

BIM4Ren

TRAINING

BIM2BEM

Interoperability between BIM and Building Energy Model (BEM), good practices and common barrier

ATI - Giacomo Marani



This project has received funding from the H2020 programme under Grant Agreement No. 820773

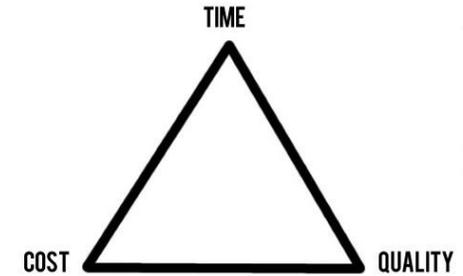
ATI | Project

CREATING A BETTER REALITY

Introduction

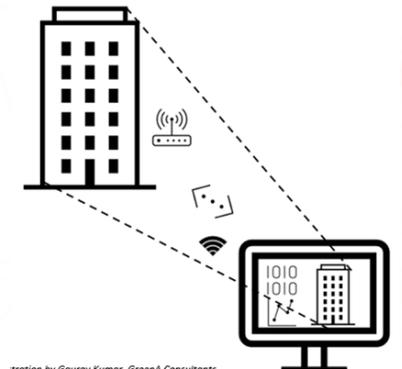


Building Information Modeling (BIM) is increasingly being adopted around the world to improve and accelerate productivity in building design and construction, reducing errors and reducing costs. To support energy-efficient design, many BIM platforms now integrate Building Energy Modeling (BEM) at the design stage, based on building geometry, location, and weather data inputs.



By increasing the level of information related to the energy consumption of the equipment and the actual measured performance of the building, the accuracy of the BEM within the BIM environment can be further improved.

This will help make better design decisions, as well as enable a more comprehensive "digital twin" that gives facilities operations and maintenance teams a comprehensive and unified view of all architectural and energy features.



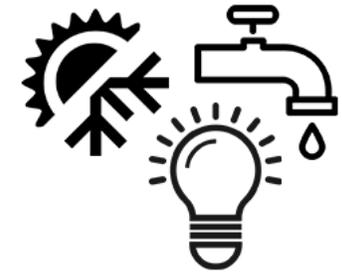
Energy design and simulation



The tools for the energy performance of buildings can be divided into two parts:

1. Design tools: they are intended to size the optimal mechanical and electrical systems, taking into account the worst-case scenarios.

2. Simulation tools: These include dynamic simulation typically for a duration of one year. Three parameters are taken into account: the building envelope, the equipment and the control and use scenario. They are used to assess energy demand, the quality of the indoor environment, carbon dioxide emissions and the payback periods of energy saving measures.



Responsibility for energy design?



Architectural
Designer

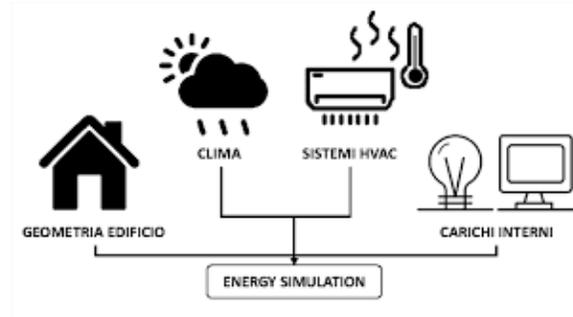


MEP
Designer

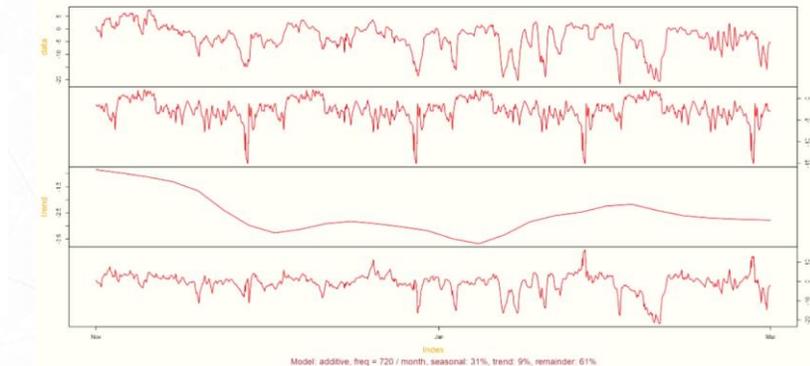
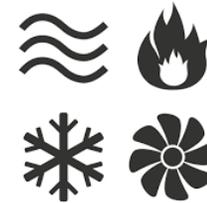
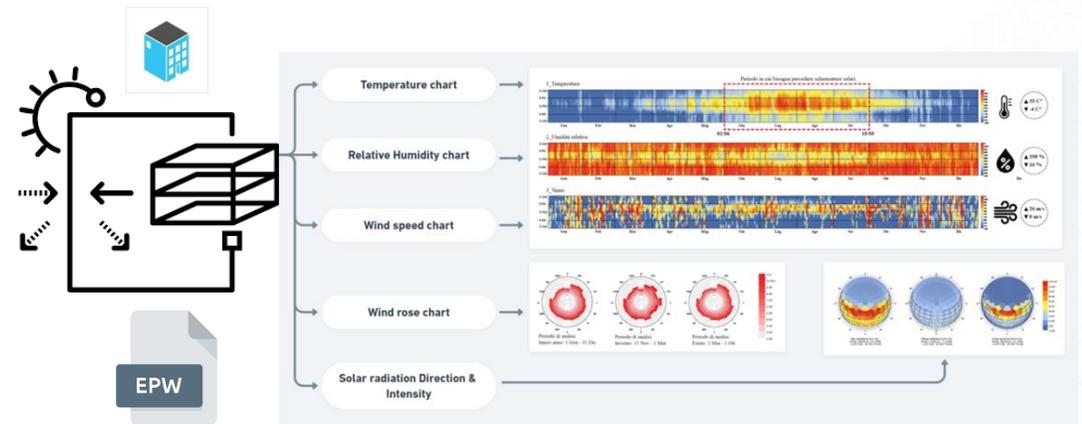
Objectives of the energy analysis

Energy workflow: standardized procedure for the preliminary analysis of the project of Climatic Context, Building, Shadow Mask, Solar Radiation, Illuminance etc.

- Determine how the context affects the building's energy consumption.



- Determine how internal loads (People, Equipment, Lights) affect the trend of the winter and summer peak load for the sizing of HVAC systems.



Understanding the transition process



This Training was developed to help BIM project users transfer architectural models to building performance analysis software to access information on daylighting, heating and cooling loads, LEED credits, energy consumption, and comfort data for building design.

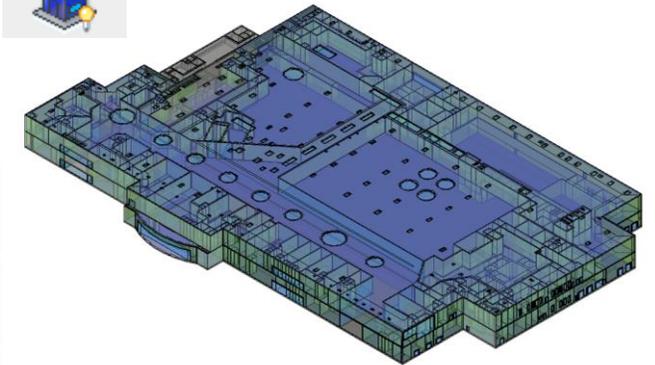
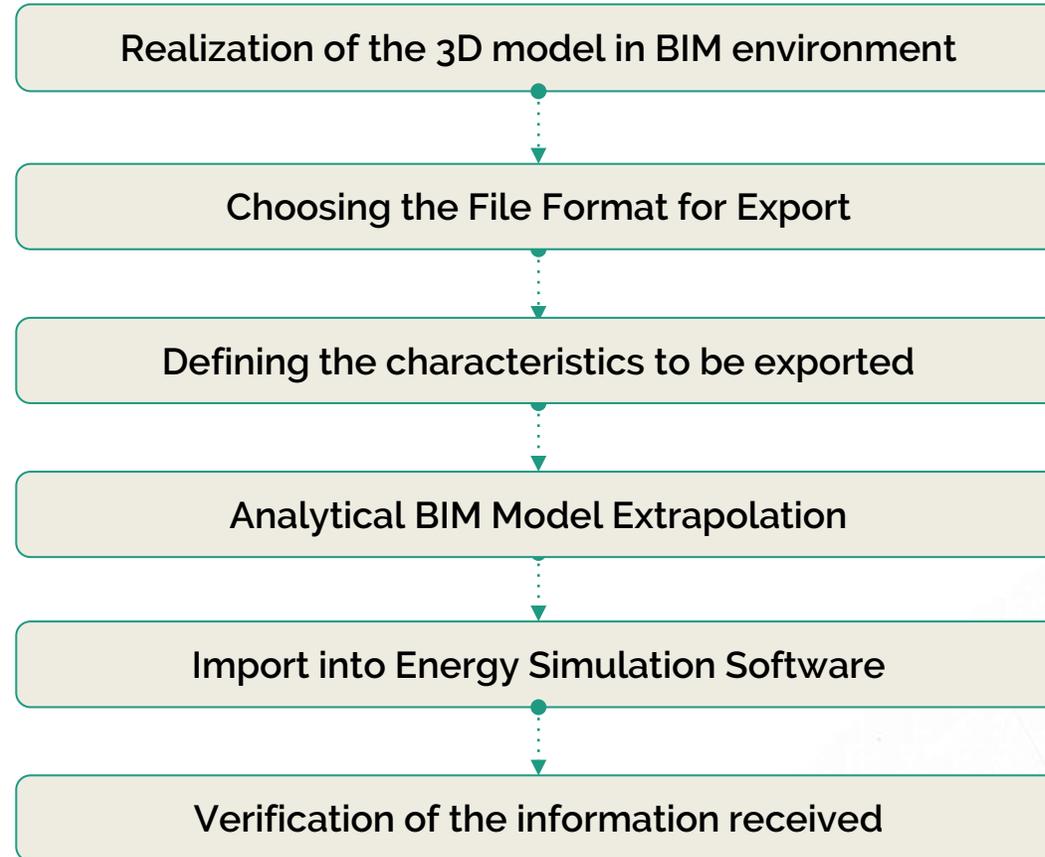
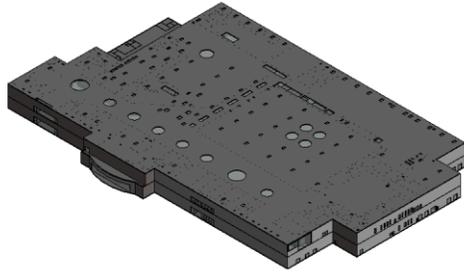


Although native BIM data provides considerable "intelligence" compared to more basic data, which consists of shapes and lines, it does not contain the volumetric/zone data required by building performance analysis tools such as IES-VE. This data must be superimposed on the native architectural model which is called the "Analytical Model" because it is the model on which the subsequent analysis is based.

