OPTIMISED ENERGY EFFICIENT DESIGN PLATFORM FOR REFURBISHMENT AT DISTRICT LEVEL

Optimised Energy Efficient Design Platform for Refurbishment at District Level
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D6.3: Report on stakeholders and IPD implementation to demonstrate the OptEEmAL platform

WP7, Task 7.5

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Abbreviations and Acronyms

Acronym	Description
AEC	Architecture, Engineering and Construction
BIM	Building Information Model
DDM	District Data Model
DEM	Data Exportation Module
DIM	Data Insertion Module
DMM	District Management Module
DPI	District Performance Indicator
ECM	Energy Conservation Measure
EPC	Energy Performance Certificate
ETL	Extract-Transform-Load
GIS	Geographic Information System
ESB	Enterprise Service Bus
GUI	Graphical User Interfaces
IFC	Industry Foundation Classes
IPD	Integrated Project Delivery
NEST	Neighbourhood Evaluation for Sustainable Territories
JSON	JavaScript Object Notation
OM	Optimisation Module
OptEEmAL	Optimised Energy Efficient Design Platform for Refurbishment at District Level.
OWL	Ontology Web Language
RDB	Relational DataBase
RDF	Resource Description Framework
RDFS	Resource Description Framework Scheme
SM	Simulation Module
TDB	Triple DataBase
XML	eXtensible Mark-up Language

Executive Summary

This document describes the stakeholder's involvement in the development and the demonstration of the OptEEmAL platform.

It presents the methodology implemented all along the OptEEmAL project to collect and take into account stakeholders feedbacks in the development and testing of the OptEEmAL platform.

The **methodology** implemented has consisted of:

- Discussions with the stakeholders to understand the specific situation of their retrofitting project.
- Collection of information/data regarding the retrofitting projects (BIM models, CityGML model, existing energy systems, targets and boundaries, etc.). This was done by the mean of IFC, CityGML and Excel files.
- Collection of information regarding the platform development. This was done by the mean of Excel questionnaires and organisation of training activities.
- Integration of their feedback in the platform development. This was done using Excel questionnaires.

The targeted audience of the activities described in this deliverable are the stakeholders of the OptEEmAL platform as per the **IPD methodology**. This methodology constitutes the background of the platform and has been implemented to define end-user's interactions with the platform. It is important to note that in this deliverable, **stakeholders** are all the people that might be interested by the results/process of the OptEEmAL platform (such as citizens for instance) while **end-users** are defined as the people using the platform.

The **results** of these activities are:

- Stakeholder's feedbacks were included in the development of the platform
- Input data needed to run the platform have been collected
- End-user's feedbacks regarding the platform at TRL7 have been collected and analysed.

For the first abovementioned point, stakeholders have provided a **feedback** regarding the **general platform design** (such as their difficulty to have BIM files) and the **outputs** to be provided by the platform (such as their need to have detailed information regarding energy and economic aspects).

For the second point, all the **input data** needed to run the OptEEmAL platform have been collected. These are: CityGML files, IFC files, Baseline energy systems, Contextual data, Energy Conservation Measures to be applied, Targets and Boundaries of their retrofitting project.

For the last point, end-users feedbacks were done regarding both the **interface** of the platform and more **general aspects of the platform**. Regarding the interface of the platform, it has been appreciated by the end-users and the use of the platform appeared as easy overall. Regarding more overall comments, they were related to existing functionalities of the platform (list of ECMs, optimisation process, etc.) and new functionalities to be implemented in the future (such as the possibility to import/export idf files). These comments and associated analysis are presented in details in this document.

From all this material, recommendations were done for the future of the OptEEmAL platform (from TRL7 to TRL9). They are presented at the end of this deliverable.

1 Introduction

1.1 Purpose and target group

This document presents the work performed in task 6.3 “TRL7 Platform ready for demonstration in operational environment” and especially the stakeholder’s involvement in these activities. The general purpose of this task is to demonstrate the developed platform on on-going/upcoming district retrofitting projects. More specifically, this deliverable is focused on the stakeholder’s involvement (in this task, but also all along the project). Several objectives are related to the work presented in this deliverable:

- Include end-users/stakeholders in the design of the platform
- Present the platform to the end-users/stakeholders in order to evaluate the usefulness of the platform
- Identify future improvements to be made to the platform while moving from TRL7 to TRL9

One important point to be noted in this deliverable is the difference between stakeholders and end-users of the platform. The definition considered within the frame of the project is provided below:

- Stakeholders: All people that might be interested by the results/process of the OptEEmAL platform (e.g. inhabitants)
- End-users: People using the OptEEmAL platform (i.e. members of the IPD group for a given project).

Also, as in all project deliverables, the following difference has to be reminded between “case study” and “demo site”:

- Case study: In OptEEmAL, a case study is an already retrofitted district used for TRL6 validation (platform prototype demonstration in relevant environment).
- Demo site: In OptEEmAL, a demo site is a “to be retrofitted” district used for TRL7 validation (platform ready for demonstration in operational environment).

This document starts with a description of the methodology used to involve the stakeholders and end-users in the platform. Then, a section describes the obtained feedbacks and provides an analysis of these feedbacks. And finally, the last section explains the outputs from this work and describes the next steps for the platform to move from TRL7 to TRL9.

1.2 Contributions of partners

Table 1 presents the main contributions of partners to the work of this task and content of this document.

Table 1: Contribution of partners

Participant short name	Contributions
TEC	Contribution to the sections related to the trainings (especially related to training sessions performed in San Sebastian)
NBK	Deliverable leader. Contribution to all sections
ACC	Relationship with WP1 activities. Contribution to section 3.1
UTRC-I	Assistance to the training program validation and section 2.6

FSS	Organisation of the training activities in San Sebastian, Contact point between the project and the involved stakeholders for the Txomin Enea district
DTTN	Organisation of the training activities in Trento, Contact point between the project and the involved stakeholders for the San Bartolomeo district
LUND	Organisation of the training activities in Lund, Contact point between the project and the involved stakeholders for the Polhem district
SEZ	Support for the organisation of the training activities (especially for the elaboration of communication materials)

1.3 Relation to other activities in the project

This work aims at validating the whole OptEEmAL platform in its relevant environment. As a consequence, it is somehow related to all the project activities. However, it has to be mentioned that this work has stronger relationships with the work performed in WP1 (IPD methodology implementation, GUIs definition, etc.) as the objective of this work package was to define the interactions between the OptEEmAL platform and its associated stakeholders.

2 Methodology

2.1 Introduction

This section aims at presenting the methodology implemented in the project to involve the potential stakeholders of the OptEEmAL platform. First, an overview of this methodology is given and then, all the steps implemented all along the project in order to demonstrate the platform are described.

From a general perspective, stakeholders were involved in the project through the five main steps described in the Figure 1 below. Those steps are then detailed in the following paragraphs.

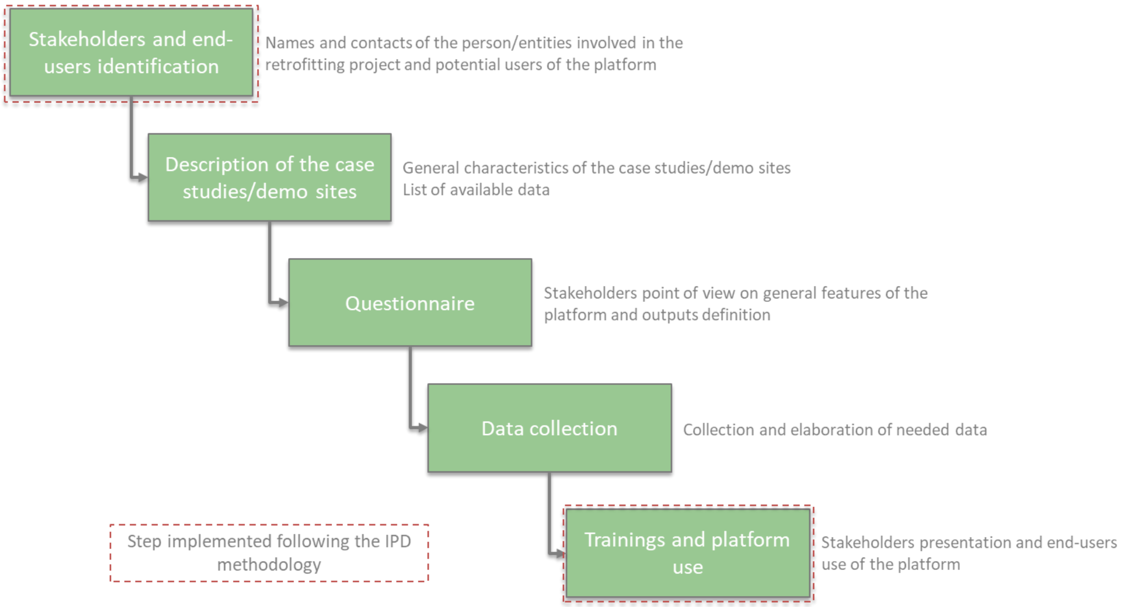


Figure 1: Steps of the methodology for stakeholders and end-users involvement

2.2 Stakeholders identification

The first step of the methodology has consisted in identifying the stakeholders following the IPD methodology. This step was used to identify, beyond project partners, who should be involved in the retrofitting project and who shall be considered as a future potential user of the platform. To do so, WP1 (T1.2) has defined the application of the IPD methodology to the OptEEmAL platform and has thus identified, which actor of a retrofitting project shall be considered as an OptEEmAL end-user or an OptEEmAL stakeholder.

The details of this methodology are provided in D1.2.

Figure 2, Figure 3 and Figure 4 below are illustrating this work. Results of this work are provided in the next section (see §3.1).

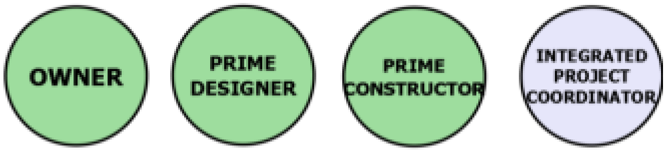


Figure 2: End-users initially defined for the platform

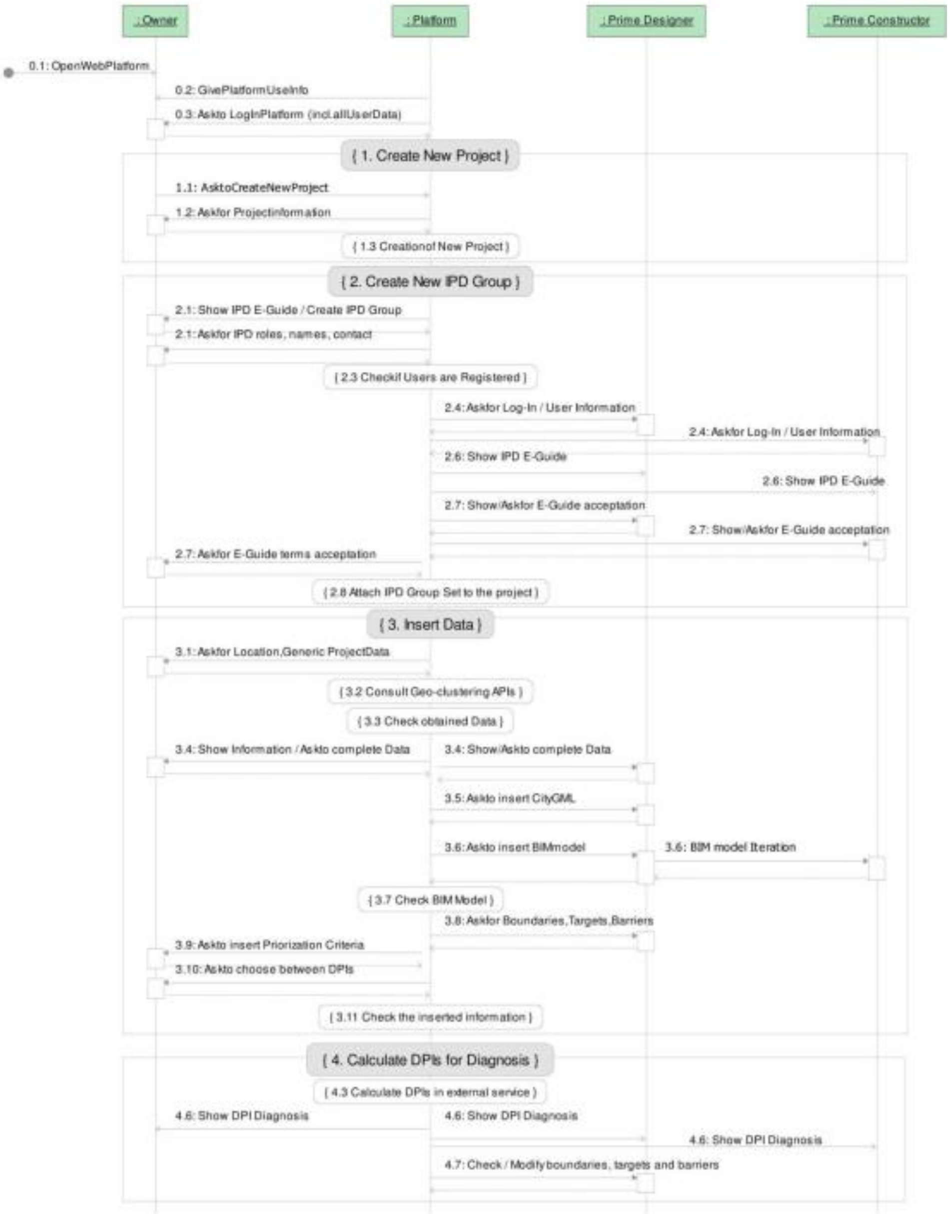


Figure 3: Excerpt of the platform's sequence diagram

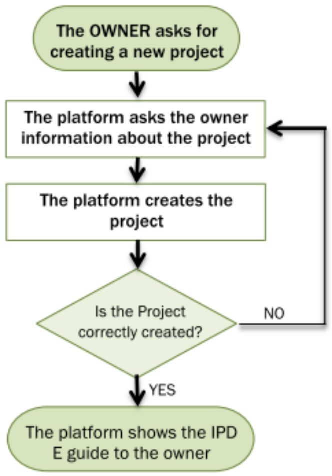


Figure 4: Example of detailed workflow diagram

2.3 Description of the case studies/demo site

The second step of the involvement was related to the description of the case studies and demo sites. This has been done for several purposes:

- To identify the available data in the case studies and demo sites
- To know better the different case studies and demo sites to be investigated during the project
- To start the technical discussions with stakeholders and get to know better each other

To do this work, an Excel table was prepared and circulated to all case study/demo site responsible. It was asked to them to get in touch with the different stakeholders of the project to collect the necessary information. Then, meetings were organised between case study/demo site responsible in order to answer questions and validate the collected data. The template used for this exercise is provided below (Table 3). The results of this work are provided in the next section (see §3.1).

It has to be noted that this work has been carried out for the 6 case studies and 3 demo sites initially planned in the project (Table 2). In the end, only 3 case studies and 3 demo sites were carried out in the project. This point is further explained in section 3.1.2.

Table 2: Initial list of case studies and demo sites

District Name	City	Country	Responsible partner
Case studies			
Cuatro de Marzo	Valladolid	Spain	CAR
Mogel	Eibar	Spain	TEC
Soma	Manise	Turkey	CAR
Historic city	Santiago	Spain	TEC
Linero	Lund	Sweden	LUND
Morley Court	Nottingham	UK	CAR
Demo sites			
San Bartolomeo	Trento	Italy	DTTN
Polhem	Lund	Sweden	LUND
Txomin Enea	San Sebastian	Spain	FSS

Table 3: Template of the Excel file used for the first round of data collection

<table>
<tr><td>Case study/Demo site X</td><td colspan="2"></td><td colspan="2" rowspan="3">PICTURE</td></tr>
<tr><td>Location</td><td colspan="2"></td></tr>
<tr><td>Partner in charge</td><td colspan="2"></td></tr>
<tr><td>Goal</td><td colspan="4"></td></tr>
<tr><td rowspan="6">Data available</td><td rowspan="6">Urban data</td><td colspan="2">Year of construction</td><td></td></tr>
<tr><td colspan="2">District surface [m²]</td><td></td></tr>
<tr><td colspan="2">Site coverage ratio [%]</td><td></td></tr>
<tr><td colspan="2">District morphology</td><td></td></tr>
<tr><td colspan="2">Uses classification (*)</td><td></td></tr>
<tr><td colspan="2">Number of buildings</td><td></td></tr>
</table>

Data needed		Building typologies	
		Net built area of buildings [m^2]	
		Net usable area of buildings [m^2]	
		Number of dwellings	
	Climatic data	Climate zone (*)	
		Heating degree day (HDD)	
		Cooling degree day (CDD)	
		Average winter temperature [°C]	
		Average summer temperature [°C]	
		Global solar radiation [kWh/m^2yr]	
		Average wind speed [m/s]	
		Average precipitation [mm/year]	
	Energy and environment	Thermal gross area of district [m^2]	
		Thermal gross volume of district [m^3]	
		Existing thermal systems (HVAC)	
		Existing energy sources (gas, oil, biomass, electricity, etc.)	
		Degree of energetic self-supply [%]	
		Degree of accordance with national laws and standards (*) [%]	
		Estimated average final energy demand per building typology [kWh/m^2yr]	
		Estimated average final energy consumption per building typology [kWh/m^2yr]	
		Average energetic class of buildings	
		Net fossil energy consumption [kWh/m^2yr]	
		Greenhouse gas emissions [$kgCO_2/m^2yr$]	
		There aren't other studies already implemented in Board (for the TRL6 case studies) as for example visual inspection, thermographic test, BlowerDoor, etc.	
	Social data	Number of inhabitants Board	
		Population density of district [$inhab/m^2$]	
		Property structure	
		Average income of inhabitants	
		Other Information	
Data needed			

Work process	
Actors / IPD	
Platform Users	
DPIs	
Related national/local policy framework	

2.4 Questionnaires (during the project)

Once the first round of data collection was finished, it was decided to ask the potential stakeholders and end-users of the platform their opinion regarding the technical developments of the platform. This was done during the technical works (WP1, 2, 3 and 4) for the definition of the platform in order to take into account stakeholder's point of view in the design of the platform.

From a very general perspective, two main interactions are done by the stakeholders/end-users with the platform:

- Data introduction
- Outputs exportation

To collect the stakeholder's point of view on those two points, it was decided to prepare:

- A general questionnaire regarding the elaboration of the platform (Table 4 below) to tackle the first point listed above.
- A specific questionnaire dedicated to the outputs definition (Table 5) considering that this point is critical to ensure the usefulness of the platform for its stakeholders.

The results of this work are detailed in the next section (see §3.1).

Table 4: General questionnaire regarding platform elaboration

	Organisation name
General questions	
What are your expectations about the platform and its use?	
What added value are you expecting from the platform?	
Do you already use tools during the decision making process?	
If yes, give more details	
How do you think that OptEEmAL platform could be helpful to the design refurbishment projects at district scale?	
To which degree do you think that OptEEmAL can aid your design process?	
Would you consider OptEEmAL an adequate decision-making tool? Why? Why not?	
Is the output obtained adequate to cover the design phase? Is something relevant missing?	

Organisation-related questions	
In your opinion, which actor (owner, designer, constructor, technician…) could centralize the information on a platform like OptEEmAL?	
Based on your experience, the number of actors involved is generally (Less than 3 / Between 3 and 5 / More than 5)	
Comment	
What is the organization for data collection in your retrofitting projects? Is there someone centralizing the data? What is used for data collection (e.g. questionnaire, excel files, etc.)?	
Are you familiar with the IPD methodology? Do you consider it useful? If so, how do you implement it? Has it been helpful?	
How is the time schedule followed in your case when developing a refurbishment project? Are certain deadlines established?	
How many and what types of iterations are followed in a regular design process of yours? What problems make these changes happen?	
About technical aspects	
Do you have some experience in working with BIM?	
If yes, do you have some kind of experience in exporting/importing BIM files through the IFC standard?	
Are you using (in some way) information about CityGML or GIS for decision-making and simulations in these projects? If yes, is this information obtained/provided via CityGML files?	
If yes, from where (or whom) you get this information? (provider, etc…)	
Do you have some experience in refurbishment projects at district scale using BIM?	
If yes, give us more details (e.g. software used)	
Do you have experience in refurbishment projects at district scale using CityGML?	
If yes, give us more details (e.g. software used)	
Which department of your organization is supposed to use the OptEEmAL platform? Technical department? Others?	
Based on your previous experience(s), what are the major technical problems you were facing in the design of a refurbishment project?	
In your opinion, is it better to include information about generic components or about real products in the enhanced BIM models generated by the platform (outputs of the platform)?	
Which urban elements (e.g. roads, green areas) should be considered in these projects taking into account that only the buildings will be refurbished?	

In your opinion, does the platform need to present at each step the imported data on a 3D model? Does it need to be represented in 3D at each step of the data import?	
What aspects are more relevant in a district analysis? How detailed is the analysis? What information do you consider necessary to start a refurbishment project?	
Do you create simulation models? If so, what type of tools do you use? To obtain what type of information? Who is in charge of these simulations? How much time do they comprise?	
Do you use some type of indicators to evaluate the performance of a district? If so, what do they measure?	
What type of measures to reduce energy consumption and CO2 emissions are normally implemented?	
Is some type of technical document or report required by law or otherwise that the platform could offer?	
About data availability	
Are the energy generation resources shared among more than one building?	
About financial aspects	
How do you evaluate if a project is financially feasible or not?	
Do you carry out an evaluation of the costs and the benefits a project could generate? Both financially and energetically speaking?	
Is this the most relevant factor when trying to carry out a refurbishment project? What are other factors to take into consideration?	

Table 5: Specific questionnaire for outputs definition

	Respondent ID
Information about the respondent	
Last name	
First name	
Email	
Organisation	
Role	
General questions	
1. According to your profile, what information is mandatory for you as an output of the design stage of a retrofitting process?	
2. What information are you usually lacking in your retrofitting projects to have a fully informed decision making process?	
3. What data would you consider important to compare different scenario possibilities? Is some specific data mandatory for you to choice between different two different possibilities?	
4. How are you planning to use the outputs of the platform? In which occasion? What for?	
BIM and CityGML related outputs	
1. What would you use this updated BIM/CityGML files for?	
2. Do you consider mandatory the compliance of the BIM and CityGML files with existing software you are using? If yes, please provide the name of the software.	
3. Would you be able to implement changes in a BIM model following some technical descriptions?	
4. Do you consider mandatory the inclusion of energy systems and building materials in the BIM and CityGML files which will be generated from the platform?	
5. If so, what type of details would you like to be included for energy systems?	
Pdf and xls related outputs	
1. Which aspects are mandatory to understand a given retrofitting option?	
2. What is the level of details you consider adequate (building or district)?	
3. How would you like the information to be presented? Do you consider the presence of graphs mandatory?	
4. Among the following categories, which one you would consider the most important in your decision making process? (and thus should be particularly detailed in the outputs)	
For this specific category, which information are you needed to take decisions?	

5. In which format would you like to see this information presented (annual or monthly average, hourly time series)?	
6. Would you consider the possibility to customise the content in the pdf or xls file (according to your needs or interests) an interesting feature?	
7. In the OptEEmAL platform, you will be able to define the targets and constraints you have for your retrofitting projects. Do you think the pdf and xls outputs have to focus on these targets and constraints or provide only general information (or both)?	
8. Generally speaking, the PDF file shall contain:	
9. Similarly, the PDF file shall contain:	
10. Generally speaking, the XLS file shall contain:	
11. Similarly, the XLS file shall contain:	
Others	

1.1 Data collection

1.1.1 Data needed to run the platform

With the evolution of the technical works related to the definition and the developments of the platform, the following step for stakeholder's involvement was related to the collection of the input data needed to run the OptEEmAL platform.

As a reminder, and from a general perspective, the **following input data are needed** to use the OptEEmAL platform:

- Members of the IPD group
- Numerical models:
    - CityGML of the district and neighbouring buildings
    - IFCs of the buildings under study
- Baseline Energy Systems: description of the energy systems present in the district before retrofitting
- Contextual data:
    - Weather file
    - Socio-economic data (energy prices and average income)
- Possible Energy Conservation Measures for the retrofitting project
- Targets and boundaries of the retrofitting project
- Prioritisation criteria of the retrofitting project

Once the needed input data were defined, discussions were made with the case studies/demo sites responsible in order to know which data was available and which was not. Overall (this is further discussed in section 3.1.4), numerical models were not available while all other information were available.

Then, the available data were collected using Excel files prepared for this purpose and a procedure (steps and responsible) was defined for the elaboration of unavailable data.

For the **available data**, an Excel file was elaborated based on the Graphical User Interfaces of the platform to ease data input while using the platform. The different steps of the data input process for which this Excel template was elaborated are:

- BES questionnaire (see Table 6, Table 7 and Table 8)
- Biomass prices (see Table 9)
- ECM questionnaire (see Table 10)
- Check strategies (see Table 11)
- Targets and Boundaries (see Table 12 and Table 13)
- Prioritisation criteria (see Table 14)

For the **unavailable data** (i.e. numerical models), the procedure and associated responsible for the different case studies/demo sites is presented below (see Figure 5, Figure 6 and Figure 7). Again, it has to be reminded that this procedure, as the one planned for all case studies and demo sites, was changed (in terms of number of case studies) in the following phases of the project (see §3.1.2). In addition, one important point to be mentioned here, which is further developed later in this deliverable (see §3.1.4), is the fact that most of the work associated with the elaboration of numerical models was not initially planned in the work programme. This has led to a significant increase of the work for the responsible partners.

Table 6: Excel template for the BES questionnaire (district part)

OptEEmAL BES questionnaire

Associated step in the platform: Baseline Energy Systems (n°3)

Cell to be filled (if relevar

District level questions

					HELP ANSWER TYPE	DISTRICT
1.1	Do you have a district energy system?				Yes/no	
1.1.1	If YES, please select system type				Selection (see below)	
		A. Heating only			"X" if YES, " " if NO	
		B. Cooling only			"X" if YES, " " if NO	
		C. Heating and cooling			"X" if YES, " " if NO	
1.1.1.1	If A, what is the district heating supply system?				Selection (see below)	
		a. Boiler plant			"X" if YES, " " if NO	
		b. Boiler and CHP plant			"X" if YES, " " if NO	
		c. Boiler and solar thermal with storage plant			"X" if YES, " " if NO	
1.1.1.1.1	If a, then				Selection (see below)	
		i.	How many boilers do you have?		Numerical value	
		ii.	What is the total boiler capacity?		Numerical value	
		iii.	What is the boiler type?		Selection (see below)	
				Non-condensing	"X" if YES, " " if NO	
				Condensing	"X" if YES, " " if NO	
				Other	"X" if YES, " " if NO	
		iv.	What is the fuel type?		Selection (see below)	
				Natural gas	"X" if YES, " " if NO	
				Diesel	"X" if YES, " " if NO	
				Biomass	"X" if YES, " " if NO	
		v.	What is the boiler efficiency		Selection (see below)	
				Numerical value between 0 and 1	Numerical value if YES, " " if NO	
				Unknown	"X" if YES, " " if NO	
1.1.1.1.2	If b, then answer questions 1.1.1.1.1 i. to v. and				Selection (see below)	
		i.	How many CHPs do you have?		Numerical value	
		ii.	What is the CHP electrical capacity?		Numerical value	
		iii.	What is the CHP thermal capacity?		Numerical value	
		iv.	What is the CHP fuel type?		Selection (see below)	
				Natural gas	"X" if YES, " " if NO	
				Diesel	"X" if YES, " " if NO	
		v.	What are the CHP efficiencies?		Selection (see below)	
				Electrical (numerical value between 0-1)	Numerical value if YES, " " if NO	
				Thermal (numerical value between 0-1)	Numerical value if YES, " " if NO	
				Unknown	"X" if YES, " " if NO	
1.1.1.1.3	If c, then answer questions 1.1.1.1.1 i. to v. and				Selection (see below)	
		i.	What is the total solar collector area?		Numerical value	
		ii.	Collector module efficiency?		Selection (see below)	
				Numerical value	Numerical value if YES, " " if NO	
				Unknown	"X" if YES, " " if NO	
		iii.	What is the thermal storage capacity?		Numerical value in kW	
		iv.	What is the storage temperature?		Selection (see below)	
				Numerical value in °C	Numerical value if YES, " " if NO	
				Unknown	"X" if YES, " " if NO	
		v.	What are the storage thermal losses?		Selection (see below)	
				Numerical value in kW	Numerical value if YES, " " if NO	
				Unknown	"X" if YES, " " if NO	
1.1.1.1.4	What is the district heating start and stop times?				Selection (see below)	
		From 7 to 18			Numerical value if YES, " " if NO	
		User defined - please give start and stop times			Numerical value if YES, " " if NO	
		Unknown			"X" if YES, " " if NO	
1.1.1.1.5	What is the hot water set point				Selection (see below)	
		70°C			"X" if YES, " " if NO	
		User defined			Numerical value if YES, " " if NO	
		Unknown			"X" if YES, " " if NO	
1.1.1.2	If B, please enter the cooling plant details				Selection (see below)	
		i.	How many chillers do you have?		Numerical value	
		ii.	What is the total chiller capacity?		Numerical value	
		iii.	What is the chiller COP?		Selection (see below)	
				Numercial value	Numerical value if YES, " " if NO	
				Unknown	"X" if YES, " " if NO	
		iv. What is the district cooling start and stop times?			Selection (see below)	
				From 7 to 18	"X" if YES, " " if NO	
				User defined - please give start and stop times	Numerical value if YES, " " if NO	
				Unknown	"X" if YES, " " if NO	
		v.	What is the chilled water set-point?		Selection (see below)	
				11°C	"X" if YES, " " if NO	
				User defined	Numerical value if YES, " " if NO	
				Unknown	"X" if YES, " " if NO	
1.1.1.3	If C, then answer questions 1.1.1.1 and 1.1.1.2				Selection (see indicated questions)	

Table 7: Excel template for the BES questionnaire (building part, Part 1)

ding level questions

				HELP ANSWER TYPE	BUILDING ID	BUILDING ID	BUILDING ID	BUILDING ID
	For each building of the district							
2.1	Does this building have access to natural gas?			Yes/No				
2.2	Does this building have a Building Energy Management System or platform with measurements system for controls implementation?			Yes/No				
2.3	Please select the system type for this building			Selection (see below)				
	a.	Heating only		"X" if YES, " " if NO				
	b.	Heating and cooling		"X" if YES, " " if NO				
2.3.1	If a. then							
2.3.1.1	Is this heating system connected to the district supply?			Yes/No				
2.3.1.1.1	If Yes, do you have additional local building level supply system?			Yes/No				
2.3.1.1.1.1	If Yes, please chooose the sytem type			Selection (see below)				
	a.	Boilers		"X" if YES, " " if NO				
	b.	Heat pumps		"X" if YES, " " if NO				
	c.	Geothermal heat pumps		"X" if YES, " " if NO				
2.3.1.1.1.1.1	If a. then							
	i.	What is the total boiler capacity?		Numerical value				
	ii.	What is the boiler type?		Selection (see below)				
			Non-condensing	"X" if YES, " " if NO				
			Condensing	"X" if YES, " " if NO				
			Other	"X" if YES, " " if NO				
	iii.	What is the fuel type?		Selection (see below)				
			Natural gas	"X" if YES, " " if NO				
			Diesel	"X" if YES, " " if NO				
			Biomass	"X" if YES, " " if NO				
	iv.	What is the boiler efficiency?		Selection (see below)				
			Numerical value	Numerical value if YES, " " if NO				
			Unknown	"X" if YES, " " if NO				
	v.	What is the system start and stop times?		Selection (see below)				
			From 7 to 18	"X" if YES, " " if NO				
			User defined - please give start and stop times	Numerical value if YES, " " if NO				
			Unknown	"X" if YES, " " if NO				
	vi.	What is the hot water set point?		Selection (see below)				
			70°C	"X" if YES, " " if NO				
			User defined	Numerical value if YES, " " if NO				
			Unknown	"X" if YES, " " if NO				
2.3.1.1.1.1.2	If b. then							
	i.	What is the total heat pump capacity?		Selection (see below)				
			Heating capacity	Numerical value if YES, " " if NO				
			Cooling capacity	Numerical value if YES, " " if NO				
	ii.	What is the heat pump COP?		Selection (see below)				
			Heating COP	Numerical value if YES, " " if NO				
			Cooling COP	Numerical value if YES, " " if NO				
			Unknown	"X" if YES, " " if NO				
	iii.	What is the system start and stop times?		Selection (see below)				
			From 7 to 18	"X" if YES, " " if NO				
			User defined - please give start and stop times	Numerical value if YES, " " if NO				
			Unknown	"X" if YES, " " if NO				
	iv.	What is the hot water set point?		Selection (see below)				
			70°C	"X" if YES, " " if NO				
			User defined	Numerical value if YES, " " if NO				
			Unknown	"X" if YES, " " if NO				
	v.	What is the chilled water set-point?		Selection (see below)				
			11°C	"X" if YES, " " if NO				
			User defined	Numerical value if YES, " " if NO				
			Unknown	"X" if YES, " " if NO				

Table 8: Excel template for the BES questionnaire (building part, Part 2)

2.3.1.1.1.1.3	If c. then								
		i.	What is the total heat pump capacity?		*Selection (see below)*				
				Heating capacity	*Numerical value*				
				Cooling capacity	*Numerical value*				
		ii.	What is the heat pump COP?		*Selection (see below)*				
				Heating COP	*Numerical value*				
				Cooling COP	*Numerical value*				
				Unknown	*"X" if YES, " " if NO*				
		iii.	What is the borehole length		*Numerical value in meters*				
		iv.	What is the system start and stop times?		*Selection (see below)*				
				From 7 to 18	*"X" if YES, " " if NO*				
				User defined - please give start and stop times	*Numerical value if YES, " " if NO*				
				Unknown	*"X" if YES, " " if NO*				
		v.	What is the hot water set point?		*Selection (see below)*				
				70°C	*"X" if YES, " " if NO*				
				User defined	*Numerical value if YES, " " if NO*				
				Unknown	*"X" if YES, " " if NO*				
		vi.	What is the chilled water set-point?		*Selection (see below)*				
				11°C	*"X" if YES, " " if NO*				
				User defined	*Numerical value if YES, " " if NO*				
				Unknown	*"X" if YES, " " if NO*				
2.3.1.1.1.1.4	For each HVAC zone in this building, what is the demand system?				*One choice per HVAC zone*				
2.3.1.1.1.1.5		a.	Baseboard Heating		*"X" if YES, " " if NO*				
		b.	Fan Coils		*"X" if YES, " " if NO*				
		c.	VAVs		*"X" if YES, " " if NO*				
		d.	CAVs		*"X" if YES, " " if NO*				
		e.	PTHP		*"X" if YES, " " if NO*				
		f.	Water to Air Heat Pump		*"X" if YES, " " if NO*				
		g.	VRF Water to Air Heat Pump		*"X" if YES, " " if NO*				
		h.	Underfloor Heating		*"X" if YES, " " if NO*				
2.3.1.1.1.2	If NO, please answer 2.3.1.1.1.1.4 question				*See associated questions*				
2.3.1.1.2	If NO, please answer all the 2.3.1.1.1.1 questions				*See associated questions*				
2.3.2	If b. then								
2.3.2.1	"Heating system", Answer all the 2.3.1 questions				*See associated questions*				
2.3.2.2	"Coolin system", Is this cooling system connected to the district supply?				*Yes/No*				
2.3.2.2.1	If Yes, do you have additional local building level supply system?				*Yes/No*				
2.3.2.2.1.1	If YES, please enter system details				*See below*				
2.3.2.2.1.1.1	What is the total chiller capacity?				*Selection (see below)*				
		Numerical value			*Numerical value if YES, " " if NO*				
		Unknown			*"X" if YES, " " if NO*				
2.3.2.2.1.1.2	What is the chiller COP?				*Selection (see below)*				
		Numerical value			*Numerical value if YES, " " if NO*				
		Unknown			*"X" if YES, " " if NO*				
2.3.2.2.1.1.3	What is the system start and stop times?				*Selection (see below)*				
		From 7 to 18			*"X" if YES, " " if NO*				
		User defined - please give start and stop times			*Numerical value if YES, " " if NO*				
		Unknown			*"X" if YES, " " if NO*				
2.3.2.2.1.1.4	What is the chilled water set-point?				*Selection (see below)*				
		11°C			*"X" if YES, " " if NO*				
		User defined	Numerical value		*Numerical value if YES, " " if NO*				
		Unknown			*"X" if YES, " " if NO*				
2.3.2.2.1.1.5	For each HVAC zone in this building, what is the demand system?				*One choice per HVAC zone*				
		a.	Fan Coils		*"X" if YES, " " if NO*				
		b.	VAVs		*"X" if YES, " " if NO*				
		c.	CAVs		*"X" if YES, " " if NO*				
		d.	PTAC		*"X" if YES, " " if NO*				
		e.	PTHP		*"X" if YES, " " if NO*				
		f.	Water to Air Heat Pump		*"X" if YES, " " if NO*				
		g.	VRF Water to Air Heat Pump		*"X" if YES, " " if NO*				
2.3.2.2.1.2	If NO, please answer 2.3.2.2.1.1.5 question				*See associated questions*				
2.3.2.2.2	If NO, please answer all the 2.3.2.2.1.1 questions				*See associated questions*				

Table 9: Excel template for the biomass prices

BIOMASS PRICES

Associated step in the platform: Contextual data (n°4)

Cell to be filled

Local current value of biomass		€/ton
Annual increase		%

Table 10: Excel template for the ECM questionnaire

ECM questionnaire

Associated step in the platform: Energy Conservation Measures (n°5)

If you answer YES to a first level question (e.g. question 3), then you have to answer associated second level questions (e.g. 3.1). If you answer NO to a first level question (e.g. questi

Cell to be filled

District level questions

		HELP ANSWER TYPE	DISTRICT
1.	Will you connect buildings to a District Heating & Cooling network ?	Y/N	
1.1	Do you have useful land surface to implement renewables?	Y/N	
1.1.1	Can you use land surface for thermal production?	Y/N	
1.1.2	Can you use land surface for electricity production?	Y/N	

