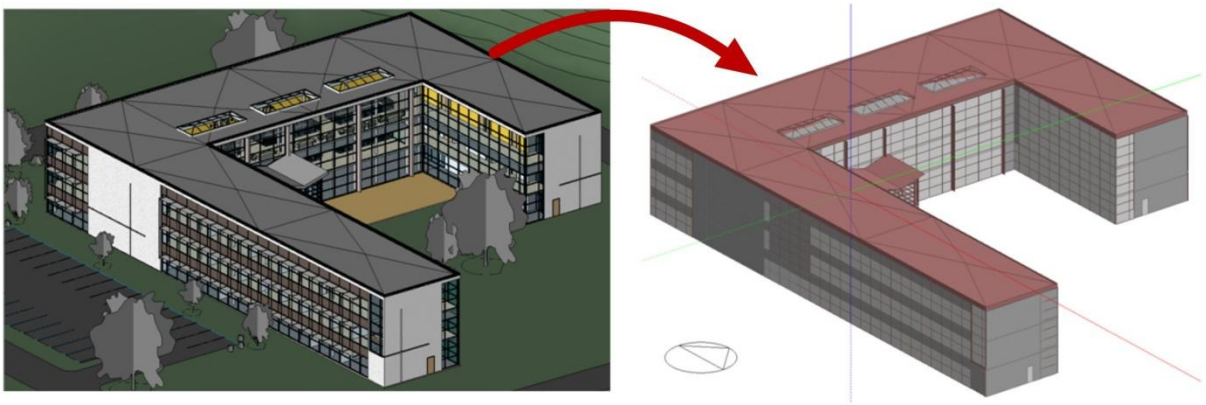
DesignBuilder Revit – gbXML Tutorial

INTRODUCTION

This tutorial has been developed to help Revit users transfer 3-D Revit architectural models to the DesignBuilder building performance analysis software to access information about daylighting, heating and cooling loads, LEED credits, energy consumption and comfort data for the building design. DesignBuilder expertise should not be required to use the tutorial.



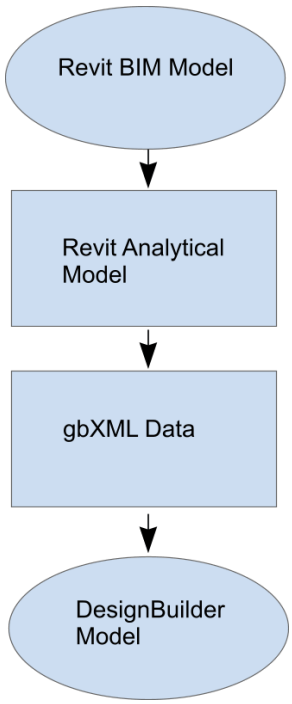
Some materials are based on other documentation available in the web, namely wikihelp.autodesk.com/Revit/ and www.designbuilder.co.uk/helpv3.1. Links have been provided to the original text and other relevant websites to allow you to find additional details.

UNDERSTANDING THE TRANSITION PROCESS

Although the native Revit BIM data provides considerable "intelligence" relative to more basic CAD data, which consist of dumb shapes and lines, it does not contain the volumetric/zonal data required by building performance analysis tools such as DesignBuilder. This data must be superimposed on top of the native Revit architectural model. It is usually referred to as the "Analytical Model" because it is the model on which subsequent analysis is based.

The diagram below shows the data objects involved in the transition process from Revit to DesignBuilder.

