SUstainable solutions for affordable REtroFIT of domestic buildings

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Survey data of occupants' satisfaction

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4	28/02/2025	ISQ, Sérgio Tadeu	Coordinator review

Disclaimer

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Abbreviations

A/C	Air condition
CAD	Computer-aided design
CO_2	Carbon Dioxide
DX SAHP	Direct Expansion Solar Assisted Heat Pump
EPC	Energy Performance Certificate
GSHP	Ground Source Heat Pump
HVAC	Heating Ventilation Air Conditioning
IT	Internet Technology
KER	Key Exploitable Result
OSS	One Stop Shop
PCM	Phase Change Material
PV	Photovoltaic
PVD	Physical Vapor Deposition
PV-VG	PV vacuum glazing
RES	Renewable Energy Sources
ROI	Return of investment
SAHP	Solar Assisted Heat Pump
TP GSHP	Thermal Pipe Ground Source Heat Pump
TRL	Technology Readiness Level
U-value	Thermal transmittance
WP	Work package

Publishable summary

The opinions, impressions, and desires of the occupant of the SUREFIT evaluation homes was an integral part of the project. The initial surveys informed the specific technologies to be installed in each home. User satisfaction and impressions are essential to product development.

In order to capture occupant opinions, a series of questionaries were developed for pre-installation of the SUREFIT technologies and another questionnaire for post-installation information during the 18-month evaluation period. These were access through the SUREFIT webpage, yet paper versions were also available. They were available in each local language, English, Finish, Spanish, Portuguese, and Greek.

The surveys show general satisfaction with the SUREFIT technologies, with the passive technologies receiving the highest approvals, while the active technologies proved problematic and indicate additional development is required.

Introduction

Leading Beneficiary: ISQ and AMS

Participants: UNOTT, AALTO, SOLIMPEKS, WINCO, KOST, PCM

Task description: Deliverable 9.5 Survey data of occupants' satisfaction

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The surveys show general satisfaction with the SUREFIT technologies, with the passive technologies receiving the highest approvals, while the active technologies proved problematic and indicate additional development is required.

1 User Survey Assessments

User surveys were used to gather occupants' opinion of the project. These include pre-renovation surveys to assess the home occupant's satisfaction with the current home situation as well as expectations from the project and installed Surefit technologies. After installation surveys were conducted to assess the impressions of the technology and the effectiveness on their home quality of life.

A standardized set of questionnaires were created to assess the user's perceptions, opinions, and suggestions about the installed technologies within the homes. These consisted of two pre-occupancy questionnaires to assess the occupant's current situation, their satisfaction and issues with the home's current heating, cooling, power, and air handling systems. A post-occupancy surview assesses the impacts, effectiveness, and issues of the installed technologies. Each survey form was available in the local languages of English, Finnish, Greek, Portuguese, and Spanish.

1.1 User Survey Assessment Forms Webpage Access

The forms were available through the Surefit webpage, as shown in Figure 1. The webpage was to allow easy access from any computer, mobile device, or smart phone. It was available in paper form.

https://surefitproject.eu/english-questionnaire-post/

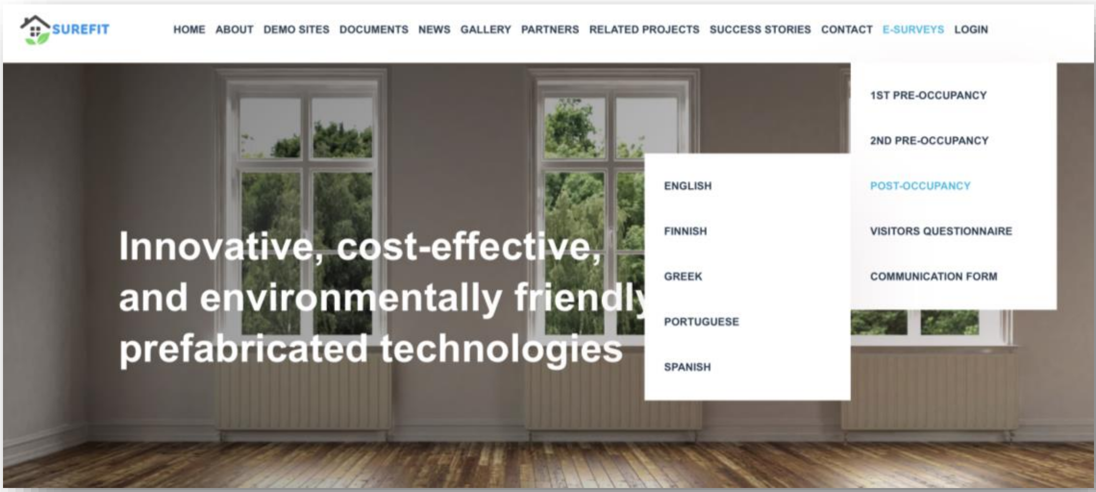


Figure 1 SUREFIT website E-Surveys forms access

The E-Surveys menu selection also provides a Visitors Questionnaire to capture opinions and impressions of both professionals in the building trade and lay person visitors to the test homes. These too are available in the local languages of English, Finnish, Greek, Portuguese, and Spanish.

2 Description of pilot buildings and installed technology

Below is a brief description of SUREFIT pilot buildings and the installed SUREFIT technologies in each building. The specific technologies for each building were chosen for the subtility of the technologies, the specific needs of the buildings, and the desires of the building owners.

2.1 Portugal

The Portuguese pilot building, constructed in 1970, is a two-story residential structure with a total area of 130 m². Located in Carvoeira, within the Municipality of Mafra, this building represents a typical example of mid-20th-century construction. Its façade consists of stone and two layers of plaster, reflecting traditional construction practices of the time.

The building's windows are single glazed with wooden frames, contributing to significant energy inefficiencies. Due to insufficient insulation, the house experiences frequent water infiltration, dampness, and elevated humidity levels. Natural ventilation is employed, but the original design does not adequately support proper air circulation or maintain good indoor air quality. Heating during winter is provided by a 2kW electric radiator, which is insufficient for maintaining consistent thermal comfort.

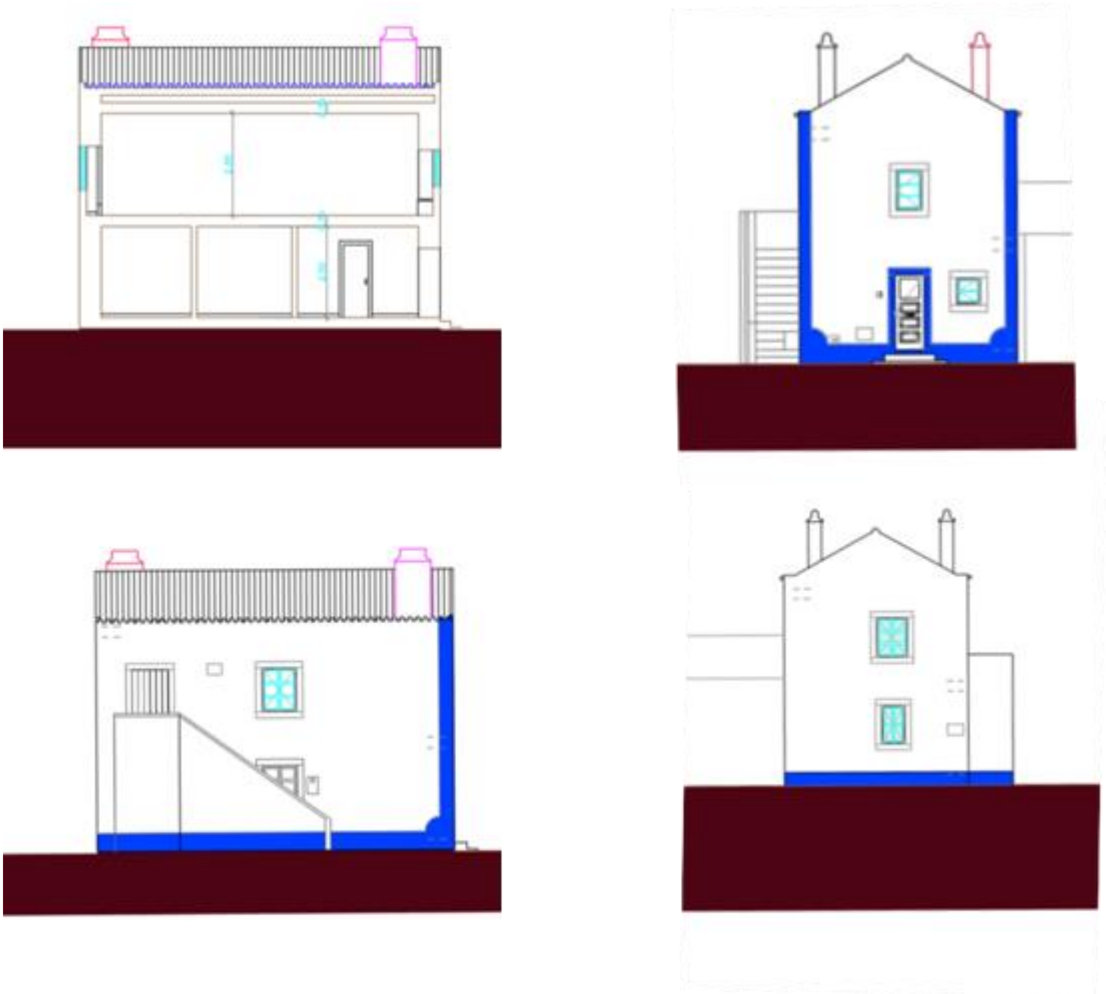
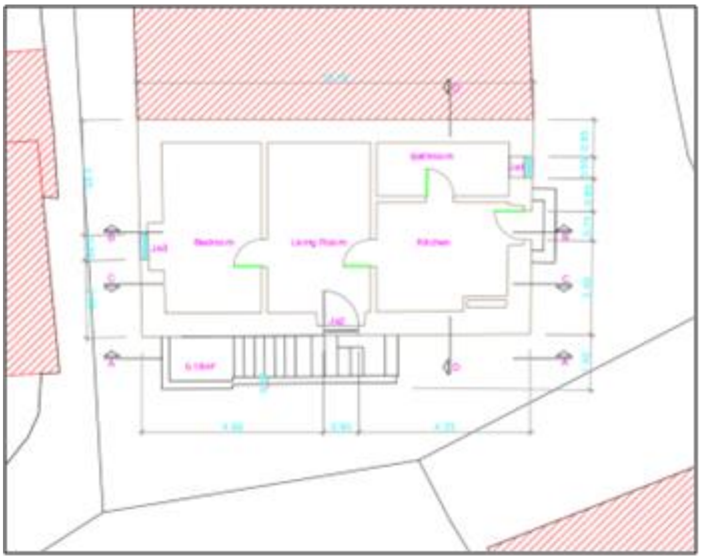