Building level questions

		HELP ANSWER TYPE	BUILDING ID	BUILDING ID	BUILDING ID	BUILDING ID
1.	Can you modify building facades?	Y/N				
1.1.	Can they be refurbished externally?	Y/N				
1.2.	Can they be refurbished internally?	Y/N				
1.3.	Do you know the thickness of the air chamber of your facades?	Y/N				
2.	Can you modify building windows?	Y/N				
3.	Can you modify building roofs?	Y/N				
3.1.	Can you apply external roof insulation?	Y/N				
3.2.	Can they be internally refurbished?	Y/N				
3.3.	Can you consider the implementation of renewable generation system on the roofs?	Y/N				
3.3.1.	Can you use the roof for thermal energy production?	Y/N				
3.3.2.	Can you use the roof for electricity production?	Y/N				
4.	Can you modify building floors?	Y/N				
4.1	Do you have crawlspace to implement floor insulation?	Y/N				
5.	Can you change the energy generation system?	Y/N				
5.1.	DO you have the functional space to implement biomass boilers?	Y/N				
6.	Can you replace or implement the energy control system?	Y/N				

Table 11: Excel template for the check strategies section

CHECK STRATEGIES
Associated step in the platform: Check strategies (n° 6)
Cell to be filled
If relevant, please indicate any kind of protection or measures (e.g. historical protection) which may prevent the implement of a given ECM? (please also mention the specific building(s) concerned)

Table 12: Excel template for the Targets and Boundaries (Part 1)

OptEEmAL

Targets & Boundaries

Associated step in the platform: Targets and Boundaries (n° 8)

Cell to be filled

Mandatory targets

			ANSWER
1.	What are the maximum values you want to consiser for these topics?		
1.1		Investments (€)	
1.1.1		Payback Period (years)	
1.1.2		Energy payback time (years)	

Optional targets and boundaries

		ANSWER	
2.	Are there values that you would like not to be surpassed? (Y/N)		If yes, please indicate the boundaries you hav

		Maximum	Minimum
ENERGY DPIs			
Energy demand	$kWh/m^2.yr$		
Final energy consumption	$kWh/m^2.yr$		
Degree of energetic self-supply	kWh/kWh		
Net fossil energy consumed	kWh/m2		
Energy demand covered by renewable sources	%		
Energy consumption in public buildings per year	$kWh/m^2.yr$		
Energy use from District Heating	$kWh/m^2.yr$		
Energy use from Biomass	$kWh/m^2.yr$		
Energy use from PV	$kWh/m^2.yr$		
Energy use from Solar Thermal	$kWh/m^2.yr$		
Energy use from Hydraulic	$kWh/m^2.yr$		
Energy use from Mini-Eolic	$kWh/m^2.yr$		
Energy use from Geothermal	$kWh/m^2.yr$		
COMFORT DPIs			
Local thermal comfort	Level		
ECONOMIC DPIs			
Operational energy cost	$€/m^2.yr$		
Investments (in Euro)	€		
Life cycle cost	€		
Payback Period	years		
ENVIRONMENTAL DPIs			
Global warming potential - GWP	$kg\ CO_2eq/m^2.yr$		
GWP investment	$kg\ CO_2eq/m^2$		
GWP reduction	$kg\ CO_2eq/m^2.yr$		
Primary energy consumption	$MJ/m^2.yr$		
Embodied energy of refurbishment scenarios	MJ/m^2		
Energy payback time	years		
SOCIAL DPIs			
Energy poverty measured as percentage of inhabitants that use more than 10% of their income to pay energy bills	%		
URBAN DPIs			
Percentage of buildings compliant with A rating on EPC	%		
Percentage of buildings compliant with PassivHaus standar	%		
Percentage of buildings compliant with EnerPhit standards	%		
Percentage of buildings compliant with nZEB standards	%		

Table 13: Excel template for the Targets and Boundaries (Part 2)

3. Are there target values that you would like to be achieved? (Y/N)			If yes, please indicate the targets you have fo	
		Maximum	Minimum	
ENERGY DPIs				
Energy demand	$kWh/m^2.yr$			
Final energy consumption	$kWh/m^2.yr$			
Degree of energetic self-supply	kWh/kWh			
Net fossil energy consumed	kWh/m2			
Energy demand covered by renewable sources	%			
Energy use from District Heating	$kWh/m^2.yr$			
Energy use from Biomass	$kWh/m^2.yr$			
Energy use from PV	$kWh/m^2.yr$			
Energy use from Solar Thermal	$kWh/m^2.yr$			
Energy use from Hydraulic	$kWh/m^2.yr$			
Energy use from Mini-Eolic	$kWh/m^2.yr$			
Energy use from Geothermal	$kWh/m^2.yr$			
COMFORT DPIs				
Local thermal comfort	Level			
ECONOMIC DPIs				
Investments (in Euro)	€			
Payback Period	years			
ENVIRONMENTAL DPIs				
Global warming potential - GWP	kg $CO_2eq/m^2.yr$			
GWP reduction	kg $CO_2eq/m^2.yr$			
Primary energy consumption	$MJ/m^2.yr$			
Energy payback time	years			
SOCIAL DPIs				
Energy poverty measured as percentage of inhabitants	%			
URBAN DPIs				
Percentage of buildings compliant with A rating on EPC	%			
Percentage of buildings compliant with PassivHaus standar	%			
Percentage of buildings compliant with EnerPhit standards	%			
Percentage of buildings compliant with nZEB standards	%			

Table 14: Excel template used for prioritisation criteria

Prioritisation criteria

Associated step in the platform: Prioritisation criteria (n°9)

Cell to be filled

Choose either use pre-defined weighting scheme for the simpler option or Use Manual Prioritisation criteria for the detailed option

Use Pre-defined weighting schemes	"X" if YES, " " if NO	
Use Manual weighting schemes	"X" if YES, " " if NO	

Pre-defined weighting schemes

1.	What is your main objective(s) to be achieved within the OptEEmAL platform		ANSWER
	To achieve a nearly zero energy district	"X" if YES, " " if NO	
	To achieve a carbon neutral district	"X" if YES, " " if NO	
	To promote energy generation through renewable systems	"X" if YES, " " if NO	
	Priority to energy generation through renewables	"X" if YES, " " if NO	
	To promote energy generation through a district heating network	"X" if YES, " " if NO	
	To prioritise environmental issues	"X" if YES, " " if NO	
	To prioritise the reduction of operational energy costs	"X" if YES, " " if NO	
2.	Do you want to prioritise economic aspects as well?	"X" if YES, " " if NO	

Manual prioritisation criteria

1. Please introduce directly into the platform the information moving the cursor to left or right depending on your priorities
   Pair-wise comparison of the different DPIs

Cuatro de Marzo - Valladolid

- IFCs
  - Data collection (plans, materials,…) [CAR]
  - Elaboration of IFC files [CAR]
  - Checking of IFC files (within the platform) [CAR]
- CityGML
  - Data collection (building footprints and heights) [CAR]
  - Elaboration of CityGML file [CAR]
  - Checking of CityGML file (within the platform) [CAR]

Mogel - Eibar

- IFCs
  - Data collection (plans, materials,…) [TEC]
  - Elaboration of IFC files [NBK]
  - Checking of IFC files (within the platform) [NBK]
- CityGML
  - Data collection (building footprints and heights) [TEC]
  - Elaboration of CityGML file [TEC]
  - Checking of CityGML file (within the platform) [NBK]

Soma - Manise

- IFCs
  - Data collection (plans, materials,…) [CAR]
  - Elaboration of IFC files [CAR]
  - Checking of IFC files (within the platform) [CAR]
- CityGML
  - Data collection (building footprints and heights) [CAR]
  - Elaboration of CityGML file [CAR]
  - Checking of CityGML file (within the platform) [CAR]

Figure 5: Numerical models elaboration procedure for the case studies in Valladolid, Eibar and Manise

Historic city - Santiago

- IFCs
  - Data collection (plans, materials,...) [TEC]
  - Elaboration of IFC files [TEC]
  - Checking of IFC files (within the platform) [NBK]
- CityGML
  - Data collection (building footprints and heights) [TEC]
  - Elaboration of CityGML file [TEC]
  - Checking of CityGML file (within the platform) [NBK]

Linero - Lund

- IFCs
  - Data collection (plans, materials,...) [LUND]
  - Elaboration of IFC files [LUND with subcontractor]
  - Checking of IFC files (within the platform) [LUND with subcontractor]
- CityGML
  - Data collection (building footprints and heights) [LUND]
  - Elaboration of CityGML file [TEC]
  - Checking of CityGML file (within the platform) [TEC]

Morley Court - Nottingham

- IFCs
  - Data collection (plans, materials,...) [CAR]
  - Elaboration of IFC files [CAR]
  - Checking of IFC files (within the platform) [CAR]
- CityGML
  - Data collection (building footprints and heights) [CAR]
  - Elaboration of CityGML file [CAR]
  - Checking of CityGML file (within the platform) [CAR]

Figure 6: Numerical models elaboration procedure for the case studies in Santiago, Lund and Nottingham

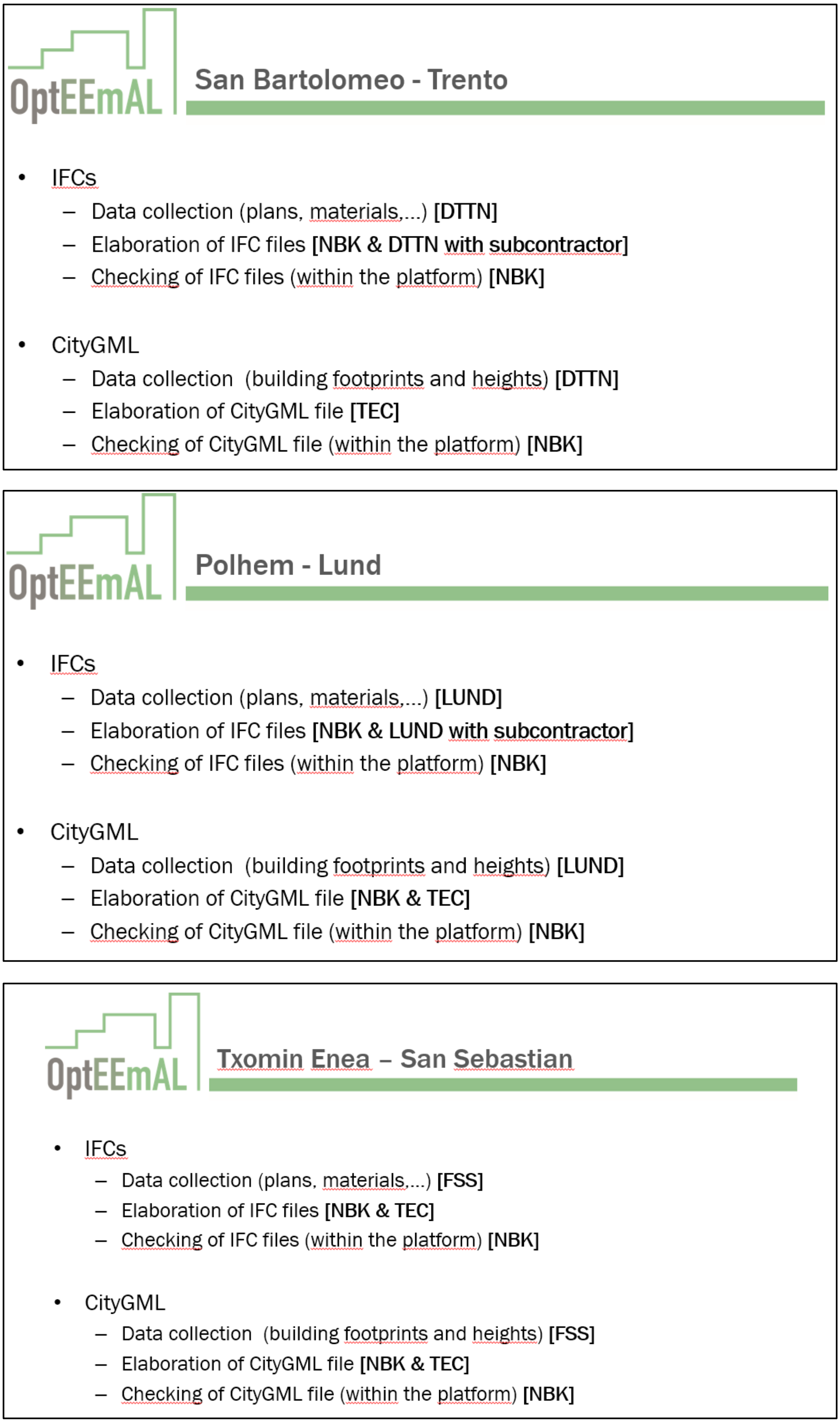


Figure 7: Numerical models elaboration procedure for the demo sites in Trento, Lund and San Sebastian

2.4.1 Data needed for results validation (only for TRL6)

For TRL6 validation activities (even though part of this work has also been performed for TRL7 activities), the collection of available data on the performance of the investigated buildings/districts was needed in order to validate the results obtained in the platform (see D6.2 for further details).

In this case, the data collection procedure was simple as it was necessary to use existing data. Indeed, it was impossible to create new ones in the field of the OptEEmAL project (such as e.g. measurement data) because it was not planned in the work plan and associated budget. The different steps of this procedure are listed below:

- Request to case studies responsible for available data among the following possibilities: Energy Performance Certificates (EPCs), simulation results, measurement data, etc.
- Collection of available data
- Verification of available data
- Discussion about obtained data (in order to clarify/verify the data) (e.g. for the Mogel district in Eibar, discussions have been done to be sure about the configuration of the simulation and thus the comparability of these simulation results with OptEEmAL results).
- Use of obtained data for verification purpose (the obtained data are not presented in this deliverable since they are presented and discussed in details in D6.2)

2.5 Trainings and platform use

The final step regarding stakeholder's involvement and IPD implementation in the project was the elaboration of trainings in the demo sites with all interested stakeholders. Below are presented the different steps implemented to perform these trainings.

2.5.1 Preliminary training program

As a first step, general discussions were made about the general objectives, for the consortium, of the training activities. This step was performed through different email/visioconference discussions and finalised during the 6th General Meeting in Brussels on April 2018. The conclusions of these discussions were as follows:

- The trainings need to tackle the following objectives:
  - Present the OptEEmAL solution
  - Let end-users use the platform and collect their feedback
  - Because it was difficult to achieve those two objectives (both for technical and logistic issues) during the same day, it was decided to have the trainings on a two days session:
    - One day dedicated to the general presentation of the project and the platform, and
    - One day dedicated to the use of the platform by its potential end-users.
- The trainings were organised once the technical developments had been finalised in order to ensure a correct use of the platform by its end-users and avoid any problems due to an anticipated use of a "not finalised" platform.

2.5.2 Final training program

As a second step, the final training program was elaborated using the same approach (email/visioconference discussions and then final discussion during the 7th General Meeting in Anglet, France on October 2018). Also, at this time, the practical details (e.g. language of the support, language of the presentation, organisation needs/logistics, etc.) were discussed and validated. The obtained final program for Day 1 and Day 2 of the trainings is presented below (Figure 8 and Figure 9).

As already mentioned, the 7th General Meeting was also the opportunity for the consortium to discuss more practical details such as:

- Dates and Places of the sessions (see Figure 10)
- Languages (see Figure 11): It was decided to adapt language as much as possible to local language to maximise the number of participants and ease their understandings. For practical reasons, we agreed to have the PPT support only in English (experience from past trainings in other projects).
- Kind of participants (see Figure 11)
- Communication (before and during) (see Figure 12): Note that communication materials used for the actions described in the figure below are presented in D7.9.
- Demonstration projects (see Figure 13): For this point, as mentioned in Figure 13, it was initially planned (due to the platform development status) to use the Demo4 case (TRL5 validation) for the presentation of the first day and case studies (TRL6) for the demonstration of the second day. This was done because the consortium wanted to be sure to present fully functional projects during the trainings. In the end, it was decided to use:
    - "Case study" (TRL6) projects for Day1 (mainly Cuatro de Marzo and Eibar)
    - "Demo site" (TRL7) project for Day2 until the optimisation step. And afterwards, results of the optimisation for "Case study" projects. This choice has been made to make users work on the projects which are taking place/will take place in their city to make them more "sensitive" to the use of the platform.

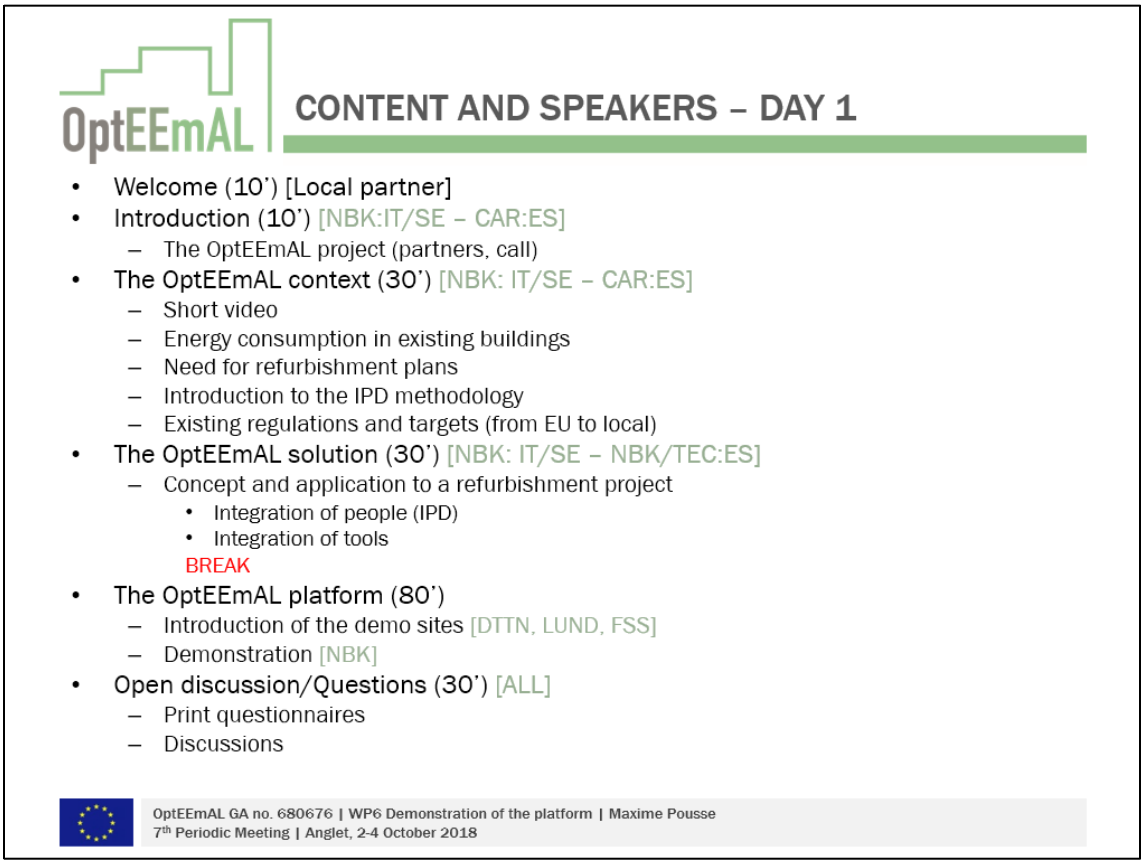


Figure 8: Training program for Day 1

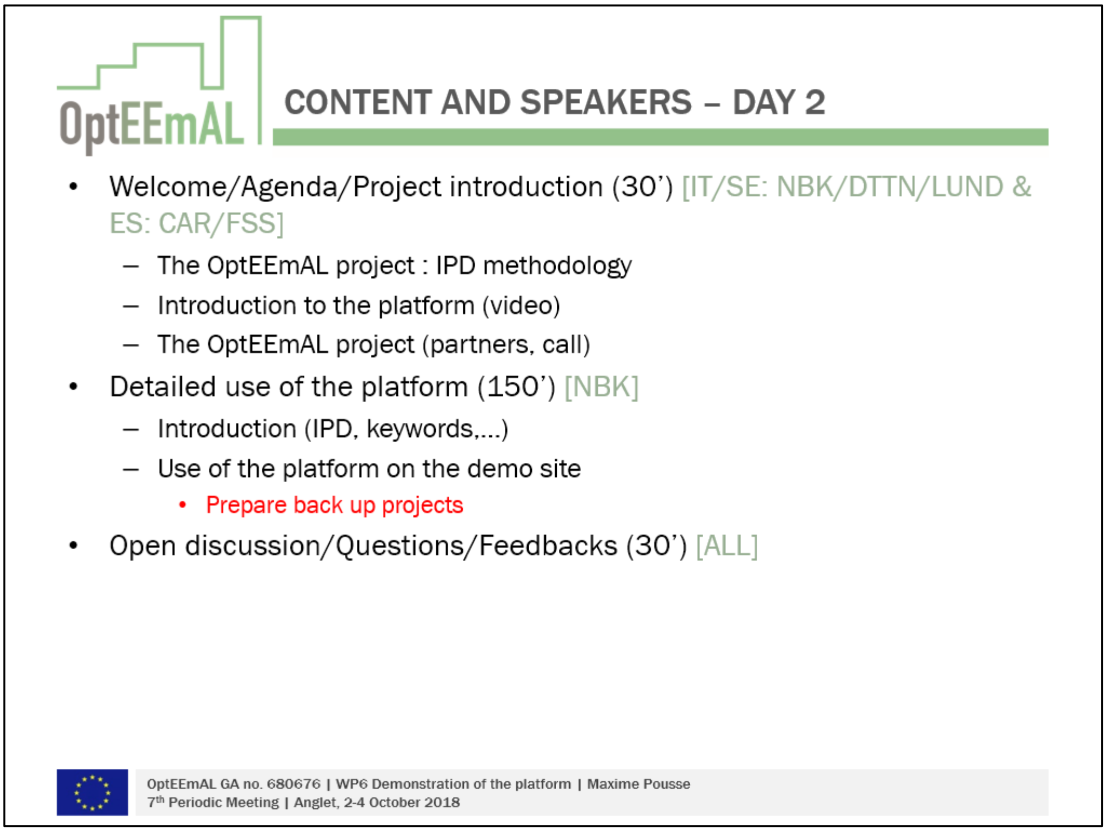


Figure 9: Training program for Day 2

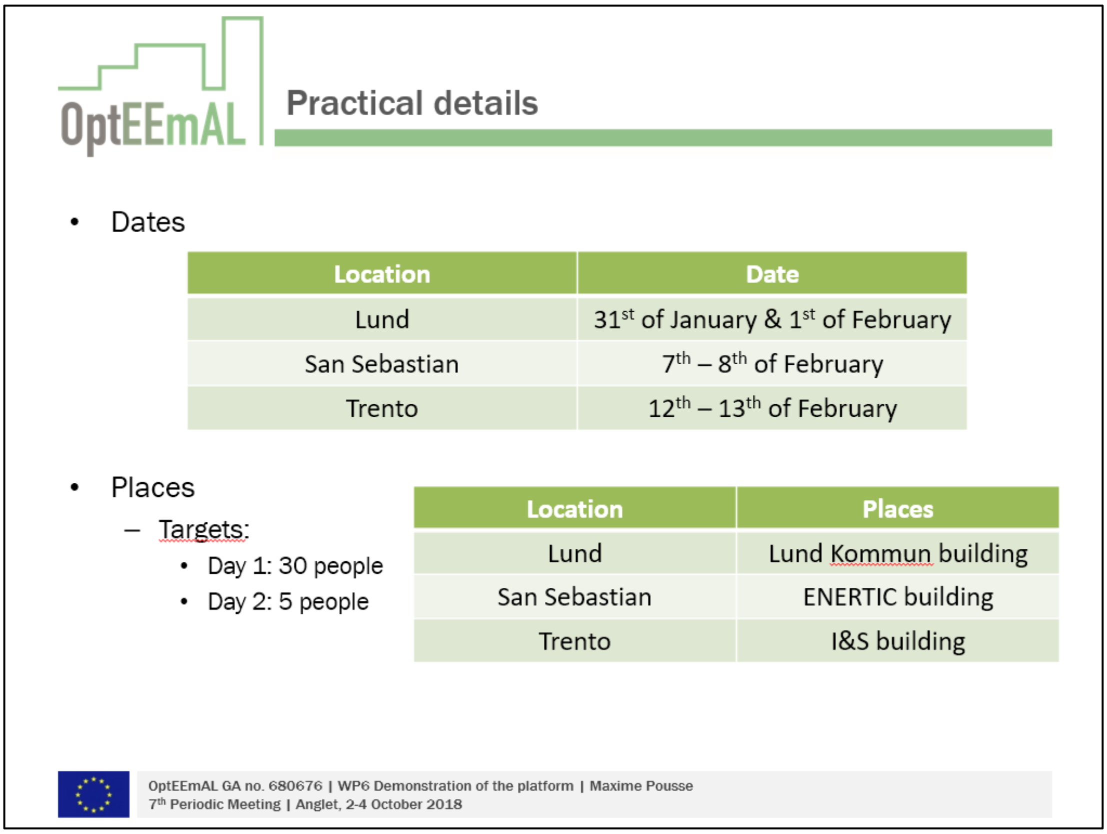


Figure 10: Dates and places for the trainings

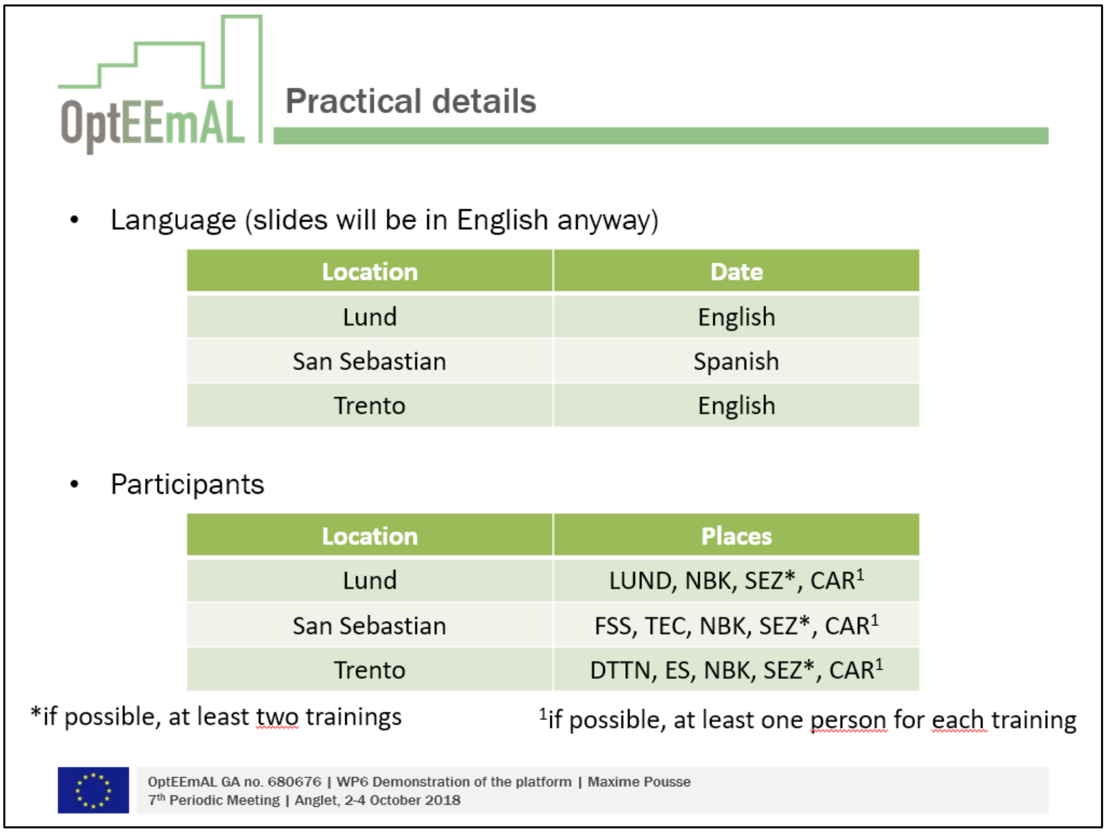


Figure 11: Language and participants for the trainings

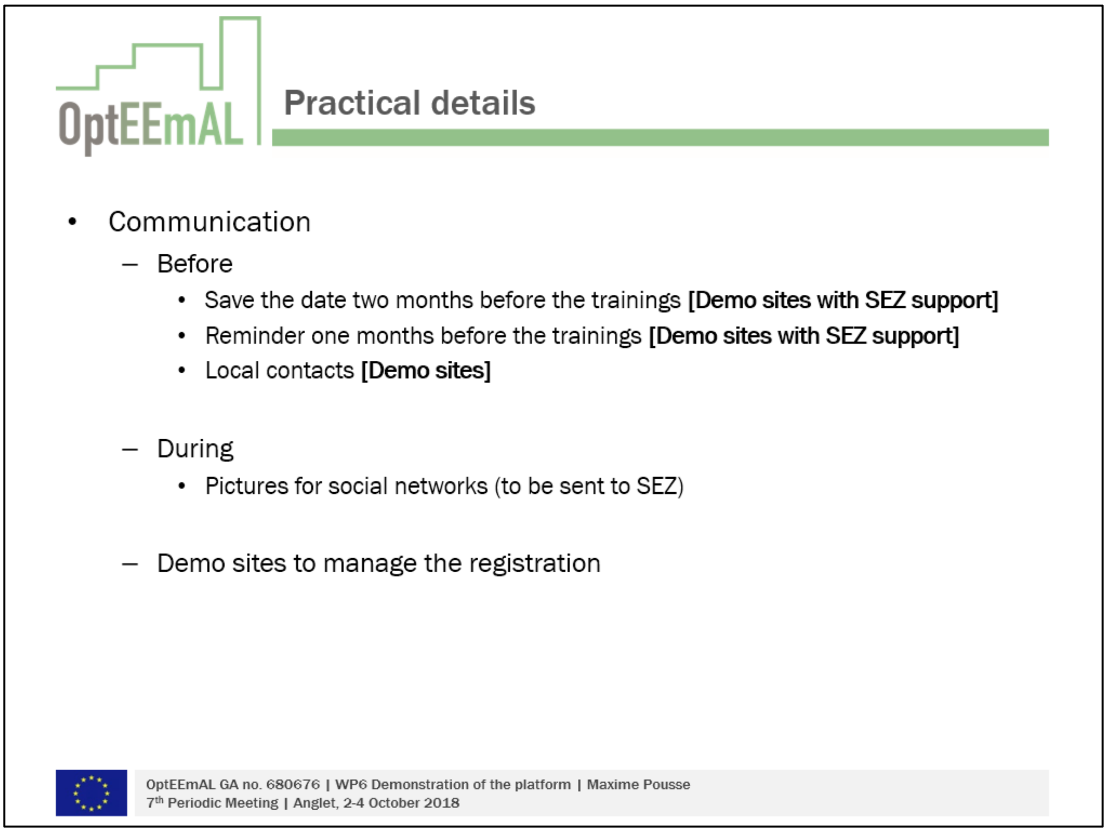


Figure 12: Communication activities before the trainings

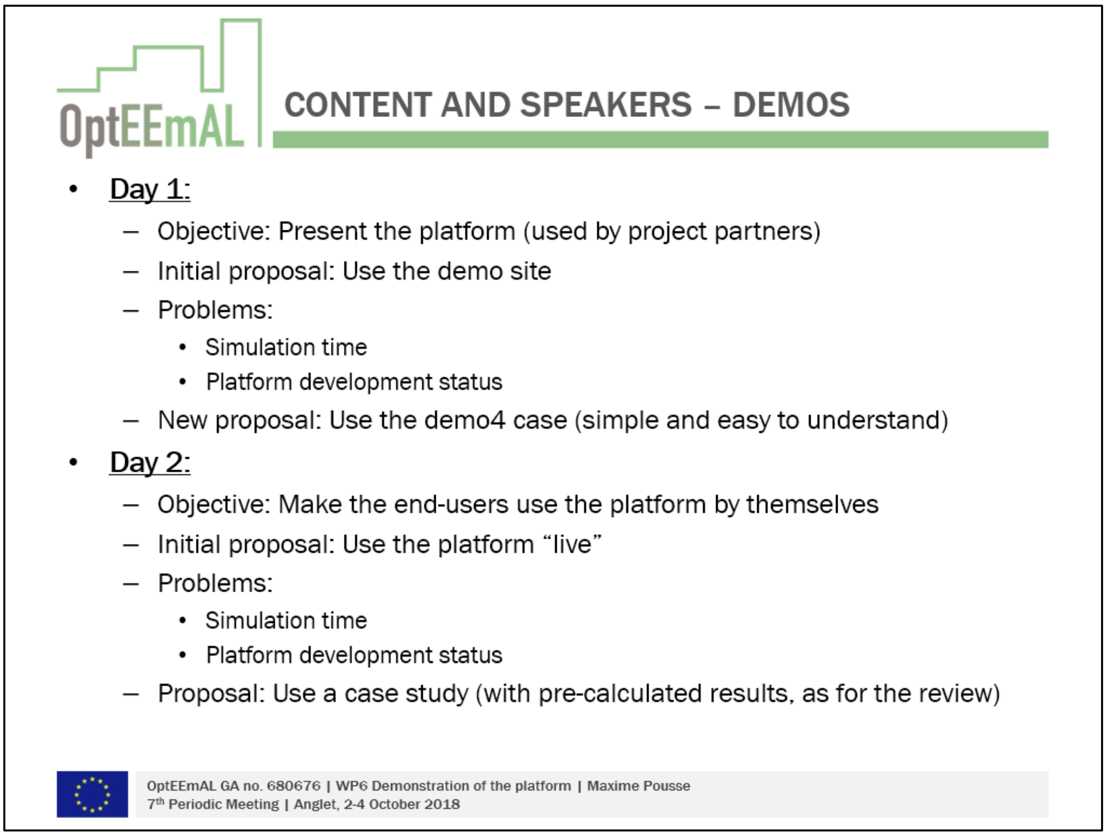


Figure 13: Projects to be used for the training activities

2.5.3 Elaboration of the training supporting materials

The last step of the training preparation consisted in the elaboration of the PowerPoint support. The results of this work are presented in annexes of this document.

2.5.4 Presentation of the trainings

Finally, the trainings were performed in the three cities where demo site districts were located. All the information related to this presentation is presented in the next section.

3 Results and collected feedback

This section presents the results obtained from the application of the methodology described in the previous section. Considering the importance of the trainings in the IPD implementation to demonstrate the OptEEmAL platform, it has been decided to separate this section in two parts: the first one dedicated to the IPD implementation and stakeholders involvement all along the project, and the second one specifically dedicated to the trainings. The Figure 14 below shows the links between the previous section and this current section.

For each step, a "main conclusion" is given regarding the use of the platform and its relationships with its stakeholders/end-users. Then, those main conclusions are aggregated to provide recommendations for the future steps of the platform's development (from TRL7 to TRL9) (see §**¡Error! No se encuentra el origen de la referencia.**).

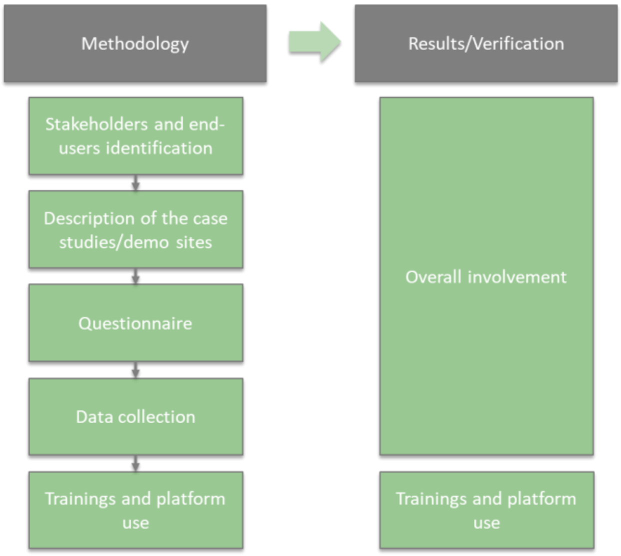


Figure 14: Links between the methodology and results sections

3.1 From the overall involvement

3.1.1 Stakeholders' and end-users identification

The various stakeholders identified in the different demo sites are presented in the Table 15 below. In this table are also identified the potential envisaged end-users of the platform as well as the real end-users of the platform at the end of the project. The difference between these two columns and between the different demo sites are mainly issuing from the status of the retrofitting projects:

- In the case of **Lund**, the project is still in its early phase, the OptEEmAL platform will thus be mainly used by the municipality in order to make the preliminary design of the retrofitting project.
- In the case of **Trento**, the same comment can be made. However, due to the local organisation, different end-users have been involved: Habitech representing the *Owner* of the district and *Consorzio Lavoro Ambiente* for technical aspects (Prime constructor and Prime designer)

In the case of **San Sebastián**, the project is already well advanced (construction works have started in 2018). In this case, it has been possible to involve all the initially planned end-users. It has to be mentioned that owners of the apartments/buildings are not using the platform in the end (too complicated for them, not possible to aggregate their different point of view) and have been represented by *Fomento de San Sebastián* which have performed several meetings with them to present the project and collect their point of view.

Table 15: Stakeholders and end-users initially planned and finally involved in the use of the platform for the different demo sites

Role	Organisation	Name	Envisaged platform user?	Real platform user in the end
San Bartolomeo - Trento				
Owner	Opera Universitaria di Trento	Gianni Voltolini	Yes	No
Prime contructor	Consorzio Lavoro Ambiente	Roberto Segalla	Yes	Yes
Prime designer	STS Trentino Engineering srl	Andrea Tomasi	Yes	No
ESCO	Consorzio Lavoro Ambiente	Roberto Segalla	Yes	Yes (as Prime Designer)
Architect	STS Trentino Engineering srl	Matteo Sebben	Yes	No
Local housing association	N/A	N/A	No	No
Integrated Project Coordinator	Habitech	Andrea Carabolona	Yes	Yes (as Owner)
Polhem - Lund				
Owner	Municipality of Lund	Jon Andersson Elin Dalaryd	Yes	Yes (all IPD roles)
Prime constructor	Is procured for each building project (his is not yet a building project)	-	Yes	No (not identified yet)
Prime designer	WSP (for structure)	-	Yes	No (not identified yet)
ESCO	Not selected yet (one company for ventilation, one for heating,…)	-	Yes	No (not identified yet)
Architect	Horisont Arkitekter	-	Yes	No (not identified yet)
Local association	Local sports clubs (several)	-	No	No (not identified yet)

Integrated Project Coordinator	Municipality of Lund	Pernilla Nevsten	Yes	Yes (all IPD roles)
Txomin Enea - San Sebastián				
Owner	Individual and multi-owners (LAN BERRI association)	(Various)	Yes	No
Prime constructor	ANDRASA	José Antonio Somoza	Yes	Yes
Prime designer	Giroa - Veolia	Haritz Mendizabal	Yes	Yes
ESCO	Giroa - Veolia	Haritz Mendizabal	Yes	Yes
Architect	AGM Arquitectos	Unai Gamboa	Yes	Yes
Architect	BASA Arquitectura	Izaskun Recarte	Yes	Yes
Local housing association	LAN BERRI	(Various)	No	No
Integrated Project Coordinator	Tecnalia	Juan Pedrero	Yes	Yes
Validator	FSS	Iker Martinez	Yes	Yes

Main conclusion from this step: The implication of the stakeholders of the platform is dependent on the status of the retrofitting projects. At the beginning of the project (of its design), it seems interesting to have a single organisation (usually owners or public authorities) using the platform to pre-define the project and have an idea of the possible refurbishment scenarios and associated indicators. As the design of the retrofitting is advancing, more and more users can be involved and especially technical users to refine the preliminary work performed by the owners/public authorities. Moreover, and as already anticipated at the beginning of the OptEEmAL project, in the case of several owners (in particular not technical ones) it is extremely difficult to make them use the platform. In this case, an "intermediate" organisation (usually public authorities) have to "translate/transfer" the wishes from the owners to the platform.