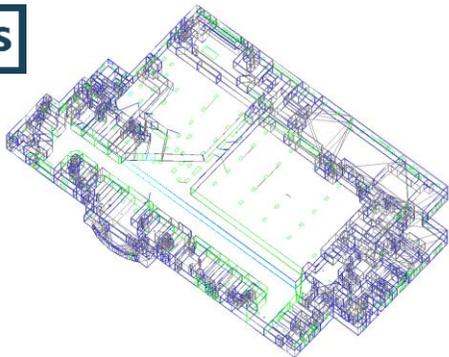
Workflow for BIM2BEM Interoperability



R



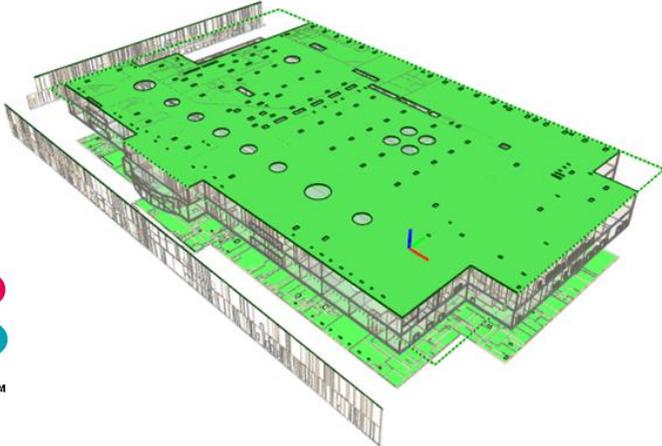
IES



Realization of the 3D model in BIM environment

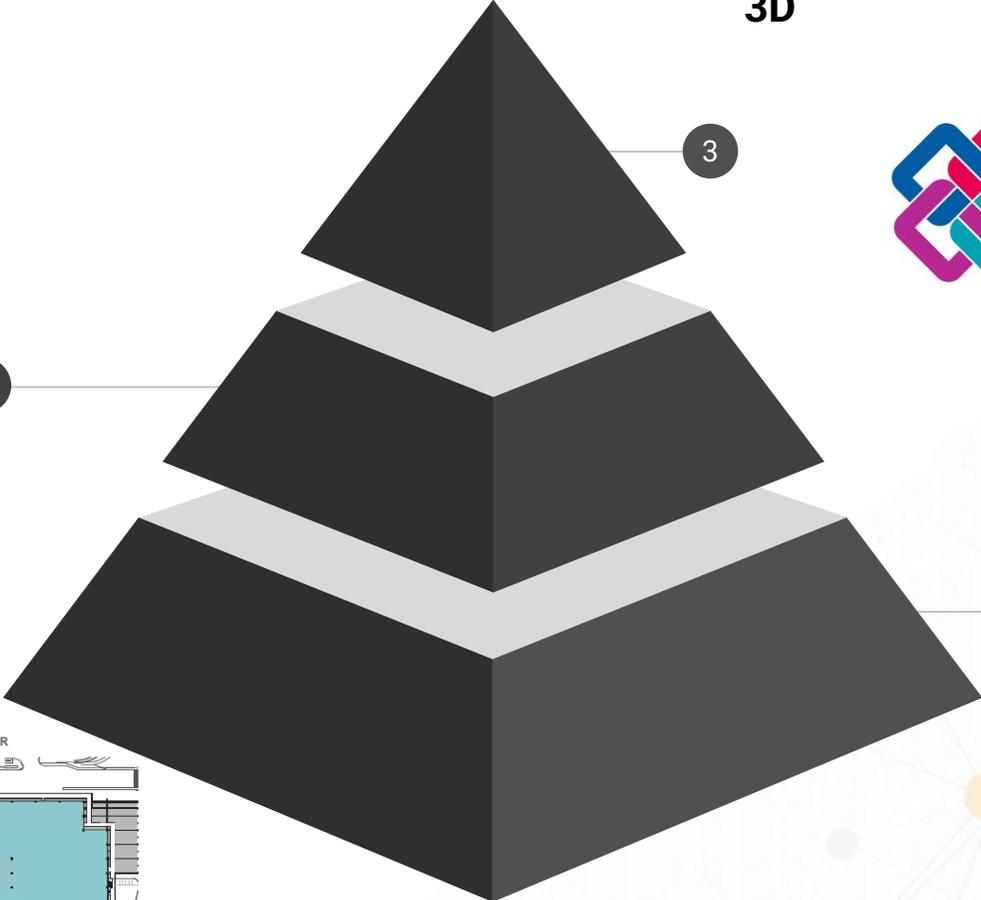


Creazione Modello 3D

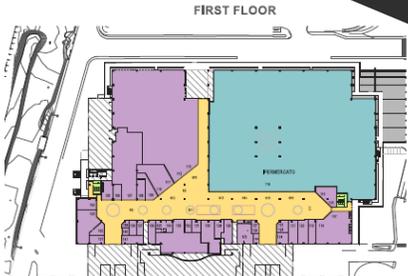
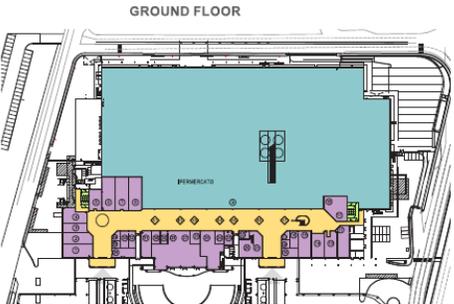


Conversione 2D

plans2bim



Inputs Data



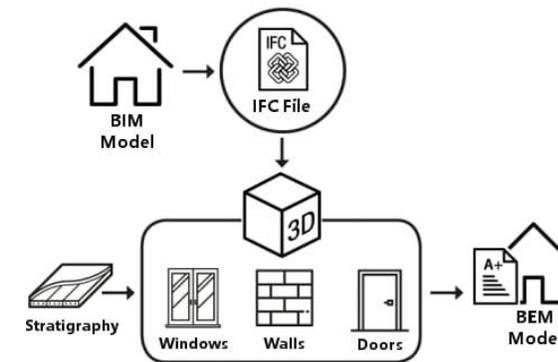
H2020 G.A. 820773



Choosing the File Format for Export

BIM software packages offer several possibilities to extract model data. One option is to generate "lists" or "schedules," and then create an output file in one of the industry-standard protocol formats:

- IFC = IFC is "the open and neutral data format for openBIM". It is an output format for sharing with different applications and groups. The limitation of this format is that it cannot be changed. Therefore, all required changes must be made to the source (i.e. within the BIM software).
- gbXML = Green Building XML. "An industry-supported scheme for sharing building information between disparate building design software tools... It allows you to share information with each other with 3D models (BIM) and analysis software."



Defining the characteristics to be exported



Features to be transmitted

Climate Context

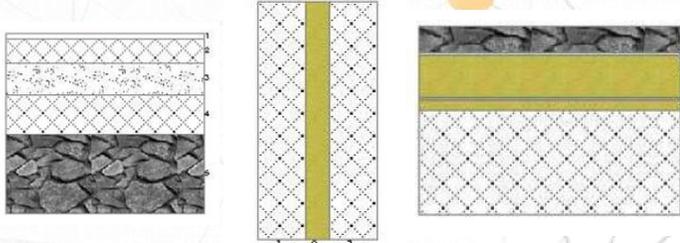
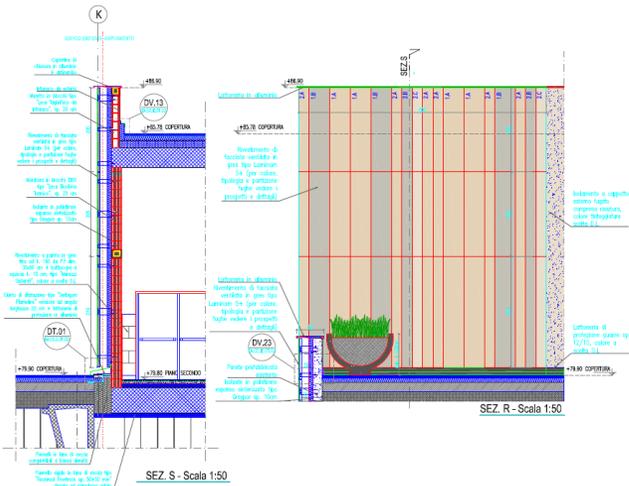
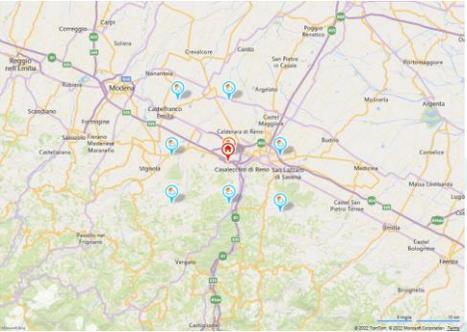
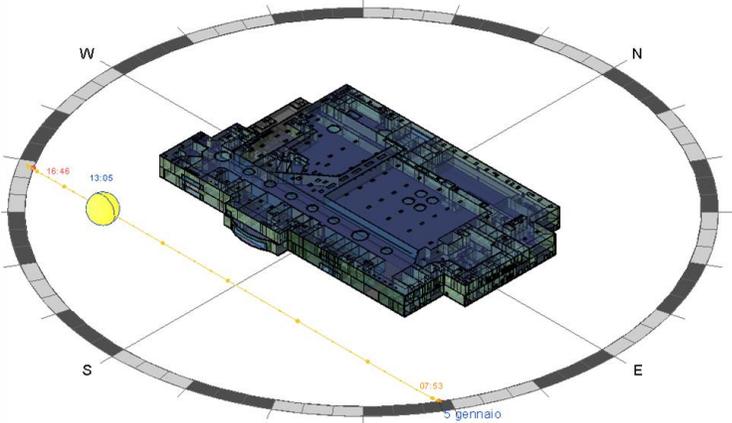
Orientation of the building

Features of the casing

Material properties

Geometry

Internal Loads



Defining the characteristics to be exported

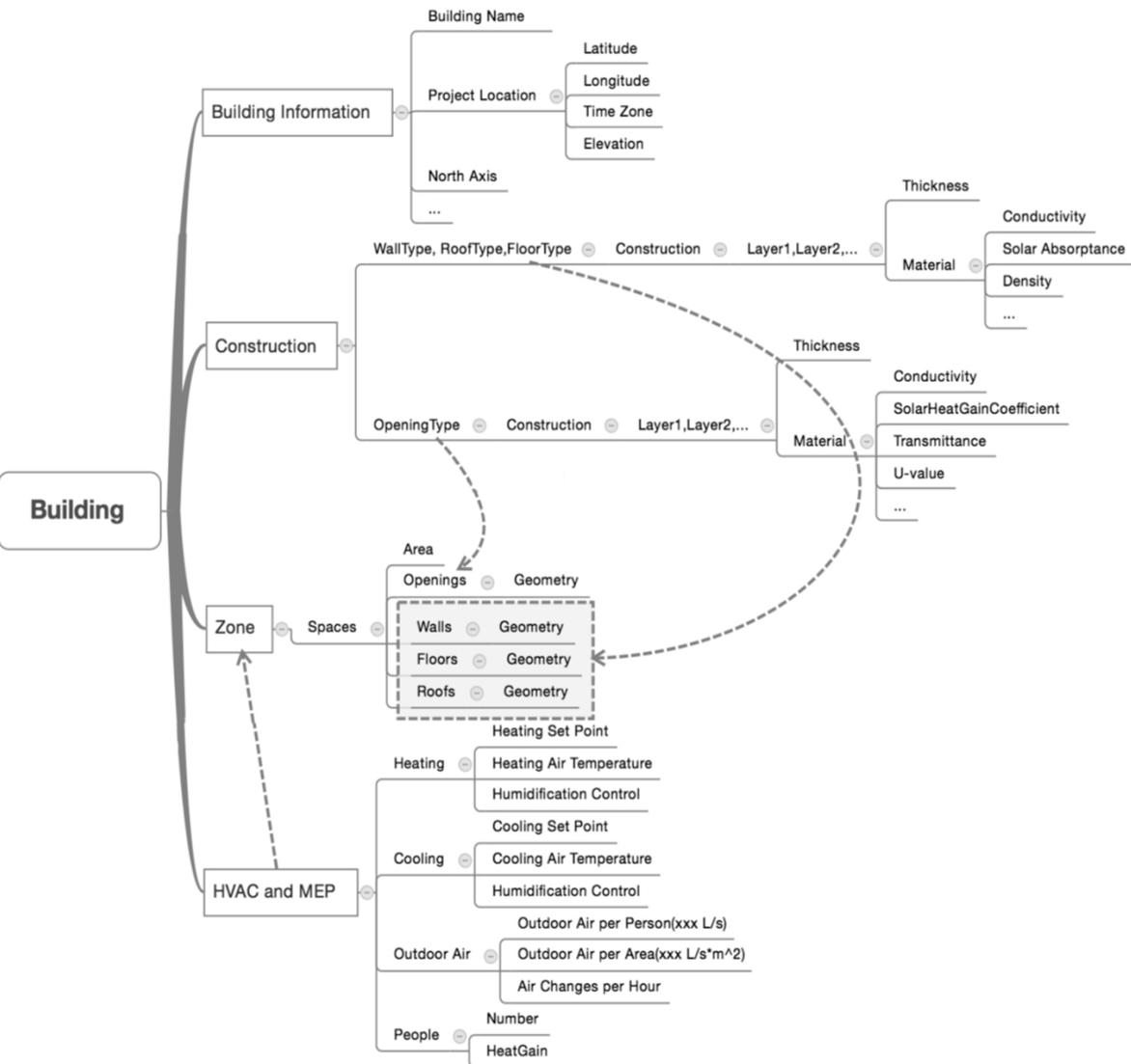


Table 1. Exchange BIM-BPS formats. Own elaboration based on Autodesk manuals and tests. Self Elaboration.

