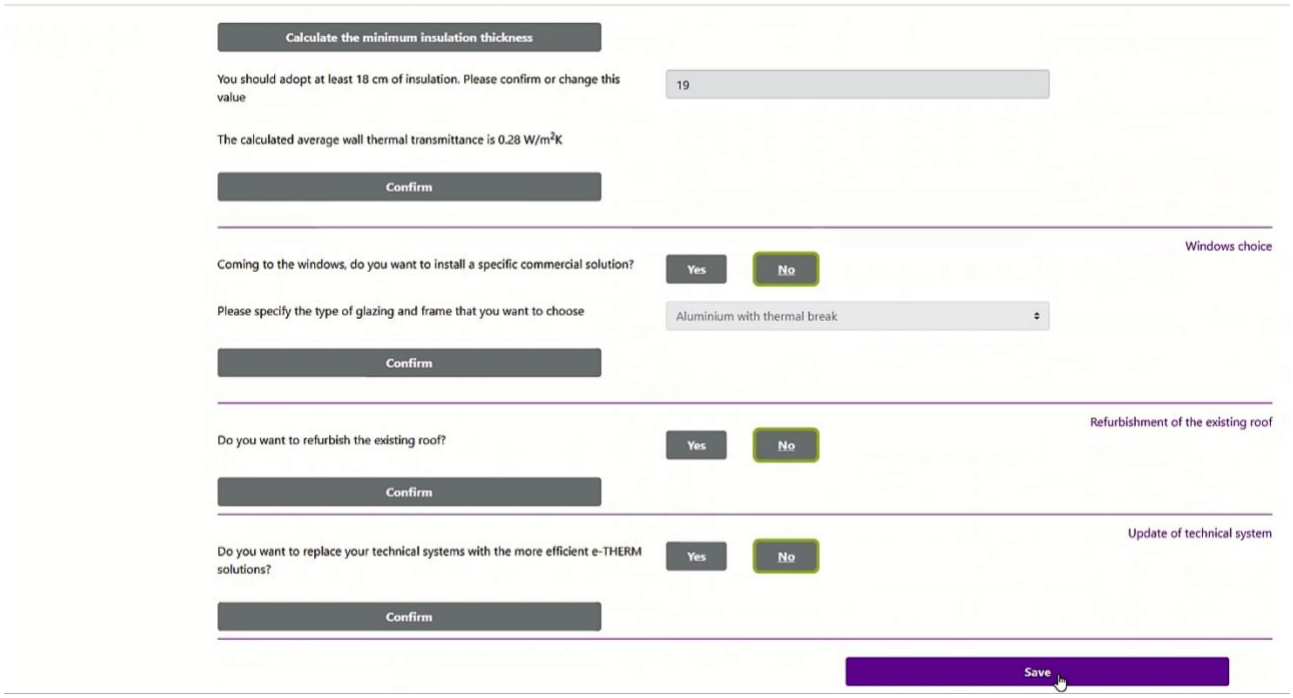

Figure 18: selection of new windows (no commercial solution), choice of roof's refurbishment (no) and update of technical system (no replace)

The technician clicks the "Save" button and the tool stores his/her choices (Figure 19).