3.1.2 Description of the case studies and demo sites

The information collected at this step is provided as annex of this document (see §0 and §0) (it was also provided in D1.2). Although this information was useful at the beginning of the project in order to better understand both the case studies and the demo sites, it was used in the following steps of the project "only" to define the possible choices allowed in the platform (e.g. type of baseline energy systems). This is the reason why the input data needed by the OptEEmAL platform were defined after this initial data collection.

Also, one important point to be highlighted here is the reduced number of case studies finally investigated within the OptEEmAL project. Indeed, as depicted in Table 16 below, only three case studies have finally been analysed in the project instead of 6 initially planned. The main reason for this lower number of case studies is data and time availability. Indeed, most of the input data needed to run the OptEEmAL platform where not present in the case studies initially planned. In the case of numerical models (i.e. IFC and CityGML files), this was a big issue because the generation of these files was not initially planned in the project and requires to devote a lot of time and resources. In addition, it has to be reminded that more than 22 IFC files have been generated as part of the OptEEmAL project and their generation was not initially planned (see 3.1.4 for further details). As a consequence, the combination of data and time availability have made impossible the generation of these files. It has to be highlighted that although the number of case studies (TRL6 validation) was reduced, the demo site in Lund has been also used at this stage to ensure a validation of the platform using a climate context different than the Spanish one.

Table 16: Initially planned and finally investigated case studies

District Name	City	Country	Responsible partner
Initially planned case studies			
Cuatro de Marzo	Valladolid	Spain	CAR
Mogel	Eibar	Spain	TEC
Soma	Manise	Turkey	CAR
Historic city	Santiago	Spain	TEC
Linero	Lund	Sweden	LUND
Morley Court	Nottingham	UK	CAR
Finally investigated case studies			
Cuatro de Marzo	Valladolid	Spain	CAR
Mogel	Eibar	Spain	TEC
Polhem	Lund	Sweden	LUND

Main conclusion from this step: No conclusion can be made from this step as it is not representative of the final use of the platform. However (this is further discussed in section 3.1.4), some interesting feedbacks were obtained regarding the elaboration of input data and especially numerical models (lack of existing BIM models and time required to elaborate those models).

3.1.3 Questionnaires (during the project)

As an introduction, it shall be mentioned that only the useful outcomes/conclusions related to the "IPD implementation and stakeholders/end-users involvement" are described in this section as other outcomes/conclusions have already been used in the design of the OptEEmAL platform and reported in the different associated deliverables.

3.1.3.1 General questionnaire

The results obtained from this questionnaire are that overall, a good matching was observed between the end-user expectations and the envisaged OptEEmAL characteristics. This is probably due to the implication of the different end-users in the definition of the initial technical specifications of the platform. In addition, some key elements were highlighted because they were indicating specific points of attention for the development of the platform. They are presented, together with the provided OptEEmAL answer, in the Table 17 below.

Table 17: Feedbacks and associated OptEEmAL answers for the general questionnaire

Feedback	OptEEmAL answer
End-users need documentation about the IPD methodology and its implementation within the OptEEmAL platform	This has been taken into account (and was already planned) through providing the IPD guide which includes the "user's manual" of the platform
End-users need a facilitated handling of BIM and CityGML models	This has been taken into account (was not planned at the beginning) through the creation of the BIM and CityGML guidelines which can be downloaded by the users in the platform
End-users need detailed information about the economic aspects (e.g. financial plan with yearly cash flows)	This has not been taken into account because it was requiring too detailed calculation (and associated input data) which was not possible considering the time and efforts available for the elaboration of the platform. One particular blocking point was the consideration of local/specific economic data such as local incentive for retrofitting.
End-users need to have an ensure data protection	This has been taken into account through the implementation of data security protocols in the data exchange procedure between the different modules of the platform
End-users need detailed information regarding simulation models	This has been partly taken into account by providing the detailed data models generated by the platform (energy, urban, etc.). This could be further improve in the future by providing the different input/output files for the different simulation tools (such as idf files for EnergyPlus)

Main conclusion from this step: The main conclusion from this step is that overall, the end-users expectations were met by the platform. However, some specific points were raised especially related to the use of BIM and CityGML models in the platform which were not available in the case studies/demo sites. Answers have been brought to encompass these limits. In addition, other specific points (especially related to economic calculations) have been raised. These points have not been included in the platform considering the time they would need for their development. They are listed in the possible technical improvements for the upcoming steps of platform development (after the project) (see section **¡Error! No se encuentra el origen de la referencia.** for more details).

3.1.3.2 Output definition

In this section we present the main results from the outputs-related questionnaire and the associated OptEEmAL answer (Table 18). For more details, please refer to D1.6 (section 3).

As an introduction, it shall be reminded that the questionnaire was distributed to 10 persons and all of them have provided an answer (see Figure 15 and Figure 16).

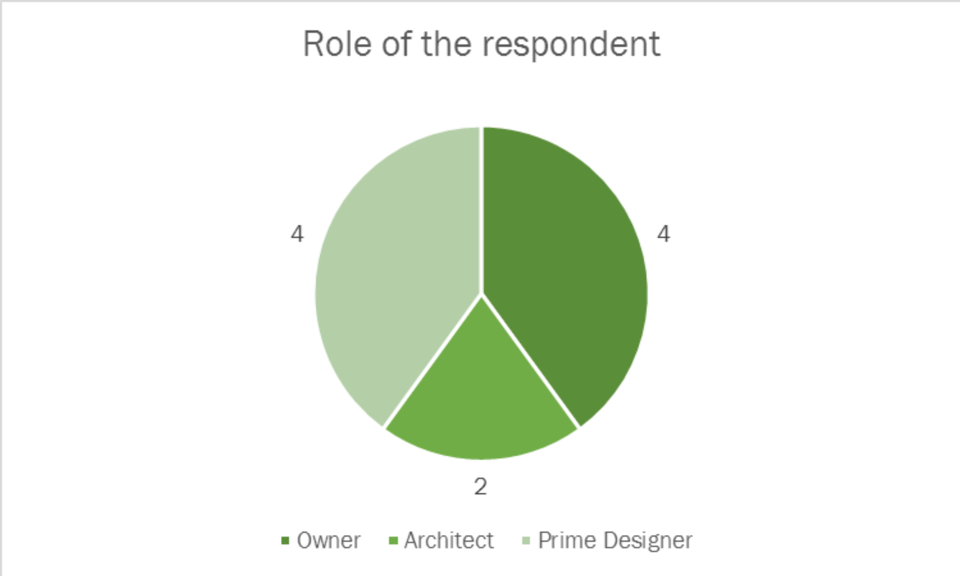


Figure 15: Distribution of the respondents according to their role

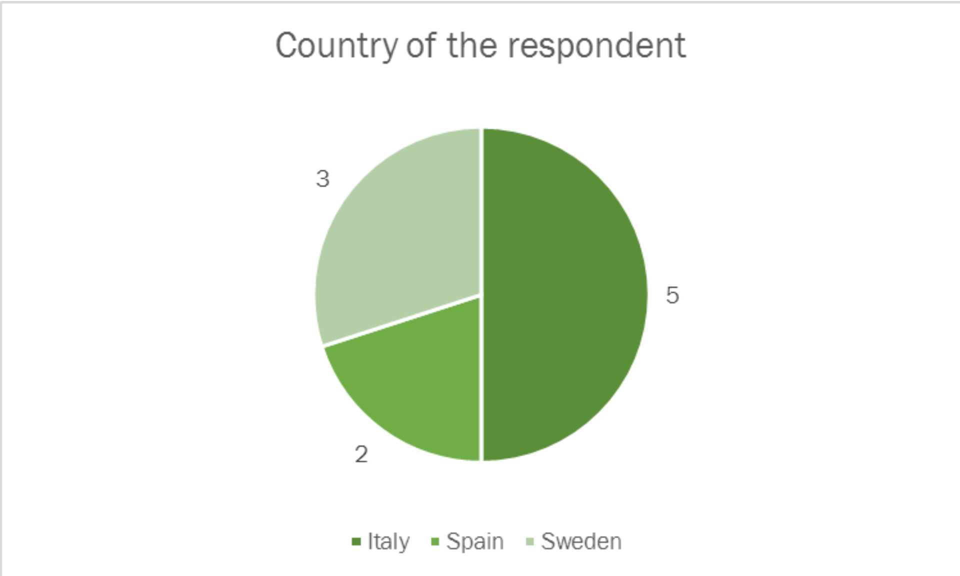


Figure 16: Distribution of the respondents according to their country

Table 18: Feedbacks and associated OptEEmAL answers for the outputs questionnaire

Feedback	OptEEmAL answer
General aspects	
End-users highlight the importance to have a detailed justification of the selected option	This has been taken into account by providing detailed excel reports as well as all the data models created by the OptEEmAL platform. More information could have been provided such as, as already mentioned, the idf file used as an input for EnergyPlus. This is an interesting feature which can be developed in the future.

End-users indicate that in their current practice, they lack information about user comfort improvement and energy demand reduction	This has been taken into account in the design of the platform as it includes indicators dedicated to comfort (COMxxx DPIs) and different indicators related to energy demand (ENE01 and ENE01.x). Also, the platform provides (both in its GUI and in the Excel reports) the difference between the baseline and the selected scenario.
End-users highlight as "other points of interest": information related to the practical implementation of an ECM (time, easiness,...) and the calculation of GHG emissions for a given option	This has been partially taken into account. Information related to the practical implementation of the ECM has not been provided. The main reason for that is that except the general information related to the different ECMs, the catalogue does not include such information. To the contrary, GHG emissions are calculated (ENV01, ENV02 and ENV03 DPIs) and this information is also available at the ECM level as this is one of the information contained in the ECM catalogue.
BIM and CityGML files	
End-users mention that compliance with other tools is critical	This has been taken into account as the exported BIM and CityGML files are compliant with the latest standards. However, some existing tools are not necessarily compliant (or fully compliant) with these standards. As a consequence, the files generated by the platform are not necessarily with all existing tools but this cannot be attributed to the platform.
End-users indicate that the possibility to use the information generated by the platform in Facility Management tools can create a significant added value for the tool	This has not been taken into account as this would have needed the identification of currently used tools and the generation of the files in the proper formats. This was not possible with the time and efforts planned for the project.
End-users highlight the importance to have the energy systems included in the generated files (and especially BIM models)	This has not been taken into account because it it difficult to properly insert energy systems in the IFC format.
If not possible, end-users indicate that most technical of them are able to include this information in the models if they have an easy access to the information and guidelines on how to proceed)	This has not been taken into account. Although this has been highly discussed within the project consortium, time and efforts were missing to properly provide the end-users with guidelines on how to insert the implemented ECMs (including active ones) in the IFC files. This is a limitation of the platform that can be overcome after the project.
PDF and excel files	
End-users indicate that those files have to focus on economic and energy aspects	This has been partially taken into account. Excel files generated by the platform includes all information per DPI category (energy, economy, environment...). They do not include only economic and energy information because this is the purpose of the platform to not focus only on those aspects.
End-users mention that those files shall provide different levels of information (general information with graphs and then detailed information)	This has been taken into account as the end-users can download excel files with only general information comparing the obtained results with the baseline through graphs and tables. Detailed information is also available for instance for applied ECMs for which all the information contained in the catalogue can be downloaded.
End-users expect both district and building level information to be provided	This has been taken into account as the end-users have access, in the platform, to the ECM applied at building and distric levels and the associated DPI at district level. One point that could be improve in the future is to provide building level indicators (BPI in this case). However, the choice has been made since the beginning of the project to not show building indicators in the platform because the purpose of the project was to tackle the district scale.

End-users mention that both inputs used by the platform and outputs generated by the platform shall be available for download	This has been taken into account has all the information inserted in the platform can be downloaded (and modified in some cases) and of course all outputs are available for download.

Main conclusion from this step: The main conclusion from this step is that most of the feedbacks provided by the end-users to this questionnaire have been taken into account. This is normal as this questionnaire was used as an input to elaborate the detailed OptEEmAL outputs. However, either for technical or for time reasons, specific feedbacks have not been included in the platform. These feedbacks are listed in the possible technical improvements to be done after the project (see section **¡Error! No se encuentra el origen de la referencia.** for more details).

3.1.4 Data collection

The results of the data collection were the different input data to be inserted in the platform. As a reminder, these are:

- Members of the IPD group
- Numerical models:
  - CityGML of the district and neighbouring buildings
  - IFCs of the buildings under study
- Baseline Energy Systems: description of the energy systems present in the district before retrofitting
- Contextual data:
  - Weather file
  - Socio-economic data (energy prices and average income)
- Possible Energy Conservation Measures for the retrofitting project
- Targets and boundaries of the retrofitting project
- Prioritisation criteria of the retrofitting project

For all data except numerical models, the data collection was quite easy for stakeholders and end-users. Most of the time, all the data were already available. For some specific aspects (Baseline Energy Systems) some specific questions (e.g. hot water set point, boiler capacities…) had to be asked to more technical people involved in the project. The collected data are available in the different deliverables related to the demonstration and validation of the platform at TRL6 (D6.2) and TRL7 (D6.3).

The critical aspect in the data collection process was the elaboration of numerical models. The Table 19 and Table 20 below give an overview of the necessary and performed work regarding those files. It has to be noted that in the case of the Cuatro de Marzo case study, existing files from the R2CITIES project (http://r2cities.eu/) have been used for the basis of the work and have been completed following OptEEmAL guidelines. Considering the work needed for these complements, there are accounted for in the table below.

Table 19: IFC files needed and elaborated within the project

District	N° of buildings	N° of IFC files needed	N° of IFC files elaborated within OptEEmAL
Cuatro de Marzo, Valladolid, Spain	5	4	4
Mogel, Eibar, Spain	15	5	5
Polhem, Lund, Sweden	6	6	6
Txomin Enea, San Sebastián, Spain	8	5	5
San Bartolomeo, Trento, Italy	6	2	2

Table 20: CityGML files needed and elaborated within the project

District	N° of CityGML file needed	N°of IFC files needed
Cuatro de Marzo, Valladolid, Spain	1	1
Mogel, Eibar, Spain	1	0
Polhem, Lund, Sweden	1	1
Txomin Enea, San Sebastián, Spain	1	0
San Bartolomeo, Trento, Italy	1	1

As abovementioned, the work related to the elaboration of these files was not initially planned in the project and has thus required a significant amount of time. This is one of the reasons for the reduced number of case studies investigated in the project. From the stakeholders/end-users perspective, the elaboration of the IFC files was considered as one of the major difficulties in the use of the OptEEmAL platform. This point is further detailed in the section dedicated to the feedbacks received during the trainings (see 3.2.2 and 3.2.2.1).

Regarding the IFC files, the following entities have been involved in the elaboration of the files:

- Cuatro de Marzo, Valladolid, Spain: CAR
- Mogel, Eibar, Spain: NBK with support of TEC for providing the necessary information
- Polhem, Lund, Sweden: LUND subcontractor with the support of LUND for providing the necessary information
- Txomin Enea, San Sebastián, Spain: NBK with support of TEC for providing the necessary information
- San Bartolomeo, Trento, Italy: DTTN subcontractor and NBK with support of DTTN for providing the necessary information.

In addition, it has to be noted that TUC has been involved in the checking of all the IFC files generated during the platform (both using the checking API developed during the project and also communicating with the different entities with regard to the modifications to be done in the files).

Regarding the CityGML files, the following entities have been involved in the elaboration of the files (it has to be noted that the CityGML files for Mogel and Txomin Enea were already available from TEC, only small adaptations have been made to those files to make them compliant with the OptEEmAL requirements):

- Cuatro de Marzo, Valladolid, Spain: CAR
- Polhem, Lund, Sweden: TEC with support of NBK and LUND for providing the necessary information
- San Bartolomeo, Trento, Italy: TEC with support of NBK and DTTN for providing the necessary information

Overall, the generation of the CityGML file was not considered to be so difficult by end-users. The only limit that raised regarding those files is the fact that end-users are not used to work with such files. This point is further detailed in the section dedicated to the feedbacks received during the trainings (see 3.2.2 and 3.2.2.1).

Main conclusion from this step: The main conclusion from this step is that the input data needed to run the OptEEmAL platform are, with the exception of numerical models, easy to be gathered. This is a positive point for the use and dissemination of the platform. Regarding numerical models (and especially IFC files), their creation is difficult and is thus a critical factor in the use of the platform. This is further detailed in the section dedicated to the feedbacks received during the trainings (see 3.2.2 and 3.2.2.1) as this was raised by the participants and also discussed in the overall recommendations for the future steps for the OptEEmAL platform (see section **¡Error! No se encuentra el origen de la referencia.**).

3.2 From trainings and use of the platform

This section aims at presenting the results obtained during the training sessions organised at the end of the project. It has to be mentioned that only the feedbacks related to the use of the platform are analysed here. Feedbacks related to the organisation of the training sessions are discussed in WP7 deliverables (D7.9). First, figures about the number of participants and their profile are provided. Then, feedbacks gathered through the technical questionnaires distributed during the technical training session (Day 2 of the training sessions) are provided. Finally, other feedbacks gathered during the open discussions of both the general training session (Day 1 of the training sessions) and the technical training session are provided. This information is addressed in the following section dedicated to the recommendations for the future steps for the OptEEmAL platform (see section **¡Error! No se encuentra el origen de la referencia.**).

3.2.1 Participation in the trainings

The overall figures for the participation in the trainings is provided in the Table 21 below. In total, and excluding project partners, 61 people took part in the training sessions. Regarding technical trainings (Day 2), in total (excluding project partners), 10 people participated in the training sessions. The lower number of people participating in these technical trainings is normal considering the fact that only technical people were invited to these training sessions which were dedicated to the real use of the platform (during Day 1, the platform was presented but participants were not able to use it directly). The profile of the participants to the technical training sessions is listed below:

- Lund, Sweden:
    - Participant 1: From Lund municipality, technical person working on the design and follow up of retrofitting projects, working on the Polhem school project
    - Participant 2: From Lund municipality, project manager implementing building/district retrofitting projects (and also new projects), working on the Polhem school project
- San Sebastián, Spain:
    - Participant 1: From Giroa-Veolia (ESCO), prime designer of the Txomin Enea project
    - Participant 2: From AGM Arquitectos, architect of the Txomin Enea project (for the part of the district that will be retrofitted)
    - Participant 3: From BASA Arquitectura, architect of the Txomin Enea project (for the part of the district that will be retrofitted)
    - Participant 4: From ANDRASA (prime constructor), prime constructor of the Txomin Enea project (for the part of the district that will be retrofitted)
- Trento, Italy:
    - Participant 1: From Habitech (local authority), project manager in charge of the design of retrofitting projects (with a special focus on environmental aspects), working on the San Bartolomeo project
    - Participant 2: From Habitech (local authority), technical person in charge of the design of retrofitting projects, working on the San Bartolomeo project
    - Participant 3: From Consorzio Lavoro Ambiente (local organisation), urban planner in charge of the design and follow up (facility maintenance) of retrofitting projects, working on the San Bartolomeo project

Overall, the participants to the technical training sessions were well representing the envisaged end-users of the platform. This was interesting for the project as they have provided interesting feedbacks on the current status of the platform but also on the potential following steps for the platform.

Table 21: Participants to the training sessions (numbers mentioned between () indicate the number of project members participating to the training)

Place	Day 1	Day 2
Lund, Sweden	8 (3)	5 (3)
San Sebastian, Spain	26 (6)	9 (5)
Trento, Italy	7 (2)	6 (2)
Total	41 (11)	20 (10)

Pictures below (Figure 17, Figure 18 and Figure 19) illustrate the purpose of these technical trainings which was to make the participants use the platform and help them in case they have any question/doubt. This training was also made to have a significant part of open discussions at the end of the training session in order to share the experience of the participants and collect their first-hand feedbacks on the platform's use (not only through questionnaires). This is further explained in the next sections.

Figure 17: Picture of the technical training session in Lund, Sweden

Figure 18: Pictures of the technical training session in San Sebastián, Spain

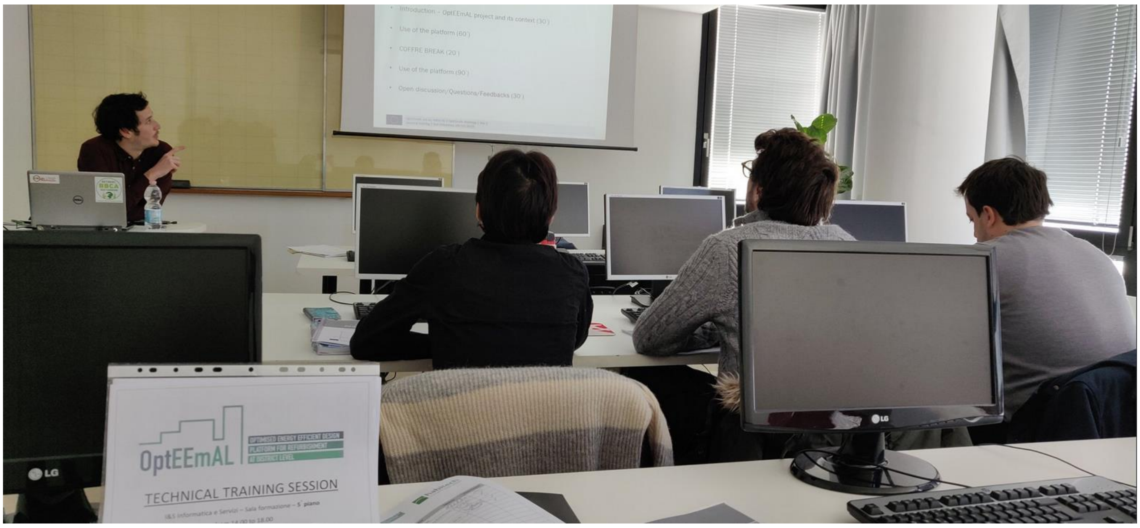


Figure 19: Picture of the technical training session in Trento, Italy

3.2.2 Feedbacks from the technical questionnaires

The technical questionnaires were used to gather the feedbacks of the different end-users regarding the platform in general but also regarding specific technical components of the platform. A section was also specifically dedicated to the Graphical User Interfaces (GUI). The distributed questionnaire is provided as annex of this document (see section 0). The obtained results are presented in the Table 22, Table 23, Table 24 and Table 25 below and analysed in the following paragraphs.

One important preliminary remark is that from the 10 participants in the technical trainings (excluding project partners), one participant of the training session in Italy did not answered the questionnaire. This is because he is the DTTN subcontractor and has been involved prior to the training in the development and testing of the platform (especially the part related to the IFC upload and checking). As a consequence, only 9 feedbacks have been collected regarding the technical questionnaire.

Also, it has to be mentioned that a "-" in the following tables indicates that the participants did not answer the related question.

Finally, possible ranking was indicated in the questionnaire and is indicated after each section title of the questionnaire in the tables below. In all cases, the best results are the ones with the highest mark/score.

Table 22: Feedbacks from the technical questionnaires (part I)

	Lund 1	Lund 2	Trento 1	Trento 2	Trento 3	San Sebastian 1	San Sebastian 2	San Sebastian 3	San Sebastian 4	AVERAGE	MIN	MAX
Platform assessment												
Overall (0 to 5)												
Overall usefulness	4	4	5	4	5	3	4	5	5	4,3	3	5
Comment	-	The different district level we have in Sweden makes this tool a bit different that other parts of EU	-	-	-	-	-	-	Interesting for public entities. In day to day work, difficult to work at district scale			
IPD (0 to 2)												
Aware	2	0	0	0	0	0	0	0	0	0,2	0	2
Clear implementation	2	2	-	1	2	1	0	2	1	1,4	0	2
Comment	-	I wasn't aware before the meeting	-	-	-	-	-	-	-			
BES (0 to 2)												
Introduction in the PF	1	2	2	1	1	1	1	2	1	1,3	1	2
Comment	-	Takes time but it's straightforward	-	-	-	-	-	-	-			
ECM (0 to 2)												
Completeness	1	2	1	2	1	1	0	2	2	1,3	0	2
Comment	Some are maybe not so common in Sweden and I am missing lighting measures	havent check them all but I think a lot of ECMs will match	As discussed, the list can be endless	-	-	-	-	-	-			

Table 23: Feedbacks from the technical questionnaire (part II)

	Lund 1	Lund 2	Trento 1	Trento 2	Trento 3	San Sebastian 1	San Sebastian 2	San Sebastian 3	San Sebastian 4	AVERAGE	MIN	MAX
TBBs (0 to 2)												
DPI list	1	2	2	1	2	1	1	2	1	1,4	1	2
Prioritisation selection	2	2	1	2	2	1	1	2	2	1,7	1	2
Comment	To us there are other really important factors that has to do with comfort and demands of our users	Nothing to add	It is difficult to have a clear idea of all weighting criteria before having the results	-	-	-	-	-	-			
Optimisation (0 to 2)												
Clearness	2	2	1	1	1	1	2	2	2	1,6	1	2
Results (pareto) clearness	2	2	1	1	1	1	1	2	1	1,3	1	2
Overall results interface	2	2	2	2	2	2	2	2	2	2,0	2	2
Comment	-	-	-	-	-	-	-	-	-			
Outputs (0 to 2)												
Clear	2	2	2	1	2	1	2	2	2	1,8	1	2
Contain all the information	-	2	2	2	1	1	2	2	2	1,8	1	2
Comment	Don't know the last one	-	-	-	-	-	-	-	-			

Table 24: Feedbacks from the technical questionnaire (part III)

	Lund 1	Lund 2	Trento 1	Trento 2	Trento 3	San Sebastian 1	San Sebastian 2	San Sebastian 3	San Sebastian 4	AVERAGE	MIN	MAX
General comments												
Please list 3 negative aspects	Maybe difficult to get results right when countries are so different	The difference with district we have in Sweden vs. Europe	Specify and detail material types for ECM	Would be useful to make the link with facility management tools	Interesting to have the idf files to validate the results	Topography is not taken into account	Implentation in real construction works	Generation of IFC and CityGML files	Generation of IFC and CityGML files			
	Costs for 3D modelling	Cost of 3D modelling the building	Black box	-	-	-	-	-	-			
	-	-	The spread of the platform depends on the spread of technical skills, public authorities must implement methods in Italy	-	-	-	-	-	-			
Please list 3 positive aspects	It really strives in the direction that we aim to go in (IPD, BIM, etc.)	Time saving	Fast and strong support to the design	The use of BIM technology as input data	Could be really useful to define renovation strategies at large scale	-	Huge quantity of information	Data integration	Inclusion of prices			
	Grat to have as a tool for decision making	Probably money saving	-	-	Interesing to have a quick (in comparison to existing solutions) idea of the possible options	-	Integration	Grouping of solutions	-			
		A tool that doesn't demand using a lot of other tools	-	-	-	-	Data	Inclusion of prices	-			

Table 25: Feedbacks from the technical questionnaire (part IV)

	Lund 1	Lund 2	Trento 1	Trento 2	Trento 3	San Sebastian 1	San Sebastian 2	San Sebastian 3	San Sebastian 4	AVERAGE	MIN	MAX
GUI												
Screen (0 to 5)												
Reading	5	5	5	5	5	3	5	4	4	4,6	3	5
Organisation	5	5	5	5	5	4	4	4	4	4,6	4	5
Sequence of screens	5	5	5	5	5	4	4	4	4	4,6	4	5
Terminology and system information (0 to 5)												
Vocabulary	5	5	5	5	5	4	5	4	5	4,8	4	5
Terminology related to task	5	5	5	5	5	4	4	4	5	4,7	4	5
Position of messages on screen		5	5	5	5	3	4	3	4	4,3	3	5
Computer informs about its progress	5	5	5	5	5	3	4	3	4	4,3	3	5
Error messages		5	5	4	5	3	4	3	4	4,1	3	5
Learning (0 to 5)												
Straitghforward	5	5	5	5	4	3	-	-	4	4,4	3	5
Help		5	5	5	4	3	4	4	4	4,3	3	5
Supplemental referene materials	5	5	5	5	4	3	4	4	4	4,3	3	5
General (0 to 5)												
Learning to operate the PF	5	5	5	5	5	3	4	5	4	4,6	3	5
Easy to do what I want	5	5	5	5	5	4	4	5	4	4,7	4	5
Interaction clear and understandable	5	5	5	5	5	4	4	5	4	4,7	4	5
System flexible to interact with	5	5	5	5	5	4	4	5	4	4,7	4	5
System easy to use	5	5	5	5	5	3	4	5	4	4,6	3	5

3.2.2.1 Platform assessment

First of all, and from a **general perspective**, Table 22 shows that the platform is considered to be useful by all participants with an average score of 4.3 (out of 5). This result validates the development of the tool and shows that the platform can be interesting for the market. The lowest score is 3 and was given by a prime constructor. In addition, this person has indicated during the training that, as a prime constructor, the platform is of low interest for him although he understands the benefits from using the platform. One of the main reason is that the ECM catalogue, in its current version, include only very little information about the implementation of the measures (e.g. time, safety…). This point was already identified by the project partners during the project implementation but can be considered as an improvement point for the next steps of the platform development.

Then, it is interesting to note that the **IPD methodology** was unknown for the training participants before the session (0.2 out of 2) and that OptEEmAL contributes to the dissemination of this methodology as its implementation is globally considered to be clear by the participants (1.4 out of 2). This is a strong point for the platform which can have significant benefits for the building sector.

Regarding **Baseline Energy Systems**, their implementation/introduction is considered to be clear for the end-users although this can be probably improved. Especially, in Sweden, the introduction of the different information related to the inclusion of the specific energy mix of Lund was a bit complicated for the participants (the real information needs to be adapted to be introduced into the platform as the energy mix of Lund is too complicated to be introduced in the platform as in reality). On this point, the conclusion is that the way to enter the information is clear but the available list of BES is maybe too restricted (especially in the case of district/regional heating running on several energy sources) or does not sufficiently accounts for local specificities. This was known by the consortium but has been difficult to implement considering the vast diversity of energy mixes in Europe. Even focusing on the demo sites it was leading to quite complex situations as in Lund (Figure 20: Scheme of the Lund energy mix).

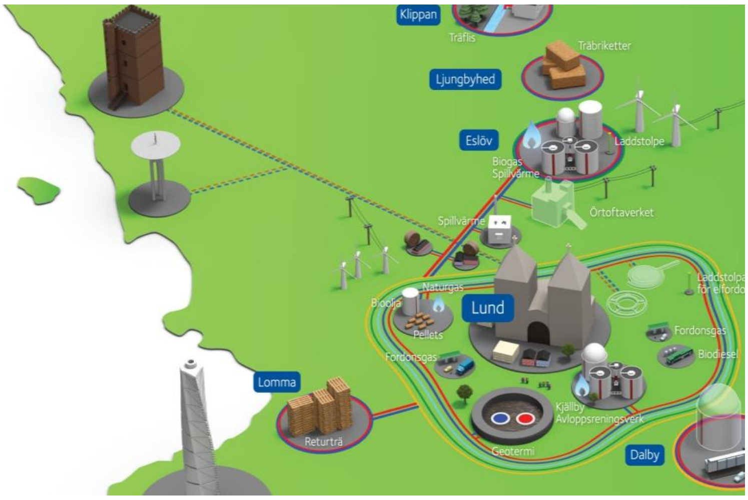


Figure 20: Scheme of the Lund energy mix (@Kraftringen)

Regarding **Energy Conservation Measures**, the available list is considered to be quite complete (1.3 out of 2). However, some remarks were made by the participants regarding the inclusion of lighting measures (this was considered to be out of the scope of the project by the consortium for a long time). Also, this remark was done orally by some participants indicating that it (LED lighting) is one of the most commonly implemented measures in their projects. Besides, regarding this point, it has to be highlighted that the participants evaluated the list of ECMs that was presented in the GUIs of the platform and not the final list of really implemented measures. This means that the implementation of these measures in the platform would be needed for the market uptake of the platform.

In terms of indicators, the list of **DPIs** is considered to be relevant and complete by most of the participants (1.4 out of 2). However, in the case of Lund, the list of comfort indicators was considered to be too restricted. This is probably because the demo site is a school and that implicates strong objectives in terms of user comfort. Regarding **prioritisation criteria**, they were considered to be clear by the participants (1.7 out of 2). One interesting point that was raised (also during the open discussions) but that is not necessarily directly related to the prioritisation criteria implementation in the platform, is the fact that most of the time it is difficult for owner or local authorities to gather the opinion of the inhabitants and include it in the retrofitting project. This point is further treated in the section related to the recommendations for the future steps of the platform development (see section **¡Error! No se encuentra el origen de la referencia.**). Finally, the last comment that was made regarding prioritisation criteria is that it would have been interesting to run the optimisation without introducing the prioritisation criteria and then filter the optimisation results selecting the different criteria. This is an interesting option but the choice has been made by the consortium to include the prioritisation criteria in the optimisation process in order to fasten it and above all to present to end-users only a limited set of scenarios.

Regarding the **optimisation process**, although being a bit complex from a mathematical perspective, end-users have understood its principles and the associated results (Pareto front and selected scenario). This is a positive point for the platform as optimisation can be difficult to understand for non-scientific people. As for the IPD methodology, it is positive that the OptEEmAL platform helps to improve the knowledge of its end-users.

Finally, another positive point for the platform is the fact that the **provided outputs** are clear and relevant for its end-users. This is critical for the usefulness of the platform as this will be the information the end-users will use in the next phase of their retrofitting project. One point that was raised during the open discussions and that is important to be mentioned here, is the fact that **data models** (available for download in the platform) are quite technical and not useful for all end-users. However, the fact that they are available is seen as a positive point in terms of transparency. This discussion generated some interesting comments regarding the platform and notably that the platform can be seen as a “black box” which is usually not good for market uptake (participants have indicated that they tend to use a tool that is transparent and for which they can check the calculation). This has then generated the idea to give as an output of the platform the idf files generated for the execution of EnergyPlus.

3.2.2.2 General comments

Regarding **negative aspects**, it has been highlighted that the platform does not sufficiently accounts for local specificities in terms of energy mixes, possible ECMs and associated economic data and local incentives. This is true and was known by the consortium for a long time. Some developments were made to tackle this issue (geo-clustering module) but for sure this point can still be improved.

Another negative aspect that has been raised is the cost of BIM modelling. This is probably one of the most mentioned point during the trainings. Similarly to local specificities, this was known by the consortium for a long time but the choice has been made to rely on this “technology” as it will grow in Europe and is considered by the consoritum to be highly relevant for the EU building sector. This is further discussed in the following section about recommendations (see section **¡Error! No se encuentra el origen de la referencia.**).

Other less common negative points include:

- To provide more details in the Check strategies screen about the ECMs (for some ECMs, the name of the insulation material is not necessarily provided, e.g. for PA.FA.EX.VE ECMs “Ventilated facade with 50 mm of insulation)
- To create links with Facility Management tools (this was more mentioned as an improvement point than a real negative aspect)
- To consider topography which can have a significant impact in some locations (especially in San Sebastián and Trento)
- To provide in the ECM catalogue (and in the associated GUI) information about the real implementation of the ECMs (time, safety issues, etc.)

In terms of **positive aspects**, the aspect that was the most raised is the fact to have a single tool instead of several different ones for the different simulations needed during the design of a retrofitting project. This was really appreciated by the participants.

Other positive aspects include:

- OptEEmAL can help to move into the right direction in terms of IPD implementation, use of BIM, etc.
- OptEEmAL can save time and money in comparison to traditional practices (it has to be highlighted that participants have been warned about the time needed to prepare the input data, to use the platform and to make the calculations)
- OptEEmAL includes detailed and editable price information about the ECM and provide interesting indicators in terms of economic aspects.

3.2.2.3 Graphical User Interfaces

As presented in Table 25, the Graphical User Interfaces of the platform have been very well evaluated by the participants (all marks above 4 out of 5). This is not surprising as, during the technical trainings, it was fortunately noted that the participants were able to use the platform on their own “only” after having seen the video presenting the detailed used of the platform. This can lead to two comments: 1) the video is clear and useful to the end-users and, 2) the GUI are well designed and, as a result using the platform is easy.

This is a very positive point for the platform because GUIs can be considered as the entry point (or “first thing viewed”) by the end-users and potential customers. It is thus considered as a key factor for a correct market uptake of the solution.

Only one small negative point has been raised regarding the optimisation. End-users have mentioned that it would be interesting to know the remaining time of the optimisation process. This was already known by the consortium but was not implemented for technical and time reasons.

3.2.3 Other feedbacks

Apart from the feedbacks gathered through the questionnaires, other interesting points have been shown by training participants on the occasion of the **open discussions** taking place during the training sessions. It has to be highlighted that this section includes information gathered from both days of the trainings. This has been done in this way because even during the general training, some “technical” remarks on the platform were done.

Below (Table 26) is given the list of the provided feedbacks (as they were provided). They have been classified per component of the platform to which they refer. The last category is dedicated to new functionalities that could be developed in the future. Also, the last column indicates if this is a positive (“+”) or negative (“-“) point for the platform. For the last category (new functionalities), the different feedbacks have not been evaluated considering that they are improvement points and not positive or negative aspects.

The obtained feedbacks presented in the table below are then further discussed (and grouped with all others received during the trainings and the whole project) in the following section.

