RINNO PROJECT

Report

Transforming energy efficiency in European building stock through technology-enabled deep energy renovation

Deliverable 6.4: Training of Stakeholders
Work Package 6

Authors:
Elsebeth Terkelsen, EGC, Eirini Lithoxoidou, CERTH,
Ilias Chrysovergis , CERTH, Stefan Pallantzas, HPHI,
Katarzina Rajkewicz, NAPE, Rosalie Bruge, LMH

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Title	RINNO - Training of Stakeholders
Author(s)	Elsebeth Terkelsen, EGC, Eirini Lithoxoidou, CERTH, Ilias Chrysovergis , CERTH, Stefan Pallantzas, HPHI, Katarzina Rajkewicz, NAPE, Rosalie Bruge, LMH
Editor(s)	Elsebeth Terkelsen, EGC, Eirini Lithoxoidou, CERTH, Ilias Chrysovergis , CERTH, Stefan Pallantzas, HPHI, Katarzina Rajkewicz, NAPE, Rosalie Bruge, LMH
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Executive Summary

This document is a report on the activities of the RINNO project, an Innovation Action project supported by the European Union Horizon 2020 programme under Grant Agreement Number 892071. The main objective of RINNO is the transformation of the energy efficiency in European building stock through technology-enabled deep energy renovation. More information on this project can be found at https://rinno-h2020.eu/.

In detail, this document represents the first version of deliverable D 6.4, and it describes the activities within task T6.2 of the WP 6 work package of the project concerning training of stakeholders.

Within this task, the first version of the design of the Training of Stakeholders - training off-site and on-site workers - is presented. This first version explains the purpose of the training, the target groups, the content, i.e. the AR toolkit and how it relates to the demo sites, and how the training is planned to be organized. The training will be according to the technologies that have been agreed to be installed in the pilot sites during renovation.

The planning of the training is in two phases:

Phase 1: Preparations

1. Identification of stakeholders on the four demo-sites
2. Tailor-made training modules for different stakeholders
3. Setting up the user support system for new users and people who want to refresh their knowledge.

Phase 2: Execution:

1. Identification of skill of the trainer and allocation of appropriate personnel in each country (CERTH and BOUYGUES),
2. Preparation of consistent training material and
3. Delivery of live training and ongoing support as a user hotline system.

The whole process will be thoroughly evaluated. This will be included in version 2 of this deliverable (D6.5) to be delivered after the training. The training, according to the actual time plans, will be performed between M32 and M37.

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Abbreviations List

AR	Augmented Reality
DSS	Decision Support System
EC	European Commission
GA	General Assembly
GA	Grant Agreement
KPI	Key Performance Indicators
O&M	Operation & Maintenance
PES	Primary Energy Savings
RPDA	RINNO Planning & Design Assistant

1 Introduction

An important part of the RINNO project is the testing of the AR-Viewer of the AR-Toolkit with the workers on site at the four demo sites. The tool has been developed by CERTH and is presented in detail in D4.7. In this deliverable, we introduce the tool, incl. re-capturing of relevant information from D4.7, inform about the stakeholders and how we plan to organize the training.

The AR-Viewer is at the time of this deliverable in a semifinal version. It has been demonstrated and pre-tested by the demo site leaders at the general assembly in Genova on the 25th November 2022, and this builds the basis for the general planning of the training. Next step is to combine it with local needs and conditions. Both the tool and the training modules will be developed and adapted during the coming months.

The AR-Viewer includes a number of tutorials on the different technologies that can be downloaded from the platform. Further content is needed from the technology providers to include all the RINNO technologies. PINK and K-FLEX have provided information on their products, and this will be used as the first testing of AR-Viewer.

The tool will be available for android smartphones and tablets. The demo sites (and later the workers), need to be equipped with tablets or smartphones to use the AR-tool.

Since smart AR helmets are still very expensive, CERTH will provide its' Microsoft HoloLens for training on at least one of the demo sites. Depending on when the version of the AR-Viewer becomes available for the HoloLens, one CERTH member will be in one of the trainings at the demo sites in person in order to help the workers be trained with it.

CERTH has resources for training sessions – for instructing in how to use the application. This must be done individually. The pre-test will show if we, eventually, can have an engineer onsite and CERTH online / remote for the training. This is also a challenge to be met for the further replication of the AR-toolkit.

