



**CBDC powered Smart PerFORrmanCe contracTs for Efficiency, Sustainable, Inclusive, Energy use**

**D4.3 Pilots execution documentation and validation assessment**

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## Abbreviations

BMS	Building Management System
CO <sub>2</sub>	Carbon Dioxide
EPC	Energy Performance Certificates
ESCO	Energy Service Companies
ETICS	External Thermal Insulation Composite System
EU	European Union
G.S.I.S.D.G	General Secretariat of Information Systems for Public Administrations
HVAC	Heating, Ventilation, and Air Conditioning
Kg	Kilogram
KPI	Key Performance Indicator
KWh	Kilowatt hour
M&V	Monitoring & Verification
OSS	One Stop Shop
PEC	Public Electricity Company
ppm	Parts per million
PV	Photovoltaic
TBD	To be determined
tn	tones
UI	User Interface
UX	User Experience
VFD	Variable Frequency Drives
VOC	Volatile organic compounds
WP	Work Package

## Executive Summary

This deliverable is part of FORTESIE WP4 – “Pilots Deployment and Validation” and specifically reports the work conducted under T4.3 – “Operational Pilots” and T4.4 – “Overall monitoring, evaluation and social acceptance assessment”. The primary objective of this deliverable is to provide a comprehensive update on all pilot-related activities and progress made up until M30. These updates include the execution of renovation works, installation of monitoring equipment, refinement of pilot-specific KPIs, and early lessons learned from the implementation phase.

In this context, the deliverable addresses the following key areas:

- Reporting on the current status of renovations and social engagement activities across all pilots.
- Finalising the KPI structure and setting baseline and target values, especially for energy-related and comfort-related indicators.
- Providing updates on the overall evaluation framework, including the technical and usage evaluation methodologies for the FORTESIE digital services.
- Presenting the pre-final version of the social acceptance survey, to be used for capturing end-user feedback on renovation outcomes, comfort improvements, and the FORTESIE digital tools.
- Highlighting pilot-specific and cross-cutting challenges encountered so far, and documenting preliminary lessons learned that can support improved implementation and future policy development.

While all pilots have now entered the execution phase, their levels of maturity vary. Most pilots have completed or are near completion of their renovation activities, with several having initiated sensor data collection and integration into the project’s data platform. The deployment of FORTESIE’s digital tools—including the mobile application and the OSS marketplace—is set to commence shortly, once core renovations are finalised. Additionally, early engagement actions have been launched in most pilot sites, with more intensive outreach and feedback collection scheduled over the next reporting period.

It is also important to highlight that the KPI structures presented in this deliverable are the result of ongoing collaboration between the project team and the pilot partners and have been adjusted to better reflect the specificities and constraints of each site. These refinements are essential to ensuring that the upcoming evaluation activities in WP4 are meaningful and robust.

Overall, this deliverable reflects the ongoing transition of the project from planning to execution and validation. It provides an updated and structured overview of where each pilot stands, what has been achieved so far, and what will be prioritised in the coming months. The insights collected here will directly inform the broader project-level policy recommendations to be reported later under WP6.

# 1 Introduction

The purpose of the current deliverable D4.3 is to document the updates of the FORTESIE pilots, which come as a result of all related activities in the context of WP4 “Pilots’ Deployment and Validation”. As such, this deliverable presents specific updates for the FORTESIE pilots, which include updates in the renovation works and the sensor (and other monitoring equipment) installations, updates in the overall KPI structure of each pilot, as well as early challenges and lessons learned that were generated based on the pilot activities up until M30. In addition, this deliverable presents updates in the overall evaluation framework of the FORTESIE pilots and the pre-final version of the survey that will be given to pilot participants and end users to evaluate the results of the renovations and the FORTESIE digital tools.

## 1.1 Project Introduction

FORTESIE aims to accelerate the Renovation Wave in Europe by designing and demonstrating innovative renovation packages in the building industry with Smart Performance-Based guarantees and financing. These renovation packages will combine state-of-the-art construction materials and technological components, such as prefabricated facades, building-integrated photovoltaics, and heat pumps. The renovation packages will be tailored to specific target groups’ needs and optimised to improve the efficient, sustainable, and inclusive energy performance while also considering comfort.

Additionally, innovative digital technologies for measurement and verification will be developed and implemented to raise the overall energy performance contract value proposition. Especially relevant for this deliverable is the gamified mobile application for consumers, which will provide information about their energy use as well as feedback and suggestions for optimising energy use and comfort. Additionally, an online marketplace will be developed and implemented to offer advice and facilitate access to these renovation services.

The FORTESIE project will evaluate the effectiveness of these solutions and validate novel business models in real demonstrators in 6 countries, for 3 different target groups in 7 versatile pilot sites.

## 1.2 Deliverable Purpose

The purpose of deliverable D4.3 “Pilots execution documentation and validation assessment” is to provide a comprehensive update on all pilot-related activities up until M30. As such, the deliverable first provides updates on the overall evaluation framework that was initially presented in deliverable D4.1 “Pilots preparation, baseline analysis and planning”. These updates help to specify on the horizontal KPIs that will be addressed in the context of WP4. These horizontal KPIs were presented in D1.1 “Quality, Risk and Innovation Handbook” and D4.1 “Pilots preparation, baseline analysis and planning”. Furthermore, the deliverable provides further updates on the technical and usage evaluation of the FORTESIE digital services by the pilot users and presents the first version of the survey that pilot participants will fill in to evaluate the renovations, energy savings, internal conditions, and the digital tools that they will use. This first version of the survey can also be considered as the pre-final version since it covers all the pilot activities with targeted questions. Any future updates in the survey will focus on making it more specific and personalised to each pilot case but will not change the overall structure.

Another aim of this deliverable is to present the current status and updates of each FORTESIE pilot. This includes updates in the renovation and social engagement timeline of the pilots to reflect delays, additions and other changes. Furthermore, the KPI structure of each pilot is finalised based on discussions with each pilot leader and baseline and target values are presented for most KPIs,

especially the ones that are related to the energy usage before and after the renovations. For KPIs that are related to the internal conditions before and after the renovations, some baseline and target values are provided for the pilots where the sensor installations are completed, and the sensor data have successfully been migrated to the project's database. Finally, all pilots present and describe early challenges and lessons learned that were generated from their activities up to this point. Given that most pilots are now in the process of completing the renovation works, the presented challenges largely represent issues and hurdles that they had to face during this process. In the discussion chapter of the deliverable these challenges are presented more holistically so that horizontal lessons and conclusions can be drawn from them.

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

### **1.3 Structure of the deliverable**

This deliverable starts with chapter 1 introducing the project, the purpose of the deliverable, and its interdependencies with other tasks and deliverables.

Chapter 2 presents the overall evaluation framework of FORTESIE, which includes horizontal and vertical KPIs related to the pilots, the framework for the technical and usage evaluation of the FORTESIE digital services, KPIs relevant to the project's social engagement activities. The chapter concludes with a pre-final version of the survey/questionnaire that will be given to pilot users and beneficiaries so that they can evaluate the renovations, the improvements in energy consumption and internal conditions as well as the FORTESIE digital services (mobile application and OSS marketplace).

Chapter 3 provides a detailed description of the updates for each pilot site. This includes updates in the overall timeline of the pilot renovation works, updates in the timeline and activities that are related to the social engagement, and updates in the KPI structure which also include the baseline and target values of several KPIs. Finally, each pilot reports challenges that they have faced so far and propose lessons and recommendations for the future.

Chapter 4 includes a discussion that is related to the challenges reported by the pilots. These challenges were collected and presented collectively depending on whether they are related to households or big, public buildings. In addition, certain challenges, which affect specific countries or geographical regions are presented collectively to show a better understanding of barriers and hurdles that one might face during a future renovation project.

Finally, chapter 5 presents the conclusions of the document and describes the next steps in the FORTESIE pilots' activities.

### **1.4 Interdependencies with other tasks and deliverables**

This deliverable builds on the results and activities of the two previous deliverables of WP4 "Pilots' Deployment and Validation" and specifically D4.1 "Pilots preparation, baseline analysis and planning" and D4.2 "Engagement Plan and Social Acceptance assessment", which respectively created the foundation for the pilots' execution and evaluation and the social engagement framework that is targeted to the pilot end users.

The deliverable is also connected with the tasks and results of WP3 "Components Development and Integration" given that parts of the survey/questionnaire and the KPI structure of each pilot are related to the deployment and evaluation of the FORTESIE digital services in the pilot sites.

The initial challenges and lessons learnt that are presented in each pilot sub-chapter are closely connected to D6.4 “White Paper: lessons learnt and policy recommendations” where the sum of these lessons will be collectively presented and discussed. Lessons learnt that are relevant to the renovation works are presented in this deliverable to take advantage of the convenient timing of submitting this deliverable which coincides with the end of renovations in most of the pilots.

Finally, the deliverable is closely connected with D4.4 “Pilots execution documentation and validation assessment”, in which the final updates of the pilots will be presented and the KPIs will be addressed and quantified based on energy data, sensor data, and the survey replies.

## 2 FORTESIE Overall Evaluation Framework

FORTESIE is a project that relies heavily on its pilots for the validation of its concept and results, including seven distinct pilot scenarios stemming from six EU countries and covering three different types of buildings (i.e., museums, residential buildings and public or commercial buildings). The overall plan that has been designed to prepare, execute, validate and guide the FORTESIE pilots relies heavily on co-creation with the partners of each pilot site and includes the following phases (Figure 1).



**Figure 1: Pilot Execution and Evaluation Methodology**

Phase 1 “Pilot requirement elicitation”, Phase 2 “Design of pilot-specific usage scenarios and service workflows” and Phase 3 “Pilots data gathering and evaluation structure” have been concluded in deliverable D4.1 “Pilots preparation, baseline analysis and planning”. Additionally, Phase 4 “FORTESIE Engagement strategy” has been presented in deliverable D4.2 “Engagement plan and social acceptance assessment”, while the strategy’s final activity plan/timeline is presented in this deliverable in each pilot’s section.

As regards Phase 5 “Pilot’s baseline assessment”, all pilots have been engaged in collecting data through their energy bills, audits, EPCs etc., in order to establish baseline values for their renovation KPIs, especially the ones related to energy consumption, reduction of energy costs and CO<sub>2</sub> emissions. Additionally, pilot 5 has retrieved baseline data through the data analytics application, from the sensors installed prior to their renovations, as regards the baseline values of the KPIs related to improvement of comfort and overall air quality improvement. For pilots 2 and 7, this baseline data information has not yet been integrated to the respective KPIs as there have been technical delays to the assimilation and migration of the sensor’s data to the data sovereignty application.

Phase 6 “Pilots execution” will be implemented once the digital tools are ready and finalised, while for Phase 7 “Pilots evaluation and validation assessment”, there has been initial progress, as for certain KPIs and specific pilots (e.g., pilots 1, 2, 5 and 6), both baseline and target values have been calculated.

## 2.1 FORTESIE Horizontal KPIs

The horizontal KPIs of FORTESIE (as these were reported in deliverable D1.1 – “Quality, Risk and Innovation Handbook”) are presented in Table 1. It should be mentioned that only KPIs related to WP4 are presented here, as the rest of the horizontal KPIs will be addressed in the other WPs, because they concern project-wide activities and not necessarily the pilot specific activities of FORTESIE.

**Table 1: FORTESIE Horizontal KPIs**

<b>WP4–Pilots Deployment and Validation</b>	4-1 Quality of the test environment and test cases	4-1-1 Number of tests that failed	<10%
	4-2 End-user evaluation and feedback reporting	4-2-1 Users acceptance average	Above average
		4-2-2 End-users feedback regarding indoor environmental quality	50% of pilot users give positive feedback
	4-3 System Validation	4-3-1 Energy reduction rate	20-75% (depending on the pilot case)
		4-3-2 Percentage of services that will be validated positively	>80%
		4-3-3 At least 5 Performance guarantees for smart contracts (energy, CO <sub>2</sub> , comfort, costs, deployment duration) and 10 KPIs related to ESIE will be measured and included in smart contracts guarantees.	>20-60% improvement measured (depending on the pilot case)
		4-3-4 The solution is being rated by end-users (pilot sites) and pilot owners as adequate and comprehensible	Minimum 75% of end-users finds the solution recommendable or highly recommendable and the solution feasible for future deployment.

The KPIs that are presented in Table 1 will be measured either through the pilots energy and sensor measurements (KPIs 4-3-1, 4-3-3) or through the answers that pilot users will give to the survey/questionnaire (KPIs 4-1-1, 4-2-1, 4-2-2, 4-3-2, 4-3-4) that is presented in section 2.3.1.

## 2.2 Technical Evaluation

The technical evaluation of the digital components, as regards their technical functionalities, will be implemented by the respective digital component leaders. Figure 2, however, presents the decomposition of software product quality characteristics according to the standard; these characteristics focus on the static and dynamic properties of a software system.

Software Product Quality							
Functional Suitability	Performance Efficiency	Compatibility	Usability	Reliability	Security	Maintainability	Portability
<ul style="list-style-type: none"> <li>• Functional Completeness</li> <li>• Functional Correctness</li> <li>• Functional Appropriateness</li> </ul>	<ul style="list-style-type: none"> <li>• Time Behaviour</li> <li>• Resource Utilisation</li> <li>• Capacity</li> </ul>	<ul style="list-style-type: none"> <li>• Co-existence</li> <li>• Interoperability</li> </ul>	<ul style="list-style-type: none"> <li>• Appropriateness recognisability</li> <li>• Learnability</li> <li>• Operability</li> <li>• User error protection</li> <li>• User interface aesthetics</li> <li>• Accessibility</li> </ul>	<ul style="list-style-type: none"> <li>• Maturity</li> <li>• Availability</li> <li>• Fault Tolerance</li> <li>• Recoverability</li> </ul>	<ul style="list-style-type: none"> <li>• Confidentiality</li> <li>• Integrity</li> <li>• Non-repudiation</li> <li>• Authenticity</li> <li>• Accountability</li> </ul>	<ul style="list-style-type: none"> <li>• Modularity</li> <li>• Reusability</li> <li>• Analysability</li> <li>• Modifiability</li> <li>• Testability</li> </ul>	<ul style="list-style-type: none"> <li>• Adaptability</li> <li>• Installability</li> <li>• Replaceability</li> </ul>

*Figure 2: Software Product Quality Characteristics*

## 2.3 Usage Evaluation Methodology & Social Acceptance Survey (1<sup>st</sup> Version)

One of the main purposes of D4.3 is to present the usage evaluation methodology as regards not only the social acceptance of FORTESIE, but also the evaluation of the social engagement strategy that was implemented in FORTESIE to engage with the pilot users. To this end, two specific KPIs have been identified to depict the pilots' overall evaluation.

*Table 2: Overall Engagement Evaluation*

	KPI	Explanation
KPI #1	Total stakeholders engaged in FORTESIE (%)	Percentage of stakeholders per pilot that were engaged in the FORTESIE project
KPI #2	Total stakeholders engaged that participated in the survey (%)	Percentage of the stakeholders per pilot that were engaged in the FORTESIE project and participated in the survey

Additionally, as regards the pilot's social engagement, some vertical KPIs have been identified for pilots 1 and 7, in order to further boost both the evaluation methodology and the engagement process. The reason that these two pilots have been singled out is that the engagement activities that will be implemented are very specific to these two pilot concepts. The vertical KPIs can be seen below in Table 3 (for pilot 1) and Table 4 (for pilot 7).

*Table 3: Pilot 1 Vertical engagement KPIs*

KPI	Target level	Data source
KPI #1: Number of students participating in a tour where the FORTESIE project is discussed	Around 30-90 Students	Museum staff's notes

KPI #2: Visitors' satisfaction with the information provided about the FORTESIE project	Minimum 75% of end-users finds the information interesting or highly interesting	Visitor survey
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**Table 4: Pilot 7 Vertical engagement KPIs**

KPI	Target level	Data source
KPI #1: Number of teachers participating in co-creation and onboarding to FORTESIE app	10 teachers	Pilot leader's notes from the session
KPI #2: Number of teachers who have implemented FORTESIE themes and content during classes	17 teachers	Data from school administration

### 2.3.1 Social Acceptance Survey (1st Version)

As regards the social acceptance assessment, a survey has been created having as an objective to collect end-user feedback on the following dimensions related to the FORTESIE project:

- Satisfaction with FORTESIE renovations and satisfaction with energy reduction
- Perceived comfort and satisfaction with internal conditions
- Satisfaction with FORTESIE digital services (mobile app/OSS marketplace)

To minimise the burden on respondents and to maximise the quality of responses, the survey content will be translated into the local language of each pilot and the survey will be designed so that it does not exceed 10 minutes to be completed. Additionally, adjustments will be implemented according to each pilot's specific needs, to have tailored surveys for all pilots. The overall structure of the social acceptance assessment strategy can be seen below in Figure 3.



**Figure 3: Social acceptance assessment survey structure**

The survey structure is as follows:

- The **survey introduction** will provide a brief summary of the survey objectives. The importance of the user feedback for the project will be emphasised. That is, the introduction will communicate to users that their survey responses will be shared with the service developers and directly contribute to improvements to the FORTESIE services.
- The **consent form** will communicate to users that their feedback will remain anonymous, and that no personally identifiable information will be collected.
- The **comfort feedback** module will explore the degree to which comfort levels have been improved (or not) by the FORTESIE services. The scope of comfort will include room temperature, air quality, and humidity levels.
- The **renovation feedback** module will explore residents' satisfaction with the renovation work completed in their homes, as well as the energy savings that the renovations achieved.
- The **digital service module** will explore residents' satisfaction with the FORTSIE digital application. Particular focus will be placed on the recommendation engine messaging, to

understand the users' opinions on the quiz, challenges, and advice content. This module will also collect feedback on aspects related to the app's UI and UX design.

- In the final **additional comments** section, users can provide any further feedback related to any aspect of the FORTESIE participation experience.

Given that each FORTESIE pilot is unique in terms of how the renovations and digital services have been implemented and the target end users (e.g. residents, employees, public building visitors), the survey will have a modular design, meaning specific sections (that are related to certain specific pilot KPIs) can easily be removed or added. This will allow partners to easily customise the survey, as needed, to be relevant to each pilot's end users while still maintaining some standardisation in terms of the evaluation format. Table 5 summarises which KPIs will be addressed by the survey for each pilot.

