D1. 5 Data acquisition protocol for the geometry and semantics within the onsite visit – Consolidated version -

EPC RECAST

ENERGY PERFORMANCE CERTIFICATE RECAST

Table of Contents

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Table of figures

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Table of tables

Abbreviations

BIM: Building Information Modeling
ER: Exploitable Result
GA: Grant Agreement
IP: Intellectual Property
Ker: Key actionable result
RES: Renewable energy source
RET: Renewable Energy Technology
SMEs: mall and medium-sized enterprises
TRL: Technology Maturity Level
WP: Work Package

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

PROJECT DURATION: 1 September 2020 – 30 June 2024

GRANT AGREEMENT NUMBER: 893118 (Action for Innovation)

WP: 1 DELIVERABLE: 1.5

LEAD BENEFICIARY: BIMEO

SUBMISSION DATE: 26/06/2024

DISSEMINATION LEVEL: PUBLIC

DUE DATE: M46

Website: http://epc-recast.eu/

REVISION HISTORY:

DATE	VERSION	AUTHOR/CONTRIBUTOR[1]	REVISION BY[2]	FEEDBACK
22/06/2024	Final	Eric LEROGNON (BIMEO)	Dominique CACCAVELLI (CSTB)	Submitted version

Thanks:

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

[1] Name NAME, ORGANIZATION

[2] Name NAME, ORGANIZATION

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

1. Executive Summary

D1.5 (Data acquisition protocol for the geometry and semantics within the onsite visit - Consolidated) is part of Work Package 1 (Methodology and protocol definition), specifically Task 1.2 (Capturing the building geometry and semantics). This task aims at defining the data acquisition technique as part of an EPC visit.

This task connects image capture and processing technologies, combined with semantic enrichment, in order to fulfill an appropriate DM – Data Model (see T1.1) in the context of EPC.

In this deliverable we provide a process for acquiring the DM using innovative 3D and AR (Augmented Reality) technology to capture volumes and plans and enrich the data with pictorial (photo) and structured (Technical) information at individual housing scale. The process of 3D scanning by drone is also introduced to provide geometric and thermographic information at building scale.According to the grant agreement, we can identify two separate actions to be carried out as part of this task:

- Provide a tool for capturing geometric data
- Enrich the metric acquisition with additional information provided by the auditor during his visit. This information will make it possible to qualify information from other generics (air quality, temperature level recorded ...) or descriptive information (semantic information to objects, state, performance ...)

There are 2 types of information captured by the BIMEO process:

- Geometric data: information captured by shape recognition integrated into the application. This data is built according to a geometric algorithm based on the definition of a part. The data will be delivered according to ifc formats (2x3 or 4).
- Descriptive information: Information entered by the operator following his observation either directly or by a specific instrumentation. The data will be transmitted according to a CSV format to be built.

This deliverable is also connected with task 2.2 (EPC RECAST real world data input layer: historical data and site visits inputs).

This task aims to adapt, develop and integrate the modules related to information acquisition and on-site data processing into the toolbox, resulting in the outer layer of the EPC RECAST certification that connects the physical environment to the virtual models. As part of this task, static and dynamic data related to the building and its use will be acquired. The static data extraction tool will build an IFC model for building geometry semi-automatically using AR2BUILD (TC1) technology, with little user action required. IR drone scanning (TC2) technology will also be integrated as an additional feature for projects in which information about the building envelope of the entire building needs to be taken into account. The generated geometric plan of the building (including window and door detection) will be complemented by a checklist to add information first at room-by-room level and then at the building level. Geometric models will be made compatible with energy simulation tools using the IFC-2-IDF (TC7) conversion tool.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

2. Introduction

The project EPC RECAST is placed in the context of EU 20-20-20 climate targets by advancing the state of the arts in energy retrofit for buildings. It is focused on supporting the emergence of the next generation of regulatory Energy Performance Certificate (EPC), introduced at European level since 2002 within the Energy Performance of Buildings Directive (EPBD). This is supposed to be a relevant instrument for a series of operations in the building sector (e.g., structuring for the assessment of buildings energy performance; supporting the decision-making on energy retrofit projects; development and articulation of financing instruments, etc.) but it is currently facing several challenges calling for its improvement.

The EPC RECAST project aims to set a well-structured process and a toolbox, deliberately tailored to existing residential buildings for which retrofit is a pressing issue. The approach is to:

- increase the EPC reliability between predicted and actual results by including the latest digital technology components, in line with the emerging International and European standards;
- ease the comparability in between building assets, thanks to consistent results;
- make the certification more owner and occupant-centric, providing clear information for end-users, as well as contributing to European benchmark and public policies analysis;
- contribute to trigger up to 136,527 MEUR deep renovation investment per year (equal to 67,764 GWh/year of primary energy savings triggered) and 195,181 MtCO2-eq/year reduction of GHG emissions in the period 2030-2050 in Europe.

The vision for exploitation at the project level consists of two types. The first are methods, tools and technologies that can be implemented in the field by professionals and organizations in the near term. The second are recommendations to policy to be considered in the revision process for EPC guidelines at the EU and national levels in the medium to long term.

Methodology

Based on existing tools under development and using 3D/AR technology, we propose to enrich the process with the information described in Task T1.1. The information thus structured will be made available to the various stakeholders and in particular to WP2 Task 2.2 and compiled with other input data such as InfraRed acquisition by Drone.

In this deliverable, we present the methodology used to achieve the objectives presented in the previous chapter. We will first explain the relationship between the work done in task 1.1 on the data model and task 1.3. Then, for each action identified in the grant agreement, we describe more precisely what each of them includes. Next, we will describe how contributions were collected from partners.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

3. Acquisition of EPC technical data with BIMEO technology

3.1 Presentation of BIMEO, its market and its products

BIMEO is a French startup that has been part of the support of the digital transition plan for the building. In 2017 BIMEO created a collaborative platform to open a workspace to BIM users. The functions of this platform are multiple:

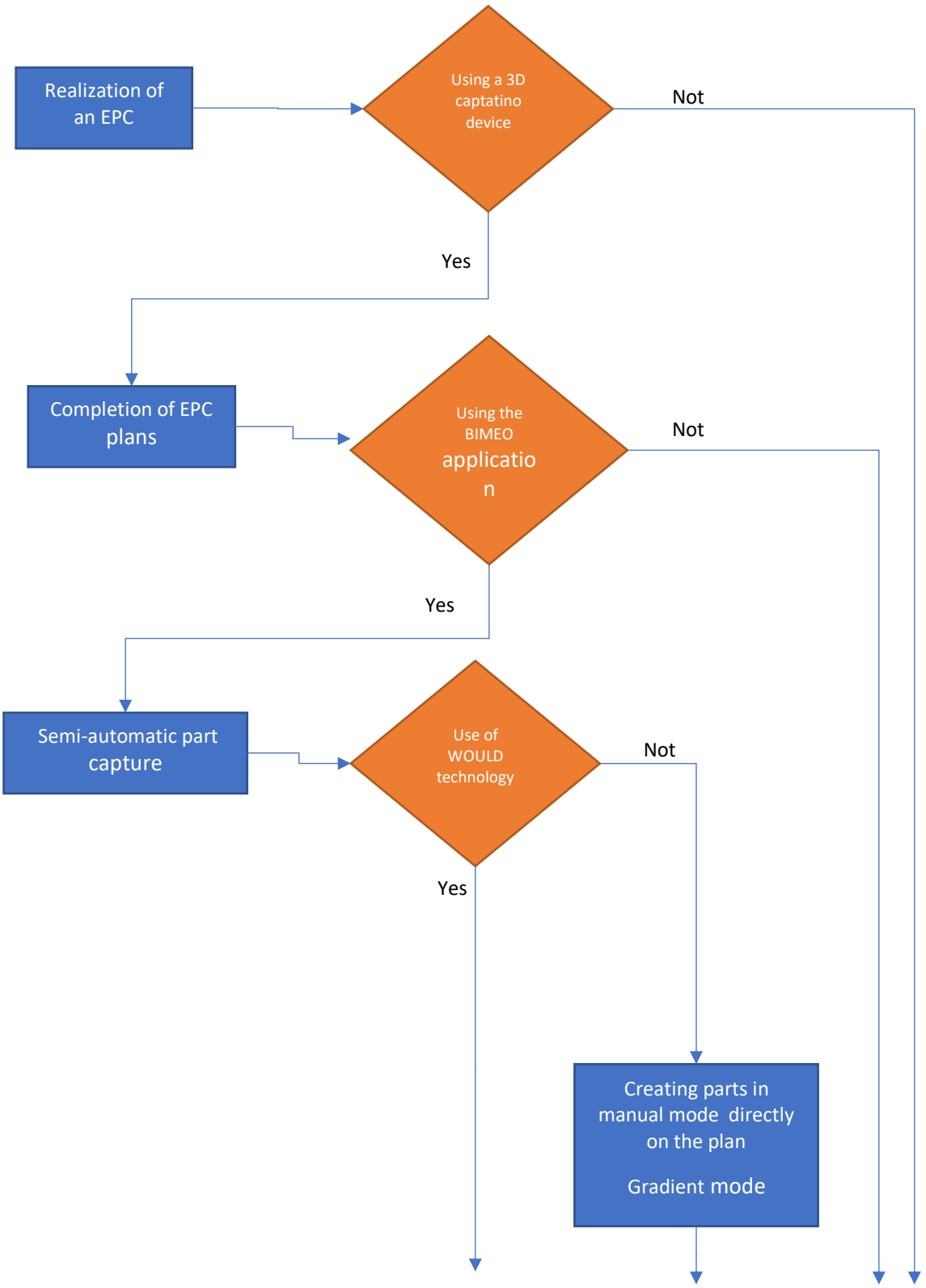
- Electronic Documentation Management (EDM)
- BIM Viewer
- VISA Process (Document Validation)
- Chat
- Mail
- History of all movements

3.2 Management of the BIM agreement

In 2018, noting that BIM would be complex to apply to existing buildings, due to the absence of a BIM model, BIMEO initiated a new program. It's a tool that uses AR (Augmented reality) technology to carry out the construction of plans. In an application format that can be loaded on mobile media, BIMEO offers several tools to capture and build the plans of a room, a floor and a building. See decision chain below.

The EPC decision chain for the user is described in the following synoptic:

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.



This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

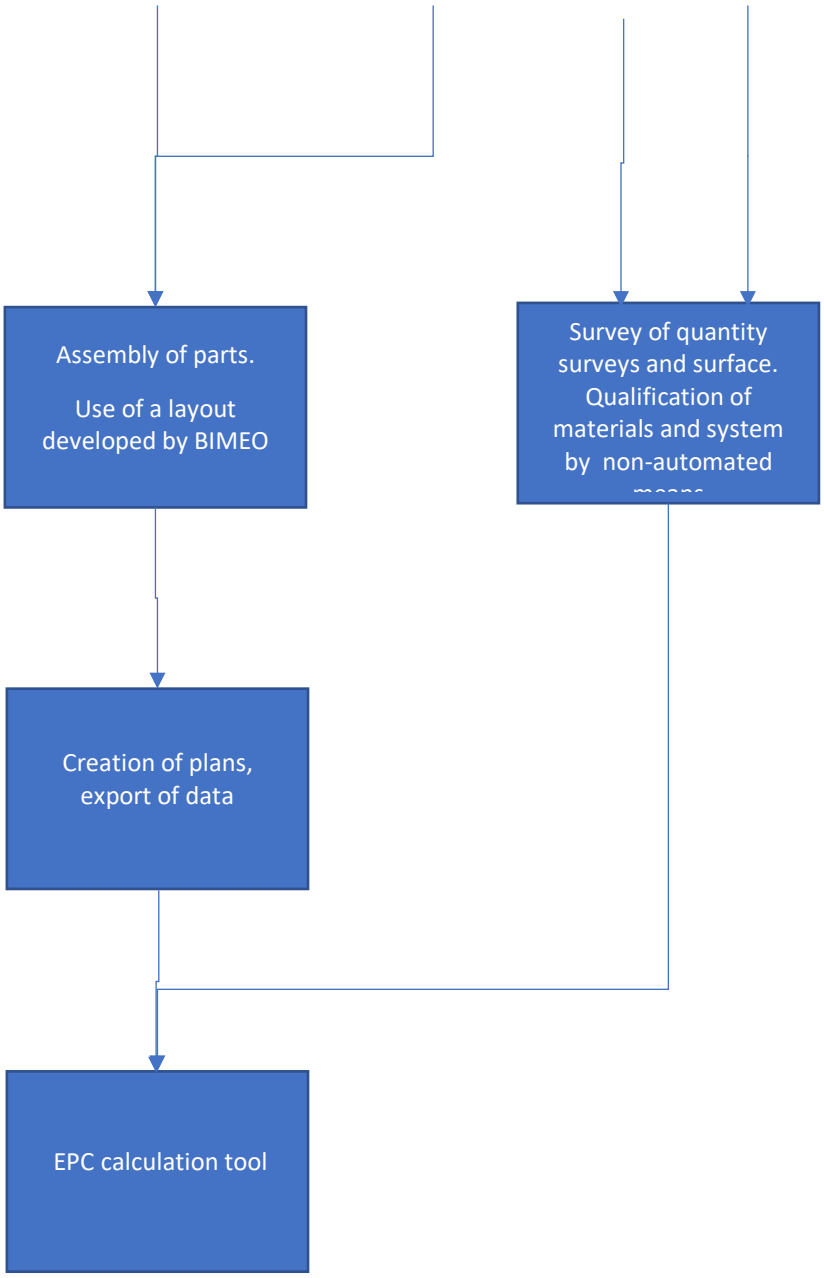


Figure 1: Decision chain to use BIMEO for EPC

BIMEO is aimed at all professionals who use the plan as input data in their process (Energy assessor, Company, Expert, Architect, Design Office ...)

BIMEO exports plans on a dozen different formats (XLS, CSV, DXF, IFC, BCF, JPG, PDF SVG, DOC ...). The plan thus initiated feeds the data of the programs to measure, quantify, simulate or project different data useful to the professional. To date, BIMEO is available on the iOS/IpadPro environment. This equipment is currently the only support for a Lidar sensor that allows the exploitation of AR in the

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

capture process. It is important to note that BIMEO is currently working on a degraded process (without sensor) for the android environment.

As part of the EPC Recast program and in accordance with the consortium, the BIMEO process will make improvements to the following features:

- ✓ Generic objects

  The plans consist of data and information related to thermal (walls, openings ..). The BIMEO application will extend its scope to the addition of so-called "generic" objects to qualify technical equipment related to heating, ventilation or equipment. This is especially useful for boiler equipment, radiators or ventilation system. Beyond the addition of a simplified form, the object may be assigned a series of information and annotations allowing the auditor to fill in at least the technical information.

- ✓ Adding "flag" function

  This function makes it possible to bring specific information to a place in the plan to describe and qualify data observed by the auditor. In particular, it is a question of giving the energy assessor the opportunity to make a comment or an alert on a specific element (pathology, risk or disorder). This function can also be used to note the installation of a measurement sensor or reading probe.

  - "Paint" function

  In the BIMEO process, user can take photos to materialize technical elements. The "Paint" function allows you to comment or annotate the photo directly to complete the technical detail.

3.3 Link to Task 1.1

Like all contributions from task1, the capture of geometric information is closely related to the data model developed in Task 1.1. Indeed, the data model makes it possible to describe the building under consideration by listing the data collected by the energy assessor, with the perspective to have a harmonized European data model.

3.4 Description of actions

As mentioned in the grant agreement and earlier in this document, Task 1. 2 is focusing on two actions that we are described below.

When visiting a dwelling to carry out an EPC, the energy assessor must carry out 2 tasks:

Geometric survey that is used to calculate heat loss for the dwelling. Although the dwelling consists of a set of objects (walls, wall, floor, window ...), not all are taken into account in the calculation of

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

loss. Indeed, only the so-called "wasteful" elements are taken into account in the simulation. We will come back to this important point later.

Descriptive statement based on the collection of information carried out by the energy assessor. This information is visual. He/she can use measuring instruments, but no connection is provided in this task to automatically go up in the application. The enrichment of the information will be completely dependent on the manual entry carried out by the energy assessor.

Geometric survey

Regarding the geometric survey we propose an acquisition solution by use of AR / 3D technologies (Augmented Reality) in which the user will be able to choose the level of technicality according to the equipment used and its technological appropriation. The purpose of this action will be to offer the energy assessor a digital and digital acquisition solution to allow him to structure the geometric data.

As described in the consortium, BIMEO contributes through 2 levels of involvement.

The first is to put its expertise and tools on the theme of the acquisition of technical data, and particularly the realization of building plans by making available its application called BIMEO. We will come back in the rest of this folder on the functionality and description of this application.

Descriptive statement

The descriptive or semantic survey is based on 2 levels of information.

The first so-called generic is part of the BIMEO capture process. It translates the usual data used at least. These are fields integrated into the BIMEO application accessible by all users of the BIMEO application. Each object is enriched with 4 to 5 fields by default. We generally find:

- The description type (free text format)
- The state of the object. This list field returns 4 possible choices (New, Good, Medium or Bad)
- The performance of the object (free text format)
- The lifetime of the object. This field specifies the duration of use while maintaining optimal performance. In other words, it characterizes the time remaining before considering its replacement. This field is of the "List" type with 5 possible choices (<1 year, 5 years, 10 years, 15 years, >20 years).

The second semantic survey makes it possible to provide much more precise characteristics. It is the subject of a specific action specified in the consortium. It is a question of allocating to each object a specific questionnaire to enrich the description of the object. This questionnaire will be structured on a CSV format to be used and exported in the EPC Recast process. Of course, this task is in complete interaction with the T1.1 and T1.3 task.

To illustrate the type of information present in the process, we can take as an example the joinery (windows) which have many parameters influencing to qualify their performance. The questionnaire may include the following information:

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

WINDOW geometry	frame_perimeter	perimeter of the frame of the window
	window_tilt_angle	tilt angle of the window (horizontal,vertical etc..)
	orientation	orientation of the window in °
	adjacency	adjacency of the window (contact with outdoor/ other rooms / non heated rooms etc..)
	window_total_surface	total surface of the window including glazing and frame.
	glazing_surface	surface of the glazing
	frame_surface	surface of the frame
WINDOW technical characteristics	glazing_type	glazing type : simple, double or triple glazing
	filling_gas_type	type of filling gas for double or triple glazing window
	gas_space_thickness	length of gas space between glazing
	glass_coating	is there a Low-E glass coating on the window
	frame_material	material of the frame : wood, plastic , metal etc..
	frame_thickness	thickness of the nonmoving part of the frame
	window_type	what is the type of window, French window, simple window
	window_position	window position relative to wall. Inside, outside or tunnel window
	joined_insulation_window_wall	is there a junction of isolation between the wall and the window.
	technical_reference	recent technical product reference of the window with all its technical data such as U value and solar factors.

Table 1 : Information used to describe a window

The technical characteristics of the window should be part of the questionnaire associated with window objects.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

3.5 Collection of contributions

The data model developed in Task 1.1 uses a description by components, separating the building envelope, ventilation and heating/cooling systems. An Excel sheet has been developed containing, for each component, all the data entered in this file will be used in the steps describes further into this document with the questionnaires.

In task 1.2 this logic of description of the building was taken up to structure the data in the BIMEO collection tool.