DXF	gbXML	ifcXML
Drawing Exchange Format	Green Building extensible markup language	Industry Foundation Classes
<ul style="list-style-type: none"> - Geometry (2d/3d) - Layers - Materials* 	<ul style="list-style-type: none"> - Building Type - Building Location - Geometry - Orientation - Area - Volume - Openings Location and Size (windows/doors) - Lighting, Electrical and Occupancy Loads* - Space Type* - Condition Type* - HVAC Heating and Cooling Setpoints* - Outside Air* - Materials** 	<ul style="list-style-type: none"> - Full geometric description in 3D - Object location and relationships - Properties (or parameters) of each object. - Structural, mechanical and energy analysis applications. - IfcSpaces

* Exported when they are added to Revit MEP models.

** depends on the BPS target software (i.e. Ecotect does recognize Materials, but Revit Architecture does not export them correctly).



The preparation of the Revit analytical model is critical to the success of the transition process.

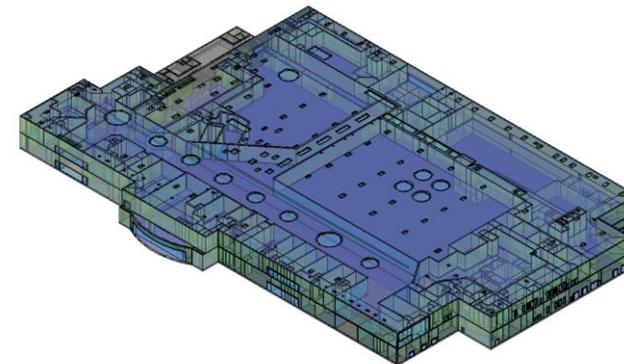
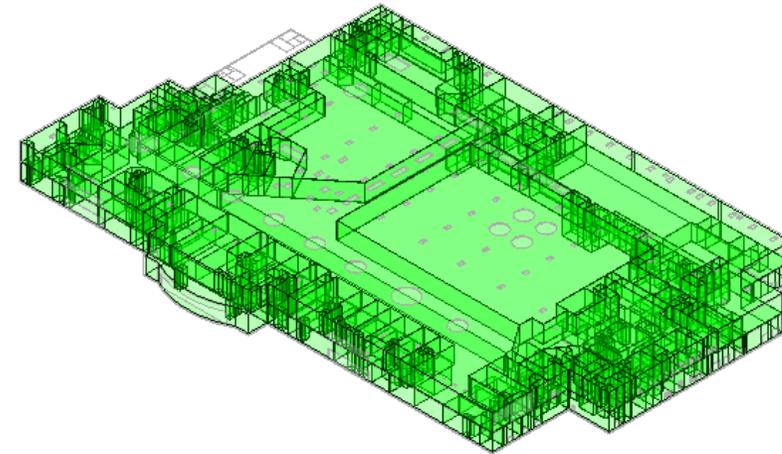


The analytical model is based on the definition of environments that overlap with the underlying Revit architectural model.

Any gbXML subsequently generated is based only on the analytical model and not on the underlying Revit architectural model.

<gbXML/>

You can usually create and make changes to the analytical model without modifying the underlying Revit model.





An effective energy analysis can only be performed if all areas of the model are defined by the room components in the building model, and the entire volume of the building model is included.

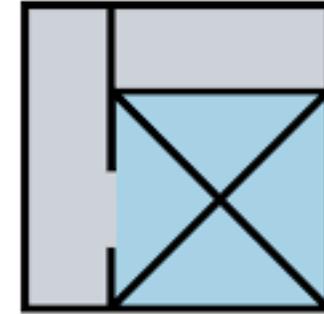
The gbXML data exported from Revit is primarily based on rooms and their bounding elements. IES' gbXML import mechanism identifies and converts these rooms into blocks and zones. Other building components such as doors, windows, and shading surfaces are also automatically created.



Spaces and Rooms

Creating Rooms: they keep information about the subdivisions of the space within the building. Rooms are used as DBs for a variety of parameters that affect the subsequent analysis of building performance, such as volumes and geometry of delimitation elements.

Definition of boundary components : The Volume of a room is defined by limit parameters and Elements that delimit the room. If the boundary elements of the room are within the range of the defined boundaries of the room, Revit uses the space defined by the boundary elements of the room when calculating the volume.

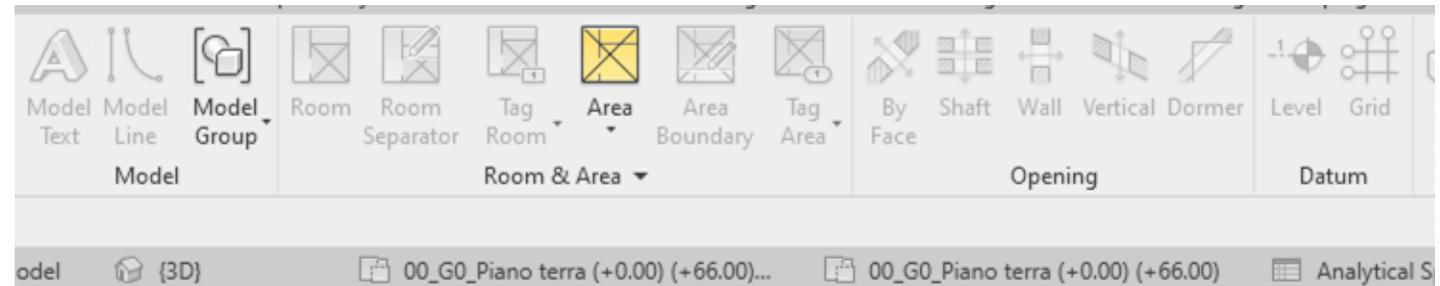


Calculation of the Zone Volume



The calculation of the volume for a space is based on its components of delimitation of the room and is calculated as the area of its base multiplied by the height of the space. In Revit, both the area and the volume are calculated based on the faces of the wall.

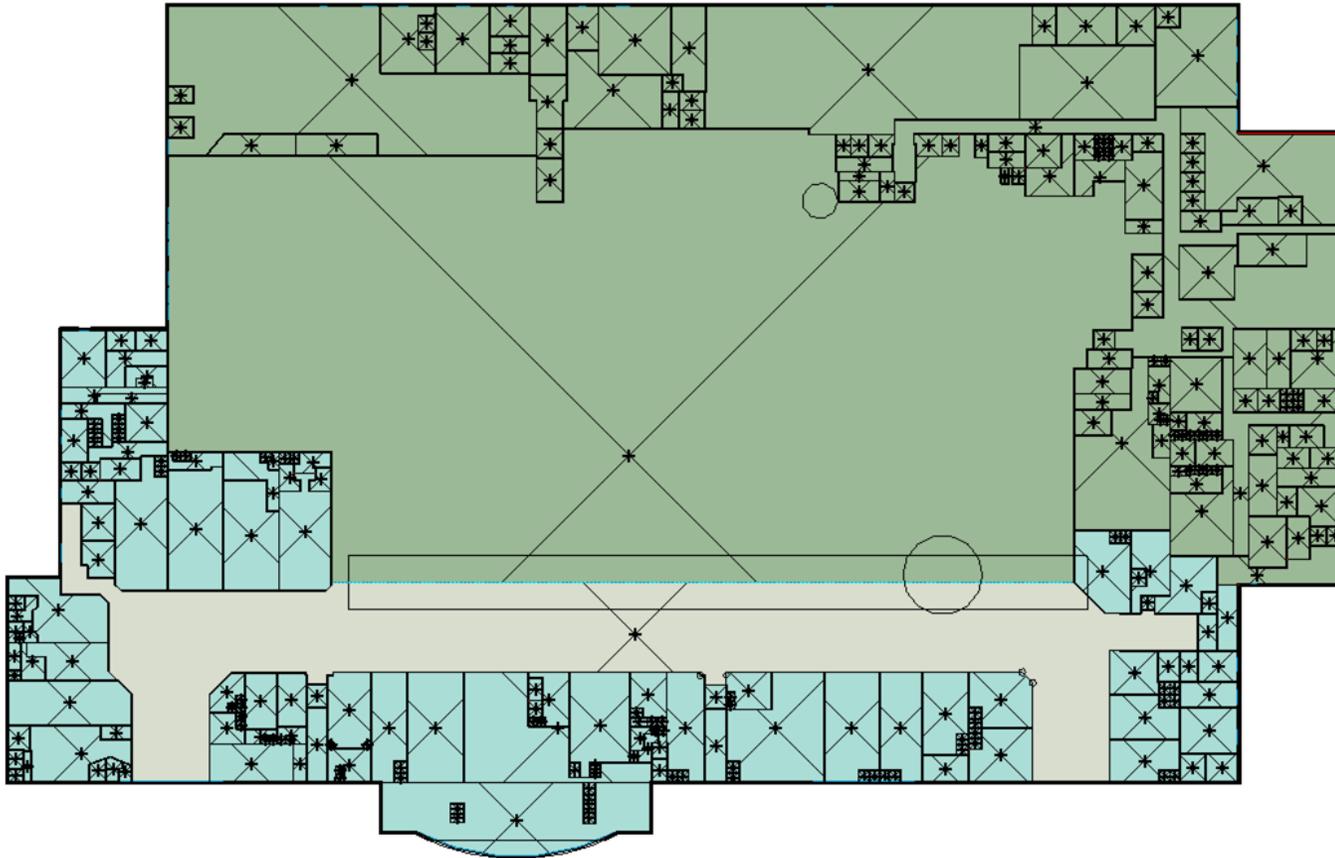
By default Revit does not calculate room volumes, you need to turn on "Area and Volumes".



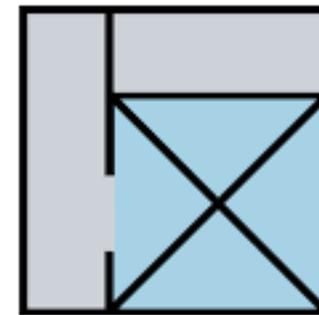
	
PROGETTO	Gran Reno
CLIENTE	Shopville Gran Reno
DATA	09.09.2019.
LOCALITA'	Bologna
FASE	Progetto esecutivo



It is necessary to create a room for all occupied and unoccupied spaces. After placing the components of the room in all areas of a plant, you can export the project as a gbXML file.