Figure 2 Portugal Home Elevation Views



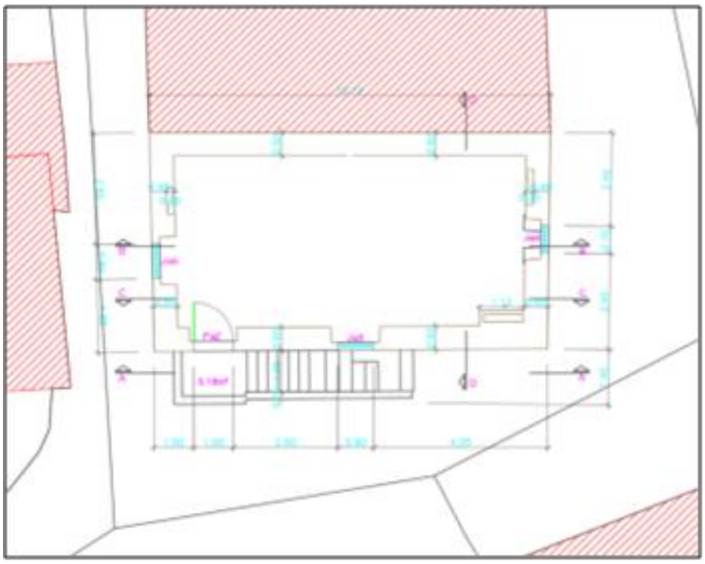


Figure 3 Portugal Home Plan Floors

2.1.1 Installed Technologies

To address these challenges and modernize the building, the following technologies have been installed:

- **PV Vacuum Glazing:** Highly efficient glazing that enhances thermal insulation and reduces heat loss through windows and produces electricity.
- **Window Heat Recovery:** A system that recovers heat from outgoing air and uses it to pre-warm incoming fresh air, reducing heating demand.
- **Daylight Louvers:** Louvers designed to optimize natural light penetration, decreasing the need for artificial lighting and improving indoor illumination.
- **Smart Controls:** Advanced control systems that manage heating, cooling, and ventilation, enhancing energy efficiency and user comfort.

- **Solar-Assisted Heat Pump:** A hybrid system that uses solar energy to assist in heating, lowering energy consumption and providing a sustainable heating solution.

Figure 4 Portugal Home Technologies

In addition, the Municipality of Mafra has sponsored the replacement of all windows with new, airtight models featuring thermal glass. This upgrade is expected to eliminate drafts, improve insulation, and significantly enhance the comfort and quality of life for the building's occupants.

2.2 Greece

The renovation activities concern the first floor of the building that is shown in the following Figure 5 through Figure 7. The building was built in 1981 and located in the city of Peristeri, Attica. The orientation of the two main facades is north south. The building is attached to two other buildings on the east and west sides. The building accommodates two small spaces on the ground floor of $45m^2$ and $25m^2$ that used to be shops, one family apartment (4 persons) of approximately $100m^2$ on the first floor and another apartment (2 persons) of approximately $100m^2$ on the second floor.

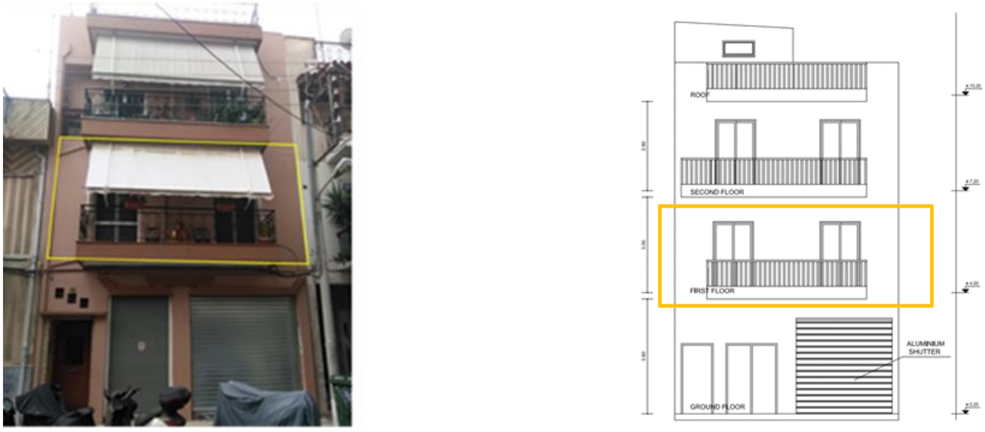


Figure 5 North facade of the Greek building. The renovated apartment is highlighted in yellow.

Figure 6 South facade of the Greek building. The renovated apartment is highlighted in yellow.

The apartment of the first floor has a living room, three bedrooms, kitchen and bathroom. The building is constructed with concrete pillars and the walls are made of bricks of six hollows and dimensions of 19x9x6cm, using an installation of single brick - polystyrene layer -single brick that offers thermal insulation. However, after 40 years, the polystyrene layer has suffered damage and is not considered to contribute to the thermal insulation of the building. The apartment has single glazed aluminium frame windows. These sliding sash windows are of 8mm single glass. Apart from the sliding sash external blinds, there are also awnings attached to exterior wall of the building. These awnings are always in use for the tenants to keep their privacy from the surrounding buildings. Heating is supplied through diesel boiler and there is a cooling system provided by air condition units: three on the first floor. Hot water is supplied by low pressure water system from a triple-energy boiler that is flexible to work also with a solar collector and electricity.

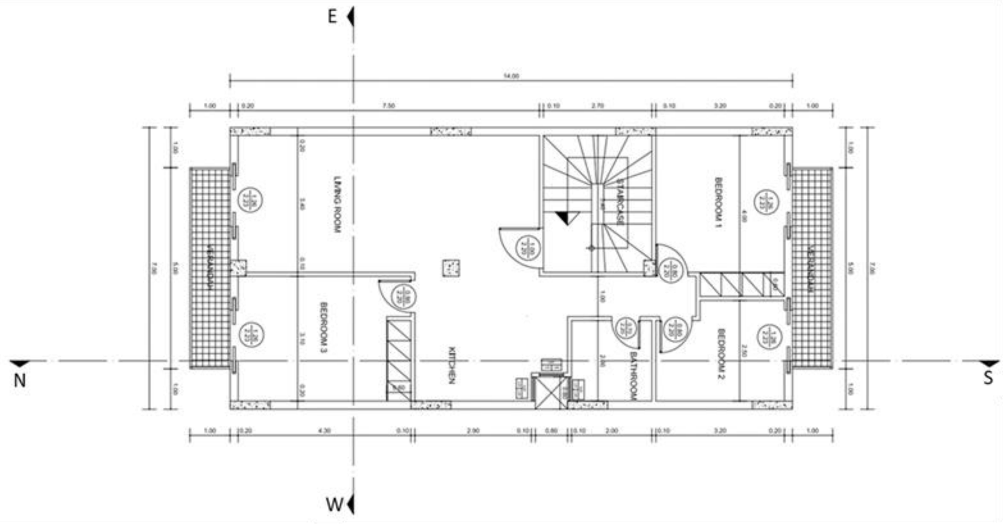


Figure 7 Drawings of the apartment of the 1st floor.

2.2.1 Installed Technologies

The installed technologies in the Greek building are presented below:

- **Prefabricated facade (CJR)**: it is a "sandwich" panel, consisted of 30mm PU panel + 20mm Aerogel blanket + 20mm XPS panel, of a total thickness 7cm. The U value of the existing wall with the prefabricated panel is 0.22W/m^{2}K. This technology was installed externally to the whole available area of the North and South facades of the apartment, to provide thermal insulation.
- **Breathable membrane (WINCO)**: the Skytech Pro XL membrane is installed to act as a rain screen in an existing façade. To operate efficiently the Skytech Pro XL membrane, a ventilated air gap is needed on the external side of the membrane. It was not possible to install it like that due to the restricted height of the façade and the balconies of the Greek apartment. However, it was installed as thermal and acoustic insulation material on the whole area of the ceiling of the ground floor. The thickness is 26mm, with λ-value of 0.029W/mK and sound reduction – 16dB.
- **PV-Thermal system (SOLIMPEKS)**: this system is used in the 1st floor apartment for the production of electricity, domestic hot water and partially for space heating (space heating will be supplemented by the existing boiler, too). The system consists of six PV panels and a tank of 300L capacity.
- **PV vacuum glazing window (UNNOT)** for a balcony door: this system was installed in a balcony door on the south facade of the apartment. The U-value is 0.45W/m^{2}K, the thickness in 8.3mm and the light transmittance is 70%. The produce electricity will be used by the tenant of the room for mobile phone charging.
- **Commercial double glazed/PVC frame balcony doors**: the commercial balcony doors have double glazing and PVC frame, and the system's U-value is 1.3W/m$^{2.}$ It was also installed external aluminium role as shutter.
- **Sensors and control systems (AMS)**: AMS has installed IAQ sensors, energy meters and actuators in the apartment for the live monitoring and control of the systems.