1.1 Scope of the deliverable / training

Purpose of the AR-Viewer, the tutorials and the training is to assist workers in implementing the technologies in the building efficiently and on time.

During the pre-test, the test, and the evaluation of the trainings, we will locate the challenges and barriers in the AR-toolkit, the organization of the trainings and the need for online support.

1.2 Relation to other WPs

The toolkit is described in detail in D4.7. For the tutorials, inputs have been given from almost all WPs.

In WP1, the scenarios were developed (D1.5). In WP2, the technologies are described. WP3 has delivered the analysis that are a basic element in the tool, BIM models and the training tool (AR-Viewer) has been created in WP4 and the time plans for the training are delivered in WP6.

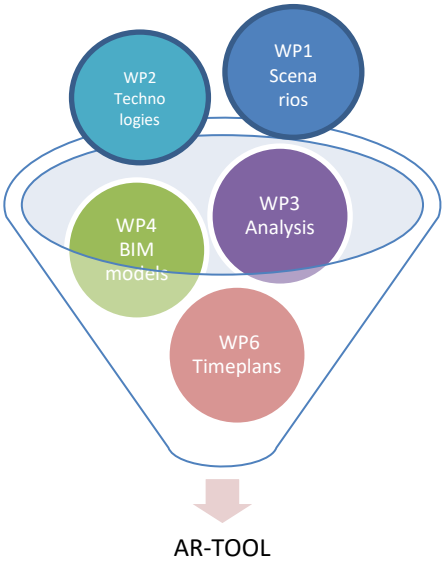

Figure 1 AR tool

2 Target groups

2.1 Workers on the renovation sites

The primary target group is the workers on site, carpenters, plumbers, electricians. The idea of the AR-Viewer is to enable the workers to find information on the technologies and how to install them in the building, saving time and avoiding mistakes and errors on the building site to accelerate the renovation process.

2.2 Advisors and consultants – architects and engineers

Another important target group is advisors and consultants – architects and engineers. They need to know what information can be found on the AR-toolkit to support the workers in the learning process. It is important that they are familiar with the tool to know the technologies, the support they can get in the building process and the managing on the building site.

2.3 Technical and administrative personnel and municipalities

The technical personnel responsible for the operation and maintenance of the building on behalf of the building owner, need to know how to access information on the technologies installed to operate and maintain the building.

The administrative personnel can be informed about the innovative tools used in the building, but do not need detailed information.

The municipalities are not directly involved but can be informed as well – to be updated on the development in the renovation sector.

2.4 Building owner and tenants

For the building owner and the tenants, it is important to be informed on what is happening in their house. Therefore, both building owners and tenants will be informed on how to see the building monitoring in 3D or AR mode. In addition, data collected from sensors (e.g., temperature, humidity) installed in the building can be viewed.

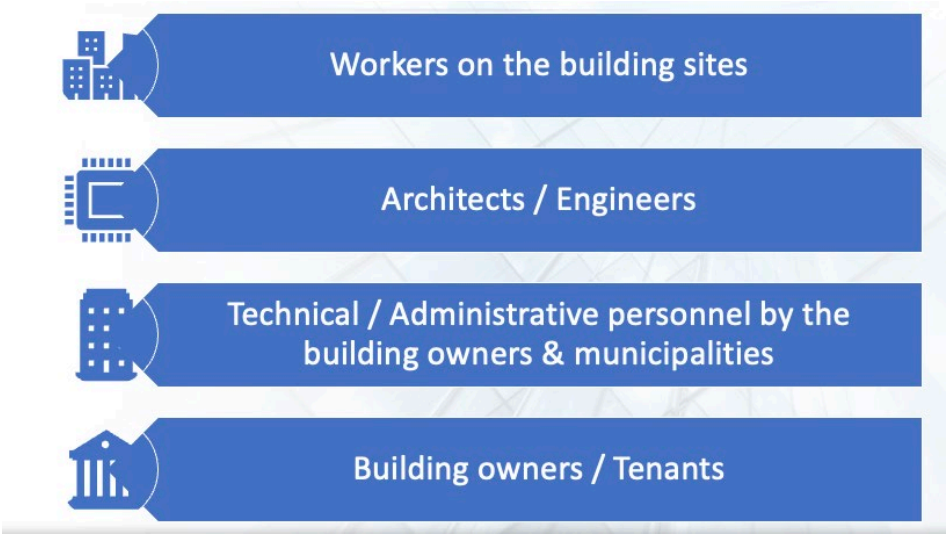

Figure 2 Target groups

3 Content and design

3.1 Short presentation of the AR-tool (from D4.7)

The training will focus on the AR-tool – one of the IT tools in the RINNO SUITE.