**Table 5: Mapping of survey respondents and KPIs to pilots**

Pilot	Survey respondents	Relevant KPI(s) from the pilots KPI tables
1	Museum employees	R106, R101, S100
2.1	Residents	R214, R210, S210
2.2	Residents	R226, R220, S220
2.3	Residents	R236, R230, S235
3	Residents	R309, R300
4	Residents	R405a, R400, S405
5	Managers of the building/ employees	R506, S502
6	Visitors	R606, S602, S603
7	Teachers and students	R706, S702, S703

Data collection for the social acceptance assessment survey will take in the following months after the renovations of each pilot have been completed. In this first phase, only the questions relevant to the renovation satisfaction will be sent. After a few months, when pilot stakeholders get used to the new internal conditions, we will send them the comfort-related questions. Finally, towards the end of the project and after the pilot stakeholders have used the digital services for an adequate amount of time, the entirety of the questionnaire will be sent to them. The results of the survey and KPI evaluation will be reported in D4.4.

**Table 6: Social Acceptance Assessment Survey**

Social Acceptance Assessment Survey	
Satisfaction with Overall Comfort	<p>How would you rate your overall comfort, in terms of temperature, in your home after the FORTESIE renovations?</p> <ul style="list-style-type: none"> <li>• Much less comfortable</li> <li>• Less comfortable</li> <li>• No change</li> <li>• More comfortable</li> <li>• Much more comfortable</li> </ul> <p>What specific changes (if any) have contributed to your sense of improved comfort, in terms of temperature? (Open-ended response)</p>

	<p>Are there any areas in your home where you feel that comfort, in terms of temperature could be further improved? (Open-ended response)</p> <p>How would you rate your overall comfort, in terms of humidity, in your home after the FORTESIE renovations?</p> <ul style="list-style-type: none"> <li>• Much less comfortable</li> <li>• Less comfortable</li> <li>• No change</li> <li>• More comfortable</li> <li>• Much more comfortable</li> </ul> <p>What specific changes (if any) have contributed to your sense of improved comfort, in terms of humidity? (Open-ended response)</p> <p>Are there any areas in your home where you feel that comfort, in terms of humidity could be further improved? (Open-ended response)</p> <p>How would you rate your overall comfort, in terms of air quality, in your home after the FORTESIE renovations?</p> <ul style="list-style-type: none"> <li>• Much less comfortable</li> <li>• Less comfortable</li> <li>• No change</li> <li>• More comfortable</li> <li>• Much more comfortable</li> </ul> <p>What specific changes (if any) have contributed to your sense of improved comfort, in terms of air quality? (Open-ended response)</p> <p>Are there any areas in your home where you feel that comfort, in terms of air quality could be further improved? (Open-ended response)</p>
Satisfaction with FORTESIE Renovations	<p>How satisfied are you with the FORTESIE renovation process? Did you find it to be:</p> <ul style="list-style-type: none"> <li>• Very intrusive/disruptive</li> <li>• Intrusive/disruptive</li> <li>• Neutral</li> <li>• Not intrusive/disruptive</li> <li>• Not intrusive/disruptive at all</li> </ul> <p>How satisfied are you with the overall quality of the FORTESIE renovations?</p> <ul style="list-style-type: none"> <li>• Very dissatisfied</li> <li>• Dissatisfied</li> <li>• Neutral</li> <li>• Satisfied</li> <li>• Very satisfied</li> </ul>

	<p>How satisfied are you with the sensors' installation process? Did you find it to be:</p> <ul style="list-style-type: none"> <li>• Very intrusive/disruptive</li> <li>• Intrusive/disruptive</li> <li>• Neutral</li> <li>• Not intrusive/disruptive</li> <li>• Not intrusive/disruptive at all</li> </ul>
	<p>If you found the sensors' installation process intrusive, or very intrusive, please provide indicate ways to improve the installation process (Open ended response)</p>
	<p>Have you ever felt that the sensors measurements (heat, humidity, air quality) were different from your personal feeling?</p> <ul style="list-style-type: none"> <li>• Yes, I have felt a big difference between the two</li> <li>• Yes, I have felt a slight difference between the two</li> <li>• Neutral</li> <li>• No, I haven't felt a big difference</li> <li>• No, I haven't felt any difference at all</li> </ul>
	<p>If you have felt a big or a slight difference between the sensors measurements and your personal feeling, could you please clarify which measurement (heat, humidity, air quality) it concerned? (Open ended response)</p>
	<p>How would you characterise your satisfaction, as regards the energy savings achieved through FORTESIE?</p> <ul style="list-style-type: none"> <li>• Very dissatisfied</li> <li>• Dissatisfied</li> <li>• Neutral</li> <li>• Satisfied</li> <li>• Very satisfied</li> </ul>
	<p>If you are dissatisfied with the energy savings, what do you think is the reason for the increased cost or the small reduction of costs? (Open ended response)</p>
	<p>Would you recommend the FORTESIE renovation service to others?</p> <ul style="list-style-type: none"> <li>• Definitely not recommend</li> <li>• Probably not recommend</li> <li>• Neutral</li> <li>• Probably recommend</li> <li>• Definitely recommend</li> </ul>
	<p>How willing would you be to spend more of your own money to implement further energy improvements in your house, after the end of FORTESIE</p> <ul style="list-style-type: none"> <li>• Definitely not willing</li> <li>• Probably not willing</li> <li>• Neutral</li> <li>• Probably willing</li> <li>• Definitely willing</li> </ul>
	<p>What aspects of the renovations did you find most beneficial? (Open-ended response)</p>
	<p>What could we improve about the renovation process or outcomes?</p>

	(Open-ended response)
Satisfaction with FORTESIE Digital Services	How satisfied are you with the ease of use of the FORTESIE mobile app? <ul style="list-style-type: none"> <li>• Very dissatisfied</li> <li>• Dissatisfied</li> <li>• Neutral</li> <li>• Satisfied</li> <li>• Very satisfied</li> </ul>
	How satisfied are you with the clarity of the information presented in the mobile app (In terms of appropriateness of the UI/UX)? <ul style="list-style-type: none"> <li>• Very dissatisfied</li> <li>• Dissatisfied</li> <li>• Neutral</li> <li>• Satisfied</li> <li>• Very satisfied</li> </ul>
	How satisfied are you with the ease of use of the FORTESIE OSS marketplace? <ul style="list-style-type: none"> <li>• Very dissatisfied</li> <li>• Dissatisfied</li> <li>• Neutral</li> <li>• Satisfied</li> <li>• Very satisfied</li> </ul>
	How satisfied are you with the accuracy of the personalised recommendations that you received through the mobile app? <ul style="list-style-type: none"> <li>• Very dissatisfied</li> <li>• Dissatisfied</li> <li>• Neutral</li> <li>• Satisfied</li> <li>• Very satisfied</li> </ul>
	How useful did you find the analytics and visualisations that the mobile app generated for you? <ul style="list-style-type: none"> <li>• Not useful</li> <li>• A little useful</li> <li>• Neutral</li> <li>• Useful</li> <li>• Very useful</li> </ul>
	Did you implement any of the recommendations that were generated for you by the app? <ul style="list-style-type: none"> <li>• Yes</li> <li>• No</li> </ul>
	If your answer was yes please indicate how many recommendations did you implement? <ul style="list-style-type: none"> <li>• 1-3</li> <li>• 4-7</li> <li>• 8-11</li> <li>• 12-15</li> <li>• More than 15</li> </ul>
	After the implementation of the recommendations, how would you rate your comfort level? <ul style="list-style-type: none"> <li>• Much less comfortable</li> <li>• Less comfortable</li> <li>• No change</li> </ul>

	<ul style="list-style-type: none"> <li>• More comfortable</li> <li>• Much more comfortable</li> </ul>
	<p>How useful do you find the digital services (mobile app/OSS marketplace) in managing your home's energy efficiency?</p> <ul style="list-style-type: none"> <li>• Not at all useful</li> <li>• Slightly useful</li> <li>• Moderately useful</li> <li>• Very useful</li> <li>• Extremely useful</li> </ul>
	<p>Would you recommend the FORTESIE digital services to others?</p> <ul style="list-style-type: none"> <li>• Definitely not recommend</li> <li>• Probably not recommend</li> <li>• Neutral</li> <li>• Probably recommend</li> <li>• Definitely recommend</li> </ul>
	<p>On a scale of 0 to 10, how likely are you to recommend our business to a friend or colleague?</p> <ul style="list-style-type: none"> <li>• 0</li> <li>• 1</li> <li>• 2</li> <li>• 3</li> <li>• 4</li> <li>• 5</li> <li>• 6</li> <li>• 7</li> <li>• 8</li> <li>• 9</li> <li>• 10</li> </ul>
	<p>What features of the mobile app/OSS marketplace do you find most valuable? (Open-ended response)</p>
	<p>What could be improved about the digital services to better meet your needs? (Open-ended response)</p>
Additional comments	<p>In the space below, please provide any additional feedback on the FORTESIE services. (Open-ended response)</p>
	<p>Thank you for your time. Check out our website to follow the latest project developments: <a href="https://fortesie.eu/">https://fortesie.eu/</a></p>

## 3 Pilot Execution

This chapter describes the latest updates per pilot. For this reason, each pilot sub-chapter starts with an overall update on the pilot status, along with updates to the pilot's general timeline and timeline for social engagement activities. Any delays and deviations compared to the timelines presented in D4.2 are justified. Following that, an update to the KPI structure of each pilot is presented. For this structure and resulting tables, extensive discussions were elaborated with each pilot partner so that we can remove old KPIs that were not deemed appropriate for some pilots and add new ones (or modify existing ones). The KPI tables that are presented in each pilot subchapter can be considered as the final KPIs, that will be used to evaluate the success of each pilot. In this version, pilots have also calculated baseline and target values for the energy consumption related KPIs. KPIs that are related to the internal comfort conditions, and which are measured by the sensors are presented for the pilots, for which the migration of their data to the FORTESIE Data Sovereignty module has been completed. Finally, all pilots conclude their chapters by describing challenges that they have faced up until this point of the project, for which they propose lessons learnt and potential mitigation actions.

### 3.1 Pilot 1: Unleashing green cultural experience / The Museum of the Society of Hellenism and Philhellenism

#### 3.1.1 Pilot status and updated timeline

The Museum of the Society of Hellenism and Philhellenism is located in central Athens, Greece, showcasing the evolution of philhellenism from the Renaissance to the present day.

As part of recent renovations, the museum underwent significant upgrades to enhance energy efficiency and sustainability. The improvements included the installation of external thermal insulation on the north façade and a state-of-the-art ventilation system with advanced heat recovery technology. Additionally, the museum's roof was transformed into a terrace featuring an outdoor cafeteria and garden, complete with a pergola equipped with photovoltaic (PV) panels.

In the coming months, smart windows with integrated PV panels are expected to be installed. The original plan was to install PV-integrated windows covering approximately 60 square meters; however, after further analysis of the building's solar exposure and energy efficiency, this plan was revised. It was determined that the top two floors receive the most direct sunlight, making them the optimal locations for PV-integrated windows. Installing them on lower floors would not yield significant energy generation, making it a less efficient investment. In addition, after the initial provider from Australia failed to collaborate with the Museum, and deliver our initial order, we have sought other existing alternatives. There are only two providers in the world, one in Spain and the other one in China. The provider located in China did not respond to our request to provide us with a quote. After discussing with the Spanish provider, we have received their requirements which limit even more the options for the installation at the third and fourth floor. The produced PV windows need to be installed in windows that are fixed (i.e., they do not open) and the minimum size to be produced is 1m x 1,7m so this limits the installation even more. Therefore, the new plan focuses on installing a smaller number of PV windows exclusively on the top two floors and only in the specific windows that conform to the above requirements, that is approximately 42 square meters.

The rest of the available budget for PV windows will be allocated for procuring and installing high-performance multi layered windows to complement the PV windows in the two floors. These were selected due to their excellent insulation properties, which will help prevent heat loss and improve indoor climate stability. The existing windows were old and not efficient, which contribute to significant wastage of energy for heating and cooling. By replacing them with multilayered, durable alternatives, the museum will achieve significant thermal improvements while optimising costs and will be able to compare them against the old windows that remain in the lower floors, which will not be replaced due to budget limitations.

Additionally, based on energy savings already observed from insulating the north façade, the decision was made to extend insulation to the remaining walls, using some remaining budget in the project from the French pilot (Oktave). Data from energy monitoring showed a considerable reduction in heat loss following the initial insulation phase, confirming its effectiveness. Expanding insulation coverage will further enhance thermal performance, reducing energy demand and ensuring a more comfortable indoor environment year-round.

To monitor indoor conditions and energy consumption, air quality meters and energy meters have been installed on each floor before the renovation started. Initially, all data was collected locally via a Raspberry Pi system on the museum premises. However, with the full deployment of the ESTHESIS tool by European Dynamics, the data was later integrated into the data sovereignty platform, ensuring efficient storage, analysis, and management of all collected information.

In Table 7 below, the updated timeline for pilot 1 is presented.

**Table 7: Timeline for renovations and FORTESIE digital services implementation in pilot 1**

Timeline	Activity
10/2022	Start date of FORTESIE and selection of the museum as the pilot building.
4/2023	Installation of temperature, humidity, air, and energy sensors.
6/2023-7/2023	Selection and procurement of renovations.
09/2023 -22/11/2023	Finalisation of the north side of the building with insulation.
1/2024	Finalisation of the 6-month period for the baseline data gathering (data sent to ED to integrate in the data sovereignty service). Delays regarding the procurement of the smart PV windows (to be resolved in the following months).
15 /7/24 -12/2024	Green roof renovation and installation of PVs
The application for connection has been accepted by HEDNO (Hellenic Electricity Distribution Network Operator), and we are awaiting the connection.	Connection of the PVs to the Electrical grid
3-4/2025	Deployment of FORTESIE digital services and mobile app.
6/2025	Installation of Smart PV windows (expected).

Regarding pilot 1, there have been some delays compared to the timelines that were reported in D4.1 and D4.2. These delays mostly concern the procurement of the renovation materials.

The most significant and challenging delay concerns the procurement of smart windows. The initial order was cancelled due to issues with the provider, leading to the need for a replacement supplier. This process proved difficult, as many potential suppliers did not respond to inquiries. Once a new supplier was identified, additional time was required to recalculate specifications, coordinate with the supplier, and finalise the order. Furthermore, the delivery timeline from the new supplier is estimated to take at least 12 weeks, contributing to the overall delay.

In addition to the delay with the smart windows, there has also been a delay in connecting the PVs to the grid. This was due to the absence of a legal framework at the project’s start, which prevented the connection process from proceeding quicker. Significant time was required to wait for the necessary regulations to be implemented and for the bureaucratic procedures to be finalised, delaying our ability to apply for and grid connection. Furthermore, there were minor delays in some of the remaining renovation tasks, which were anticipated due to the complexity of coordinating multiple activities and the availability of resources. These minor delays, while expected, have been carefully managed to ensure they do not impact the overall project timeline.

There are no further delays expected, and the pilot building will be fully renovated prior to the deployment of the digital services (June 2025).

In Table 8 below, the updated engagement activity timeline for pilot 1 is presented.

**Table 8: Engagement activity plan for pilot 1**

Timeline	Activity	Target group	Description
3/2024	Communication	Visitors	<ul style="list-style-type: none"> <li>Communication about the renovations and the FORTESIE project on the museum website and social media</li> </ul>
3/2024	Workshop	Museum employees	<ul style="list-style-type: none"> <li>Ideating strategies to promote the renovation to visitors</li> </ul>
From 4/2024 until end of project	Information about renovations to visitors	Visitors	<ul style="list-style-type: none"> <li>Posters inside the museum, leaflets/fact sheets</li> <li>Display/tablet showing meter data and analytics of achieved improvements in specific parameters, emphasising the benefits in comfort and enjoyment during the visit.</li> <li>Information on the website / social media</li> <li>Screen at the entrance showing before and after photos of the museum and playing an interview of the museum owner.</li> </ul>
6/2024	FORTESIE app onboarding session	Museum employees	<ul style="list-style-type: none"> <li>In-person meeting to introduce the FORTESIE app and support the museum employees in downloading and starting to use the app</li> </ul>
From 6/2024 until end of project	Engagement for school groups’ tours	School groups visiting the museum	<ul style="list-style-type: none"> <li>Sharing information about the renovation and its impact during the tour</li> <li>Quiz at the end of the tour</li> </ul>
From 6/2024 until end of project	Feedback from visitors	Visitors	<ul style="list-style-type: none"> <li>Short feedback survey on engagement activities and museum’s indoor conditions</li> <li>Distributed via a poster with a QR code</li> </ul>
6/2025	Interviews	Museum employees	<ul style="list-style-type: none"> <li>Gathering qualitative feedback from the museum staff about improvement of comfort and experiences of the engagement activities</li> </ul>

### 3.1.2 KPIs Updates, Validation, and Verification

In table 9 below, the final KPIs of pilot 1 are presented along with some baseline and target values where that was possible.

**Table 9: Pilot 1 KPIs Final Version**

Physical Renovation KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
R101	Satisfaction of the renovation process	Survey	N/A	%	> 75% of end-users find the renovation recommendable or highly recommendable
R102	Overall air quality improvement	Sensor (McoHome MH10-WA)	13.55 ug/m3	%	≈20% improvement
R103	Reduction of humidity	Sensor (McoHome MH10-WA)	40.57%RH	%	≈10% improvement
R104	Reduction of energy consumption	energy bills	1708.5 kWh/month	%	≈30% reduction
R105	Reduction of CO <sub>2</sub> Emissions from energy consumption	Multiplication of monthly kWh with the CO <sub>2</sub> emission factor for Greece	456.2 kgs of CO <sub>2</sub> /month	%	≈30% reduction
R106	Improvement of comfort (qualitatively)	Survey	Will be gathered from surveys in the following months.	qualitative	50% of pilot users give positive feedback
R107	Waste management of removed materials that will be donated to be used again	Renovation logs	N/A	Type and quantity of material	TBD
Digital Services KPIs					
KPI id	KPI description	Means of verification/ FORTESIE tool	Baseline Value	Unit	Target Value
S101	Level of engagement of FORTESIE web application	1. % of users that have downloaded the app 2. number of interactions/user 3. % of users who were satisfied with the service	N/A	% Number of users %	>80% acceptance and satisfaction
S102	Integrated package with performance guarantees	OSS Marketplace	N/A	Number of packages	1 for this pilot

The baselines for KPIs R102 and R103 were measured from the sensors. Sensor data were drawn so that averages can be calculated. The baseline energy consumption was measured from the energy

bills while the baseline CO<sub>2</sub> emissions were measured from the monthly energy consumption in KWh and the latest data for CO<sub>2</sub> emissions concerning Greece<sup>1</sup>.