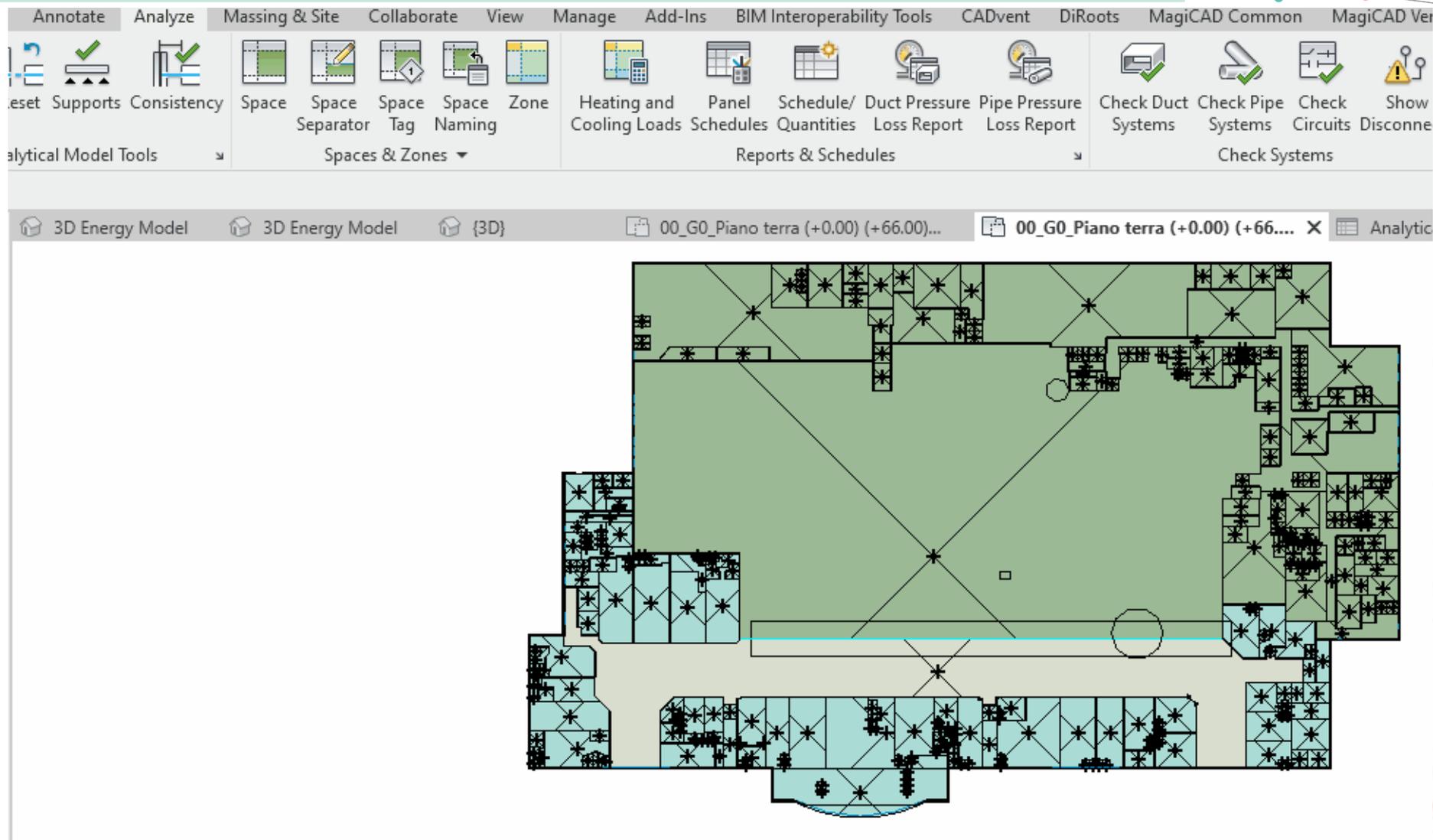
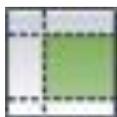


To facilitate the visualization of the rooms it is possible to activate the visibility of the rooms in plan to make the rooms and their reference lines visible.

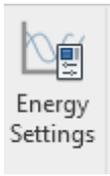
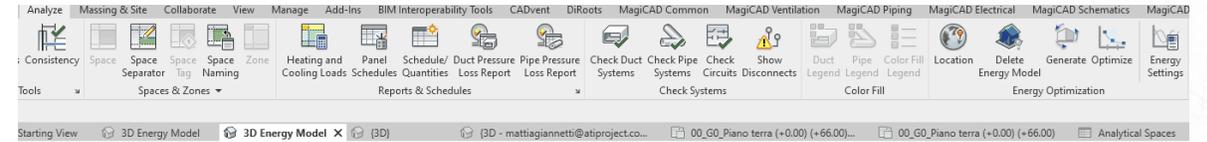


Room Creation

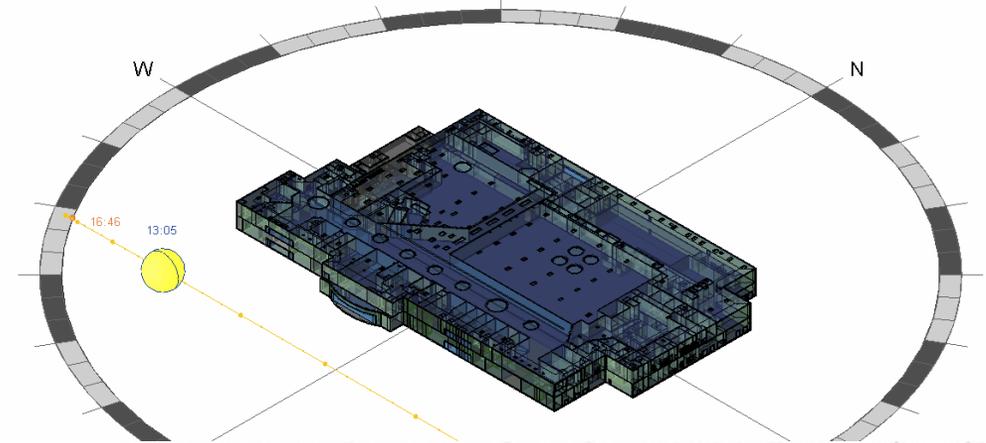
Once the model is populated with the rooms, creating the spaces connected to the latter is an automated process



Analytical BIM Model Extrapolation

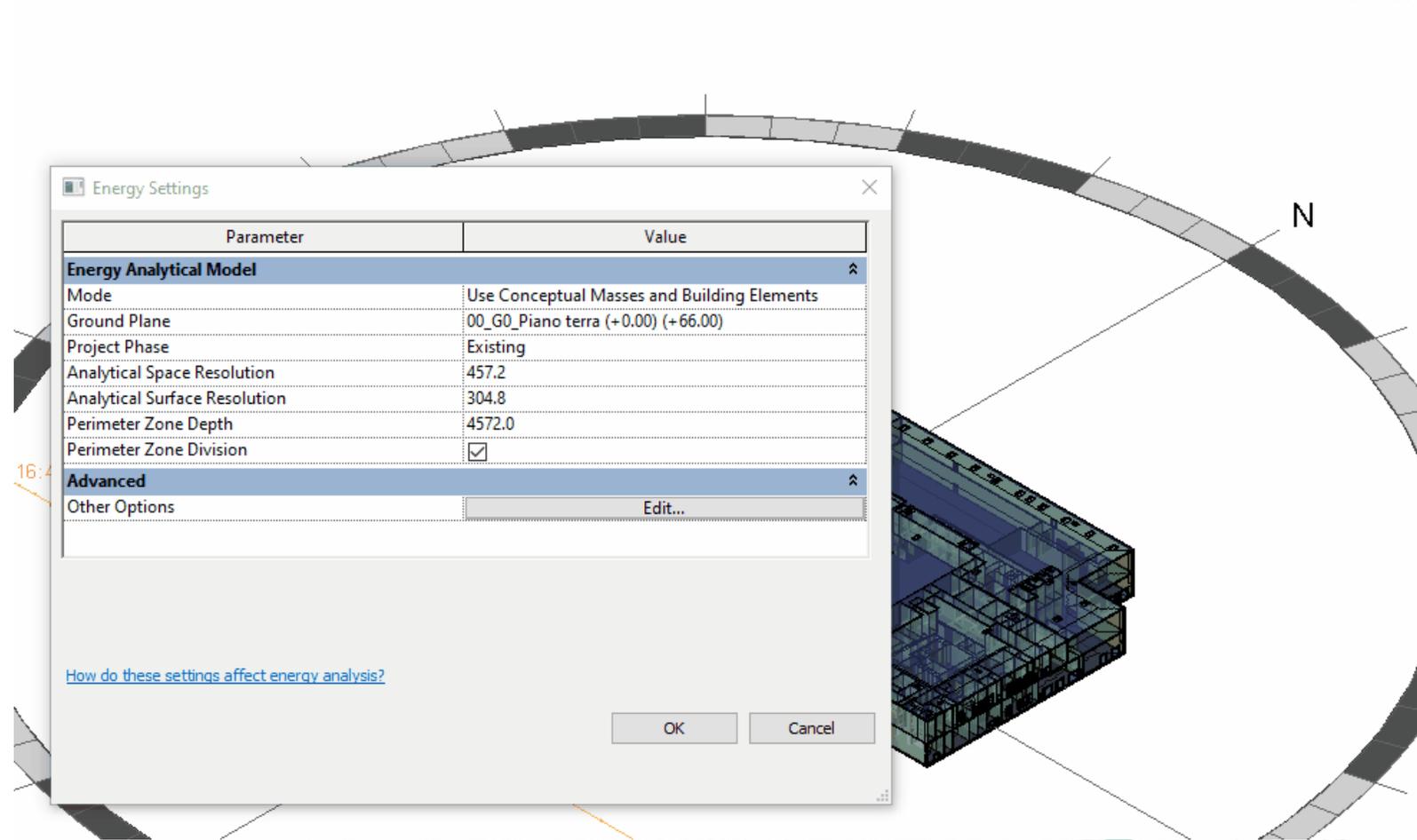


Energy analysis settings are available to help control the parameters that define the values and are subsequently exported to the gbXML file.



When this parameter is set to Rooms, Revit passes the Local object name and the corresponding analytic compartment number.

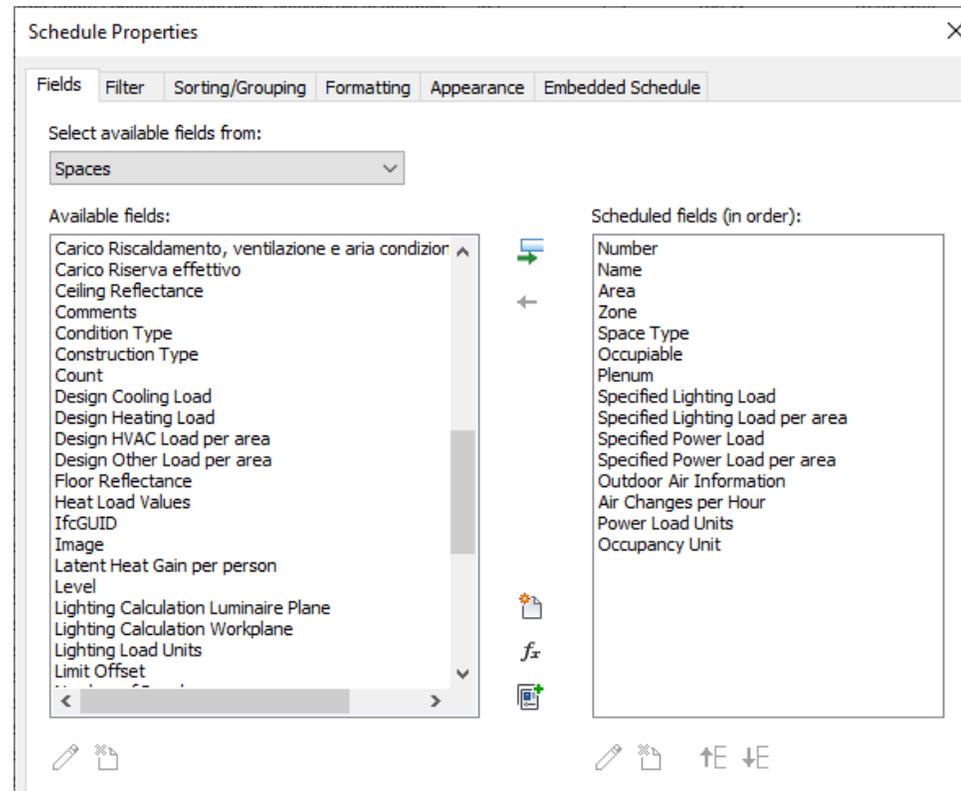
When set to Spaces, Revit transfers the following information for use in the analysis: object name and compartment number, occupation, lighting, equipment, and area.