2.3 UK

The UK evaluation home is a 3-bedroom freehold semi-detached house located in Nottingham, UK. The house has a total 92m^2, was constructed in 1948, with three bedrooms, two bathrooms, and two reception rooms. According to the UK government EPC evaluation, this house is assessed as band D (score:56) and the current primary energy consumption used for only lighting, heating and hot water is estimated as 306 kWh/m^2 per year. Based on estimations, the house currently produces approximately 5.5 tonnes of carbon emission every year. It is built with solid brick external wall without any insulation, with non-insulated pitched roof and 100mm insulated loft. The ground floor is all solid with no insulation. All the windows are fully renovated with double glazing in 2012. The house uses a natural gas boiler and radiators as the main heating system to provide both space heating and hot water. The room radiators can be controlled with room thermostat and TRVs. And low energy lighting is fixed in each room. The NG8 district is mainly owned by local people of Nottingham with three quarters of houses are owned by the owners, and only one quarter of houses are privately or socially rented houses.

Figure 8 Front and rear photos of Nottingham house

2.3.1 Installed Technologies

The installed technologies in the Greek building are presented below:

- **Solar Assisted Heat Pump (SOLIMPEKS)**: this used a direct expansion solar thermal system to increase the performance of the hot water heating system. This was coupled with a large water thermal storage tank to provided hot water at night and periods of low solar thermal energy availability.
- **Ground Source Heat Pump (Arkara)**: A ground source heat pump system that uses a novel ground loop array system that allows installation in a much smaller area than standard systems at a much lower cost compared to current systems.

- **Prefabricated facade (CJR)**: it is a "sandwich" panel, consisted of 30mm PU panel + 20mm Aerogel blanket + 20mm XPS panel, of a total thickness 7cm. The U value of the existing wall with the prefabricated panel is 0.22W/m^{2}K.
- **Solar PV electrical with Smart Controls (SOLIMPEKS)**: A solar PV array installed on the south and west facing sloped roofs. This was then connected to the smart control system, controlling heating, cooling, hot water, and ventilation.
- **PV vacuum glazing window (UNNOT)** in upper bedroom. The system was installed in the south façade, first floor. The U-value is 0.45W/m^{2}K, the thickness in 8.3mm and the light transmittance is 70%.
- **Evaporative Cooler (UNNOT)** install on the exterior of the home to provide cooling, as needed in the hottest days of the UK summer.
- **Window Heat Recover System (UNNOT)**: A self-contained heat recovery unit that allows ventilation for fresh air yet recovered the heat or cool air of the interior of the home, reducing heating and cooling costs.

2.4 Spain

Valladolid, located in the northern part of Spain's central plateau, has a continental Mediterranean climate characterized by hot, dry summers with average highs of 30–35°C (86–95°F) in July and August, and cold winters with frequent frosts, occasional snowfall, and average lows around 0°C (32°F) in January. Annual rainfall is moderate, averaging 400–500 mm, with most precipitation occurring in autumn and spring, while summers remain dry. The city's inland location and elevation (~700 meters above sea level) contribute to significant temperature fluctuations between day and nigh

Within the neighbourhood of San Pedro Regalado in Valladolid different types of housing are developed, depending on their location and the stage of urban development. All of them maintain the typology of housing in mill house on the ground floor plus a height and patio at the back, although in some cases it also has a basement. The plots have approximately 60 m^2, the construction occupying half .

These are three rectangular buildings with a depth of 7.10 m and a width of 4.40 m. To identify the different owners, since the houses are located at Avenida de Santander 40, 42, and 44.

The homes are distributed across three floors: basement, ground floor, and first floor. The kitchen is located on the ground floor, while the bathroom is on the first floor. The remaining rooms are dedicated to residential use, with different layouts depending on each owner.

The staircase is positioned perpendicularly to the long side of the rectangle, at 1/3 of its length, and spans from the basement to the first floor.

The main façade faces Santander Avenue, while the rear façade opens onto a backyard that each home has at the back.

The construction consists of load-bearing walls made of two layers of brick: a single hollow brick layer on the interior, an air cavity, and a half-brick-thick layer of solid brick on the exterior, with a total thickness of 200 mm. The party wall is made of perforated half-brick (110 mm).

The floors, unlike much of the rest of the neighbourhood, are made of precast reinforced concrete beams and concrete filler blocks.

The roof is constructed with brick parapets, flat brick tiles, and a compression layer of cement mortar, finished with concrete tiles, which have been recently installed in the homes undergoing this intervention.

The carpentry varies depending on each home and ranges from PVC, with or without thermal break, to aluminium in its natural colour, with one or two panes.

Table 1 Systems per house

Dwellings Avenida de Santander. Spain Pilot														
Number	40				42				44					Totals
Facades			P1	P2			P1	P2			P1	P2		
	N-E				N-E				N-E		20,62 m^2	23,64 m^2	44,26 m^2	
	N-W		8,93 m^2	9,59 m^2	N-W		8,93 m^2	9,59 m^2	N-W		8,93 m^2	9,59 m^2	55,56 m^2	
	S-W				S-W				S-W					
	S-E		8,25 m^2	9,25 m^2	S-E		8,25 m^2	9,25 m^2	S-E		8,25 m^2	9,25 m^2	52,50 m^2	152,32 m^2
Windows	N-E				N-E				N-E					
	N-W	2 ud	1,25 m^2	1,25 m^2	N-W	2 ud	1,25 m^2	1,25 m^2	N-W	2 ud	1,25 m^2	1,25 m^2	7,50 m^2	6 ud
	S-W				S-W				S-W					
	S-E	4 ud	1,46 m^2	1,60 m^2	S-E	4 ud	1,46 m^2	1,60 m^2	S-E	4 ud	1,46 m^2	1,60 m^2	9,18 m^2	12 ud
Roof			34,00 m^2				34,00 m^2				34,00 m^2		102,00 m^2	102,00 m^2
Basement			30,00 m^2				30,00 m^2				30,00 m^2		90,00 m^2	90,00 m^2
Bedroom			8,51 m^2				8,51 m^2				8,51 m^2		25,53 m^2	25,53 m^2
Heating	1 Natural Gas condensing boiler + Water				1 Electric radiators. 1 Electric Boiler				1 Natural Gas condensing boiler + Water					
Windows	PVC + Climalit				Double Aluminium. Simple Glass				Double Aluminium. Simple Glass					

Figure 9 Front part of the houses

Figure 10 Rear side of the houses

Figure 11 Buildings in San Pedro Regalado

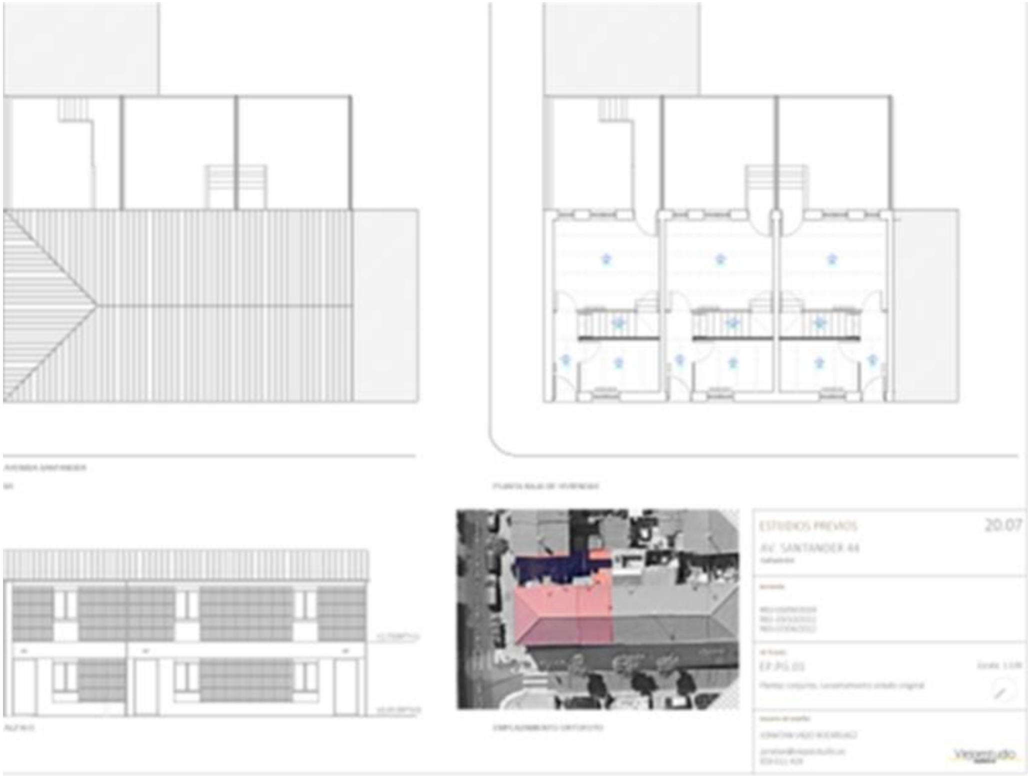


Figure 6 Spanish pilot characteristics

2.5 Finland

The Finnish demo building is shown in Figure 12. It's a rental apartment building in Helsinki, owned by the municipality. There are four residential storeys and a basement area, which contains garages, storage rooms and a common sauna section. Each apartment has two bedrooms, a living room, a bathroom, and a kitchen with a dining area. The apartments are connected to the central hallway.

The building underwent a conventional energy renovation between 2022-23. During this renovation, a hybrid heating system comprising ground source heat pumps and district heating was installed. This replaced the old fully district heating -based system. PV panels were installed on the roofs to improve the share of renewables in energy use. The airtightness of the building was improved by replacing the window and door seals and by improving the balcony wall insulation, bringing the infiltration rate under 50 Pa pressure difference from 3 ACH down to 1.5 ACH. The original mechanical exhaust ventilation system without heat recovery was replaced with balanced mechanical ventilation equipped with heat recovery.