### 3.1.3 Challenges and Lessons Learnt

Throughout the project, we have faced several challenges that have impacted timelines and operations. These include issues with material ordering, delays in regulatory processes, limited social engagement, and financial constraints. Below is a summary of the challenges and the lessons we have learned:

#### Material Ordering and Supply Chain Issues

The initial order for smart windows was cancelled, resulting in delays. Finding a new provider was challenging, as many suppliers did not respond to our inquiries. Once communication with a provider was established, additional time was needed to recalculate material specifications, discuss requirements, and finalise the order. To compound the delay, we were informed that the new order would require at least 12 weeks for delivery.

##### Lessons Learned:

- Establish relationships with multiple suppliers early in the project to mitigate risks.
- Maintain proactive communication with potential providers and build time buffers into the project schedule to accommodate supply chain uncertainties.

#### Roof PV System Connection

Delays were encountered due to the absence of a legal framework for connecting the PV system to the grid. Significant time was spent waiting for the necessary regulations to be put in place before applying for the connection.

##### Lessons Learned:

- Engage with regulatory bodies at the project outset to address potential bureaucratic obstacles.
- Incorporate anticipated delays due to legal processes into project planning.

#### Social Engagement

The museum's limited staff (only two employees) hindered broader engagement in project activities. This made it difficult to foster active participation.

##### Lessons Learned:

- Seek support from external stakeholders or volunteers to compensate for internal resource limitations.

#### Financial Constraints

Rising costs and unforeseen additional expenses strained the project's budget. These costs, which had not been fully predicted during the initial planning phase, included increased material prices due to inflation and unexpected logistical expenses.

##### Lessons Learned:

- Include contingency funds in the budget to account for inflation and unforeseen expenses.
- Perform more detailed financial forecasting during the planning phase to better anticipate potential cost overruns.

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<sup>1</sup> <https://thegreentank.gr/2024/09/02/emissionswatch-jul24-el/>

## **3.2 Pilot 2: Green, comfortable, and sustainable homes in Spain and France**

Pilot 2 consists of three sub-pilots. Two of these pilots conduct renovations in single-family homes or apartment blocks: García Rama's sub-pilot in Spain and Oktave's sub-pilot in France. The third sub-pilot, run by Veolia in Spain, leverages FORTESIE digital tools in a residential area where some of the buildings have been renovated in a previous project, and now execute EPC contracts, which will be placed in a digital form, to validate the EPC digital module and mobile app.

### **3.2.1 García Rama**

#### **3.2.1.1 Pilot description and timeline**

The pilot site includes two residential buildings with a total of 36 housing units in El Entrego, Asturias, Spain. They were constructed in 1958. The buildings suffer from inadequate thermal insulation and thermal bridges, causing heat loss and issues like condensation and lack of indoor comfort, resulting in high energy demands. The buildings' envelopes have pathologies due to age and inadequate maintenance and they lack sufficient acoustic insulation.

The planned renovations include insulating the building facades and under-roof space, replacement of windows in staircases and entrance doors of the buildings, and installation of PV panels with an annual production of 33,000 kWh/year in each building. The renovations will be funded by the property owners.

It is important to note that a different pilot site was originally proposed for García Rama's sub-pilot. However, this site was determined to be not eligible for the FORTESIE project, and onboarding a new pilot site has delayed the schedule of this sub-pilot.

Renovation work began in November 2024 on the buildings in El Entrego, also known as the San Vicente neighbourhood. Scaffolding has been assembled, and preparatory works for the new façade have begun. This includes the removal of all external surfaces that are not part of the supporting structure and are in poor condition, to ensure the proper application of the ETICS. Additionally, the site is being prepared to receive the necessary materials, and the façade is being assessed to determine the required installation machinery.

Efforts have been made to engage homeowners in the installation of sensors; however, only one resident from the San Vicente neighbourhood has agreed to participate, and their sensors have already been installed. To meet the target of 10 residents with sensors installed, as set out in the GA for the pilot, it was decided to extend the initiative to other multi-dwelling residential buildings currently undergoing façade renovations by García Rama. These buildings are also implementing the turnkey renovation with guarantees business model developed under the FORTESIE project. The buildings approached include Calle León XIII 16 and Avenida de Oviedo 7-9, both located in Gijón. Renovations are ongoing at both sites, and efforts to onboard residents for sensor installation are also in progress.

The FORTESIE budget allocated to GAR covers the technical fees for an independent accredited technician to prepare, sign, and submit all the documentation required by the municipality to undertake the rehabilitation project in the San Vicente neighbourhood pilot site. The project budget also covers the cost of monitoring devices and associated technical fees. Homeowners are responsible for the renovation costs.

In Table 10 below, the updated timeline for García Rama is presented.

**Table 10: Timeline for renovations and FORTESIE digital services implementation in pilot 2, García Rama's sub-pilot**

Timeline	Activity
10/2022	Initial selection of the pilot building.
3/2023	Initially selected pilot building was found to be not eligible for participating in FORTESIE. Search for new pilot building.
7/2023	Preliminary commitment agreement from homeowners of a potential new pilot building.
10/2023	Selection of a new pilot building finalised.
9/2023-10/2023	Drafting technical reports for assessing the neighbourhood and its buildings. Ongoing communication with the municipal architect to align on technical matters.
11/2023-2/2024	The municipal architect's position remained vacant for 3 months, resulting in delays in commencing the drafting of the architectural projects, as the guidance of the municipal architect is crucial during this phase. Furthermore, the municipal architect's approval is necessary to obtain building permits.
1/2024	Budget drafted and revised by project coordination.
2/2024	New municipal architect was hired, and the pilot project can continue.
2/2024-6/2024	Drafting of the architectural project by the new municipal architect. The entire process requires a 3-month period to be completed.
6/2024-9/2024	Awaiting the processing of the construction permit application by the Municipality and the granting of the building licence to start the construction work.
10/2024	Start of renovations
11/2024-05/2025	Completion of baseline data gathering
01/2025	Due to low participation of homeowners in sensor installation, additional buildings following the same FORTESIE business model and renovation timeline were incorporated into the pilot site.
4/2025	Deployment of FORTESIE mobile app
7/2025	Finalisation of renovations

The pilot case of Garcia Rama has faced some unforeseen delays. Firstly, the initial pilot building site was found to be not eligible for participation in FORTESIE (there was an issue with the budget as the homeowners had already received a government grant to complete the renovations, which made them ineligible to also receive funding from FORTESIE). As such, the pilot leaders had to start over and search for a new pilot site which caused some delays. Further delays were caused (after the selection of the new pilot site) due to delays in administrative public processes, specifically for the hiring of the new municipal architect as the position was vacant for three months. The position of municipal architect was filled in February 2024. In addition, due to the change in the pilot site, the renovation period will take longer to complete compared to the initial plan. The FORTESIE digital services and the mobile application will be implemented as soon as a significant number of renovation tasks have been completed, after coordination with the pilot leaders. In addition, this pilot, in its new form, will allow us to measure the impact of specific individual renovations, given that the renovation tasks will run in parallel to the pilot execution. As such, and with the help of the FORTESIE digital services, we will be able to measure the impact of each renovation after it is completed.

In Table 11 below, the updated engagement activity plan for García Rama is presented.

**Table 11: Engagement activity plan for pilot 2, García Rama's sub-pilot**

Timeline	Activity	Target group	Description
7/2023	Meeting with homeowners	Homeowners	<ul style="list-style-type: none"> <li>García Rama advises and informs about the benefits of the building retrofit and introduces</li> </ul>

			the FORTESIE project, encouraging homeowners to agree to the rehabilitation of the building following FORTESIE guidelines.
10/2023-11/2023	Meetings with municipal architect	Municipal government	<ul style="list-style-type: none"> <li>Meetings with municipal architect to discuss technical aspects and progress with the proposal.</li> </ul>
12/2023-2/2024	Meetings with Mayor	Municipal government	<ul style="list-style-type: none"> <li>Face-to-face meetings with the mayor aimed at pushing forward the project.</li> </ul>
2/2024	Meetings with homeowners	Homeowners	<ul style="list-style-type: none"> <li>Meeting with neighbourhood representatives to discuss the status of the proposal within the Municipality.</li> </ul>
6/2024	Meeting with homeowners	Homeowners	<ul style="list-style-type: none"> <li>García Rama explains the project progress to homeowners and invites them to participate by installing measurement devices in their homes.</li> <li>Information is provided on the FORTESIE app.</li> <li>Conducting the pre-renovation survey</li> </ul>
6/2024 - 7/2025	Ongoing communication during the renovation	Municipal government Homeowners Construction workers Property management	<ul style="list-style-type: none"> <li>Throughout the rehabilitation process, homeowners, construction workers, property management and García Rama maintain a constant exchange of information.</li> <li>Property management serves as the primary link between homeowners and García Rama, providing information on the renovation schedule, among other aspects.</li> <li>Homeowners also communicate with the construction workers and technicians present on-site during the rehabilitation process, informing them of any issues or queries. The workers convey this information to property management and García Rama, as necessary.</li> <li>Given the pioneering and innovative nature of the project's rehabilitation, the municipal government has requested to be kept informed about the project's progress. Therefore, it will stay in direct contact with the project's key representatives, overseeing its development.</li> </ul>
1/2025	Meetings and phone calls with homeowners and neighbourhood representatives	Homeowners	<ul style="list-style-type: none"> <li>Following the incorporation of new buildings in the pilot site, in-person one-on-one meetings with neighbours interested in installing measurement devices in buildings undergoing renovation following the FORTESIE model.</li> </ul>
2/2025	Meeting with homeowners	Homeowners	<ul style="list-style-type: none"> <li>The meeting was scheduled to address any concerns the neighbours might have regarding the costs and progress of the construction work.</li> </ul>
4/2025	FORTESIE app onboarding session	Homeowners	<ul style="list-style-type: none"> <li>In-person meeting to introduce the FORTESIE app and support homeowners in downloading and starting to use the app</li> </ul>
7/2025	Meeting with homeowners organised by property management	Homeowners	<ul style="list-style-type: none"> <li>Sharing information about the improvements and benefits achieved through the renovation.</li> <li>FORTESIE app users share their experiences and encourage others to start using the app.</li> <li>Conducting the post-renovation survey.</li> </ul>

### 3.2.1.2 KPIs updates, validation and verification

In table 12 below, the final KPIs of García Rama are presented along with some baseline and target values where that was possible.

**Table 12: Pilot 2 (GAR) KPIs Final Version**

Physical Renovation KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
R211	Satisfaction with the FORTESIE renovations	Survey	N/A	%	> 75% of end-users find the renovation recommendable or highly recommendable.
R212	Time for deployment	Renovation logs	12-18 months	months	10 months
R213	Overall energy reduction	* Energy consumption data for a specific time period before renovation (EPCs) * Energy consumption for another specific time period after renovation (actual data from sensors)	331.3 kWh/m <sup>2</sup> ·year	%	30% reduction
R214	CO <sub>2</sub> Emissions from energy consumption	* Energy consumption data for a specific time period before renovation (EPCs) * Energy consumption for another specific time period after renovation (actual data from sensors)	69.2 kg CO <sub>2</sub> /m <sup>2</sup> ·year	%	30% reduction
R215	Improvement of comfort (qualitatively)	Survey	Will be gathered from surveys in the following months.	%qualitative	Improvement from baseline
R216	Improvement of comfort (quantitatively)	Retrieved from sensors for a specific time period before and after renovation	TBD once we have the sensors installed	%	TBD
Digital Services KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
S211	Accuracy of measurements from smart sensors	According to the specifications of the manufacturer	Temperature sensor: -40...85°C (± 0.5 °C) Humidity sensor: 0-100% RH (± 0.3 %) CO <sub>2</sub> NDIR sensor**: 400-5000ppm (± 30ppm	% of accuracy based on sensor readings and users' experience/perceptions	>95% accuracy

S212	Level of engagement of FORTESIE mobile application	<ol style="list-style-type: none"> <li>1. % of users that have downloaded the app</li> <li>2. number of interactions/user</li> <li>3. % of users who were satisfied with the service</li> </ol>	N/A	<p>%</p> <p>Number of users</p> <p>%</p>	>80% acceptance and satisfaction
S213	User's comfort satisfaction after implementing app recommendations	Surveys	N/A	% of users who are satisfied with the comfort	>80% acceptance and satisfaction
S214	Accuracy of personalised recommendations	Survey	N/A	% of users who are satisfied with the recommendations	>80% acceptance and satisfaction
S215	Amount of green euros rewarded for the pilot	Green Euro Application logs	N/A	<p>Amount of euros rewarded/user</p> <p>% of total euros (from the maximum of 50) that each user earned</p>	TBD
S216	Integrated package with performance guarantees	OSS Marketplace	N/A	Number of packages	1 for this pilot

The baseline value of 12-18 months for deployment of renovations was set because, based on our experience, that is the average execution time for a building envelope renovation. The administration also sets a completion deadline of 2 years from the notification of the granting of the licence.

We have set a target value of 10 months to align with the timeline of the FORTESIE project. We believe this target is ambitious, as it reduces our typical execution time, but it is also achievable.

The baseline value of 331.3 kWh/m<sup>2</sup>-year for overall energy reduction was set because it is the value obtained from the EPC of the building in its current state, produced by an independent architect using the software programme (CE3X) developed by the Spanish government for the energy certification of buildings. This is the only type of EPC allowed to justify the energy efficiency of buildings in relation to the public administration.

The target value of a 30% reduction is required for property owners to qualify for a subsidy from the public administration for improvement or renovation works on predominantly residential buildings. This reduction must be at least 30% in primary non-renewable energy consumption. Therefore, all the building renovations we offer aim to achieve at least this 30% reduction. Additionally, the EPC of the building in its renovated state demonstrates an actual reduction of 62%.

The baseline value of 69.2 kg CO<sub>2</sub>/m<sup>2</sup>-year for CO<sub>2</sub> emissions from energy consumption was set because it is the value obtained from the EPC of the building in its current state, the same as the value for non-renewable primary energy consumption mentioned above.

In line with the target for non-renewable primary energy consumption, the target value was set at a 30% reduction. According to the EPC of the building in its renovated state, a 60% reduction is expected.

### 3.2.1.3 Challenges & Lessons learned

The pilot site has encountered several challenges. The first issue arose when the initially selected pilot building was deemed ineligible due to receiving a government grant to partially cover renovation costs. As a result, GAR had to initiate a new selection process to identify an alternative pilot building that aligned with the project's scope.

Following the selection of the new pilot site, the rehabilitation project experienced delays because the municipal architect vacated their position. Due to limited staff resources, no other municipal technician could assume the role. Coordination with the municipal architect is essential for drafting technical renovation projects and obtaining municipal licences. The recruitment process for a new architect took three months to complete.

As such, a significant challenge is that the timing of administrative processes is beyond our control.

Further difficulties arose due to the reluctance of residents to install sensors. A mitigation plan is currently underway, involving a revised engagement approach and the inclusion of additional buildings undergoing renovation under the FORTESIE model to engage more residents.

## 3.2.2 Oktave

### 3.2.2.1 Pilot description and timeline

Oktave provides homeowners with technical, administrative, and financial consultation in renovation processes. They typically manage approximately 200 renovations per year. In the FORTESIE project their goal is to install smart meters in 20 to 100 single-family homes that are already renovated to have large scale data that will help monitor the improvements in energy use and internal conditions after a renovation.

The homes are typically built in 1940-1970. The exact renovation packages will depend on the selected houses. Indicatively, the renovations may include insulation, window replacement, and improved solutions for heating and ventilation. All projects will have heat pumps for heating and hot water.

In Table 13 below, the updated timeline for Oktave is presented.

**Table 13: Timeline for renovations and FORTESIE digital services implementation in pilot 2, Oktave's sub-pilot**

Timeline	Activity
2/2024	Selection of 20-100 houses for large scale monitoring.
2/2025	The list of 120 potential homeowners has been finalised, Individual calls were made to 60 homeowners, 1st wave of 20 homeowners have been onboarded, signed the consent form and are waiting for sensors
3/2025	1st wave of 20 sensors will be ordered, sent to Oktave, and forwarded to each address, Installation of sensors by the homeowners, photo justification will be sent by mail, They will be introduced to the FORTESIE mobile application to get user feedback.
03/2025	1st wave test run: Start of pilot execution, with LINKY API and FORTESIE APP, Quizzes, Green euro Rewards
4/2025	2nd wave onboarding, calls, emails, webinars etc.

	Sensors order, shipment, installation
5/2025	2nd wave pilot execution,
09/2025	Onboarding cutoff: 01/09/2025 minimum measurement period 6 months of winter

Initially, this pilot aimed to monitor 50 renovation projects (with sensors) and perform full renovations to 12 buildings that would have been selected from the list of 50. However, following comprehensive discussions between the project and pilot partners, it was decided to pivot the focus of the pilot to a large-scale monitoring pilot. The reason for this is that building renovations in France are very well subsidised (e.g., via zero-interest loans and national subsidies), which means that the available FORTESIE budget would be better used to buy sensors for a larger number of houses. The number of houses that will be monitored depends on the personal motivation of the homeowners. Oktave is procuring the sensors from partner MESH for the monitoring of the houses. MESH has developed a new series of commercial sensors.

Concerning other delays, the LINKY API development had some technical difficulties, which resulted in delays. For this reason, Oktave started onboarding a first group of 20 homeowners to test the onboarding process, sensor shipping and in home installation, to identify user problems and FAQs.

In Table 14 below, the updated engagement activity plan for Oktave is presented.

**Table 14: Engagement activity plan for pilot 2, Oktave’s sub-pilot**

Timeline	Activity	Target group	Description
Onboarding period 6 months	Renovation planning	Homeowners	<ul style="list-style-type: none"> <li>During the renovation planning consultations, clients are introduced to the FORTESIE project and tools offered (smart meters, FORTESIE app) and the conditions for using them.</li> <li>These meetings also include consultation on the renovation options and exploring the homeowners’ preferences.</li> </ul>
1 <sup>st</sup> month of onboarding	Pre-renovation survey	Homeowners	<ul style="list-style-type: none"> <li>Invitation via e-mail to participate in a survey where they can share their experiences of the indoor conditions at their home</li> </ul>
During the 12 following months	Ongoing communication during the renovation	Homeowners	<ul style="list-style-type: none"> <li>Oktave meets the clients approximately once a week for updates when the renovation is ongoing.</li> <li>Some clients have a cheaper service where Oktave coaches the homeowner to ensure the renovation is going well, without being onsite.</li> </ul>
12 months after renovation finish	FORTESIE app onboarding and follow-up	Homeowners	<ul style="list-style-type: none"> <li>Homeowners are provided with information about the app and instructions for downloading and using it through a leaflet or via e-mail.</li> <li>If the customers haven’t downloaded the app within a certain timeframe, Oktave follows up with a phone call to ask if the customer needs help.</li> </ul>
End of pilot, after 12 months	Meeting for clients to share experiences	Homeowners	<ul style="list-style-type: none"> <li>If enough clients participating in the FORTESIE project are in the same area, Oktave considers organising a meeting for them to share experiences of their renovations.</li> </ul>
Approximately 1 year after onboarding	Post-renovation survey	Homeowners	<ul style="list-style-type: none"> <li>Invitation via e-mail to participate in a survey where they can share their experiences of the indoor conditions at their home after the renovation and participation in the FORTESIE</li> </ul>

Approximately 1 year after onboarding	Post-renovation engagement activities	Homeowners	<p>project</p> <ul style="list-style-type: none"> <li>The exact format of the engagement activities depends on Oktave's resources, interest from the homeowners and location of their homes.</li> <li>The events could include e.g. open house events to present the results of the renovations to others interested, creating testimonial videos to be shared, and/or announcing and rewarding the households that have achieved most savings.</li> </ul>
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### 3.2.2.2 KPIs updates, validation and verification

In table 15 below, the final KPIs of Oktave are presented along with some baseline and target values where that was possible.