Parameters Export Rooms



Creation of an schedule for checking the parameters to be assigned to the compartments



<Space Schedule>

B	C	D	E	F	G	H	I	J	K	L	M	N	O
Name	Area	Zone	Space Type	Occupiable	Plenum	Specified Lighting	Specified Lighting	Specified Power Load	Specified Power L	Outdoor Air Inform	Air Changes per H	Power Load Units	Occupancy Unit
lpermarket - First Floor	19 m²	HVAC_Zone_First_Floor	Area negozi centro commerciale: commercio al dettaglio	<input checked="" type="checkbox"/>	<input type="checkbox"/>	357 W	18.30 W/m²	210 W	10.76 W/m²	From Space Type	3	Power Density	By Space Type
lpermarket - First Floor	10 m²	HVAC_Zone_First_Floor	Area negozi centro commerciale: commercio al dettaglio	<input checked="" type="checkbox"/>	<input type="checkbox"/>	188 W	18.30 W/m²	110 W	10.76 W/m²	From Space Type	3	Power Density	By Space Type
lpermarket - First Floor	10 m²	HVAC_Zone_First_Floor	Area negozi centro commerciale: commercio al dettaglio	<input checked="" type="checkbox"/>	<input type="checkbox"/>	187 W	18.30 W/m²	110 W	10.76 W/m²	From Space Type	3	Power Density	By Space Type



Parameters Export



Define the type of intended use, through the type compartments

Space Type Settings

Filter:

<Building>
Aereo/treno/autobus: area bagagli
Aeroporto: corridoio
Albergo/centro congressi: congressi/incontri
Alloggi: stazione di polizia/pompieri
Alloggiamento: albergo
Alloggiamento: dormitorio
Alloggiamento: motel
Altre aree gare per riprese televisive: arena sportiva
Area clienti della banca
Area di lettura: biblioteca
Area di parcheggio/pedonale: parcheggio coperto
Area di parcheggio/solo con custode: parcheggio coperto
Area di pratica degli sport: arena sportiva
Area di vendita generica: commercio al dettaglio
Area di vendita grandi superfici: commercio al dettaglio
Area di vendita negozi specializzati: commercio al dettaglio
Area di vendita servizi personali: commercio al dettaglio
Area di vendita supermercato: commercio al dettaglio
Area esercizi: centro sportivo
Area esercizi: palestra
Area esposizioni: centro congressi
Area negozi centro commerciale: commercio al dettaglio
Area operazioni bancarie: ufficio
Area smistamento: ufficio postale
Area sport da ring: arena sportiva
Area vendita articoli pregiati: commercio al dettaglio

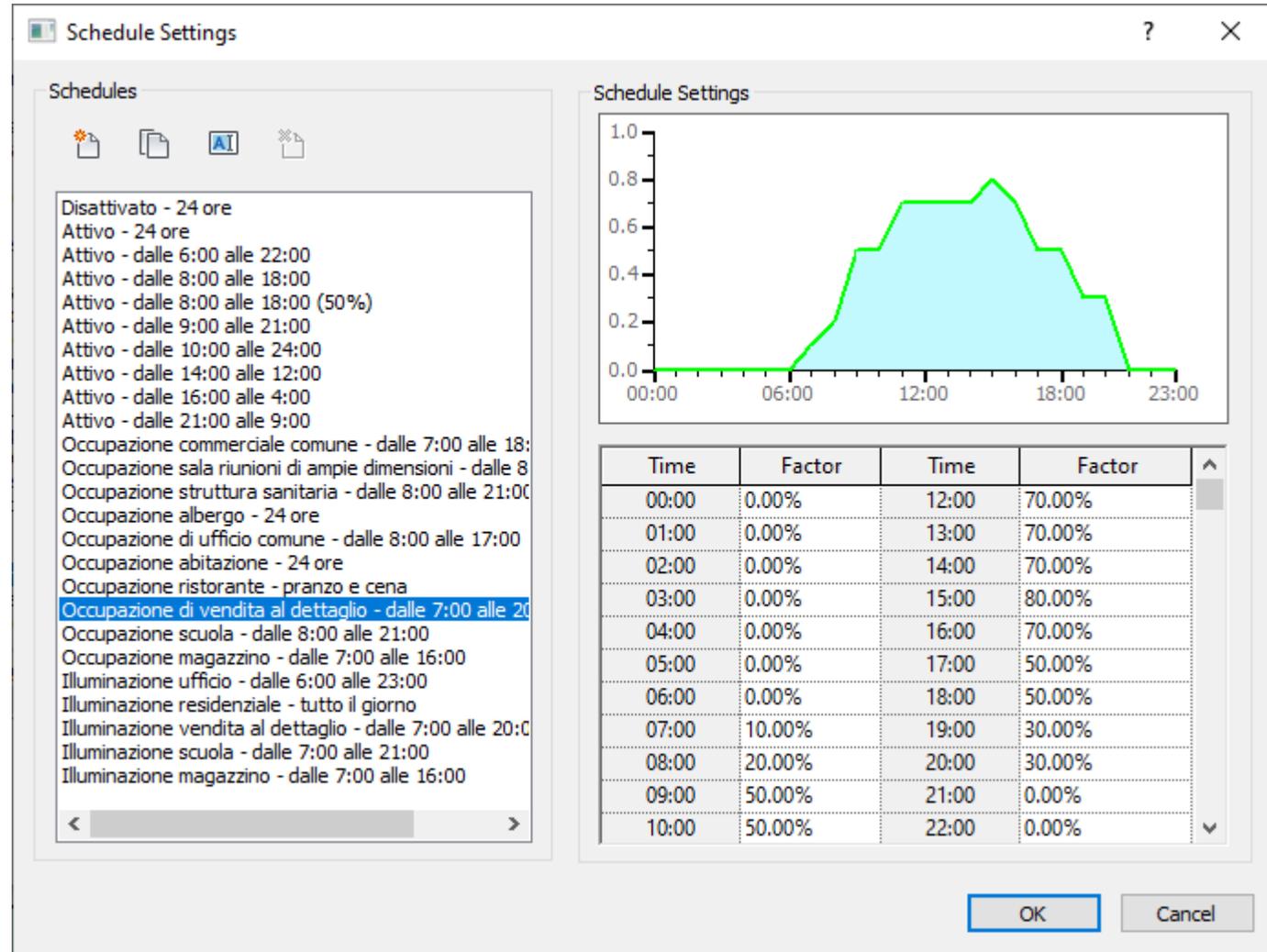
Parameter	Value
Energy Analysis	
Area per Person	2.500 m ²
Sensible Heat Gain per person	73.27 W
Latent Heat Gain per person	58.61 W
Lighting Load Density	18.30 W/m ²
Power Load Density	10.76 W/m ²
Plenum Lighting Contribution	20.0000%
Occupancy Schedule	Occupazione di vendita al dettaglio - dalle 7:00 alle 20:00
Lighting Schedule	Illuminazione vendita al dettaglio - dalle 7:00 alle 20:00
Power Schedule	Illuminazione vendita al dettaglio - dalle 7:00 alle 20:00
Outdoor Air per Person	3.54 L/s
Outdoor Air per Area	0.61 L/(s·m ²)
Air Changes per Hour	3.000000
Outdoor Air Method	by People and by Area

OK Cancel

Parameters Export



Define the occupancy schedule of the compartment. That will be used to define the internal peak loads within the energy model

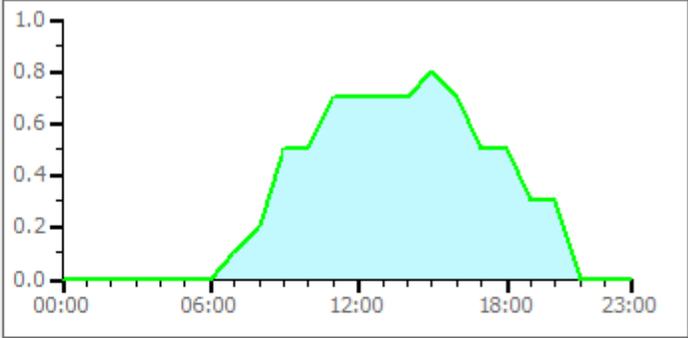


Schedule Settings

Schedules

- Disattivato - 24 ore
- Attivo - 24 ore
- Attivo - dalle 6:00 alle 22:00
- Attivo - dalle 8:00 alle 18:00
- Attivo - dalle 8:00 alle 18:00 (50%)
- Attivo - dalle 9:00 alle 21:00
- Attivo - dalle 10:00 alle 24:00
- Attivo - dalle 14:00 alle 12:00
- Attivo - dalle 16:00 alle 4:00
- Attivo - dalle 21:00 alle 9:00
- Occupazione commerciale comune - dalle 7:00 alle 18:00
- Occupazione sala riunioni di ampie dimensioni - dalle 8:00 alle 18:00
- Occupazione struttura sanitaria - dalle 8:00 alle 21:00
- Occupazione albergo - 24 ore
- Occupazione di ufficio comune - dalle 8:00 alle 17:00
- Occupazione abitazione - 24 ore
- Occupazione ristorante - pranzo e cena
- Occupazione di vendita al dettaglio - dalle 7:00 alle 20:00**
- Occupazione scuola - dalle 8:00 alle 21:00
- Occupazione magazzino - dalle 7:00 alle 16:00
- Illuminazione ufficio - dalle 6:00 alle 23:00
- Illuminazione residenziale - tutto il giorno
- Illuminazione vendita al dettaglio - dalle 7:00 alle 20:00
- Illuminazione scuola - dalle 7:00 alle 21:00
- Illuminazione magazzino - dalle 7:00 alle 16:00

Schedule Settings



Time	Factor	Time	Factor
00:00	0.00%	12:00	70.00%
01:00	0.00%	13:00	70.00%
02:00	0.00%	14:00	70.00%
03:00	0.00%	15:00	80.00%
04:00	0.00%	16:00	70.00%
05:00	0.00%	17:00	50.00%
06:00	0.00%	18:00	50.00%
07:00	10.00%	19:00	30.00%
08:00	20.00%	20:00	30.00%
09:00	50.00%	21:00	0.00%
10:00	50.00%	22:00	0.00%

OK Cancel

Parameters Export



People [X]

Occupancy

Values: Specified [v]

Number of People: 64.969443

Area per Person: 2.500 m²

Heat Gain (per Person)

Values: Specified [v]

Sensible: 73.27 W

Latent: 58.61 W

OK Cancel Help

Electrical Loads [X]

Lighting

Values: Specified [v]

Load: 2972.35 W

Load Density: 18.30 W/m²

Contribution to plenum (if exists):

[Slider] 20.00%

Power

Values: Specified [v]

Load: 11747.68 W

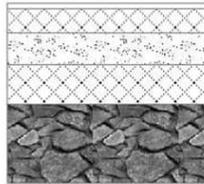
Load Density: 10.76 W/m²

OK Cancel Help

It is possible to vary environment by environment the characteristics of the internal loads associated with people lights and equipment.