Table 26: Feedbacks gathered during the open discussions

OVERALL	
Really interesting to perform all the simulations in one place. Interesting for teaching purpose	+
Tool with huge potential. Can be really useful for municipalities in order to have an idea of the possibilities in terms of retrofitting solutions. Explore different scenarios prior to hiring a company in order to have counter arguments.	+
Few projects at district level. Usually more at building level	-

To trust a tool, you need to know what is inside so transparency will have to be provide for the platform	-
For energy consultants: Projects at district level are rare. More at buildings level	-
Could also be interesting for little village with similar building characteristics	+
Huge potential especially for local authorities (planning, definition of financial incentive strategies).	+
Very little existing and (use of) BIMs and CityGML in rehabilitation projects.	-
Rare to work at district scale, usually at building level	-
Problem of BIM models for renovation projects (really hard to have). OptEEmAL promotes the process but lack of available data.	-
IPD	
Not useful for the construction companies (before their implication).	-
Interesting for cities to define strategies at global level (to see where to put the money, to promote a given measure…). “Path the way for public authorities” --> Planning	+
BES	
The complex energy mix of Sweden / Lund is difficult to implement in the platform.	-
Ease the introduction of demand systems	-
Have a better view of which building is selected while answering questionnaires	-
Implementation of geothermal systems building and district levels (common in Italy)	-
ECM	
Some specific ECMs which are used in Sweden are not necessarily present in the platform	-
Would be useful to have specific ECM data for each country	-
DPI	
Interesting to integrate IAQ and comfort issues with other criteria/indicators	-
Would be useful to have specific data on local incentives, etc.	-
Would be interesting to aggregate all the DPIs into a single, economic indicator	-
Would be interesting to account more for local specificities (energy prices, financial incentives…)	-
RESULTS	
Could be interesting to provide more details on the results? Where the difference in coming from? From which ECM mainly?	-
NEW	
Could be interesting to create a link with thermal regulation simulation tools in the different countries (eg. JUL/CALENER in Spain).	N/A
Could be also interesting to import idf file directly into the platform	
Would be interesting to have a planning of the renovation works as an output of the platform. Give the possibility to study different scenarios in time	
Implication of people/building occupants. Actually there is a problem to convince building occupants of the need to perform retrofitting and the associated benefits for them and the society in general.	
Would be interesting to have, for a block, a tool and a methodology to collect occupant’s point of view, aggregate their needs and discuss with them. Make them aware of their energy consumption and the need to act	
Interesting to create the link with measured data after the implementation of the ECMs	
Different software to plan building maintenance (less sophisticated). Might be perfect for future facility management.	

Can be very interesting for the sector (facilities). Inclusion of management planning (management of contracts, owner to send alerts if a system is broken)	

4 Outcomes and recommendations

This section aims at discussing the different feedbacks (both positive and negative) obtained all along the activities presented in this deliverable (with a special focus on training activities considering their importance in this exercise). The goal is to provide an objective assessment of the platform and to identify recommendations for the future steps of the platform (from TRL7 to TRL9) with the aim of maximising the market uptake of the platform.

This section starts with a general sub-section dedicated to the overall platform and then provides a detailed analysis for each step of the platform. Finally, this section ends with a sub-section dedicated to new functionalities that can be included in the platform in the future.

4.1 Overall

From a general perspective, the OptEEmAL platform is **considered to be useful by its potential end-users**. Especially, it seems to be very interesting for owners or entities in charge of several buildings (e.g. public authorities) in order to define retrofitting strategies at a large scale. The platform can be for instance useful for **public authorities** to define the financial incentives they will put on certain retrofitting measures or to have an idea of the different possibilities in terms of possible ECMs for a given project. For **prime designers**, the platform is useful as it can be used to initiate discussions with owners on technical aspects related to the retrofitting strategy. In this sense, the OptEEmAL platform clearly meets one of the objectives of the IPD methodology which is to make the different actors of a retrofitting project work together since the beginning of the design of the retrofitting project. For the last category of actors (i.e. **prime constructor**), the platform seems to be used to early in the process. This highlights the need to promote even more the IPD methodology (although it has been showed that the platform helps to get this) which aims at solving this issue and including such actor early enough in the process.

From all the positive points listed in this document, the one that has been especially highlighted during the training activities is the possibility to run different simulations without the need to use different tools.

Regarding **negative aspects**, the main one that has been faced during the project implementation and pointed out by training participants is the elaboration/existence of BIM models (IFC files) for existing buildings. Another important negative point that has been expressed several times is the "black box" aspect of the platform. Several participants mentioned that *"to trust a tool, you need to know what it does"*. This can be seen as a drawback of all the data integration and automatic processes provided by the OptEEmAL platform. In any case, this can be overcome by the developments of new functionalities which are listed later on in this section.

4.2 Step by step analysis

4.2.1 IPD group creation

This step is clear for the end-users and the platform seems to support the dissemination of the IPD methodology which is a positive point for the platform.

4.2.2 Data upload

4.2.2.1 BIM – CityGML Upload

This step is related to the major limitation of the platform which is related to the availability of BIM models (IFC files) for existing buildings. As already mentioned in this deliverable, this was known by the consortium since the beginning of the project but the choice was made to continue with IFC files for three main reasons: 1) it is the purpose of projects like OptEEmAL to promote new technologies,

2) OptEEmAL partners are convinced that BIM is a key to ensure the energy transition of the EU-building sector and 3) BIM models is growing rapidly for new buildings and is starting for existing buildings but the OptEEmAL consortium is convinced that it will be widely used in the coming years.

Regarding CityGML files, they appear to be less known by potential end-users but also that they are easier to be generated.

Except the generation of the file itself, the upload of the file in the platform is easy and clear.

4.2.2.2 BIM – CityGML matching

The matching process is clear and easy to perform. This is a good point for the platform as this functionality was difficult to be developed both from a GUI perspective and also from a data management perspective.

4.2.3 Baseline Energy Systems

The way to enter the information in the platform is considered to be clear by the potential end-users although it would be useful to have the possibility to easily identify the building for which the questionnaire is being answered. Otherwise, the main limitation related to energy systems is related to the inclusion of local specificities and especially in the case of district heating running on several energy sources. This is a point to be improved in the future.

Also another limitation is related to the introduction of demand systems. This was already identified by the project consortium but has been highlighted during the open discussions of the training sessions.

4.2.4 Contextual data

This part is considered to be useful and has been appreciated by the end-users. During the trainings, it has been highlighted several times that the possibility to modify the collected information is important because most of the time epw weather files are not very precise/updated.

4.2.5 ECM questionnaire

The ECM questionnaire itself is considered to be clear and the list of available ECM is considered to be well representative of the possible options. As mentioned during the trainings, the ECM list could be endless and the possibility to add ECM in the catalogue shall be investigated further in the future. Some specific measures commonly implemented in retrofitting projects (e.g. LED lighting) are not present in the platform and this can be a limitation for the dissemination of the OptEEmAL platform.

The possibility of having country specific data in the ECM catalogue has also been highlighted as an interesting feature. Of course, this is possible (and known by the consortium) but was impossible to implement within the project lifetime. Of course, this can be done by local partners in charge of the dissemination of the tool (if this option is retained for dissemination) in the future.

Finally, the possibility to access implementation related information (time, safety, etc.) for the ECM appears as something important. Although this has been initiated within the project, this can be further improved in the future.

4.2.6 Check strategies

All the comments made to the *ECM questionnaire* can be applied to the *Check strategies* section. In addition, it has been highlighted that the name of the ECM provided in this screen are not sufficiently clear in the sense that they do not necessarily mention the names of all the materials used.

4.2.7 Baseline results

This step is clear for the end-users and provides interesting information. During the trainings, it was mentioned that it could be interesting to have the possibility to have detailed results per buildings.

This functionality has been disabled by the consortium since the beginning of the project to promote the work at the district scale. Also, and if needed, the platform can be used for a single building.

In the list of DPIs, end-users have mentioned that it could be interesting to focus more on the comfort through indicators related to Indoor Air Quality (although this is already present in the platform). Another comment was related to the possibility to have a single score (a combination of all DPIs into a single indicator) to ease decision making.

4.2.8 Targets and Boundaries

This step is considered to be clear and easy to perform by the end-users. No improvements have been raised by the potential end-users.

4.2.9 Prioritisation criteria

This step is considered to be clear for end-users. One point that was shown during the technical trainings is the possibility to apply the prioritisation criteria after the optimisation process (to filter the optimisation results). This has not been implemented within the platform for the reasons mentioned earlier in this deliverable.

4.2.10 Optimisation

This step is clear for the end-users. The only limitation that appeared raised is that it could be interesting for the platform's users to have an indication about the time required for the optimisation process.

4.2.11 Selection of the final scenario

This step is clear for the end-users. Potential improvements related to this step are: the possibility to view the influence of a single ECM on the results and the possibility to have results at building level.

4.2.12 Export

The export step is clear and easy to use for the end-users. The main improvement point for this step is related to the "black box" aspect of the platform. In order to encompass this, one option could be to allow the user to generate the "intermediate" models generated by the platform to feed the different simulation tools that are used within the platform. Considering the importance of energy calculations in the platform, it could be interesting to allow the user to download the idf files generated by the platform to run the EnergyPlus calculations.

4.3 New functionalities

The list of new functionalities to be potentially developed in the future is:

- The link with national regulation tools for energy analysis
- The import/export of idf files (as discussed in the previous paragraph)
- The planning of renovation works among years (this would mean adding information in the ECM catalogue and "intelligence" in the whole optimisation process)
- The development of a methodology and associated tools to gather inhabitants point of view and to ease the acceptance of the retrofitting project
- The creation of a link with measured data and facility management tools (planning of maintenance interventions according to initially planned performance (from OptEEmAL) and real performance (from measured data)).

It has to be noted that additional improvement possibilities have been identified by "internal" project partners during their use/test of the platform. This list is provided in D6.4.

5 Conclusion

All along the project, the stakeholders and end-users of the OptEEmAL platform have been involved. From the initial steps of the project to define the main characteristics of the platform (and their respective needs) until the end to provide feedbacks on the developed platform during the training sessions, they have provided highly valuable inputs to this project.

This deliverable describes the methodology and tools used to involve these actors and the associated results. It should be mentioned that this deliverable is a complement to D6.2 and D6.4 which provide more technical feedbacks from the consortium itself) while this one is more oriented on feedbacks coming from potential future users of the OptEEmAL platform (outside the consortium).

The main objective of this deliverable was to identify, based on the stakeholder's feedbacks, the next steps for the OptEEmAL platform and especially for a proper market uptake of the platform. From what is reported in this deliverable, the following main steps can be identified:

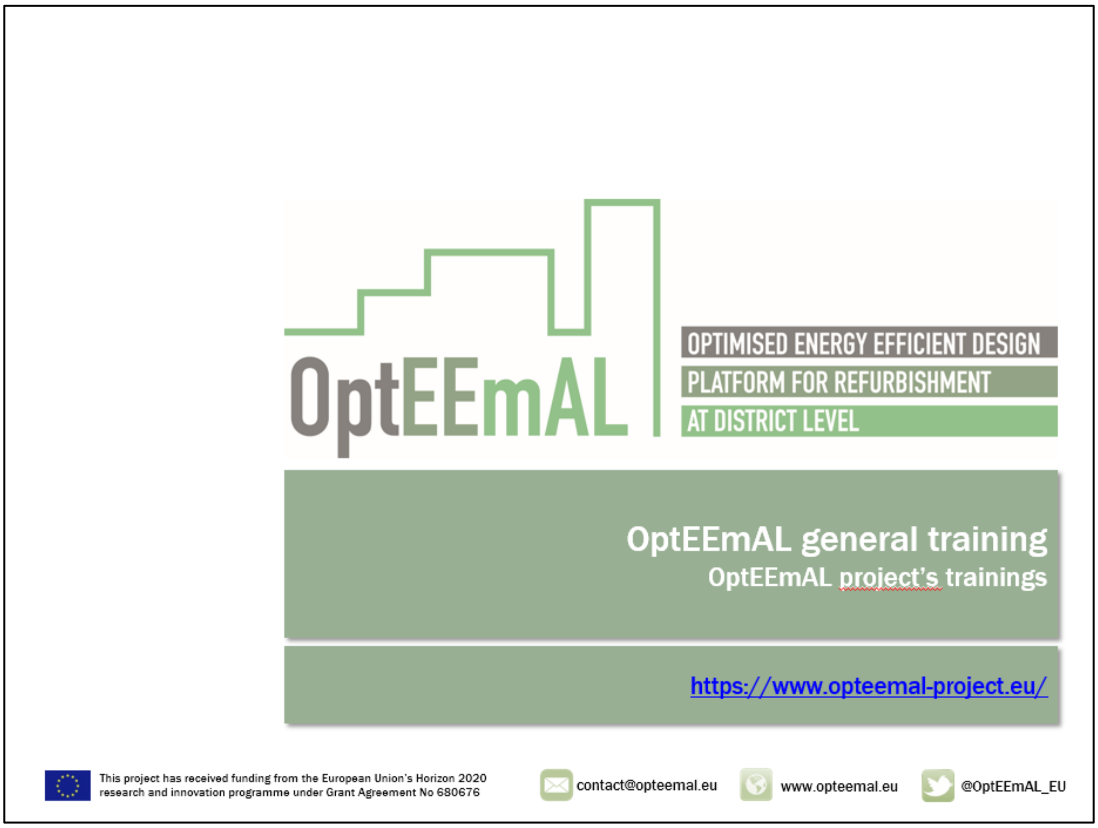
- Technical "steps" (improving the current platform without adding new functionalities):
  - Facilitate the insertion of input data related to energy systems (district scale, demand systems, etc.)
  - Implement "usually" used ECMs such as LED lighting
  - Provide more transparency in the platform through the possibility to export the idf files generated files (the possibility to import existing idf files is considered a new functionality)
- Exploitation "steps":
  - This is widely discussed in other deliverables (from WP7) but the business model of the platform (and more specifically of its ECM catalogue) can have a significant influence of the inclusion of latest technologies in this catalogue and thus act in favour of a wider dissemination towards potential end-users
- External "steps":
  - Act for the creation of a regulation dedicated to the elaboration of BIM models (in IFC format) for existing buildings
  - Make the necessary work to make this regulation align as far as possible with the OptEEmAL requirements

New functionalities have also been identified. They can increase the potential market uptake of the platform but are not considered, for the moment, as priorities. They are listed below:

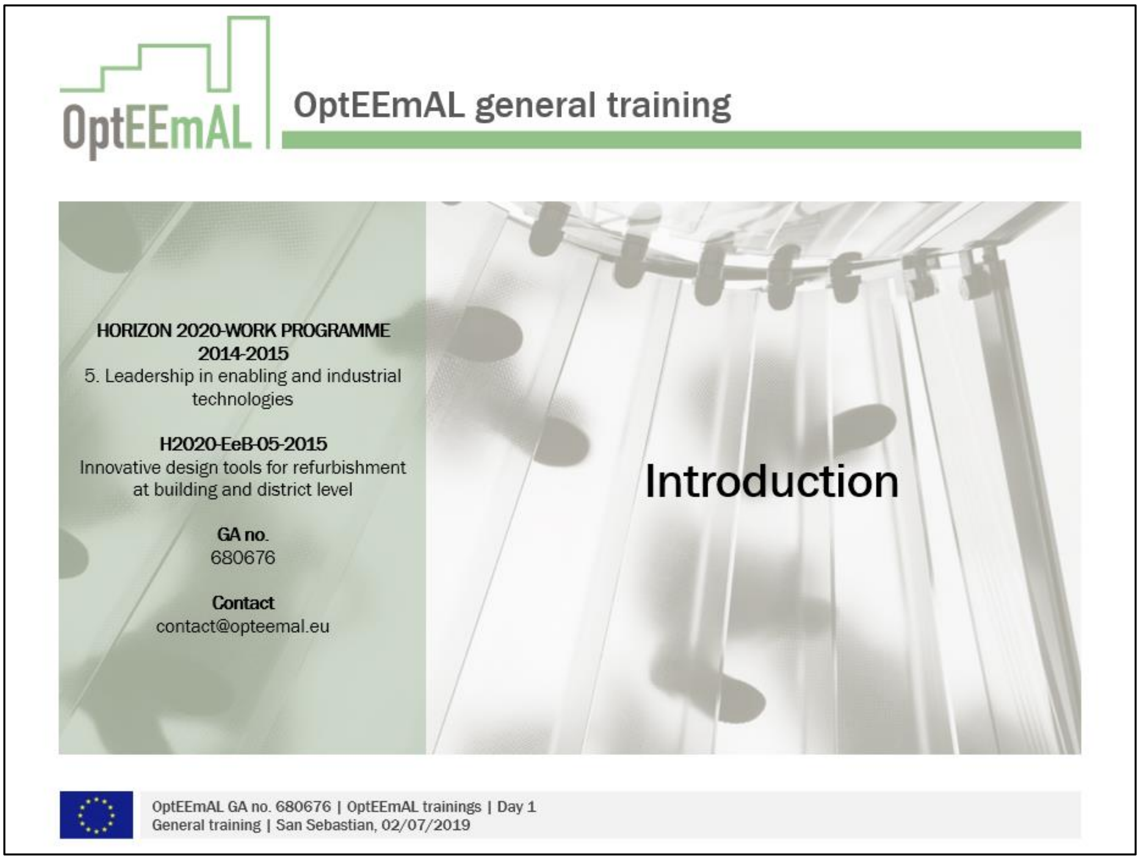
- Create links with national regulation tools for energy analysis
- Allow the importation of existing idf files
- Add intelligence in the optimisation process and ECM catalogue to generate retrofitting works planning (which intervention in which year)
- Develop a methodology and associated tools to gather inhabitants point of view and to ease the acceptance of the retrofitting project
- Create a link with measured data and facility management tools

Annex 1: PPT support for day 1 of the trainings

The PPT support for the day 1 of the training is presented below. This PPT support is the one used in San Sebastián. It has to be noted that where specific information are provided, it has been adapted to the different countries/cities.




OptEEmAL
OptEEmAL general training
HORIZON 2020-WORK PROGRAMME 2014-2015
5. Leadership in enabling and industrial technologies
H2020-EeB-05-2015
Innovative design tools for refurbishment at building and district level
GA no.
680676
Contact
contact@opteemal.eu
Welcome
OptEEmAL GA no. 680676 | OptEEmAL trainings | Day 1
General training | San Sebastian, 02/07/2019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5. Leadership in enabling and industrial technologies
H2020-EeB-05-2015
Innovative design tools for refurbishment at building and district level
GA no.
680676
Contact
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Introduction
OptEEmAL GA no. 680676 | OptEEmAL trainings | Day 1
General training | San Sebastian, 02/07/2019

OptEEmAL

Objectives

- Present the OptEEmAL context and project
- Present the OptEEmAL platform
- Show the benefits of the OptEEmAL platform for district energy retrofitting

OptEEmAL GA no. 680676 | OptEEmAL trainings | Day 1
General training | San Sebastian, 02/07/2019

OptEEmAL

Speaker's introduction

- Ana Aizpuru:
  - Fomento de San Sebastian
  - In charge of the demonstration site in San Sebastian (Txomin Enea district)
- Julia Vicente Gomez :
  - CARTIF (ES)
  - Project coordinator
- Juan Pedrero Alegria
  - TECNALIA (ES)
  - Technical advisor for the demonstration site in Txomin Enea
- Maxime Pousse:
  - Nobatek (FR)
  - In charge of demonstration activities

OptEEmAL GA no. 680676 | OptEEmAL trainings | Day 1
General training | San Sebastian, 02/07/2019

Agenda

- Welcome (10')
- Introduction: The OptEEmAL project and its context (40')
- The OptEEmAL solution (30')
- Coffee break (20')
- The OptEEmAL platform (80')
- Open discussion/Questions (30')

OptEEmAL GA no. 680676 | OptEEmAL trainings | Day 1
General training | San Sebastian, 02/07/2019

Keywords

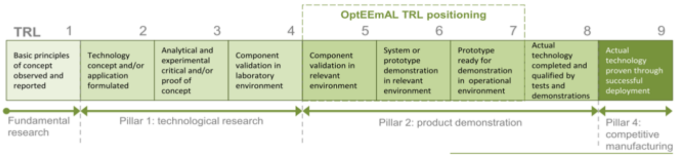
- OptEEmAL: Optimised Energy Efficient Design Platform for Refurbishment at District Level
- Optimised: Use of optimisation methods to find the best option
- Energy efficient: Focus on energy but integrates other aspects (economic, environmental, social, etc.)
- Platform: Integration of people and tools
- Refurbishment: For existing districts and buildings

OptEEmAL GA no. 680676 | OptEEmAL trainings | Day 1
General training | San Sebastian, 02/07/2019

Project

- H2020 project
  - Energy efficient buildings
  - Innovative design tools for refurbishing of buildings at district level
  - From September 2015 to February 2019

- 13 project partners
  - Coordinated by CARTIF (ES)
- Final objective:
  - Validate the OptEEmAL platform at TRL 7



OptEEmAL GA no. 680676 | OptEEmAL trainings | Day 1
General training | San Sebastian, 02/07/2019

OptEEmAL general training

HORIZON 2020-WORK PROGRAMME 2014-2015
5. Leadership in enabling and industrial technologies

H2020-EeB-05-2015
Innovative design tools for refurbishment at building and district level

GA no.
680676

Contact
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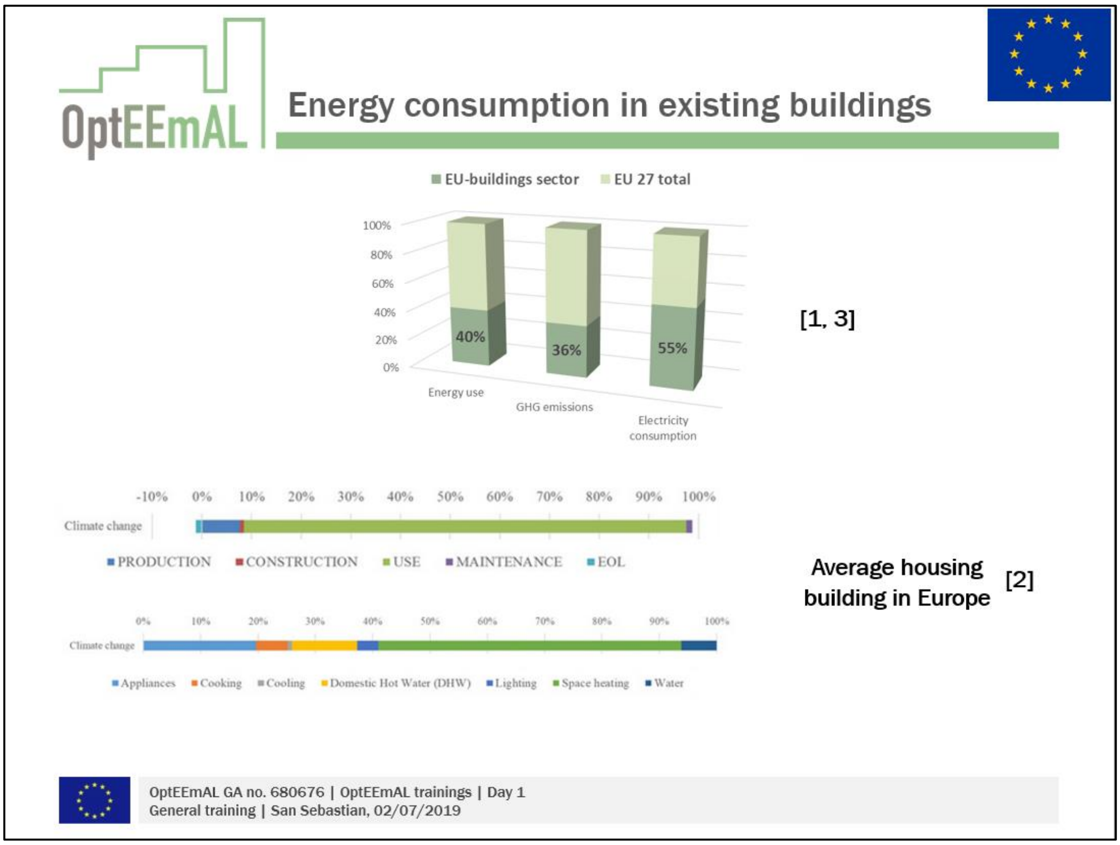
The OptEEmAL context

OptEEmAL GA no. 680676 | OptEEmAL trainings | Day 1
General training | San Sebastian, 02/07/2019


OptEEmAL
Energy consumption in existing buildings
EU-buildings sector
EU 27 total
100%
80%
60%
40%
20%
0%
40%
36%
55%
Energy use
GHG emissions
Electricity consumption
[1, 3]
-10% 0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Climate change
PRODUCTION CONSTRUCTION USE MAINTENANCE EOL
Average housing building in Europe
[2]
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Climate change
Appliances Cooking Cooling Domestic Hot Water (DHW) Lighting Space heating Water
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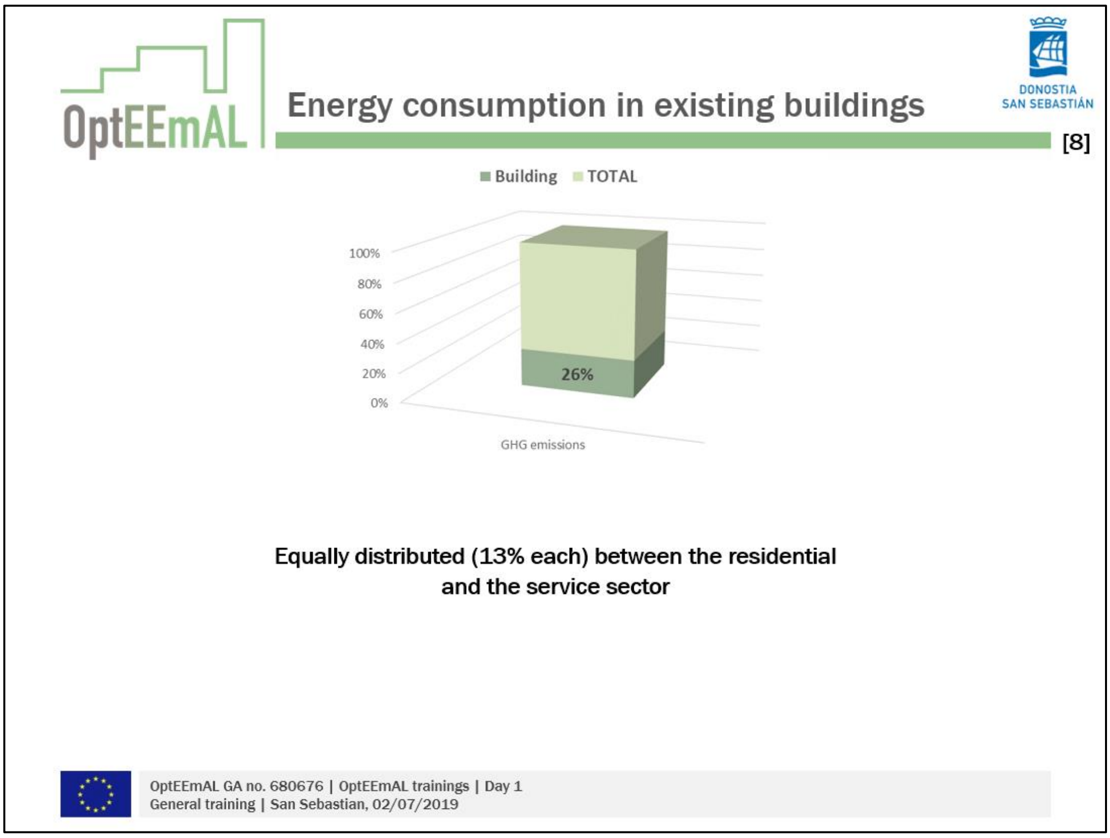
OptEEmAL
Energy consumption in existing buildings
DONOSTIA SAN SEBASTIÁN
[8]
Building
TOTAL
100%
80%
60%
40%
20%
0%
26%
GHG emissions
Equally distributed (13% each) between the residential and the service sector
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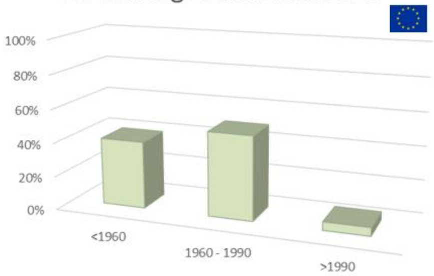
Energy consumption in existing buildings

EU buildings construction date

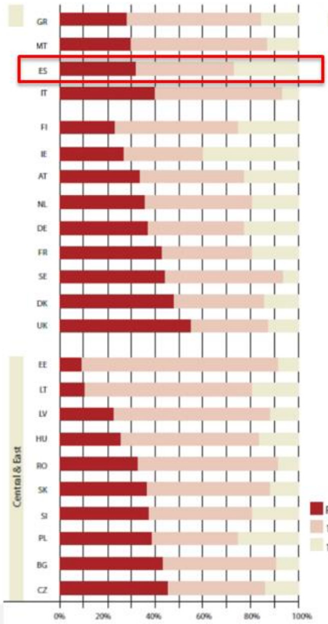


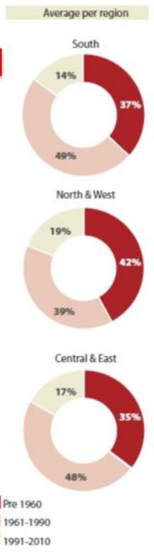
Almost 75% of the building stock is energy inefficient

[1]

Over 30% of the building stock is more than 50 years old

[9]





[3]

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The overall challenge

EU Roadmap for moving to a competitive low carbon economy in 2050

Long-term objective of decreasing the GHG emission levels for the building sector by **88%-91% in 2050**, compared to 1990 levels.

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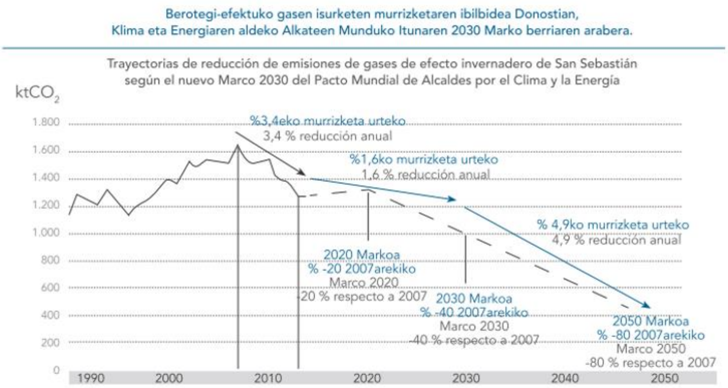
The local challenge

Pacto Mundial de Alcaldes por el Clima y la Energia

Reduce GHG emissions by 40% in 2030 in comparison to 2007 + Tackle at the same time mitigation and adaptation to climate change



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The possibilities (1)

[6]

	Track 1	Track 2	Track 3
Renovation rate	3%	2.3%	2.3%
Energy efficiency ambition level	Average	Average	High
Renewable energy & heat recovery systems	Low	High	High

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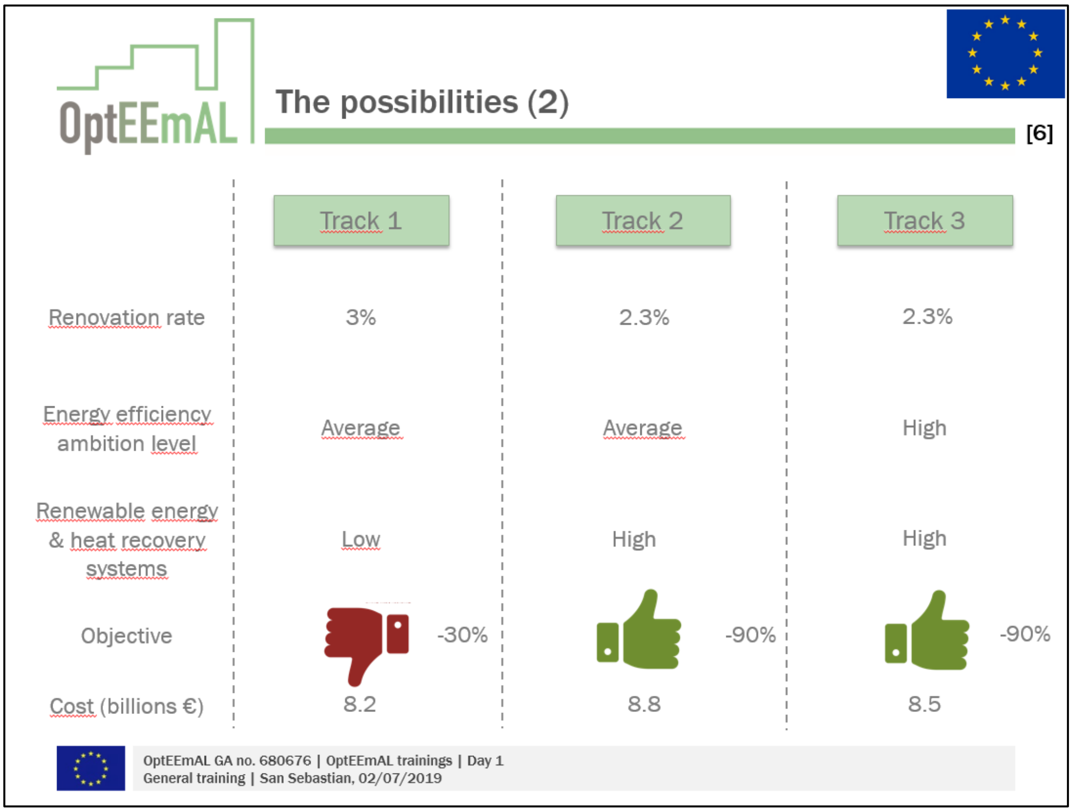
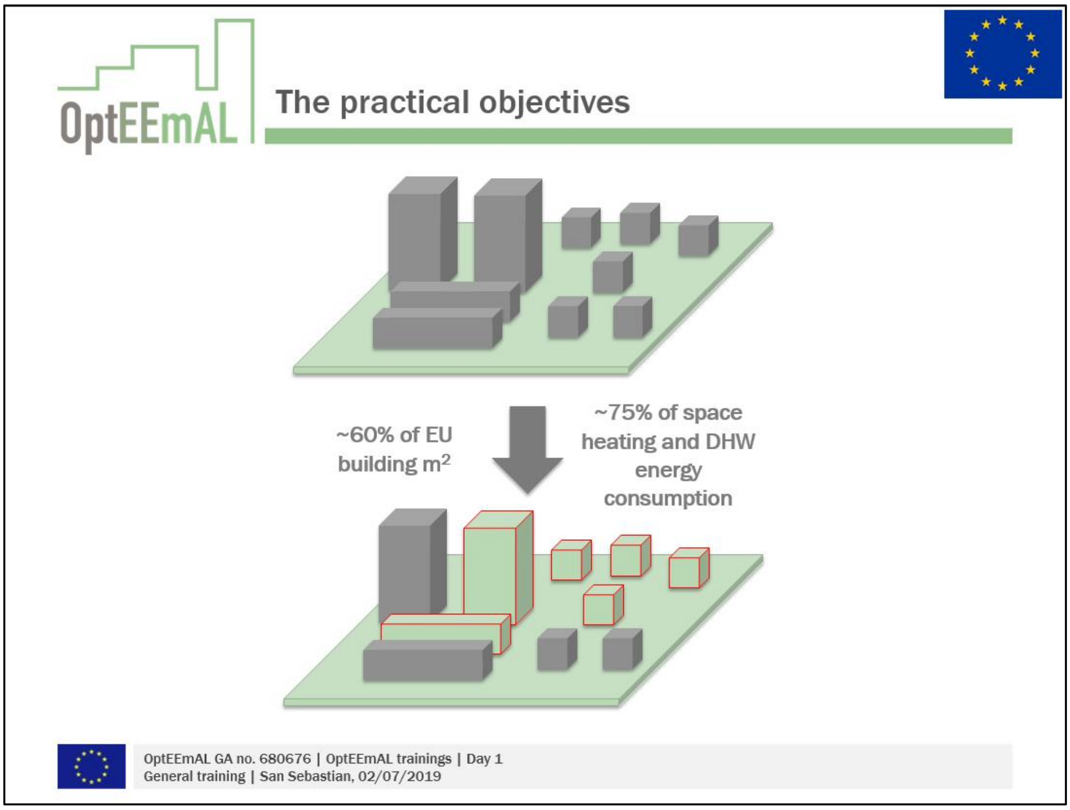
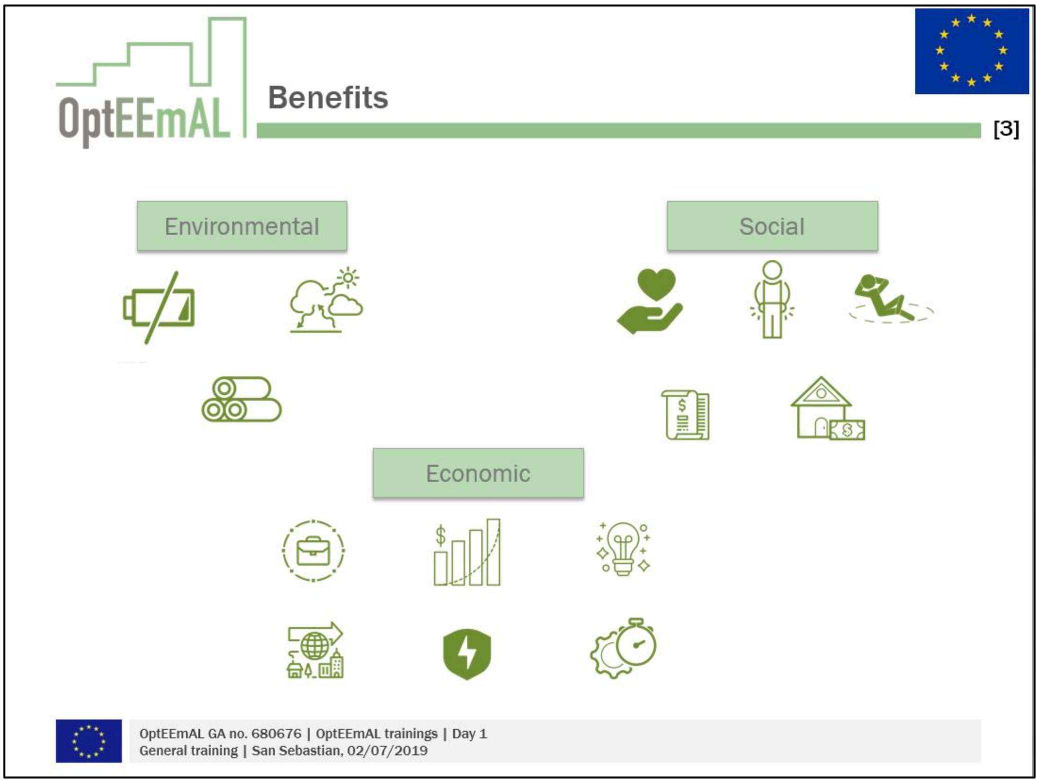