The building data is broken down according to the detailed items:

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

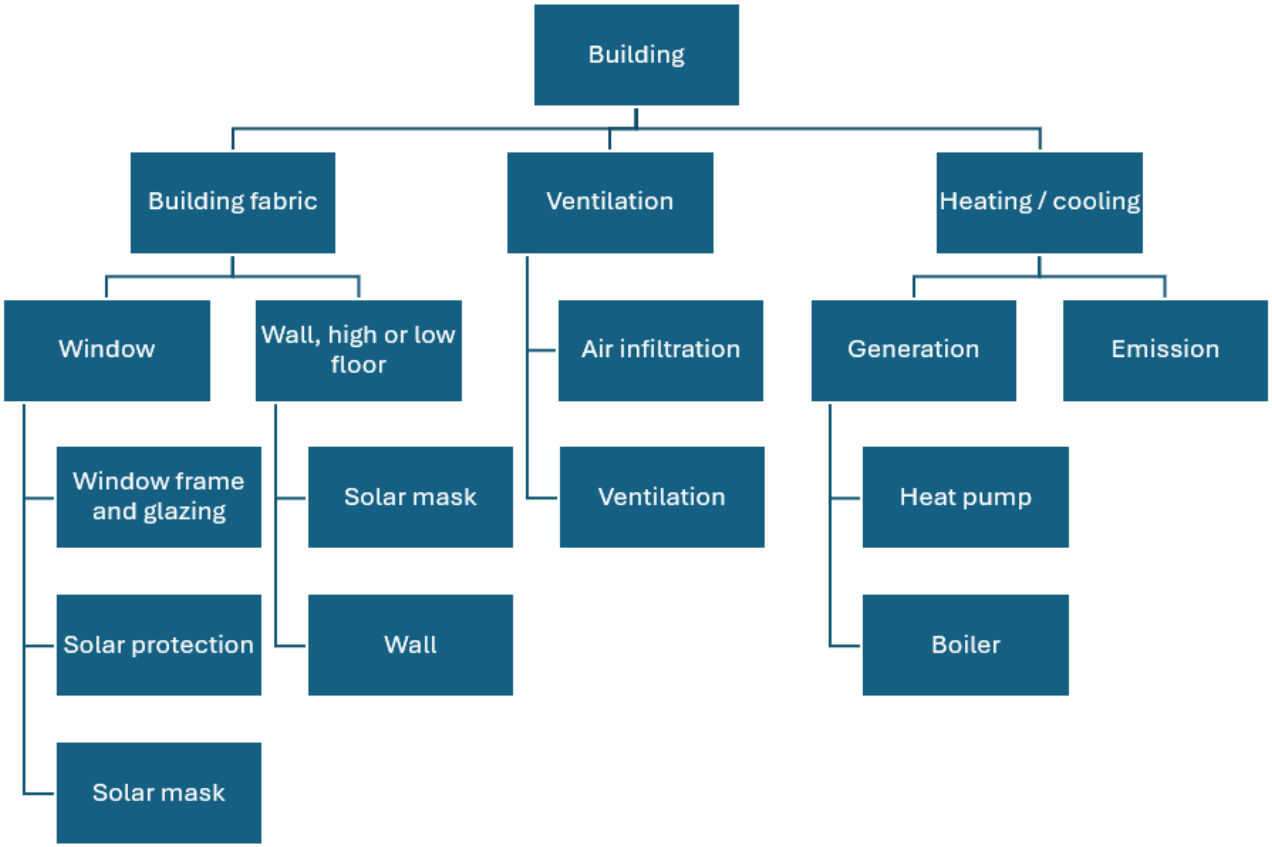


Figure 2 : Decomposition of the information describing the building

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Information such as "Solar mask" mainly concerns the external environment of the building. The BIMEO application only concerns the interior environment of the building. Information using external information will not be taken into account in the development of the new functions.

Each of the objects structuring the "model_data" has been the subject of work in task 1.1. We specify here what will be used as input data to build the questionnaires (see Annex - 1)

From this exhaustive data, we will validate with the Task 1.1 team the data to be integrated into the questionnaire.

For each of the data, we qualify the ability to integrate it into the BIMEO collection tool according to 4 choices:

- ✓ NO => Unable to integrate
- ✓ Extract => Data extracted using a method of calculating the information already generated
- ✓ Quantity => Data deduced from a calculation from the geometric construction
- ✓ Semantic => Data present in specific questionnaire.

Attached is the data table filled in these fields: *See Annex - 2*

4. Geometric construction of the dwelling with BIMEO technology

4.1 Standard IFC

In this chapter we will explain the geometric construction of dwellings.

The structure of a project meets the IFC (BIM) standards according to a defined tree structure:

Cf : Site Building Smart France : https://bimstandards.fr/travailler-avec-les-ifc/organisation-spatiale/

```
IfcProject                (Projet)
  > IfcSite               (Site)
    > IfcBuilding         (Bâtiment)
      > IfcBuildingStorey  (Niveau)
        > IfcProduct       (Produit, Equipement)
        > IfcSpace         (Local)
          > IfcProduct     (Produit, Equipement)
```

Figure 3 : Structuring a project by the IFC format

All objects, products or equipment are structured in this tree.

The relational system is one of the foundations of the IFC; objects are linked together by the IfcRelContainedInSpatialStructure class. For example, a window is attached to a wall, and that same wall depends on a floor. These relationships are usually managed automatically by business software.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

An IFC file must contain only one building. To manage several buildings belonging to the same site, it is necessary to create as many native files as buildings by assigning them the same project name (IfcProject) and site name (IfcSite).

IfcProduct elements can be contained in a level (IfcBuildingStorey) or in a local (IfcSpace), which is itself contained in a level.

Project

The IfcProject class is the highest level in the tree structure of an IFC file.

All files in a project must have the same GUID and Name attribute under the IfcProject class. It is recommended to use the GUID of the architect's file. If the business software does not preserve the GUID, we can be satisfied with the Name attribute.

Site

The IfcSite class defines the land on which one or more buildings can be placed (IfcBuilding). Only one IfcSite object can be contained in the project (IfcProject).

The land name is indicated in the IfcSite.Name attribute, and the cadastral parcel number in the IfcSite.LandTitleNumber field.

As with the IfcProject, the IfcSite object must have the same GUID and Name in all IFC files.

This class defines in particular the georeferencing of the project.

Building

The IfcBuilding class includes all the objects that make up the building.

A building number can be specified in the Pset_BuildingCommon.BuildingID field, while the building name is included in the IfcBuilding.Name field.

Levels

The levels, defined by the IfcBuildingStorey class, must respect the spatial logic of the building, including mezzanines or half-levels.

It is not recommended to use fictitious levels to adjust the heights of certain elements simultaneously. Any fictitious level of drawing aid (e.g. ground plan) must be excluded from IFC export.

Level coding is established by 2-character codes in the IfcBuildingStorey.Name field + a more complete description of the level in the IfcBuildingStorey.LongName field.

`IfcBuildingStorey.Name`	`IfcBuildingStorey.LongName`	
00	**Ground floor**	Corresponds to the level of access to the building from the public space
01, 02, 03, ...	**Floors**	Elevation levels above the ground
S1, S2, S3, ...	**Basement**	Buried levels
TT	**Roof**	Above the top floor level

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Table 2: IFC Floor Naming Standard

It is also possible to specify the entry level in the building with the attribute Pset_BuildingStoreyCommon.EntranceLevel=TRUE on the relevant level. You can also set the levels above ground with the attribute Pset_BuildingStoreyCommon.AboveGround=TRUE.

Premises

Each room is represented by an IfcSpace object corresponding to the spatial boundaries of that part, in all three dimensions.

The code (number) of the room is inserted in the IfcSpace.Name field, while its name (ex: room, office) is entered in the IfcSpace.LongName field. The code is generally based on a nomenclature specific to the contracting authority, for example in the form "SITE_BATIMENT_ETAGE_NUMERO-PIECE".

Example of a room nomenclature

`IfcSpace.Name`	`IfcSpace.LongName`	Comment
CE_A_00_001	**Entrance hall**	Local "Entrance Hall" n°001 located on the ground floor of Building A, on the site "Campus Erdre" (CE)
CE_A_00_012	**Bureau**	Local "Office" n°012 located on the ground floor of building A, on the site "Campus Erdre" (CE)
CE_A_01_027	**Household**	"Household" room n°027 located on level 1 of building A, on the site "Campus Erdre" (CE)
CL_D_03_005	**Meeting room**	Local "Meeting room" n°005 located on level 3 of building D, on the site "Campus Loire" (CL)

Table 3: Listing name in the IFC

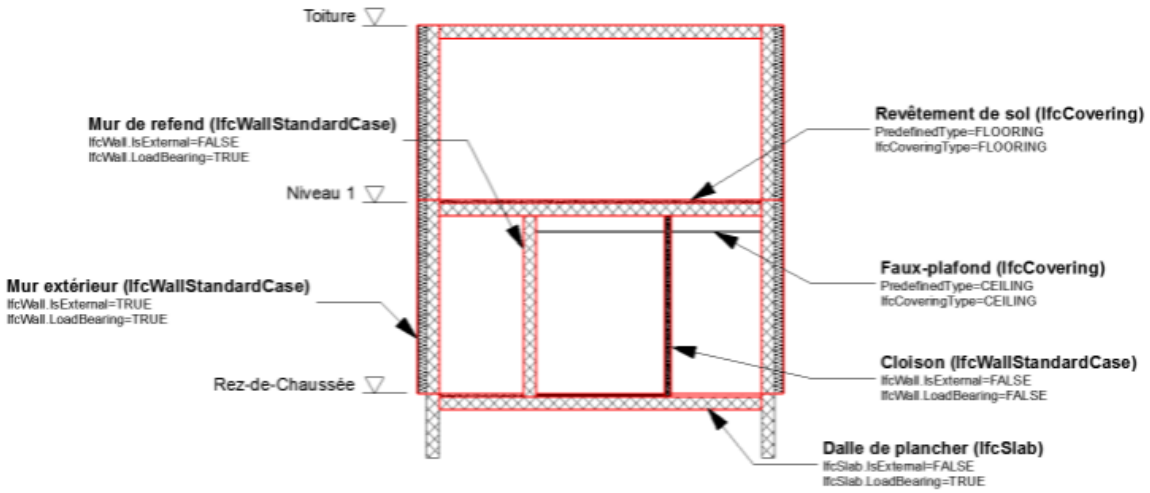
It is possible to define relationships between several rooms using the IfcZone class (e.g. thermal zones, fire overlap zones, functional zones, acoustics, or several rooms belonging to the same dwelling). The same room can belong to several zones.

Modeling method

Points of vigilance:

- Each object is assigned to a floor
- The walls are intersected between two levels
- When in doubt, model as you build.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.



44: IFC Object Modeling Method

4.2 Geometric construction BIMEO

Spatial capture technique

The BIMEO application uses a capture tool integrated into an iPad brand tablet. The capture is done by means of an integrated sensor based on LIDAR technology.

In general, the operation of lidar resembles that of radar (based on echolocation).

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

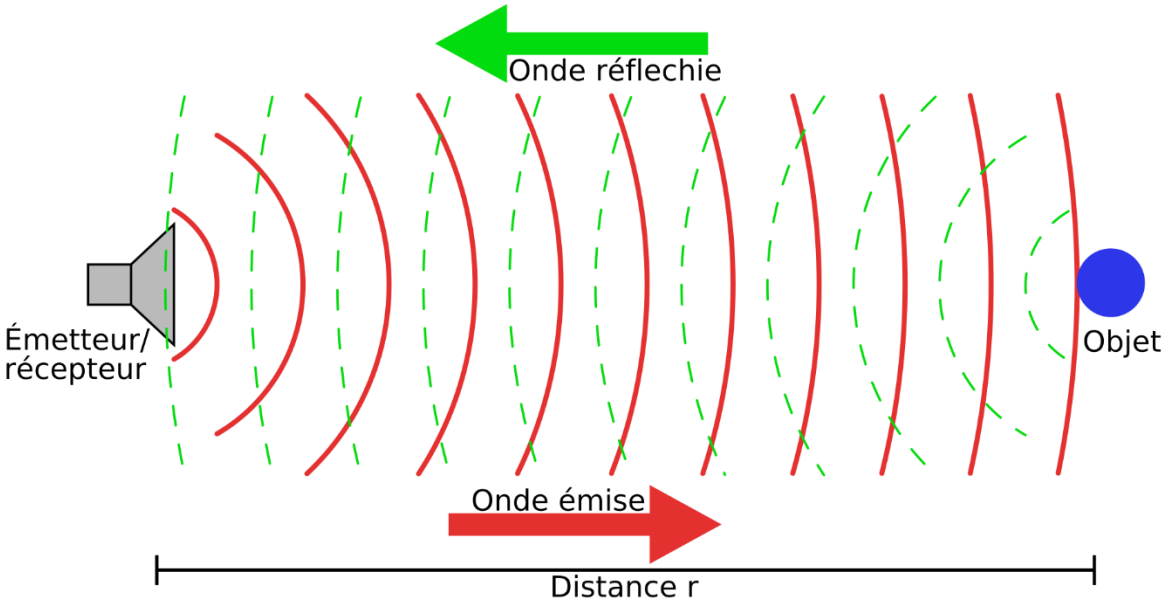


Figure 5 : How a LIDAR Works

A lidar is an optoelectronic system consisting of a laser transmitter, a receiver comprising a light collector (telescope or other optics) and a photodetector that transforms light into an electrical signal, as well as an electronic signal processing chain that extracts the information sought.

Geometric translation by Lidar technology

The BIMEO application uses lidar to detect the flat surfaces of a wall. The part thus consists of a series of surface walls qualified by a flat area the size of an A4 sheet. The geometry of the part is directly modeled on the geometry of the box thus built.

A room will be systematically donated a closed volume.

The construction of this room will be done in a very precise order:

Step 1: Capture the floor

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

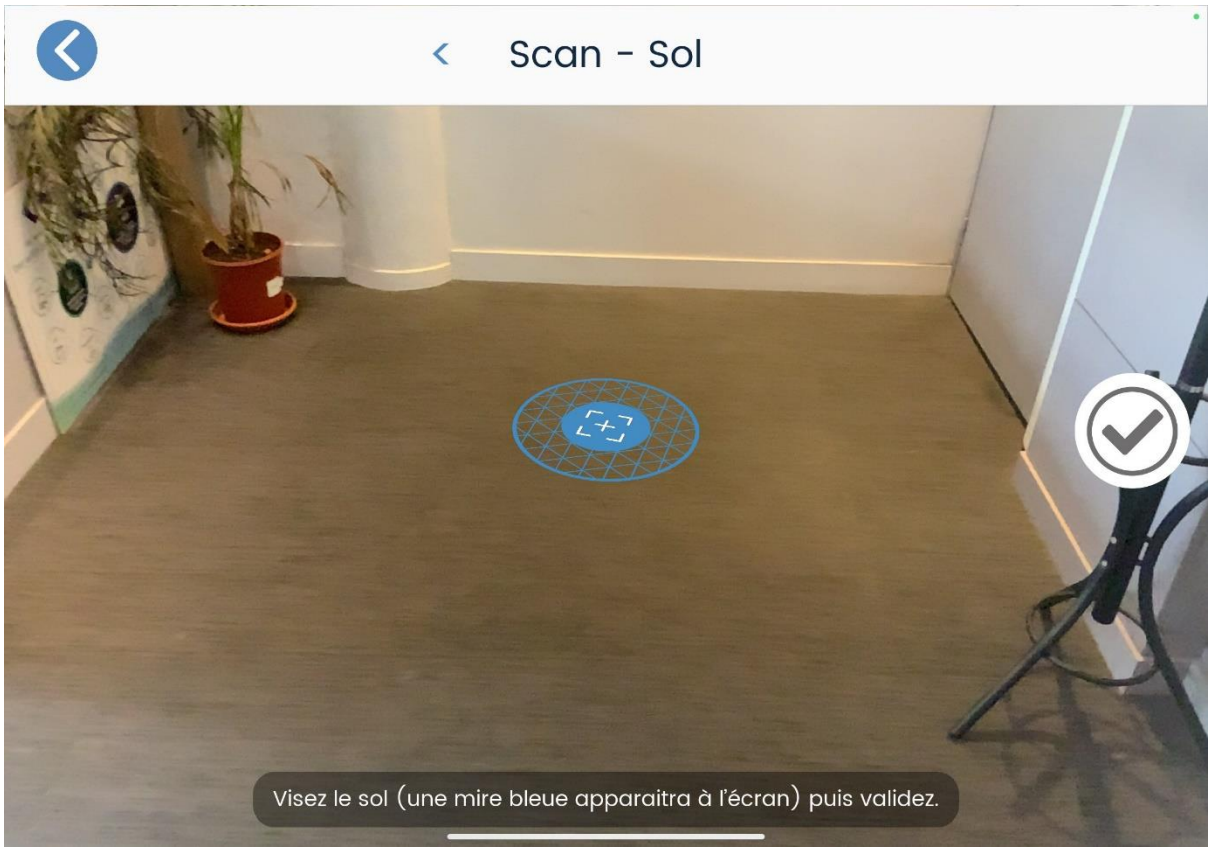


Figure 6 : Step 1 - Capture the ground

Step 2: Capture the ceiling or manually enter the ceiling height value

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

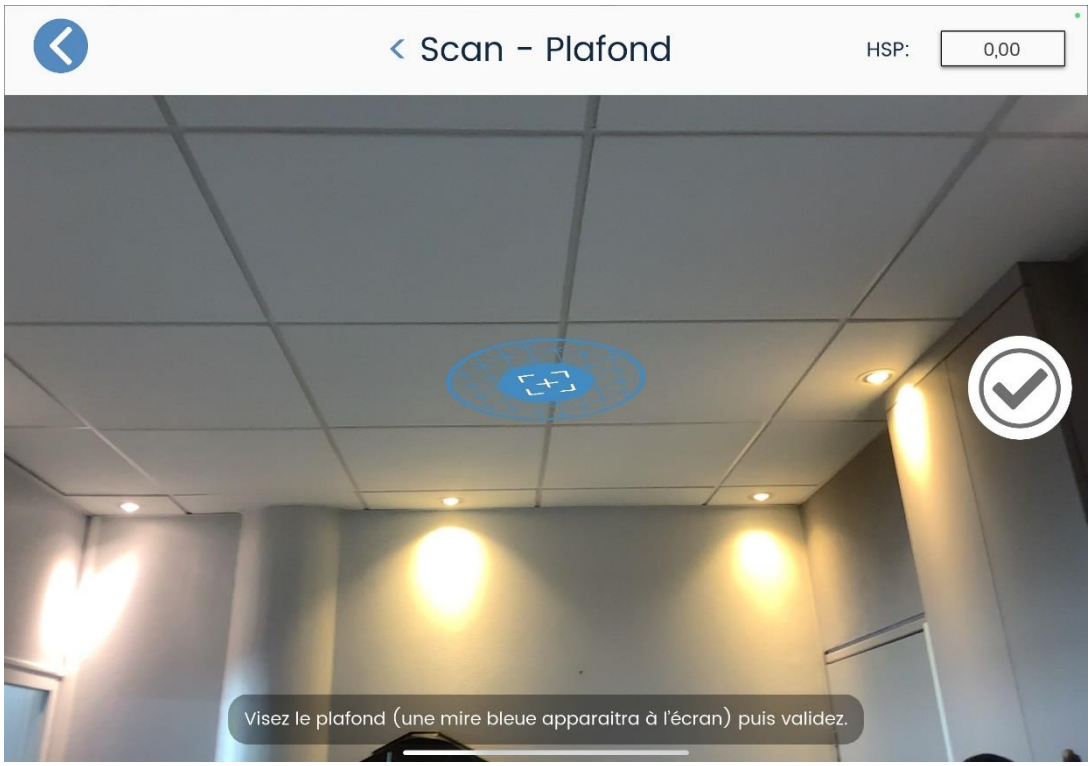


Figure 7 : Step 2 - Capture the ceiling

Step 3: Capture the different walls (at least 3) clockwise (from left to right).

Figure 8 : Step 3 capture the walls

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

It is during this stage that the inclined ceilings of the "creeping" type are built in the geometry.