Export Thermal Properties of the building



You can select the specific item categories for which you want to use schema types. All categories of elements that are not overwritten with a schematic type will continue to use the default conceptual types. If Detailed Elements is enabled, schematic types and conceptual types are replaced by material-based thermal properties, where defined.

Advanced Energy Settings

Parameter	Value
Detailed Model	
Target Percentage Glazing	0%
Target Sill Height	750.0
Glazing is Shaded	<input type="checkbox"/>
Shade Depth	457.2
Target Percentage Skylights	0%
Skylight Width & Depth	914.4
Building Data	
Building Type	Commercio al dettaglio
Building Operating Schedule	Default
HVAC System	Central VAV, HW Heat, Chiller 5.96 COP, Boilers 84.5 eff
Outdoor Air Information	Edit...
Room/Space Data	
Export Category	Spaces
Material Thermal Properties	
Conceptual Types	Edit...
Schematic Types	<Building>
Detailed Elements	<input type="checkbox"/>

[How do these settings affect energy analysis?](#)

OK Cancel

Export Thermal Properties of the building



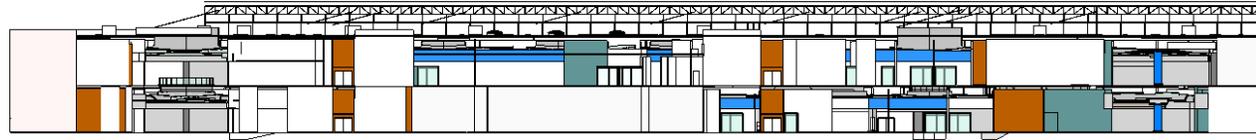
When you want to perform energy analysis for a Revit model that contains building elements such as floors, walls, and roofs, you can use the thermal properties of the material from the detailed elements.

Type Properties

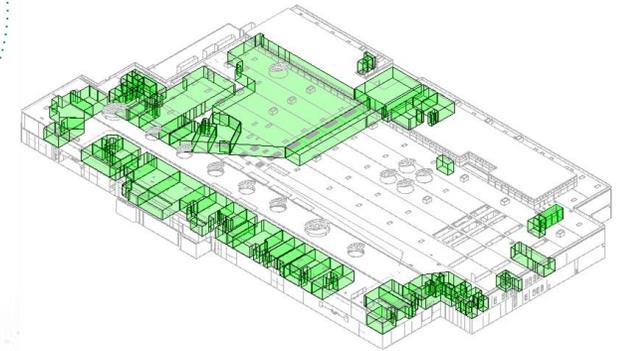
Parameter	Value
Construction	
Structure	Edit...
Wrapping at Inserts	Do not wrap
Wrapping at Ends	None
Width	425.0
Function	Exterior
Graphics	
Coarse Scale Fill Pattern	
Coarse Scale Fill Color	Black
Materials and Finishes	
Structural Material	C.S.i
Analytical Properties	
Heat Transfer Coefficient (U)	0.2627 W/(m ² ·K)
Thermal Resistance (R)	3.8069 (m ² ·K)/W
Thermal mass	51.00 kJ/K
Absorptance	0.700000
Roughness	3
Identity Data	
Type Image	
Keynote	
Model	



Top export errors



LoD non adeguato



Wall Room Separation Line



Two walls with a void
Wrong



Two walls without a void
Wrong



A wall and a separation line
Wrong



Two overlapping walls
Wrong

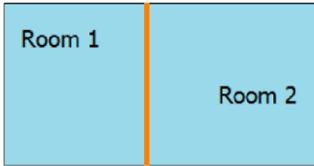


Overlapping wall and room separation line
Wrong

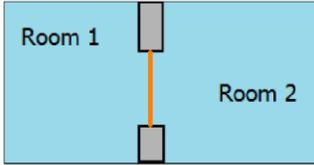
Wall Room Separation Line



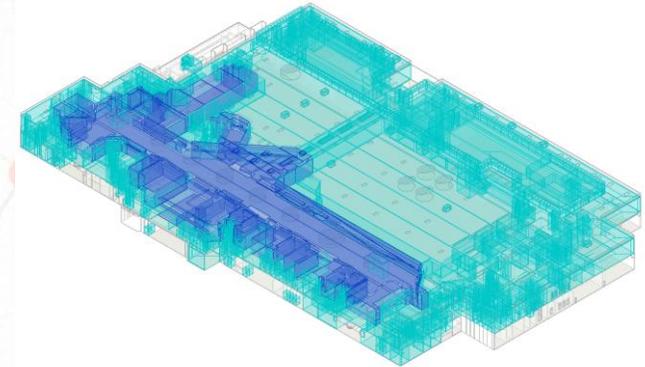
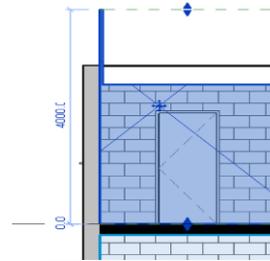
A single wall
OK



A single separation line
OK



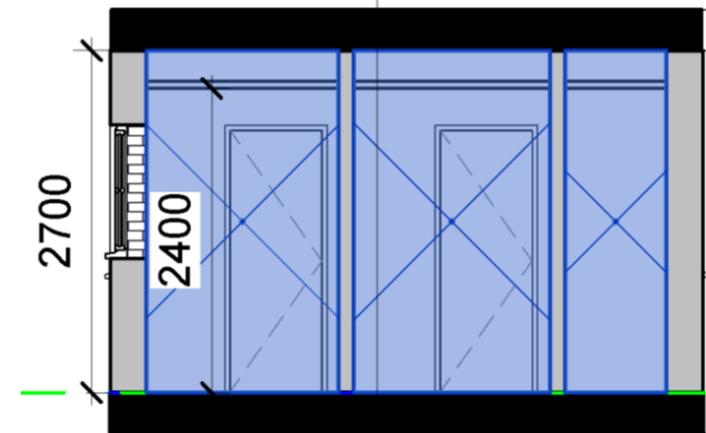
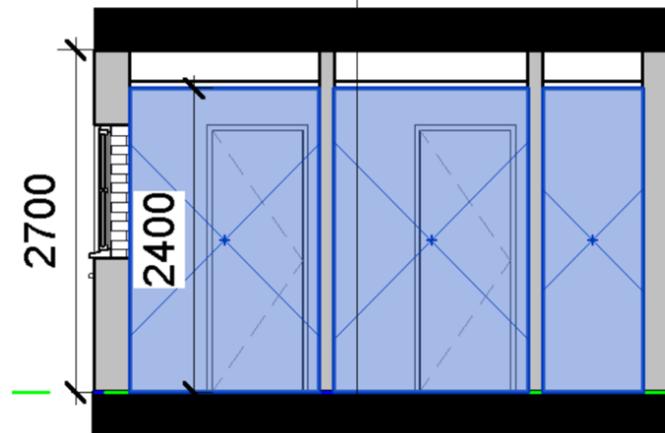
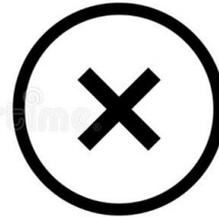
Any combination of walls and separation lines that don't overlap
OK



Common mistakes

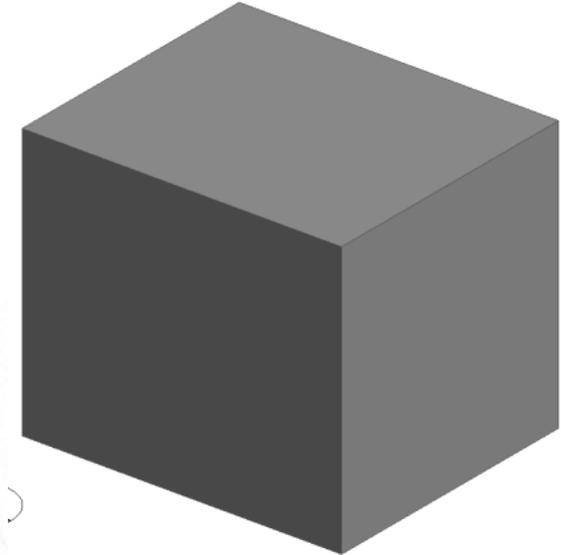
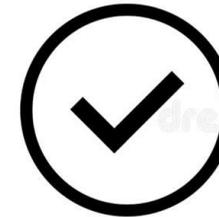
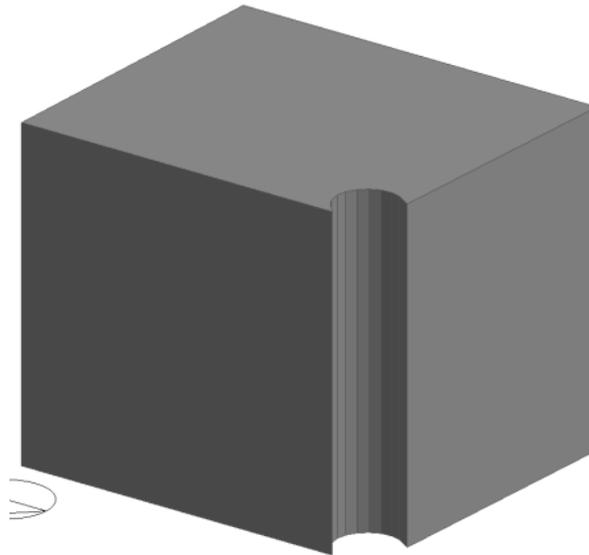
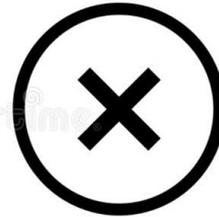
Some elements should not be included in the energy model. In Revit, you can enable/disable the Room Bounding parameter of many items.