Data Diagram for the Revit to DesignBuilder Transition



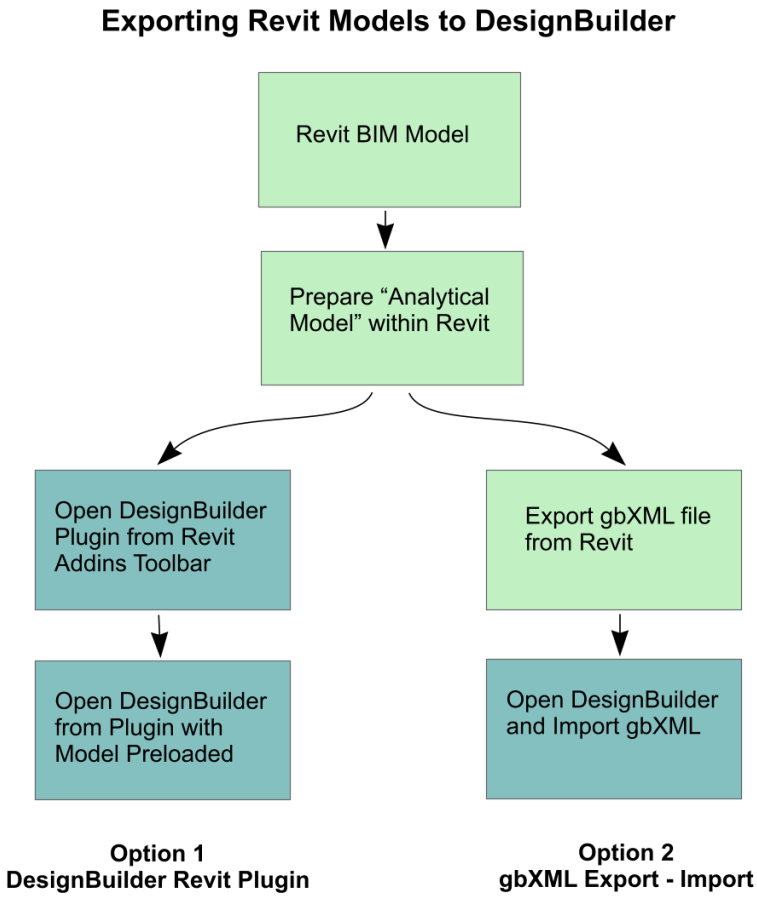
1. Start with a standard Revit Architecture or Revit MEP model
2. Create an Analytical Model by adding Rooms to the Revit model.
3. Green Building XML (gbXML) data is generated from the Analytical Model.
4. gbXML data is loaded to DesignBuilder for performance analysis

Overview of the Process

There are currently two ways to transfer Revit BIM data to DesignBuilder:

1. Using the DesignBuilder Revit Plugin
2. Using the built-in Revit gbXML export menu option

The diagram below shows the processes required in the 2 methods of data transfer from Revit.



Interoperability with Building Information Modeling (BIM) is achieved through basically the same underlying processes regardless of which of the 2 methods is used. The list below describes the similarities between the 2 methods:

- The preparation of the Revit Analytical model is the same in both cases. This process is described in the next section.
- Both methods use the same Revit gbXML export capability.
- Both methods use the same DesignBuilder gbXML import capability.

It is important to understand that in both cases care must be taken to prepare the Revit analytical model for export. The most important of these steps is to accurately identify the "rooms" or "spaces" in the model. These steps are described in more detail below.

Preparing the Analytical Model

Preparation of the Revit analytical model is crucial to the success of the transition process. The analytical model is based around the definition of rooms which are superimposed on the underlying Revit architectural model. Any gbXML subsequently generated is based on the analytical model only and not on the underlying Revit architectural model. It is usually possible to create and make changes to the analytical model without modifying the underlying Revit model.

DEFINING ROOMS

Rooms

Revit Rooms maintain information on sub-divisions of space within the building. In simple terms a room could literally be a room from the actual building or in some cases a collection of real world adjacent rooms. Rooms store values for a variety of parameters that affect subsequent building performance analysis such as volumes and the geometry of bounding elements.

Rooms are identified based on bounding elements such as walls, floors, roofs, and ceilings. Revit refers to these room-bounding elements when computing the perimeter, area, and volume of a room. You can turn on/off the "Room bounding" property of these elements allowing flexibility in how rooms are configured. You can also use room separation lines to further subdivide space where no room-bounding elements exist. When you add, move, or delete room-bounding elements, the room's dimensions update automatically.

An effective energy analysis can only be accomplished if all the areas in your 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 based mainly on rooms and their bounding elements. The DesignBuilder gbXML import mechanism identifies and converts these rooms into blocks and zones. Other building components like doors, windows and shading surfaces are created automatically as well.