Figure 12 Finnish apartment building

During and after the conventional renovation, technologies from the SUREFIT project were installed into one pilot apartment. The original idea was to have two technologies (air vapour barrier, louvers) in the apartment but due to miscommunication between the contractors of the conventional renovation, the air vapour barrier could not be installed. The louvers were installed in two batches: onto bedroom and living room windows in March 2023 and onto balcony windows in October 2023. Figure 13 shows the floor plan of the pilot apartment and the placement of the window louvers.

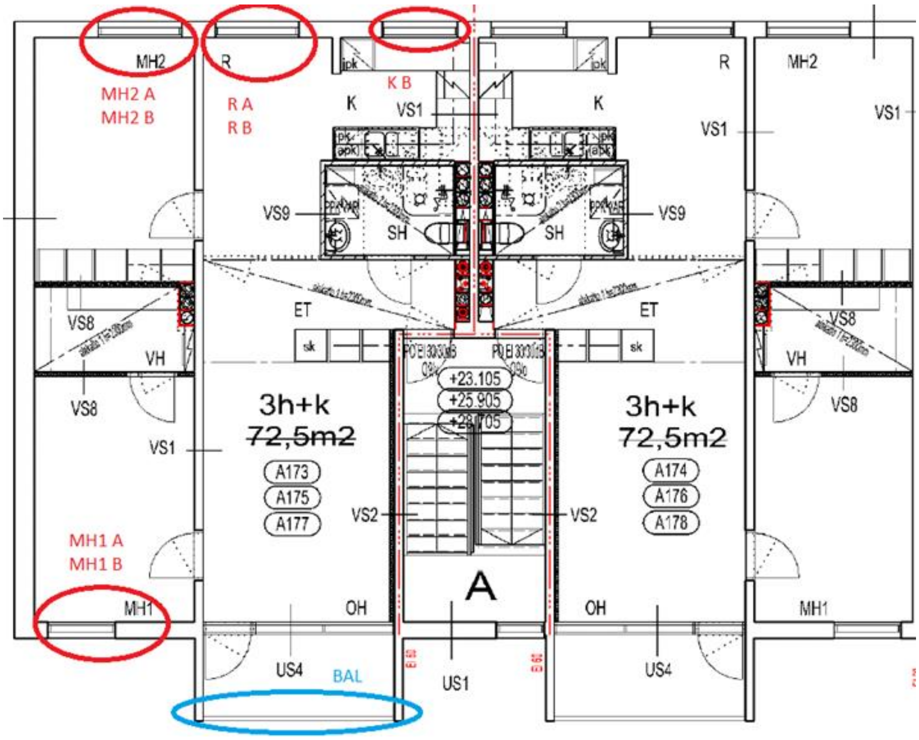


Figure 13 Floor plan of the Finnish pilot apartment (the left one) including positions for the louvers. The kitchen window (K B) had no louver installed as it is a tiny one.

3 Technology Survey Assessments Results

Below are the summary of the Pre-Occupancy and Post-Occupancy surveys for each of the test home locations. Each technology is addressed separately, as well as more general survey results.

3.1 Portugal

3.1.1 User receptiveness to surveys

A survey was conducted to assess the effectiveness of the technologies and the satisfaction levels of the occupants and the pilot building owner:

- **Engagement:** The owners were open to providing feedback, understanding the importance of data for continuous system improvement. The occupant was somewhat resistant to adopting new technologies. More than innovation, these projects involve a shift in mindset, requiring resilience.

Challenges: The occupant reported difficulties due to the complexity of the forms and the time required to complete them. Additionally, they were not pleased with the presence of people in their home. However, the building owner was always available.

3.1.2 Pre-Occupancy Survey

Before occupancy, surveys revealed the following perceptions:

- **Initial Impressions:** Future owners were impressed with the integration of cutting-edge technologies, highlighting modernity and commitment to sustainability.
- **Expectations and Hopes:** There were high expectations regarding reduced energy costs and improved thermal and environmental comfort. Owners expected a responsive environment tailored to their needs.
- **Anticipated Pain Points:** Concerns were identified regarding the complexity of control systems and the maintenance of advanced technologies, which might require specialized technical support.

3.1.3 Post Occupancy Survey

After a period of use, the surveys provided a detailed insight into the occupants' experiences:

3.1.3.1 *Technology Name*

- **PV Vacuum Glazing:** An interesting technology but of little use due to its small surface area.
- **Window Heat Recovery:** This system was widely praised for reducing the need for additional heating, contributing to a more comfortable indoor environment, especially in cold periods. It allows automatic CO2 level control using Smart Controls.
- **Daylight Louvers:** Optimized natural light entry and reduced artificial lighting use during the day. However, they are currently located in a rarely used room.
- **Smart Controls:** While the automated systems proved efficient, both the occupant and owner initially struggled with the interface. They requested improvements in design and usability to facilitate daily use. This request was promptly addressed by OnControl.

- **Solar-Assisted Heat Pump:** The hybrid performance of the system showed a reduction in conventional energy consumption without depending on direct sunlight. However, this technology received the most complaints: noise, vibration, and system complexity caused inconvenience not only to CJR but also to the owner and occupant.

3.1.4 Data Collection

For a robust impact analysis, qualitative data was collected:

1. **Location**
   a. **Answer:** Portugal – Mafra
2. **On a scale of 1 to 5, how satisfied are you with the installation of innovative technologies to improve energy efficiency in your home?**
   a. **Answer:** 4 (Satisfied)
3. **Did you experience any noticeable inconvenience during the installation process?**
   a. **Answer:** The discomfort was as expected since simultaneous building use always causes some disturbances during installation.
4. **How long did the installation process take? Was it longer or shorter than expected?**
   a. **Answer:** It was slightly longer than expected.
5. **Were you informed in a timely manner about the installation process, and did the project managers respond appropriately to your questions?**
   a. **Answer:** Yes, there was consistent phone and email communication between the parties, which was crucial to the project's success.
6. **From an aesthetic perspective, how do you rate the final appearance of the installed technologies? Did the installation negatively affect or improve your home's aesthetics?**
   a. **Answer:** Externally, there were no significant aesthetic changes. However, inside, the equipment installation took up substantial useful space.
7. **Additional comments or observations regarding the installation of these energy-efficient technologies?**
   a. **Answer:** No.

3.1.5 Conclusion of technologies effectiveness, positive and negative impacts on users

The experience with installed technologies in Portugal demonstrated positive results and identified areas for improvement:

Technology Effectiveness:

The implemented solutions achieved the proposed objectives, significantly reducing energy consumption and enhancing occupant comfort.

Positive Impacts:

- **Energy Cost Reduction:** Heat recovery and smart systems contributed to lower energy bills.
- **Improved Thermal Comfort:** The integrated systems provided a more stable and pleasant indoor environment.
- **Environmental Sustainability:** The use of renewable sources and consumption optimization reinforced sustainability commitments.

Negative Impacts and Challenges:

- **System Complexity:** Some devices, especially the heat pump, required an adaptation and training period.
- **Specialized Maintenance:** Regular maintenance is necessary to ensure continuous equipment performance, potentially leading to additional costs.
- **Performance Fluctuations:** Under unfavourable weather conditions, such as cloudy days, certain systems showed variable performance, highlighting the need for operational adjustments, particularly PV Vacuum Glazing and Daylight Louvers, which depend on sunlight.

Recommendations:

- **Interface Improvements:** Simplify smart system interaction to make them more intuitive and accessible.
- **Continuous Training:** Provide training sessions to help occupants maximize system functionalities.
- **Preventive Maintenance:** Implement a regular maintenance plan to ensure equipment efficiency and durability.
- **Operational Adjustments:** Refine system parameters, especially under low sunlight conditions, to guarantee consistent performance.
- **Heat Pump Adjustments:** Simplify the system, make it more compact, and reduce vibrations and noise to enhance home integration. Otherwise, it may struggle to gain user acceptance.

This report serves as an assessment of the achieved results and as a basis for future implementations and improvements. Overall, the acquired experience reinforces the feasibility of integrated projects combining energy efficiency and environmental comfort, contributing to the promotion of sustainable practices in Portugal.

3.2 Greece

3.2.1 User receptiveness to surveys

In the case of the Greek apartment, the receptiveness of the occupants to user surveys (online surveys and printed surveys) is characterised as neutral, in the sense that they were not very willing to answer all the SUREFIT surveys, but they finally responded. Occupants' responses were more a result of the "obligation" that the project generated on them, and not a real willingness to participate in the relevant processes of the project and provide feedback through questionnaires. On the contrary, the occupants were more willing to provide feedback and give details of their perception of the project's results **during in person discussions**. This is an important notice coming from the SUREFIT experience as well as from other similar projects, however frequent in person discussions is too demanding for a company's personnel.

3.2.2 Pre-Occupancy Survey

At the beginning of the SUREFIT project, the occupants participated in questionnaires related to the apartment needs. From these questionnaires, it came out that the major issues of the apartment are the **heating** and **cooling** and the **noise** coming from outdoor sources. In the graphs below, the major outcomes of the pre-occupancy surveys are summarised.

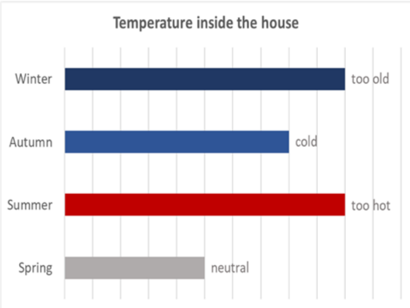


Figure 14 Temperature inside the apartment – post occupancy answers.

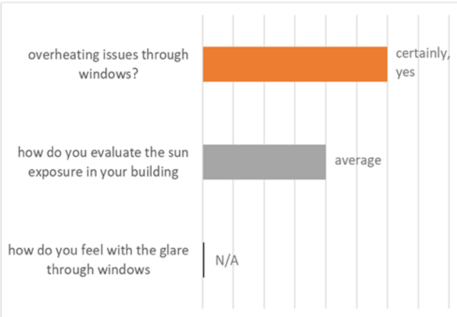


Figure 15 Overheating issues through windows – post occupancy answers.