**Table 15: Pilot 2 (OKT) KPIs Final Version**

Physical Renovation KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
R221	Satisfaction with FORTESIE renovations	Survey	N/A	%	> 75% of end-users find the renovation recommendable or highly recommendable.
R222	Time for deployment	Renovation logs	N/A	months	12-18m
R223	Overall energy reduction	Energy sensors/LINKY	baseline 318 kWh/m <sup>2</sup> /year after renovation 101 kWh/m <sup>2</sup> /year Overall reduction 217 kWh/m <sup>2</sup> /year Average 68% reduction	KWh/m <sup>2</sup> /year %	<110 kWh/m <sup>2</sup> /year  >55%
R224	CO <sub>2</sub> Emissions from energy consumption	Energy sensors/LINKY	baseline 45.4 gCO <sub>2</sub> /m <sup>2</sup> /year after renovation 2.78 gCO <sub>2</sub> /m <sup>2</sup> /year Overall reduction 42.6 gCO <sub>2</sub> /m <sup>2</sup> /year Average 93.8% reduction	gCO <sub>2</sub> /m <sup>2</sup> /year %	<11 kg CO <sub>2</sub> /m <sup>2</sup> /year  >55%
R225	Reduction of energy costs	Energy sensors/LINKY	On average, homeowners pay 26 €/m <sup>2</sup> /year Average house size of 144m <sup>2</sup> After renovation they pay 5.7 €/m <sup>2</sup> /year Average 78% price reduction	€/m <sup>2</sup> /year %	>50%
R226	Improvement of comfort	Sensors	TBD when sensors have been installed	%	TBD

	(quantitatively)				
R227	Improvement of comfort (qualitatively)	Qualitative Questionnaires	-	Will be gathered from surveys in the following months.	Qualitative TBD
Digital Services KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
S221	Accuracy of measurements from smart sensors	According to the specifications of the manufacturer	Temperature sensor: -40...85°C (± 0.5 °C) Humidity sensor: 0-100% RH (± 0.3 %) CO2 NDIR sensor**: 400-5000ppm (± 30ppm)	% of accuracy based on sensor readings and users' experience/perceptions	>95% accuracy
S222	Accuracy of M&V calculations	Partners which act as managers of EPCs (VEO, OKT, CRD) compare the M&V module results to their internal data using their current methods for the calculations	N/A	%	TBD by the component owner
S223	Level of engagement of FORTESIE mobile application	1. % of users that have downloaded the app 2. number of interactions/user 3. % of users who were satisfied with the service	N/A	% Number of users %	>80% acceptance and satisfaction
S224	User's comfort satisfaction after implementing app recommendations	Surveys	N/A	% of users who are satisfied with the comfort	>80% acceptance and satisfaction
S225	Accuracy of personalised recommendations	Survey	N/A	% of users who are satisfied with the recommendations	>80% acceptance and satisfaction
S226	Amount of green euros rewarded for the pilot	Green Euro Application logs	N/A	Amount of euros rewarded/user % of total euros (from the maximum of 50) that each user earned	TBD
S227	Integrated	OSS Marketplace	N/A	Number of	1 for this

	package with performance guarantees			packages	pilot
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The baseline and target values that are presented in the table above have been calculated based on the 9 projects that have finished the energy audit. All of the sample houses use heat-pumps for heating and hot water.

### 3.2.2.3 Challenges & Lessons learnt

Since France has a vast national renovation program, the FORTESIE budget was allocated to sensors. The goal is to have a larger sample of homeowners to participate in FORTESIE. The current challenge is to contact individually a large number of different homeowners, explain FORTESIE and the advantages of joining the project. Starting with a first wave of 60 houses, Oktave has currently 20 homes that are interested in FORTESIE. Homeowners that are currently renovating are very occupied with the renovation itself. A better target might be past Oktave customers. Once the renovation is complete, it might be easier to convince homeowners to join FORTESIE.

We are now working with MESH to program the sensors so they plug-in seamlessly to the LORAWAN radio network. This issue is currently being resolved.

## 3.2.3 Veolia

### 3.2.3.1 Pilot description and timeline

The pilot site is an urban residential district of 20 buildings called FASA, located in the southeast of Valladolid in Spain. It was constructed in the 1950's and 1960's. The buildings are considered an owner's community (condominium). All buildings except for one were renovated in 2018.

Veolia's sub-pilot does not include renovations. The main purpose of this sub-pilot is to leverage the FORTESIE digital services to measure improvements achieved through the 2018 renovations by comparing measurements between the renovated buildings and the non-renovated building. The analytics services will also be used for improved management of the district. New sensors have been installed along with the existing ones. Also, pre-renovation data collection period is not needed as the current sensors have collected data for 1,5 years.

Regarding the current status of the pilot, significant progress has been made in temperature, humidity and CO<sub>2</sub> sensors installation. Sensors have been successfully installed in the non-renovated building. We are currently in the process of completing sensor installation in one of the renovated buildings, which will provide valuable comparative data. All these sensors have been delivered to the residents, ensuring their participation and cooperation in the project.

Data collection is ongoing, with existing sensors continuing to gather information. The newly installed humidity, temperature, and CO<sub>2</sub> sensors are also actively collecting data. This extensive sensor network will allow us to conduct a comprehensive analysis of conditions in both renovated and non-renovated buildings, providing valuable insights into the effectiveness of the renovations carried out in 2018.

In Table 16 below, the updated timeline for Veolia is presented.

**Table 16: Timeline for FORTESIE digital services implementation in pilot 2, Veolia's sub-pilot**

Timeline	Activity
10/2022	Selection of the district for the pilot

6/2024	Deployment of first version of FORTESIE mobile app
10/2024	Homeowner onboarding: Introducing sensor installation - non-renovated building home selection
12/2024	Sensor installation in non-renovated building
12/2024	Homeowner onboarding: Introducing sensor installation - renovated building home selection
02/2025	Sensor installation in renovated building

Veolia works in a specific district that was renovated in the past, except for one building, which only received renovations in the district heating network. As such, Veolia will leverage the FORTESIE digital services to compare the energy efficiency of the non-renovated building to the renovated ones. Sensors have already been installed in the pilot building and the data gathering activities are completed (there are 18 months' worth of data for the pilot). In addition to the sensors already installed, new humidity, temperature and CO<sub>2</sub> sensors are being installed in the homes of the renovated and non-renovated buildings. The timeline of the Veolia pilot has changed in that the installation of the MESH sensors in the selected dwellings has been added.

In Table 17 below, the updated engagement activity plan for Veolia is presented.

**Table 17: Engagement activity plan for pilot 2, Veolia's sub-pilot**

Timeline	Activity	Target group	Description
28/11/2023	Neighbourhood meeting	Homeowners	<ul style="list-style-type: none"> <li>Introducing the FORTESIE project.</li> </ul>
06/2024	Survey	Homeowners	<ul style="list-style-type: none"> <li>Measuring satisfaction with indoor conditions to compare results between the renovated and non-renovated building.</li> </ul>
11/2024	Neighbourhood meeting	Homeowners	<ul style="list-style-type: none"> <li>Users of the FORTESIE app share their experiences.</li> <li>Results of the measurements in the renovated and non-renovated house are presented.</li> <li>Survey to gather feedback on the project.</li> </ul>
03/2025	Pilot Buildings Notice Board Update	Homeowners	<ul style="list-style-type: none"> <li>Update the notice board of the pilot buildings with information about the project and include a sign-up sheet where interested residents can add their names if they wish to participate</li> </ul>
06/2025	Energy Savings Pilot Results Distribution	Homeowners	<ul style="list-style-type: none"> <li>Distribute 20 flyers and posters with updates on energy savings and comfort improvements on the buildings of the pilot.</li> </ul>
09/2025	Open house event	Homeowners and other stakeholders	<ul style="list-style-type: none"> <li>Host an open house event with guided tours and community engagement.</li> </ul>
TBD once the APP is ready	FORTESIE app onboarding session	Homeowners	<ul style="list-style-type: none"> <li>In-person meeting to introduce the FORTESIE app. and support homeowners in downloading and starting to use the app.</li> </ul>

The timeline of the Veolia pilot has experienced one significant modification compared to what was reported in D4.2. The FORTESIE app onboarding session, initially scheduled for September 2024, has been postponed until the app is fully developed. This adjustment was necessary to ensure a more effective implementation of the digital services. All other engagement activities have been successfully completed according to the original timeline.

### 3.2.3.2 KPIs updates, Validation and Verification

In table 18 below, the final KPIs of Veolia are presented along with some baseline and target values where that was possible.

**Table 18: Pilot 2 (VEO) KPIs Final Version**

Physical Renovation KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
R231	Satisfaction with renovations	Survey	N/A	%	> 75% of end-users find the renovation recommendable or highly recommendable.
R232	Overall energy reduction	To be measured via * Energy consumption data for a specific time period before renovation (bills) * Energy consumption for another specific time period after renovation (actual data from sensors)	3,002.12 MWh per year	%	40% reduction
R233	CO <sub>2</sub> Emissions from energy consumption	To be measured via CO <sub>2</sub> emissions calculated with the factor for natural gas provided by an official Spanish source and the energy consumption data before renovation * CO <sub>2</sub> emissions calculated with the factor for natural gas and biomass provided by an official Spanish source and the energy consumption data after renovation	549,387.57 Kg CO <sub>2</sub> e per year	%	70 % reduction
R234	Overall air quality improvement	To be measured via sensor data	TBD when all sensors are installed	%	TBD
R235	Reduction of humidity	To be measured via sensor data	TBD when all sensors are installed	%	TBD
R236	Reduction of energy costs	To be measured via * Energy annual cost before renovation (bills) * Energy annual cost after renovation (bills)	192,774.755 € per year	%	15 % reduction
R237	Improvement of perceived comfort	Survey	Will be gathered from surveys in the following months.	qualitative	Improvement from baseline
Digital Services KPIs					

KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
S231	Accuracy of measurements from smart sensors	According to the specifications of the manufacturer	Temperature sensor: -40...85°C ( $\pm$ 0.5 °C) Humidity sensor: 0-100% RH ( $\pm$ 0.3 %) CO2 NDIR sensor**: 400-5000ppm ( $\pm$ 30ppm)	% of accuracy based on sensor readings and users' experience/perceptions	>95% accuracy
S232	Accuracy of M&V calculations	Partners which act as managers of EPCs (VEO, OKT, CRD) compare the M&V module results to their internal data using their current methods for the calculations	N/A	%	TBD by the component owner
S233	Level of engagement of FORTESIE mobile application	1. % of users that have downloaded the app 2. number of interactions/user 3. % of users who were satisfied with the service	N/A	%  Number of users  %	>80% acceptance and satisfaction
S234	User's comfort satisfaction after implementing app recommendations	Surveys	N/A	% of users who are satisfied with the comfort	>80% acceptance and satisfaction
S235	Accuracy of personalised recommendations	Survey	N/A	% of users who are satisfied with the recommendations	>80% acceptance and satisfaction
S236	Amount of green euros rewarded for the pilot	Green Euro Application logs	N/A	Amount of euros rewarded / user % of total euros (from the maximum of 50) that each user earned	TBD
S237	Integrated package with performance guarantees	OSS Marketplace	N/A	Number of packages	1 for this pilot

The baseline value of 3,002.12 MWh per year for overall energy reduction was set based on actual measurements of the building's energy consumption before renovation. This approach provides a solid and accurate foundation for assessing energy efficiency improvements.

We have set a target value of 40% reduction, which is an increase from the initial 30% target. This new target is based on the current observed performance after initial renovations. We believe this target is both ambitious and achievable, as it reflects the energy-saving potential identified during the early stages of the project.

The baseline value of 549,387.57 kg CO<sub>2</sub>e per year for CO<sub>2</sub> emissions from energy consumption was calculated using the baseline heating consumption (3,002,117.18 kWh/year) and the emission factor for natural gas provided by the Spanish Ministry for Ecological Transition and Demographic Challenge<sup>2</sup>. Specifically, we used the emission factor of 0.183 Kg CO<sub>2</sub>e/KWhGCV for natural gas in 2014, 2015, and 2016. This method ensures a precise and official estimate of CO<sub>2</sub> emissions associated with the building's energy consumption before renovations.

The target value of a 70% reduction in CO<sub>2</sub> emissions is based on the actual performance observed in 2023, the consumption of natural gas and of biomass chips. Using the 2023 emission factor for natural gas (0.182 kg CO<sub>2</sub>e/kWh) and considering biomass as carbon neutral according to the Spanish Ministry for Ecological Transition and Demographic Challenge<sup>2</sup> stating that the use of biomass as fuel is considered neutral in CO<sub>2</sub> emissions as it is of biogenic origin.

We have added a new KPI for the reduction of energy costs. The baseline value for the reduction of energy costs has been set at 192,774.755€. This value represents the annual energy cost before renovation, as measured via energy bills. We aim for a 15% reduction in energy costs, which we believe is achievable given the significant improvements in energy efficiency.

Two more new KPIs have been added to measure overall air quality improvement and reduction of humidity. These were included due to the installation of sensors in homes that measure CO<sub>2</sub>, temperature, and humidity. While specific target values are yet to be determined, these KPIs will allow us to assess the impact of renovations on indoor environmental quality and occupant well-being.

### 3.2.3.3 Challenges & Lessons learnt

Throughout the implementation of our project, we have faced several challenges that have provided us with valuable lessons. One of the main obstacles we encountered was the initial resistance from some residents to install sensors in their homes. This challenge highlighted the crucial importance of clear and transparent communication about the purpose and benefits of the sensors. To address this, we focused on providing detailed explanations and addressing residents' concerns individually, which helped increase acceptance within the community.

The age demographics of the occupants presented another significant challenge. The majority of residents are elderly, which posed difficulties in terms of understanding and accepting the new technology. This experience taught us the importance of adapting our approach to this age group. We found that dedicating more time to explaining the technology in simpler terms and demonstrating its practical benefits in everyday life helped increase understanding and acceptance among older residents.

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<sup>2</sup> [https://www.miteco.gob.es/content/dam/miteco/es/cambio-climatico/temas/mitigacion-politicas-y-medidas/factoremission\\_tcm30-542746.xlsx](https://www.miteco.gob.es/content/dam/miteco/es/cambio-climatico/temas/mitigacion-politicas-y-medidas/factoremission_tcm30-542746.xlsx)

### 3.3 Pilot 3: Green, comfortable, and sustainable homes in Portugal (energy poverty houses)

#### 3.3.1 Pilot status and updated timeline

Just a Change renovates homes of people who suffer from housing deprivation and energy poverty. These homes can't provide safe or healthy living conditions, as they have many structural deficiencies. The renovations by Just a Change typically provide basic structures such as roofs, flooring, insulation, doors, and windows, but also other basic needs such as piped water and electricity.

The houses are renovated by a team of volunteers, with one experienced volunteer leading the team and one professional master builder overseeing and leading the renovation work.

Our objective was to renovate 10 houses across 10 different locations, encompassing both urban and remote areas. To date, we have successfully completed renovations on all 10 houses, located in the following areas: Porto, Viana do Castelo, Murça, Golegã, Alvaiázere, Odemira, Tomar, Famalicão, Vila Pouca de Aguiar, and Lagoa.

Except for Viana do Castelo, renovations for all other houses are 100% finished. In Viana do Castelo, additional work was added to the initial plan due to budget availability. Specifically, we decided to renovate the roof, which will be undertaken in the coming months.

Regarding the installation of MESH sensors, we have successfully placed them in 9 out of the 9 planned houses. In Porto (House #1), a different type of sensor has been installed, which is already transmitting data. However, with MESH sensors, we encountered challenges both during installation and in data collection. These challenges are primarily due to the limited technical literacy of the beneficiaries and the geographical distance between houses, which prevents regular weekly visits or remote check-ins by the beneficiaries. This situation may lead to interruptions in data collection and, consequently, a reduced dataset available for calculating our KPIs.

In Table 19 below, the updated timeline for pilot 3 is presented.

**Table 19: Timeline for renovations and FORTESIE digital services implementation in pilot 3**

Timeline	Activity
10/2023-2/2024	Visits to 18 locations to gather information about possible houses to renovate.
2/2024-4/2024	Short-listing the houses visited, initial budgeting for each house/renovation.
3/2024-4/2024	Final decision taken; selection of 10 houses.
3/2024-4/2024	Initial measurements and renovations taking place in the first house, to serve as a prototype. Discussions with MESH as regards the sensors deployment.
2/2024-4/2024	Protocol for intervention with the local municipality. Planning dates of the intervention work. Planning other logistics, such as housing for volunteers, meals, local contractors to hire, local supply chain for building materials, etc.
5/2024-6/2024	Implementation of initial measurements for the collection of baseline data. Measurements of temperature, air quality, energy consumption etc will be implemented to have comparable data for each house, before and after the renovations.
7/2024-9/2024	Main renovation work that takes about two weeks with the support of the association's volunteers.

	Data collection immediately after the end of the renovation.
11/2024-01/2025 and possibly throughout 2025	Finalising the renovation of some of the houses (mostly replacement of doors and windows) Post-renovation data collection, to obtain data during the winter months as well. Visits to some of the houses took place along the months either to implement last steps of the renovation, either to install gateway, router or substitution of batteries in the MESH sensors.
01/2025 - onward	Collection of data to be able to make a comparison with pre-renovation data and measure the impact. Benchmark for the installation of the solar panels.

The main renovation of all houses was completed within the planned two-week timeframe. However, the final completion date for some houses was delayed due to third-party work dependencies. Specifically, delays occurred in the delivery and installation of new doors and windows. Additionally, external thermal insulation was added to one house (house in Alvaiazére) as a later decision, further extending its renovation timeline. We will also replace the roof in the house located in Viana do Castelo. This will happen during the early months of 2025.