	Track 1	Track 2	Track 3
Renovation rate	3%	2.3%	2.3%
Energy efficiency ambition level	Average	Average	High
Renewable energy & heat recovery systems	Low	High	High
Objective	-30%	-90%	-90%
Cost (billions €)	8.2	8.8	8.5

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Benefits
[3]
Environmental
Social
Economic
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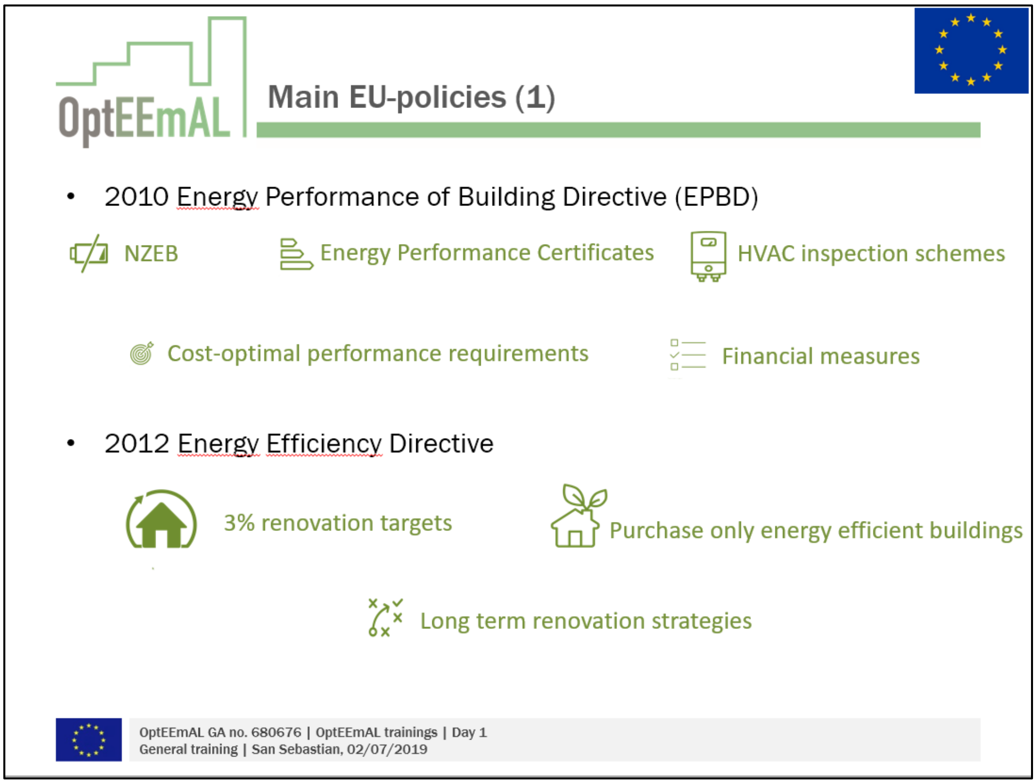
OptEEmAL
Main EU-policies (1)
• 2010 Energy Performance of Building Directive (EPBD)
NZEB
Energy Performance Certificates
HVAC inspection schemes
Cost-optimal performance requirements
Financial measures
• 2012 Energy Efficiency Directive
3% renovation targets
Purchase only energy efficient buildings
Long term renovation strategies
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Main EU-policies (2)

- 2016 Revised Energy Performance of Building Directive (EPBD)
  - Long term renovation strategies → Decarbonising the building stock by 2050
  - Common scheme for the smart readiness of buildings
  - E-mobility
  - National energy performance requirements for comparison
  - Promote health and well-being of users

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Main policies

donostiasustapena fomentosansebastián
DESARROLLO ECONÓMICO DE SAN SEBASTIÁN
DONOSTIAKO GARAPEN EKONOMIKOA
SAN SEBASTIAN ECONOMIC DEVELOPMENT

- Smart City Plan [9]

Project E1: Municipal Energy Development Agency	
Strategic Goal: Line of Action	Rehabilitate buildings in order to get an almost zero consumption. Prepare a catalogue of solutions, propose funding mechanisms and business models, adapt regulatory framework of CO2 emissions
Goals	Analyse the current form of organization for the municipal energy development and its management. Define the strategy, organization, management and resources necessary for the creation of an agency
Project E2: Community biomass heating: DH Txomin	
Strategic Goal: Line of Action	Implement Central Heating Systems with renewable energies. Generate business models (join technical and economic viability), communicate economic, social and environmental benefits
Goals	Encourage energy in the residential sector and implement centralized heating systems with renewable energies. Their installation will result in a more efficient use of energy and in a direct reduction on household energy bills. Generate business models joining technical and economic viability, and also communicate economic, social and environmental benefits
Project E3: Energy bankruptcy	
Strategic Goal: Line of Action	Exploit alternative marketing and consumption models. Introducing public-private energy models (ESCOs)
Goals	Promote energy efficiency in the residential sector, by performing a comprehensive rehabilitation of a set of "Bankruptcy" buildings. Making a city map to prepare an energy cadastre, identifying the areas in need and the actions to be performed by each building. Pilot execution in a building exploring alternative marketing and consumption models, besides of public-private energy exploitation models.
Project E4: Energy rehabilitation of the existing municipal buildings	
Strategic Goal: Line of Action	Improvement of energy efficiency in public buildings. Energy cadastre of public buildings
Goals	Prioritize the interventions to be performed depending on the cost and profitability of the intervention

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Cliquez pour ajouter un titre

DONOSTIA SMART CITY/Smart City Plan

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OptEEmAL

DONOSTIA SAN SEBASTIÁN

Main policies

- Climate Change Plan – Plan Klima DSS 2050 [10]
  - More than 80% of buildings with a high level of energy efficiency
    - Reduce primary energy consumption in the city by 20% in 2030 in comparison to 2007
    - Increase to 20% the rate of renewable energy in the city by 2030
- Ordenanza de eficiencia energética y calidad ambiental de los edificios
  - Reduciendo la demanda energética del edificio.
  - Promoviendo instalaciones energéticamente eficientes.
  - Utilizando energías renovables o alternativas en los edificios.
  - Gestionando parámetros (Agua y Residuos) de Calidad Ambiental

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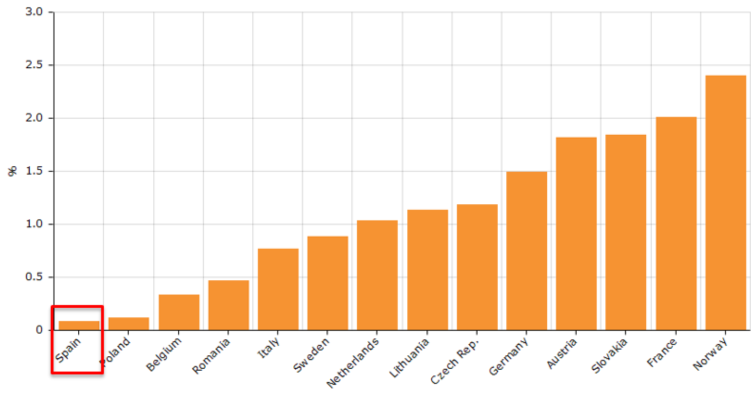
Current situation

- Not at the 3% target (from EED)



[4]

  – In San Sebastian, 0.15% buildings refurbished (with improved energy perf.)
  – Will be increased in the following years (energy retrofitting under development)

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Barriers

[3]

Financial barriers
- Renovation costs
- Access to finance
- Low energy prices

Technical barriers
- Lack of technical solutions
- Cost of technical solutions
- Lack of knowledge of construction professionals

Process barriers
- Fragmentation of the supply chain
- Burdening of home owners

Regulatory barriers
- Varying ambition of performance requirements
- Multiple definitions for renovation

Awareness barriers
- Lack of awareness

Tackled by OptEEmAL

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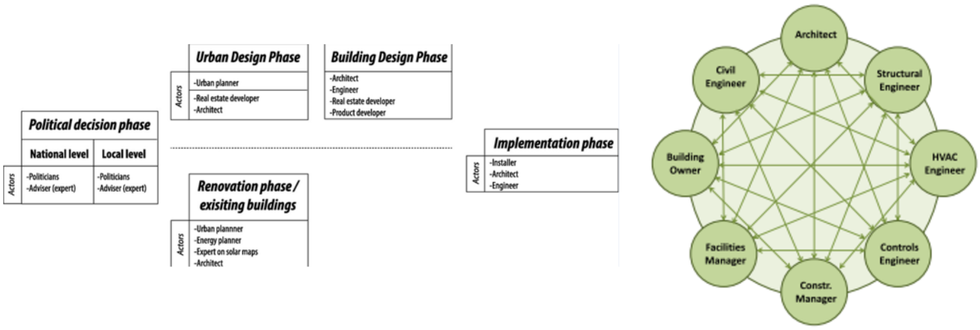
Diversity of actors / Involved at diff. steps



[5]

- Misunderstandings
- Late inclusion of wishes from specific actors
- Difficulty to “speak the same language”
- Difficulty to implement changes (time and cost)

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Diversity of tools

- A wide variety of tools to investigate:
  - Energy aspects: DesignBuilder, Ecotect, IES, OpenStudio…
  - Environmental aspects: GaBi, OneClickLCA, openLCA
  - Same for social, economic and comfort aspects
- Numerical formats
  - .rvt
  - .xls
  - .pdf
  - .db
  - .dxf
  - .dwg
  - .skp
  - .idf
  - …
- Leading to problems of:
  - Data mapping/transfer
  - Misunderstandings
  - Time
  - Cost

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2014-2015
5. Leadership in enabling and industrial technologies
H2020-EeB-05-2015
Innovative design tools for refurbishment at building and district level
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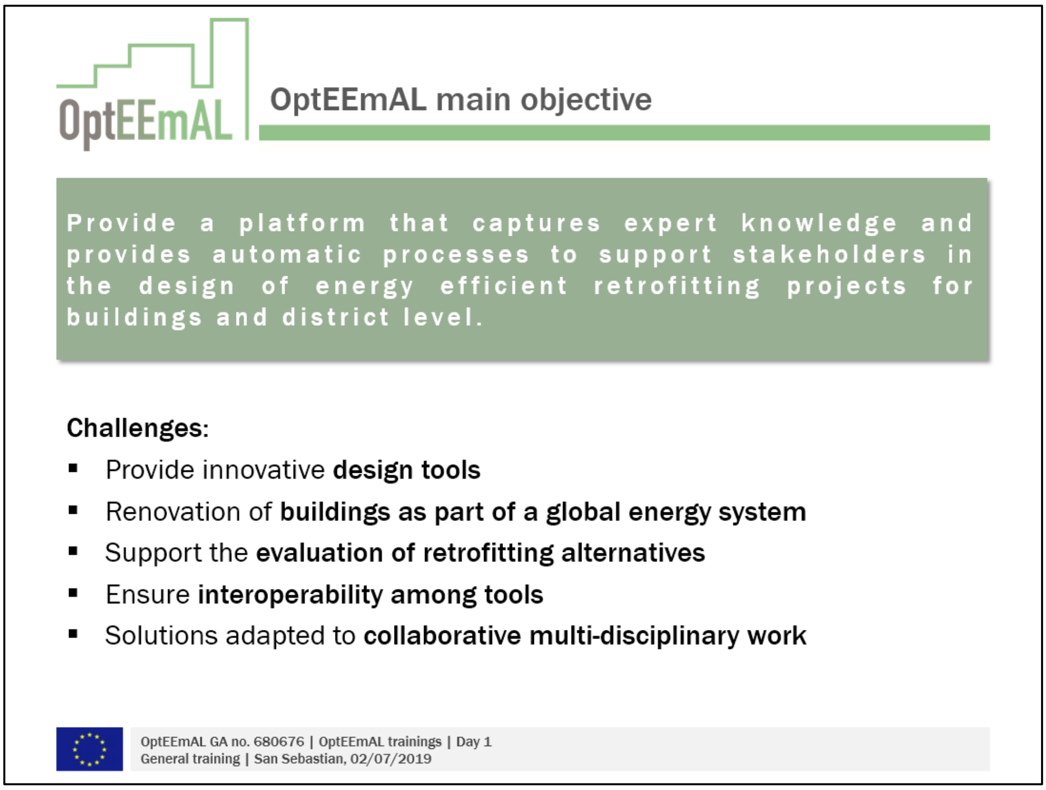
OptEEmAL
OptEEmAL main objective
Provide a platform that captures expert knowledge and provides automatic processes to support stakeholders in the design of energy efficient retrofitting projects for buildings and district level.
Challenges:
Provide innovative design tools
Renovation of buildings as part of a global energy system
Support the evaluation of retrofitting alternatives
Ensure interoperability among tools
Solutions adapted to collaborative multi-disciplinary work
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OptEEmAL main objective

- Web-based platform for district energy-efficient retrofitting design to:
  - Support integrated design methodologies (IPD methods)
    - ➡ Integrate people
  - Systemic delivery of optimised designs
    - ➡ Integrate tools and methodologies
  - Reduce uncertainties and time of the design process
    - ➡ Creation a common language and & common « working place »
  - Provide improved solutions compared to Business-as-usual
    - ➡ Make use of Best Available Technologies

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OptEEmAL main objective

- District (within OptEEmAL)
  - A group of entities (buildings, energy systems, etc.) for which an energy relationship exists (or is planned to exist) in terms of passive, active or RES systems, and which are planned to be retrofitted under the same retrofitting project.
- Retrofitting project:
  - A case that OptEEmAL aims at solving characterised by the district information model(s) containing information about actors, geometry, materials, use, energy systems, their interconnections, boundaries, targets and barriers.

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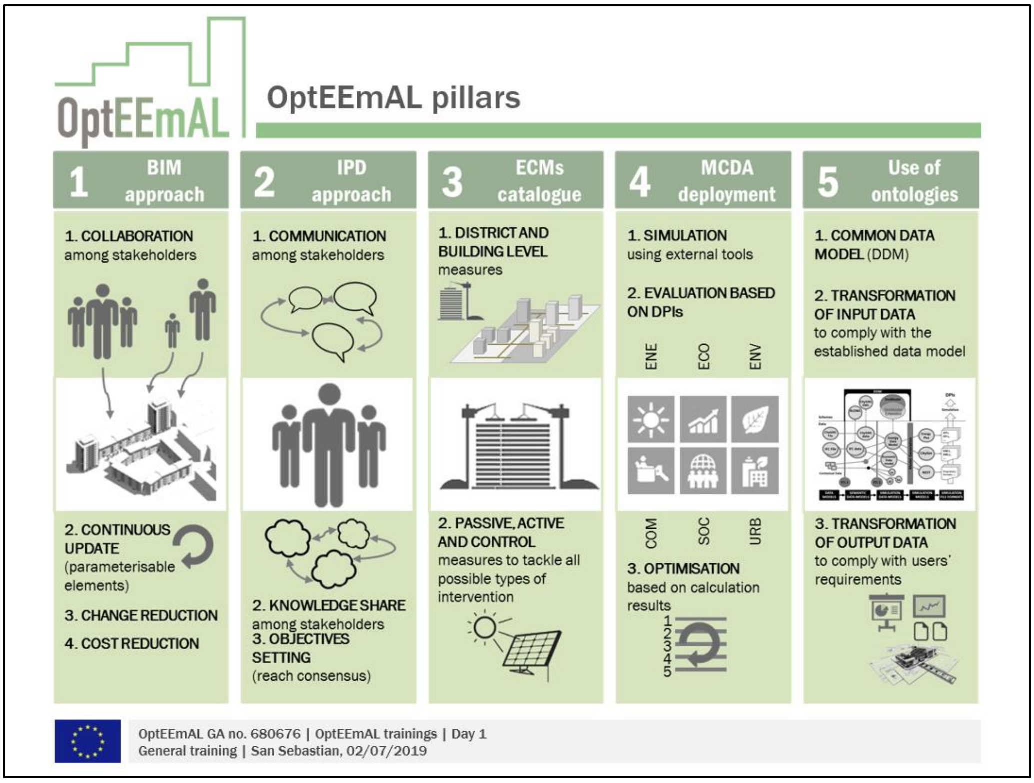
OptEEmAL
OptEEmAL pillars
1 BIM approach
1. COLLABORATION among stakeholders
2. CONTINUOUS UPDATE (parameterisable elements)
3. CHANGE REDUCTION
4. COST REDUCTION
2 IPD approach
1. COMMUNICATION among stakeholders
2. KNOWLEDGE SHARE among stakeholders
3. OBJECTIVES SETTING (reach consensus)
3 ECMs catalogue
1. DISTRICT AND BUILDING LEVEL measures
2. PASSIVE, ACTIVE AND CONTROL measures to tackle all possible types of intervention
4 MCDA deployment
1. SIMULATION using external tools
2. EVALUATION BASED ON DPIs
ENE ECO ENV
COM SOC URB
3. OPTIMISATION based on calculation results
5 Use of ontologies
1. COMMON DATA MODEL (DDM)
2. TRANSFORMATION OF INPUT DATA to comply with the established data model
3. TRANSFORMATION OF OUTPUT DATA to comply with users' requirements
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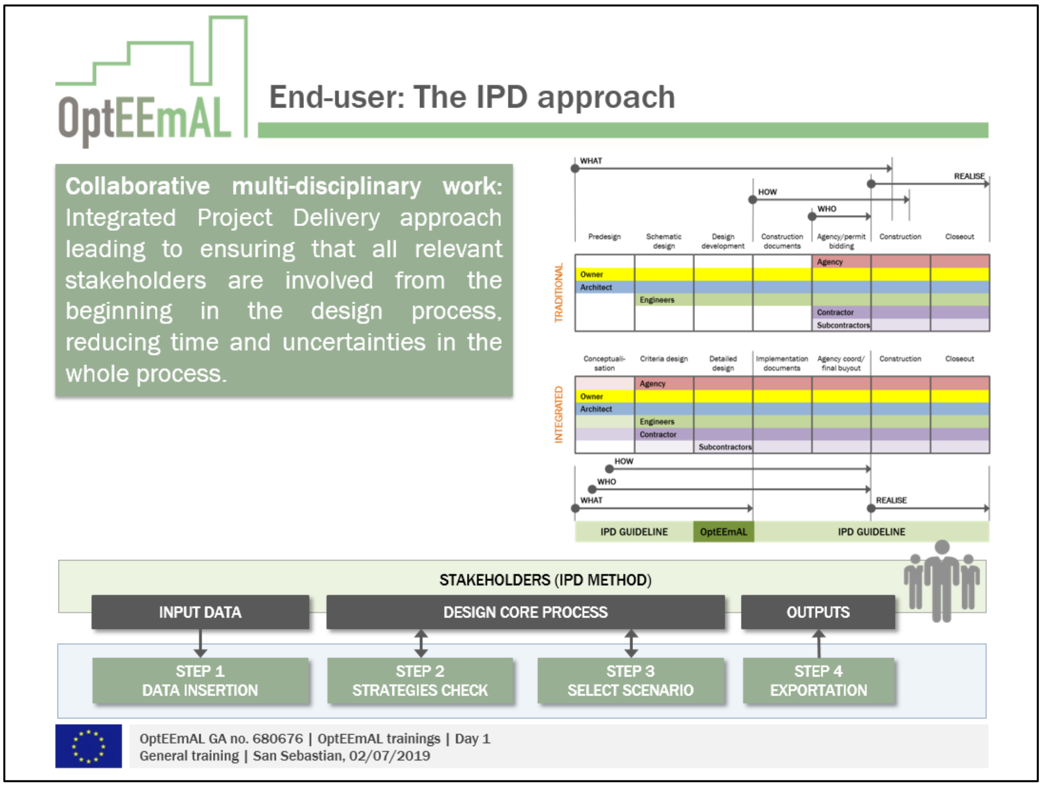
OptEEmAL
End-user: The IPD approach
Collaborative multi-disciplinary work: Integrated Project Delivery approach leading to ensuring that all relevant stakeholders are involved from the beginning in the design process, reducing time and uncertainties in the whole process.
TRADITIONAL
INTEGRATED
IPD GUIDELINE
OptEEmAL
IPD GUIDELINE
STAKEHOLDERS (IPD METHOD)
INPUT DATA
DESIGN CORE PROCESS
OUTPUTS
STEP 1 DATA INSERTION
STEP 2 STRATEGIES CHECK
STEP 3 SELECT SCENARIO
STEP 4 EXPORTATION
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The process: OptEEmAL steps

- Four main steps that define the platform:
  - **Problem statement**: end-user involvement and input data
  - **Problem mapping**: data integration (DDM)
  - **Problem solving**: tools for simulation and optimisation
  - **Solution exporting**: serialisation and data exportation

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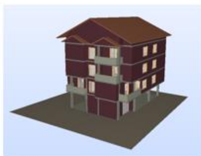
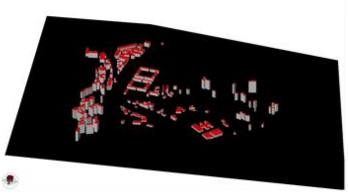
The process: (1) Problem statement

1

INPUT DATA
(IFC, CityGML, contextual)





- Contextual data:
  - Weather
  - Energy prices
  - ...
- Information about energy systems
  - Type
  - Capacity
  - Energy sources
  - ...

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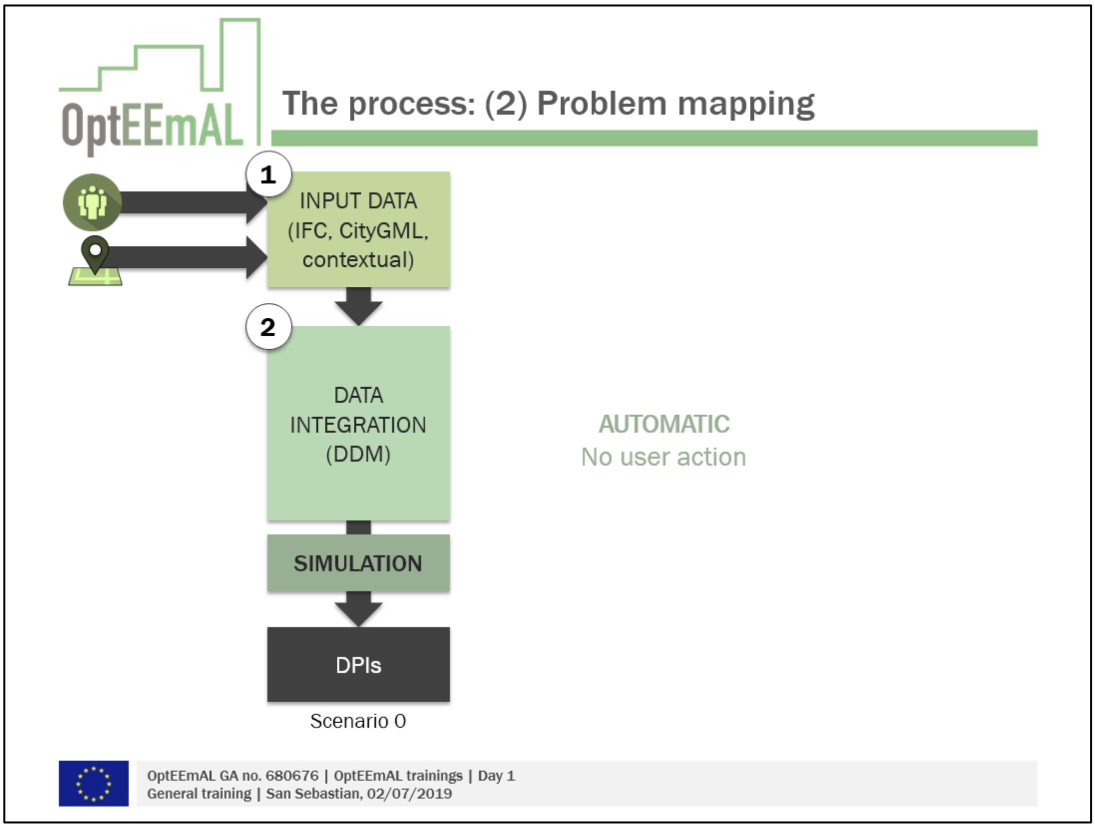
The process: (2) Problem mapping
1
INPUT DATA (IFC, CityGML, contextual)
2
DATA INTEGRATION (DDM)
AUTOMATIC
No user action
SIMULATION
DPIs
Scenario 0
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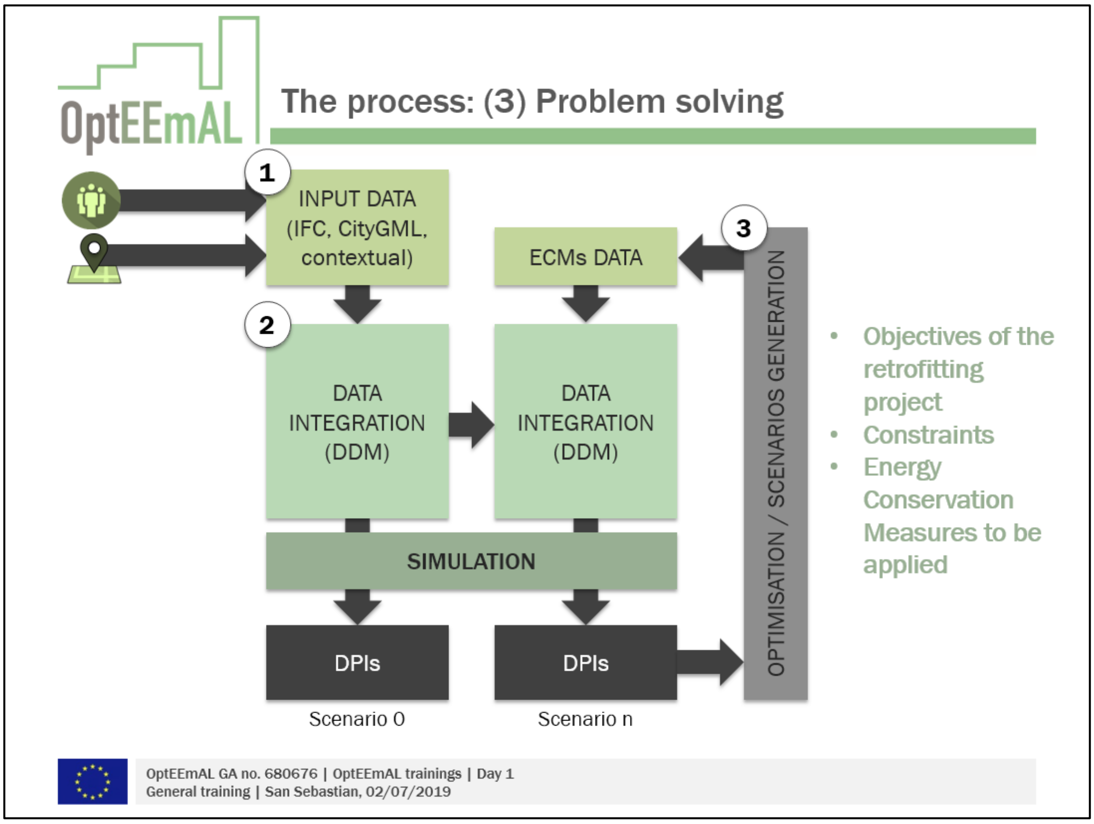
The process: (3) Problem solving
1
INPUT DATA (IFC, CityGML, contextual)
ECMs DATA
3
2
DATA INTEGRATION (DDM)
DATA INTEGRATION (DDM)
OPTIMISATION / SCENARIOS GENERATION
Objectives of the retrofitting project
Constraints
Energy Conservation Measures to be applied
SIMULATION
DPIs
DPIs
Scenario 0
Scenario n
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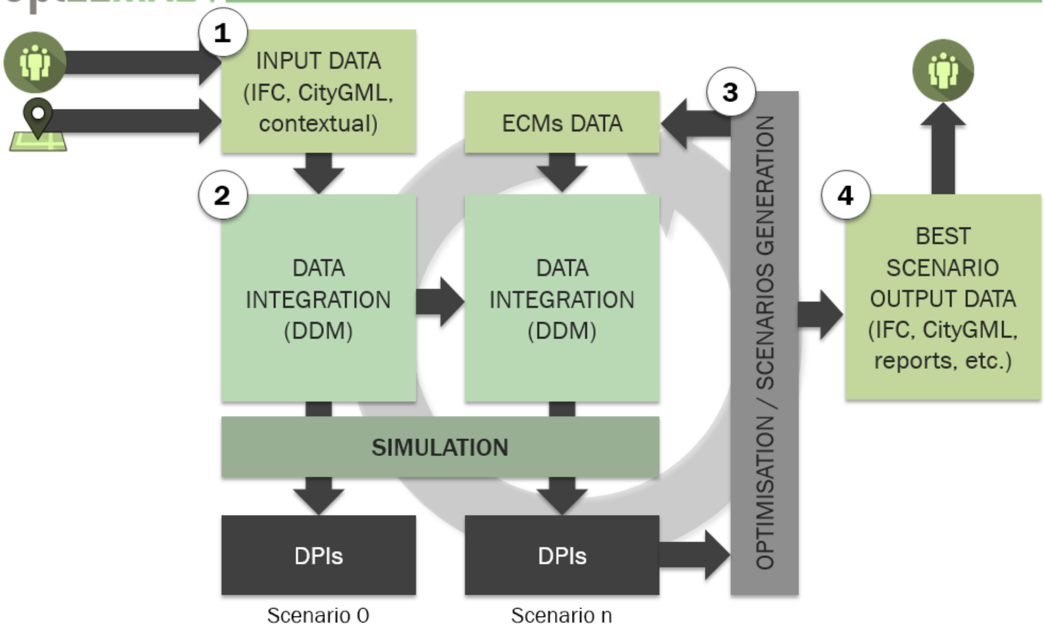
The process: (4) Solution exporting



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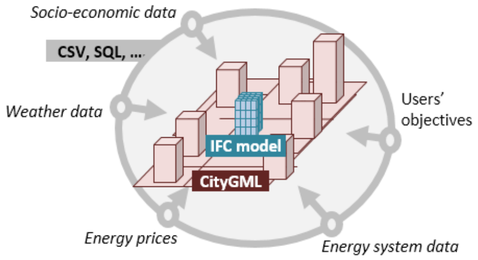
Focus on technical innovations (1): The DDM

Considering the different scales, the different tools and the different actors, a common data model has to be created to facilitate interoperability between different data sources

- The **Data Management Module (DMM)** which includes the **District Data Model (DDM)**, to facilitate interoperability between different data sources (BIM and GIS models, weather, social, economic, etc.) necessary to perform the simulations (e.g., building energy simulations).



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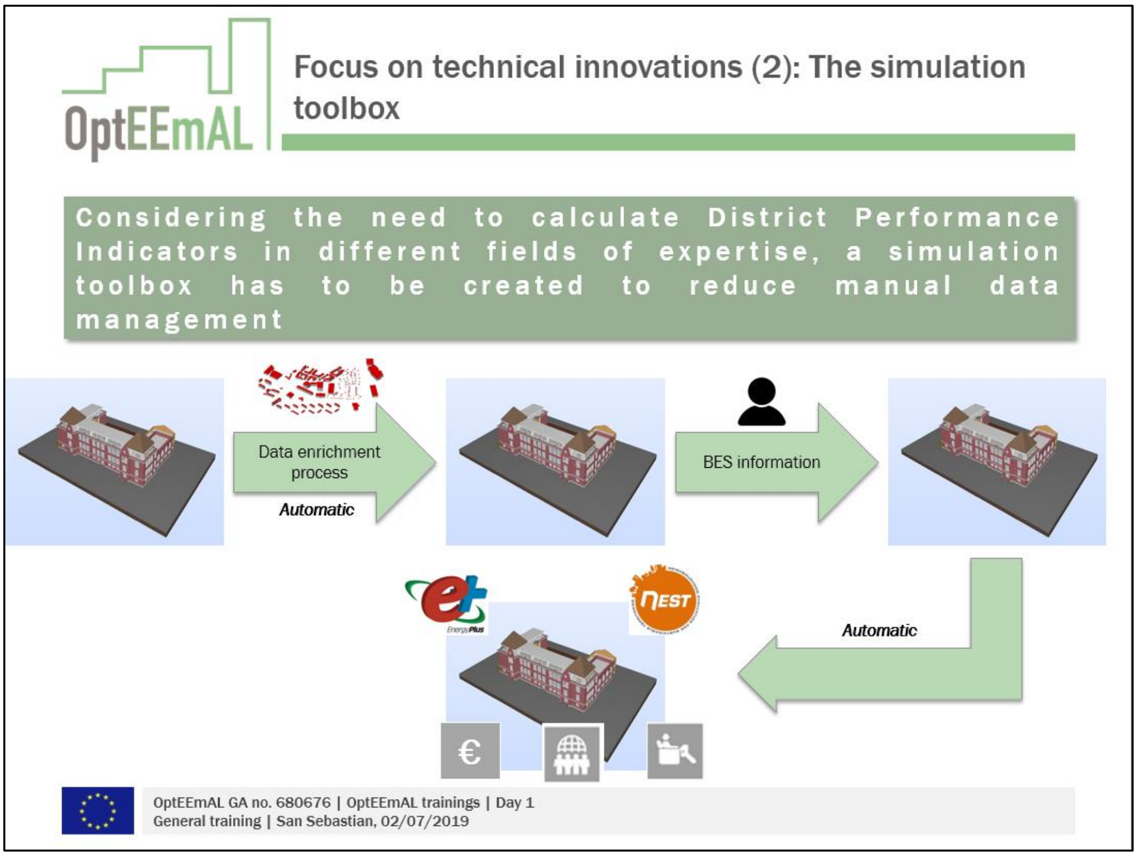
OptEEmAL
Focus on technical innovations (2): The simulation toolbox
Considering the need to calculate District Performance Indicators in different fields of expertise, a simulation toolbox has to be created to reduce manual data management
Data enrichment process
Automatic
BES information
Automatic
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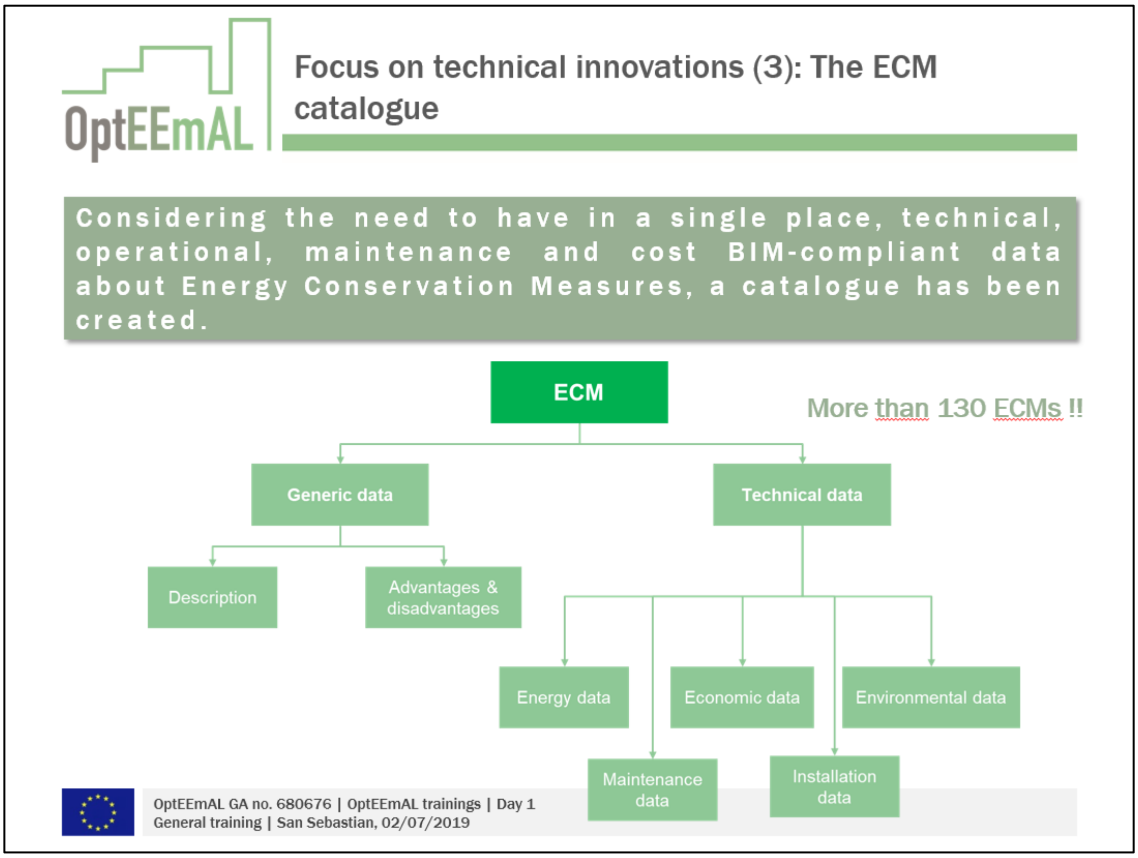
OptEEmAL
Focus on technical innovations (3): The ECM catalogue
Considering the need to have in a single place, technical, operational, maintenance and cost BIM-compliant data about Energy Conservation Measures, a catalogue has been created.
ECM
More than 130 ECMs !!
Generic data
Technical data
Description
Advantages & disadvantages
Energy data
Economic data
Environmental data
Maintenance data
Installation data
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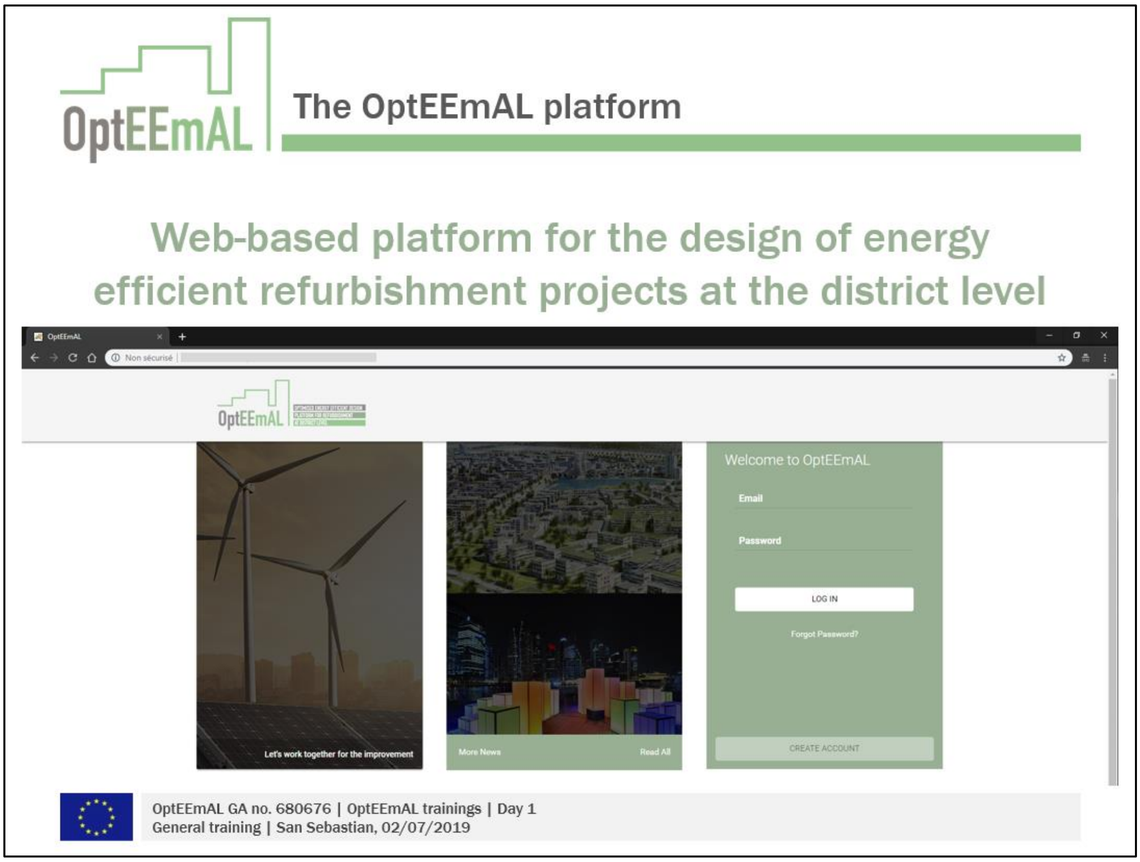
The OptEEmAL platform
Web-based platform for the design of energy efficient refurbishment projects at the district level
Welcome to OptEEmAL
Email
Password
LOG IN
Forgot Password?
CREATE ACCOUNT
Let's work together for the improvement
More News
Read All
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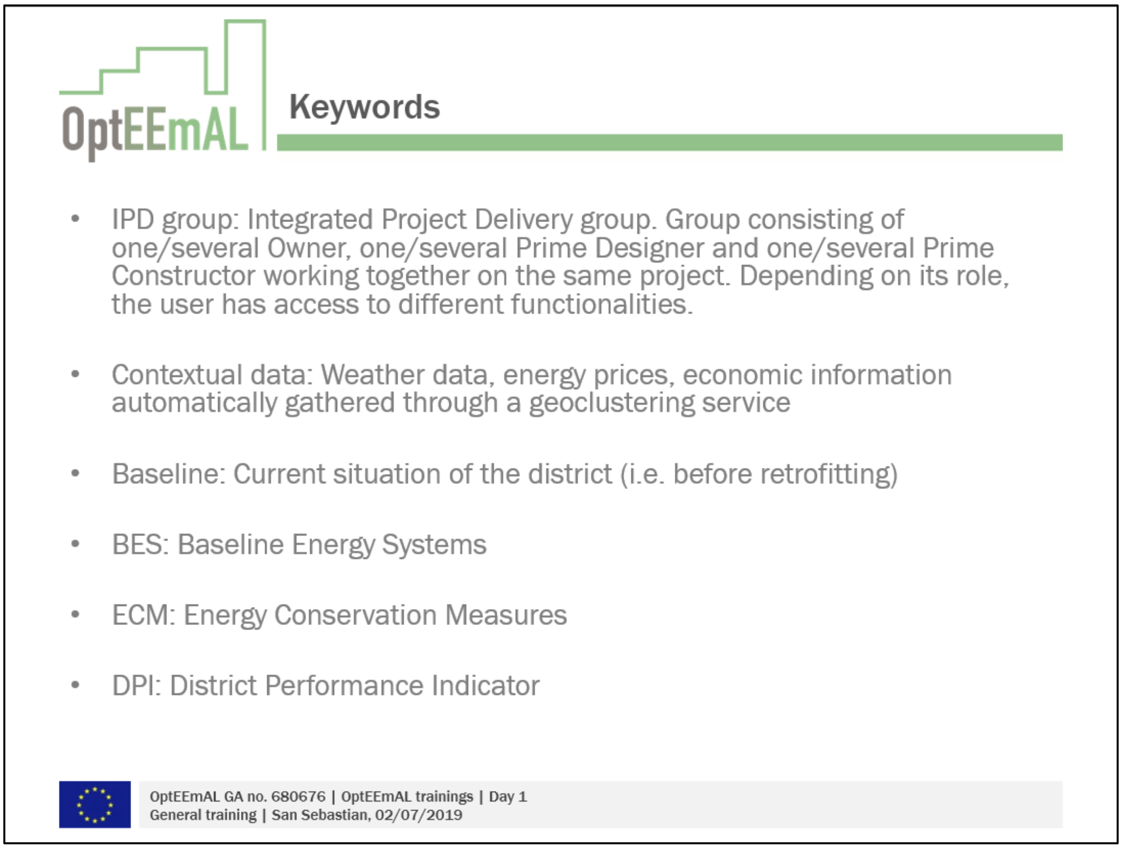
Keywords
• IPD group: Integrated Project Delivery group. Group consisting of one/several Owner, one/several Prime Designer and one/several Prime Constructor working together on the same project. Depending on its role, the user has access to different functionalities.
• Contextual data: Weather data, energy prices, economic information automatically gathered through a geoclustering service
• Baseline: Current situation of the district (i.e. before retrofitting)
• BES: Baseline Energy Systems
• ECM: Energy Conservation Measures
• DPI: District Performance Indicator
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OptEEmAL