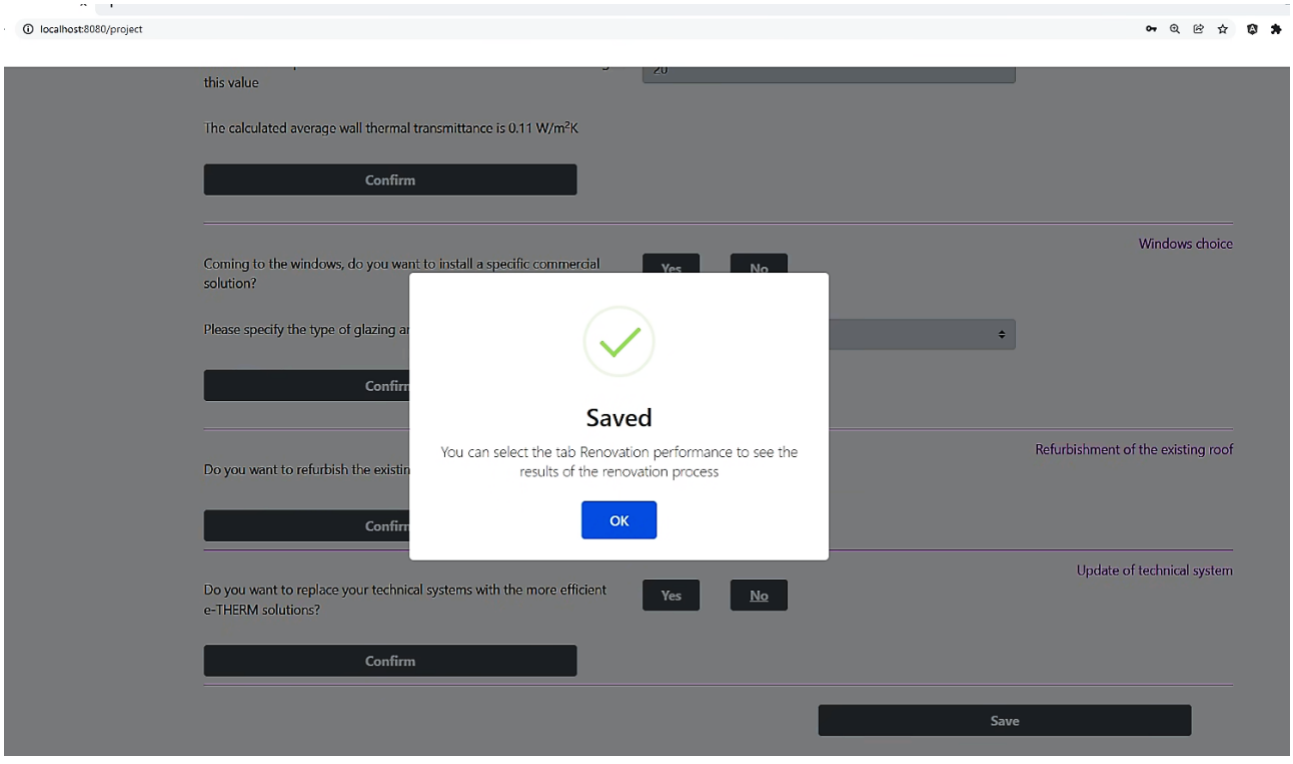

Figure 19: final step of building renovation co-design process (energy retrofit)

At this point, he/she can go to the *Renovation Performance* tab to know the outcome of the renovation process and mainly to see the final comparison – pre and post renovation performance – of the building. Figure 20 and Figure 21 show the screenshots of *Renovation performance* tab that was split in more images for the sake of readability.

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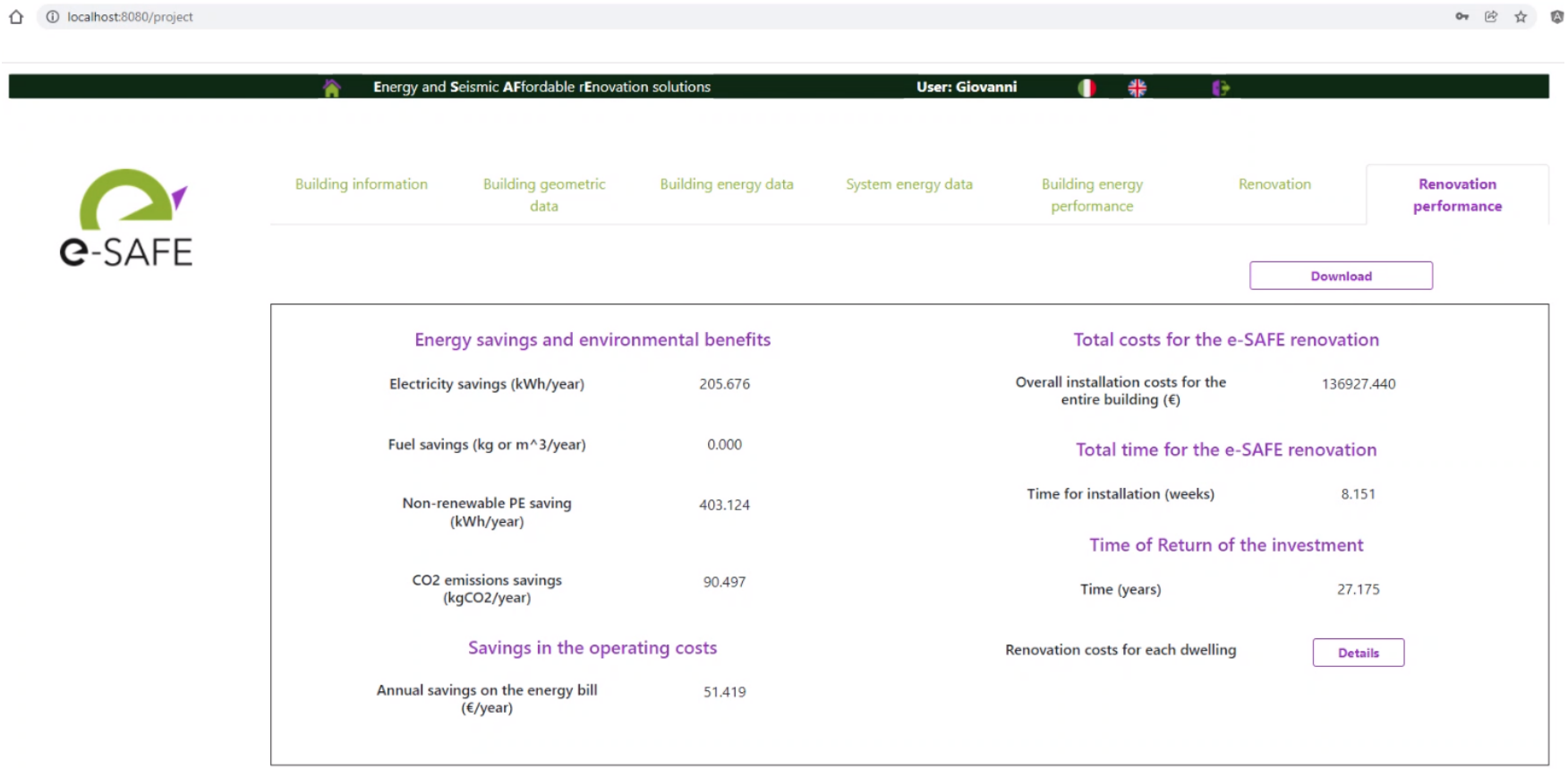

Figure 20: comparison between the pre and post renovation performance - 1

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Figure 21: comparison between the pre and post renovation performance -2

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