The piece is built by extending all the faces until creating the stops at the junction of the planes.

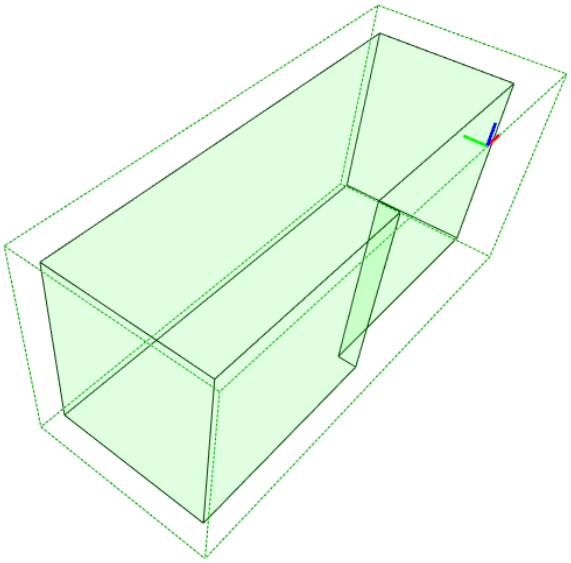


Figure 9: Example of a room representation

From this volume, all geometric data is calculated and stored in the application (Volume, area and perimeter).

In the rest of the acquisition process, objects such as windows or doors are integrated into the walls. There is currently only one opening shape (Rectangular) in BIMEO. The carpentry will be built by the construction of a diagonal:

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

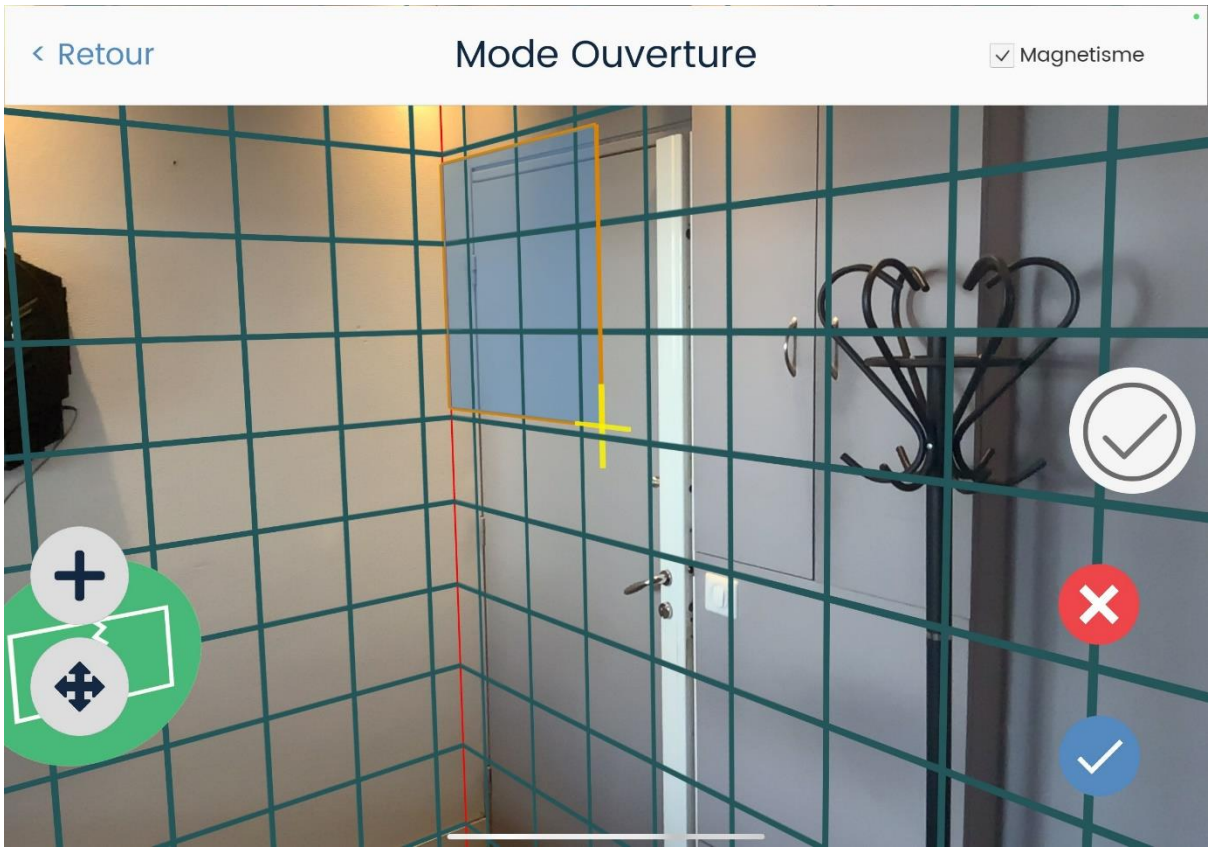


Figure 10 : Capture a window

All dimensions (volume, area, perimeters) are calculated by the application and each object created has all of this data in its properties.

Once validated, the part is created in 3D to be integrated into the plan

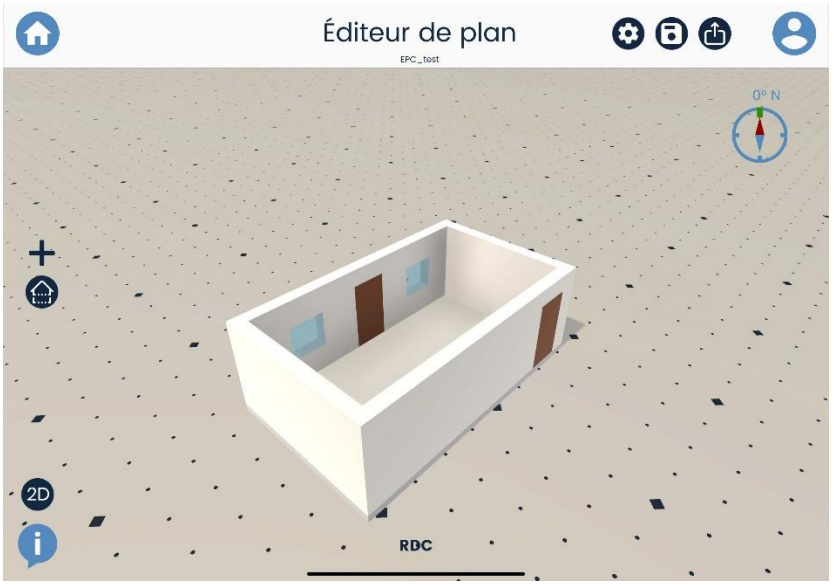


Figure 11 : 3D Mode of the room

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Manual geometric translation without Lidar

The BIMEO app also offers a creation function without using the automatic detection process using Lidar. This mode called "Sketch" allows you to create a part directly on the screen of the application.

In the "create a room" function, simply select the "Sketch mode" option *See Annex - 3*

- In this mode, the user positions the points on a plane using grid magnetism or perpendicularity options.
- To validate the volume of the room the user enters the name of the room and the Ceiling Height (HSP)
- The part can then be modified either by changing the value of the angles,
- Either by changing the length of a wall
- Once these steps are validated the part is created and perhaps enriched with creeping and opening.
- Once completed, the part is built in its 3D geometry

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Construction of plans

Each created part is stored in a library for use on a plan editor called "Layout"

From a 2D plan manager, the pieces are assembled with each other like building a puzzle. Using "magnetism" options AR2toBuild assembles the rooms with each other to build an overall plan of the building.

The wall thicknesses are set to automatically construct the plans.

There are 2 types of walls (wall and partition). When 2 rooms are next to each other, the wall separating the rooms is a partition. If a wall in one room is not in contact with another room, the plan builds a wall (exterior). The thickness of each wall can be built indifferently, and the value can be changed before laying a room.

The pieces come together by creating the different ones.

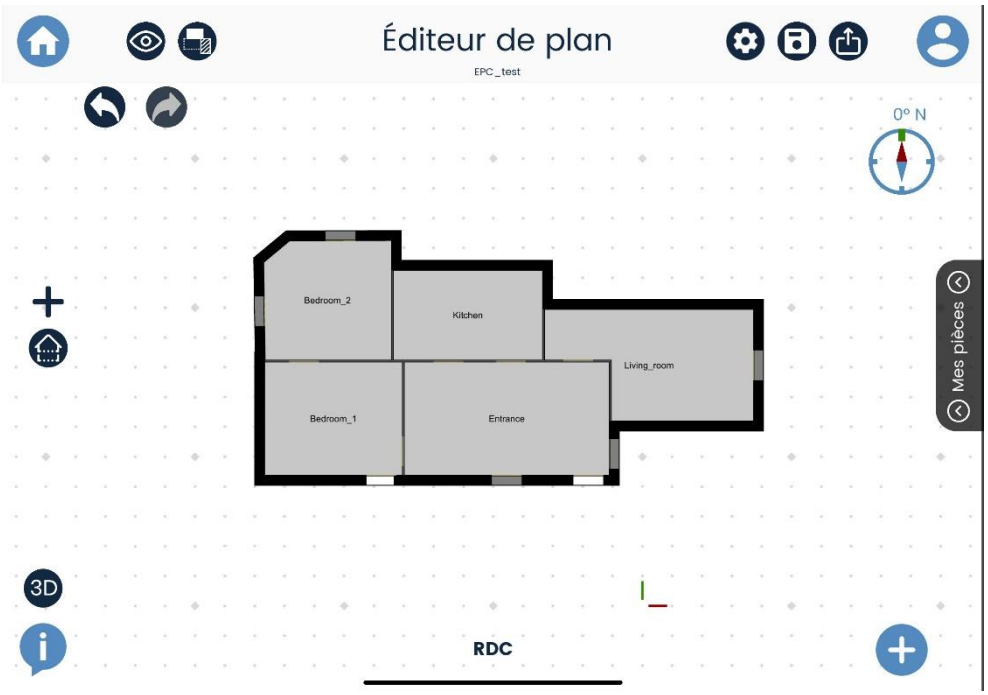


Figure 12 : Layout Mode - Assembling Parts

The Zone function allows you to group a certain number of rooms into a "zone". This function can be useful for delimiting common areas of a building or apartments.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

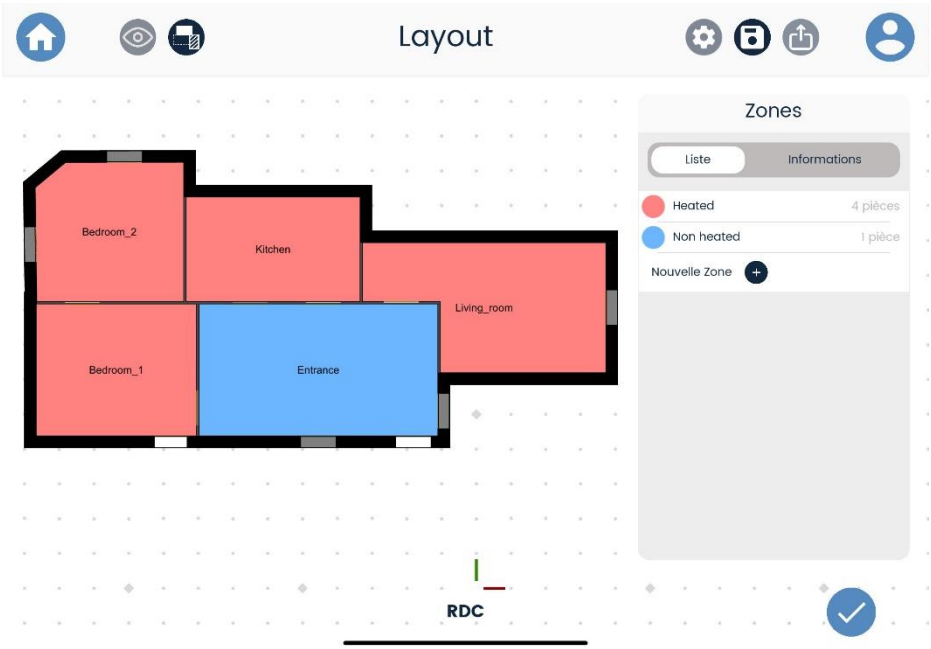


Figure 13 : Layout View - Creating Zones

Once built the plan is exportable with all the calculated metric data. This information is found in the IFC file data

The metric data for the parts is as follows:

IFCSpace

Nom	Valeur	Unit
Element Specific		
CompositionType	ELEMENT	
Guid	2_cNHL$6rFvfChrVGPiUmP	
IfcEntity	IfcSpace	
LongName	Salle	
Name	1	
Profile		
ProfileName		
AR2BuildQuantitatifs		
Hauteur sous dalle (mm)	2 415,925049	
Périmètre brut (mm)	19 436,421875	
Surface au sol (m2)	19,360798	
Surface au sol à 1.80m (m2)	19,360798	

Figure 14: Geometriotic properties of IFCSpace

IFCWall

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Nom	Valeur
Element Specific	
Guid	1FGHljc$r6FunZAw2l2X7k
IfcEntity	IfcWall
Name	Mur Extérieur
Profile	
ProfileName	
ARtoBuildQuantitatifs	
Azimut au nord (°)	90
Epaisseur (mm)	350
Exposition cardinale	E
Hauteur (mm)	2 699,999756
Longueur (mm)	4 178,587891
Surface brute (m2)	13,172186
Surface des ouvertures (m2)	1,768022
Surface nette (m2)	11,282186
Volume (m3)	4,275248

Figure 15: Geometriotic properties of IFCWall

IFCWindows

Nom	Valeur	Unit
Element Specific		
Guid	0VOtcV45b7Mg32t1J1PVbZ	
IfcEntity	IfcWindow	
Name	Vitrage simple	
OverallHeight	1 415,921082	mm
OverallWidth	1 248,672974	mm
Profile		
ProfileName		
ARtoBuildQuantitatifs		
Hauteur (mm)	1 415,921082	
Largeur (mm)	1 248,672974	

Figure 16: Geometrioue properties of IFCWindows

IFCDoor

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Nom	Valeur	Unit
Element Specific		
Guid	2jLQBXpQn5nPCsyuAVSfE5	
IfcEntity	IfcDoor	
Name	Porte simple	
OverallHeight	2 196,66748	mm
OverallWidth	2 332,29248	mm
Profile		
ProfileName		
ARtoBuildQuantitatifs		
Hauteur (mm)	2 196,66748	
Largeur (mm)	2 332,29248	

Figure 17: Geometriotic properties of IFCDoor

IFCRoof

Element Specific	
Guid	02MQF1zvTE$9UKgFctsNvt
IfcEntity	IfcRoof
Name	Toit
PredefinedType	FLAT_ROOF
ARtoBuildQuantitatifs	
Epaisseur (mm)	194,892334
Périmètre (mm)	26 315,207669
Surface brute (m2)	31,345289
Surface nette (m2)	31,350687
Volume (m3)	6,109483

Figure 18 : Geometriotic properties of IFCRoof

During the geometric construction of parts and objects, the metric data is enriched according to the typology of the objects.

The metric data is therefore directly integrated into the IFC format. BIMEO generates IFC according to the 2 formats IFC2x3 and IFC4.

BIMEO also offers to transcribe this geometric data on an XLS or CSV format. This file is generated by the operator directly from a menu in the application.

The export of these files covers the following families:

Floors	Name
	Floor area
	Surface habitable
	Perimeter
	Elevation

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

	Number of rooms
	Number of exterior walls
	Number of partitions
	Number of openings
	Number of generic objects
Zone	Name
	Description
	Number of rooms
	Floor area
	Surface habitable
Coins	Name
	Floor area
	Surface habitable
	Perimeter
	Number of walls
	Number of openings
	Number of generic objects
Walls	Floor
	Exhibit 1
	Exhibit 2 (if adjacent to a room = name of the room, otherwise "Exterior")
	Thickness
	Length
	Gross inland area
	Clean interior surface
	Gross exterior area
	Net exterior surface
	Exhibition (according to the 8 cardinal points)
	Name
	Comment
	State
	Performance
Opening	Floor
	Room
	Type (window / Door)
	Surface
	Length
	Width
	Exhibition (according to the 8 cardinal points)
	Name
	Comment
	State
	Performance
Generic objects	Floor
	Room

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

	Length
	Width
	Height
	Volume
	Air
	Name (class)
	Comment
	State
	Performance

4.3 Overview of the acquisition process for EPC

In the following graph is explained the process of data acquisition by BIMEO for the EPC Reacst program.

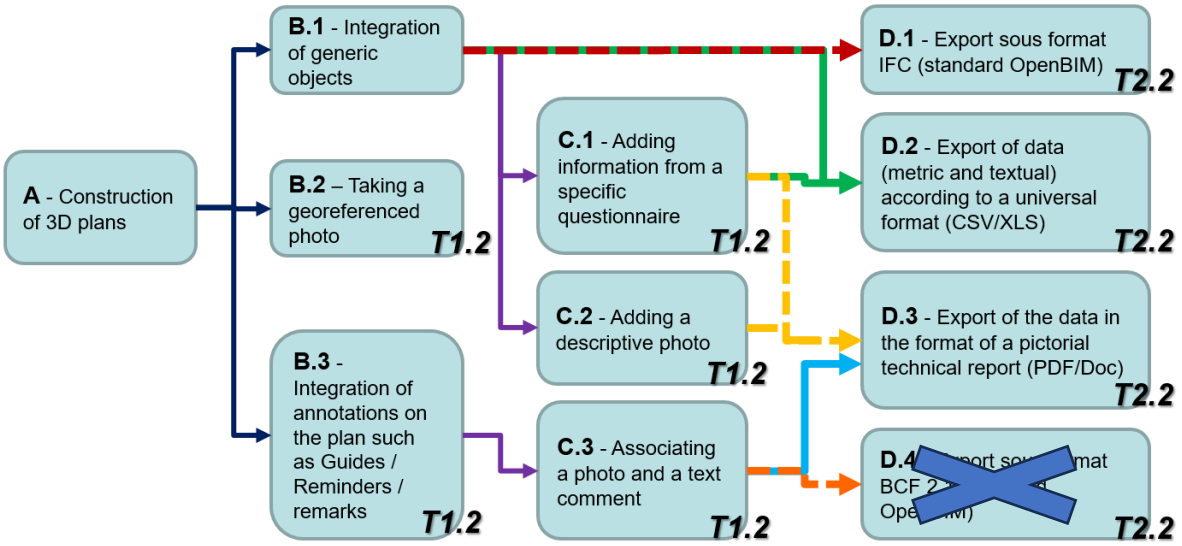


Figure 19 : Acquisition Process for BIMEO

The T1.2 task is closely related to stain T2.2. In this Task T1.2 we focus on building how BIMEO collects geometric and semantic information.

The T2.2 task translates this amount of information to make it available in a specific format.