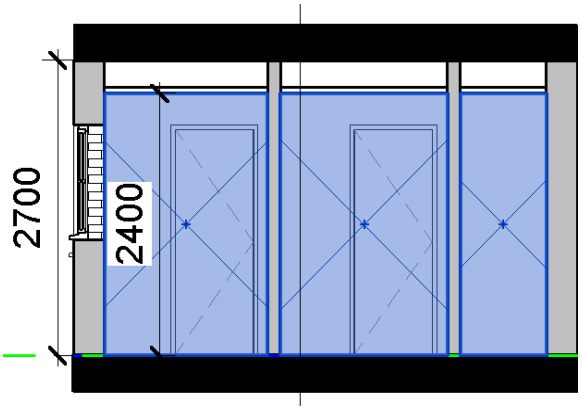
Note: Revit MEP uses the Space component instead of Rooms to maintain spacial information. Revit Architecture "Rooms" and Revit MEP "Spaces" are very similar but independent components used for different purposes. "Rooms" are architectural components used to maintain information about occupied areas. "Spaces" are exclusively used for the MEP disciplines to analyze volume. For the rest of this tutorial, except where distinctions are drawn, the terms "Space" and "Room" are used interchangeably.

Room Boundaries

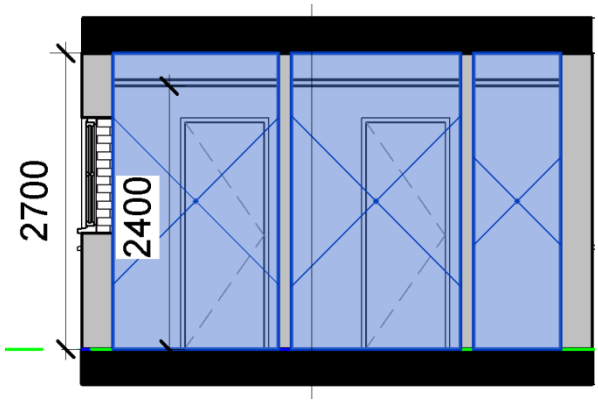
The Volume of a Room is defined by limit parameters and Room-Bounding Elements. If room-bounding elements occur within the range of the room's defined limits, Revit uses the space defined by the room-bounding elements when computing the volume.

In Revit the Upper Boundary (Upper Limit, Limit Offset, Level) and Lower Boundary (Base Offset) parameters define the height of the room.

In the example shown below left, the false ceiling is a room-bounding element at 2400 mm above floor height. It occurs *below* the upper limit of a room specified with 2700 mm height. In this case Revit computes the room volume up to the room-bounding element and the ceiling void is not included in the analytical model.



"Room bounding" property for the ceiling elements switched **ON**



Room Bounding property for the ceiling elements switched **OFF**

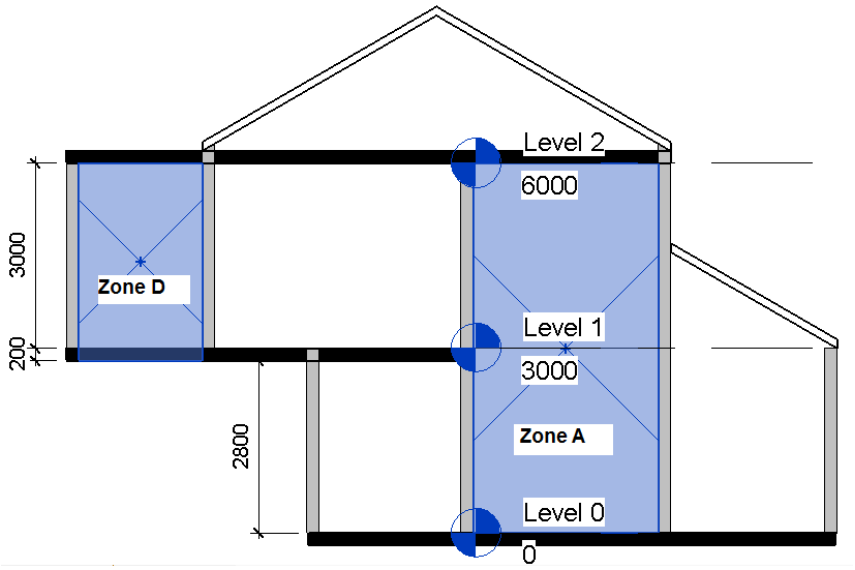
The false ceiling volume (indicated in white in the diagram above left) is not included in the zone volume which is shown in blue. In this case, you could turn off the Room Bounding property for the ceiling elements to ensure that the zone includes the ceiling void volume within the main occupied zone. This change is shown in the diagram above right.