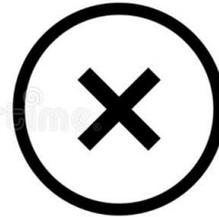
Properties	
Compound Ceiling EA_CE_Plaster	
Ceilings (1) Edit Type	
Constraints	
Level	00_G0_Piano terra (+0.00) (+)
Height Offset From Level	3480.00
Room Bounding	<input checked="" type="checkbox"/>
Text	
CMB_WBS code	
CMB_EPU code	
CMB_Material sheet	
Dimensions	
Slope	
Perimeter	22320.08
Area	29.381
Volume	1.954 m ³



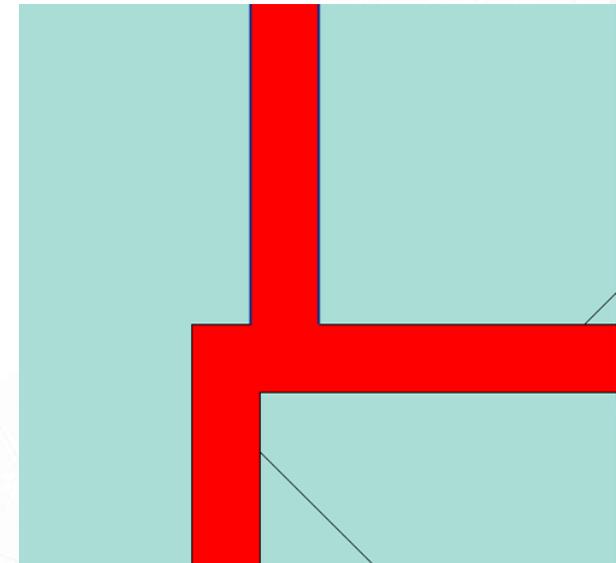
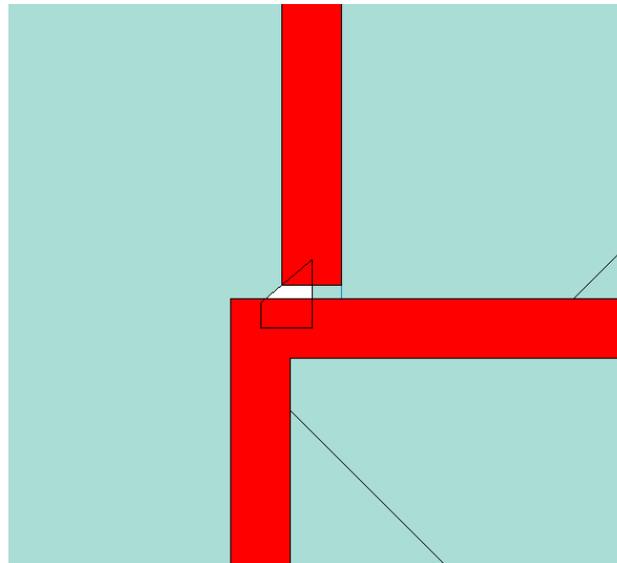
Common mistakes

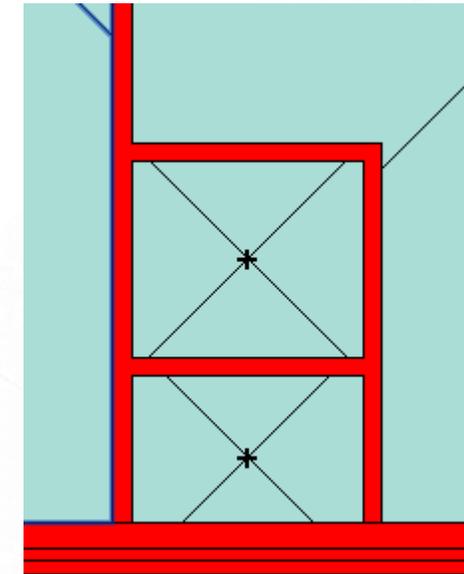
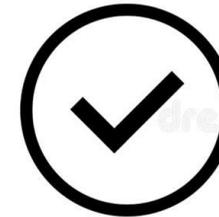
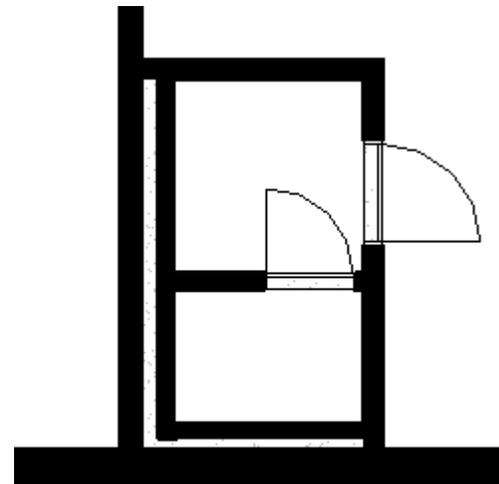
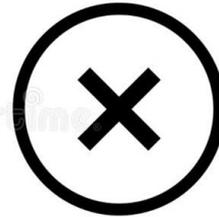
Disable the delimitation of the rooms of the structural pillars to avoid problems.





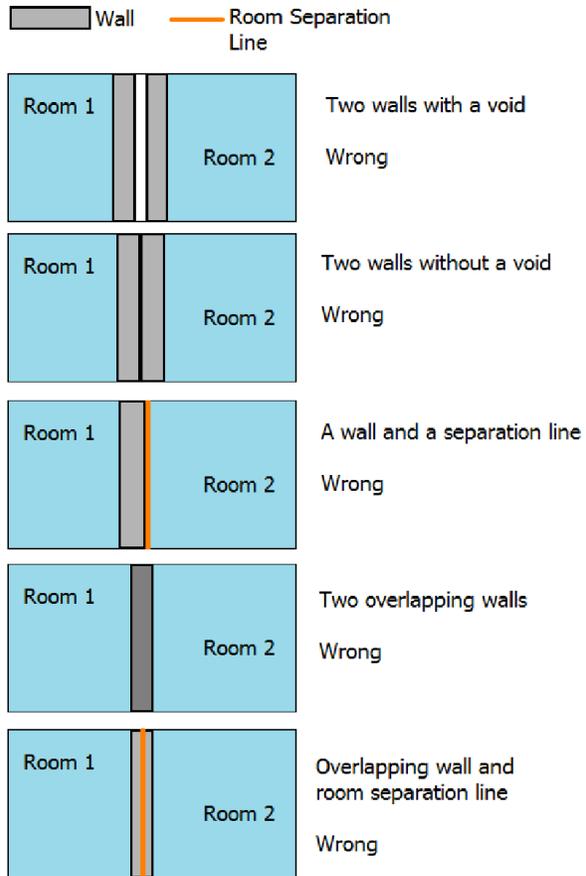
Le stanze in Revit devono avere una regione adeguatamente chiusa.



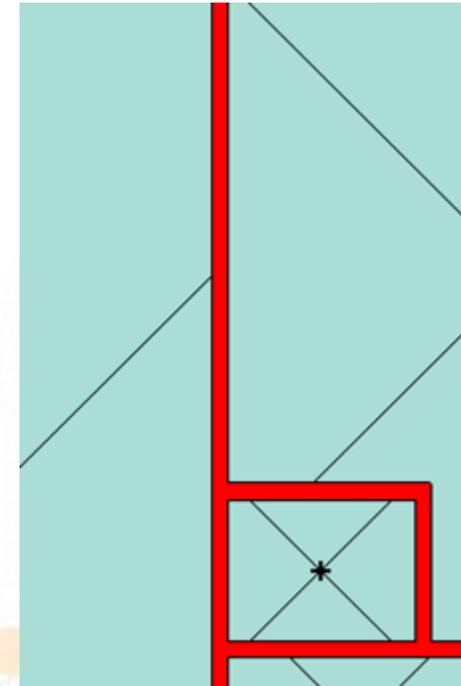
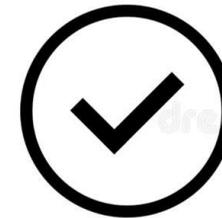
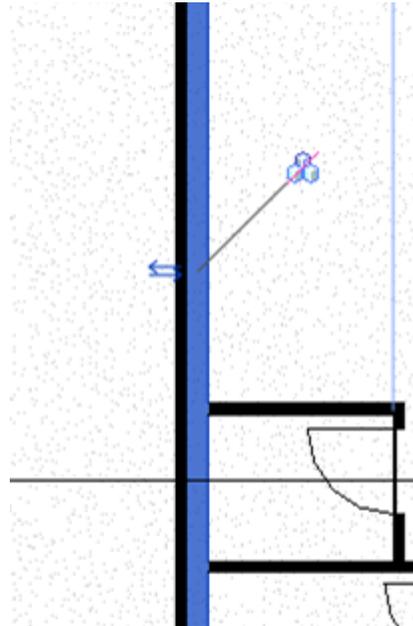
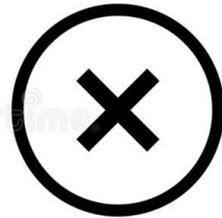


Verification of technical spaces such as Cavedi and other spaces dedicated to the vertical connections of the building

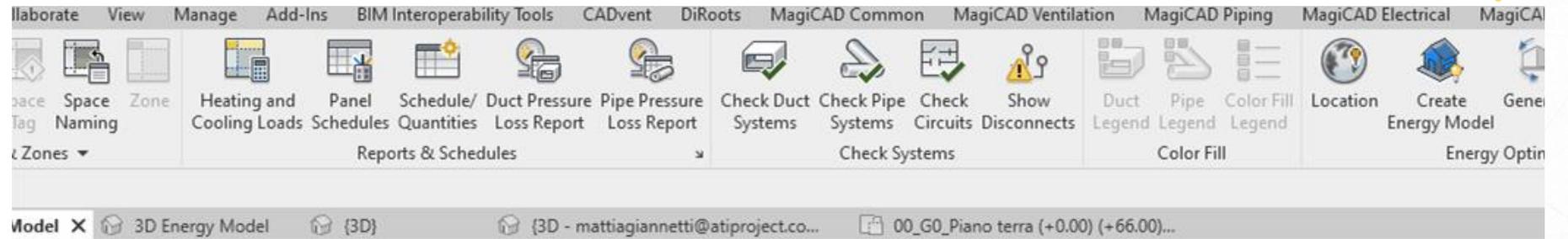
Common mistakes



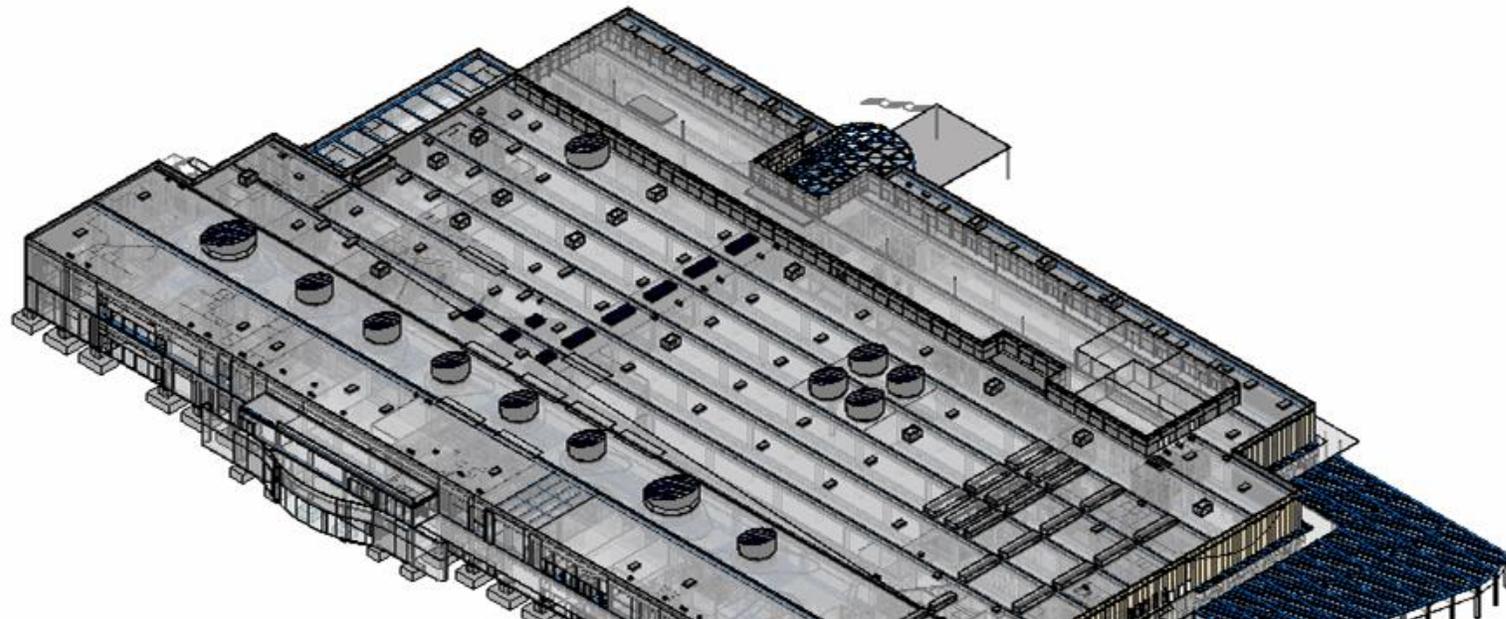
Avoid overlapping boundary elements.