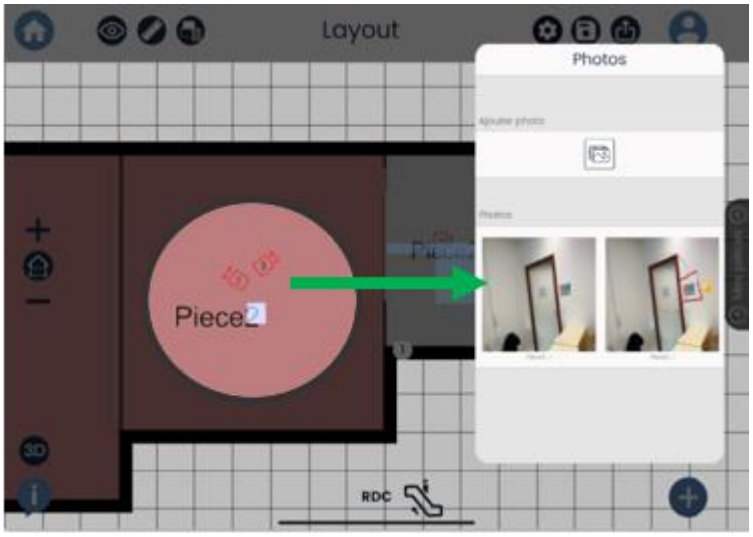
This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

4.4 Available functions

Function Name: Generic Object Integration	**B1**
Input data type: Semantics	
Description of the function This function allows you to create objects of simple shape (surface, cylinder, cube) in order to add an object according to its class (Technique, architecture, furniture ...). The object thus integrated into the 2D and 3D plane can be associated with semantic data.	
Enriched information Geometric information (Surface, volume, height ...) Semantic information (name, appurtenance to a room, a floor, State, performance ...) Like any object, generic objects can be attached to a specific questionnaire.	
Visual  *Figure 20: Generic Object Function*	

Function Name: Georeferenced Photo Taking	**B2**
Input data type: Semantics	
Description of the function This function is an aid to the energy assessor to take visual details during the visit. The photographic shot is inscribed at the place of the shot on the plan. This function ensures that photos are located on plan and guarantees a perfect exploitation of visual information.	
Enriched information	

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

The information does not enrich a data base since the photo is not associated with data-type information. However, the photo is proposed in a PDF type report that includes all the photos positioned on the piece-to-piece plans.
Visual    *Figure 21: Georeferenced photos function*

Feature Name: Embedding Annotations on the Plane	**B3**
Input data type: Semantics	
Description of the function This function makes it possible to integrate structured information to materialize either an alert or important information. This information is structured around the BCF format of the BIM process, which makes it usable by a future BIM integration.	
Enriched information The information entered in this function is visual (photo) but also semantic. Indeed, the BCF format makes it possible to qualify the type of annotaition (Problem, Commantaire, demand, solution), The family (Architect, Electricity, HVAC, Specification, Structure, Technology), the state (Open, Outstanding, Closed, Resolved) or priority (Low, Medium, High Urgent). Each of the specifications can be left in "undefined". In addition to this information, the annotation can be shared and scheduled.	
Visual	

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

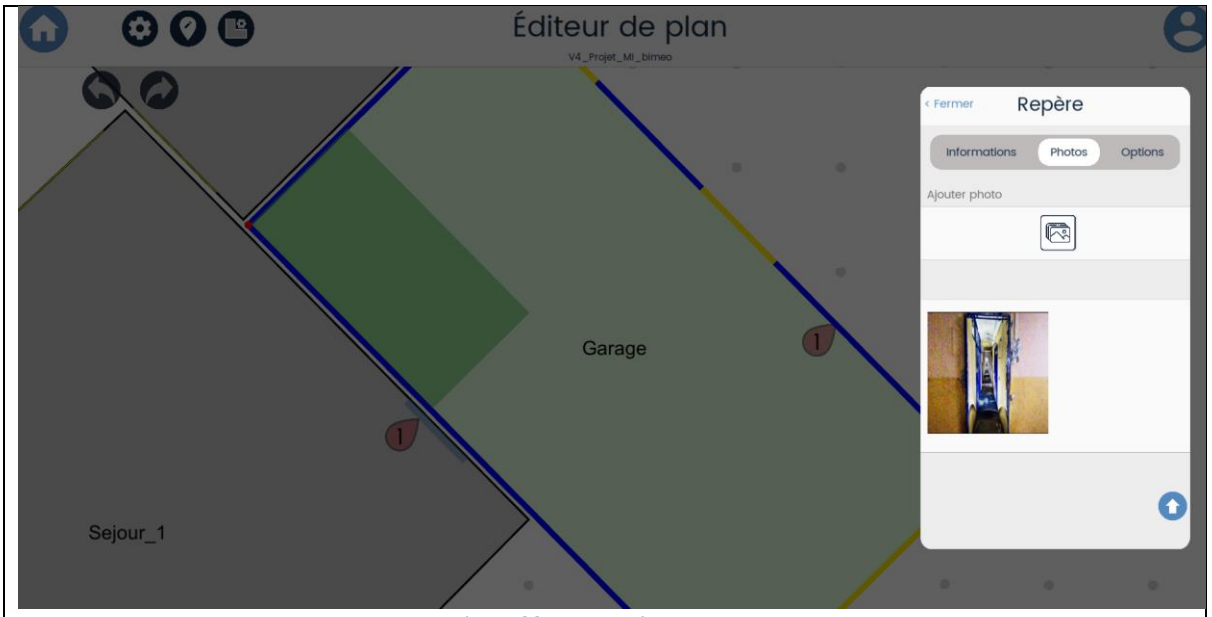


Figure 22: Annotations Feature

4.5 Features under development

Function Name: Adding a Questionnaire	**C1**
Input data type: Semantics	
Description of the function For each object (Building, floor, room, area, wall, opening ...) BIMEO will offer a sample questionnaire to allow the energy assessor to enter semantic information.	
Enriched information All useful information can be enriched by this configurable questionnaire.	
Visual ***Liste des objets d'une famille :*** - Mur 1 - Mur 2 - Mur 3 ... **1 objet** ⟷ **1 questionnaire** ***Questionnaire Type :*** - Question 1 - Question 2 - Question 3 ...	

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

For the final product, we decided to create 3 “pre-made” questionnaires that the users need to download before going on site with the iPad:

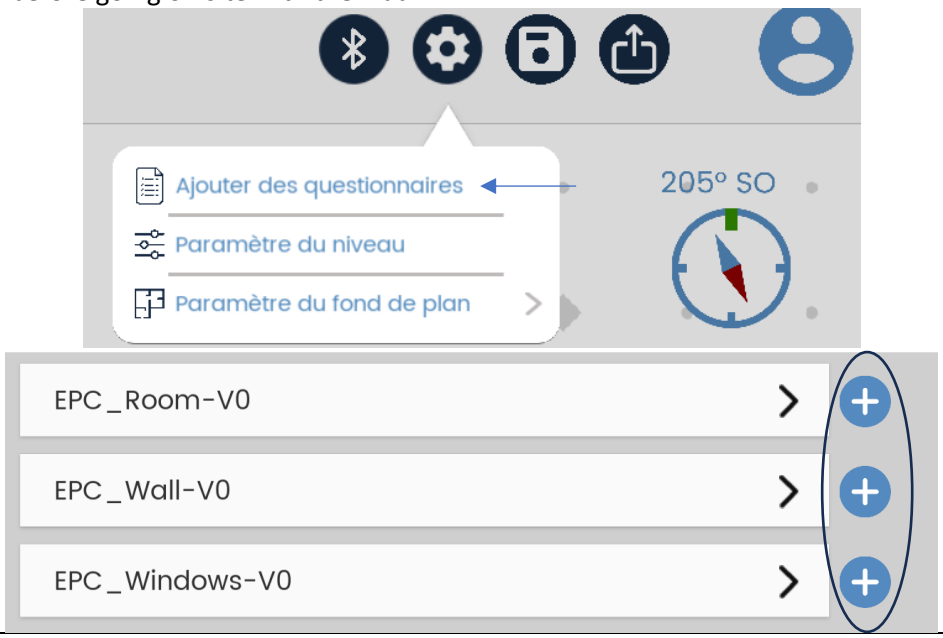


Figure 23: Questionnaire function

Feature Name: Adding a Descriptive Photo to Objects	**C2**
Input data type: Semantics	
Description of the function In addition to photos on annotations and directly georeferenced on the plan, we also propose to link a photo to an object such as a wall, opening or generic object. This information makes it possible to associate visual information with semantic data. It is important in the context of an EPC report to visualize the elements cited.	
Enriched information The photo does not give information that can be integrated into a database but makes it possible to embellish a visual report.	
Visual	

Figure 24: Photos attached to objects function

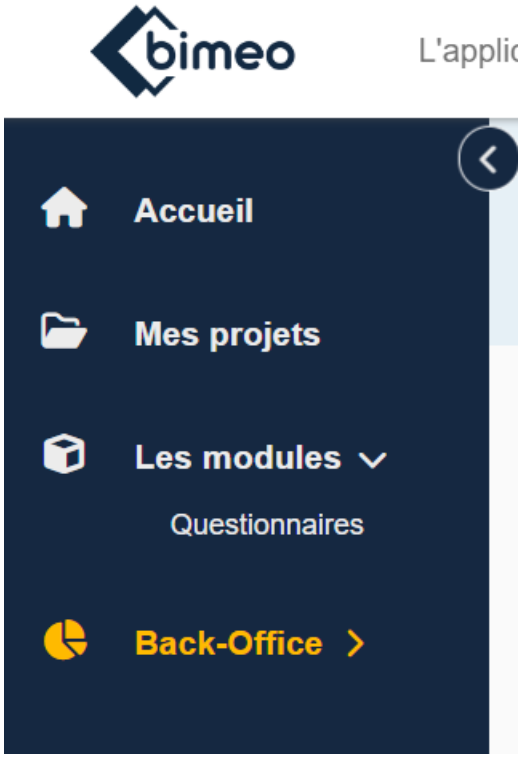
This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

4.6 Exploitation of the data available from BIMEO

In accordance with the description provided in the Grand Agreement, BIMEO was committed to develop a process for acquiring semantic data in addition to metric data. After characterizing the information developed in task 1.2, we agreed to implement a "technical" questionnaire to qualify and describe the technical definition of elements (walls, systems, etc.).

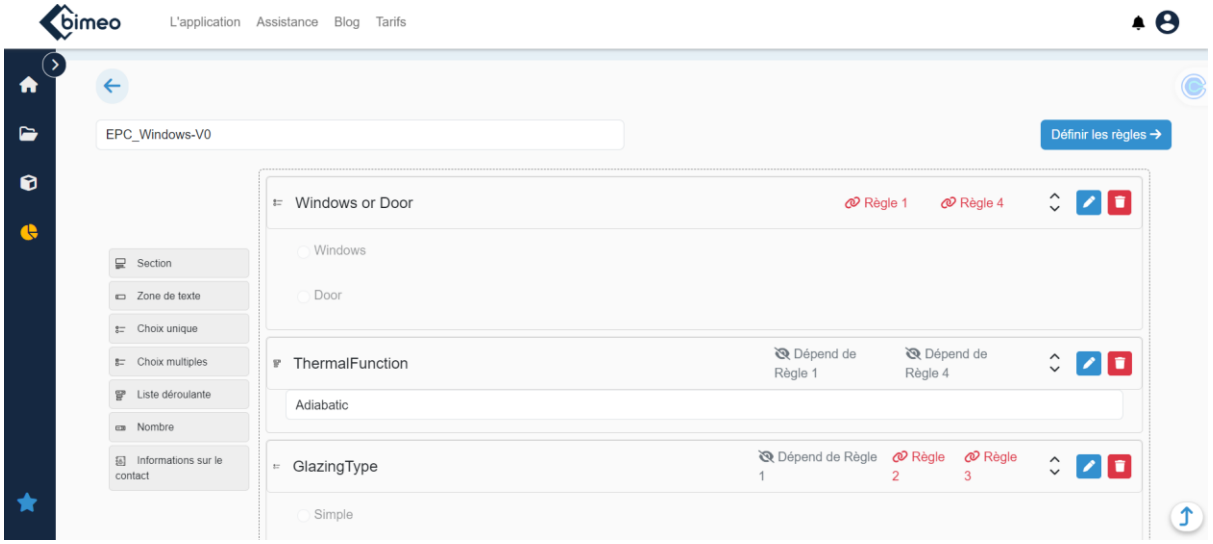
The challenge lies in the diversity of terminologies or technical descriptions from different consortium partners. Each member country of the EPC program has its own designations or characteristics that enable professionals to share and qualify data. While BIMEO already possesses technical knowledge and expertise in the French market, this is not the case in other countries. In the French market, BIMEO addresses the technical information collection stage with an application currently in market testing.

For the EPC RECAST project, we chose to develop a field data acquisition process through a configurable questionnaire that allows each actor to create their own list and capture methodology. This questionnaire module is accessible in SAS mode directly in BIMEO's user space.



This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

From this module, users can create any type of questionnaire by structuring "blocks" of questions in various forms.



Each question can be associated with rules to manage the conditions for displaying the questions. With the "BIMEO" questionnaire, energy assessors can create as many questionnaires as needed for their audits. These questionnaires will be assigned to projects and to the walls and systems being diagnosed based on their relevance.

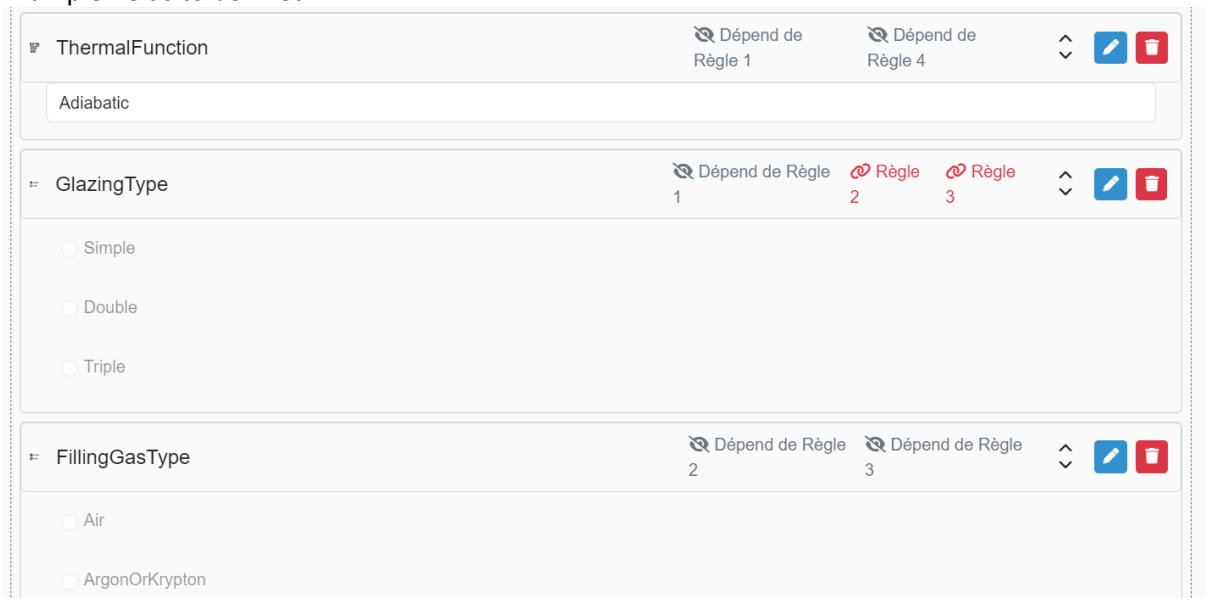
"Feel free to include links to the tutorials I posted online."

As part of the EPC, BIMEO structured three types of questionnaires to assist partners in collecting and processing data at pilot site level:

The first questionnaire concerns openings (windows and doors). It includes all the minimum common characteristics for describing the openings. Each partner will have to derive the thermal coefficient values based on their calculation and simulation methods.

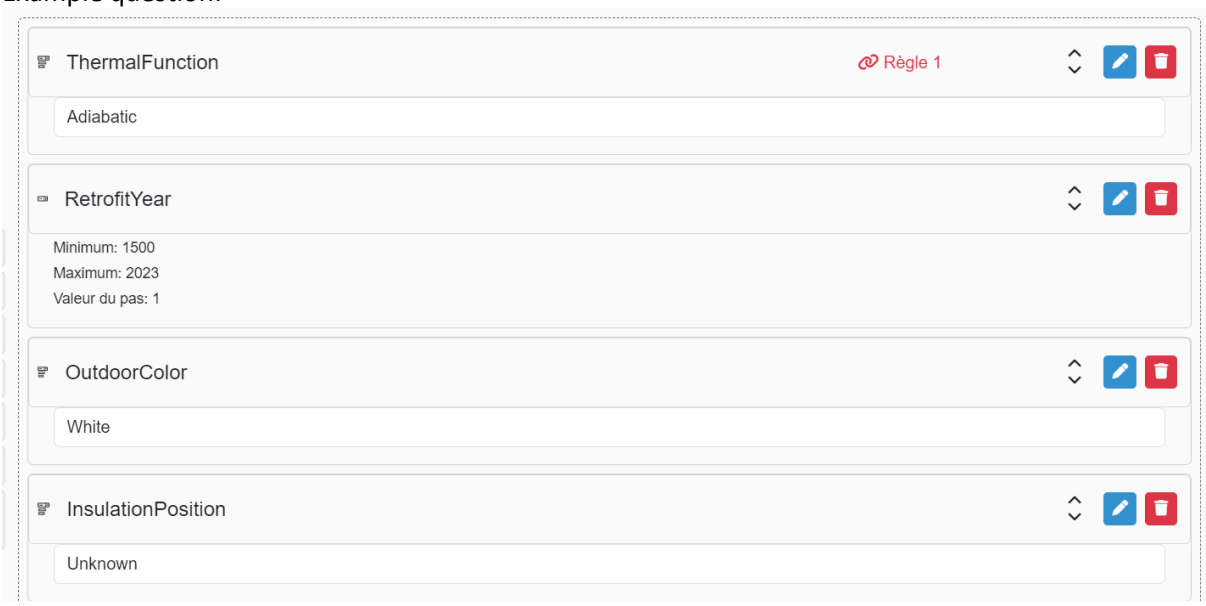
This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Example fields to be filled in:



The second questionnaire concerns walls. The questions address both the technical characteristics of the walls and the identification of any horizontal thermal bridges at the bottom or top of the wall.