Defining the upper boundary of a room

Together, the Upper Limit and Limit Offset parameters define the upper boundary of the room.

The following figure shows two samples of Rooms with these parameters defined:

- Room Zone A is double-height and has an Upper Limit of Level 0 and a Limit Offset of 6000.
- Room Zone D has an Upper Limit of Level 1 and a Limit Offset of 3000.



Defining the lower boundary of a room

Together, the Level and Base Offset parameters define the lower boundary of a room.

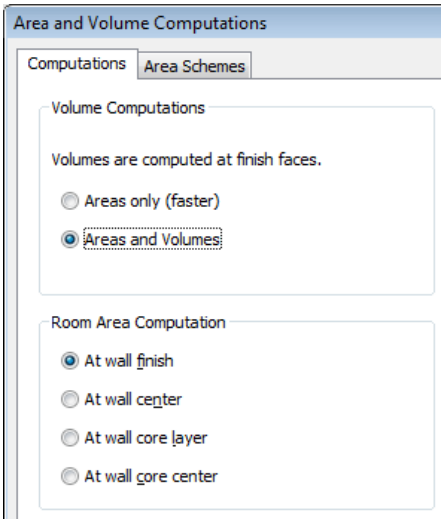
For the model above, the defined parameters are:

- Room Zone A has a Base Offset of 0. The lower boundary of the room starts at Level 0, i.e. from the top of the ground floor slab.
- Room Zone D has a Base Offset of –200. The lower boundary of the room starts 200 mm below Level 1. This allows the volume of the external floor slab to be included within the volume of the room. This is indicated by the highlighted blue shading overlapping the external floor slab element in the figure above.

ZONE VOLUME COMPUTATIONS

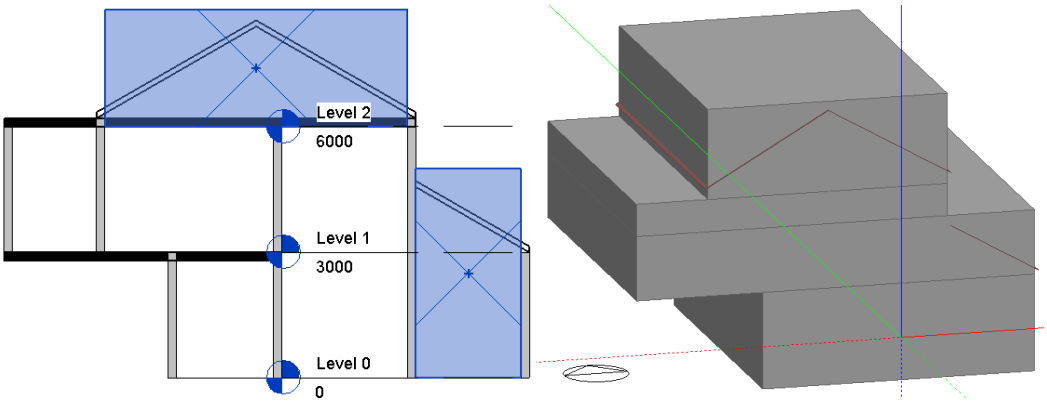
The volume computation for a space is based on its room-bounding components and is calculated as the area of its base multiplied by the height of the space. In Revit, both area and volume are calculated to wall faces.

By default, Revit does not compute room volumes. You must switch on “Area and Volumes” in the Volume Computations panel under the Computations tab of the Area and Volume Computations dialog before exporting your model (see Enabling Volume Computations).