The OptEEmAL platform

Web-based platform for the design of energy efficient refurbishment projects at the district level

https://vimeo.com/314252162/c00eeb8ea6

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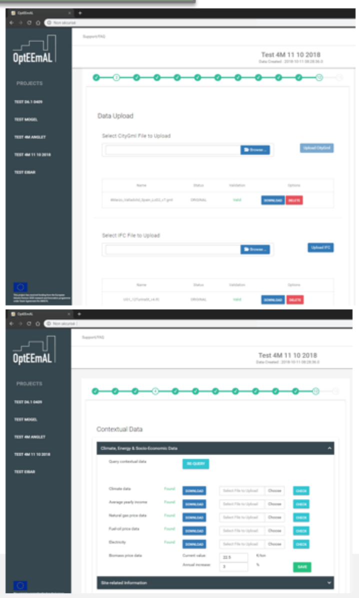
OptEEmAL's steps (1)

A - Define the current situation (baseline)

1. IPD group definition
2. Data input (IFCs & CityGML)
3. Energy Systems questionnaire
4. Contextual data (weather, social,...)

BASELINE SCENARIO



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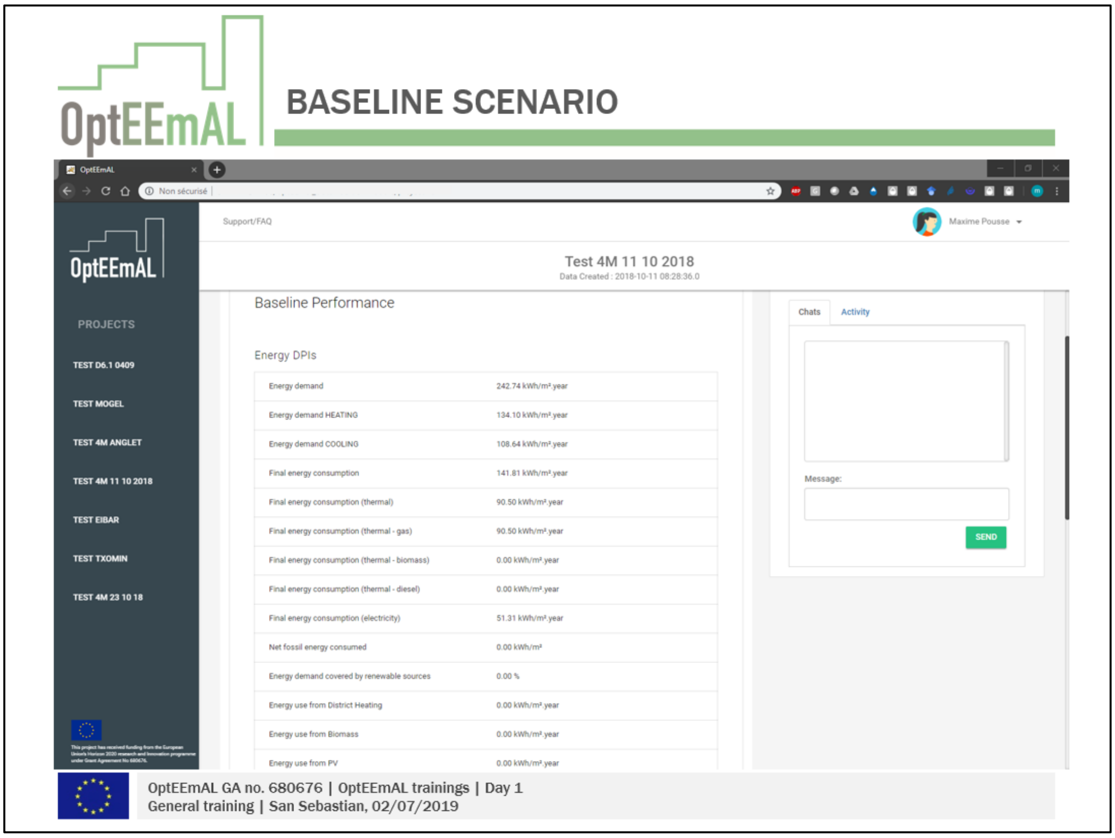
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BASELINE SCENARIO
Support/FAQ
Maxime Pousse
Test 4M 11 10 2018
Data Created : 2018-10-11 08:28:36.0
PROJECTS
TEST D6.1 0409
TEST MOGEL
TEST 4M ANGLET
TEST 4M 11 10 2018
TEST EIBAR
TEST TXOMIN
TEST 4M 23 10 18
Baseline Performance
Energy DPIs
Energy demand 242.74 kWh/m² year
Energy demand HEATING 134.10 kWh/m² year
Energy demand COOLING 108.64 kWh/m² year
Final energy consumption 141.81 kWh/m² year
Final energy consumption (thermal) 90.50 kWh/m² year
Final energy consumption (thermal - gas) 90.50 kWh/m² year
Final energy consumption (thermal - biomass) 0.00 kWh/m² year
Final energy consumption (thermal - diesel) 0.00 kWh/m² year
Final energy consumption (electricity) 51.31 kWh/m² year
Net fossil energy consumed 0.00 kWh/m²
Energy demand covered by renewable sources 0.00 %
Energy use from District Heating 0.00 kWh/m² year
Energy use from Biomass 0.00 kWh/m² year
Energy use from PV 0.00 kWh/m² year
Chats
Activity
Message:
SEND
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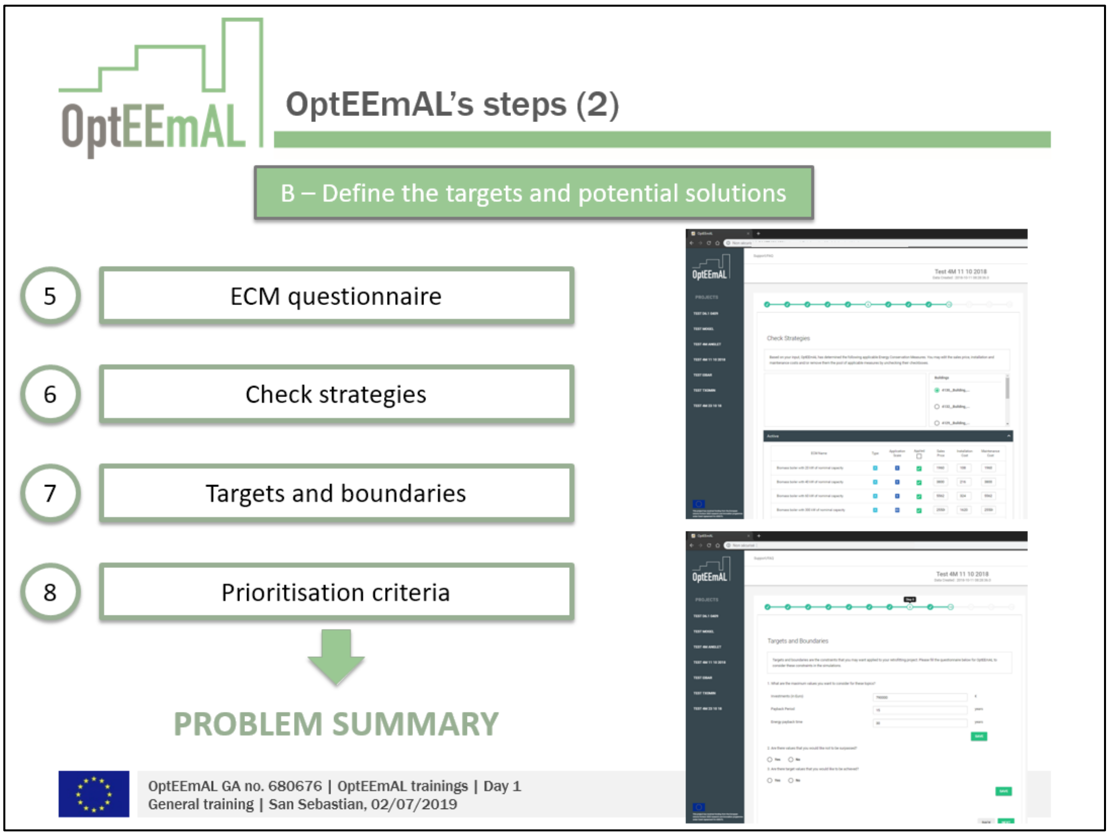
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OptEEmAL's steps (2)
B – Define the targets and potential solutions
5 ECM questionnaire
6 Check strategies
7 Targets and boundaries
8 Prioritisation criteria
PROBLEM SUMMARY
OptEEmAL GA no. 680676 | OptEEmAL trainings | Day 1
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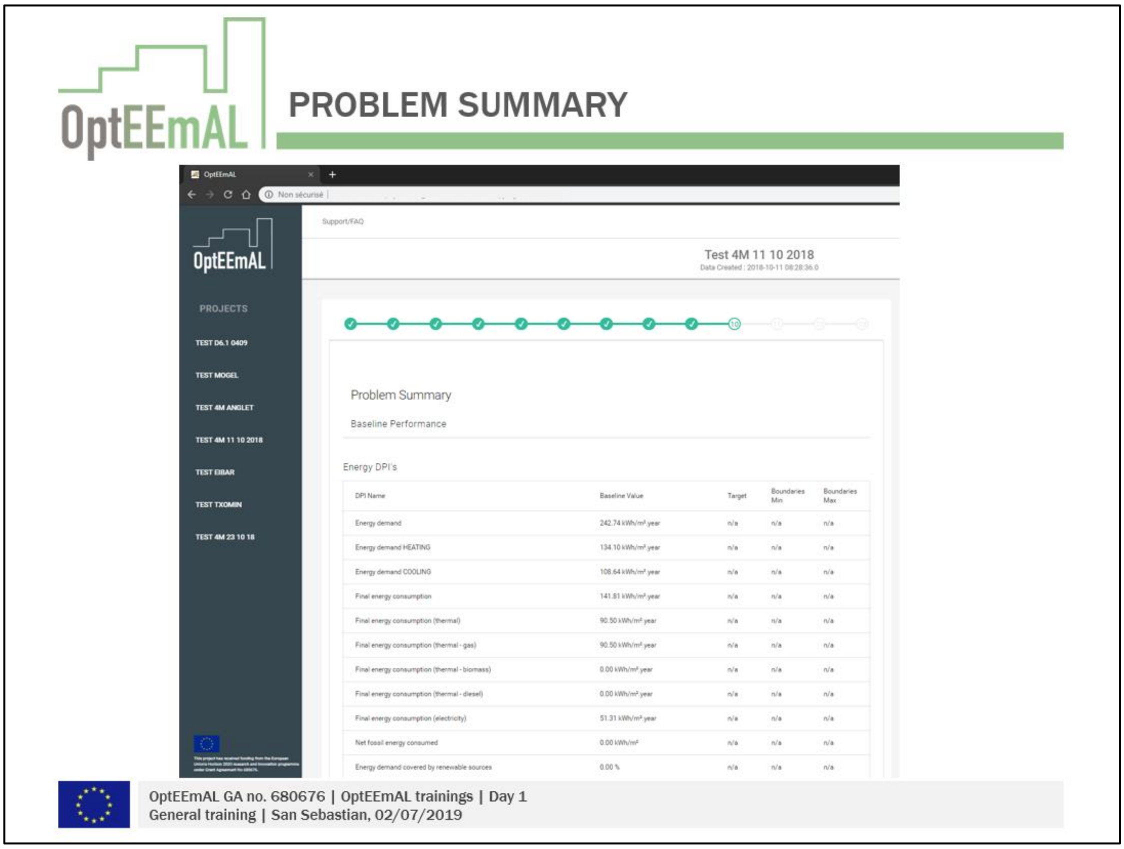
PROBLEM SUMMARY
Test 4M 11 10 2018
PROJECTS
TEST D6.1 0409
TEST MOGEL
TEST 4M ANGLET
TEST 4M 11 10 2018
TEST EIBAR
TEST TXOMIN
TEST 4M 23 10 18
Problem Summary
Baseline Performance
Energy DPI's
DPI Name | Baseline Value | Target | Boundaries Min | Boundaries Max
Energy demand | 242.74 kWh/m² year | n/a | n/a | n/a
Energy demand HEATING | 134.10 kWh/m² year | n/a | n/a | n/a
Energy demand COOLING | 108.64 kWh/m² year | n/a | n/a | n/a
Final energy consumption | 141.81 kWh/m² year | n/a | n/a | n/a
Final energy consumption (thermal) | 90.50 kWh/m² year | n/a | n/a | n/a
Final energy consumption (thermal - gas) | 90.50 kWh/m² year | n/a | n/a | n/a
Final energy consumption (thermal - biomass) | 0.00 kWh/m² year | n/a | n/a | n/a
Final energy consumption (thermal - diesel) | 0.00 kWh/m² year | n/a | n/a | n/a
Final energy consumption (electricity) | 51.31 kWh/m² year | n/a | n/a | n/a
Net fossil energy consumed | 0.00 kWh/m² | n/a | n/a | n/a
Energy demand covered by renewable sources | 0.00 % | n/a | n/a | n/a
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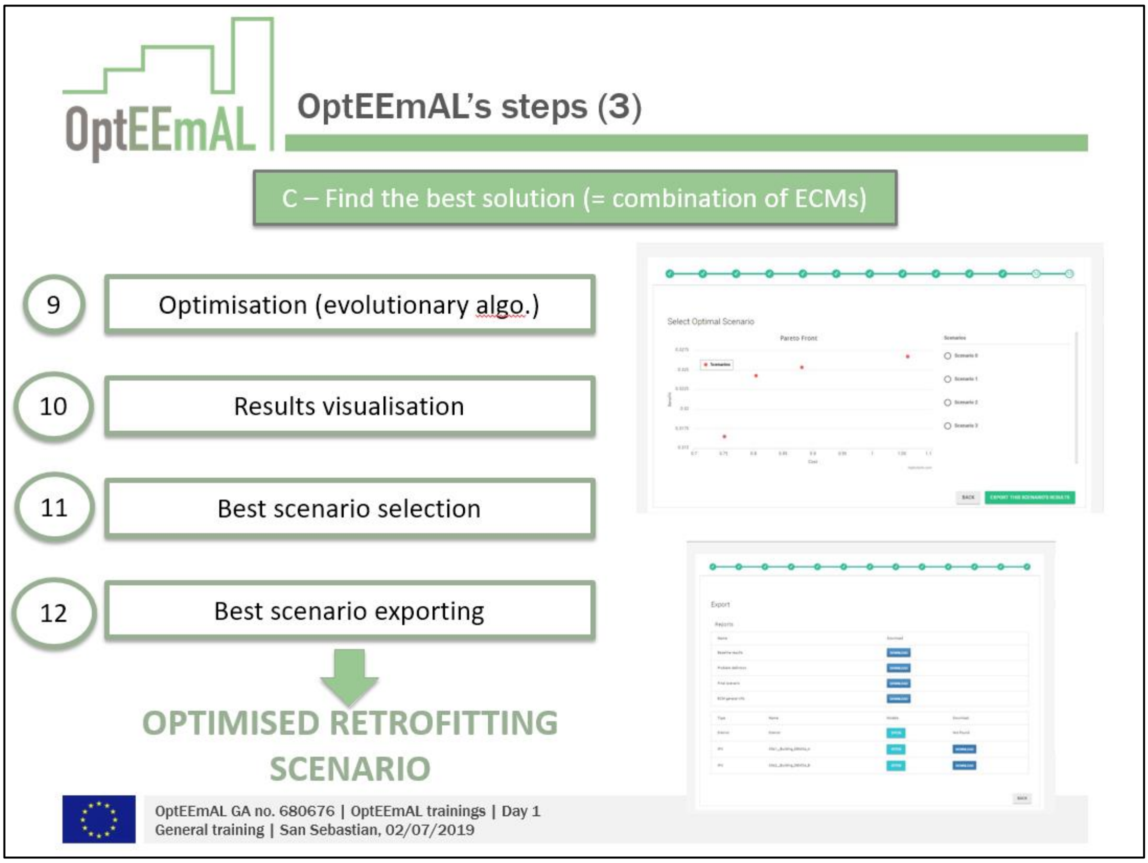
OptEEmAL's steps (3)
C – Find the best solution (= combination of ECMs)
9 Optimisation (evolutionary algo.)
10 Results visualisation
11 Best scenario selection
12 Best scenario exporting
OPTIMISED RETROFITTING SCENARIO
Select Optimal Scenario
Export
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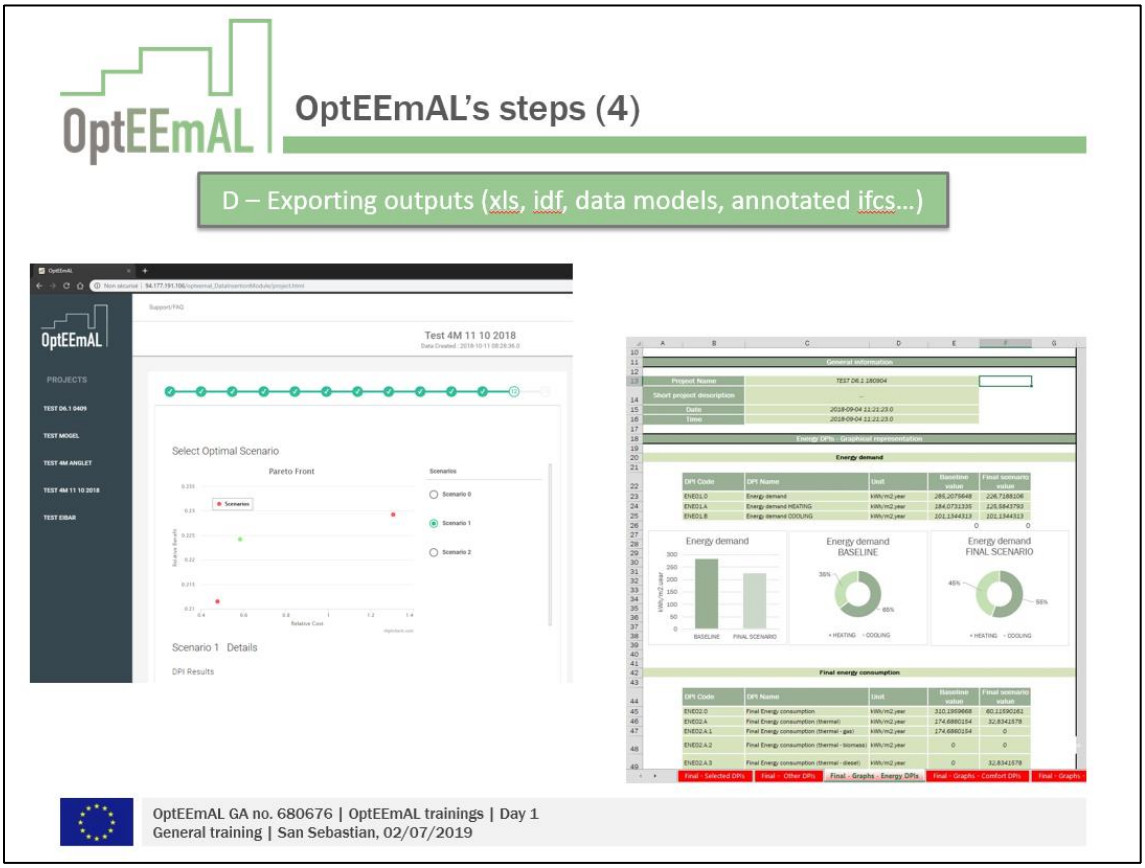
OptEEmAL
OptEEmAL's steps (4)
D – Exporting outputs (xls, idf, data models, annotated ifcs…)
OptEEmAL
PROJECTS
Test 4M 11 10 2018
Select Optimal Scenario
Pareto Front
Scenarios
Scenario 0
Scenario 1
Scenario 2
Scenario 1 Details
DPI Results
General information
Project Name
Short project description
Date
Time
Energy DPIs - Graphical representation
Energy demand
Energy demand BASELINE
Energy demand FINAL SCENARIO
Final energy consumption
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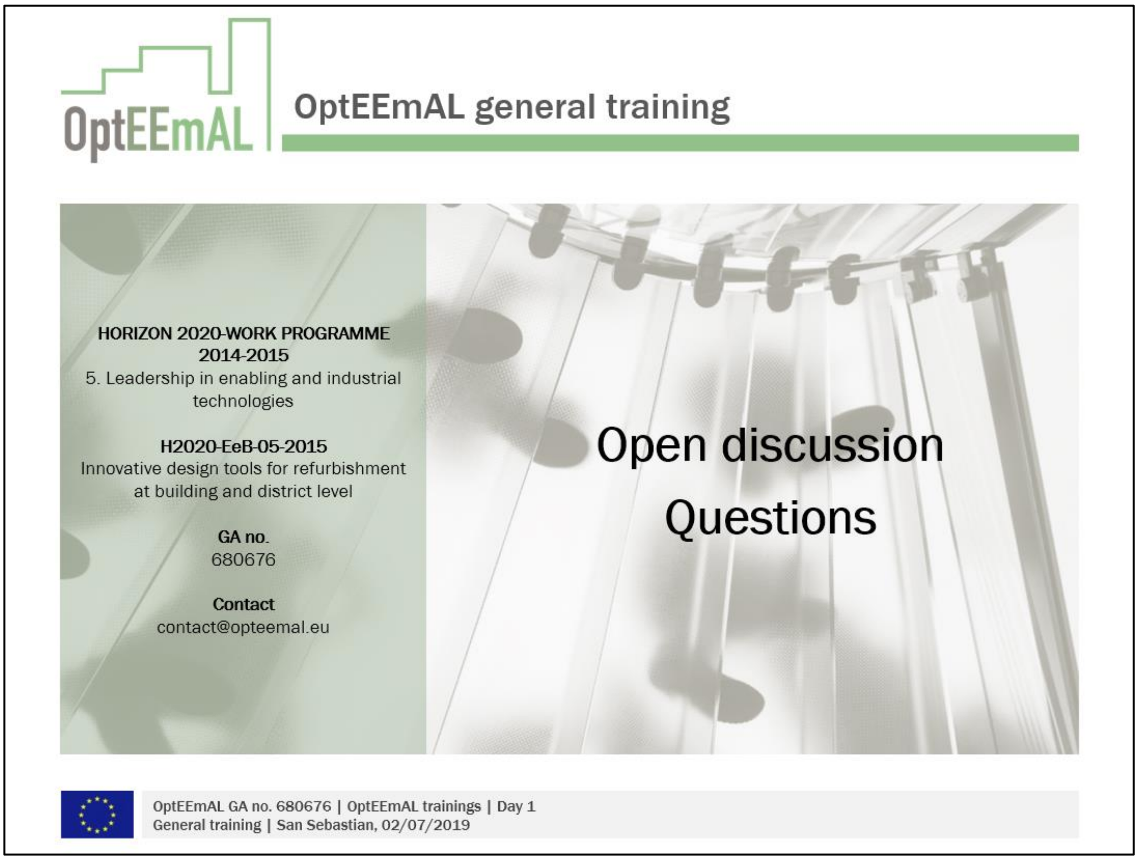
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Open discussion
Questions
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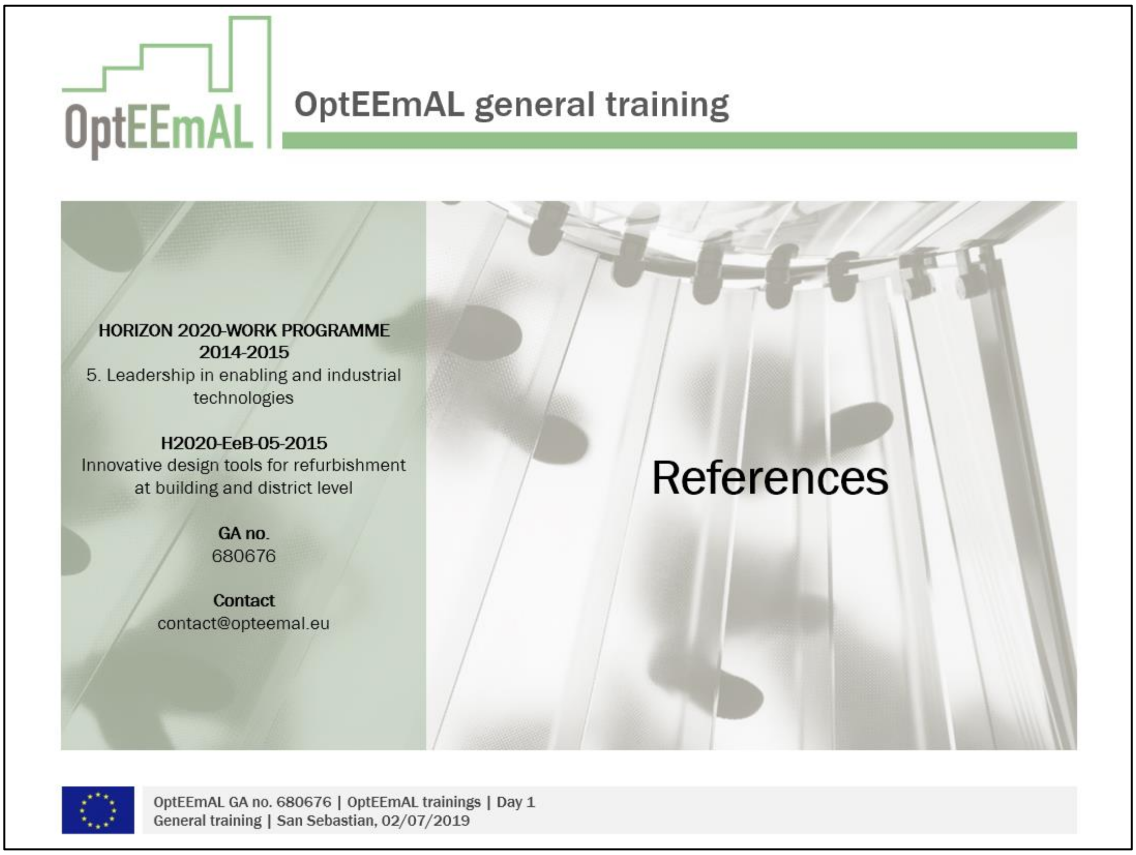
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contact@opteemal.eu
References
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References

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Icons from the Noun Project: https://thenounproject.com/

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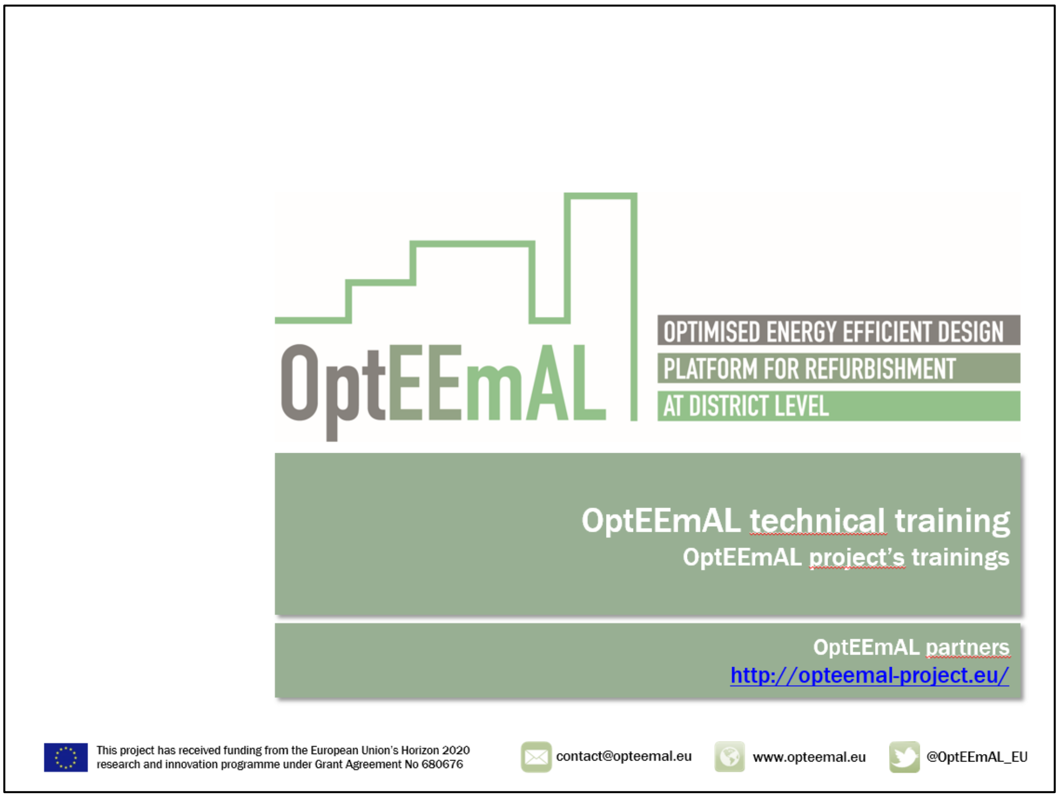
Annex 2: PPT support for day 2 of the trainings

The PPT support for the day 2 of the training is presented below. This PPT support is the one used in San Sebastian. It has to be noted that this ppt support was only used as a support for the first minutes of the training session, as this training session was mainly dedicated to the use of the platform by the participants.

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Introduction
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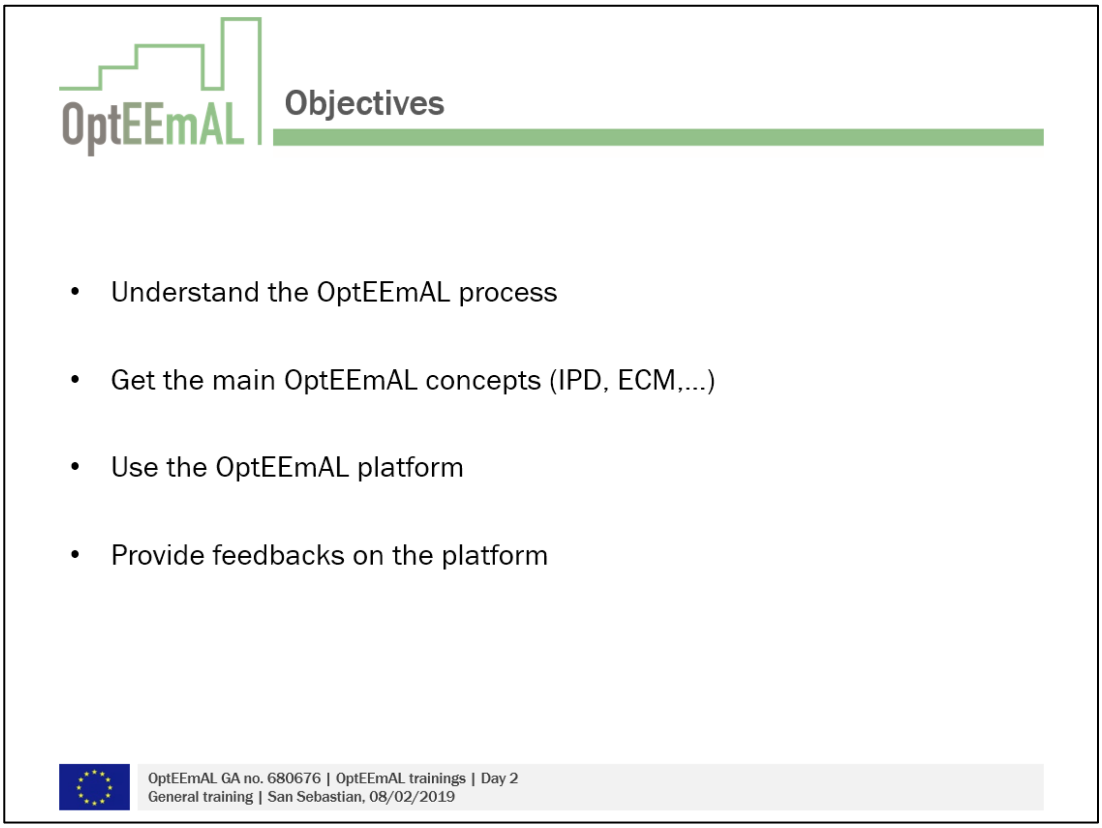
Objectives
• Understand the OptEEmAL process
• Get the main OptEEmAL concepts (IPD, ECM,...)
• Use the OptEEmAL platform
• Provide feedbacks on the platform
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Project's participants

- Iker Martinez Gonzalez, Gorka Diez Jimenez & Ana Aizpuru:
  - Fomento de San Sebastian
  - In charge of the demonstration site in San Sebastian (Txomin Enea district)
- Julia Vicente Gomez :
  - CARTIF (ES)
  - Project coordinator
- Juan Pedrero Alegria
  - TECNALIA (ES)
  - Technical advisor for the demonstration site in Txomin Enea
- Maxime Pousse:
  - Nobatek (FR)
  - In charge of demonstration activities

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Agenda

- Welcome (10')
- Introduction – OptEEmAL project and its context (30')
- Use of the platform (60')
- COFFRE BREAK (20')
- Use of the platform (90')
- Open discussion/Questions/Feedbacks (30')

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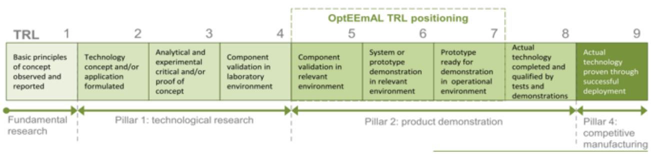
Keywords

- OptEEmAL: Optimised Energy Efficient Design Platform for Refurbishment at District Level
- Optimised: Use of optimisation methods to find the best option
- Energy efficient: Focus on energy but integrates other aspects (economic, environmental, social, etc.)
- Platform: Integration of people and tools
- Refurbishment: For existing districts and buildings

Project

- H2020 project
  - Energy efficient buildings
  - Innovative design tools for refurbishing of buildings at district level
  - From September 2015 to February 2019
- 13 project partners
  - Coordinated by CARTIF (ES)

- Final objective:
  - Validate the OptEEmAL platform at TRL 7




OptEEmAL
General project presentation
https://www.youtube.com/watch?v=TLRNuHBXn1w&feature=youtu.be
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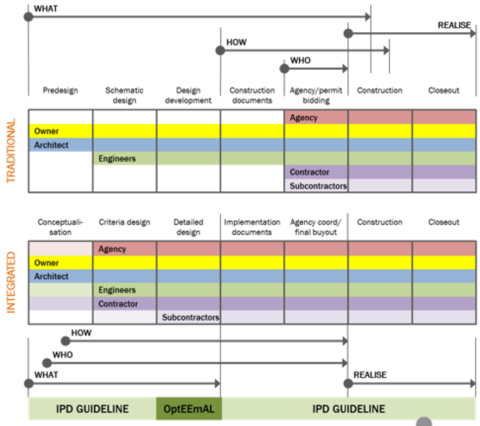
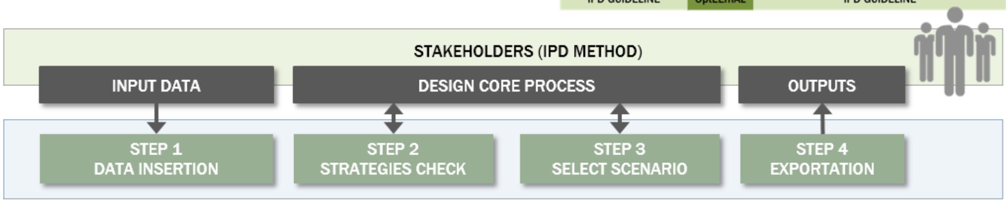
End-user: The IPD approach

Collaborative multi-disciplinary work: Integrated Project Delivery approach leading to ensuring that all relevant stakeholders are involved from the beginning in the design process, reducing time and uncertainties in the whole process.