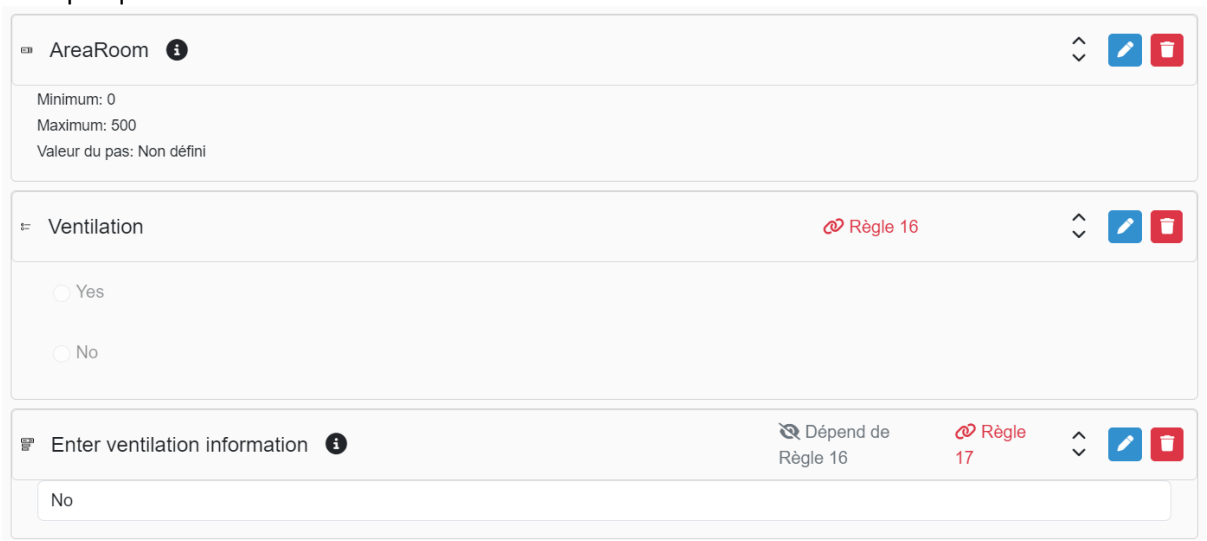
Example question:



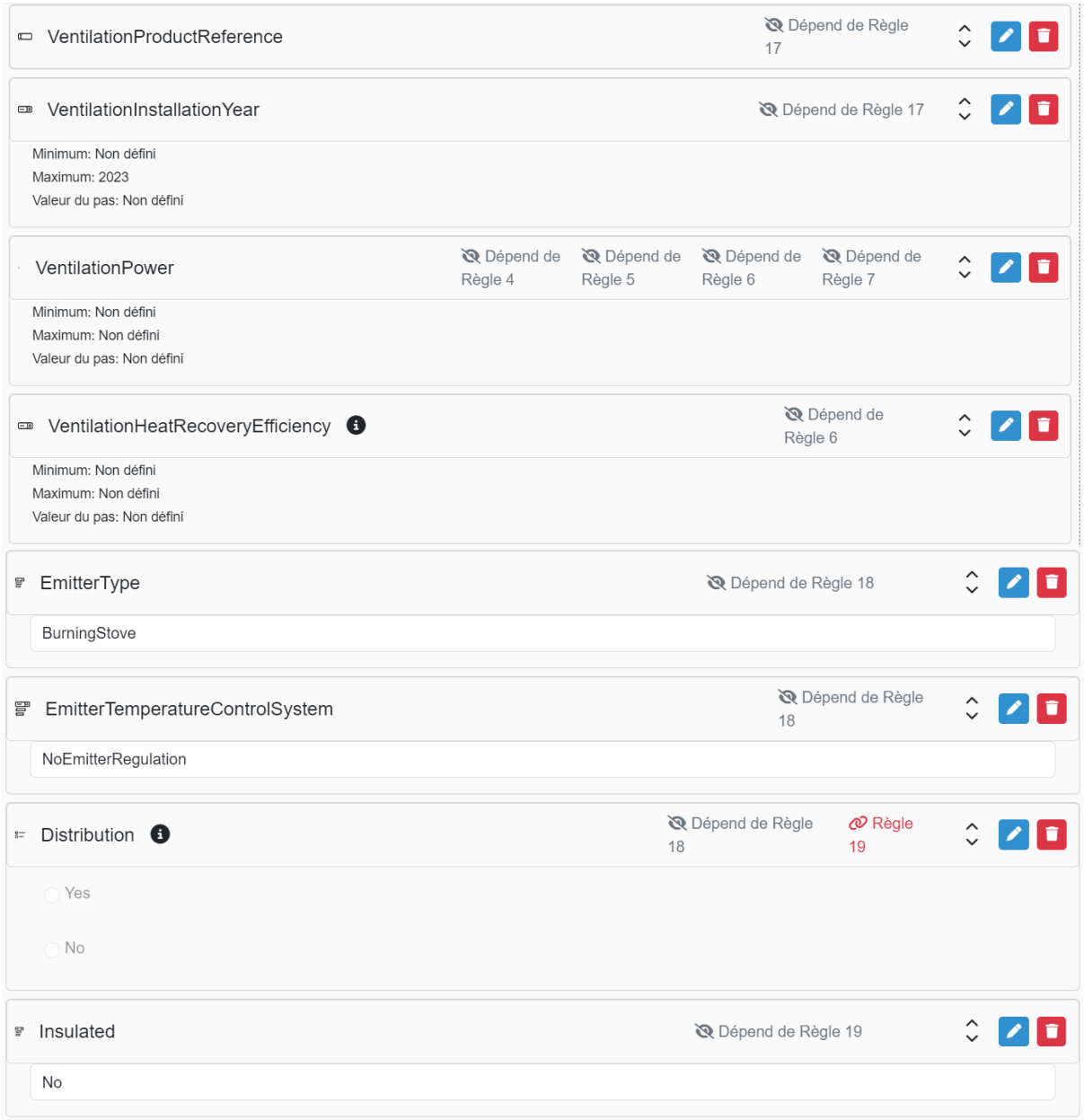
The third questionnaire concerns the information present in the rooms. This questionnaire covers both technical equipment (emission, ventilation, heating system) and the horizontal dissipative walls of the room. Assembling all these questions allows managing only three questionnaires to qualify the data.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Example question:



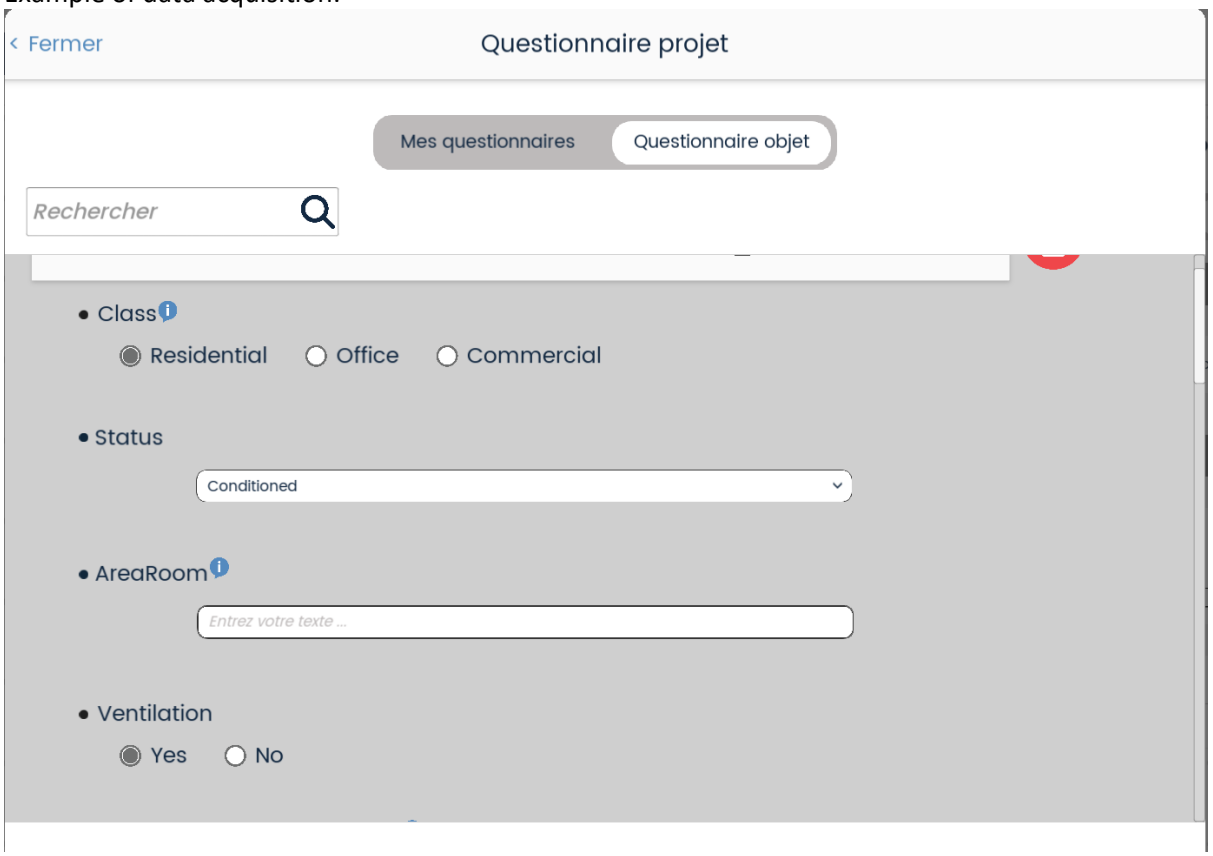
This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.



Once created in the user database, the questionnaires can be shared through an import/export file process. This action allowed these questionnaires to be distributed to all EPC partners to use a standard acquisition process. The responses to each questionnaire are structured in XLS and CSV file formats to be used digitally. In the data acquisition application used on site, the questionnaires integrate into the acquisition flow throughout the technical visit.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

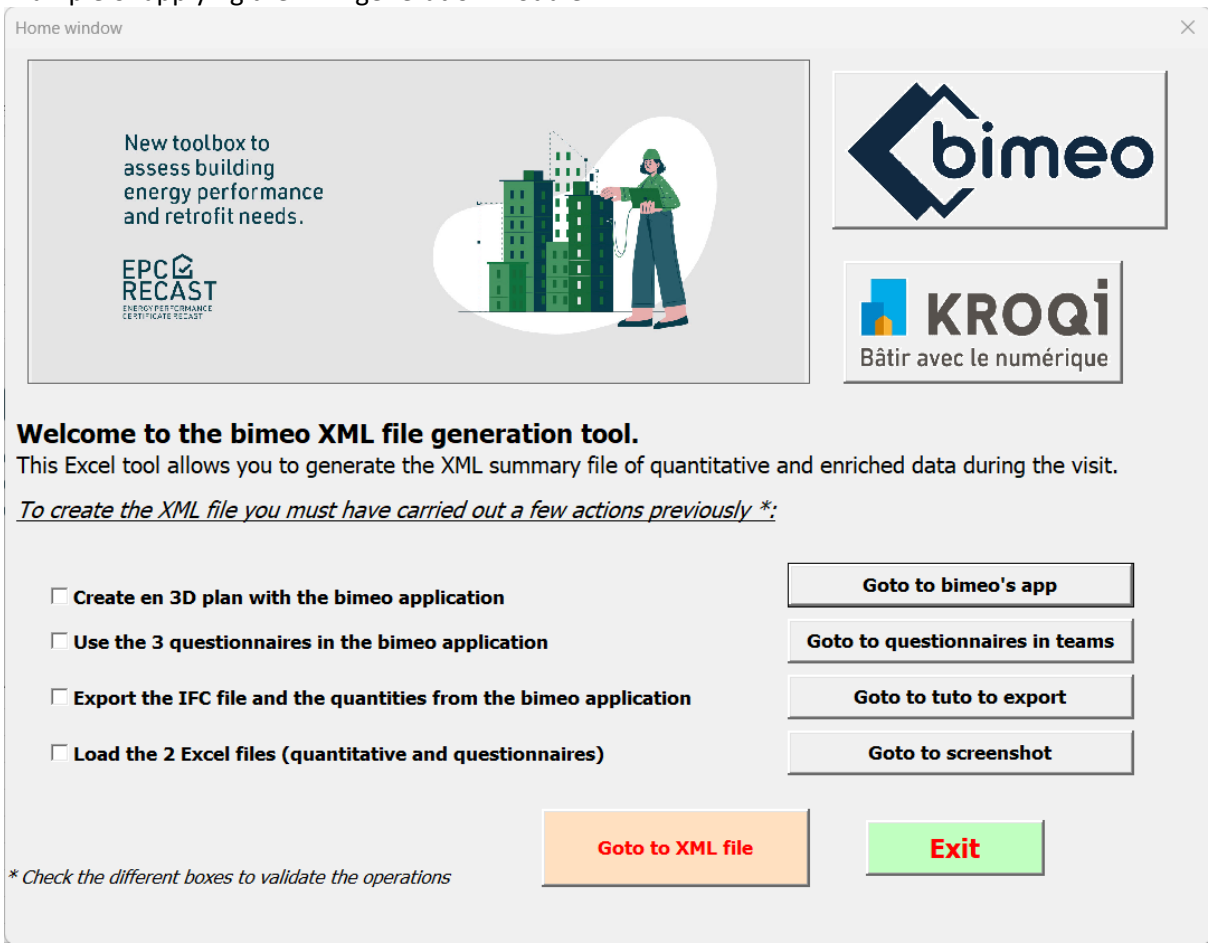
Example of data acquisition:



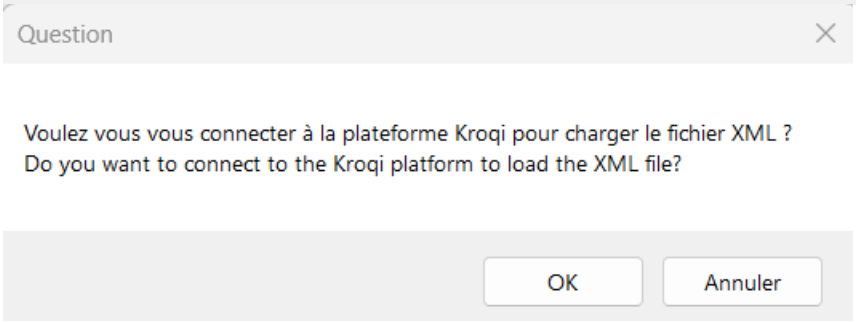
The goal of the EPC RECAST project is to qualify an XML file that gathers all the metric and semantic information from the diagnosis. While this process should ideally be done through a web form or application to generate the different pieces of information, the difficulties encountered in standardizing information and data qualification prevented BIMEO from coding a specific application. This application underwent a "prototype" phase in EXCEL/macro format to confirm and link metric and semantic information. Upon completing the visit, the energy assessor exports the various structured metric and semantic information into XLS/CSV files. An Excel file consolidates and structures an XML file that will serve as input data for the simulation tools initiated by EPC. From this Excel application, it is also possible to connect to the Kroqi platform to import the XML file. While this file/application format may not be standard for EPC, it validates the process and can serve as a specification for developments tailored to the user countries.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Example of applying the XML generation module:



This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.



This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Extract from the XML file:

```
<?xml version="1.0" encoding="UTF-8" standalone="yes"?>
<Project id="EPC BEN ALAYA 104">
    <Name>EPC BEN ALAYA 104</Name>
    <Location>
        <Address>6B rue de la Rame</Address>
        <PostalCode>49100</PostalCode>
        <City>ANGERS</City>
        <Region></Region>
        <Country>FR</Country>
        <NUTSRegion></NUTSRegion>
    </Location>
    <AuditData>
        <Auditor>
            <Name>Eric LEROGNON</Name>
            <Company>bimeo</Company>
            <Email>contact@bimeo.fr</Email>
            <Phone>06 67 50 17 36</Phone>
        </Auditor>
        <Tool>bimeo_Version V2a-1 du 16/04/2024</Tool>
    </AuditData>
    <Building id="my_building">
        <YearOfConstruction>2021</YearOfConstruction>
        <ExistingBuilding>1</ExistingBuilding>
        <BuildingElements>
            <Wall id="wall_132">
                <Name>WL_132_Chambre2_W</Name>
                <Orientation>W</Orientation>
                <ThermalFunction></ThermalFunction>
                <Dimensions>
                    <Area>
                        <Value>9.95</Value>
                    </Area>
                    <Height>
                        <Value>2.48</Value>
                    </Height>
                    <Length>
                        <Value>4.01</Value>
                    </Length>
                    <Width>
                        <Value>0.35</Value>
                    </Width>
                </Dimensions>
                <RetrofitYear>
```


This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

4.7 BIMEO self-verification tests

This chapter presents the self-monitoring tests developed under Task 1.2.

The main useful tests will be carried out for the qualification of geometric information. Indeed, BIMEO uses LIDAR type technologies that require verification.

These tests will be defined in connection with WP4 at the time of the operating stages.

In this WP4 it can be set up tables of comparative quotation taking:

Test rating N°	
Date	
BIMEO Version Number	
Project Name	
Floor	
Room	
Object tested	
Description of the context Describe the project and its context.	
Plan Information Photo of the plan and identification of the dimension	
BIMEO Rating	Annual rating
Deviation (cm) %error age	

The BIMEO process is defined for a dimension tolerance per cm. It will be measured a tolerance of +/- 1 cm

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

5. Acquisition of EPC technical data with ENGIE's Infrared diagnostics drones

5.1 Presentation

The use of drones allows an approach combining energy experience and 3D modeling in order to collect in a targeted way the relevant data of a building. This data will be interpreted and can be used for numerical simulation to anticipate optimal energy gains following a renovation, for example.
The technologies allow us to meet many needs : visual inspection, thermal inspection, 3D interior and exterior reconstruction, construction site monitoring, reduction of inspection costs and increased security. It can optimize maintenance actions while naturally increasing operational performance.

The drone allows quick and low-risk access to this type of data, for example large roof insulation heterogeneity that would not otherwise be seen.

These technologies will increase operational performance with a better level of information, coupling with digital visualization platforms and easy and secure access to data, integration of data analysis and machine learning.

The use of drones can fulfill different purposes :

- Capturing data that is difficult to access by conventional and dangerous means, indoors or outdoors.
- Complete inspection of buildings and infrastructures.
- More global views than from the ground
- Reconstruction of a structure in 3D (and facades in 2D)
- Construction of a digital twin
- Digitization to BIM
- Reduction of the downtime of the inspected facility
- Reduce inspection time and site occupation
- Gain flexibility and security
- Obtain accurate analysis of captured data

Concerning the energy audits, drones can help in the estimation of the energy efficiency of the envelope of a building. Two approaches are possible:

- A global calculation of the thermal efficiency (HLC) of the building
    - Advantages : quantified macroscopic efficiency, energy renovation and quantifiable gains at the end of the work
    - Disadvantages : long implementation time, need to know perfectly the materials of the house as well as the weather conditions (relative humidity, wind, temperature) as well as the heating instructions.
- A pragmatic approach allowing to visualize the heterogeneities of the temperatures
    - Advantages : quick intervention, no need to know perfectly the materials of the house as well as the weather conditions (rough temperature is sufficient) as well as the heating instructions (no need at all), direct visualization of insulation defects

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

- Disadvantages : no quantified data on the energy status of the building.

Three-dimensional (3D) imaging is an important tool in many fields, ranging from industrial and architectural design to diagnostics of materials and artifacts, from medicine to entertainment (cinema, video games) and the fruition of historical and artistic heritage (augmented reality, virtual reconstruction).

Infrared (IR) thermography (IRT) is also a technique that has grown very rapidly in recent years, now characterized by increasingly advanced applications.

Therefore, the joint use of these two techniques is of great interest and potential and represents a very current research topic.

5.2 InfraRed camera

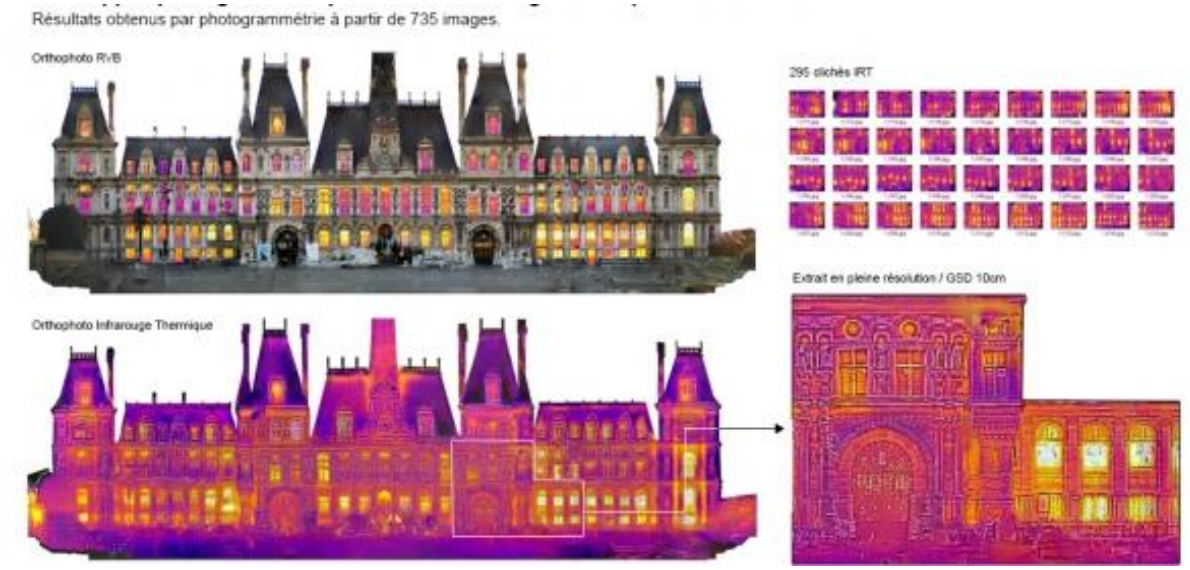
3D thermography can be very useful, for example, in structural diagnostics, energy efficiency assessment of buildings, inspection and monitoring, and these evaluations may be enhanced by performing them from UAVs (Unmanned Aerial Vehicles—also known as drones).