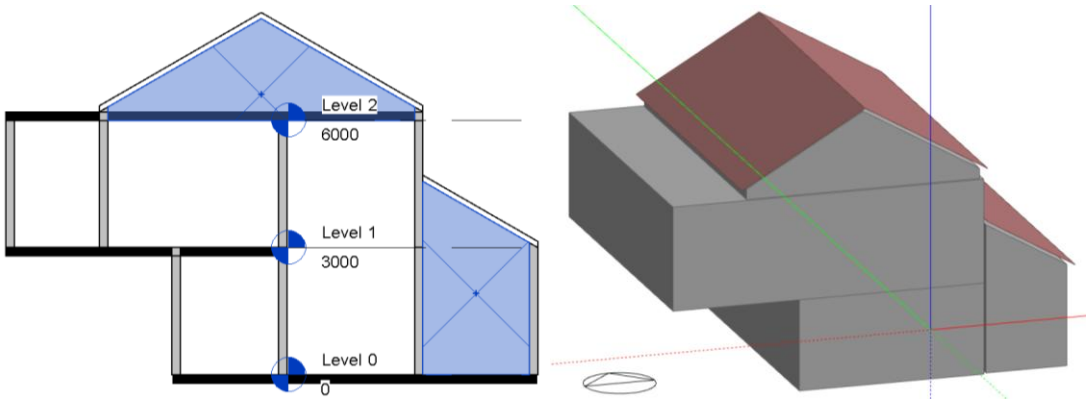


The Revit section views below illustrate the effect of these settings on the exported DesignBuilder model.

“**Areas only (faster)**” Volume Computations option - incorrect zones are created in the DesignBuilder model.



"Areas and Volumes" Volume Computations option **– correct zones generated in the DesignBuilder model below**.

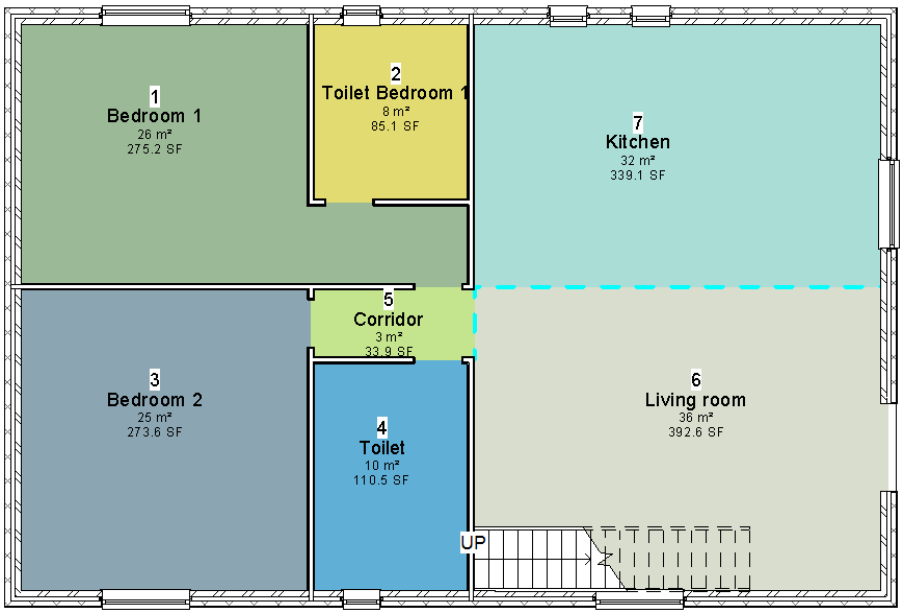


The Room volume defined in Revit should be approximately the same as the zone volume in DesignBuilder.

Placing a room

It is necessary to Create a Room for all spaces occupied and unoccupied before generating the gbXML or to use the plugin. After you have placed room components in all the areas in a plan, you can export your design as a gbXML file to perform a load analysis of your model in Designbuilder software.

In order to facilitate the visualisation of the rooms you can Control the Visibility of Rooms to make rooms and their reference lines visible as well as Color Schemes.