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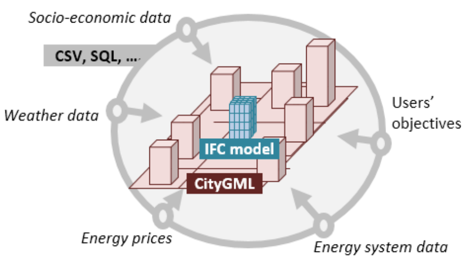
Data interoperability: The DDM

Considering the different scales, the different tools and the different actors, a common data model has to be created to facilitate interoperability between different data sources

- The **Data Management Module (DMM)** which includes the **District Data Model (DDM)**, to facilitate interoperability between different data sources (BIM and GIS models, weather, social, economic, etc.) necessary to perform the simulations (e.g., building energy simulations).



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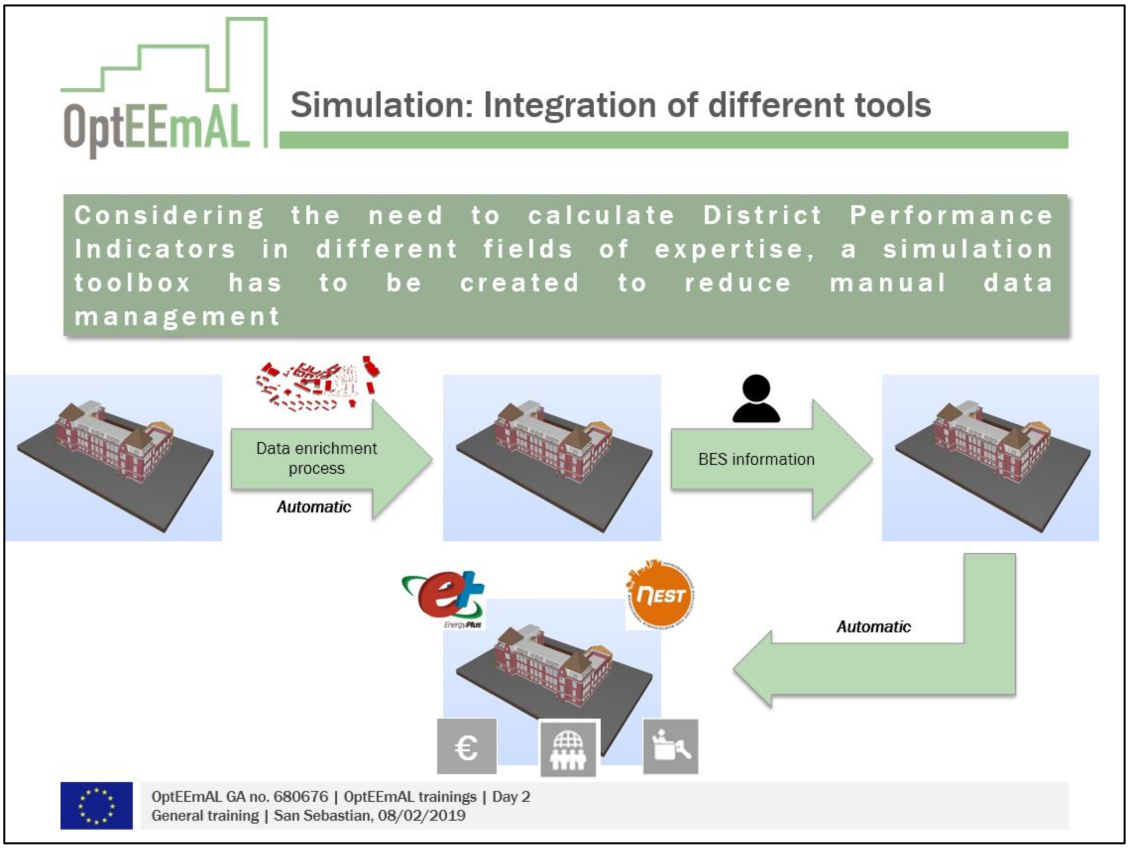
Simulation: Integration of different tools
Considering the need to calculate District Performance Indicators in different fields of expertise, a simulation toolbox has to be created to reduce manual data management
Data enrichment process
Automatic
BES information
Automatic
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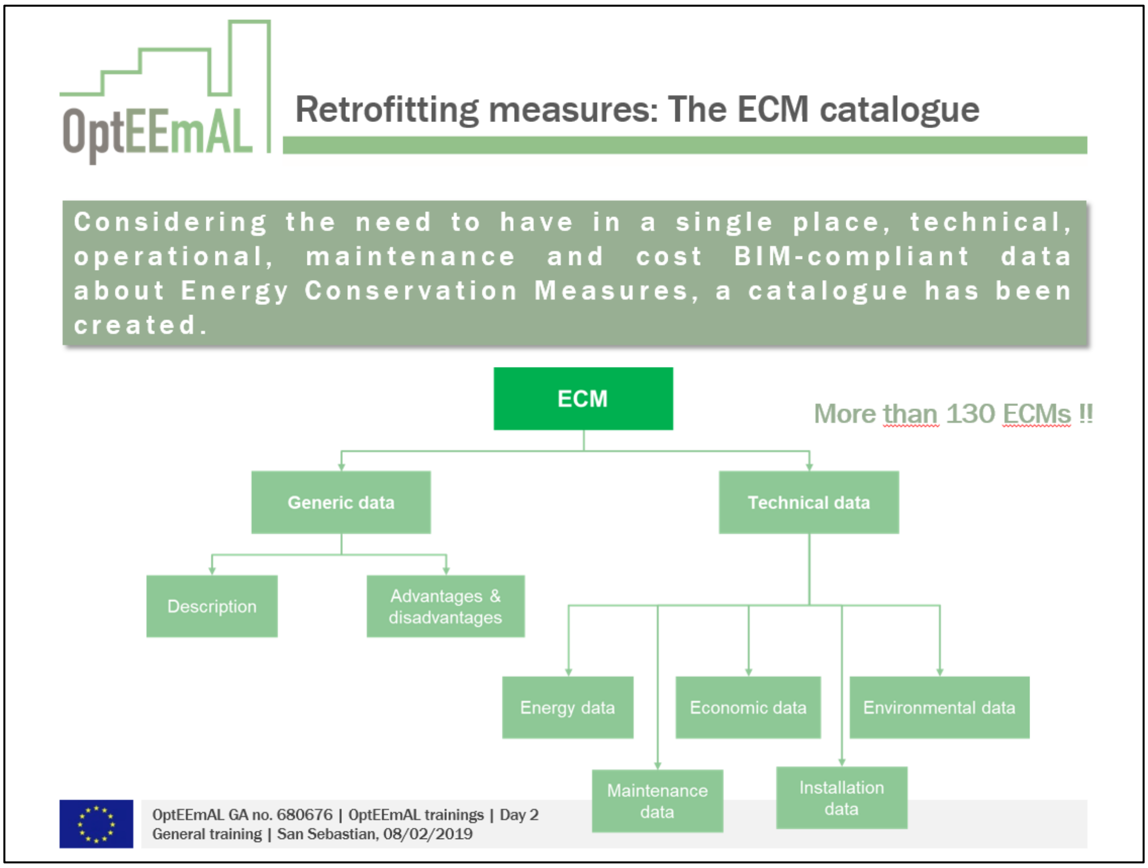
Retrofitting measures: The ECM catalogue
Considering the need to have in a single place, technical, operational, maintenance and cost BIM-compliant data about Energy Conservation Measures, a catalogue has been created.
ECM
More than 130 ECMs !!
Generic data
Technical data
Description
Advantages & disadvantages
Energy data
Economic data
Environmental data
Maintenance data
Installation data
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The process: OptEEmAL steps

- Four main steps that define the platform:
  - **Problem statement**: end-user involvement and input data
  - **Problem mapping**: data integration (DDM)
  - **Problem solving**: tools for simulation and optimisation
  - **Solution exporting**: serialisation and data exportation

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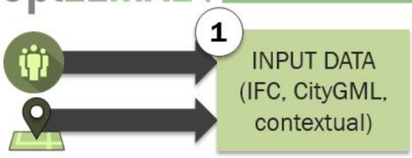
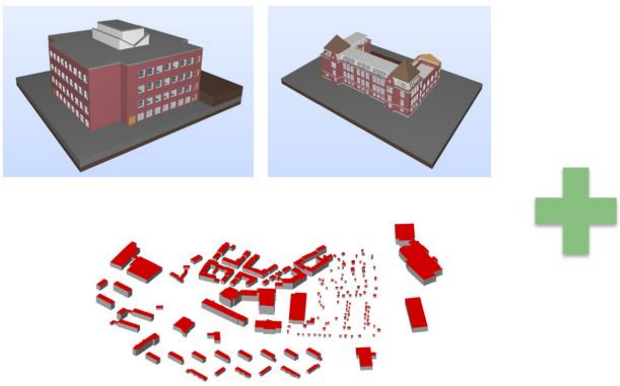
The process: (1) Problem statement





- Contextual data:
  - Weather
  - Energy prices
  - ...
- Information about energy systems
  - Type
  - Capacity
  - Energy sources
  - ...

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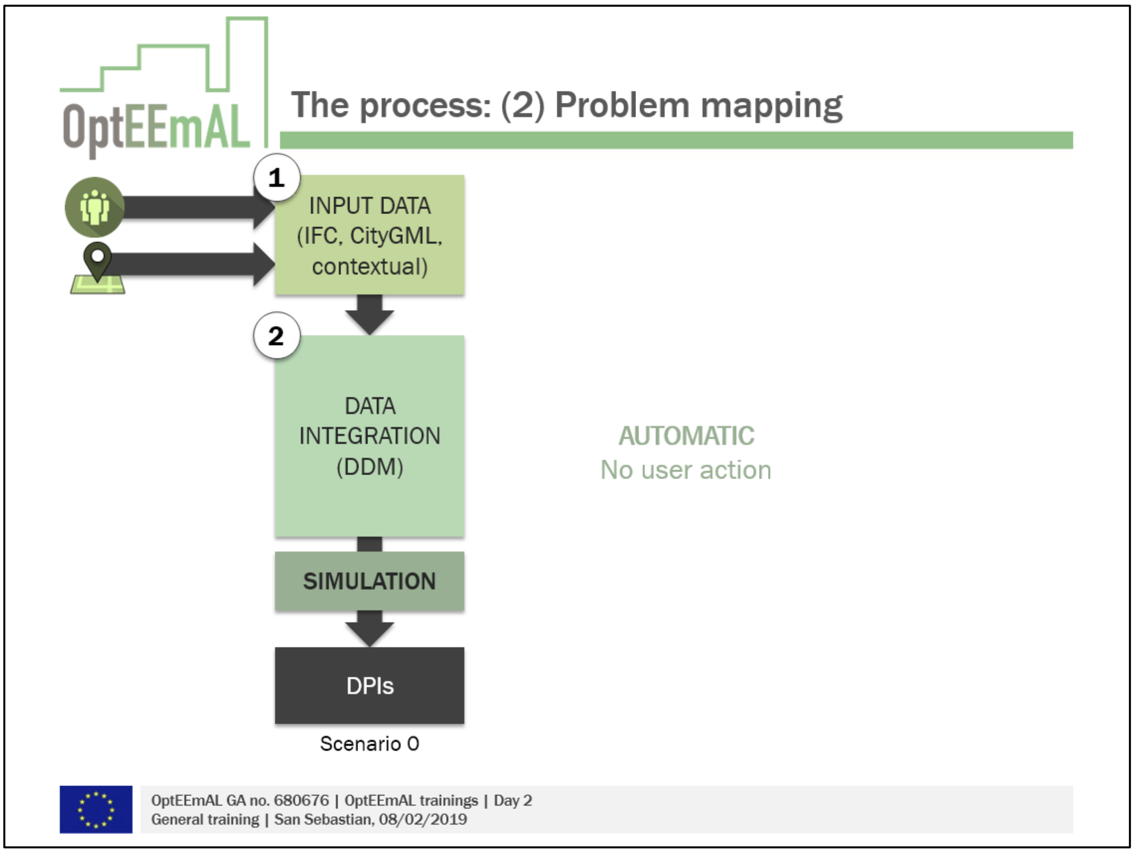
OPTIMISED ENERGY EFFICIENT DESIGN PLATFORM FOR REFURBISHMENT AT DISTRICT LEVEL


The process: (2) Problem mapping
1
INPUT DATA
(IFC, CityGML,
contextual)
2
DATA
INTEGRATION
(DDM)
AUTOMATIC
No user action
SIMULATION
DPIs
Scenario 0
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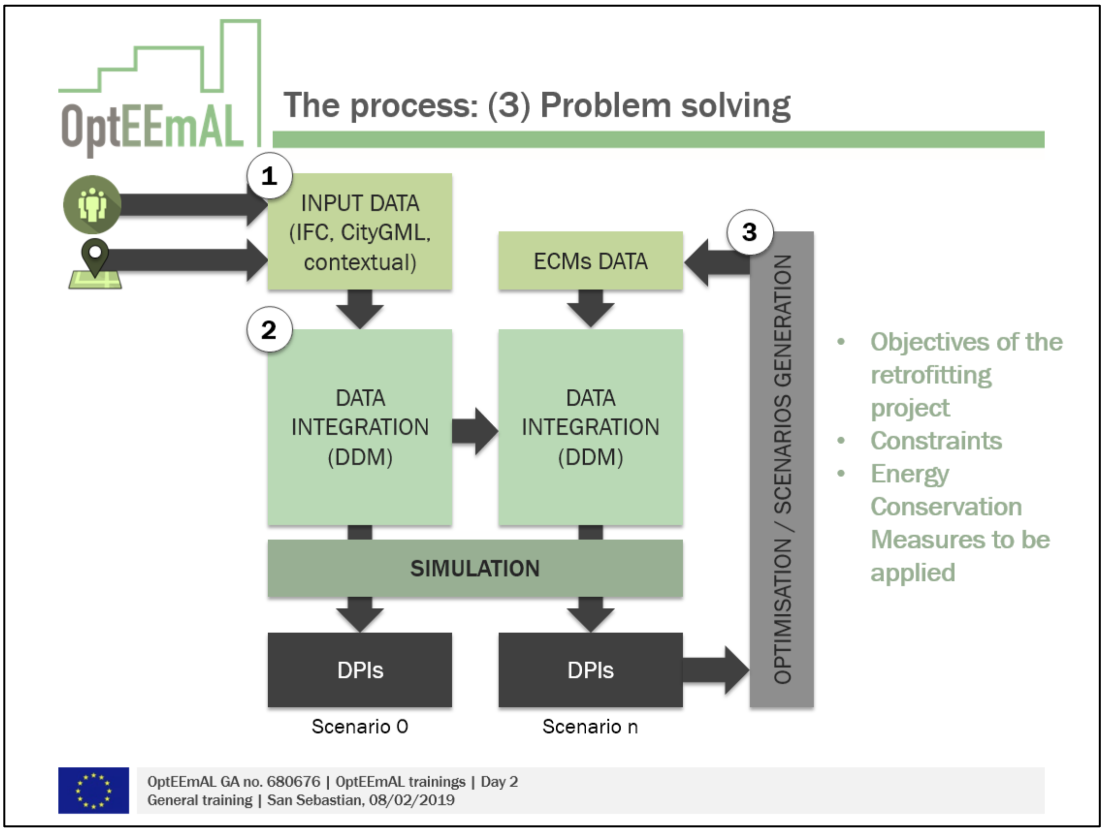
The process: (3) Problem solving
1
INPUT DATA
(IFC, CityGML,
contextual)
ECMs DATA
3
2
DATA
INTEGRATION
(DDM)
DATA
INTEGRATION
(DDM)
OPTIMISATION / SCENARIOS GENERATION
Objectives of the retrofitting project
Constraints
Energy Conservation Measures to be applied
SIMULATION
DPIs
DPIs
Scenario 0
Scenario n
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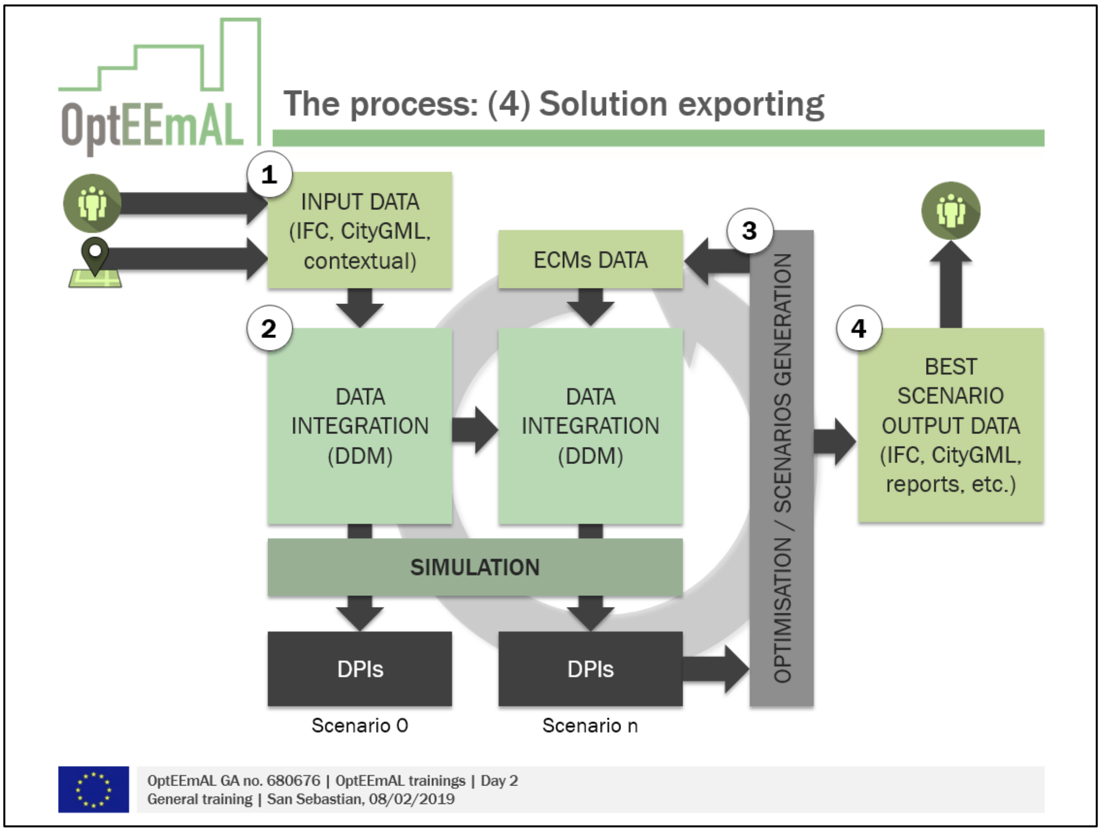
The process: (4) Solution exporting
1
INPUT DATA (IFC, CityGML, contextual)
2
DATA INTEGRATION (DDM)
ECMs DATA
3
DATA INTEGRATION (DDM)
SIMULATION
DPIs
DPIs
Scenario 0
Scenario n
OPTIMISATION / SCENARIOS GENERATION
4
BEST SCENARIO OUTPUT DATA (IFC, CityGML, reports, etc.)
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Use of the platform
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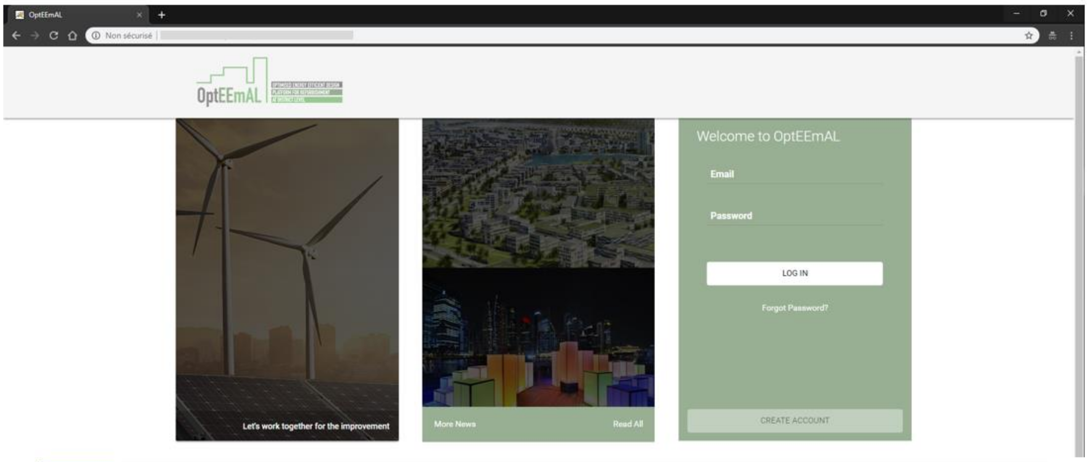
The OptEEmAL platform

Web-based platform for the design of energy efficient refurbishment projects at the district level



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Keywords

- IPD group: Integrated Project Delivery group. Group consisting of one/several Owner, one/several Prime Designer and one/several Prime Constructor working together on the same project. Depending on its role, the user has access to different functionalities.
- Contextual data: Weather data, energy prices, economic information automatically gathered through a geoclustering service
- Baseline: Current situation of the district (i.e. before retrofitting)
- BES: Baseline Energy Systems
- ECM: Energy Conservation Measures
- DPI: District Performance Indicator

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Video on the use of the platform

Web-based platform for the design of energy efficient refurbishment projects at the district level

https://vimeo.com/314252162/c00eeb8ea6

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Use of the platform

- Create a new project (one of you)
- Invite other participants to the project
- Use the platform "as in a real case"
- Input files/data are available on the distributed USB stick
- Provide feedback on the platform functionalities and use

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Annex 3: Description of initial case studies

Table 27: Cuatro de Marzo district, Valladolid, Spain

Case study 1	District retrofitting promotion in a residential district based on a target energy consumption reduction and maximum investment		
Location	Cuatro de Marzo district – Valladolid (Spain)		
Partner in charge	FUNDACIÓN CARTIF		
Goal	The Municipality wants to promote a district retrofitting in an area with two building typologies, with a target of reducing a 60% the net fossil energy consumption and with a maximum public contribution of 2M€.		
Data available	Urban data	Year of construction	1960
		District surface [m²]	140,000
		Site coverage ratio [%]	27
		District morphology	Building blocks following an orthogonal grid, some of them forming interior courtyards.
		Uses classification (*)	Residential
		Number of buildings	189
		Building typologies	Residential line block Residential tower block
		Net built area of buildings [m²]	210,000
		Net usable area of buildings [m²]	175,000
		Number of dwellings	1,950
	Climatic data	Climate zone (*)	D2 Continental Mediterranean
		Heating degree day (HDD)	3,121
		Cooling degree day (CDD)	394

		Average winter temperature [°C]	5.0
		Average summer temperature [°C]	20.5
		Global solar radiation [kWh/m²yr]	1,701
		Average wind speed [m/s]	2.3
		Average precipitation [mm/year]	1.2
	Energy and environment	Thermal gross area of district [m²]	166,000
		Thermal gross volume of district [m³]	457,000
		Existing thermal systems (HVAC)	Individual boilers
		Existing energy sources (gas, oil, biomass, electricity, etc.)	Natural gas Electricity
		Degree of energetic self-supply [%]	0
		Degree of accordance with national laws and standards (*) [%]	85.12%
		Estimated average final energy demand per building typology [kWh/m²yr]	171.4
		Estimated average final energy consumption per building typology [kWh/m²yr]	197.4
		Average energetic class of buildings	E
		Net fossil energy consumption [kWh/m²yr]	202.54 (37.84 electrical + 164.70 thermal)
		Greenhouse gas emissions [kgCO$_2$/m²yr]	37.42
		Other studies already implemented in the case study (for the TRL6 case studies) as for example visual inspection, thermographic test, BlowerDoor, etc.	Visual inspection Calener energy simulation
	Social data	Number of inhabitants	3,800
		Population density of district [inhab/m²]	0.027
		Property structure	Private ownership
		Average income of inhabitants	Medium class
		Other Information	High population and urban density.
Data needed	Cadastre, GIS, BIM, statistics, thermographic test or BlowerDoor needed for the TRL7 demo-cases		

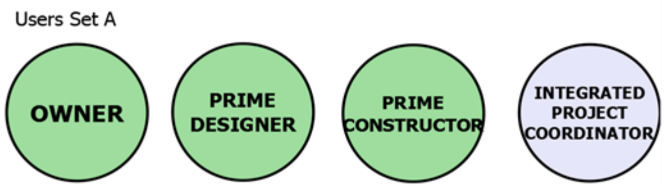
Work process	• Evaluation of current conditions • Evaluation of possible retrofitting scenarios in terms of energy consumption and investment • Design of selected scenario
Actors / IPD	Include agreed share of decision weight (if applicable) Owner (PRIMARY): Citizens + Neighbourhood associations Integrated Project coordinator (PRIMARY): Cartif Prime Designer (PRIMARY): Energy Service Company Design Consultants (KEY SUPPORTING): - Prime Constructor (PRIMARY): Energy Service Company Trade Contractors (KEY SUPPORTING): (possibly existent in the future for the renovation of façades) Suppliers (KEY SUPPORTING): Agencies (KEY SUPPORTING): ViVa 
Platform Users	Owner (PRIMARY): ViVa (representing interests of owners) Integrated Project coordinator (PRIMARY): Cartif Prime Designer (PRIMARY): Energy Service Company Prime Constructor (PRIMARY): Energy Service Company
DPIs	Net fossil energy consumption (kWh/m^{2}yr), Energy demand covered by renewable resources - share of RES production (%) Energy use from PV Total investment (€) Return of investment (years) Global Warming Potential – GWP (kg CO2) GWP reduction
Related national/local policy framework	Spanish technical building code, General Urban Development Plan of the city
Others	
	NOTE: In order to be able to compare the results obtained from OptEEmAL with the real interventions being applied in the case studies, the definition of the real actuations would be needed in the evaluation stage. With the aim of not conditioning the design of the OptEEmAL tool, this information will not be included at this stage. (*) According to national law

Table 28: Manise province district, Soma, Turkey

Case study 2	District retrofitting promotion in a residential district based on a target energy consumption reduction and minimum investment		
Location	Manisa Province district – Soma (Turkey)		
Partner in charge	FUNDACIÓN CARTIF		
Goal	A public company wants to promote a district retrofitting in an area with three building typologies, with a target of reducing a 70% the net fossil energy consumption and using the existing district heating.		
Data available	Urban data	Year of construction	1983
		District surface [m^2]	215,000
		Site coverage ratio [%]	15
		District morphology	Isolated tower blocks surrounded by greenery
		Uses classification (*)	Residential Public concurrence
		Number of buildings	85
		Building typologies	Residential building blocks (82) Guest houses (2) Convention centre (1)
		Net built area of buildings [m^2]	65,000
		Net usable area of buildings [m^2]	52,000
		Number of dwellings	346
	Climatic data	Climate zone (*)	Zone 2 Mediterranean
		Heating degree day (HDD)	1,458
		Cooling degree day (CDD)	514
		Average winter temperature [°C]	8.5
		Average summer temperature [°C]	26.4
		Global solar radiation [kWh/m^{2}yr]	1,311

		Average wind speed [m/s]	2.5
		Average precipitation [mm/year]	1.3
	Energy and environment	Thermal gross area of district [m²]	42,000
		Thermal gross volume of district [m³]	120,000
		Existing thermal systems (HVAC)	District heating
		Existing energy sources (gas, oil, biomass, electricity, etc.)	Lignite
		Degree of energetic self-supply [%]	0
		Degree of accordance with national laws and standards (*) [%]	53.09 %
		Estimated average final energy demand per building typology [kWh/m²yr]	137.60
		Estimated average final energy consumption per building typology [kWh/m²yr]	154.17
		Average energetic class of buildings	F
		Net fossil energy consumption [kWh/m²yr]	163.95
		Greenhouse gas emissions [kgCO_2/m²yr]	100
		Other studies already implemented in the case study (for the TRL6 case studies) as for example visual inspection, thermographic test, BlowerDoor, etc.	--
	Social data	Number of inhabitants	2,000
		Population density of district [inhab/m²]	0.010
		Property structure	Private ownership
		Average income of inhabitants	Medium class
		Other Information	-
Data needed	Cadastre, GIS, BIM, statistics, thermographic test or BlowerDoor needed for the TRL7 demo-cases		
Work process	• Evaluation of current conditions • Evaluation of possible retrofitting scenarios in terms of energy consumption and investment • Design of selected scenario		
Actors / IPD	Owner (PRIMARY): SEAS Integrated Project coordinator (PRIMARY): Demir Enerji		

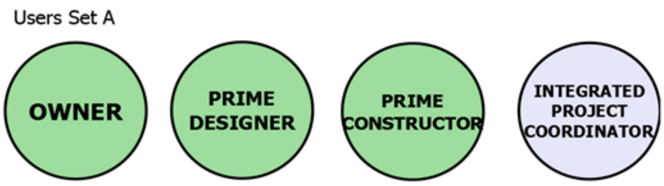
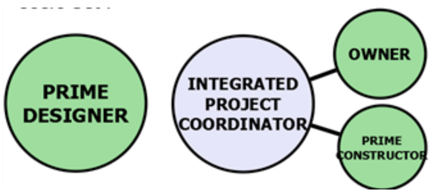
	Prime Designer (PRIMARY): ITU Design Consultants (KEY SUPPORTING): - Demir Enerji Prime Constructor (PRIMARY): Reengen + MIR Agencies (KEY SUPPORTING): Soma Belediyesi + Manisa Municipality 
Platform Users	Owner (PRIMARY): SEAS Integrated Project coordinator (PRIMARY): Demir Enerji Prime Designer (PRIMARY): ITU Prime Constructor (PRIMARY): Reengen + MIR
DPIs	Energy demand Final energy consumption Energy demand covered by renewable sources Energy use from district heating Energy use from PVs Energy use from solar thermal Global warming potential GWP reduction Investments Return of investment
Related national/local policy framework	TSE 825
Others	
	NOTE: In order to be able to compare the results obtained from OptEEmAL with the real interventions being applied in the case studies, the definition of the real actuations would be needed in the evaluation stage. With the aim of not conditioning the design of the OptEEmAL tool, this information will not be included at this stage. (*) According to national law

Table 29: Historic city district, Santiago de Compostela (Spain)

Case study 3	The Old Town of Santiago is a World Heritage Site and is therefore protected by severe historic preservation restrictions. Santiago is located in the west of Europe. The selected district contains mostly tertiary and residential building,		
Location	Part of Historic City district – Santiago de Compostela (Spain) Rua Castiñeiros, Pelamios, Vista Alegre and Salvadas		
Partner in charge	TECNALIA		
Goal	District selected for this case study includes different typologies of buildings. Within each type there are various circumstances in relation to the refurbishing of the buildings and the incorporation or not of thermal isolation and other betterments.		
Data available	Urban data	Year of construction	Various from XVIIIth to XXIst Centuries
		District surface [m^2]	83,038.50 m^2
		Site coverage ratio [%]	20%
		District morphology	Linear development with small and larger multi-family-houses
		Uses classification (*)	Various: dwelling, university, sport, religious
		Number of buildings	100
		Building typologies	Multifamily house Single family house Apartment block Non-domestic building
		Net built area of buildings [m^2]	16,619 m^2
		Net usable area of buildings [m^2]	
		Number of dwellings	593
	Climatic data	Climate zone (*)	C1
		Heating degree day (HDD)	1,508
		Cooling degree day (CDD)	67
		Average winter temperature [°C]	11.9ºC

Others		Average summer temperature [°C]	16.3ºC
		Global solar radiation [kWh/m²yr]	1,413.34
		Average wind speed [m/s]	
		Average precipitation [mm/year]	1,787
	Energy and environment	Thermal gross area of district [m²]	To be obtained from simulation through the FASUDIR Tool [3]
		Thermal gross volume of district [m³]	To be obtained from simulation through the FASUDIR Tool [3]
		Existing thermal systems (HVAC)	Radiant room heater
		Existing energy sources (gas, oil, biomass, electricity, etc.)	Gas Electricity
		Degree of energetic self-supply [%]	0
		Degree of accordance with national laws and standards (*) [%]	
		Estimated average final energy demand per building typology [kWh/m²yr]	To be obtained from simulation through the FASUDIR Tool [3]
		Estimated average final energy consumption per building typology [kWh/m²yr]	
		Average energetic class of buildings	
		Net fossil energy consumption [kWh/m²yr]	
		Greenhouse gas emissions [kgCO_2/m²yr]	
		Other studies already implemented in the case study (for the TRL6 case studies) as for example visual inspection, thermographic test, BlowerDoor, etc.	
	Social data	Number of inhabitants	
		Population density of district [inhab/m²]	
		Property structure	Private ownership
		Average income of inhabitants	Medium class
		Other Information	
Others	**Additional Information available:**		

	Building footprints from Spanish Cadaster (free) LiDAR Data from Spanish National Institute of Geography (free) Digital Terrain Model – DTM from Spanish National Institute of Geography (free) 2D Geometric representation of other city elements such as Roads, Railways, Green areas, etc. from free data sources such as Cartociudad or OpenStreetMap. 3D City Model (CityGML LoD2) developed within the FASUDIR project [3]. Other data collected within the FASUDIR project [3] for the buildings in the selected district for energy performance simulations, including window % of façades, heating and cooling systems and fuels. Climatic Data (from Meteogalicia), including monthly data for average, min and max temperatures, relative humidity, solar radiation, precipitation. Social data collected within the FASUDIR project [3] such as; average change in purchase prices of residential buildings in district in last three years, average of yearly change in rental fees of residential buildings in last three years, average of change in area median income in last three years, average unemployment rate in district in last three years, average yearly change in district population in last three years, share of inhabitants older than 60 years.
Data needed	Geometry: 3D City Model (CityGML LoD2) of the district and 2km radius around General data about district, buildings and other city elements such as green areas, parking areas, roads, etc. Default data templates Climatic Data
Work process	• Define current state of the district (Baseline) • Evaluate current state through KPIs • Simulate variants (retrofitting scenarios) • Compare variants through KPIs • Select the most suitable one for each building typology
Actors / IPD	Urban Manager -> IPD Actor = Owner (public body) or Prime Designer Building Owners -> IPD Actor = Owner (citizen) Investor -> IPD Actor = Design Consultant Grant Manager -> IPD Actor = Agencies Building Solution Provider -> IPD Actor = Supplier Technical Staff (Consorcio de Santiago) -> IPD Actor = Prime Designer 
Platform Users	Urban Manager -> IPD Actor = Owner (public body) or Prime Designer Grant Manager -> IPD Actor = Agencies Building Solution Provider -> IPD Actor = Supplier Technical Staff -> IPD Actor = Prime Designer

<table>
<tr><td>DPIs</td><td>List of KPIs at district level identified in FASUDIR (D2.4 IDST Key Performance Indicators) [3]:

ENVIRONMENTAL
Total Primary Energy Demand
Operational Energy Use
Energy Demand Embodied
Share of Renewable Energy on Site
Global Warming Potential (GWP)
Acidification Potential (AP)
Ozone Depletion Potential (ODP)
Eutrophication Potential (EP)
Photochemical Ozone Creation Potential (POCP)
Abiotic Depletion Potential Elements (ADPe)
Intensity of Water treatment
Soil sealing
SOCIAL
Parking facilities
Infrastructure for innovative concepts: car sharing, charging infrastructure for electric / hybrid vehicles
Internal Accessibility: Bus, Tram, Subway stops, Railway station
Bicycle facilities
Bicycle and Pedestrian network quality
Barrier-Free Accessibility of the District
Access to Services and Facilities
Access to Parks and Open Spaces
Percentage of building area over noise limit
Outdoor temperature / Heat island effect
Gentrification Index
ECONOMIC
Life cycle costs aggregated
Investment costs aggregated
Running costs energy aggregated
Running costs non-energy aggregated
Return on Investment</td></tr>
<tr><td>Related national/local policy framework</td><td>Many of the buildings are protected, that means that requires respect to the cultural heritage value of the buildings and their elements.