IRT is based on the fact that all bodies having temperature above absolute zero emit radiation; from this radiation, it is possible to trace the temperature of the body. Therefore, thermography is a method capable of detecting the temperature of objects under investigation without contact.

A thermographic camera is a calibrated device capable of measuring the radiation emitted by objects and calculating their temperature. The radiation measured by their sensor also depends on the properties of the investigated surface (emissivity) and the environment (radiation absorbed or emitted by the atmosphere between sensor and object and contribution of other objects in the environment).

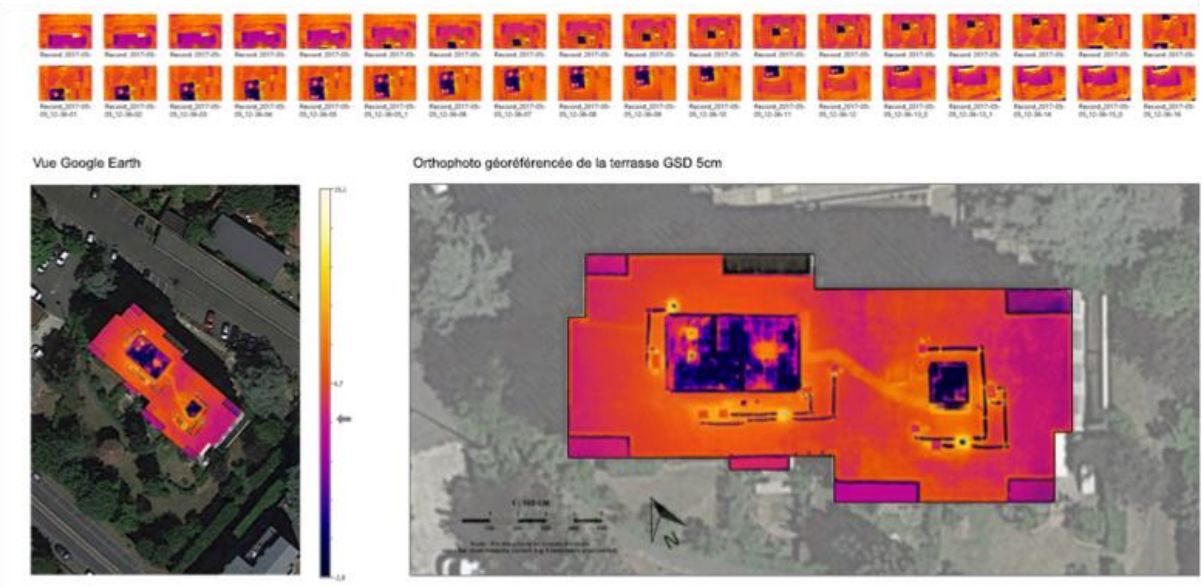
The result is an image of the object in which the color or gray levels correspond to the different temperatures on the object's surface. The measurement accuracy also depends on parameters such as ambient temperature, wind or solar radiation. Possible variations in temperature may be due to differences in materials surface finish (intrinsic or as a result of ageing/damage) or subsurface defects.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.



This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Here above 2D photogrammetric reconstruction (native model in 3D) and below roof reconstruction :



5.3 As part of the project

As part of an EPC project, the drone is a tool that will allow to scan a building in its entirety and obtain a complete vision thanks to 3D reconstruction. We could for example associate a classic scan from the ground for the walls and a drone for the roof. We can associate a thermal camera and different sensors and thus realize an audit of our building and detect its state by infrared thermography.

The drone activity is regulated by the DGAC, so it cannot be used for all pilot projects or systematically for the reliability of future DPE. On the other hand, it can be an interesting tool within the framework of the EPC Recast project to define the best way to make the data and their acquisition reliable.

Indeed, drones allow to have an easy and quick access to elements that we can't see from the ground, like for example a big heterogeneity of insulation on the roof that we wouldn't see otherwise.

A classic scan can be done from the ground with a light drone (1kg max) with integrated IR sensors. With this type of machine, it is possible to take data from 90% of the roof.

With the arrival of drones of the OPEN category of European regulations, energy assessors will be able to use this type of equipment, especially for a machine of mass less than 1kg.

The data will be easily exploitable since the output formats are visible and infrared photos. They will allow the identification of heterogeneity, with the 3D scan, the projection of photos on cloud of points, to have the whole state of the thermal envelope.

5.4 Specific constraints

Upstream, it will be necessary to pay attention to a certain number of constraints in order to carry out the mission in the best conditions. It will be necessary to identify all the potential obstacles (from wires to larger obstacles) that could prevent the drone to access the building.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

It will also be necessary to make the administrative steps and declaration of mission (min 7 days in advance) to have all the necessary authorizations. These constraints depend on the airspace (airport/aerodrome) and on the elements close to the ground (railroad; national road, highway, waterways).

States regulation

To perform such missions with drones, operators have to respect member states regulation. Today only OPEN category missions are unified (low weight, low risks out of urban zones) and for SPECIFIC category, operators have to respect STS (Standard Scenarios).

In the SPECIFIC category, UAV operations can be carried out on the basis of:

- a statement; an operating license: see here
- of a lightweight UAV Operator Certificate (LUC): see here

UAS operations carried out on the basis of a declaration must comply with a standard scenario i.e. a type of UAV operation for which a precise list of risk mitigation measures has been established. for which the operators declare that they will strictly apply these mitigation measures during their operations.

For Specific Operations Risk Analysis purposes, see here : link 1

- European standard scenarios (not yet applicable)

European regulations have, to date, defined two European standard scenarios (also called STS "Standard scenarios"):

  - Standard scenario 1 ("STS-01") covers line-of-sight operations (VLOS) carried out with a UAS of class C5 (CE marking) at a maximum height of 120 m above a controlled area on the ground in a populated environment (the scenario can however be used in an unpopulated environment).
  - Standard scenario 2 ("STS-02") covers operations that can be performed out of sight (BVLOS), with the unmanned aircraft on board at a maximum distance of 1 km from the remote pilot. This distance can be increased to 2 km if airspace observers are present. The evolutions take place at a maximum height of 120 m above a controlled area on the ground in an environment with low population density, with a UAS of class C6 (CE marking).

- SORA our Standard scenarios :
  - STS-01 : http://jarus-rpas.org/sites/jarus-rpas.org/files/jar_doc_6_sora_sts_01_edition1.1.pdf
  - STS-02 : http://jarus-rpas.org/sites/jarus-rpas.org/files/jar_doc_6_sora_sts_02_edition1.0.pdf

Operating conditions

The operation of unmanned aircraft is covered by the implementing regulation (EU) 2019/947 of May 24, 2019 on rules and procedures for the operation of unmanned aircraft. This regulation is applicable since December 31, 2020. It describes in particular the requirements associated with this operation around the following topics:

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

- Operating conditions and aircraft eligible for operation in the specific category,
- Requirements related to the training of the remote pilot and his qualifications,
- Responsibilities of the operator and the remote pilot,
- Declarations and authorizations to operate.

In general, any operation that does not meet the requirements of the open category falls into the specific category, subject to prior declaration or authorization by the DSAC depending on the operating conditions. In France, open category operations are forbidden in public areas in built-up areas.

Under certain conditions, an operator can be exempted from the operating license. To do so, he must operate according to national or European standard scenarios or hold a light operator certificate.

Steps are necessary for the realization of these flights (at least a prefectural declaration, and potentially other steps depending on the site: request for authorization from the competent authorities). A minimal delay is necessary to be able to make these steps.

Respect of privacy

The persons present will be informed if the aircraft is equipped with a camera or any other sensor likely to record data concerning them.

Any diffusion of image allowing to recognize or identify persons (faces, license plates...) will be subject to an authorization of the concerned persons or the owner in the case of a private space (house, garden etc.) and this diffusion will respect the rights to the image, the private life and the private property of the persons.

Realization of the mission

In order to carry out the mission in complete safety, it will be asked for the flight area to be secured with an exclusion perimeter to be defined according to the buildings to be audited. A take-off/landing area will also be planned before each flight.

An exclusion zone for third parties must be defined. The persons external to the operation of the drone but whose presence would be necessary inside the safety perimeter must be the subject of a particular information. A certificate of information will be given to them for signature.

6. Integration and validation by contributors of tasks T1.2 and T2.2

The work carried out by BIMEO must make it possible to exploit and connect image capture and processing technologies, associated with semantic enrichment, in order to fulfill an appropriate MD (see T1.1) for the construction of ep evaluation in the context of EP.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

6.1 Limits of the action schedule

Human and organizational difficulties have slowed down the work of BIMEO. The health crisis and a turnover of staff in a small structure such as BIMEO did not make it possible to develop the actions in accordance with the initial program. However, it is important to note that the EPC RECAST project benefits from the developments of BIMEO since July 2020. These developments and functionalities make the process and application more robust and ergonomic.

The BIMEO app has now polished its scanning process as well as the integration of the questionnaires. The application is now more fluid and has a lot of new features to help scan and to create 3D buildings.

Here are some of the new added features:

- We have simplified our sketch mode by adding visual aids that allow you to place your right angles more intuitively. Enjoy better plan construction thanks to the improvement of our assembly algorithm! Visual aids will make it easier to attach your pieces. It is now possible to automatically create a piece when an empty space appears between the pieces you assemble on your floor plan.
- You can now connect to a laser meter via Bluetooth on our Windows version. This feature allows for automatic integration of dimensions into the application, providing more precise measurements and real-time verification of dimensions.
- No more fear of mistakes with the Undo/Redo function now available in the plan editor. This feature allows you to revert your actions for piece editing and assembly. You can now characterize your partitions and openings directly from the plan editor.
- Dive into even more realistic plans with our improved 3D view.

6.2 Deliverable Management

The reports delivered by BIMEO for the EPC RECAST project must provide guidelines how to use new technologies), but also an exhaustive collection of information. These deliverables are formalized by several possible formats described in the following table:

Type of information	Deliverable format	Remarks
Metric	IFC2x3 and IFC4	3D construction in accordance with IFC standard. Integration of metric data into the IFC calculated by the BIMEO process
Metric	XLS et SCV	The metric of the objects (Floor, Rooms, Walls, Openings

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

		...) are exportable according to a tabbed format
Semantics	XML	The descriptive information of the characteristics of the objects (Parts, Walls, Openings ...) entered by the operator during the visit is provided in a structured format
Photo, Annotations …	BCF	All information entered on the plans can be transmitted according to the BCF 2.1 format defined by BuildingSmart International. This format makes it possible to exploit the information georeferencing information and type Semantics.

Table 4 : List of Deliverables

6.3 Partner Integration

The animation of this development calls on the knowledge and skills of the other partners at 2 levels:

Choice of input data:

The information to be investigated under the ECD was worked on under task T1.1. This data is used to structure the acquisition process of the BIMEO application. Other information is also introduced from the working group's feedback, in particular on the topic of energy audits. Information in the form of generic questionnaires was proposed by the working group (in particular ENGIE) to define the generic input information of an EPC.

Proposal and validation of deliverables

The various deliverables have been validated by the project team and in particular Tecnalia, Polimi and the CSTB. Sample files are exchanged to validate data structuring and integration into the EPC Recast suite.

The interest of using the IFC format to structure the building data is multiple:

- Strengthen its support for universal 3D formats that will eventually be imposed on all buildings
- Connect to calculation tools that increasingly use the IFC format as an exchange data for building plans. This is particularly the case for the E+ calculation which can be analyzed in the project.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

The grant agreement also refers to the intersection of data inside and outside the building. A reflection focuses on external information such as Infrared Thermography captured by Drone (ENGIE Partner). This technology makes it possible to identify heat treatment deviations on areas or surfaces. Without being a real measurement tool, this image-type information can complement or detail semantic information in the report. Exchanges between the partners will have to define the direction taken in the management and coordination of this data.

7. Conclusions

Tasks T1.2 and T2.2 deal with the data collected during the first stage of the EPC process (on-line visit). With a technological mastery of 3D capture, BIMEO provides a process capable of acquiring geometric but also semantic data.

This action also combines data qualified by Infrared acquisition by drone developed by ENGIE.

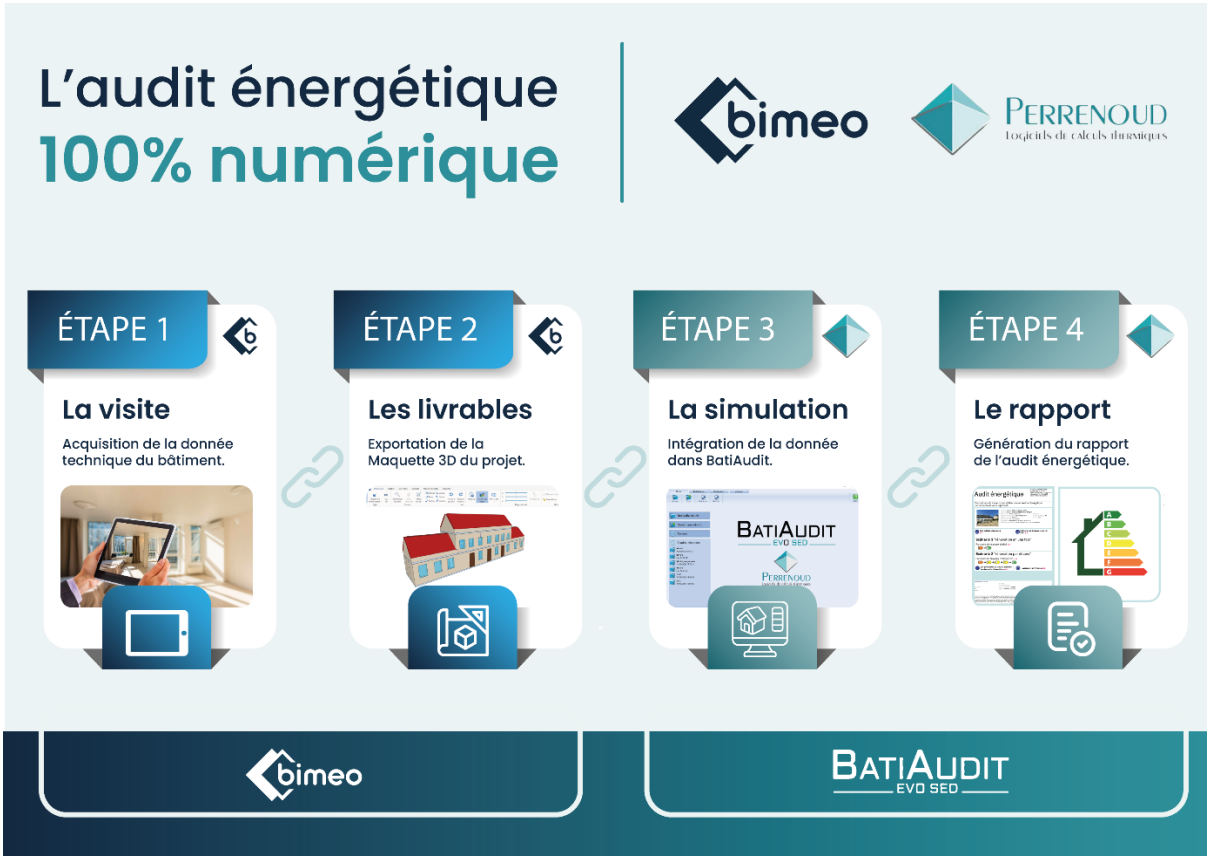
We all know that the quality of data acquisition for existing buildings is an absolute goal to ensure a good diagnosis and EPC (Energy Performance Certificate). This is where BIMEO has brought its expertise to the program. Aware of the technical challenges, BIMEO has been dedicated for over 6 years to supporting the sector and diagnostic professionals in synthesizing technological tools and developing operational, efficient, and precise applications.

In the EPC RECAST project, BIMEO provided all the developments carried out and made major advancements to meet the consortium's needs. It is important to note that these developments are advanced and have significantly progressed the French diagnostics sector. Indeed, alongside the EPC RECAST project, BIMEO has implemented series processes with energy simulation actors (Perrenoud, OBBC, Izuba, etc.). By the completion date of the EPC RECAST project, BIMEO has become an operational tool to meet the market demand for energy renovation of housing in France. The experience from the EPC RECAST project has allowed better targeting of needs and tools to move towards the digitization of diagnostics.

A bridge between BIMEO and a French software provider (Perrenoud) enables the application of the EPC RECAST project's objectives.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.



The use of 3D construction and data enrichment combined with the power of computing allows us to envision optimization and development avenues to scale up the renovation of buildings within the European community.