The AR-tool with tutorials on different types of media (such as images, videos, and 3D models) show how different technologies are installed, used, maintained and repaired.

Workers can view these tutorials on demand either off or on site using their smartphones or tablets to understand how a specific task is performed. Finally, inexperienced workers can ask for remote assistance from more experienced ones to help them solve problems regarding the completion of tasks of the renovation, instantaneously and without adding delays to the retrofitting process.

In the following, the AR-tool is presented as-is to build the basis for the development of the training modules in T6.2.

3.2 RINNO – Augmented Reality 'On-the-Job' training services for craftsmen and technical advisors and personnel

The AR "On-the-Job" training and assistance toolkit is comprised of different applications that are either web-based, mobile-based or built for the HoloLens. A detailed description can be found in D4.7. However, in this report a brief presentation of the applications is given of central elements, as these are important to understand the AR-tool.

The AR toolkit consists of the following:

i. A web app (AR-Creator) with which the technology providers are able to create tutorials on their solutions.
ii. A web server (AR-Server) where all data regarding the tutorials are saved, and with which remote communication is established.
iii. A mobile app (AR-Viewer) with which the worker can view the tutorials and ask for remote assistance by an experienced worker or engineer.
iv. A mobile app (AR-Manager) in which the site manager can view the progress of the construction works, and data collected from sensors (e.g., temperature, humidity) installed in the building.
v. A HoloLens app (AR-Constructor) with which the contractor responsible to implement all the retrofitting solutions, can find on which specific location all the tasks have to be performed.

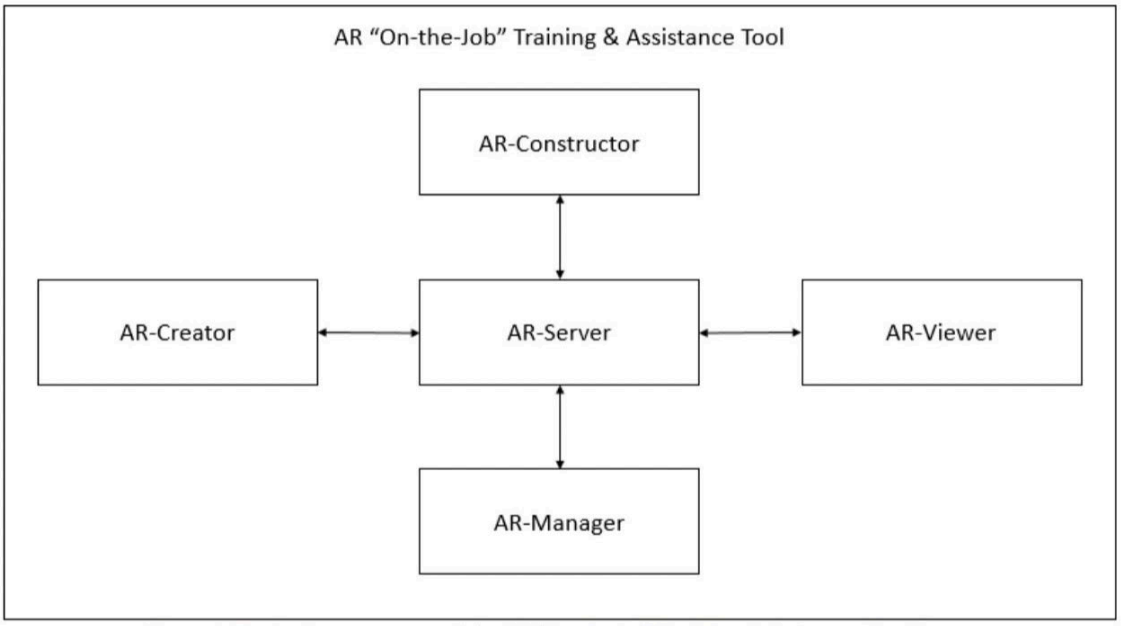

Figure 3 - The basic components of the AR "On-the-Job" Training & Assistance Toolkit

Using the AR-viewer, workers can be trained in new technologies. In the concept of RINNO, these technologies have to do with the solutions provided for the renovation of buildings e.g. showing how PINK and K-FLEX, partners of RINNO, can utilize the AR-Viewer to train their personnel on their technologies.