### Challenges in Data Collection

1. Energy Bills: Collecting energy bills presented significant challenges, as many of our beneficiaries are elderly with limited technical literacy and do not retain their bills. To address this, we collaborated with the energy provider to retrieve the required data. We also conducted awareness campaigns with beneficiaries to emphasise the importance of retaining energy bills, which we hope will mitigate similar issues in the future.
2. MESH Sensors Installation: According to our plan, MESH sensors were to be installed in ten houses. However, in House 1, we had to install an alternative type of sensor because the MESH sensors were not available at the time. Upon receiving the sensors in July, they were installed in all planned houses. Given the remote locations of the properties, we had to procure routers with data SIM cards to enable connectivity. Following installation, we encountered several operational issues, including data transmission interruptions and limited battery life. The remote locations of the houses have posed logistical challenges, as frequent visits are required to ensure the sensors function correctly.

In Table 20 below, the updated engagement activity plan for pilot 3 is presented.

**Table 20: Engagement activity plan for pilot 3**

Timeline	Activity	Target group	Description
1-4/2024	First visit at the beneficiary's house	Beneficiary	<ul style="list-style-type: none"> <li>• Just a Change's team visits the beneficiary with a municipality employee (typically social worker).</li> <li>• Creating an overview of the situation, renovation needs, and the beneficiary's preferences (e.g. for paint colour).</li> </ul>
5-6/2024	Second visit at the beneficiary's house	Beneficiary	<ul style="list-style-type: none"> <li>• Leader of the camp and Just a Change's central team visit the beneficiary to further their understanding of the location.</li> <li>• Installation of the sensors</li> <li>• First survey to the beneficiary (covers e.g., comfort and well-being, safety, health).</li> </ul>

5-6/2024	Communication	Volunteers	<ul style="list-style-type: none"> <li>• Communication via e-mail during the recruitment process</li> </ul>
7-8/2024	Onboarding camp	Volunteers	<ul style="list-style-type: none"> <li>• Before starting the renovation, volunteers attend an onboarding camp at the municipality where the renovation takes place.</li> <li>• Topics covered: briefing about the renovation, security training, training on Just a change's values, briefing on how to engage with the beneficiary.</li> </ul>
7-8/2024	Start of the renovation	Beneficiary Volunteers	<ul style="list-style-type: none"> <li>• Introducing the renovation team, master builder, and the beneficiary to one another</li> <li>• Sharing the construction plan with the beneficiary</li> <li>• Encouraging the beneficiary to join the renovation work if they can</li> <li>• Ensuring that the beneficiary will be around during the renovation</li> </ul>
7-8/2024	Renovation	Beneficiary Volunteers	<ul style="list-style-type: none"> <li>• Renovation work</li> <li>• Volunteers are encouraged to actively engage with the beneficiary and make sure that the beneficiary is aware of the renovation plan and progress and happy with the ongoing work.</li> </ul>
8-9/2024	Finalisation of the renovation	Beneficiary Volunteers	<ul style="list-style-type: none"> <li>• A small farewell party after the volunteers' work is completed</li> </ul>
9-12/2024	Visits to finalise the renovation	Beneficiary	<ul style="list-style-type: none"> <li>• Leading team typically visits the beneficiary a few times to finalise the renovation (e.g. doing small corrections, installing equipment that was delivered late).</li> <li>• They also ensure that the beneficiary is adapting to the new house and uses the new appliances correctly and ask for any issues or mistakes the beneficiary may have noticed.</li> </ul>
10-12/2024 and organically afterwards	Follow-up engagement	Beneficiary	<ul style="list-style-type: none"> <li>• Just a Change keeps in touch with the beneficiary or their social worker.</li> <li>• The teams that worked in the house visit a few times throughout the year to understand what changes have happened.</li> <li>• Insights from the meter data are shared with the beneficiary.</li> </ul>
12/2024	Christmas Visit	Beneficiaries Volunteers	<ul style="list-style-type: none"> <li>• Volunteers involved in the renovation returned to the houses for a Christmas visit. These visits provided an opportunity to follow up with beneficiaries and assess the condition of the renovations after the first winter months. Additionally, these visits hold significant value for the volunteers, as they help maintain and strengthen their connection with the beneficiaries.</li> </ul>
One year after the renovation	Survey	Beneficiary	<ul style="list-style-type: none"> <li>• Impact measurement's interviews</li> <li>• Follow-up /Continuous assessment survey focusing on how permanent the changes were</li> </ul>

Activities until the end of the year (2024) run as expected without delays. During the month of December volunteers visited the houses renovated during summer. This worked as an opportunity to follow up with beneficiaries but also to assess the conditions of the houses after the first winter months.

### 3.3.2 KPIs updates, validation, and verification

In table 21 below, the final KPIs of pilot 3 are presented along with some baseline and target values where that was possible. Compared to deliverable D4.1 we removed one KPI initially planned, namely the “Reduction in biomass usage”. This decision was based on the information collected during our Christmas visit during which we realised that there is no use of wood nor coal in any of the houses we renovated through the project.

**Table 21: Pilot 3 KPIs Final Version**

Physical Renovation KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
R301	Time for deployment	Renovation logs	15 days	days	No major delays in the duration
R302	Overall energy reduction	* Energy consumption data for a specific time period before renovation (bills) * Energy consumption for another specific time period after renovation (bills)	94.48 kWh/month	%	TBD Overall energy reduction
R303	CO <sub>2</sub> reduction	* Energy consumption data for a specific time period before renovation (bills) * Energy consumption for another specific time period after renovation (bills)	13.13 kg CO <sub>2</sub> /month	%	TBD CO <sub>2</sub> reduction
R304	Reduction of energy costs	* Energy consumption data for a specific time period before renovation (bills) * Energy consumption for another specific time period after renovation (bills)	27.36 euros/month	%	TBD Reduction of energy costs
R305	Improvement in energetic classification	Audit from external partner. We are evaluating external providers for the generation of certificates.	Baseline Energetic classification level	Increase by 1 level in the European Energy class	Improvement in energetic classification
R306	Improvement of comfort (qualitatively)	The baseline value for this KPI will be determined through interviews conducted with beneficiaries. These interviews will capture the initial comfort level and provide a reference point for measuring the improvement achieved.	66% of beneficiaries consider that our intervention has greatly improved their well-being at home	% of beneficiaries that consider that our intervention has greatly improved their well-being at home	Maintain or improve upon the baseline
R307	Improvement of comfort (quantitatively)	Sensor data	Average temperature: 22.58 Celsius Average humidity: 70.83% Average CO <sub>2</sub> : 739.53 ppm	%	Improvement in humidity, CO <sub>2</sub> , and internal temperature

R308	Reduction in danger	The baseline value for this KPI will be determined through interviews conducted with beneficiaries. These interviews will capture the initial conditions of the homes and provide a reference point for measuring the improvement achieved through the renovation project.	90% of the security risk identified have been eliminated	%	Maintain the 90%
Digital Services KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
S301	Accuracy of measurements from smart sensors	According to the specifications of the manufacturer	Temperature sensor: -40...85°C (± 0.5 °C) Humidity sensor: 0-100% RH (± 0.3 %) CO2 NDIR sensor**: 400-5000ppm (± 30ppm	% of accuracy based on sensor readings and users' experience/perceptions	>95% accuracy
S302	Usefulness of FORTESIE analytics and visualisations	Surveys	N/A	qualitative	>80% acceptance and satisfaction

Just a Change impact measurement changed in 2023. Since then, we have developed a new model for measuring impact indicators in conjunction with the Social Data Lab. Interviews with beneficiaries are carried out by an external entity, where changes are assessed in different dimensions of their lives on a scale of -5 to 5.

The interviews are carried out one year after the work, with the indicators referring to interventions carried out in the previous year. This new model allows us to make a more impartial and in-depth assessment of the impact we created in their lives.

It should be mentioned also that for the case of Portugal and to calculate the CO2 emissions, we used a factor of 130gCO<sub>2</sub>/kWh, according to information from the following source<sup>3</sup>.

Finally, regarding the target values of the energy-related KPIs, these are not set given that in this specific pilot, the beneficiaries were living in energy poverty. As such, it can be expected that in these KPIs we are expecting an increase instead of a decrease, which is more difficult to predict.

### 3.3.3 Challenges and lessons learnt

Throughout this project, we have encountered various challenges that have impacted both the implementation timeline and data collection. Below, we outline the key obstacles and lessons learned during each phase of the project so far.

<sup>3</sup> <https://tco2e.net/kwh/country/portugal/>

### House and Social Case Selection

Selecting houses from different regions allowed us to address a diverse range of social cases while focusing on homes in need of renovation. This process also provided valuable opportunities to become more familiar with different territories and strengthen relationships with local stakeholders. However, the distance from our hubs in Lisbon, Porto, and Guimarães made it difficult to visit these locations frequently.

### Pre-Renovation Phase

During the preparation phase, we faced the following challenges:

- **Electricity Bill Collection:** Many of our beneficiaries have limited or no digital literacy, making it difficult to collect electricity bills from the 12 months preceding the renovation. As a result, we had to contact electricity providers directly to obtain the necessary documents.
- **Sensor Installation:** (Refer to the "Sensors" section for specific challenges related to sensor installation.)

### Renovation Phase

During the Renovation, we faced the following challenges:

- **Shortage of Skilled Labor:** Portugal is currently facing a shortage of skilled workers, which has affected not only this project but also our other initiatives in the country. During the renovation, we encountered issues with workers leaving earlier than expected or failing to complete tasks as planned. This led to delays and required us to recruit additional professionals to ensure the project's completion.
- **Unforeseen Repairs:** In some homes, particularly those in Alvaiázere and Vila Pouca de Aguiar, additional issues arose during renovation that were not initially accounted for. While our renovation plan includes a structured workflow, unexpected problems often surface, requiring additional time, resources, and materials to ensure both safety and a thorough renovation.
- **Delays in Material Delivery:** Certain renovation materials were ordered from external suppliers, and this year we faced significant delays in the delivery of windows and doors. Since replacing these elements is a key step in improving energy efficiency, these delays pushed back the completion dates for several renovations. This challenge prompted us to reconsider our operational timeline and adjust our methodology to ensure more reliable deliveries in future projects.

### Sensor Installation and Management

Over the months, we encountered the following challenges related to the installation and management of sensors:

- **Delivery Delays:** Sensor installation was initially planned for six months before the renovation period. However, apart from the sensor for the Porto house (purchased separately by Just a Change due to a different renovation timeline), all other sensors were only delivered in July. Some renovations had already begun in June, making it impossible to collect pre-renovation data. Additionally, we later realised that all locations—except one—required the installation of a gateway for the sensors to communicate with the provider. This further delayed data collection and required extra time for receiving, training, and setting up the gateways.

- **Connectivity Issues:** Since the houses are located in remote areas, we had to purchase routers and SIM cards to ensure internet connectivity for the sensors. This not only increased costs but also required additional visits to the sites, further delaying installation and data collection.
- **Lack of Technical Preparation:** Due to the team's limited experience and lack of technical training, we had to seek additional support before deploying the sensors. This support was crucial in equipping both our central and local teams with the necessary knowledge for installation and long-term maintenance.
- **Operational Challenges:** Many beneficiaries, due to their low technological literacy, unintentionally removed or damaged the sensors. Given the remote locations, our ability to visit frequently and resolve these issues in a timely manner was limited.

Overall, we believe that more thorough training and preparation for our local project managers could have helped mitigate these challenges and improved our readiness to address problems as they arose.

#### Post-Renovation Phase

- **Electricity Bill Collection:** Despite maintaining direct communication with beneficiaries, collecting electricity bills remains a challenge. Many beneficiaries lack digital skills and prefer to provide paper documents rather than sending them via email. This necessitates in-person visits, slowing down the process.
- **Higher Costs and Resource Allocation:** Due to the various challenges encountered, both costs and human resource demands exceeded initial estimates. As a result, despite planning to use additional funds to either enhance renovations or refurbish an 11th house, we are now finalising the renovation of 10 houses.
- **Solar Panel Installation and Energy Certification:** Our initial plan to install solar panels and issue energy certificates through a partner had to be revised, as the partner is no longer available to provide this service. We are currently gathering new quotes to implement this critical component of the project.

### **3.4 Pilot 4: Green and comfortable households through prosumer engagement in Cooperatives**

#### **3.4.1 Pilot status and updated timeline**

In pilot 4, ten single-family houses whose owners are prosumer members of Coopérnico are renovated in FORTESIE. Coopérnico is a Portuguese renewable energy cooperative and the pilot leader. The Just a Change association supports them with selecting the houses for renovations, planning the renovations, and sub-contracting local renovation companies.

The houses are located in different regions of Portugal, are aged 15 years or more, and have not benefited from energy efficiency renovations in the past. Nevertheless, there is the exception of 2 houses, one built in 2007 and the other in 2019, which benefited from some renovation works in the past. However, these houses were also selected as the improvement measures that were implemented in their previous renovations proved to be insufficient.

FORTESIE renovations mostly focused on passive measures, such as placing thermal insulation in the external envelope or replacing windows and doors. The 10 selected houses of this pilot were disclosed to their homeowners in January 2024, including the proposal for improvement measures studied by Coopérnico and the Just a Change team. From then on, with the involvement of the homeowners, building construction enterprises, equipment suppliers and service providers were

sought in the local market to request quotes for each improvement measure of energy efficiency. This period took up the first few months of the year and in some cases lasted longer than expected. Quotations arrived from May 2024 until July 2024.

In July 2024, Coopérnico presented to the homeowners the budgets collected and the improvement measures that were selected based on the financial viability to deploy them. Some Coopérnico members also contributed with some of their own money so that the improvement measures could be implemented in full. The agreement on home renovations and respective budgets were expressed in contracts signed in-between July and August, by Coopérnico, Just a Change and the beneficiaries of FORTESIE.

Renovation work began soon after and the home renovations were completed in their entirety at the end of 2024, and all have been paid for. Some additional, minor works were finished on January, February and March.

Regarding the monitoring of internal conditions, the sensors were received at the beginning of July 2024 and that same month a digital meeting (July 10th) was held between MESH, Coopérnico and all FORTESIE beneficiaries to explain how to install them.

Two of the beneficiaries who have a central heating system, in addition to the various sensors, also received temperature controllers for each radiator and a gateway to be connected to the router. Coopérnico asked for a sensor to be installed in its office, to learn about the technology, and subsequently access the MESH portal to monitor whether all sensors were always fully functioning.

Monitoring the sensors by Coopérnico through the MESH platform made it possible to check when the sensors were not transmitting data. It was concluded that there were sensors whose batteries did not last as long as expected. According to MESH, the LORA system in Portugal is not working as expected and the way to overcome the problem was to send gateways to 3 of the beneficiaries, in August 2024. Later, another issue was detected with the sensors of two other members and MESH sent new sensors to replace them in November 2024.

In Table 22 below, the updated timeline for pilot 4 is presented.

**Table 22: Timeline for renovations and FORTESIE digital services implementation in pilot 4**

Timeline	Activity
8/2023-11/2023	Initiation of the building selection process and reach out to the respective homeowners.
11/2023-12/2023	Compiling the initial list of applicants. Shortlist of 20 houses. Technical visits to the shortlisted houses.
12/2023-1/2024	Selection of 10 houses to be renovated in FORTESIE. Two additional “standby” houses were also selected to cover any issues.
3/2023-7/2023	Request for quotations from the various suppliers, constructors, etc.
5-7/2023	Quotations were received and evaluated.
7-8/2024	Virtual meetings with homeowners to discuss the proposed improvement measures according to the budget, which was 10,000 euros/house Contracts were signed between COOP, Just and FORTESIE beneficiaries,
7-8/2024	Installation of sensors for baseline data gathering. All sensors were fully operational in November 2024.
7/2024	Start of home renovation works with installation of thermal insulation in the attics of 3 houses, paid and carried out by the members themselves. The peak of activity in the home renovations occurred between September and November 2024.
12/2024	Completion of renovations. Some small issues were sorted out after December 2024,

	but everything is complete and paid for at the moment.
6/2025	Deployment of FORTESIE mobile app.

Regarding delays, compared to the initially reported timeline, there was a period of misunderstanding between Coopérnico and Just a Change about who would be searching for local builders to request quotations. In March 2023, Coopérnico asked FORTESIE beneficiaries to collaborate in identifying local companies and their respective contacts.

“Micro companies”, in which the builder performs all functions within his company took longer to send quotes. If an error was detected in the budget or a change was requested to the order, a few more days/weeks were added in the delay. Other contractors did not respond or said they no longer had an agenda for 2024. The goal of requesting 3 quotes for each improvement measure fell through, as we were running out of time.

In Table 23 below, the updated engagement activity plan for pilot 4 is presented.

**Table 23: Engagement activity plan for pilot 4**

Timeline	Activity	Target group	Description
7/2023-9/2023	Application period	All Coopérnico prosumer members	<ul style="list-style-type: none"> <li>Information about FORTESIE and opportunities for funding a renovation through the project is shared in all Coopérnico’s channels (newsletters, social media, website).</li> <li>Those interested and fitting the criteria are asked to fill in an application, detailing their house’s specifications, energy consumption profile, habits, household characteristics.</li> </ul>
11-12/2023	House visits and pre-renovation survey	Homeowners shortlisted from applications	<ul style="list-style-type: none"> <li>Coopérnico and Just a Change visit 20 shortlisted houses to better understand the renovation needs and to share more information about the project with the homeowners.</li> <li>During the visit, more information regarding the homeowners’ personal experiences of e.g., comfort level, issues in the house and PV system characteristics are gathered through the pre-renovation survey. Additionally, building architectural measurements were done.</li> <li>Based on these visits, the final 10 houses to be renovated are selected.</li> </ul>
7-8/2024	Pre-renovation information and installation of sensors	Homeowners chosen for FORTESIE renovations	<ul style="list-style-type: none"> <li>Details of the renovations are discussed with the homeowners.</li> <li>Sensors are installed to start gathering baseline measurements</li> </ul>
From 2/2024 until the end of the project	Communication through Coopérnico channels	Homeowners chosen for FORTESIE renovations	<ul style="list-style-type: none"> <li>Coopérnico has a newsletter, social media channels, and different online meetings, providing regular information and updates.</li> </ul>
3/2024	Mailing list for FORTESIE households	Homeowners chosen for FORTESIE renovations	<ul style="list-style-type: none"> <li>Coopérnico considers setting up a mailing list for FORTESIE households to share project updates.</li> </ul>
7/2024-2/2025	Communication during renovations	Homeowners chosen for FORTESIE renovations	<ul style="list-style-type: none"> <li>Regular communication between COOP and households regarding renovation and surveying works</li> </ul>

From 11/2024 until the end of the project	Post-renovation engagement activities	Homeowners chosen for FORTESIE renovations Potentially other Coopérnico members	<ul style="list-style-type: none"> <li>The exact format of the engagement activities depends on Coopérnico resources, interest from the homeowners and location of their homes.</li> <li>The events could include e.g. open-house events to present the results of the renovations to others interested, creating testimonial videos to be shared, and/or announcing and rewarding the households that have achieved most savings.</li> </ul>
4/2025 onwards	Post-renovation survey	Homeowners chosen for FORTESIE renovations	<ul style="list-style-type: none"> <li>Invitation via e-mail to participate in a survey where they can share their experiences of the indoor conditions at their home after the renovation and their participation in FORTESIE.</li> </ul>
6/2025	FORTESIE app onboarding session	Homeowners chosen for FORTESIE renovations	<ul style="list-style-type: none"> <li>Online meeting to introduce the FORTESIE app and support homeowners in downloading and starting to use the app</li> </ul>

Beneficiaries volunteered several times to help and be involved in numerous activities, such as providing in-depth details about their PV installations, helping to identify local companies, providing house plans with heating, cooling systems, and hot water production localisation and characteristics, organising their personal and professional life to accommodate technical visits from Coopérnico, sending electricity bills since January 2022 to calculate baseline data, and so on.