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

ANNEXES

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

1. Annex 1 - All information used to describe the building and its systems

theme	component	Corresponding CEN standard from Mandate M480 (and link toward the EPB Center correpsonding demo file including input data)	subcomponent	collected_data_name	description
GENERALITIES			Altitude	Building_altitude	Altitude of the building
			Weather	Weather_data_station	tilt angle of the window (horizontal,vertical etc..)
BUILDING FABRIC	WINDOW		WINDOW geometry	frame_perimeter	perimeter of the frame of the window
				window_tilt_angle	tilt angle of the window (horizontal,vertical etc..)
				orientation	orientation of the window in °
				adjacency	adjacency of the window (contact with outdoor/ other rooms / non heated rooms etc..)
				window_total_surface	total surface of the window including glazing and frame.
				glazing_surface	surface of the glazing
				frame_surface	surface of the frame
				glazing_type	glazing type : simple, double or triple glazing

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

			WINDOW technical characteristics	filling_gas_type	type of filling gas for double or triple glazing window
				gas_space_thickness	length of gas space between glazing
				glass_coating	is there a Low-E glass coating on the window
				frame_material	material of the frame : wood, plastic , metal etc..
				frame_thickness	thickness of the non moving part of the frame
				window_type	what is the type of window, French window, simple window
				window_position	window position relative to wall. Inside, outside or tunnel window
				joined_insulation_window_wall	is there a junction of isolation between the wall and the window.
				technical_reference	recent technical product reference of the window with all its technical data such as U value and solar factors.
			Solar protection system	solar_protection_system_type	type of solar protection system (manual control, automatic control, shutter, rolling shutter, curtain, etc..)
				solar_protection_system_thickness	thickness of the solar protection system
				technical_reference	recent technical product reference of the window with all its technical data such as thermal resistance
			Solar mask	simple_building_solar_mask_configuration	configuration of the component field of view regarding outdoor obstacles of the

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

					building itself : balcony on top , window on a deck , lateral masking of the building etc..
				environmental_mask_main_angle	solar mask generated by other building, trees or topography of surrounding environment. A single summary value is calculated for the whole field of view
				detailed_measurement_outdoor_obstacles	detailed measurement of the outdoor obstacles of the building for the field of view of the window. These measurement are used to calculate solar mask. Window height, floor height, right,left and top obstacles dimensions are measured.
				detailed_environmental_mask_angle	detailed solar mask angle for each mask section of X ° of the field of view (vector) of the environment
				detailed_building_mask_angle	detailed solar mask angle for each mask section of X ° of the field of view (vector) of the building
	Wall, High Floor, low Floor		Wall geometry	perimeter	perimeter of the wall
				surface	surface of the wall
				adjacency	adjacency of the wall (contact with outdoor/ other rooms / non heated rooms etc..)
				orientation	wall orientation
				inclination	wall inclination

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Walls technical characteristics	construction_period	construction period of the component. Can be used to evaluate by default the insulation characteristics of the wall when it is impossible to inspect the wall composition.
	retrofit_perod	retrofit period of the component (when it has been insulated). Can be used to evaluate by default the insulation characteristics of the wall when it is impossible to inspect the wall composition.
	wall_outdoor_color	color of the outdoor wall (dark or light) used to calculate solar gain
	main_layer_type	main layer type, usually this layer is the structure layer. The type of layer is used to calculate a default thermal conductivity for this layer (hollow bricks, formed concrete etc…)
	main_layer_thickness	thickness of the main layer
	insulation_position	position of insulation (outdoor insulation , indoor insulation or self isolating structure material
	insulation_thickness	thickness of the insulation layer
	insulation_product	product or insulation material (used to calculate the thermal resistance of the insulation)
	insulation_thermal_conductivity	thermal conductivity of the insulation layer. If unknown a default value could be pick
	doubling_type	type of interior doubling for the wall (used to calculate additional resistance)

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

				insulation_technical_reference	Insulation technical product reference including all its thermal performance parameters for simulation(new or recent product)
				technical_reference	whole wall technical product reference including all its thermal performance parameters for simulation(new or recent product)
				solar_factor	solar factor of the glazing
				layer_type	layer type for each layer. The type of layer is used to calculate a default thermal conductivity of that layer
				layer_thickness	thickness of each layer
				layer_thermal_conductivity	thermal conductivity of each layer
				layer_position	position of the layer (contact with outdoor, indoor or inbetween)
			Solar mask	simple_building_solar_mask_configuration	configuration of the component field of view regarding outdoor obstacles of the building itself : balcony on top , window on a deck , lateral masking of the building etc..
				environmental_mask_main_angle	solar mask generated by other building, trees or topography of surrounding environment. A single summary value is calculated for the whole field of view
				detailed_measurement_outdoor_obstacles	detailed measurement of the outdoor obstacles of the building for the field of view of the component. These measurement are used to calculate solar

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

					mask. Window height, floor height, right,left and top obstacles dimensions are measured.
				detailed_environmental_mask_angle	detailed solar mask angle for each mask section of X ° of the field of view (vector) of the environment
				detailed_building_mask_angle	detailed solar mask angle for each mask section of X ° of the field of view (vector) of the building
	THROUGH		THROUGH	perimeter	perimeter of the door
				adjacency	adjacency of the door (contact with outdoor/ other rooms / non heated rooms etc..)
				surface	surface of the door
				orientation	orientation of the door
				door_type	type of door. To be used to calculate default U value
				technical_reference	technical product reference including all its thermal performance parameters for simulation

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

2. Annex 2 - Processing of information by BIMEO

theme		component	Corresponding CEN standard from Mandate M480 (and link toward the EPB Center correpsonding demo file including input data)	subcomponent	BIMEO	collected_data_name
GENERALITIES				Altitude	No	Building_altitude
				Weather	No	Weather_data_station
BUILDING FABRIC		WINDOW		WINDOW geometry	Quantity	frame_perimeter
					No	window_tilt_angle
					No	orientation
					Extract	adjacency
					Quantity	window_total_surface
					No	glazing_surface
					No	frame_surface
					Semantic	glazing_type
					Semantic	filling_gas_type

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

				WINDOW technical characteristics	Semantic	gas_space_thickness
					Semantic	glass_coating
					Semantic	frame_material
					Semantic	frame_thickness
					Semantic	window_type
					Semantic	window_position
					Semantic	joined_insulation_window_wall
					Semantic	technical_reference
				Solar protection system	Semantic	solar_protection_system_type
					Semantic	solar_protection_system_thickness
					Semantic	technical_reference
				Solar mask		simple_building_solar_mask_configuration
						environmental_mask_main_angle
						detailed_measurement_outdoor_obstacles
						detailed_environmental_mask_angle
						detailed_building_mask_angle
				Wall geometry	Quantity	perimeter
					Quantity	surface

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

					Extract	adjacency
					Extract	orientation
					No	inclination
					Semantic	construction_period
					Semantic	retrofit_perod
					Semantic	wall_outdoor_color
					Semantic	main_layer_type
					Semantic	main_layer_thickness
					Semantic	insulation_position
					Semantic	insulation_thickness
					Semantic	insulation_product
					Semantic	insulation_thermal_conductivity
					Semantic	doubling_type
					Semantic	insulation_technical_reference
					Semantic	technical_reference
					Semantic	solar_factor
					Semantic	layer_type
					Semantic	layer_thickness

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

					Semantic	layer_thermal_conductivity
					Extract	layer_position
				Solar mask	No	simple_building_solar_mask_configuration
					No	environmental_mask_main_angle
					No	detailed_measurement_outdoor_obstacles
					No	detailed_environmental_mask_angle
					No	detailed_building_mask_angle
		THROUGH		THROUGH	Quantity	perimeter
					Extract	adjacency
					Quantity	surface
					No	orientation
					Semantic	door_type
					Semantic	technical_reference
INERTIA		INERTIA			Semantic	Building_inertia
VENTILATION		VENTILATION		AIR INFILTRATION	Semantic	building_type
					Semantic	construction_period
					Semantic	retrofit_perod
					Semantic	window_seals

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

					Semantic	blower_door_airflow_rate
				VENTILATION	Extract	volume
					Semantic	ventilation_system_type
					Semantic	ventilation_power
					Semantic	technical_reference
LIGHTING		LIGHTING			Semantic	lighting_type
					Semantic	lighting_power
					Semantic	lighting_regulation_mode
HEATING / COOLING / DHW SYSTEM		GENERAL		general	Semantic	installation_type
					Semantic	heated_surface
		GENERATION	ON 12 098-1	ALL GENERATION	Semantic	generation_use
					Semantic	fuel_type
					Semantic	generator_position
			IN 15 316-4-1	BOILER	Semantic	generation_control
					Semantic	boiler_type
					Semantic	installation_period
					Semantic	smoke_evacuation_system
					Semantic	technical_reference

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

					Semantic	full_load_power
					Semantic	part_load_power
					Semantic	full_load_efficiency
					Semantic	part_load_efficiency
					Semantic	mean_water_temperature_full_load
					Semantic	mean_water_temperature_part_load
					Semantic	standby_heat_loss
					Semantic	seasonal_space_heating_energy_efficiency
			IN 15 316-4-2	HEAT PUMP	Semantic	heat_pump_type
					Semantic	installation_period
					Semantic	technical_reference
					Semantic	seasonal_cop
					Semantic	seasonal_eer
					Semantic	cop_standard_test_conditions
		DISTRIBUTION	IN 15 316-3	pipe dimension	Extract	building_dimension
					Extract	number_of_floor
					No	pipe_length
					Semantic	distribution_type

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

			distribution system characteristics	Semantic	construction_period
				Semantic	pipe_insulation_presence
				Semantic	pipe_insulation_thickness
				Semantic	pipe_insulation_material
			pump and pressure drop	Semantic	pipe_system_type
				Semantic	distribution_pump_control
				Semantic	pump_energy_efficiency
				Semantic	additional_pressure_resistances_objects
				Semantic	distributed_surface
				Semantic	distribution_temperature
				Semantic	emitter_type
		EMISSION	IN 15 316-2	Semantic	room_regulation_type
				Semantic	emitter_type
				Semantic	technical_reference_emitter
				Semantic	temperature_variations
				Semantic	radiant_factor
				Semantic	room height
				Semantic	nominal_emitter_power

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

		STORAGE	IN 15 316-5		
Energy Production		Photovoltaic Solar System	IN 15 316-4-3		

	Semantic	storage_volume
	Semantic	position_storage
	Semantic	storage_use
	Semantic	technical_reference_storage
	Semantic	storage_type_and_fuel
	Semantic	storage_auxiliary_power
Geometry and Surface	Semantic	solar_panel_tilt_angle
	Semantic	solar_panel_orientation
	Semantic	solar_panel_number_of_modules
	Semantic	solar_panel_surface
Technical Characteristics	Semantic	installation_period
	Semantic	solar_panel_technology
	Semantic	technical_reference

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

3. Annex 3 - create a room with "Sketch mode"

In the "create a room" function, simply select the "Sketch mode" or “Croquis à main levée”.

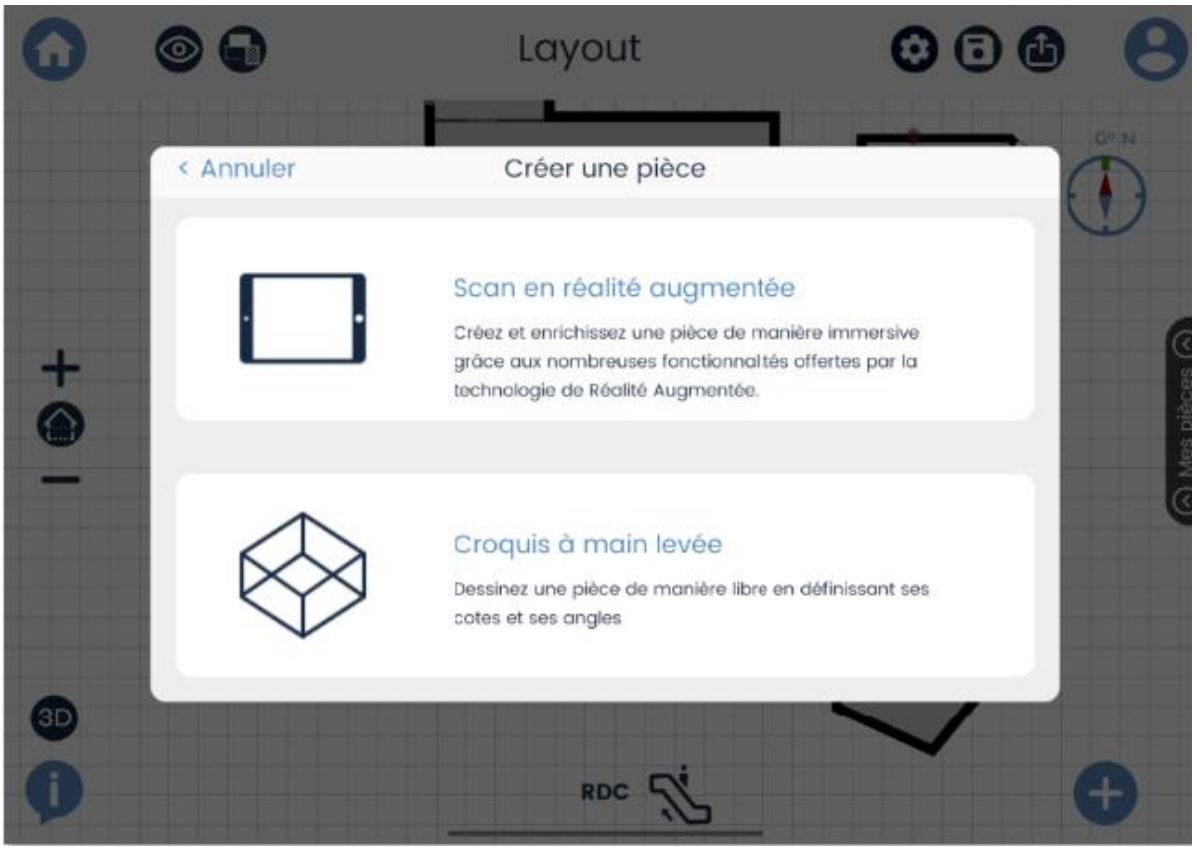


Figure 25: BIMEO Choosing the Acquisition Type

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

In this mode, the user positions the points on a plane using the different options such as perpendicular etc.

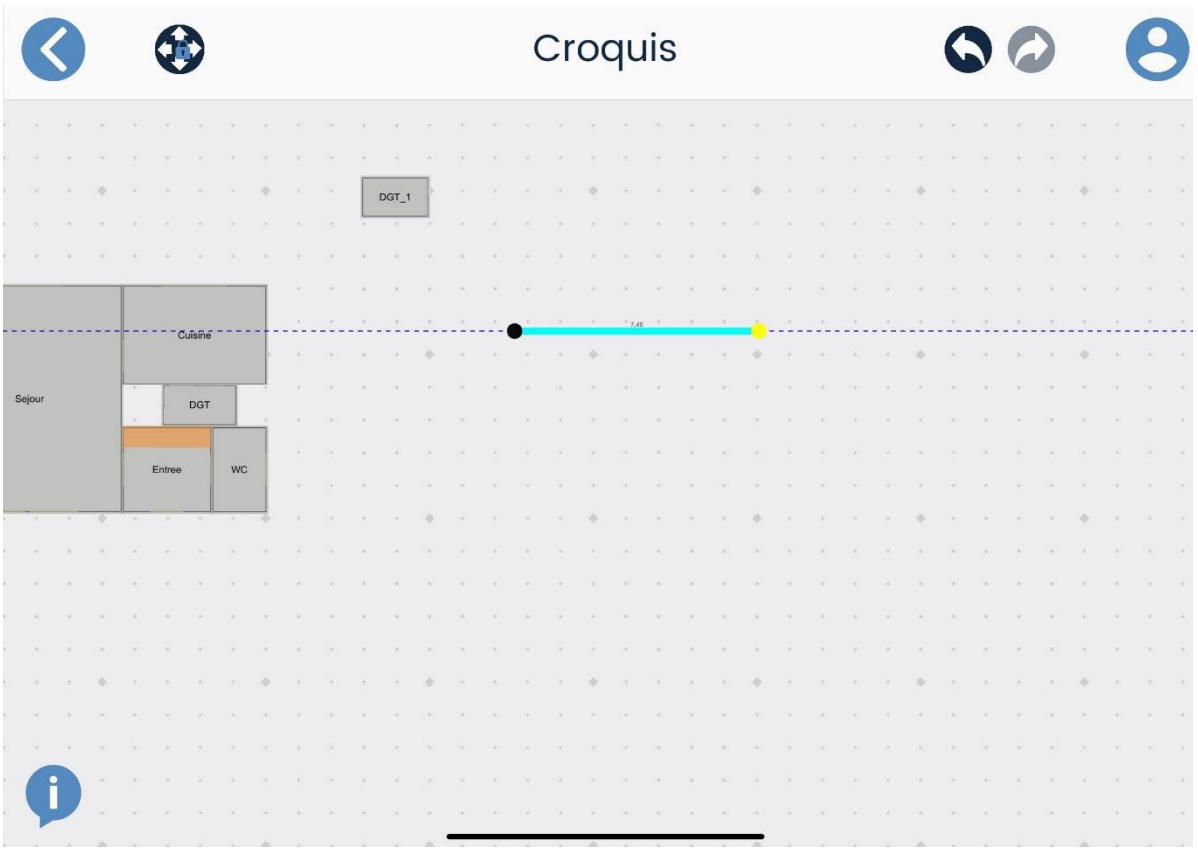


Figure 26 : Sketch Mode - First Point

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

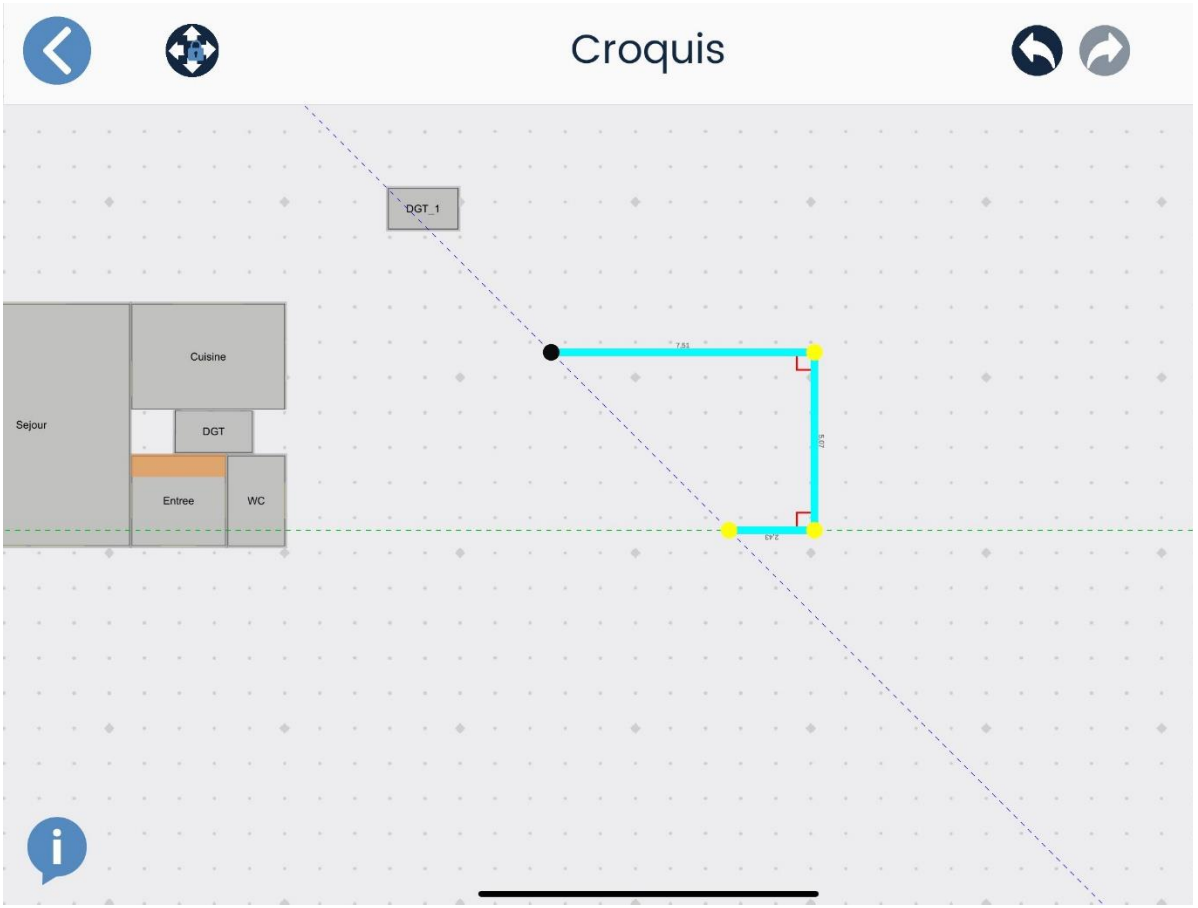


Figure 27: Sketch Mode - Intermediate Points

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

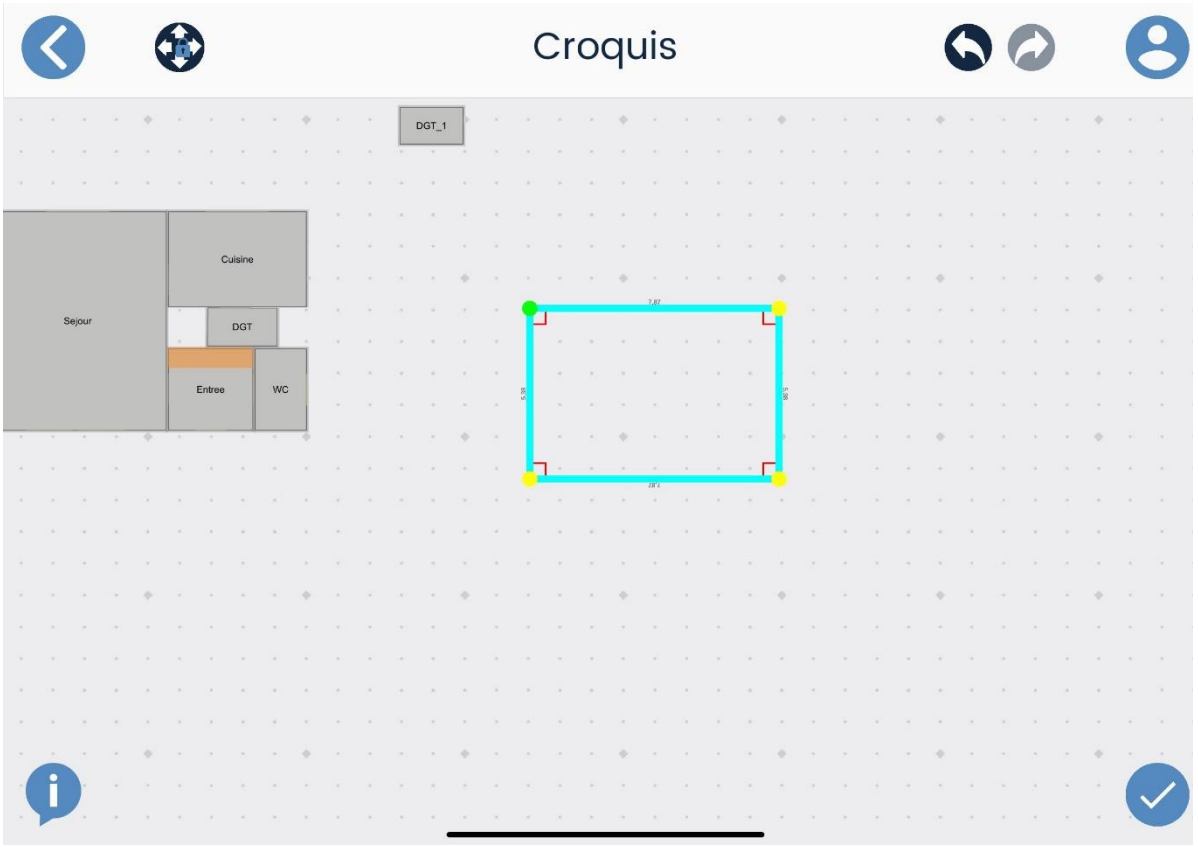


Figure 28 : Sketch Mode - Closing the Part

To validate the volume of the room the user enters the name of the room and the Ceiling Height (HSP).