The AR-Viewer is a mobile application developed with the Unity3D engine. It has three different pages with which the users can interact.

1) Log in and sign-up page. Through this page, the users can sign up and their information is saved in the database of the AR-Server. Then, they can log in by sending their credentials to the AR-Server.
2) A button for each available procedure shows a representative image of it and its name. When the procedure button is chosen, the description of it is shown. The user can then choose to watch the tutorial.

Figure 4 - Photo - Demonstration at the RINNO GA in Genova – choice of technologies – PINK and K-FLEX

3) The third page is the one that shows the tutorials of the selected procedure. Here one can see what functionalities are available and which actions trigger the execution of other actions. When the page opens, the users can see the tools and components that are related to each action. The users can also see the procedures, operations and actions names, the action's description and a list of all the different operations and actions on that procedure.

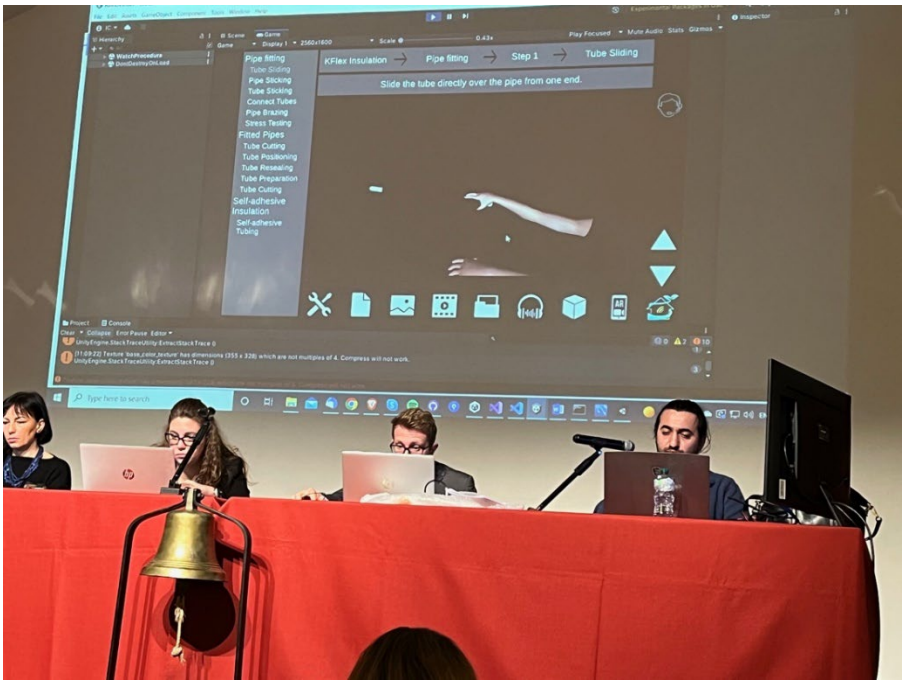

Figure 5 - Photo – Demonstration at the RINNO GA in Genova – list of actions and in the bottom the different medias for the instruction

Additionally, for each action the users have the choice to select whichever media they want to view - if available.

The AR-tool will be translated into the languages of the four demo sites.

3.3 Information meeting for building owner, tenants, administrative personnel on RINNO and energy efficiency

When informing on the AR tool, it is an occasion that can be used for some general information on energy efficiency and energy savings. It is a well-known fact that without training user behavior, the investment in the renovation might not lead to the expected energy savings.

4 Planning and timeline

4.1 Preparation activities

4.1.1 Tailor made modules for the training

The training will be tailored the renovation project at each demo site, instructing in the implementation of the actual technologies:

1. French demo: Bio-based pipes and sheets (K-FLEX), MicroVent sustainable Ventilation system (EKOLAB), K-BOX bio-based insulating system for parts of energy systems (KFLEX).

2. Greek demo: Bio-based double layer panels (K-FLEX), Thermochromic glass (GREENSTRUCT), Building integrated photovoltaic panels (GREENSTRUCT).

3. Polish demo: Bio-based double layer panels (K-FLEX), Bio-based pipes and sheets (K-FLEX), Isocell Cellulose Insulation (EKOLAB), Zappa PV -Roof and -Facade solutions (EKOLAB).