National Building Technical Code</td></tr>
<tr><td></td><td>NOTE: In order to be able to compare the results obtained from OptEEmAL with the real interventions being applied in the case studies, the definition of the real actuations would be needed in the evaluation stage. With the aim of not conditioning the design of the OptEEmAL tool, this information will not be included at this stage.

(*) According to national law</td></tr>
</table>

Table 30: Linero district, Lund, Sweden

Case study	Linero		
Location	Lund (Sweden)		
Partner in charge	LUND		
Goal	Lund municipality social housing company wants to refurbish this district to reduce energy consumption and associated GHG emissions.		
Data available	Urban data	Year of construction	1972-74
		District surface [m²]	129,000 m²
		Site coverage ratio [%]	17%
		District morphology	Residential apartment blocks
		Uses classification (*)	Rental apartments
		Number of buildings	28
		Building typologies	3 storey buildings
		Net built area of buildings [m²]	71,258 m² A_{temp}
		Net usable area of buildings [m²]	71,258 m² A_{temp}
		Number of dwellings	681 apartments
	Climatic data	Climate zone (*)	Numeral
		Heating degree day (HDD)	3,667
		Cooling degree day (CDD)	99
		Average winter temperature [°C]	-0.5
		Average summer temperature [°C]	16.5
		Global solar radiation [kWh/m²yr]	975
		Average wind speed [m/s]	Approx. 5-6 m/s
		Average precipitation [mm/year]	666
	Energy and environm	Thermal gross area of district [m²]	71,258 m² A_{temp}
		Thermal gross volume of district [m³]	Ca 178,000 m³

		Existing thermal systems (HVAC)	District heating
		Existing energy sources (gas, oil, biomass, electricity, etc.)	District heating, electricity
		Degree of energetic self-supply [%]	0
		Degree of accordance with national laws and standards (*) [%]	---
		Estimated average final energy demand per building typology [kWh/m²yr]	141
		Estimated average final energy consumption per building typology [kWh/m²yr]	158
		Average energetic class of buildings	---
		Net fossil energy consumption [kWh/m²yr]	36.3
		Greenhouse gas emissions [$kgCO_2/m^2yr$]	15.5
		Other studies already implemented in the case study (for the TRL6 case studies) as for example visual inspection, thermographic test, BlowerDoor, etc.	Cityfied, report 4.3
	Social data	Number of inhabitants	Ca 2,000
		Population density of district [inhab/m²]	0.016
		Property structure	All houses are owned by LKF
		Average income of inhabitants	2013: 157,000 SEK/year (59% of average income in Lund)
		Other Information	
Data needed	Cadastre, GIS, BIM, statistics, CityGML model...		
Work process	• Pilot buildings renovated • Procurement of contractor for next phase Is completed • Large scale refurbishment of flats started		
Actors / IPD	Owner: LKF, Lund municipal housing company Integrated project coordinator: LKF, Lund municipal housing company Prime constructor: NN Energy services: Kraftringen, Lund municipal energy company Citizens		

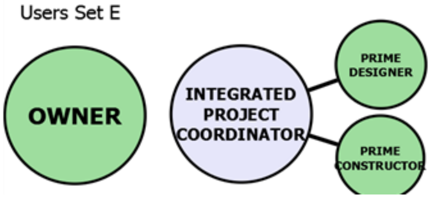
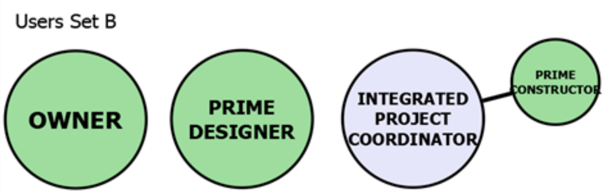
	
Platform Users	Owner: LKF, Lund municipal housing company Integrated project coordinator: LKF, Lund municipal housing company Prime constructor: NN Energy services: Kraftringen, Lund municipal energy company
DPIs	Energy demand Primary energy consumption Global warming potential Total investments
Related national/local policy framework	National building legislation: Boverkts byggregler (BBR)
	NOTE: In order to be able to compare the results obtained from OptEEmAL with the real interventions being applied in the case studies, the definition of the real actuations would be needed in the evaluation stage. With the aim of not conditioning the design of the OptEEmAL tool, this information will not be included at this stage. (*) According to national law

Table 31: Mogel district, Eibar, Spain

<table>
<tr><td>Case study 5</td><td colspan="3">Energy efficiency improvement of the residential buildings in the district. This would be achieved primarily by improving the building envelope as well as the installation of a system for sanitary hot water production by means of solar panels.</td><td rowspan="3"></td></tr>
<tr><td>Location</td><td colspan="3">Mogel district – Eibar (Spain)</td></tr>
<tr><td>Partner in charge</td><td colspan="3">TECNALIA</td></tr>
<tr><td>Goal</td><td colspan="4">Retrofitting project, including the works on the lift installation and improvement in energy efficiency of the buildings in the Mogel neighbourhood. Estimated an improvement of 60% in residential buildings
The retrofitting project gives answer to the following needs:
• Lift installation in buildings
• Improvement of the building envelope (facades, roofs, etc.)
• Duplicate the effect of the implementation of the Spanish Technical Building Code (CTE) for the new building, regarding the losses of the building envelope
• Change of windows (some of them were already upgraded)
• Installation of a hot water production system by means of solar panels with central storage system
• Improvement of lighting efficiency in common areas</td></tr>
<tr><td rowspan="8">Data available</td><td rowspan="8">Urban data</td><td colspan="2">Year of construction</td><td>1949</td></tr>
<tr><td colspan="2">District surface [m2]</td><td>13,500 m2</td></tr>
<tr><td colspan="2">Site coverage ratio [%]</td><td>---</td></tr>
<tr><td colspan="2">District morphology</td><td>Buildings integrated into various blocks in line. Each building is a rectangular plot elongated with the façades orientated on both streets.</td></tr>
<tr><td colspan="2">Uses classification (*)</td><td>Residential</td></tr>
<tr><td colspan="2">Number of buildings</td><td>15</td></tr>
<tr><td colspan="2">Building typologies</td><td>Buildings have a mixed system of facades with stone loadbearing in the ground floor and brick in the rest, with wood slabs. The staircase is concrete made</td></tr>
<tr><td colspan="2">Net built area of buildings [m2]</td><td>9,450</td></tr>
</table>

		Net usable area of buildings [m²]	
		Number of dwellings	150
	Climatic data	Climate zone (*)	C1
		Heating degree day (HDD)	1,883
		Cooling degree day (CDD)	150
		Average winter temperature [°C]	8ºC
		Average summer temperature [°C]	20ºC
		Global solar radiation [kWh/m²yr]	1,292.73
		Average wind speed [m/s]	
		Average precipitation [mm/year]	1,507
	Energy and environment	Thermal gross area of district [m²]	
		Thermal gross volume of district [m³]	
		Existing thermal systems (HVAC)	Individual instant boilers (electrical and gas) for heating
		Existing energy sources (gas, oil, biomass, electricity, etc.)	Electricity Natural Gas
		Degree of energetic self-supply [%]	
		Degree of accordance with national laws and standards (*) [%]	
		Estimated average final energy demand per building typology [kWh/m²yr]	
		Estimated average final energy consumption per building typology [kWh/m²yr]	
		Average energetic class of buildings	
		Net fossil energy consumption [kWh/m²yr]	
		Greenhouse gas emissions [kgCO_2/m²yr]	
		Other studies already implemented in the case study (for the TRL6 case studies) as for example visual inspection, thermographic test, BlowerDoor, etc.	BlowerDoor Thermographies
	Social data	Number of inhabitants	302
		Population density of district [inhab/m²]	

<table>
<tr><td rowspan="3"></td><td rowspan="3"></td><td>Property structure</td><td>Private ownership</td></tr>
<tr><td>Average income of inhabitants</td><td>Medium class</td></tr>
<tr><td>Other Information</td><td></td></tr>
<tr><td>Others</td><td colspan="3">Additional Information available:
2D Drawings
Reference standards values extracted from the Spanish building normative – CTE (Indoor air temperature, Heat gains from persons, Heat gains from lighting, Heat gains from equipment, Ventilation airflow, DHW)
The average infiltration rate (Air leakage) obtained from Blower door test
Exterior Thermographies
Historic energy bills collected from some flats showing consumption of gas and electricity.</td></tr>
<tr><td>Data needed</td><td colspan="3">Cadastre, GIS, BIM, statistics, thermographic test or BlowerDoor needed for the TRL7 demo-cases</td></tr>
<tr><td>Work process</td><td colspan="3">• Evaluation of current situation
• Evaluation of possible retrofitting scenarios in terms of energy consumption, investment and owners comfort.
• Design of selected scenario
• Performance of the retrofitting works in the buildings</td></tr>
<tr><td>Actors / IPD</td><td colspan="3">• Commission of neighbours -> IPD Actor = Owner (citizen)
• Town council and regional government-> IPD Actor = Integrated Project Coordinator (IPC)
• Development Agency (Debegesa) -> IPD Actor = Integrated Project Coordinator (IPC) or Agency
• Project redactors -> IPD Actor = Prime Designer
• Legal advisors -> IPD Actor = Design consultant and subcontractor
• The construction company -> IPD Actor = Prime Constructor Manager
</td></tr>
<tr><td>Platform Users</td><td colspan="3">• Town council-> IPD Actor = Integrated Project Coordinator (IPC)
• Development Agency (Debegesa) -> IPD Actor = Integrated Project Coordinator (IPC) or Agency
• Project redactors -> IPD Actor = Prime Designer</td></tr>
<tr><td>DPIs</td><td colspan="3">• Environmental Performance
  ○ Primary energy used from energy need in building [kWh/m²yr]
  ○ Greenhouse gas emissions from energy need in building [kg/m²/yr]
• Cost
  ○ Investment cost [€]
  ○ Maintenance [€/year]
  ○ Total cost in present value [k€]
  ○ Total energy cost in present value [k€]</td></tr>
</table>

	• Energy Generation
	  ○ Existing energy infrastructure connected to the building (District heating, National electricity mix, Natural gas boiler, Wood pellets burner) [kWh/m^{2}yr]
	  ○ Building on-site generation systems connected to the energy infrastructure (PV, Solar thermal) [kWh/m^{2}yr]
	  ○ Energy storage on-site (Heating) [kWh/m^{2}yr]

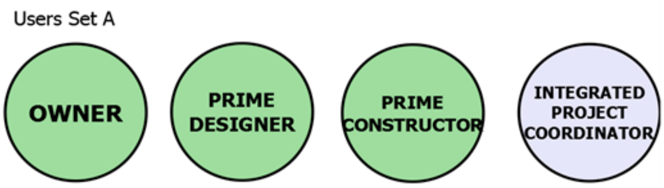
Related national/local policy framework	The neighbourhood is included in the Catalogue of Cultural Interest Items incorporated in the Planning Regulations of Eibar Sustainable strategies and energy efficiency goals of the Bajo Deba Region National Building Technical Code
	NOTE: In order to be able to compare the results obtained from OptEEmAL with the real interventions being applied in the case studies, the definition of the real actuations would be needed in the evaluation stage. With the aim of not conditioning the design of the OptEEmAL tool, this information will not be included at this stage. (*) According to national law

Table 32: Sneinton district, Nottingham, UK

<table>
<tr><td>Case study 6</td><td colspan="3">An intensive retrofitting programme will be deployed in the Sneinton area in order to achieve a low energy district.</td><td rowspan="3"></td></tr>
<tr><td>Location</td><td colspan="3">Sneinton district – Nottingham (UK)</td></tr>
<tr><td>Partner in charge</td><td colspan="3">FUNDACIÓN CARTIF</td></tr>
<tr><td>Goal</td><td colspan="4">Targets for West walk buildings:
• density of final energy demand < 25kWh/m2yr
• primary energy consumption < 120 kWh/m2yr + ((QH – 15 kWh/m2yr)·1.2)
• air change rate due to air tightness < 1 h-1
• investments < 720,000 €
• energy production costs < 80% of current EPCs
• local thermal comfort
Targets for maisonettes:
• DH implementation</td></tr>
<tr><td rowspan="9">Data available</td><td rowspan="9">Urban data</td><td>Year of construction</td><td colspan="2">From 1960 - 70</td></tr>
<tr><td>District surface [m^2]</td><td colspan="2">18,000</td></tr>
<tr><td>Site coverage ratio [%]</td><td colspan="2">30%</td></tr>
<tr><td>District morphology</td><td colspan="2">The majority of the area is residential with very low levels of local commercial, some of which are local shops. However the area borders on more commercial areas on the basis of its proximity to the City Centre. Also there are two areas in the demonstration area to underline. One of these is a school and the other is King Edwards Park which contains amenities such as football goals, and play equipment</td></tr>
<tr><td>Uses classification (*)</td><td colspan="2">Residential</td></tr>
<tr><td>Number of buildings</td><td colspan="2">Typology A (Maisonettes): 6
Typology B (William Moss houses): 2</td></tr>
<tr><td>Building typologies</td><td colspan="2">Variety of typologies within the Sneinton area ranging from one bedroom flats to three bedroom terraced houses.</td></tr>
<tr><td>Net built area of buildings [m^2]</td><td colspan="2">Typology A (Maisonettes): 7,020 (78 per dwelling)
Typology B (William Moss houses): 2,088 (116 per dwelling)</td></tr>
</table>

		Net usable area of buildings [m2]	Typology A (Maisonettes): 5,796 (64.4 per dwelling) Typology B (William Moss houses): 1,522.8 (84.6 per dwelling)
		Number of dwellings	Typology A (Maisonettes): 90 Typology B (William Moss houses): 18
	Climatic data	Climate zone (*)	Oceanic Hardiness zone number 8
		Heating degree day (HDD)	3,077
		Cooling degree day (CDD)	80
		Average winter temperature [°C]	4.1
		Average summer temperature [°C]	15.8
		Global solar radiation [kWh/m2yr]	963.6
		Average wind speed [m/s]	3.70
		Average precipitation [mm/year]	709.4
	Energy and environment	Thermal gross area of district [m2]	1,589.67
		Thermal gross volume of district [m3]	1,845
		Existing thermal systems (HVAC)	Mainly gas boilers but in some cases electric heating. Also some electric storage heaters are used. Ventilation is provided through extract fans.
		Existing energy sources (gas, oil, biomass, electricity, etc.)	Gas and electricity
		Degree of energetic self-supply [%]	0
		Degree of accordance with national laws and standards (*) [%]	162%
		Estimated average final energy demand per building typology [kWh/m2yr]	Typology A (Maisonettes): 180 (buildings) 200 (dwelling) Typology B (William Moss houses): 4,106.55 (buildings) 228 (dwelling)

		Estimated average final energy consumption per building typology [kWh/m²yr]	Typology A (Maisonettes): 205.74 per dwelling • Ground floor mid: 174.79 • Ground floor end: 307.20 • First floor mid: 185.71 • First floor end: 326.32 Typology B (William Moss houses): 234.53 per dwelling • Mid terrace: 223.65 • End terrace: 272.61
		Average energetic class of buildings	C
		Net fossil energy consumption [kWh/m²yr]	280.27
		Greenhouse gas emissions [kgCO_2/m²yr]	71.65
		Other studies already implemented in the case study (for the TRL6 case studies) as for example visual inspection, thermographic test, BlowerDoor, etc.	Visual inspection Thermographic test Energy simulation
	Social data	Number of inhabitants	5,582
		Population density of district [inhab/m²]	0.004166
		Property structure	council owned property & private owners
		Average income of inhabitants	Middle class
		Other Information	There is a much lower number of people in the area who are married than there is nationally and a significantly higher number of single people. This is reflected in the household composition, which shows that almost 50% of the households are single person or single adult. The number of owner occupiers both with and without mortgages is low in this area. The socio-economic classification shows that a high number of citizens in the REMOURBAN area work in lower managerial, administrative and professional occupations, closely followed by routine and semi-routine occupations. However this is comparable with national distribution and that of the Nottingham City area.
Data needed	Cadastre, GIS, BIM, statistics, thermographic test or BlowerDoor needed for the TRL7		

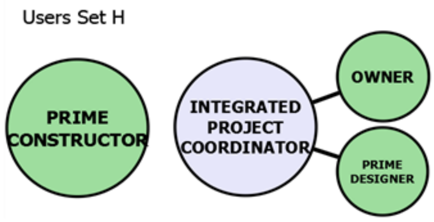
	demo-cases.
Work process	• City Audit: all the necessary information is collected in order to develop an accurate diagnosis of the current situation of the district • Technical definition of the specific intervention that will be undertaken in the demo site: Review of building envelope solutions, heating and ventilation solutions, ultra-low energy solutions , lighting solutions • Development of the financial and implementation plan • Public procurement, selection of installers, request of the necessary licences and permits • Development of the interventions, commissioning and test of energy conservation measures and energy generation facilities • Monitoring and analysis of the performance
Actors / IPD	Owner (PRIMARY): dwelling owners, City council, energy managers (ESCO) (DH) Integrated Project coordinator (PRIMARY): Design team Prime Designer (PRIMARY): Design team Design Consultants (KEY SUPPORTING): - Energy managers (ESCO) Prime Constructor (PRIMARY): Nottingham City Council
Platform Users	Owner (PRIMARY): City council, energy managers (ESCO) (DH) Integrated Project coordinator (PRIMARY): Design team Prime Designer (PRIMARY): Design team Prime Constructor (PRIMARY): Nottingham City Council 
DPIs	Energy demand Final energy consumption (kWh/m2yr) Energy use from district heating Local thermal comfort Investments (€) Return of investment (years)
Related national/local policy framework	UK Low Carbon Transition Plan, national Renewable Energy Strategy, Nottingham City Council's Emerging Planning Policy, Nottingham Sustainable Energy Strategy, Climate Change Strategy, Waste Strategy and Local Development Framework
	NOTE: In order to be able to compare the results obtained from OptEEmAL with the real interventions being applied in the case studies, the definition of the real actuations would be needed in the evaluation stage. With the aim of not conditioning the design of the OptEEmAL tool, this information will not be included at this stage. (*) According to national law

Annex 4: Description of demo sites

Table 33: San Bartolomeo district, Trento, Italy

<table>
<tr><td>Case study 7</td><td colspan="2">District retrofit analysis and implementation on a Board on the basis of a cost benefit analysis that considers both the reduction of energy consumption and payback time.</td><td rowspan="3"></td></tr>
<tr><td>Location</td><td colspan="2">San Bartolameo District - Trento (Italy)</td></tr>
<tr><td>Partner in charge</td><td colspan="2">DTTN</td></tr>
<tr><td>Goal</td><td colspan="3">Achieve energy savings through enhancement of building energy performance and improvement of the Operation and Maintenance Plan.</td></tr>
<tr><td rowspan="14">Data available</td><td rowspan="10">Urban data</td><td>Year of construction</td><td>2007</td></tr>
<tr><td>District surface [m2]</td><td>20.000</td></tr>
<tr><td>Site coverage ratio [%]</td><td>60%</td></tr>
<tr><td>District morphology</td><td>declivity</td></tr>
<tr><td>Uses classification (*)</td><td>E 1.1 boarding school</td></tr>
<tr><td>Number of buildings</td><td>6</td></tr>
<tr><td>Building typologies</td><td>Dorm and Board with Gymnasium, Auditorium and Bar</td></tr>
<tr><td>Net built area of buildings [m2]</td><td>Board 8,500
Sanbapolis 7,000</td></tr>
<tr><td>Net usable area of buildings [m2]</td><td>Board 25,000
Sanbapolis 8,000</td></tr>
<tr><td>Number of dwellings</td><td>Board 750</td></tr>
<tr><td rowspan="4">Climatic data</td><td>Climate zone (*)</td><td>GG 2567 Zone</td></tr>
<tr><td>Heating degree day (HDD)</td><td>2,782</td></tr>
<tr><td>Cooling degree day (CDD)</td><td>101</td></tr>
<tr><td>Average winter temperature [°C]</td><td>5°C</td></tr>
</table>

		Average summer temperature [°C]	24°C
		Global solar radiation [kWh/m²yr]	1,371 kWh/m²yr
		Average wind speed [m/s]	--
		Average precipitation [mm/year]	1,250 mm/yr
	Energy and environment	Thermal gross area of district [m²]	Board 25,000 Sanbapolis 7,000
		Thermal gross volume of district [m³]	Board 75,000 Sanbapolis 80,000
		Existing thermal systems (HVAC)	Heat pump, hair handling unit and boiler
		Existing energy sources (gas, oil, biomass, electricity, etc.)	Gas and Electrical
		Degree of energetic self-supply [%]	0%
		Degree of accordance with national laws and standards (*) [%]	100%
		Estimated average final energy demand per building typology [kWh/m²yr]	Boarding school (5 buildings): 2,500,000 kWh/yr Gymnasium, Auditorium (1 building): 1,000,000 kWh/yr
		Estimated average final energy consumption per building typology [kWh/m²yr]	Boarding school (5 buildings): 3,050,000 kWh/yr Gymnasium, Auditorium (1 building): 1,100,000 kWh/yr
		Average energetic class of buildings	Estimated D class (<180 [kWh/m²yr])
		Net fossil energy consumption [kWh/m²yr]	3,850,000 kWh/yr 120 kWh/m²yr
		Greenhouse gas emissions [kgCO₂/m²yr]	770,000 kgCO₂/yr 24 kgCO₂/m²yr
		There aren't other studies already implemented in Board (for the TRL6 case studies) as for example visual inspection, thermographic test, BlowerDoor, etc.	
	cia – dat	Number of inhabitants Board	850

	Population density of district [inhab/m²]	0,032
	Property structure	Opera Universitaria di Trento
	Average income of inhabitants	n.d.
	Other Information	Sanbapolis is LEED GOLD certified.
Data needed	Cadastre, statistics of energy consumption, hours of operation and occupation of inhabitants, thermographic test.	
Work process	• Evaluation of target of the Building Owner Definition of energy, functional and economic objectives. • Stakeholders: Building Owner – Facility Manager – HVAC Engineer • Evaluation of current conditions: evaluation of building's energetic performance and of consumption both Gas and Electrical. • Stakeholders: Building Owner – Facility Manager – HVAC Engineer- Controls Engineer • Evaluation of possible retrofitting scenarios in terms of energy consumption and investment by creating an energy model based on the actual consumption. Evaluation of economic incentives for refurbishment. • Stakeholders: Building Owner – Facility Manager – HVAC Engineer - Controls Engineer – Civil Engineer – Architect – Construction Manager • Design of selected scenario • Stakeholders: Building Owner – Facility Manager – HVAC Engineer - Controls Engineer – Civil Engineer – Architect – Construction Manager	
Actors / IPD	Building Owner – Facility Manager – HVAC Engineer - Controls Engineer – Civil Engineer – Architect – Construction Manager Inhabitants – Municipality- Suppliers – General Contractor - Subcontractors 	
Platform Users	Building Owner – Facility Manager – HVAC Engineer - Controls Engineer – Civil Engineer – Architect – Construction Manager- General Contractor – Subcontractors	
DPIs	Net energy source [kWh/m²yr], Net Energy source per inhabitant [kWh/inh] Energy savings for the "i" scenario [kWh/m²yr], Investment for the "i" scenario [€]. Ratio of the Investment and the Energy savings [€/(kWh/m²yr)] Net Energy sshare of RES production (%), total investment (€), return of investment (years)	
Related	L 10/91 "Norme per il contenimento del consumo energetico per usi termici negli	

national/local policy framework	edifici." D.P.R. del 26/08/93 n°412" Regolamento di attuazione della Legge 09/01/91 n°10, sul contenimento dei consumi energetici." DPR 59/09 "Attuazione del DLgs 192/05" DPR 37/2008 "…disposizioni in materia di attività di installazione degli impianti all'interno degli edifici" – UNI EN 12831 "Impianti di riscaldamento degli edifici - Metodo per il calcolo dei requisiti energetici e dei rendimenti dell'impianto"- UNI 7129/2008 "Impianti a gas per uso domestico e similari alimentati da rete di distribuzione", UNI TS 11300/2008 "Prestazioni energetiche degli edifici", UNI 10200/2013 "Impianti termici centralizzati di climatizzazione invernale e produzione di acqua calda sanitaria - Criteri di ripartizione delle spese di climatizzazione invernale ed acqua calda sanitaria".
	NOTE: In order to be able to compare the results obtained from OptEEmAL with the real interventions being applied in the case studies, the definition of the real actuations would be needed in the evaluation stage. With the aim of not conditioning the design of the OptEEmAL tool, this information will not be included at this stage. (*) According to national law

Table 34: Txomin Enea district, San Sebastian, Spain

<table>
<tr><td>Case study 8</td><td colspan="2">Retrofitting of Residential buildings including the connection to a District Heating system. Small area which backbone is the Urumea river. The District is affected by continuous flooding problems.</td><td rowspan="3"></td></tr>
<tr><td>Location</td><td colspan="2">Txomin Enea district – San Sebastián (Spain)</td></tr>
<tr><td>Partner in charge</td><td colspan="2">Fomento de San Sebastian</td></tr>
<tr><td>Goal</td><td colspan="3">Retrofitting project improving the energy efficiency of 6 blocks of residential buildings and including the connection of those buildings to a District Heating system.
The residential buildings are located in Txomin neighbourhood and the retrofitting consists of 156 dwellings distributed along 10 doorways, totalling 18,365m². The intervention will include the general connection of the buildings to the District Heating system and all the individual and common installations within the buildings.</td></tr>
<tr><td rowspan="12">Data available</td><td rowspan="10">Urban data</td><td>Year of construction</td><td>3 blocks 1967
2 blocks 1968
1 block 1970
2 blocks 1976
2 blocks 1980</td></tr>
<tr><td>District surface [m²]</td><td>18,365</td></tr>
<tr><td>Site coverage ratio [%]</td><td></td></tr>
<tr><td>District morphology</td><td>Small area which backbone is the Urumea river. The District is affected by continuous flooding problems.</td></tr>
<tr><td>Uses classification (*)</td><td>Residential</td></tr>
<tr><td>Number of buildings</td><td>8</td></tr>
<tr><td>Building typologies</td><td>Multifamily</td></tr>
<tr><td>Net built area of buildings [m²]</td><td></td></tr>
<tr><td>Net usable area of buildings [m²]</td><td></td></tr>
<tr><td>Number of dwellings</td><td>156</td></tr>
<tr><td rowspan="2">Climatic data</td><td>Climate zone (*)</td><td>D1</td></tr>
<tr><td>Heating degree day (HDD)</td><td>1,234</td></tr>
</table>

		Cooling degree day (CDD)	19
		Average winter temperature [°C]	10
		Average summer temperature [°C]	19
		Global solar radiation [kWh/m²yr]	1,533
		Average wind speed [m/s]	5
		Average precipitation [mm/year]	1,740
	Energy and environment	Thermal gross area of district [m²]	
		Thermal gross volume of district [m³]	
		Existing thermal systems (HVAC)	Individual boilers
		Existing energy sources (gas, oil, biomass, electricity, etc.)	Natural gas Electricity
		Degree of energetic self-supply [%]	
		Degree of accordance with national laws and standards (*) [%]	
		Estimated average final energy demand per building typology [kWh/m²yr]	
		Estimated average final energy consumption per building typology [kWh/m²yr]	
		Average energetic class of buildings	
		Net fossil energy consumption [kWh/m²yr]	
		Greenhouse gas emissions [kgCO₂/m²yr]	
		Other studies already implemented in the case study (for the TRL6 case studies) as for example visual inspection, thermographic test, BlowerDoor, etc.	-
	Social data	Number of inhabitants	500
		Population density of district [inhab/m²]	
		Property structure	Private owners
		Average income of inhabitants	
		Other Information	
Data needed	.		
Work process	• Evaluation of different retrofitting alternatives in 2016		

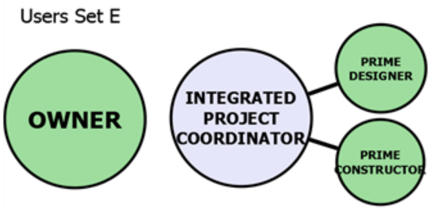
	• Start of Retrofitting in 2017 • Connection to the District Heating System
Actors / IPD	• ESCO • Fomento de San Sebastian and the City Council
Platform Users	• Tecnalia • Fomento de San Sebastian
DPIs	• Investment Cost • Maintenance Cost • Greenhouse gas emissions • Primary energy consumption • Internal rate of return and the time needed to get back the investment.
Related national/local policy framework	Spanish Technical building Code and the Local Regulation of the Municipality of San Sebastian.
Others	
	NOTE: In order to be able to compare the results obtained from OptEEmAL with the real interventions being applied in the case studies, the definition of the real actuations would be needed in the evaluation stage. With the aim of not conditioning the design of the OptEEmAL tool, this information will not be included at this stage. (*) According to national law

Table 35: Polhem school district, Lund, Sweden

Case study 9	POLHEM AREA		
Location	Lund (Sweden)		
Partner in charge	LUND		
Goal	No goals set for the specific district since retrofitting plans do not exist yet. There are goals for the entire building stock of municipal buildings and for the municipality as a whole: • The energy consumption in the municipal buildings shall decrease by 10% until 2016 compared with 2014. • The municipality shall be a fossil fuel free organisation by 2020. • The primary energy use in the municipal building shall decrease by 2020 compared to 2013.		
Data available	Urban data	Year of construction	Polhemsskolan (high school): 1914, 1961, 1985, 1975, 1982, 1991 Bollhuset (sports hall): 1966
		District surface [m2]	63,240 m2
		Site coverage ratio [%]	24%
		District morphology	School yard with several school buildings of different shape, type and age. Sports hall with adjacent athletic ground.
		Uses classification (*)	Polhemsskolan: High school. Bollhuset: Sports hall.
		Number of buildings	9 (or 5 depending on how you count. Some are linked together,

			but they are referred to as different buildings)
		Building typologies	Polhemsskolan: 2 and 3 story brick buildings. Bollhuset: 1 story brick and sheet building.
		Net built area of buildings [m²]	Polhemsskolan: 26,987 m² Bollhuset: 5,481 m²
		Net usable area of buildings [m²]	Polhemsskolan: 24,288 m² Bollhuset: 4,686 m²
		Number of dwellings	Zero dwellings, only public buildings
	Climatic data	Climate zone (*)	Nemoral
		Heating degree day (HDD)	3,667
		Cooling degree day (CDD)	99
		Average winter temperature [°C]	-0,5
		Average summer temperature [°C]	16,5
		Global solar radiation [kWh/m²yr]	975
		Average wind speed [m/s]	Approx. 5-6 m/s
		Average precipitation [mm/year]	666
	Energy and environment	Thermal gross area of district [m²]	Polhemsskolan: 23,903 m² Bollhuset: approx. 4,680 m²
		Thermal gross volume of district [m³]	We do not have this figure.
		Existing thermal systems (HVAC)	District heating
		Existing energy sources (gas, oil, biomass, electricity, etc.)	District heating
		Degree of energetic self-supply [%]	0%
		Degree of accordance with national laws and standards (*) [%]	We do not measure this or have any gathered information.
		Estimated average final energy demand per	Polhemsskolan: 154

		building typology [kWh/m²yr]	kWh/m²yr Bollhuset: 202 kWh/m²yr Since the buildings are heated with district heating the demand and the consumption are the same.
		Estimated average final energy consumption per building typology [kWh/m²yr]	Polhemsskolan: 154 kWh/m²yr Bollhuset: 202 kWh/m²yr
		Average energetic class of buildings	The buildings have not been classified according to the new classification. There are energy declarations, but according to the previous Swedish scale.
		Net fossil energy consumption [kWh/m²yr]	Polhemsskolan: 5.7 kWh/m²yr Bollhuset: 7.5 kWh/m²yr
		Greenhouse gas emissions [$kgCO_2/m^2yr$]	Polhemsskolan: 1.50 kg CO2/m²yr Bollhuset: 2.08 kg CO2/m²yr
		Other studies already implemented in the case study (for the TRL6 case studies) as for example visual inspection, thermographic test, BlowerDoor, etc.	There are energy declarations, protocols from regular ventilation inspections and material from an ECP project that was carried out in 2008.
	Social data	Number of inhabitants	Zero (it is an area of public buildings only)
		Population density of district [inhab/m²]	Same as above.
		Property structure	Both objects are owned by Lund municipality.
		Average income of inhabitants	-
		Other Information	2D Drawings. Energy statistics. Records of some of the taken

	measures.
Data needed	3D models/BIM models
Work process	To be defined within the project.
Actors / IPD	Owner (project leaders, technical staff, culture and leisure department etc), users (staff, pupil, sports associations), contractors, neighbours, environmental department, energy company, consultants. 
Platform Users	Technical staff, project leaders, person responsible for building at the culture and leisure department, environmental department, consultants.
DPIs	Energy demand Primary energy consumption Global warming potential Total investments
Related national/local policy framework	Municipal environmental goals Municipal energy plan National building legislation National environmental goals
	NOTE: In order to be able to compare the results obtained from OptEEmAL with the real interventions being applied in the case studies, the definition of the real actuations would be needed in the evaluation stage. With the aim of not conditioning the design of the OptEEmAL tool, this information will not be included at this stage. (*) According to national law

Annex 5: Technical questionnaire distributed during the trainings

OptEEmAL OPTIMISED ENERGY EFFICIENT DESIGN PLATFORM FOR REFURBISHMENT AT DISTRICT LEVEL

Optimised Energy Efficient Design Platform for Refurbishment at District Level

H2020-WORK PROGRAMME 2014-2015 – 5. Leadership in enabling and industrial technologies

H2020-EeB-05-2015: Innovative design tools for refurbishment at building and district level

	Technical questionnaire
	WP6
	February 2019
Deliverable version:	N.A
Dissemination level:	Confidential
Author(s):	WP6 partners

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1 Platform overall assessment

This section is dedicated to the assessment of the OptEEmAL platform as a whole. Please select your answer by clicking/checking on the associated checkbox.

1.1 Overall

Based on the training performed today, do you consider that the OptEEmAL platform can provide a significant added value in the design of your retrofitting projects at district scale.

	0	1	2	3	4	5
Overall usefulness *"0" = Not useful / "5" = Very useful*	☐	☐	☐	☐	☐	☐
Please comment						

1.2 Integrated Project Delivery

	0	1	2
Where you aware of the IPD methodology? *"0" = Not at all / "2" = Yes*	☐	☐	☐
Is the way the IPD methodology implemented in the platform clear? *"0" = Not at all / "2" = Yes*	☐	☐	☐
Please comment			

1.3 Baseline Energy Systems

	0	1	2
How was the introduction of Baseline Energy Systems information? *"0" = Difficult / "2" = Easy*	☐	☐	☐
Please comment			

1.4 Energy Conservation Measures

	0	1	2
Was the list of ECMs representative of the technologies you are using in your project? *"0" = Not at all / "2" = Yes*	☐	☐	☐
Please comment			

1.5 Targets, Barriers and Prioritisation criteria

	0	1	2
Is the list of DPIs representing your concerns when designing retrofitting projects *"0" = Not at all / "2" = Yes*	☐	☐	☐
Is the way to select your prioritisation criteria clear? *"0" = Not at all / "2" = Yes*	☐	☐	☐
Please comment			

1.6 Optimisation

	0	1	2
Is the optimisation process clear to you? *"0" = Not at all / "2" = Yes*	☐	☐	☐
Is the results of the optimisation process (Pareto Front) clear to you? *"0" = Not at all / "2" = Yes*	☐	☐	☐
Is the overall result presentation interface clear to you? *"0" = Not at all / "2" = Yes*	☐	☐	☐

Please comment	

1.7 Outputs

	0	1	2
Are the outputs clear? *"0" = Not at all / "2" = Yes*	☐	☐	☐
Do you think they give all the information you need to move forward in your project? *"0" = Not at all / "2" = Yes*	☐	☐	☐
Please comment			

1.8 Please list 3 negative aspects about the OptEEmAL platform:

1.9 Please list 3 positive aspects about the OptEEmAL platform:

2 Graphical User Interfaces assessment

This section is dedicated to the assessment of the GUIs of the OptEEmAL platform. Please select your answer by clicking/checking on the associated checkbox.

2.1 Screen

	0	1	2	3	4	5
Reading characters on the screen *"0" = Hard / "5" = Easy*	☐	☐	☐	☐	☐	☐
Organisation of information *"0" = Confusing / "5" = Very clear*	☐	☐	☐	☐	☐	☐
Sequence of screens *"0" = Confusing / "5" = Very clear*	☐	☐	☐	☐	☐	☐

2.2 Terminology and system information

	0	1	2	3	4	5
Use of terms throughout the system *"0" = Inconsistent / "5" = Consistent*	☐	☐	☐	☐	☐	☐
Terminology related to task *"0" = Never / "5" = Always*	☐	☐	☐	☐	☐	☐
Position of messages on screen *"0" = Inconsistent / "5" = Consistent*	☐	☐	☐	☐	☐	☐
Computer informs about its progress *"0" = Never / "5" = Always*	☐	☐	☐	☐	☐	☐
Error messages *"0" = Unhelpful / "5" = Helpful*	☐	☐	☐	☐	☐	☐

2.3 Learning

	0	1	2	3	4	5
Performing tasks is straightforward	☐	☐	☐	☐	☐	☐

Please give this questionnaire to the event organisers or send it via email or postal mail to:	
Maxime Pousse Nobatek/INEF4 Esplanade des Arts et Métiers F-33400 TALENCE FRANCE	Maxime Pousse E-Mail: mpousse@nobatek.inef4.com

"0" = Never / "5" = Always						
Help messages on screen "0" = Unhelpful / "5" = Helpful	☐	☐	☐	☐	☐	☐
Supplemental reference materials "0" = Confusing / "5" = Clear	☐	☐	☐	☐	☐	☐

2.4 General

	0	1	2	3	4	5
Learning to operate the platform is easy for me *"0" = Improbable / "5" = Probable*	☐	☐	☐	☐	☐	☐
I find it easy to get the system to do what I want to do *"0" = Improbable / "5" = Probable*	☐	☐	☐	☐	☐	☐
My interaction with the system is clear and understandable *"0" = Improbable / "5" = Probable*	☐	☐	☐	☐	☐	☐
I find the system flexible to interact with *"0" = Improbable / "5" = Probable*	☐	☐	☐	☐	☐	☐
I find the system easy to use *"0" = Improbable / "5" = Probable*	☐	☐	☐	☐	☐	☐