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

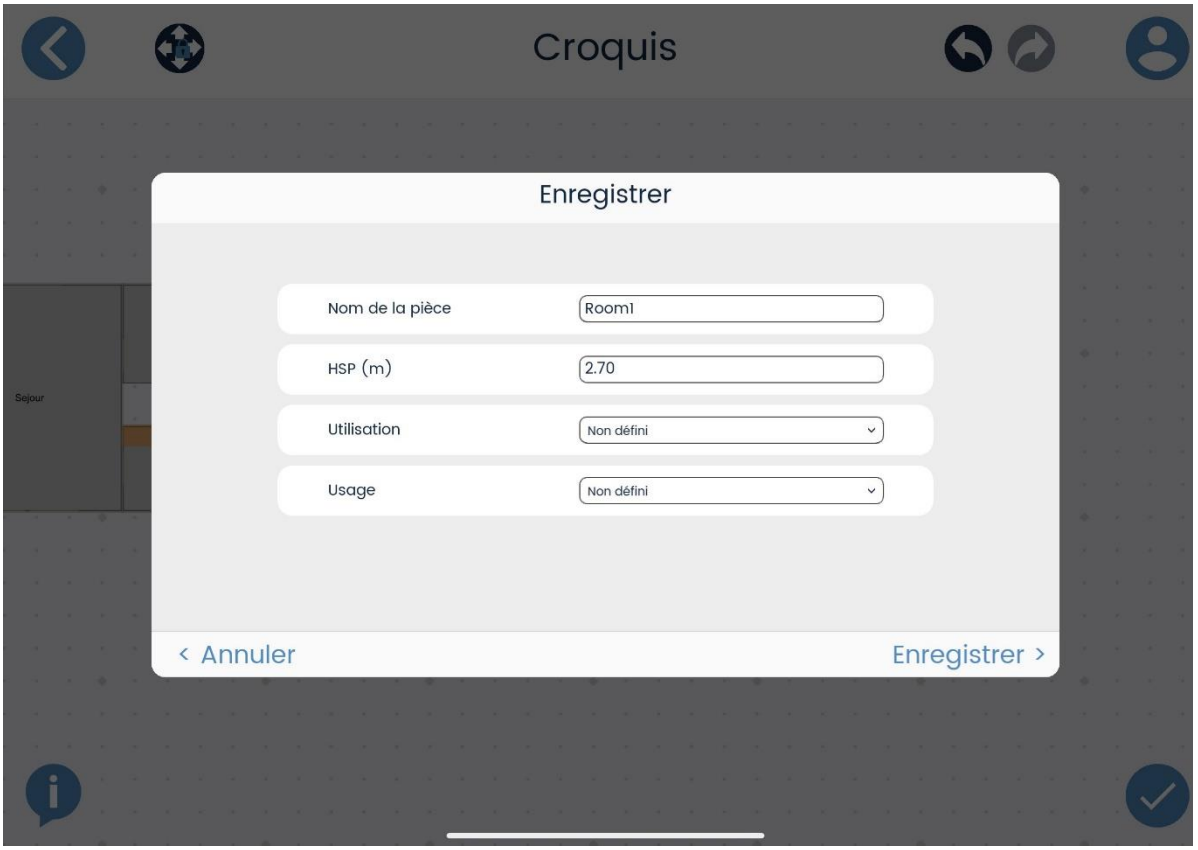


Figure 29 : Sketch Mode - Ceiling Height

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

The whole room can be modified indefinitely. You have the hand on the thickness/height of the walls, you can modify the angles etc.

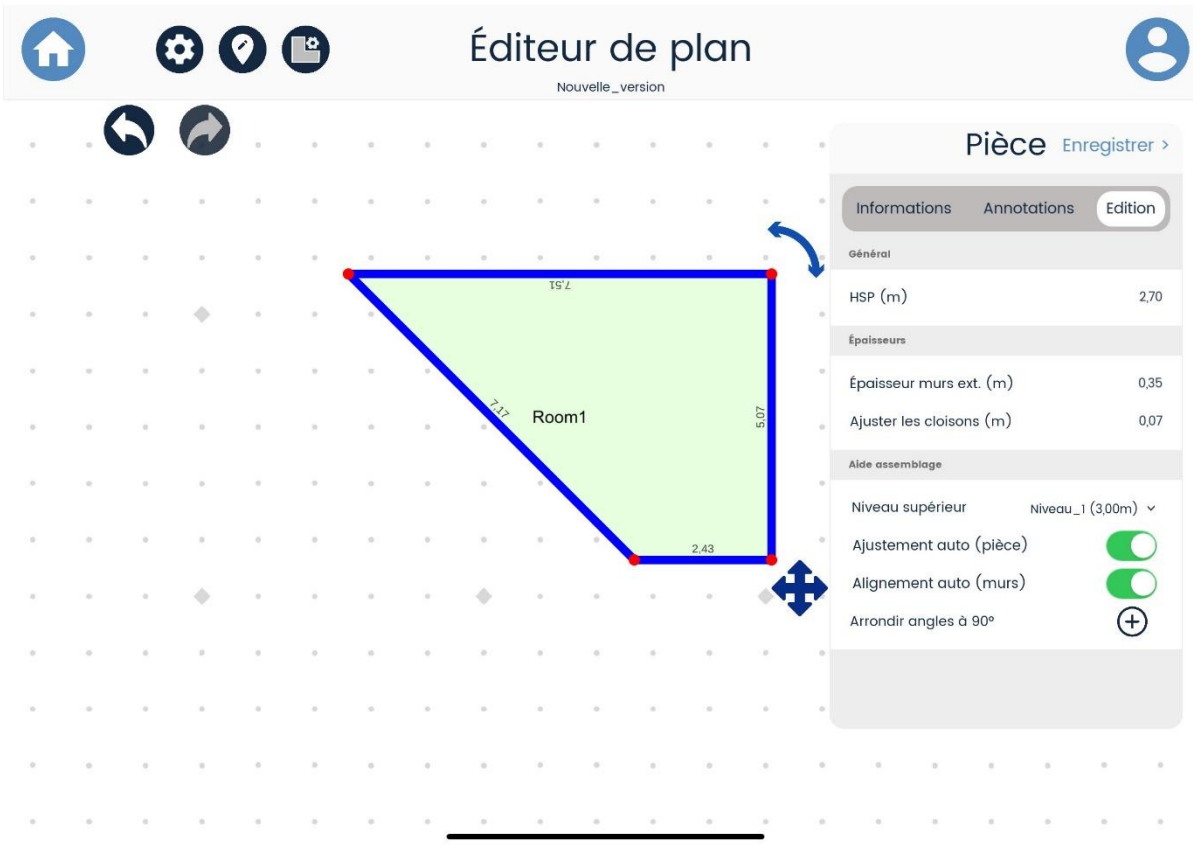


Figure 30 : Sketch Mode – Edition tab

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

This is where you add the questionnaire to the room.

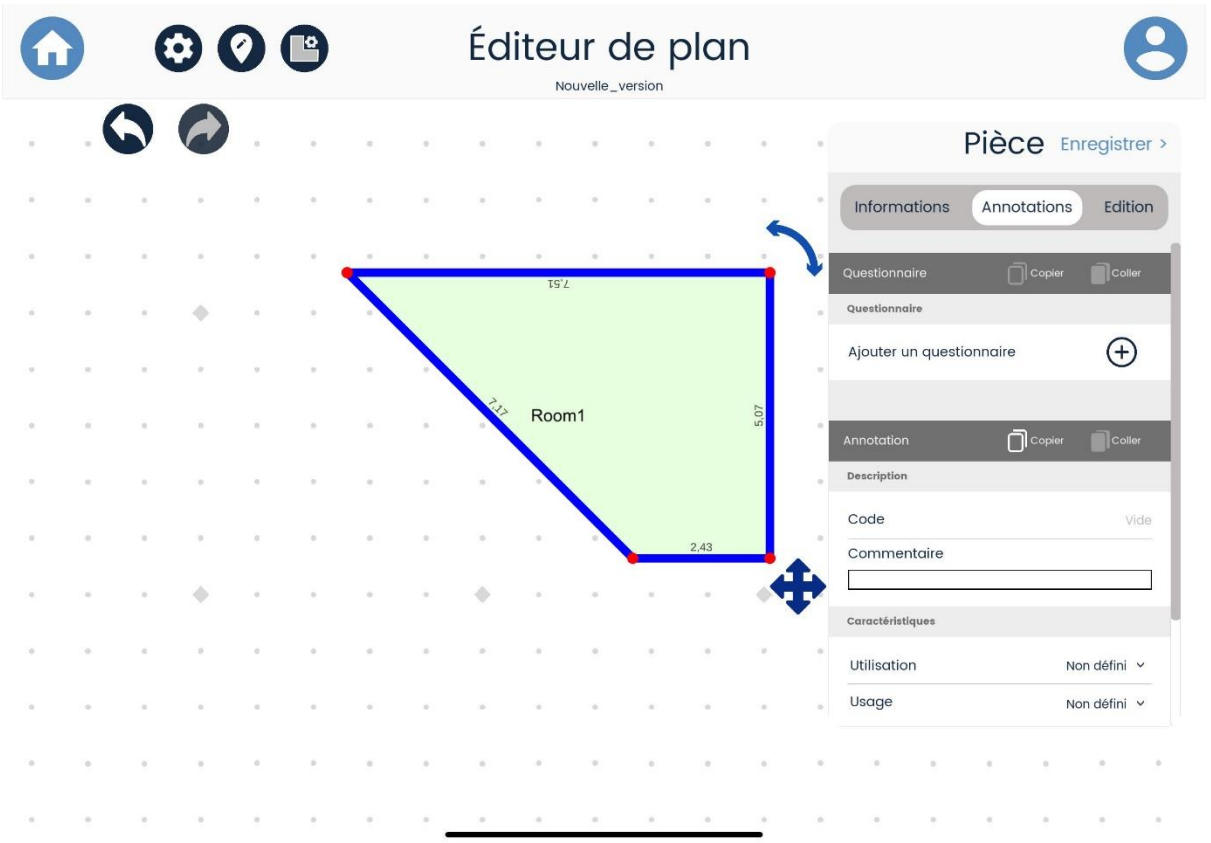


Figure 31 : Sketch Mode – Annotations tab

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Once these steps are validated you can view everything in this tab: “informations”.

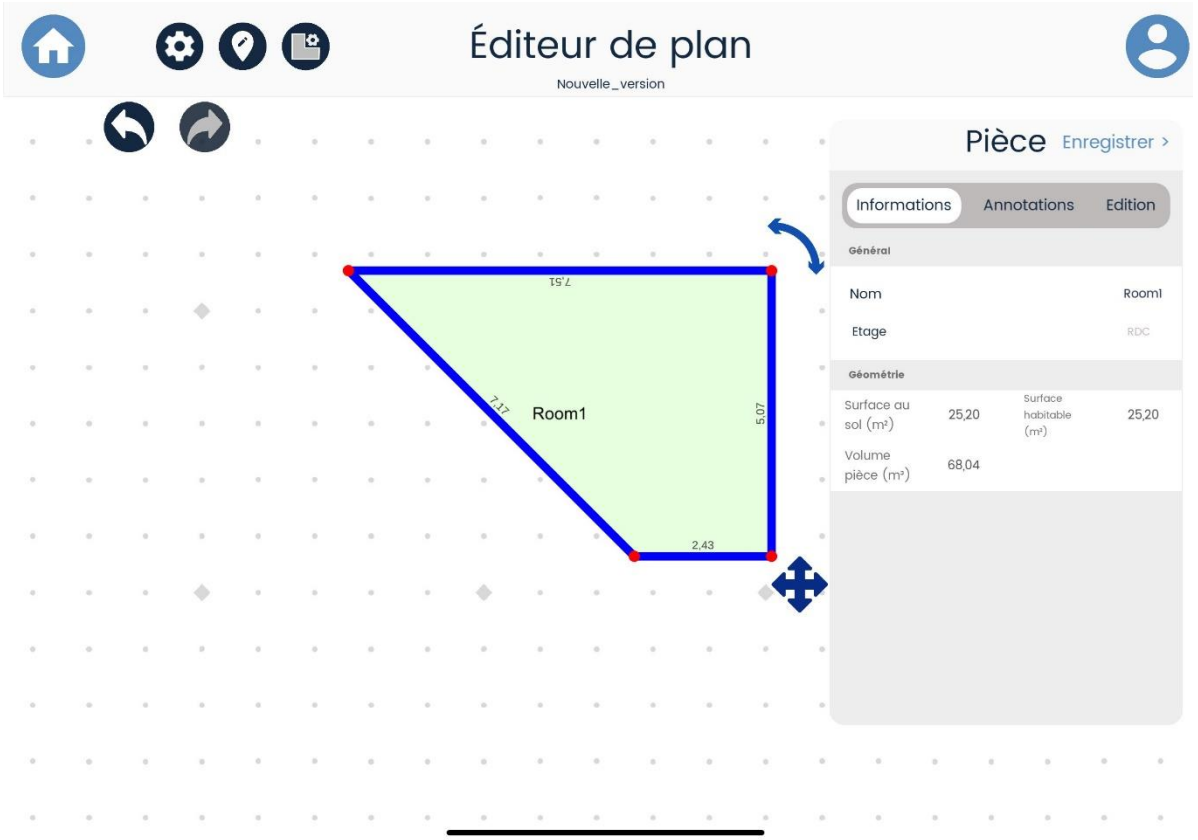


Figure 32: Sketch Mode Informations tab

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

Once completed, the part is built in its 3D geometry.

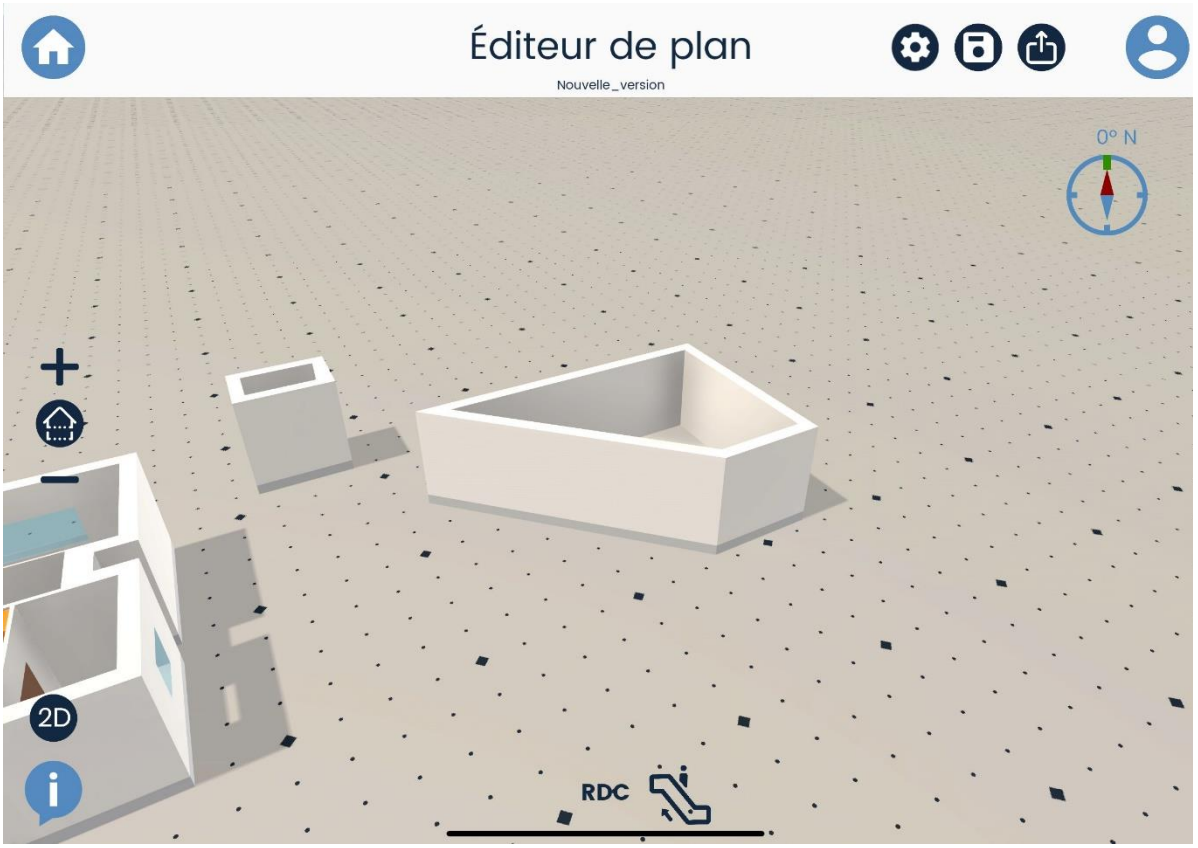


Figure 34: Sketch Mode - 3D View

This project received funding from the European Union's Horizon 2020 research and innovation program under grant agreement number 893118. The European Union is not responsible for the use that may be made of the information contained in this document, which only represents the point of view of the authors.

OUR TEAM

bimeo
CSTB le futur en construction
EDF
ENGIE
REHVA Federation of European Heating, Ventilation and Air Conditioning Associations
LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY LIST
R2M RESEARCH TO MARKET SOLUTION
tecnalia Inspiring Business
Fraunhofer IBP
ENBEE Environment & Building Energy Efficiency
POLITECNICO MILANO 1863

See you online!

www.epc-recast. EU
@epcrecast
@EpcRecast
EPC REDESIGN

R RELIABILITY
E ENERGY AND BEYOND
C COMPARABILITY
A AWARENESS, ACCEPTANCE & USER-FRIENDLINESS
S STANDARDS & SMART-READINESS
T TRANSPARENCY

EPC RECAST
ENERGY PERFORMANCE CERTIFICATE RECAST