Members' engagement was very important during the home renovations. During the renovations and after their completion, beneficiaries sent photos that can be showcased on the project's dissemination channels. Finally, Coopérnico has already started post-renovation technical visits and is carrying out interviews to collect statements from the beneficiaries.

### 3.4.2 KPIs updates, validation, and verification

In table 24 below, the final KPIs of pilot 6 are presented along with some baseline and target values where that was possible.

**Table 24: Pilot 4 KPIs Final Version**

Physical Renovation KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
R401	Time for deployment	Renovation logs	N/A	Days	Home renovations started on end July and went until end of 2024. the average per home renovation was 8.5 weeks, which is, approx. 2 months. All in all, it took 59 Days / home renovation.
R402	Overall energy reduction	* Energy consumption data for a specific time period before renovation (bills)	328.51KWh on average	%	TBD

		* Energy consumption for another specific time period after renovation (bills)			
R403	CO <sub>2</sub> Emissions from energy consumption	* Energy consumption data for a specific time period before renovation (bills) * Energy consumption for another specific time period after renovation (bills)	42.7kgCO <sub>2</sub> on average	%	TBD
R404	Reduction of energy costs	* Energy costs for a specific time period before renovation (bills) * Energy costs for another specific time period after renovation (bills)	60.42 euros on average	%	TBD
R405	Improvement of comfort (air quality, humidity, internal temperature) (qualitatively)	The baseline value for this KPI will be determined through interviews conducted with beneficiaries. These interviews will capture the initial comfort level and provide a reference point for measuring the improvement achieved.	The baseline value for this KPI will be determined through interviews conducted with beneficiaries. These interviews will capture the initial comfort level and provide a reference point for measuring the improvement achieved.		
R406	Improvement of comfort (air quality, humidity, internal temperature) (quantitatively)	Sensor data before and after the renovations	Average temperature: 20.5 Celsius Average humidity: 78.62% Average CO <sub>2</sub> : 860.9 ppm	%	TBD
R407	Optimisation/flexibility of self-consumption	Distribution System Operator (DSO) platform	N/A	Quantitative (percentage of self-consumption in peak hours)	80% (indicative)
R408	Material & equipment building quality	CE-Marking Material & equipment origin Energy labelling	N/A	Qualitative evaluation	50%. National and local as much as possible.

		VOC (volatile organic compounds)			B or + National legislation
Digital Services KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
S401	Accuracy of measurements from smart sensors	According to the specifications of the manufacturer	Temperature sensor: -40...85°C (± 0.5 °C) Humidity sensor: 0-100% RH (± 0.3 %) CO2 NDIR sensor**: 400-5000ppm (± 30ppm)	% of accuracy based on sensor readings and users' experience/perceptions	>95% accuracy
S402	Level of engagement of FORTESIE mobile application	1. % of users that have downloaded the app 2. number of interactions/ user 3. % of users who were satisfied with the service	N/A	%  Number of users  %	>80% acceptance and satisfaction
S403	User's comfort satisfaction after implementing app recommendations	Surveys	N/A	% of users who are satisfied with the comfort	>80% acceptance and satisfaction
S404	Accuracy of personalised recommendations	Survey	N/A	% of users who are satisfied with the recommendations	>80% acceptance and satisfaction
S405	Accuracy of cost savings / energy predictions	Survey	N/A	% of users who are satisfied with the accuracy	>80% acceptance and satisfaction on accuracy
S406	Amount of green euros rewarded for the pilot	Green Euro Application logs	N/A	Amount of euros rewarded/ user % of total euros (from the maximum of 50) that each user earned	TBD
S407	Integrated package with performance guarantees	OSS Marketplace	N/A	Number of packages	1 for this pilot

It should be mentioned also that for the case of Portugal and to calculate the CO2 emissions, we used a factor of 130gCO<sub>2</sub>/kWh, according to information from the following source<sup>3</sup>. Energy-related data

were aggregated from energy bills and sensor-related data were calculated with the help of the FORTESIE data analytics.

Regarding KPI R408, in April 2024, it was explained to Just a Change that Coopérnico had committed to using ecological materials at FORTESIE and that no other materials would be accepted. However, the expectation of collecting at least 3 quotations per improvement measure for each householder began to fall when the team started to realise the difficulty in finding local contractors and material suppliers and the time they were taking to send a budget. Given the difficulties described above, we were not extremely demanding in observing whether the materials had CE marking and whether they were ecological or even national. Certified and ecological materials are also more expensive, and we had budget restrictions. In the end, we compromised with specific indications of the windows and the respective glass characteristics, the density of the rock wool and whether it had a breathable membrane, for instance.

### **3.4.3 Challenges and lessons learnt**

When Coopérnico discussed the improvement measures to be implemented with the beneficiaries according to the available budget (10k/householder), there were several members who were willing to cover some of the cost. For example, we had 5/10 beneficiaries who bought ecological thermal insulation for their attics and installed it themselves, given the ease of installation that rock wool allows. There were other notable investments.

Looking at the path taken with the beneficiaries from the very beginning, it can be said that there was generally great involvement from their side. Coopérnico made a point of explaining FORTESIE during technical visits and that the involvement of the beneficiaries was expected. There was always close communication, where the beneficiary was informed at every step and their opinion was heard, when appropriate. It was important for both parties that Coopérnico practiced a close dialogue and that the beneficiaries did not feel that we were imposing the renovations on them without their knowledge.

Furthermore, it was concluded that some construction companies, when they do not have any reference of a new client, also have their fears. If there is not yet an established relationship of trust, this may affect their involvement.

To support members in quotation request and to better understand how to look for the right materials for their renovations, COOP created a document with technical specifications on all improvement measures. It was required to generate a specific document informing about the importance of trickle vents integrated into the windows frame and drawing attention to technical specificities to be checked during the home renovations works.

## **3.5 Pilot 5: Green, comfortable working environment / General Secretariat of Information Systems for Public Administrations**

### **3.5.1 Pilot status and updated timeline**

The site of pilot 5 is located in the headquarters of the General Secretariat of Information Systems for Public Administrations (G.S.I.S.D.G.), located close to the city centre of Athens, Greece. The building was originally in industrial use, but in 1995-1999 it was reconstructed into an office space. It consists of two basements and five floors and is used daily by approximately 930 employees. The program focuses on developing and demonstrating "renovation packages" tailored to optimise energy management and reduce energy consumption, leveraging integrated technological solutions with guaranteed performance for buildings.

Based on the needs of the pilot area and the extent of the intervention required, the technical equipment was appropriately selected. The current status of the building is that the renovation installations have been completed.

The renovation of the project included the following:

- Installation of 103 energy consumption meters in motion and lighting panels throughout the building. Through them energy consumption per meter is being measured.
- Installation of 23 variable frequency drives (VFDs) in HVAC units. They control the speed of fan motors, optimising their operation.
- Installation of 194 air quality sensors in office spaces. They monitor, track, and record CO<sub>2</sub> levels, enabling the regulation of supply and exhaust fan speeds based on CO<sub>2</sub> concentrations.
- Implementation of an energy management platform for monitoring and optimising HVAC systems and overall energy efficiency. The system of the platform could remotely monitor and control any connected device installed (as the above mentioned) in a building, regardless of connectivity protocol or measurement type. This platform collects and analyses operational and energy performance data from the building systems, providing actionable insights to facilitate anticipatory adjustments.
- Installation of a PV system with a total installed capacity of 85KW on the building's roof. The PV station will operate as an independent electricity generation unit, supplying the produced energy to the internal electrical installation.

In Table 25 below, the updated timeline for pilot 5 is presented.

**Table 25: Timeline for renovations and FORTESIE digital services implementation in pilot 5**

Timeline	Activity
10/2022	Selection of the pilot site.
5/2023	Tender procedure. Deployment of sensors to measure the baseline situation.
8/2023	Final evaluation of the tender results.
10/2023	Confirmation and signatures have been received
11/2023	Deployment of renovations (electrical and mechanical installations).
2/2024	Installation of 194 sensors has been completed.
03/2024	Installations of 44 energy meters and VFD's are in progress.
05/2024	Start of renovation deployment
6/2024	Completion of renovations
4/2025	The connection to the grid for the PV is expected
6/2025	Deployment of FORTESIE digital tools.

As regards Pilot 5, delays were reported in administrative public processes, the installation of inverters, and the timely arrival of material orders. The arrival of these materials also marked the initiation of renovations. However, no further delays were encountered. The total delays in the integration of renovation lasted about one month due to the above-mentioned issues.

In addition, the installation of the PV system has been completed, and we are currently awaiting the network operator to proceed with the connection of the PV system to the grid.

At present, GSIS has obtained approval from the Public Electricity Company (PEC) for connecting the PV panels to the National Electricity Grid. Upon GSIS accepting the PEC's terms, PEC will proceed with the final connections. This delay is a big problem and comes as a result of Greek bureaucracy, which is something that the construction company cannot overtake. The only way to overcome or

reduce all bureaucratic difficulties is to start the licensing procedures earlier with the hope that they will be completed by the end of the renovation.

In Table 26 below, the updated engagement activity plan for pilot 5 is presented.

**Table 26: Engagement activity plan for pilot 5**

Timeline	Activity	Target group	Description
11/2023	Communication and a survey (Completed)	All employees	<ul style="list-style-type: none"> <li>Invitation to participate in a survey where they can share their experiences of the indoor conditions at the office</li> </ul> <p>192 responses, which are divided into 106 complete responses and 86 partial responses</p> <ul style="list-style-type: none"> <li>Communicating the renovations and the FORTESIE project</li> </ul> <p>Via Emails &amp; employees could send direct their queries for the project etc. to "Fortesie@gsis.gr"</p>
3/2024	Communication	All employees  Facility Management Team (Completed)	<ul style="list-style-type: none"> <li>E-mail explaining the upcoming renovation work and its goals</li> </ul> <p>Via Emails</p> <ul style="list-style-type: none"> <li>Sharing results from the pre-renovation survey and how the issues identified in the survey will be addresses through the renovations</li> </ul> <p>Via Emails</p>
6/2024	Onboarding BMS users to FORTESIE app	Energy & Facility Management Team & Part of Employees (Paused)	<ul style="list-style-type: none"> <li>Instruction on how to install and use the FORTESIE app</li> <li>Active communication with the teams to gather feedback and learnings for office-wide roll-out of the app</li> </ul>
7/2024	Co-creation session	Energy & Facility Management Team (Completed)	<ul style="list-style-type: none"> <li>Introducing the FORTESIE project to the energy management team and ideating ways of engaging all employees in the project</li> </ul>
9/2024	Event to onboard employees to FORTESIE app	Energy & Facility Management Team & Part of Employees (Paused)	<ul style="list-style-type: none"> <li>Presentation of the FORTESIE project and the app</li> <li>Support in downloading and starting to use the app</li> </ul>
From 9/2024 until the end of the project	Engagement activities	Energy & Facility Management Team  Press Release (Ongoing))	<ul style="list-style-type: none"> <li>Potential engagement activities co-created with the energy management team</li> </ul> <p>Periodical meetings (discussion, study and analysis of data)</p> <ul style="list-style-type: none"> <li>These could include e.g. communication campaigns or events related to FORTESIE themes</li> </ul> <p>LinkedIn, X, Facebook</p>
11/2024	Survey	All employees (Pending)	<ul style="list-style-type: none"> <li>Feedback regarding indoor conditions at the building after the FORTESIE solution installation</li> <li>Social acceptance of the FORTESIE solutions and project activities</li> </ul>
12/2024	Communication	All employees (Pending)	<ul style="list-style-type: none"> <li>Sharing results of the post/renovation survey</li> <li>Motivating continued use of the FORTESIE app</li> </ul>

A pre-renovation survey to the employees in the building, regarding the comfort conditions of the building has been completed. The responses of the employees were at high levels of satisfaction.

The completion of renovation was in the summer of 2024. The energy conservation and the proper rulers of the inverters started at the end of 2024 (November). As such, and for the execution of the post-renovation survey, the building should work with the new status for an appropriate range of time.

### 3.5.2 KPIs updates, validation, and verification

The following table (Table 27) presents a detailed overview of the KPIs associated with the building renovation project, along with the respective data requirements, baseline values, target values, and justifications for each metric. These KPIs were carefully selected to evaluate critical aspects such as renovation deployment efficiency, energy consumption and cost reduction, air quality improvements, and employee comfort.

**Table 27: Pilot 5 KPIs Final Version**

Physical Renovation KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
R501	Time for deployment	Either measure time of deployment or also include the time of delivery	6 months	Days/ months	5 months
R502	Reduction of energy consumption	* Energy consumption data for a specific time period before renovation (bills) * Energy consumption for another specific time period after renovation (actual data from sensors)	Yearly Energy Consumption 3.608.172 kWh	%	10-15% reduction in Yearly Energy Consumption 3.066.946 kWh
R503	Overall air quality improvement	Quantitative - Measurements of CO <sub>2</sub> Levels	The measurements taken during the winter months (01/12/2022 - 30/04/2023) for indoor CO <sub>2</sub> levels indicated an average concentration of 470 ppm. Maximum values n working hours fluctuates from 900 ppm to 1450 ppm.	PPM	<1000 ppm in working hours
R504	Reduction of energy costs	* Energy annual cost before renovation (bills) * Energy annual cost after renovation (bills)	Yearly Energy Cost 615.470 €	€ and %	10-15% Reduction in Yearly Energy Cost 523.150€
R505	Improvement	Qualitative -	The average indoor	°c, %	According to

	of comfort of employees.	Questionnaires Quantitative from sensors *Measurements of internal temperature *Measurements of humidity levels	temperature recorded in the building during the winter season (01/12/2022 - 30/04/2023) prior to the renovation was 23,1°C, while the average indoor humidity level during the same period was 37,5%. Maximum values in working hours fluctuates from 29 to 35oC.	respectively	Greek law high efficiency limits: For temperature: Winter period 20°C, Summer period 26°C For humidity: Winter period 35%, Summer period 45%
R506	CO <sub>2</sub> Reduction		Yearly CO <sub>2</sub> Emissions 2.164,9 tn	tn and %	10-15% Reduction in Yearly CO <sub>2</sub> Emissions 1.844,7 tn
Digital Services KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
S501	Accuracy of measurements from smart sensors	According to the specifications of the manufacturer	Temperature sensor: -40...85°C (± 0.5 °C) Humidity sensor: 0-100% RH (± 0.3 %) CO2 NDIR sensor**: 400-5000ppm (± 30ppm	% of accuracy based on sensor readings and users' experience/perceptions	>95% accuracy
S502	Accuracy of M&V calculations	Partners which act as managers of EPCs (VEO, OKT, CRD) compare the M&V module results to their internal data using their current methods for the calculations	N/A	%	TBD by the component owner
S503	Level of engagement of FORTESIE mobile application	1. % of users that have downloaded the app 2. number of interactions/user 3. % of users who were satisfied with the service	N/A	%  Number of users  %	>80% acceptance and satisfaction
S504	Amount of green euros rewarded for the pilot	Green Euro Application logs	N/A	Amount of euros rewarded/user % of total euros (from the maximum of 50) that	TBD

				each user earned	
S505	Integrated package with performance guarantees	OSS Marketplace	N/A	Number of packages	1 for this pilot

The baseline values are derived from pre-renovation measurements and data, while the target values align with established standards, such as European Standard EN 13779, ASHRAE 62.1-2019, and the Technical Chamber of Greece's Energy Performance Regulation (TOTEK-KENAK). By achieving these targets, the project aims to enhance energy efficiency, reduce operational costs, and provide a healthier, more comfortable indoor environment for employees, ensuring compliance with national and international best practices for energy conservation and indoor air quality.

The optimal benefit of upgrading the building facility through renovation will be the reduction of energy consumption, as well as the optimisation of internal conditions for the benefit of the employees.

To calculate the baseline reference value of consumption, the energy consumption for a period of one year prior to the renovation was determined. The annual consumption was derived as the average of the monthly energy consumptions over a period of 14 months (pre-renovation).

Similarly, the cost of electricity consumption was calculated. The cost calculation was based on the price of electricity from the energy provider's bills, excluding taxes.

Correspondingly, from the calculation of the baseline energy consumption value, the baseline value for CO<sub>2</sub> emissions is determined using the appropriate conversion factors for Greece.

According to the interventions carried out in the building (inverters, meters, sensors, energy platform and management, and PV installation), the expected savings are estimated to be approximately up to 15%. Therefore, using the initially calculated energy consumption value before the interventions, the target value is determined with a 15% energy saving. A corresponding reduction in cost is also expected due to the proportionality of the energy price to electricity consumption.

As for internal comfort conditions, according to European Standard EN 13779 and ASHRAE 62.1-2019, indoor CO<sub>2</sub> concentrations should not exceed 700 ppm above outdoor levels (typically 300-500 ppm), establishing a recommended limit of 1000 ppm for good air quality. Similarly, the guidelines outlined in the Technical Chamber of Greece's Energy Performance Regulation (TOTEK-KENAK) specify that the recommended indoor temperature during the winter should be maintained at 20°C, with an ideal indoor humidity level of 35%. These standards serve as benchmarks for assessing air quality and thermal comfort in office buildings, ensuring compliance with both Greek law and international best practices. Baseline measurements, such as pre-renovation energy consumption, CO<sub>2</sub> concentrations, temperature, and humidity levels, are critical for evaluating progress. By comparing these baseline values to post-renovation data, the project can accurately assess the improvements in energy efficiency, indoor air quality, and employee comfort, while also aligning with the goal of achieving optimal thermal comfort with minimal energy consumption.