4. Danish demo: Bio-based pipes and sheets (K-FLEX), Isocell Cellulose Insulation (EKOLAB), Zappa PV -Roof and -Facade solutions (EKOLAB), MicroVent sustainable Ventilation system (EKOLAB), K-BOX bio-based insulating system for parts of energy systems (KFLEX).

The preparation of the training will take place as follows:

Dec 2022 – Jan 2023	Developing the national training programs in cooperation with CERTH and the national partners
Jan 2023	Agreements with speakers, settling the dates
Jan 2023	Finishing of the national programs
Feb 2023	List of potential participants
Feb 2023	Lay out of invitations
Feb - May 2023	Sending out invitations
Feb - June 2023	Trainings in France, Greece, Poland and Denmark according to timetables in 5.2

Figure 6 Time line for the planning of the training

4.1.1.1 Training the AR Viewer

The training of the AR-Viewer will include instructions on

1) Accessing the AR-Viewer (installation, log in etc.)
2) Information on the general use and the overall information, available through the AR tool
3) Testing the tool on site
4) Evaluating the tool

Within the timeframe of the RINNO project, and the challenge of coordinating with the time plans of the demo sites, not all tutorials will be finished. But PINK and K-FLEX tutorials will be used in the testing of the AR-Viewer.

Example - K-FLEX tutorial

The AR-tool shall include the different situations, the workers will meet, when they are to install the K-FLEX pipes. This is rather a big challenge. As an example, the different situations concerning the K-FLEX pipes, can be described as follows:

1. Pipes that need to be fitted
2. Pipes already fitted
3. Self-adhesive insulation tubing
4. Insulating an 90° elbow fitting with tubes of the same diameter
5. Insulating an 90° elbow fitting with tubes of different diameter
6. Segmented insulation of an 90° elbow fitting with tubing of the same diameter
7. Segmented insulation of an 90° elbow fitting with tubing of different diameter
8. Insulating a T-fitting with a 90° cut-out
9. Insulating a T-fitting with a round insert
10. Insulating a reducer
11. Elbow fittings over 90°
12. Insulating a straight pipe with a sheet
13. Creating elbows
14. Creating “T” fittings
15. Creating Reducers
16. Insulating ducting with standard sheet
17. Insulating ducting with self-adhesive sheet

To simplify the tutorials, the 17 different tasks can be categorized into five procedures for the technicians / workers easily to understand what they are about, select the one they need and then choose from the operations list which one they want to view. These five procedures are the following:

1. Straight pipe fitting with tubes
2. Insulation with elbows
3. Insulation with “T” fittings
4. Insulation with reducers
5. Insulation with sheets

4.1.1.2 Information on energy efficiency

Including energy efficiency and user behavior is an important element in the training. This could e.g. include:

1. Introduction to the RINNO project, purpose and means
2. About the AR toolkit
3. The modernization of the building
4. PV Installation – collective prosumer and energy efficiency
5. Air quality in apartments - results of measurements
6. Other relevant information on energy efficiency, user behaviour etc.

4.1.2 Training materials

4.1.2.1 Training material for training the AR tool

The training material will be a guide on how to use the AR-Viewer. In D4.7, the basic material

for the guide is already available. This will be developed further in relation to the starting of the training and translated into Greek, French, Polish and Danish.

4.1.2.2 Information material on energy efficiency

A lot of material is already developed on energy efficiency and user behavior. A special guide / folder on the four demo sites and the RINNO project will be developed to support the training sessions.

4.1.3 Setting up support system for new users

See chapter 5 – Ongoing user hotline.

4.2 Execution

The training is to take place during the construction period to optimize the motivation of the workers and the surrounding stakeholders.

The demo sites have just revised their time plans (D6.2), and the training will be integrated as follows:

<u>French demosite</u>

Retrofitting		Start M	End M
Tender and signing for selection of retrofitting contractor and subcontractors	demo leaders, advisors	Jun.22	
Sending administrative authorization of works	demo leaders, advisors	Jun.22	
Bill of Quantities	demo leaders, advisors	Jan.23	
Material/Product orders	demo leaders / contractor	Jan.23	
Preparing works	demo leaders / contractor	Jan.23	
Training of workers	Demo leaders /advisors/CERTH	Feb.23	
Works in the building to apply the technologies of scenario 3 (Thermical works)	Constructor	Mar.23	
Works in the interior of flats	Constructor	Jun.23	Nov.23