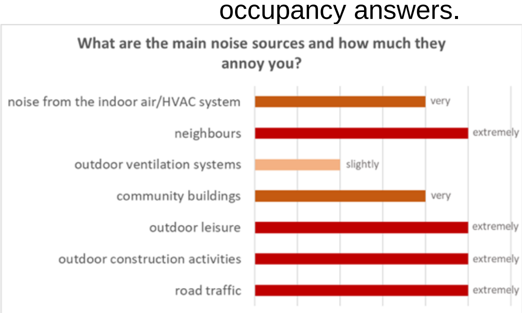


Figure 16 Noise issues – post occupancy answers.

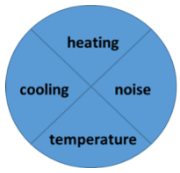


Figure 17 The most important needs that the occupants would like to improve in the house.

After the occupants were informed about the installations that will take place in the apartment, they stated that all the relevant information has been quite clear for them and that they would expect to have a 50% energy savings after the renovation. They also stated that they would not be willing to cover with their own expenses any other renovation that will not be covered by the SUREFIT project and that they accept the fact that during the renovation works they will experience some necessary disturbances that will also affect their everyday activities.

3.2.3 Post Occupancy Survey

In general, the occupants are very satisfied with the renovation performed in their apartment. The major result that they are experiencing is the improvement of the thermal insulation. The apartment is heated up during Winter and cooled down in the Summer more quickly. The temperature in the house is much more comfortable throughout the year, the noise coming from outside has been significantly reduced. There are also no overheating issues through the new windows.

3.2.3.1 *Technology Name*

- **Prefabricated facade (CJR)**: the opinion of the occupants is positive. They consider that the thermal insulation that this system offers has greatly assisted in the improvement of the thermal insulation of the apartment.
- **Breathable membrane (WINCO)**: the opinion of the occupants is positive. They have not experienced the result from the thermal insulation of the ceiling of the underneath space, however they expect that the membrane contributes to the general improvement of the thermal insulation of the apartment. However, they have experienced noise reduction coming from the ground floor and they believe that this is due to the membrane.
- **PV-Thermal system (SOLIMPEKS)**: the opinion of the occupants is positive. They attribute to this system much of the energy savings of the apartment.
- **PV vacuum glazing window (UNNOT)** for a balcony door: the opinion of the occupant of the specific room where this system is installed is neutral. There is some complaining related to the reduced light transmittance due to the PV film, however she is satisfied from the noise reduction and the thermal insulation improvement related to the PV vacuum glazing.
- **Commercial double glazed/PVC frame balcony doors**: the replacement of the old balcony doors with new energy efficient systems was one of the major requests of the occupants at the beginning of the project. Therefore, they are very satisfied from the new balcony doors, and they experience huge noise reduction and thermal insulation improvement.
- **Sensors and control systems (AMS)**: only one of the four occupants makes use of the smart control systems, and he is very satisfied having the opportunity to control. He is an electrician, so he was anyway interested in such smart systems. He had also installed similar systems in houses as part of his profession.

3.2.4 Tables, plots,

The following Table summarises the occupants' opinion pre- and post – SUREFIT renovations on the major issues that the apartment had.

Table 2 Pre-renovation vs. Post renovation feedback from the occupants on the major issues of the apartment.

Question to the tenants	Pre-renovation	Post renovation
How would you describe the temperature inside the house during Spring?	Neutral	Neutral
During Summer?	Too hot	Neutral
During Autumn?	Cold	Neutral
During Winter?	Cold	Hot
Is this building slow or quick to heat up during Winter?	Slow	Quick

Is this building slow or quick to cool down during Summer?	Slow	Quick
How much does noise from the various external sources annoying you?	Extremely/very much	Slightly
In your opinion, is there any overheating issues through the windows in your house?	Definitively yes	Certainly no

3.2.5 Conclusion of technologies effectiveness, positive and negative impacts on users

In general, the occupants consider the installed technologies as effective and with positive feedback to them.

More specifically, the improvement in the indoor temperature and the fact that the apartment is cooled down fast in the Summer and heated up fast during the Winter, is attributed to the combine effect of the prefabricated panels, the SKYTECH PRO XL membrane, the new balcony doors (commercial and the PV vacuum glazing by UNNOT) and of course, to the PV-Thermal system. The reduction of the noise from outdoor sources is attributed to the new balcony doors. The reduction of noise coming from the ground floor is due to the effect of the SKYTECH PRO XL membrane. Finally, the fact that there are no overheating issues through the balcony doors is attributed to the new balcony doors (commercial and the PV vacuum glazing by UNNOT).

3.3 UK

3.3.1 User receptiveness to surveys

The homeowner was generally open to surveys in principle, yet it was found that repeatedly asking for them to be completed was required. It was understood the importance of the surveys, the simplicity of the online form, and the need to do the pro-renovation survey on a regular basis, yet the few formal surveys were completed. The majority of the information of the survey were from conversations with the homeowner.

3.3.2 Pre-Occupancy Survey

The homeowner understood the advantages and potential energy savings possible with the technologies. The systems of the home prior to the Surefit technology installation provided home heating with gas boiler system yet at a high cost and high carbon emissions. The owner wished to modernize the home with PV systems to make the home 'green'. It was also realized that while the windows were modernized two decades earlier, providing much better insulation, the exterior walls were poorly insulated and required insulation.

3.3.3 Post Occupancy Survey

The lack of many formal survey results meant that most of the survey data below was via conversations with the homeowner. Because these conversations were not timely, at regular periods over the survey period, but mostly at the end of the survey period, the specifics of each technology were likely lost, and the results are more general.

Summary of user comments and opinions on each technology.

- **Solar Assisted Heat Pump**: The owner was pleased with this system. The operation was basically automatic, with operation controlled by the smart controller and the heat pump controller. The heat pump unit and solar thermal panels were installed in an exterior garage; no noise issues were reported. The thermal storage tank provided sufficient hot water storage for the winter months, yet reviewing the data shows that is was perhaps undersized. A prolonged sunless and cold period would have likely exhausted the heat storage with the solar assistance unavailable. The owner did express concern if snow were to cover the panels, how would the system operate.
- **Ground Source Heat Pump**: The owner was pleased with this system. The operation was basically automatic, with operation controlled by the smart controller and the heat pump controller. At maximum power, limited by the size of the ground array, the heat pump produced approximately 1/3 of the heating power needed for the home. Data showed a larger system would be required if the sole heating system, yet it was evaluated at the same time as the solar assisted heat pump.
- **Prefabricated facade**: This created the largest impact on home energy use and created a very positive impression on the owner. The exterior panels allowed for a relatively rapid installation, creating minimal disruption to the homeowner. The owner appreciated the simplicity of the panels and then meeting local planning requirements, normally a complicated process in the UK.
- **Solar PV electrical with Smart Controls**: Once installed, the owner was very pleased with the system. It operated without any user interaction and greatly reduced energy bills. Installation was complicated due to the required scaffolding around the building.

- **PV vacuum glazing window:** The owner was very pleased with this. The installation was time consuming compared to more common dual pain windows, but once installed, the owner did not notice any issues with the window unit. The PV power production was automatic and required no input from the user.
- **Evaporative Cooler:** This was evaluated for only three days in the hottest days of the summer. It required user interaction and did not provide sufficient cooling to cool more than part of one room. The owner made it clear the system was not sufficient or at the stage of development for consumer use.
- **Window Heat Recover System:** The owner was not at all pleased with this system. While conceptually, the fresh air was a great idea, the noise of the system made it unusable at nighttime in the bedroom. The only time it was used was when the room was unoccupied. The owner stated it seemed to be undersized, not able to produce sufficient air flow for the room.

3.3.4 Conclusion of technologies effectiveness, positive and negative impacts on users

The owner was in general pleased with the Surefit technologies. The installation times were relatively short and the monitoring not excessively intrusive. The passive technologies (solar PV, exterior insulation, smart control, PV glassing) were fully accepted by the owner with no real negative comments.

The heat pump systems were also very well received by the owner. They operated basically automatically with little user input. Importantly these, combined with the passive technologies reduced the home energy consumption and costs.

The window heat recovery unit was not well received. The owner made it clear the unit noise made it unusable. Similarly evaporative cooler. The unit was under scaled and was only used for three days. With both these technologies, the owner felt that perhaps with further development, they might be useful to him.

3.4 Spain

3.4.1 Installed Technologies

- **Prefabricated facade (CJR)**: it is a "sandwich" panel, consisted of 20mm XPS panel + 20mm Aerogel blanket + 20mm XPS panel, of a total thickness 7cm. The U value of the existing wall with the prefabricated panel is 0.481W/m^{2}K. This technology was installed externally to the whole available area of the North and South facades of the apartment, to provide thermal insulation.
- **Extra insulation:** Installation of 8 cm of XPS in the H40, as a request of the owners and financed by them
- **Breathable membrane (WINCO)**: the Skytech Pro XL membrane is installed to act as a reflective and rain screen. Complete wrapping of the building with the membrane by WINCO, including roofs and facades. The thickness is 26mm, with λ-value of 0.029W/mK and sound reduction – 16dB.
- **PCM panel (PCM)**: Installation of PCM panels, S27 in 40, S29 in 42 and no one in the 44 because of a proposal of PCM technicians.
- **PV-Thermal system (SOLIMPEKS)**: for production of electricity, DHW and heating (DHW, heating is supplemented by the existing oil boiler).
  - H40, the storage tank (300L) has been installed in the outside of the building due to space requirements. A shelter to protect this equipment was foreseen but finally not installed due to budgetary issues.
  - H42, same as H40 with the only difference that the storage tank has a backup resistance due to the absence of a gas boiler. The storage tank has also been installed on the outside, at the courtyard.
  - H44, the storage tank, smaller than the others (200L) has been installed inside the building and this also has a backup resistance.
- **PV vacuum glazing window (UNNOT)** for a balcony door. The U-value is 0.45W/m^{2}K, the thickness in 8.3mm and the light transmittance is 70%.
  - H40, replacement of the door to the backyard, and installation of the PV Vacuum Glazing Window, change of one of the windows that will receive the Heat Recovery Unit. The rest of the windows were changed at the owner's cost.; H42 same as H40;
  - H44, same changes, but the rest of the windows that were already changed by the owner.
- **Window Heat Recovery Units (UNNOT)** have been installed on the top of the windows attending to the UNOTT's proposal, provided with energy from the PV Vacuum Glazing Windows.
- **Daylight Louvers (Köester)**: Installation on Daylight louvers in three windows of the ground floor in each of the houses.
- **Sensors and control systems (OnControl)**: ONControl has installed IAQ sensors, energy meters and actuators in the apartment for the live monitoring and control of the systems.
- **Finishes:** Installation of a mixed wood and concrete boards to finish the envelope and create a ventilated gap. This is not a SUREFIT technology, but it is required to complete the installation