Analytical BIM Model Extrapolation



Automatic creation of a precise and complete energy model directly from an architectural model.

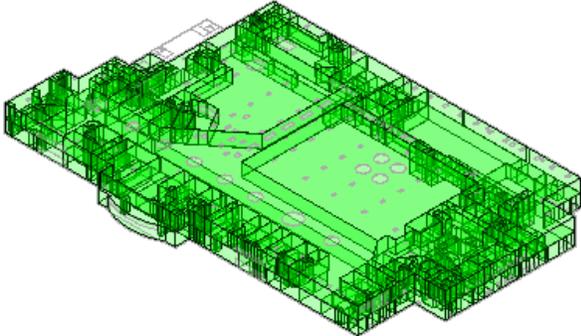


Analytical BIM Model Extrapolation



Check del modello analitico creato, con visualizzazione facilitata degli errori.

Heating and Cooling Loads



General Details

Spaces Analytical Surfaces

- 133 I - GF Ipermarket - Ground Floor
- 133 K - GF Kiosks - Ground Floor
- 134 I - GF Ipermarket - Ground Floor
- 134 K - GF Kiosks - Ground Floor
- 135 I - GF Ipermarket - Ground Floor
- 135 K - GF Kiosks - Ground Floor
- 136 K - GF Kiosks - Ground Floor
- 137 K - GF Kiosks - Ground Floor
- 138 K - GF Kiosks - Ground Floor
- 139 K - GF Kiosks - Ground Floor
- 140 K - GF Kiosks - Ground Floor
- 141 K - GF Kiosks - Ground Floor
- 142 K - GF Kiosks - Ground Floor
- 143 K - GF Kiosks - Ground Floor
- 144 K - GF Kiosks - Ground Floor
- 145 K - GF Kiosks - Ground Floor
- 146 K - GF Kiosks - Ground Floor
- 147 K - GF Kiosks - Ground Floor
- 148 K - GF Kiosks - Ground Floor
- 149 K - GF Kiosks - Ground Floor
- 150 K - GF Kiosks - Ground Floor
-  151 K - GF Kiosks - Ground Floor
- 152 K - GF Kiosks - Ground Floor
- 153 K - GF Kiosks - Ground Floor
- 154 K - GF Kiosks - Ground Floor
- 155 K - GF Kiosks - Ground Floor
- 156 K - GF Kiosks - Ground Floor

Space Type:
Area negozi centro commerciale: commercio al dettaglio

Construction Type:
<Building>

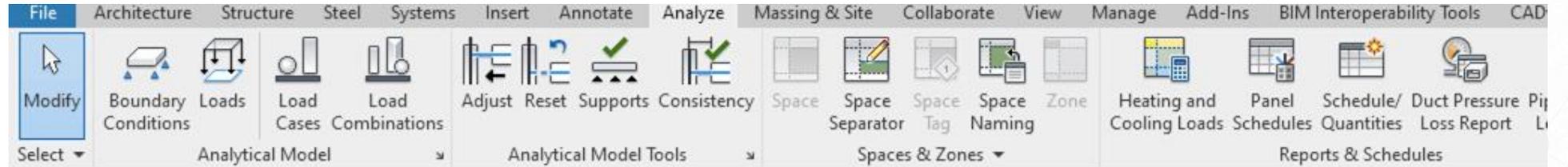
People:
0.90857 People : 2.500 m² Area per Person

Electrical Loads:
Lighting: 0.00 W : Power: 0.00 W

Calculate Save Settings Cancel

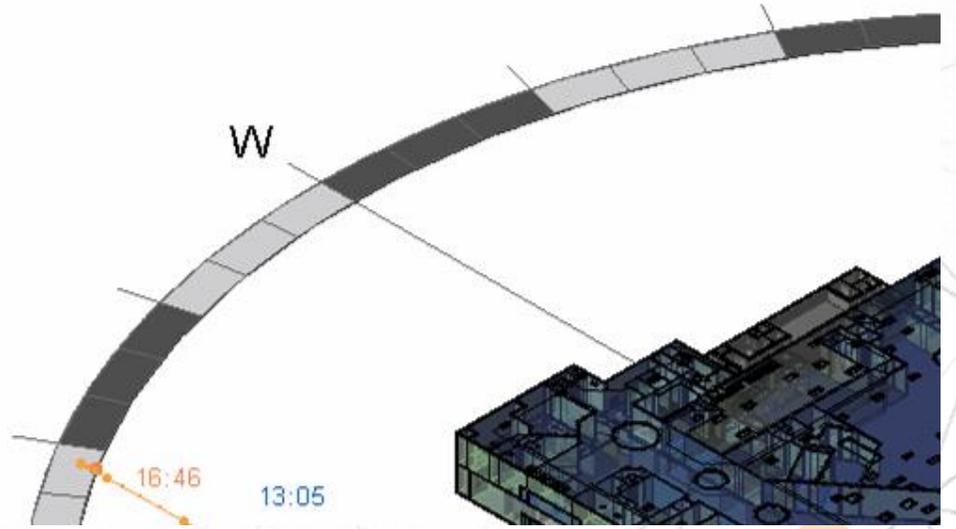


Analytical BIM Model Extrapolation



Properties | CE_EA - Starting View | 3D Energy Model | 3D Energy Model X | {3D} | 00_G0_Plan

3D View Vista 3D	
3D View: 3D Energy Model	
Edit Type	
Graphics	
View Scale	1 : 100
Scale Value 1:	100
Detail Level	Medium
Parts Visibility	Show Original
Visibility/Graphics Overrides	Edit...
Graphic Display Options	Edit...
Discipline	Coordination
Show Hidden Lines	By Discipline
Default Analysis Display Style	None
Sun Path	<input checked="" type="checkbox"/>
Extents	
Crop View	<input type="checkbox"/>
Crop Region Visible	<input type="checkbox"/>
Annotation Crop	<input type="checkbox"/>
Far Clip Active	<input type="checkbox"/>



Esportazione **gbXML** tramite Energy Settings



Import into Energy Simulation Software



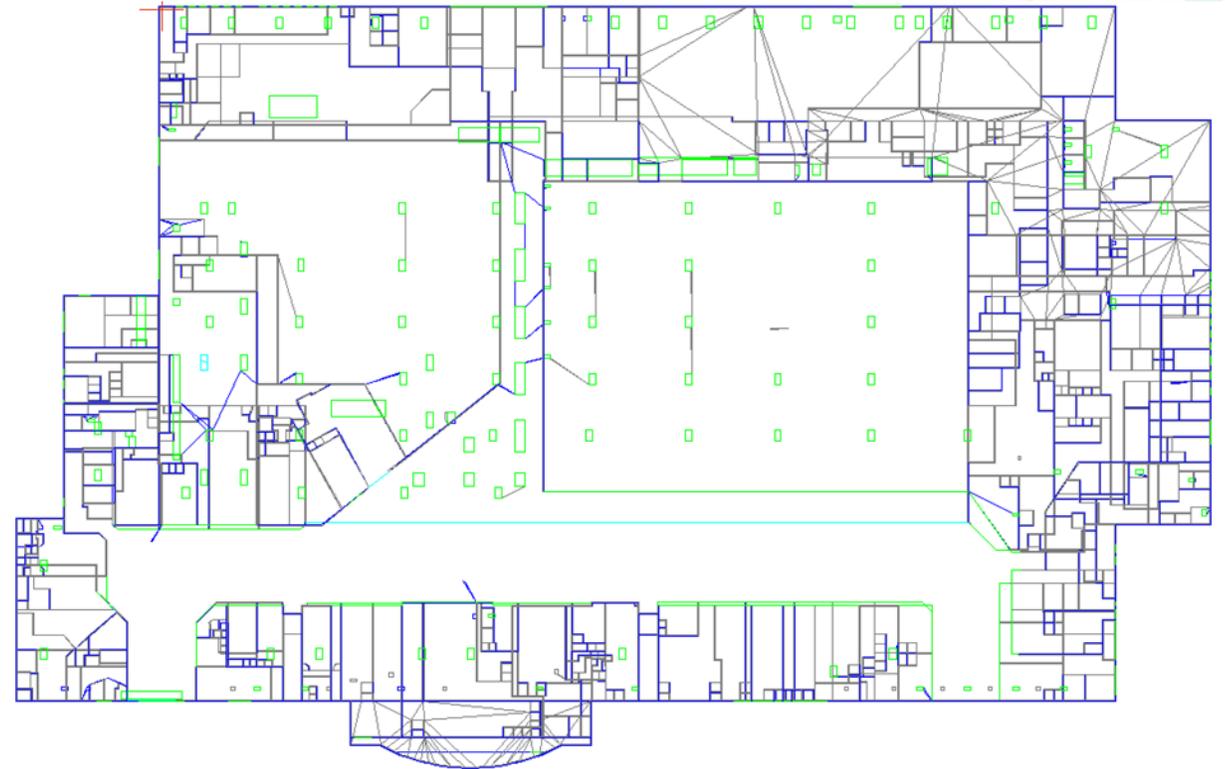
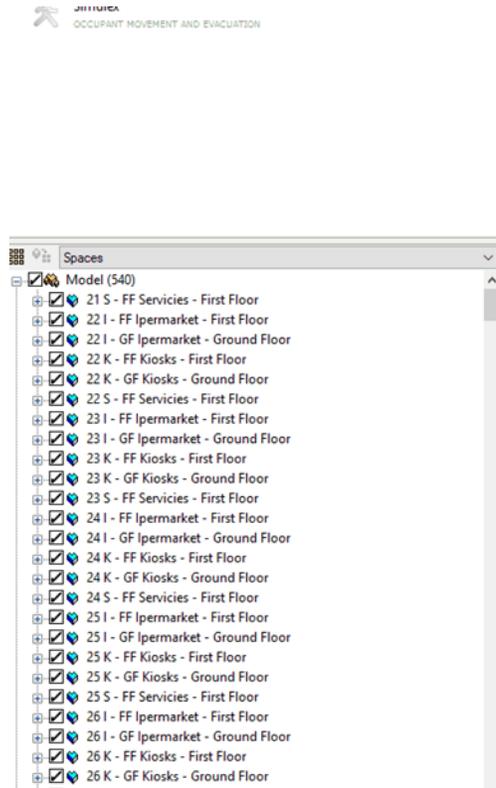
Import **gbXML** into **BEM**
IES-VE software

The screenshot shows the IES VE 2021 software interface. The left sidebar contains navigation options: IES Online, New Project (highlighted), Open Project, and About. The main area is titled 'New Project' and offers several creation methods: Schematic Geometry Wizard, Create From Starter Geometry, Create From Project Template, Create From BIM File (highlighted), and Quick-Create Project. The 'Create From BIM File' dialog is open, showing a selected BIM file: 'Gran Reno_Model_REV00_SPACE EXP.xml' (gbXML Model File, 22/02/2022 19:55:58). Under 'Import Options', 'Geometry + Assigned Data' is selected. Other options include 'Data Only', 'Geometry Only', 'Geometry + All Data', 'Geometry + Simple Assignment', and 'Geometry + Detailed Assignment'. Under 'Other Options', 'Import gbXML+ HVAC systems (only when available)' and 'Customize space thermal template mappings for this import (gbXML & veXML only)' are unchecked, while 'Display the Import Log after importing' is checked. At the bottom, 'Location & Weather' is set to 'None' and 'HVAC Methodology' is set to 'Simplified (ApSystems)'. A 'Save Settings as Defaults' button and a 'Create Project' button are visible.



Check of the information received

Check of the correct creation of the energy model in the BEM environment



BIM4Ren

TRAINING

Thank you for
your attention



This project has received funding from the H2020 programme under Grant Agreement No. 820773

<http://bim4ren.eu/>



[@bim4ren](https://twitter.com/bim4ren)