To determine the savings (in energy, emissions, costs), the data of the individual meters installed in the building during the renovation will be leveraged. However, since different external temperature conditions affect the building's consumption (due to air conditioning), considering the baseline year as the period before the renovation, the baseline equation was created in relation to the heating and cooling degree days for the building's area.

### 3.5.3 Challenges and lessons learnt

During the renovation process of the building facility, several issues emerged, leading to delays in the project completion.

The primary issue concerned delays in material orders. Although these delays were not extensive, they disrupted the project's schedule by about a week. It's crucial to place orders with companies familiar with managing large-scale orders to mitigate such risks. Additionally, installers should anticipate potential delays of this nature, as they are quite common due to the substantial volume of orders or extended response times.

The most significant challenge encountered was the bureaucratic procedures involved in obtaining permits, especially when governmental agencies are involved. This issue arose during the connection of the PV system to the grid. Despite the installation being completed on schedule, the connection is still pending. To address this, installers should initiate the necessary procedures well in advance, allowing them to progress concurrently with the installation work whenever possible. Furthermore, they should maintain constant communication with various agencies to expedite the process as much as possible. The challenge of governmental bureaucracy and permitting procedures is difficult to overcome solely by the installer. It should be approached as a process of continuous communication, accounting for a potentially significant delay in time.

## 3.6 Pilot 6: Comfortable and sustainable (public) pools / Municipal swimming pool in Góra Kalwaria, Poland

### 3.6.1 Pilot status and updated timeline

The pilot site is a public pool built in 1999, located in Góra Kalwaria, Poland. Around 20 people work daily in the building with opening hours from 06:00 AM to 9:45 PM. Approximately 110,000 tickets to the pool are sold per year.

The building needed renovations due to outdated technology and wear on its components. The renovation includes replacing ducts, insulation, and installing new equipment for air handling units and heating substation. The electrical board is also updated, and access control and user satisfaction measurement systems are installed, adjusted, and integrated with the data exchange system. Additionally, a PV plant will be installed on the pool's roof.

In Table 28 below, the updated timeline for pilot 6 is presented.

**Table 28: Timeline for renovations and FORTESIE digital services implementation in pilot 6**

Timeline	Activity
10/2022	Selection of the pilot site.
6/2023	Finalisation of project designer selection for the renovation project.
10/2023-12/2023	Delay with final submission of renovation project due to missing data from the pool operator regarding heating substation. Delays due to challenges with procurement.
1/2024	Finalisation of the preparation of the renovation project and notification of the intention to carry out the renovation to the county office.
5/2024	New tender announced by the municipality.
6/2024	Resolution of the tender was unsuccessful due to an excessively high offer from the potential contractor.

8/2024	New tender announced by the municipality, with a new allocated budget
09/2024	Selection of the general contractor for the renovation.
12/2024	Renovation (duration 4 months). Pool will be out of service during the renovation.
1/2025	Order of ventilation units, preparational works
2-3/2025	Rooftop preparation and PV installation
3/2025	Units to be delivered to the pool
4-5/2025	Finalisation of renovation
6/2025	Deployment of FORTESIE digital services

As regards the timeline implementation of Pilot 6, delays were reported due to the time-consuming and bureaucratic procedures needed for the public procurement. These procedures require certain time periods for validation (e.g., after the selection of the tender, one month is needed for the selection of contractors). Delays were also encountered from both formal factors, due to public entity regulations, and financial factors, as a result of overall cost increases. The final renovation costs significantly exceeded the initial estimates, which led to the first announced tender remaining unresolved. Consequently, the Municipality had to identify alternative sources of funding to maintain adherence to the renovation plan, requiring additional time. This process involved several steps, including planning, presentation to the Municipality Council, voting, approval, and public announcement, all of which extended the timeline. The Municipality announced a new contractor procurement, but the deadline was extended due to numerous inquiries from potential contractors, in accordance with standard formal procedures in such cases.

In Table 29 below, the updated engagement activity plan for pilot 6 is presented.

**Table 29: Engagement activity plan for pilot 6**

Timeline	Activity	Target group	Description
8-10/2024	Questionnaires/ Survey	Pool visitors	<ul style="list-style-type: none"> <li>Opportunity to participate in a survey where they can share their experiences of the conditions at the pool.</li> <li>Survey is shared through a QR code/link on a poster at the pool lobby. Paper surveys are also made available.</li> </ul>
7/2023 1/2024 9/2024	Communication	Citizens of the municipality	<ul style="list-style-type: none"> <li>Communication on the municipality's channels about the project activities.</li> </ul>
8-10/2024	Communication	Citizens of the municipality	<ul style="list-style-type: none"> <li>Communication on the municipality's channels about the renovation, its impact, and closing of the pool for the renovation period.</li> </ul>
3/2025	Communication	Citizens of the municipality	<ul style="list-style-type: none"> <li>Information about the completion of the renovation, the survey results, and how the renovation improves the issues identified in the survey.</li> </ul>
3-4/2025	Onboarding employees to new systems	Pool employees	<ul style="list-style-type: none"> <li>Introduction of the new system for managing conditions at the pool and instruction on using the new equipment.</li> </ul>
4-6/2025	Onboarding visitors to FORTESIE app	Pool visitors	<ul style="list-style-type: none"> <li>FORTESIE app is promoted to the visitors by employees working at the counter as well as through posters and information on website and social media.</li> </ul>
6-9/2025 9-10/2025	Experimentation with pool conditions	Pool visitors Pool employees	<ul style="list-style-type: none"> <li>Testing different conditions at the pool and gathering user feedback through the FORTESIE app.</li> </ul>

10-12/2025	Feedback / evaluation session	Pool employees	<ul style="list-style-type: none"> <li>Evaluating the results of the renovation</li> <li>Evaluating the engagement activities and results of experimentation with the pool conditions</li> </ul>
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Pre-renovation surveys have been completed as well as Communication actions related to project activities, the renovation itself and the progress made so far.

### 3.6.2 KPIs updates, validation, and verification

In table 30 below, the final KPIs of pilot 6 are presented along with some baseline and target values where that was possible.

**Table 30: Pilot 6 KPIs Final Version**

Physical Renovation KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
R601	Time for deployment (renovation itself)	Renovation logs	6 months	Months	4 months
R602	Overall electricity reduction	Compared bills from before and after renovation	656980 kWh (2023)	%	-15/20 %
R603	Overall thermal reduction	Compared bills from before and after renovation	5562 GJ / 1545000 kWh (2023)	%	-15/20 %
R604	Reduction of CO <sub>2</sub> Emissions from energy (electricity) consumption	Emission per kwh of electricity consumption in Poland for 2022: 685 g CO <sub>2</sub> /kWh	450031300 g CO <sub>2</sub> /kWh	%	-15/20 %
R605	Reduction of CO <sub>2</sub> Emissions from energy (thermal) consumption	Emission per kwh of thermal consumption in Poland (gas) for 2020: 55480 g CO <sub>2</sub> /GJ	308579760 g CO <sub>2</sub> /GJ	%	-15/20 %
R606	Reduction of energy costs	Measured from electricity and thermal bills, before and after renovation	Electricity consumption and distribution costs combined: 172,334.32 EUR  Thermal consumption costs: 277,835.47 EUR	%	-10/15 % (considering rise of costs)
R607	Improvement of comfort (quantitatively)	Sensor data	Internal temperature of: Sports pool: 27.59 Celsius Recreational pool: 30.33 Celsius	%	TBD
R608	Improvement of comfort (qualitatively)	Survey	Will be gathered from the survey in the following months	Qualitative	TBD

Digital Services KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
S601	Accuracy of measurements from smart sensors	According to the specifications of the manufacturer	Temperature sensor: -40...85°C (± 0.5 °C) Humidity sensor: 0-100% RH (± 0.3 %) CO2 NDIR sensor**: 400-5000ppm (± 30ppm)	% of accuracy based on sensor readings and users' experience/perceptions	>95% accuracy
S602	Level of engagement of FORTESIE mobile application	1. % of users that have downloaded the app 2. number of interactions/user 3. % of users who were satisfied with the service	N/A	%  Number of users  %	>80% acceptance and satisfaction
S603	Amount of green euros rewarded for the pilot	Green Euro Application logs	N/A	Amount of euros rewarded/ user % of total euros (from the maximum of 50) that each user earned	TBD
S604	Integrated package with performance guarantees	OSS Marketplace	N/A	Number of packages	1 for this pilot

The baseline for overall electricity and thermal reduction is the pool consumption data for 2023, while the target value reduction is estimated based on projections from the renovation project designer. The reduction in overall electricity and thermal costs will be measured by comparing utility bills from before and after the renovation.

Baseline for reduction of CO<sub>2</sub> emission per kwh of electricity consumption in Poland for 2022: 685 g CO<sub>2</sub> /kWh, multiplied by 656980 (pool electricity consumption in 2023) = 450031300.

Source: report of The National Centre for Emissions Management (KOBiZE), responsible for the National Database on Emissions of Greenhouse Gases and Other Substances (m.in National Database) and provides government and local government administration and interested entities with statements, analyses and reports<sup>4</sup>.

Baseline for reduction of CO<sub>2</sub> emission per kwh of thermal consumption in Poland (gas) for 2020: 55480 g CO<sub>2</sub> /GJ multiplied by 5562 (pool thermal consumption in 2023) = 308579760.

<sup>4</sup>[https://www.kobize.pl/uploads/materialy/materialy\\_do\\_pobrania/wskazniki\\_emisyjnosci/Wskazniki\\_emisyjnosci\\_2022.pdf](https://www.kobize.pl/uploads/materialy/materialy_do_pobrania/wskazniki_emisyjnosci/Wskazniki_emisyjnosci_2022.pdf)

Source: report of The National Centre for Emissions Management (KOBiZE), responsible for the National Database on Emissions of Greenhouse Gases and Other Substances (m.in National Database) and provides government and local government administration and interested entities with statements, analyses and reports<sup>5</sup>.

Pre-renovation surveys (questionnaires) were conducted during a public event to measure the satisfaction of pool users and visitors. User groups were identified, and various conditions were examined, including water and air temperature, humidity, and other factors.

Post-renovation interviews will be conducted after the project's completion, focusing on indicators related to the interventions carried out. These interviews will assess the level of improvement in pool conditions while ensuring that pool sanitary restrictions are fulfilled and the level of comfort remains the same or improves, providing reduction of energy consumption and costs.

### 3.6.3 Challenges and lessons learnt

#### Bureaucracy and Delays

Throughout the project, we encountered several challenges that affected timelines and operations. These included delays in formal processes due to lengthy governmental and institutional procedures, as well as financial constraints that further prolonged decision-making.

#### Key Lessons Learned:

- Anticipate delays caused by legal and bureaucratic processes and incorporate them into the project planning.
- Establish a network of experts, including construction companies with specialised expertise, in advance.
- Familiarise oneself with relevant procedures, such as voting systems in public authority council meetings and tender formalities.

#### Tender Requirements and Process Efficiency

Given the scale and nature of the building, a large number of stakeholders were involved, and the scope of work was underestimated. Finding a contractor who met the specific requirements of the project proved challenging. Policy makers should work to streamline these processes to minimise delays and ensure a more efficient impact.

#### Key Lessons Learned:

- Improve forecasting of work complexity and resource needs: to contact other institutions that have similar characteristics and consult/share experiences and suggestions.
- Advocate for more agile procurement processes, particularly for highly specialised projects.
- Encourage policy adjustments that support faster and more effective contractor selection (e.g., easing requirements by expanding them to broader scope of experts). In GKW Pool's case study there was strict restriction that the contractor must have experience with pools. What was helpful to find a contractor was expanding it to big halls, sport centres etc.)

#### Financial Constraints:

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<sup>5</sup>[https://www.kobize.pl/uploads/materialy/materialy\\_do\\_pobrania/monitorowanie\\_raportowanie\\_weryfikacja\\_emisji\\_w\\_eu\\_ets/WO\\_i\\_WE\\_do\\_monitorowania-ETS-2023.pdf](https://www.kobize.pl/uploads/materialy/materialy_do_pobrania/monitorowanie_raportowanie_weryfikacja_emisji_w_eu_ets/WO_i_WE_do_monitorowania-ETS-2023.pdf)

Rising costs and unforeseen expenses placed a strain on the project's budget. Factors such as inflation-driven material price increases and unexpected logistical costs had not been fully anticipated during the initial planning phase.

Key Lessons Learned:

- Conduct more detailed financial forecasting to better anticipate potential cost overruns.
- Include contingency funds in the budget to accommodate inflation and unforeseen expenses.
- If public funding is involved, understand the public budgeting cycle, including when financial decisions must be made (e.g., rules regarding budgeting particularly for time before the fiscal year closes or at the start of a new one)

Social Engagement Activities

Effective communication with the local community (e.g., pool visitors) and their involvement in public events, such as offline surveys, helped strengthen engagement and ensured their needs were considered.

Key Lessons Learned:

- Maintain clear and open communication with the local community throughout the project
- Actively involve and engage stakeholders in decision-making and planning through public events and surveys

Optimal Timing for Pool Closure During Renovation

To minimise disruption, the pool should be closed for the shortest period possible to avoid negatively impacting the operation of other parts of the building and to maintain pool users' engagement. Renovation work should also be scheduled during the most suitable season, as weather conditions in Poland can influence the pace of construction.

Key Lessons Learned:

- Schedule renovation to ensure minimal disruption to other facilities
- Plan work during appropriate seasonal windows to optimise construction efficiency

## **3.7 Pilot 7: Comfortable, inclusive, and sustainable green schools**

### **3.7.1 Pilot status and updated timeline**

The pilot site of pilot 7 is the 9th Secondary School, located in Riga, Latvia. The school was constructed in 1972, and a renovation of the façade and roof thermal insulation was done in 2022.

The building has four floors with a total of 37 classrooms. The school is attended by 315 pupils. School employees consist of 38 teachers and 23 members of the technical staff.

In the FORTESIE renovation, a heating adjustment system will be installed, giving maximum possibilities for regulating heat in the building. New equipment will also be installed for ventilation as well as sensors and controllers that allow the school to manage and control its microclimate.

In Table 31 below, the updated timeline for pilot 7 is presented.

**Table 31: Timeline for renovations and FORTESIE digital services implementation in pilot 7**

Timeline	Activity
10/2022	Selection of pilot site.
8/2023	BMS system built, including: <ul style="list-style-type: none"> <li>MESH on-demand management platform for heating and ventilation system and each individual unit including all necessary licenses self-service panels with sensors CO<sub>2</sub>, VOC, Temperature, Humidity, Pressure (18.800) in classrooms and 232 microregulation points using Mesh RRC-030 controllers (12.500).</li> <li>Regulating/balancing valves for heating system in order to allow microregulation per classroom (232 points, 10.900).</li> </ul>
12/2023	Public tender completed. Installation of air handling units in 22 classrooms, wireless MESH infrastructure for sensor gateways and system management for the heating. Some issues with the ventilation observed.
1/2024-2/2024	Start of renovations
5/2025	Finalisation of renovation work
9/2025	Deployment of FORTESIE digital services

As regards the timely implementation of Pilot 7, no delays have been reported.

In Table 32 below, the updated engagement activity plan for pilot 7 is presented.

**Table 32: Engagement activity plan for pilot 7**

Timeline	Activity	Target group	Description
11/2023	Communication and planning	School management	<ul style="list-style-type: none"> <li>Explaining the installation plan</li> <li>Creating an installation plan to match the school's schedule</li> <li>Discussing benefits of the project</li> <li>Planning ways to engage the teachers, students, and their parents</li> </ul>
12/2023 - 01/2024	Communication and a survey	Teachers	<ul style="list-style-type: none"> <li>Communicating the renovations</li> <li>Invitation to participate in a survey where they can share their experiences of the indoor conditions at the school</li> </ul>
08/2024	Communication, instruction	Building maintenance	<ul style="list-style-type: none"> <li>Providing the building maintenance company with instructions on how to maintain the new equipment</li> </ul>
From 9/2024 until the end of the project	Engagement with the FORTESIE themes and content during classes	Students Teachers	<ul style="list-style-type: none"> <li>Teachers use the FORTESIE app's insights and other FORTESIE materials in their teaching to engage their students</li> </ul>
9/2024 until the end of the project	Communication	Parents	<ul style="list-style-type: none"> <li>Informing parents about the FORTESIE project, its benefits, data availability, and proper dressing at school via the school's communication channels.</li> </ul>
From 4/2025 until the end of the project	Workshop and communication	Stakeholders (Riga City Council's	<ul style="list-style-type: none"> <li>Workshop with the stakeholders about the ventilation topic/ building renovation in the educational buildings</li> </ul>

		Property Department; Relevant ministries; Riga energy agency; building associations; energy experts)	<ul style="list-style-type: none"> <li>Workshop with stakeholders to present the results of created guidelines for ventilation in the educational buildings</li> <li>Disseminating the results of the project to relevant stakeholders (e.g., "Dzīvo siltāk" or another event)</li> </ul>
9/2025 until the end of the project	Engagement	Students	<ul style="list-style-type: none"> <li>Informing students about project and results during lessons using tablets</li> </ul>
10-11/2024 (before renovation of ventilation system) 02-03/2026 (after)	Survey	Teachers, staff	<ul style="list-style-type: none"> <li>Asking teachers for feedback regarding 1) indoor conditions at the school after the FORTESIE solution installation, and 2) social acceptance of the FORTESIE solutions and project activities</li> </ul>

During discussions with the school and considering the restrictions on phone use, it was decided that the FORTESIE app will not be installed on each student's phone. Instead, tablets will be provided for teachers to use with students during lessons to answer quizzes related to the project renovations, energy efficiency, and other relevant topics.

### 3.7.2 KPIs updates, validation, and verification

In table 33 below, the final KPIs of pilot 7 are presented along with some baseline and target values where that was possible.