3.4.2 User receptiveness to surveys

In the case of the Spanish pilot, the receptiveness of the occupants to user surveys and project-related feedback mechanisms has been generally positive. The owners of Houses 40 and 44 have shown a proactive attitude, engaging actively in discussions and providing input on the process. The owner of House 42, while interested, has been somewhat less responsive in certain aspects. Several face-to-face meetings have been conducted to explain the technologies and the overall process, ensuring that all participants understand the importance of gathering information. While their willingness to participate has been evident, direct interaction through meetings has proven to be the most effective way to obtain feedback, reinforcing the idea that personal engagement remains a key factor in user involvement, despite the additional effort it requires from project personnel.

3.4.3 Pre-Occupancy Survey

The pre-occupancy survey conducted among the residents of the demonstration buildings reveals key insights into their perception of the existing conditions and their expectations for renovation.

Building Quality and Neighbourhood Satisfaction

The perceived quality of construction materials varies among residents. The owner of House 40 rates it relatively high (7/10), while the owners of Houses 42 and 44 consider it low (3/10). Despite this, all residents express satisfaction with their neighbourhood, with two of them being "very satisfied."

Indoor Climate Conditions

All houses lack cooling systems, and heating systems differ: Houses 40 and 44 use gas boilers, while House 42 relies on electric radiators. Perceived indoor temperatures indicate discomfort, particularly in summer, where all occupants report excessive heat. In winter, temperatures range from "cold" to "very cold," highlighting inadequate thermal insulation and heating efficiency.

Air Quality and Ventilation

Humidity levels are a concern, with all respondents describing their homes as "somewhat humid" or "humid." Ventilation issues are evident, particularly in House 44, where the air is perceived as "poorly ventilated" and "malodorous." The other houses report mixed perceptions of air freshness, but none describe their indoor air quality as excellent.

Noise Perception

The most reported noise disturbances come from traffic and neighbours. House 42 reports the highest sensitivity to road noise, while the other two houses describe it as a minor issue. None of the respondents indicate major disturbances from external ventilation or industrial noise sources.

Lighting Conditions

Natural and artificial lighting conditions are generally satisfactory. House 44 rates them as "very satisfactory," while the other two consider them merely "satisfactory." Despite this, overheating through windows is a notable issue, with Houses 40 and 42 confirming it as a problem.

Desired Improvements and Willingness to Invest

Residents highlight thermal insulation, better windows, and improved heating and cooling solutions as their primary renovation priorities. House 44's owner is willing to invest €20,000 for improvements, while the other two owners indicate they lack financial resources for such investments.

Conclusion

The survey highlights significant thermal discomfort, air quality issues, and concerns about overheating and noise. The findings emphasize the necessity of targeted renovations, particularly in insulation, ventilation, and heating solutions, to enhance indoor comfort and energy efficiency. Although financial constraints may limit contributions from some owners, there is a clear recognition of the need for improvement across all households.

Table 3 Occupancy survey results

House	Cooling System	Spring Temperature	Summer Temperature	Autumn Temperature	Winter Temperature	Air Quality - Humidity	Air Quality - Odor	Air Quality - Ventilation	Noise from Traffic	Noise from Neighbors	Natural Light Satisfaction	Artificial Light Satisfaction	Sun Exposure	Overheating Issues	Preferred Improvements	Willing to Pay for Renovation
40	No	Somewhat Cold	Too Hot	Somewhat Cold	Cold	Somewhat Humid	Neutral	Neutral	Slightly	Slightly	Satisfactory	Satisfactory	Good Amount	Yes	Better insulation, solar panels, improved windows	No
42	No	Neutral	Too Hot	Neutral	Cold	Somewhat Humid	Somewhat Malodorous	N/A	Moderately	Slightly	Satisfactory	Satisfactory	Good Amount	Yes	Everything	No
44	No	Hot	Too Hot	Somewhat Cold	Very Cold	Humid	Malodorous	Poorly Ventilated	Slightly	Slightly	Very Satisfactory	Very Satisfactory	Good Amount	No	Full thermal envelope improvement, mechanical ventilation	20,000€

3.4.4 Post Occupancy Survey

The comparison between the pre- and post-renovation survey responses from the owner of House 44 reveals notable improvements in various aspects of comfort, air quality, and energy efficiency. The perceived construction quality has improved significantly, with the occupant rating it 8 out of 10 after the renovation, compared to a low score of 3 before. This suggests that the structural improvements and material upgrades have had a positive impact on the perception of the building.

Indoor thermal comfort has also improved. Before the renovation, the house was described as too hot in summer and very cold in winter, highlighting poor insulation and energy inefficiencies. After the renovation, temperatures in spring, summer, and autumn are now perceived as neutral, although winter is still reported as cold. While heating has been upgraded from a gas boiler to a mixed biomass and electric system, the owner notes a preference for a heating system with greater thermal inertia, such as underfloor heating.

Air quality has seen moderate improvements. The home was previously described as humid, poorly ventilated, and malodorous. After the renovation, the perception has shifted to "somewhat humid" with neutral ventilation and a near-odourless indoor environment. These responses suggest that while air circulation has improved, humidity remains a concern, possibly due to the delayed operation of the mechanical ventilation system.

Regarding noise perception, the resident's sensitivity to external noise has remained largely unchanged, with slight disturbances from traffic and neighbours. However, a moderate increase in discomfort from bars and restaurants is now noted, which could be related to changes in sound insulation or external factors unrelated to the renovation.

Lighting conditions, which were already well-rated, remain very satisfactory for both natural and artificial lighting. The occupant continues to report no overheating issues through the windows, confirming that any previous concerns in this area have been effectively addressed.

In terms of overall satisfaction, the renovation has achieved significant improvements in comfort, especially in construction quality and temperature regulation. However, some areas, such as heating efficiency and mechanical ventilation operation, could still be optimized. The owner does not indicate a strong need for further improvements but expresses interest in ensuring the proper functioning of the ventilation system. The overall impact of the renovation appears highly positive, leading to a planned 25% rental price increase, suggesting that the improvements have added substantial value to the property.

Table 4 Air quality survey results

Category	Pre-Renovation	Post-Renovation
Construction Quality (1-10)	3	8
Spring Temperature	Hot	Neutral
Summer Temperature	Too Hot	Neutral
Autumn Temperature	Somewhat Cold	Neutral
Winter Temperature	Very Cold	Cold
Air Quality - Humidity	Humid	Somewhat Humid
Air Quality - Odor	Malodorous	Somewhat Inodor
Air Quality - Ventilation	Poorly Ventilated	Neutral Ventilation
Noise from Traffic	Slightly	Slightly
Natural Light Satisfaction	Very Satisfactory	Very Satisfactory
Artificial Light Satisfaction	Very Satisfactory	Very Satisfactory
Overheating Issues	No	No

3.4.4.1 *Technology Name*

1. Prefabricated Panels and reflective membrane for Overheating Protection

The importance of prefabricated panels and reflective membrane in protecting homes from overheating is rated at 5.0, indicating unanimous recognition of their value. This technology is seen as an effective solution to mitigate excessive indoor heat, particularly in hot weather. Additionally, a noticeable positive difference in interior temperatures is reported, with a rating of 4.5, reinforcing the effectiveness of this insulation method.

2. Hybrid Photovoltaic and Thermal (PV/T) System

The solar energy system integrating both electricity and thermal energy production receives a strong interest rating of 4.25. The perceived benefits of this system in reducing energy bills are rated at 4.0, showing confidence in its potential economic impact.

3. Energy Efficiency in Cooling Technology

Energy efficiency in cooling systems is considered important, with a rating of 4.25. The passive cooling technology using Phase Change Materials (PCM) is rated at 4.25 in terms of interest, demonstrating appreciation for solutions that reduce electricity consumption while maintaining indoor comfort.

4. PV Vacuum Glazing Technology

Interest in adopting PV vacuum glazing technology, which combines renewable electricity generation with thermal insulation, receives mixed responses, with an average score of 2.75. The perceived benefit of this technology in reducing overheating is rated at 2.75, indicating some scepticism or a need for further demonstration of its advantages.

5. Passive Daylight Control Systems

The idea of a daylight control system that prevents overheating while maintaining natural light receives an interest score of 4.0. The importance of having a view through the window while preventing overheating is rated at 4.25, highlighting the preference for solutions that balance thermal protection and visual comfort.

6. Windows Heat Recovery System

In face-to-face meetings, the windows heat recovery system has been perceived as the least developed solution, with significant room for improvement. While all users acknowledge the necessity of research and innovation in this field, there is a general scepticism regarding its functionality and effectiveness. This highlights the need for further refinement and practical demonstrations to enhance confidence in the system's benefits.

Conclusions

The installed technologies are generally well-received, particularly the prefabricated panels for thermal insulation and the hybrid PV/T system. Passive cooling solutions and energy-efficient cooling technologies also generate interest. PV vacuum glazing technology, however, shows lower enthusiasm, suggesting the need for additional explanation or improvements in perceived effectiveness. The importance of natural light and views through windows is emphasized, reinforcing the necessity of integrating energy efficiency measures without compromising visual comfort. Additionally, the windows heat recovery system is identified as an area requiring further development and validation, as scepticism remains regarding its effectiveness in real-world applications.