Retrofitting		Start M	End M
Tender and signing for selection of retrofitting contractor and subcontractors	demo leaders, advisors	Jun.22	
Sending administrative authorization of works	demo leaders, advisors	Jun.22	
Bill of Quantities	demo leaders, advisors	Jan.23	
Material/Product orders	demo leaders / contractor	Jan.23	
Preparing works	demo leaders / contractor	Jan.23	

Training of workers	Demo leaders /advisors/CERTH	Feb.23	
Works in the building to apply the technologies of scenario 3 (Thermical works)	Constructor	Mar.23	
Works in the interior of flats	Constructor	Jun.23	Nov.23

Figure 7 Time plan France

Greek demosite

Retrofitting		*Start M*	*End M*
Selection of the Renovation Scenario to be executed	*demo leader*	*Feb.22*	
Bill of Quantities	*Design office / contractor*	*Jun.22*	
Developing the campaign strategy	*Demo leader*	*Jun.22*	
Website of the project	*Demo leader*	*Jun.22*	
Starting the crowdfunding campaign	*Demoleader + Partners*	*Nov.22*	
Material/Product orders	*Demo Leader*	*Mar.22*	
Site preparation	*demo leader*	*Apr.22*	
Training of workers	*Demo leaders /advisors/CERTH*	*May 23*	
Delivery of material/products	*Technology providers*	*May.22*	
Retrofitting (deployment/installation)	*demo leader / contractors*	*Jun.23*	*Sep.23*

Figure 8 Time plan Greece

Polish demosite

Retrofitting		Start M	End M
Definition of authorisations/licenses required, Contact with relevant authorities	demo leaders	Dec.22	
Identifying funding mechanisms and applying for/securing funding	demo leaders/owners	Jan.23	
Application for relevant licenses (in parallel with conceptual and detailed design)	demo leaders (design office)	Feb.23	
Obtaining relevant licenses	demo leaders (design office)	Mar.23	
Bill of Quantities	demo leaders (contractor)	Apr.23	
Tender and signing for selection of retrofitting contractor and subcontractors	demo leaders	Apr.23	
Material/Product orders	demo leaders (contractor)	Apr.23	

Site preparation	demo leaders (contractor)	Apr.23	
Training of workers	demo leader / advisor /CERTH	May.23	
Delivery of material/products	Technology providers	May.23	
Retrofitting (deployment/installation)	demo leaders (contractor)	Jun.23	Oct.23

Figure 9 Time plan Poland

Danish demosite

Retrofitting		Start M	End M
Finalisation of monitoring equipment	demo leader	Mar.22	
Selection of the Renovation Scenario to be executed	demo leader/building owner	Mar.22	
Appointing Design Office	demo leader/building owner	Nov.22	
Detailing project	Design Office	Feb.23	
Tender and signing for selection of retrofitting contractor and subcontractors	demo leader/ Design Office	Mar.23	
Bill of Quantities	demo leader / contractor	Mar.23	
Material/Product orders	demo leaders / contractor	Apr.23	
Delivery of material/products	Technology providers	May.23	
Site preparation	Contractor	May.23	
Training of workers	Demo leader / advisors/ CERTH	Jun.23	
Start works	Contractor	Aug.23	
Retrofitting (deployment/installation)	Contractor	Aug.23	Dec.23

Figure 10 Time plan Denmark

4.2.1 Identification of trainers (CERTH & BOUYGUES)

The trainers are primarily **experts from CERTH**, who will instruct in accessing the AR-tool (installation, log in etc.) and information on the general use and the overall information, available through the AR-Viewer.

The **demo leaders** will assist on location in the four demo sites in the testing the tool and the evaluating of the tool.

4.2.2 Identification of personnel (HPHI, LMH, NAPE & EGC)

The demo site leaders will identify the personnel to participate in the training. This will be at least three months before the planned training.

The personnel is to be found between the stakeholders mentioned above:

- Workers on site (carpenters, plumbers, electricians a.o.)
- Architects and engineers
- Technicians – managing the building

An information meeting will be a part of the training – for the building owners, the administrators of the building, the tenants, and evt. the municipalities.

4.2.3 Identification of localities

The demo site leaders will find localities and provide the necessary equipment and catering for the training.

4.2.4 Invitations to stakeholders in the four demo countries

The demo site leaders will provide invitations to the identified personnel.