**Table 33: Pilot 7 KPIs Final Version**

Physical Renovation KPIs					
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
R701	Satisfaction of the renovation process	Questionnaire	N/A	%	70% satisfied
R702	Overall energy reduction	Heat consumption from heating system operator  Electricity consumption from Riga department	80 kWh/m2  0 kWh/m2	%	-25%  Does not exceed +1.46 kWh/m2
R703	CO <sub>2</sub> reduction from heat	Calculations	16.048 t CO <sub>2</sub> /m2	%	-25%
R704	Reduction of heat energy costs	Heat energy bills	17 EUR/m2	%	-20%
R705	Improvement of comfort and air quality (surveys)	Gathered from questionnaires	To gather baseline data in the following months	Qualitative	70% satisfied
R706	Improvement of comfort and air	Measured from sensors	N/A	Quantitative	Temperature 18 C Humidity 30-70%

Digital Services KPIs					CO <sub>2</sub> does not exceed 1000 ppm
KPI id	KPI description	Means of verification	Baseline Value	Unit	Target Value
S701	Accuracy of measurements from smart sensors	Accuracy of measurements from smart sensors	According to the specifications of the manufacturer	Temperature sensor: -40...85°C (± 0.5 °C) Humidity sensor: 0-100% RH (± 0.3 %) CO2 NDIR sensor**: 400-5000ppm (± 30ppm)	% of accuracy based on sensor readings and users' experience/perceptions
S702	Level of engagement of FORTESIE mobile application	<ol style="list-style-type: none"> <li>% of users that have downloaded the app</li> <li>number of interactions/user</li> <li>% of users who were satisfied with the service</li> </ol>	N/A	%  Number of users  %	>80% acceptance and satisfaction
S703	Amount of green euros rewarded for the pilot	Green Euro Application logs	N/A	Amount of euros rewarded/user % of total euros (from the maximum of 50) that each user earned	TBD
S704	Integrated package with performance guarantees	OSS Marketplace	N/A	Number of packages	1 for this pilot

Instead of the initial KPI, 'Time for Deployment,' it was decided to change it to 'Satisfaction with the Renovation Process,' as there are no existing examples or experience with the installation of such ventilation systems, and no baseline data is available. To measure this KPI, we will conduct questionnaires among the school staff.

The overall energy reduction will be divided into heat energy consumption data and electricity consumption data (kWh/m<sup>2</sup> per year) before and after the BMS system installation.

CO<sub>2</sub> reduction from energy consumption will be calculated both before and after the pilot implementation.

Energy cost reduction will be calculated based on the bills before and after the pilot implementation.

For the heat consumption baseline, we calculated it for the heating season in Latvia from October 2022 to April 2023, prior to the BMS renovation. According to Latvian legislation, climate correction is necessary for data comparison, as winters can vary in temperature. The total heat consumption during this period was 352 MWh, but after applying the climate correction, it amounts to 418 MWh. To establish the baseline value, we divide the consumption by the building's area of 5,258 m<sup>2</sup>, resulting in a value of 80 kWh/m<sup>2</sup>.

For electricity consumption, we set the baseline value at 0 kWh/m<sup>2</sup>, as no ventilation systems were installed previously. Currently, electricity consumption is primarily attributed to the lighting system, with an average of 23 kWh/m<sup>2</sup> per year based on data from 2019 to 2022. We cannot set a percentage target for the lighting system, as the electricity consumption up until now does not affect the ventilation system.

CO<sub>2</sub> reduction from heating is calculated by multiplying heat consumption by the natural gas CO<sub>2</sub> emission factor of 0.202 t CO<sub>2</sub>/MWh.

The baseline target value for comfort and air quality improvement (via sensors) is set by Latvian legislation for public buildings, which defines the minimum values that must be maintained in classrooms.

### **3.7.3 Challenges and lessons learnt**

There were some challenges during the bureaucratic process for the public tender. The lesson learned is to plan time in advance for this process.

Additionally, social engagement activities faced challenges, including busy teachers and a lack of mobile phones for younger students.

Regarding the ventilation system, there were delays in material orders as this type of system is being produced for the first time by the company.

## 4 Discussion on Early Pilot Challenges

The pilot activities that were/are ongoing (depending on the timing of each pilot) and that have been reported in the three WP4 deliverables included preparatory steps for the various pilot settings, creating suitable forms and templates for the collection of information and data, ordering of renovation materials and completion of renovation works, installing the sensors, setting up the KPIs of each pilot and calculating baseline and target values, as well as setting up the various social engagement activities among others. In all three deliverables of WP4, the pilots reported various issues, barriers, challenges and delays that are related to the aforementioned activities. Given that most of the pilots (with some exceptions) are close to finalising (or have already finalised) the renovations, this chapter includes a discussion on the reported challenges. While the challenges of each individual pilot have been reported in their respective pilot subchapters, where also lessons learnt were generated based on the challenges of each pilot, this chapter presents a discussion and some early conclusions that can be drawn. For this reason, in the following table the challenges of all pilots have been collected and are presented (after removing duplicates, i.e., challenges that were reported by multiple pilots). As such, we present the challenges and mark the ones that affect each pilot. In each pilot, we mark in parenthesis whether the pilot concerns homeowners (H) or big/public buildings (B) as well as the country where the pilot is being implemented.

Challenges	Pilots (expressed in pilot numbers) (H signifies homeowner pilots and B signifies big public buildings such as pool, school, etc.)								
	1 (B) (GR)	2 (VEO) (H) (ES)	2 (GAR) (H) (ES)	2 (OKT) (H) (FR)	3 (H) (PT)	4 (H) (PT)	5 (B) (GR)	6 (B) (PL)	7 (B) (LT)
Material Ordering and Supply Chain Issues	X				X		X		X
PV System Connection	X						X		
Social Engagement	X	X	X	X					X
Financial Constraints	X				X	X		X	
Ineligible pilot building			X						
Administrative or bureaucratic delays	X		X				X	X	X
Sensor technical issues				X	X	X			
Unwillingness to install sensors		X	X						
Elderly pilot users/ lack of digital literacy		X	X		X				
Remote houses to be renovated					X				
Electricity bill collection					X	X			
Shortage of skilled labour					X	X			
Unforeseen repairs					X				
Building operation during renovation								X	

Based on the information that can be drawn from the previous table, as well as the description of the challenges by each pilot, we can draw some conclusions for each challenge that are presented below. The challenges are grouped in the following groups: renovation/construction related challenges, administrative/bureaucratic challenges, and social engagement challenges. As seen in the following paragraphs, the largest number of challenges were located during the renovation works and all the stages that they include.

### **Renovation/Construction Related Challenges**

#### **Material Ordering and Supply Chain Issues.**

This challenge affected pilots 1, 3, 5, and 7. Three of these pilots (1, 5, 7) concern big buildings and one pilot (3) concerns homeowners. It can be surmised from the descriptions in the pilot subchapters that this challenge was largely circumstantial and that it is not suitable for drawing horizontal conclusions and lessons learnt. Specifically, for pilot 3 the delay constituted an anomaly compared to their usual processes and timelines and for pilot 7 the delay concerned the ventilation system which is quite innovative and is being produced by the company for the first time. Similarly, for pilot 1, where the material delays mostly concern the smart windows which are very innovative with not many companies selling them. It could potentially be assessed that since both Greek pilots showed delays in material ordering, a lesson could be drawn for the case of Greece. However, in pilot 5 the delays pushed back the renovation timeline by only a week, which is not enough to make a case for delays in the case of Greece. It can be concluded, as initially mentioned, that such delays are circumstantial. As such, the affected pilots have created strategies to mitigate such delays in the future.

#### **Ineligible Pilot Building**

This issue only appeared in one pilot (Garcia Rama) as the initial building was ineligible due to receiving funding from another renovation project. The issue was resolved by the pilot quickly and renovations in the new building are underway.

#### **Sensors Technical Issues**

This issue was reported by pilots 2 (Oktave), 3, and 4. These pilots received sensors built by MESH (an official member of the consortium and pilot support to pilot 7). The company constructed a new sensor that measures temperature, humidity, and CO<sub>2</sub> in a house. These sensors were then sent to the pilot sites. The MESH partners had several training sessions with pilot representatives to teach them about the installation process of the sensors and then the pilots were installed in the houses. The sensors operate in the LoRaWAN network, which is a low-power, wide area networking protocol built on top of the LoRa radio modulation technique. It wirelessly connects devices to the internet and manages communication between end-node devices and network gateways. This option was applied to overcome a challenge faced by pilot 3 specifically, as the renovated houses are remote and most of them do not have an internet connection. As with any new product, some technical issues appeared that had to do with high battery usage and connectivity issues with the network. However, MESH applied a new patch/update to the sensors to combat the high battery usage and had many discussions with the pilot representatives to overcome connectivity issues. MESH partners have set up bilateral communication channels with the affected pilot so that they can provide seamless technical support. These channels proved to be very useful, and the technical issues are being resolved shortly after they appear.

#### **Remote houses to be renovated**

This challenge, by definition, only affected pilot 3 that is renovating old, remote houses owned by beneficiaries that live in energy poverty. The only issue that arose from this challenge was the

inability of the pilot leaders to make frequent visits to the selected houses. However, Just a Change is a company that specialises in setting up and completing such renovation projects, which is well reflected in their activities and processes. Any further required communication is done via phone calls since the beneficiaries of the pilot do not have an internet connection.

#### Shortage of skilled labour

This challenge appeared in both Portuguese pilots, i.e., pilot 3 and pilot 4. It has been expressed by both pilots in their respective subchapters but also in discussions and pilot-related meetings that this is a national problem that needs to be resolved, especially as the renovation wave intensifies in the following years. This creates two distinct problems. The first one concerns delays due to the lack of skill or due to workers/contractors leaving early and before the renovation was complete. The second issue is related to the need from the side of the pilot leaders to find other contractors and workers that can finish the job. It was reported by the Portuguese partners that most construction companies that they approached did not reply to the emails. In some cases, the pilot partners phoned the construction companies. In both cases, it appeared that construction companies have trust issues when asked to collaborate with a new partner that they do not know. As such, it is suggested that Portuguese companies that undertake renovation projects need to branch out and create a bigger network of collaborating organisations so that they can explore other options when a certain contractor cannot handle a renovation work.

#### Unforeseen repairs

This challenge has only affected (up until this point of the project) pilot 3. While this is an issue that can create delays in the completion of a renovation project, in the case of pilot 3 it is also connected with the lack of enough skilled workers that handled the work. In any case, having to also account for unforeseen repairs should not be viewed as uncommon during renovations and it is suggested that renovation timelines (especially in research projects like FORTESIE) need to become more flexible to account for such delays. Also, given that research projects operate on a strict timeline, a potential solution would be for the renovations to start earlier in a project's duration. This also means that the preparatory steps that are required to set up the renovations need to be completed faster.

#### Building operation during renovation

This challenge only affected pilot 6, given that the public pool must temporarily terminate its operation until the renovations can be completed. This challenge did not show up in any of the other public buildings. In any case, as also reported in the subchapter of pilot 6, this challenge cannot be completely resolved. However, the aim is to organise renovations in public buildings in a way that minimises the period when the building will not operate, while also doing the renovations during a suitable season (that depends on seasonal conditions of each country) so that bad or intense weather effects do not cause additional delays.

#### Electricity bills collection

This challenge was reported by pilots 3 and 4 that are both located in Portugal. The main issue was that several of the pilot beneficiaries in both cases did not have the electricity bills that were required (12 months of electricity bills prior to the completion of the renovations) that would help us calculate their baseline energy consumption, costs, and CO<sub>2</sub> emissions. This issue was even bigger in pilot 3, as most of the beneficiaries have limited or no digital literacy. In such cases, the electricity providers were contacted with the consent of the beneficiaries to request the missing bills.

## **Administrative/Bureaucratic Challenges**

### Administrative or bureaucratic delays

This is a challenge that affected all the public building pilots (pilots 5, 6, 7) as well as pilot 2 (Garcia Rama). In the cases of public buildings this challenge concerned delays for receiving the approval for the building permits, delays in drafting and signing the tenders as well as delays caused from the transition of personnel in specific public administrations. In the case of pilot 2 and Garcia Rama, the delay concerned the hiring of a new municipal architect that needed to review and sign the renovation project before it could begin. This truly constitutes an important challenge that need to be resolved by European member states. While the European and national targets for energy transition and climate neutrality are quite ambitious, the lack of agility in the administrative processes does not fit in with the urgency of the matter. It is thus, strongly suggested that national processes need to become much more agile. Even in countries with chronic bureaucratic issues, administrative processes that are related with renovation projects and PV systems (as described in the next challenge) need to take priority and be resolved quickly so that the benefits of each renovation can be reaped as soon as possible.

### PV System Connection

This issue appeared in both Greek pilots that also concern big buildings. While the PV systems have been installed in both buildings, to this day, the connection of the PVs to the electrical grid has not been completed for these pilots, due to administrative delays. As such, it can be said that such processes must become much more agile in Greece, especially for big and public buildings that are required by the state to reduce their electrical costs in the following years.

### Financial Constraints

This issue appeared in pilot 1, pilot 3, pilot 4, and pilot 6. Two of these pilots are in Portugal (3, 4) while the other two concern renovations in big buildings (1, 6). While this is an issue that was more or less reported by most pilot partners, it affected the aforementioned ones the most. The financial constraints are not related to the lack of budget from the project but rather to the steep inflation rates that we have seen globally in these last years, due to war and the energy crisis. While this is an issue that is hard to predict and address adequately in research projects, potential solutions include the execution of financial forecasting at the proposal stage as well as instituting a level of flexibility in the renovation budgets so that such challenges can be resolved.

## **Social Engagement Challenges**

### Social Engagement (in general)

This challenge was the one that most pilots had an issue with, given that apart from pilots 3, 4, 5, and 6 all other pilots reported difficulties in engaging with their end users. The main issue faced by the pilot leaders was a difficulty in convincing their stakeholders to participate in the full spectrum of FORTESIE activities. In some cases, pilot stakeholders are too few (e.g., pilot 1), while in other cases they were unwilling to install sensors (e.g., Veolia and Garcia Rama). In the case of pilot 3, the number of homeowners that need to be engaged create big overheads to the pilot partner while in the case of pilot 7 (public school), the busy schedule of teachers made it difficult to find suitable times for meetings with them. In the end, most of these challenges have been sufficiently resolved (or their resolution is underway). Also, some successful practices can be drawn from the case of pilot 6 who managed to maintain the desired engagement with their local community through a steady stream of communication activities, making the communication material clear and well-

explained as well as actively involving and engaging stakeholders in the decision-making and planning of the renovation.

#### Unwillingness to install sensors and Elderly pilot users/lack of digital literacy

These two challenges are presented together as they appeared in the two Spanish pilots (Veolia and Garcia Rama) and they are closely interconnected. In both these pilots, the tenants of the renovated buildings are mostly elderly and do not have a high level of digital literacy. This created challenges in convincing them to install and use the sensors for monitoring their houses' internal conditions. Based on feedback from the pilot leaders, the tenants considered that the improvements from the renovations were enough and were not willing to perform the additional step of installing sensors as they were not aware of the benefits. In the case of Veolia, this challenge was resolved quite adequately as the pilot leaders provided even further explanations and tried to resolve the concerns of each tenant at a personal level. While Garcia Rama performed the same actions to help further convince more tenants, these actions were not as successful as in the case of Veolia. One factor that might have made a difference, is that the district where Veolia operates is quite tight and they have frequent meetings about any issues that arise. As such, the pilot leaders were able to leverage the help of the district president who also acted as an evangelist for the sensors and managed to convince enough tenants. One conclusion that can be drawn from this challenge is that social engagement strategies need to be more reflective and targeted towards the elderly. However, even in such cases where everything is done as well as possible, we need to be prepared that not every person can be convinced. Another strategy that can be tested towards the end of the project is to approach once more the unwilling tenants, show them the benefits and positive testimonials of people who agreed to have the sensors installed and see if this can help in convincing them.

## 5 Conclusions and Next Steps

Deliverable D4.3 – “Pilots execution documentation and validation assessment” represents the next phase in the progression of FORTESIE’s pilot implementation activities, following the preparatory work of D4.1 (“Pilots preparation, baseline analysis and planning”) and the engagement and social acceptance strategy outlined in D4.2. This deliverable builds upon those foundations by documenting the actual execution status of the renovations, the deployment of monitoring infrastructure, the establishment of updated KPI structures, and the preparation for the evaluation of both physical interventions and digital services.

The current deliverable contributes to WP4 by:

1. Presenting updated renovation and engagement timelines per pilot, reflecting any delays, changes, or optimisations based on local conditions.
2. Providing the final version of the KPI tables for each pilot, including baseline and target values, wherever such data is available.
3. Reporting on the progress of sensor installation and data migration activities that are critical for assessing comfort, energy use, and environmental conditions post-renovation.
4. Introducing the pre-final version of the social acceptance survey that will be used across pilot sites to capture end-user feedback in a modular and locally adaptable format.
5. Highlighting early challenges experienced during pilot deployment, offering pilot-specific and horizontal lessons learned that will inform both future project activities and the upcoming policy recommendations under WP6.

It is evident that the FORTESIE pilots are now at varying stages of renovation completion, digital tool integration, and stakeholder engagement. Certain pilots—particularly those with public buildings or previously selected pilot sites—are further ahead in their implementation, while others (mainly multi-residential settings) have experienced delays due to factors such as administrative bottlenecks, supplier unavailability, and end-user hesitance. Nonetheless, progress has been consistent across all sites, and corrective actions are being implemented where necessary.

The comprehensive documentation and coordination mechanisms established in the earlier stages of the project—such as the pilot reporting spreadsheet and first/second-level support structure—have proven instrumental in keeping the pilot activities aligned and traceable. These tools will continue to be used to track remaining milestones and coordinate the collection of data needed for the final validation and assessment phase of WP4.

The following actions will guide the next phase of pilot implementation and assessment activities:

- Finalisation of renovation activities in the remaining pilot sites, including the resolution of ongoing procurement and installation issues (e.g., smart windows, sensor placement).
- Completion of sensor deployment and data integration into the FORTESIE data sovereignty platform to allow for continuous monitoring and comparative assessments.
- Rollout of the FORTESIE digital tools, including the mobile application and the OSS marketplace, tailored to each pilot’s timeline and end-user profile.
- Phased implementation of the social acceptance survey, beginning with modules related to renovation satisfaction, followed by comfort and digital services evaluation in alignment with user experience timelines.
- Monitoring of KPIs and preliminary validation of performance metrics, including energy use reduction, CO2 emissions, comfort improvements, and digital engagement.

- Contributions to D4.4, the final deliverable of WP4, which will present validated results from each pilot and offer quantifiable evidence on the impact of FORTESIE interventions.
- Collaboration with WP6 to feed into the lessons learned and policy recommendations (D6.4), ensuring that practical insights from pilot deployment are reflected in forward-looking strategies for EU-wide renovation efforts.

Overall, the transition from pilot preparation to execution marks a pivotal point in the FORTESIE project. With the renovation groundwork nearly complete and the digital infrastructure ready for deployment, the consortium is now well-positioned to gather impactful data, demonstrate the effectiveness of the FORTESIE model, and validate its potential for broader replication.