3.4.5 Conclusion of technologies effectiveness, positive and negative impacts on users

The evaluation of the installed technologies, based on pre- and post-renovation surveys, visitor feedback, and face-to-face discussions, highlights a generally positive impact on indoor comfort and energy efficiency. However, the perception of effectiveness varies across different solutions, with some technologies being well-received while others generate scepticism.

Effectiveness and Positive Impacts

The prefabricated thermal insulation panels are widely recognized as one of the most effective interventions. Users report a noticeable improvement in indoor temperature stability, particularly in mitigating summer overheating. The hybrid photovoltaic and thermal (PV/T) system is also perceived positively, with high interest in its potential for reducing energy bills and enhancing sustainability. Passive cooling technologies, such as Phase Change Materials (PCM), receive appreciation for their ability to maintain comfortable indoor conditions without increasing electricity consumption.

The renovation has led to a significant improvement in the perception of construction quality, increasing from a low rating to a much higher level of satisfaction. Temperature control in transitional seasons (spring and autumn) is now considered neutral, a major improvement from the previous complaints of excessive heat in summer and extreme cold in winter. Users also recognize the importance of natural daylight control and its role in balancing thermal comfort without unnecessary energy use.

Challenges and Negative Impacts

Despite the overall improvements, some aspects remain challenging. The PV vacuum glazing technology has received mixed feedback, with lower enthusiasm compared to other solutions. Users express doubts about its real impact on reducing overheating and improving energy efficiency, suggesting a need for clearer evidence of its benefits.

Another critical point is the windows heat recovery system, which is perceived as the least developed solution. In face-to-face discussions, users acknowledge the importance of research in this area but remain sceptical about its functionality and effectiveness. This highlights the need for further refinement and practical demonstration to increase trust in the system.

Additionally, it is necessary to conduct further analysis on the thermal behaviour of the building, particularly regarding heat retention and envelope inertia during spring. The combination of improved insulation and changing exterior temperatures in the transition period between heating and non-heating seasons may lead to higher indoor temperatures. This aspect requires close monitoring to ensure that overheating does not become a secondary issue due to improved energy retention.

Final Assessment

Overall, the technological interventions have significantly improved thermal comfort, energy efficiency, and user satisfaction. Insulation and passive cooling solutions are the most positively perceived, whereas advanced glazing and heat recovery technologies still require optimization and better communication of their advantages. While there is clear recognition of the need for innovation, some scepticism persists regarding the real-world effectiveness of certain technologies. Further analysis of the building's thermal inertia, along with system optimization and user education, will be crucial to maximizing the long-term benefits of the renovation.

3.5 Finland

3.5.1 Installed Technologies

Daylight louvers by KOST, installed into bedroom, dining room and balcony windows.

3.5.2 User receptiveness to surveys

The occupants were extremely disinterested in answering surveys or interviews regarding the technologies, to the extent that we were only able to get feedback from them once during the installation visit of the bedroom/dining room louvers.

3.5.3 Pre-Occupancy Survey

No survey results could be obtained from the occupants.

3.5.4 Post Occupancy Survey

No survey results could be obtained from the occupants.

3.5.4.1 *Daylight louvers*

The interview during the installation visit revealed that the occupants were happy about the looks of the technology and the quality of the installation but did not like the cumbersome operation of the louvers.

3.5.5 Conclusion of technologies effectiveness, positive and negative impacts on users

The very limited feedback showed that the users seemed mostly happy with the technology although they were concerned with how difficult it was to operate the louvers.

4 Conclusion

4.1 Survey Methods

The online forms seemed to offer an efficient method to collect the survey information. The webform was optimized for webpages, mobile devices, and smart phone to allow convenient data entry by the home occupants. Yet despite the simplicity, occupant use of the system was minimal. While many of the questions offered yes-no or pull-down answer selection, many of the questions were subjective. Subjective answers combined with subtle differences in the questions per language and the specific questions meant the surveys did not produce data easily analysed and compared between locations.

4.2 Receptiveness to surveys

The online surveys and number of surveys were not well received by the home occupants. The were considered too long and cumbersome. The frequency of surveys as planned for the Surefit project was much too ambitions. The paper forms had a similar reception.
While the local Surefit leads tried to impart the importance of the surveys, this was not a driver for the occupants to complete the forms regularly.

4.3 Survey Results per Technology

- **Prefabricated insulation panels by CJR**

This passive technology was we received in all the installed locations. The speed of installation and immediate improvement in insulation positively affected the homes and impressions from the occupants. The prefabricated panels and reflective membrane in protecting homes from overheating is rated at 5.0, indicating unanimous recognition of their value. This technology is seen as an effective solution to mitigate excessive indoor heat, particularly in hot weather and provide greatly improved insulation for colder climates.

- **Skytech Pro XL membrane by WINCO**

The occupants had no direct impact that they could point to, but it was appreciated it was part of the larger building fabric improvement. They did experience noise reduction coming from other rooms in the building and attributed this to the membrane.

- **PCM panel provided by PCM**

The opinion of the occupants is positive. They attribute to this system much of the energy savings of the apartment. Rooms that previously were excessively hot in the summers were perceived as more usable in the hottest months. The passive PCM received very positive reviews.

- **PV vacuum glazing system by UNNOT**

The insulative properties and noise reduction were well appreciated by the occupants. The complexity of installing a much heavier window was of some concern. While the system does generate electricity, this was not directly noticed by the occupants. The costs of these systems make adoption financially challenging.

- **Window Heat Recovery Unit provided by UNNOTT**

This system was widely praised for reducing the need for additional heating, contributing to a more comfortable indoor environment, especially in cold periods. It allows automatic CO2 level control using Smart Controls. Yet most occupants were not at all satisfied with the system. The noise in operation made the system unusable when the room was occupied. This highlights the need for further refinement and practical demonstrations to enhance confidence in the system's benefits.

- **Daylight louvers provided by Köester**

The idea of a daylight control system that prevents overheating while maintaining natural light received high satisfaction. Optimized natural light entry and reduced artificial lighting use during the day.

- **PV-thermal system by SOLIMPEKS**

The solar energy system integrating both electricity and thermal energy production receives a strong interest and satisfaction by all users. It is a passive system and once installed, needs no additional owner attention. The reduction of energy bills was very important to the occupants.

- **Smart control units by ONCONTROL**

While the automated systems proved efficient, both the occupant and owner initially struggled with the interface. They requested improvements in design and usability to facilitate daily use.

- **Solar Assisted Heat Pump by UNNOT**

The hybrid performance of the system showed a reduction in conventional energy consumption without depending on direct sunlight. However, in one location, this technology received the most complaints: noise, vibration, and system complexity caused inconvenience not only to CJR but also to the owner and occupant.

- **Evaporative Cooler by UNNOT**

This was evaluated for only three days in the hottest days of the summer. It required user interaction and did not provide sufficient cooling to cool more than part of one room. The owner made it clear the system was not sufficient or at the stage of development for consumer use.

- **Ground Source Heat Pump**

The occupant was pleased with this system with operation was basically automatic. At maximum power, limited by the size of the ground array, the heat pump produced approximately 1/3 of the heating power needed for the home. Data showed a larger system would be required if the sole heating system, yet it was evaluated at the same time as the solar assisted heat pump.

4.4 Overall Surefit Survey Results

Overall, the Surefit technologies offered significant improvement in energy efficiency of the evaluation homes and the occupants were generally satisfied. While there is clear recognition of the need for innovation, some scepticism persists regarding the real-world effectiveness of certain technologies. The passive technologies (solar PV, exterior insulation, membrane, smart control, PV glassing) were fully accepted by the owner with no real negative comments.

The heat pumps system where well received in one location while it posed significant issues at other location. The window heat recovery unit was not well received. The owner made it clear the unit noise made it unusable. Similarly evaporative cooler. The unit was under scaled and was only used for three days. With both these technologies, the owner felt that perhaps with further development, they might be useful to him. In general, the occupants consider the installed technologies as effective and with positive feedback to them.

Appendix A Informed Consent Form

Below is the Informed Consent Form used to comply with EU regulations. This is common from for each of the survey forms, with versions in English, Finish, Portuguese, Spanish, and Greek.

SUREFIT

Welcome to our questionnaire!

Informed consent form

Project acronym:	SUREFIT
Project name:	SUstainable solutions for affordable REtroFIT of domestic buildings
Grant Agreement no.:	894511
Project type:	Innovation Action (IA)
Start date of the project:	01/09/2020
End date of the project:	31/08/2024
Involved partner/researcher:	ISQ/UNOTT/FSM/AALTO/AMS

1. Introduction

This document is an informed consent form, please read this document carefully before making a decision on whether participating or not. Please feel free to ask any questions to ensure that you fully understand the purpose and proceedings of this study, including risks and benefits.

2. SUREFIT project

SUREFIT project will demonstrate fast-track renovation of existing domestic buildings by integrating innovative, cost-effective, and environmentally conscious prefabricated technologies. This is to reach target of near zero energy through reducing heat losses through building envelope, and energy consumption by heating, cooling, ventilation and lighting, while increasing the share of renewable energy in buildings. This will be achieved through a systematic approach involving key stakeholders (building owners/users, manufacturers, product/services developers) in space heating, cooling, domestic hot water, lighting and power generation, as well as a demonstration phase in 5 representative buildings in different European climates. More info about the project can be found at https://surefitproject.eu/.

3. Purpose of this activity

SUREFIT, among other activities, is performing a socio-economic modelling and a social acceptance assessment associated to the scope of the project (i.e. fast-track renovation of existing domestic buildings by integrating innovative, cost-effective, and environmentally conscious prefabricated technologies). With this purpose, you have been selected to participate in this survey to be undertaken for the tasks of WP2/ WP8.