Expected participants (to be confirmed before the trainings):

	France	Greece	Poland	Denmark
	jan.23	mar.23	feb.23	jun.23
	Participants	Participants	Participants	Participants
Information meeting for building owner, tenants a.o. stakeholders	**10**	**10**	**5**	**10**
Bio-based double layer panels (K-FLEX)		Plumber	Plumber	
Bio-based pipes and sheets (K-FLEX)	Plumber		Plumber	Plumber
K-BOX bio-based insulating system for parts of energy systems (KFLEX)	Plumber			Plumber
Thermochromic glass (GREENSTRUCT)		Carpenter		
Building integrated photovoltaic glass (GREENSTRUCT) incl. Mounting system		Carpenter plumber electrician		
Isocell Cellulose Insulation (EKOLAB)			Carpenter	Carpenter
Zappa PV -Roof and -Facade solutions (EKOLAB)			Carpenter plumber electrician	Carpenter plumber electrician
MicroVent sustainable Ventilation system (EKOLAB)	Electrician masons			Electrician masons
De-centralized domestic hot water solution (PINK)				Electrician
Particpants in the trainings	**3**	**10**	**7**	**6**
Total participants	**13**	**20**	**12**	**16**

Figure 11 Estimated number of participants

It is important that the participants' invitation and participation lists can be exported into an Excel database for the further use e.g. sending out final program, links to the tool etc.

Below a paradigm for registration in categories to be integrated in the RINNO website (example from Danish Round Table). TBC.

Navn	Mail	tlf	titel	Organisation	Type	Region	Kolonne5

Figure 12 Registration of participants

4.2.5 Delivery of training

The identified trainers together with the demo site leaders will perform the training – on location and with remote participation from CERTH.

Preliminary program for 1-day training:

PROGRAM (DRAFT FOR THE DANISH TRAINING SESSION)

10:00	**Welcome and introduction to participants** By EGC - European Green Cities, FOB – building owner and EKOLAB – engineering company Participants: Building owner, tenants, FOB administrative and technical personnel, architect and engineer
10:15	**Presentation of the renovation and RINNO –** ● Introduction to the RINNO project, purpose and means ● The modernization of the building incl. new technologies ● PV Installation – collective prosumer and energy efficiency ● Air quality in apartments - results of measurements ● Other relevant information on energy efficiency, user behaviour etc. ● About the AR toolkit ● Questions and discussion By Diana Oleen, EKOLAB and Elsebeth Terkelsen, EGC
11:30	**Testing the AR tool** By CERTH and EKOLAB Participants: All
12:00	**Lunch break** Participants: All

The second part of the training will be for the workers only

13:00	**Training in the AR tool** ● Accessing the AR-Viewer (installation, log in etc.) ● Information on the general use and the overall information, available through the AR tool By CERTH
14:00	**Testing the tool on site**
15:00	**Coffee break**
15:30	**Evaluating the tool and the training** Questionnaire and interviews By EGC
16:00	**End of training**

4.2.6 Evaluation of the training

After the training, the whole process will be evaluated. This will be in the form of interviews with the four stakeholder groups and questionnaires to analyse the results and get insights on which functionalities in the AR-tool are helpful and which need to be improved.

Evaluation questionnaires will be developed in cooperation between CERTH and the demo leaders.

5 Ongoing user hotline

5.1 Creation of platform

According to the GA, a platform to deliver an ongoing user hotline is to be provided. The AR-tool is constructed so that users can communicate with each other, more skilled workers, and the technology providers during use. Another platform is not necessary.

5.2 Creation of organization to maintain the platform

Maintaining the AR-tool is in the interest of the technology providers, whos' technologies are demonstrated on the platform. A business model will be developed to ensure the maintenance beyond the RINNO project. Further use will be discussed in WP7 and in the replication plan D6.5.

5.3 Information on the platform

Information on the platform will be provided as a part of the dissemination and communication tasks in WP8.

ABOUT RINNO

RINNO is a four-year EU-funded research project that aspires to deliver greener, bio-based, less energy-intensive from a life cycle perspective and easily applicable building renovation elements and energy systems that will reduce the time and cost required for deep energy renovation, while improving the building energy performance. Its ultimate goal is to develop, validate and demonstrate an operational interface with augmented intelligence and an occupant-centered approach that will streamline and facilitate the whole lifecycle of building renovation.

For more information, please visit **https://rinno-h2020.eu/**

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