4. Involvement in the activity

If you agree to participate in the study, you will be asked to participate in a survey carried out through an online form.

The participation in these activities is strictly voluntary, and you have the right to withdraw it at any moment and may decline to answer any questions.

5. Privacy and confidentiality

The results of this study will be published but this publication will not contain any information that could identify you. SUREFIT will collect and store your contact details (name, company, email and phone number), and may gather information on your profile (e.g. professional activity, age, years of occupation in the building, etc.). These contact and profile data will guarantee your anonymity and will not be included in any deliverable or publication.

This collection is in strict compliance with national and European legislation on data protection, will not be shared with third entities, and will be destroyed after SUREFIT project ends. The treatment and analysis of the data collected in this activity will the responsibility of partners ISQ, UNOTT, FSM, AALTO and AMS, and will be used only under the project scope. All data collected by the partners will be stored digitally in a shared folder (cloud), accessible only to key personnel from each consortium partner working in SUREFIT who has already signed a Non-Disclosure Agreement.

It is important to note that SUREFIT activities to be conducted will not involve:

• Collection or processing of sensitive personal data (e.g. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction) nor the processing of genetic information.

• Tracking or observation of participants (e.g. surveillance or localization data, and WAN data, such as IP address, MACs, cookies etc.).

6. Consent

By continuing to the questionnaire, you are accepting these terms and agreeing to take part in the study. You will be given a copy of this document for your records and one copy will be kept by the project coordinator with the study records. Be sure that questions you have about the study have been answered and that you understand what you are being asked to do. Please, do not hesitate to contact the researcher after this activity if having additional questions.

7. Contact

If you have any questions about this research or your prospective involvement in it, please contact the project coordinator, Sérgio F. Tadeu, Instituto de Soldadura e Qualidade, email: surefitproject@isq.pt, telephone: +351 214 228 100.

8. Statement of consent

This consent form is made pursuant to the relevant national, European and international data protection laws and regulations and personal data treatment obligations. Specifically, this consent document complies with the EC Data Protection Directive 95/46/EC of the European Parliament and of the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data.

Please, select “yes” or “no” to affirmatively consent to the following statements:

• I confirm that I have read and understood this informed consent form, and have been informed by the researcher in charge of this activity. I had the time and opportunity to ask questions as needed, and they were answered.

• I understand that I am free to withdraw my consent at any time without giving reason.

• My personal data can be gathered to be used, stored and shared in the ways described in this informed consent form.

• Data from my participation may be used to write project deliverables, articles for peer reviewed journals and relevant industry magazines, for presentations at conferences and workshops, under the scope of the project and not containing any personal or sensitive information or information that could identify me.

• I agree to voluntarily take part in the SUREFIT research.

Appendix B 1st Pre-Occupancy Survey

Questions to the occupants BEFORE renovation

A. General

A1. How would you rate the quality of the construction materials of the house on a scale from 1 (extremely low quality) to 10 (very high quality)?

A2. In general, how satisfied are you with this neighbourhood (surrounding area) as a place to stay/live/work?

B. Heating/cooling

B1. Is there any cooling system in the house?

B2. Is there any heating system in the house?

B3.1. How would you describe the temperature inside the house during Spring?

B3.2. during Summer?

B3.3. during Autumn?

B3.4. during Winter?

B4.1. How often do you adjust the indoor temperature by using the relevant control system of your cooling system during Summer?

B4.2. during Spring?

B4.3. during Autumn?

B5.1. How often do you adjust the indoor temperature by using the relevant control system of your heating system during Winter?

B5.2. during Spring?

B5.3. during Autumn?

B6. Is this building slow or quick to heat up during Winter?

B7. Is this building slow or quick to cool down during Summer?

C. Indoor air – Ventilation

C1. How would you describe the air movement in the building?

C2. How would you describe the indoor air quality in this building regarding humidity?

C3. How would you describe the indoor air quality in this building regarding smell/odour?

C4. How would you describe the indoor air quality in this building regarding freshness?

C5.1. How often do you adjust air related issues by opening/closing windows during Spring?

C5.2. during Summer?

C5.3. during Autumn?

C5.4. during Winter?

C6. How often do you adjust air related issues by operating portable fan or ceiling fan?

C7. At what setting do you generally use the main mechanical ventilation system?

C8. How many hours per week do you set the mechanical ventilation system at a higher setting?

C9.1. How many hours per week do you have a ventilation grid open in the following rooms: living room

C9.2. sleeping room

C9.3. kitchen (other than the kitchen/cooker hood)

C9.4. bathroom

C9.5. office

C10.1. How many hours per week do you open a window in the following rooms: living room

C10.2. sleeping room

C10.3. kitchen

C10.4. bathroom

C10.5. office

C11. In the kitchen, is there any extra ventilation when cooking?

C12. Is there mould/fungi on the walls, ceilings, in the window frames etc. in the building?

D. Noise

D1.1. How much does noise from the following sources annoying you: road traffic

D1.2. rail traffic

D1.3. air traffic

D1.4. sea, river traffic

D1.5. outdoor construction activities

D1.6. industrial activities

D1.7. outdoor leisure (sports, playground etc.)

D1.8. community buildings (cinema, theater, schools, churches etc.)

D1.9. other activities (bars, restaurants etc.)

D1.10. outdoor ventilation systems

D1.11. neighbours

D1.12. Noise from the indoor air/HVAC system

E. Lighting and solar shade

E1. Regarding the natural light, how would you describe the typical indoor conditions in this building?

E2. Regarding the artificial light, how would you describe the typical indoor conditions in this building?

E3. How do you feel with the glare through windows?

E4. How often do you adjust lighting by using window blinds or shades?

E5. How often do you adjust lighting by switching on the light overhead?

E6. How often do you adjust lighting by switching on desk/task light?

E7. How do you evaluate the sun exposure in your building?

E8. In your opinion, is there any overheating issues through the windows in your house?

F. Desirable improvements

F1. Please, write the improvements that you wish to take place in this building regarding the aforementioned categories (heating, cooling, temperature, indoor air, noise, lighting, ventilation etc.)

F2. Please, write the 3 most important improvements that you wish to take place in this building regarding the aforementioned categories (heating, cooling, temperature, indoor air, noise, lighting, ventilation etc.)

G. Value for money

G1. In case you pay rent for this apartment/building, do you think the rent for this property represents good or poor value for money?

G2. In case you pay rent for this apartment/building, you will be willing to pay a X (choose from the drop down list) rent increase if all your aforementioned needs (question F1) were improved by at least 35%.

G3. In case you pay rent for this apartment/building, you will be willing to pay a X (choose from the drop down list) rent increase if the 3 most important needs (question F2) were improved by at least 50%.

G4. In case you own the apartment/building, what is the amount of money you are willing to pay for renovation in order to improve all your aforementioned needs (question F1) by at least 35%?

G5. In case you own the apartment/building, what is the amount of money you are willing to pay for renovation in order to improve the 3 most important needs (question F2) by at least 50%?

G6. In case you own the apartment/building, what is the amount of the rent increase that you plan to ask for after the renovation?

Appendix C 2nd Pre-Occupancy Survey

Questions

1. Have you received information about the technologies to be installed in your building?

2. Was this information sufficiently clear and understandable?

3. From what you have understood, what are your expectations regarding the renovation?
   Optional expect to obtain savings of 10%, 25%, or 50%

4. Would you be willing to complete with your own means, actions not covered by the Surefit project?

5. Do you accept that during the renovation there may be inconveniences that alter your normal daily functioning?

6. For how long would these inconveniences be bearable?

Appendix D User Survey

A. General

A1. How would you rate the quality of the construction materials of the house on a scale from 1 (extremely low quality) to 10 (very high quality)?

B. Heating/cooling

B1. Is there any cooling system in the house?

B2. Is there any heating system in the house?

B3.1. How would you describe the temperature inside the house during Spring? *

B3.2. during Summer?

B3.3. during Autumn?

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B6. Is this building slow or quick to heat up during Winter?

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C1. How would you describe the air movement in the building?

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C3. How would you describe the indoor air quality in this building regarding smell/odour?

C4. How would you describe the indoor air quality in this building regarding freshness?

C5.1. How often do you adjust air related issues by opening/closing windows during Spring?

C5.2. during Summer?

C5.3. during Autumn?

C5.4. during Winter? *

C6. How often do you adjust air related issues by operating portable fan or ceiling fan?

C7. At what setting do you generally use the main mechanical ventilation system?

C8. How many hours per week do you set the mechanical ventilation system at a higher setting? *

C9.1. How many hours per week do you have a ventilation grid open in the following rooms: living room

C9.2. sleeping room

C9.3. kitchen (other than the kitchen/cooker hood)

C9.4. bathroom

C9.5. office

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C10.3. kitchen

C10.4. bathroom

C10.5. office

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C12. Is there mould/fungi on the walls, ceilings, in the window frames etc. in the building?

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D1.4. sea, river traffic

D1.5. outdoor construction activities

D1.6. industrial activities

D1.7. outdoor leisure (sports, playground etc.)

D1.8. community buildings (cinema, theater, schools, churches etc.)

D1.9. other activities (bars, restaurants etc.)

D1.10. outdoor ventilation systems

D1.11. neighbours

D1.12. Noise from the indoor air/HVAC system

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E1. Regarding the natural light, how would you describe the typical indoor conditions in this building?

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E5. How often do you adjust lighting by switching on the light overhead?

E6. How often do you adjust lighting by switching on desk/task light?

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F2. Please, write the 3 most important improvements that you wish to take place in this building regarding the aforementioned categories (heating, cooling, temperature, indoor air, noise, lighting, ventilation etc.)

G. Value for money

G1. In case you pay rent for this apartment/building, do you think the rent for this property represents good or poor value for money?

G2. In case you pay rent for this apartment/building, you will be willing to pay a X (choose from the drop down list) rent increase after the renovations that have been carried out?

G3. In case you own the apartment/building, what is the amount of the rent increase that you plan to ask for after the renovation?