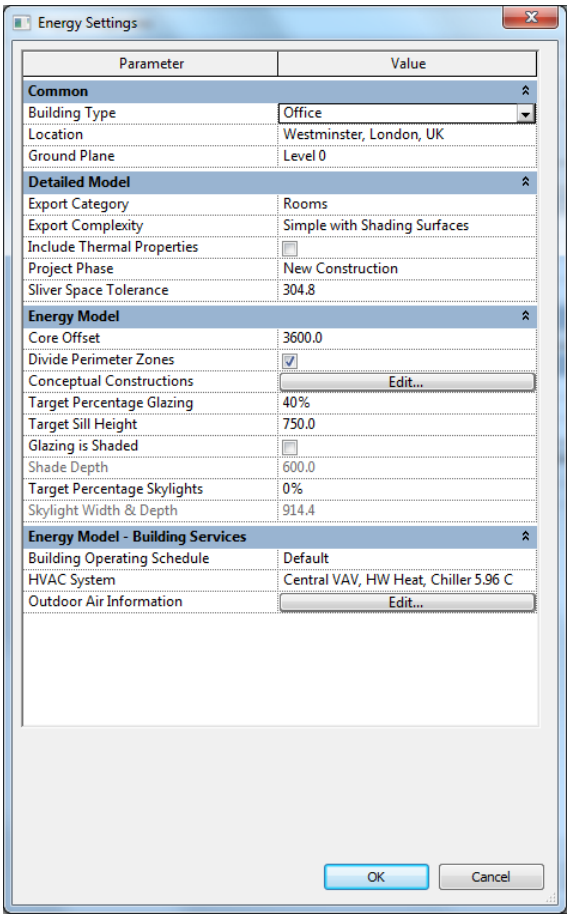


You can use the Room Separation Lines tool to add and adjust room boundaries. They are useful for designating one room within another when there aren´t walls. In the sample above Room separation lines are room-bounding between the kitchen, living room and corridor zones.

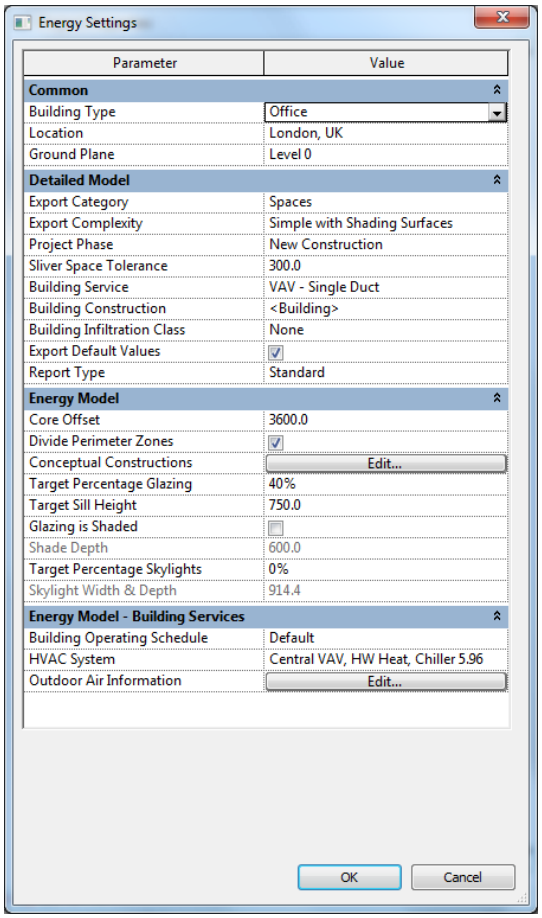
ENERGY ANALYSIS SETTINGS

Settings are available to help control parameters that define values that are exported to gbXML files.

Click on Manage tab > Settings panel > Project Information > Edit on the Energy settings to define the parameters.



Revit Architecture - Rooms



Revit MEP - Spaces

On the Energy settings dialog, Detailed Model, only “Export category”, “Export complexity” and “Sliver space tolerance” affect the DesignBuilder model.

Export Category

This option determines whether rooms or spaces are exported. You should choose “Spaces” if spaces were placed in a Revit MEP model. Otherwise select “Rooms” if Rooms were placed in Revit Architecture. Selecting “Rooms” or “Spaces” determines which of the options below are available. See also the difference in the dialog images above.

Export Complexity

This data specifies the level of detail provided when generating gbXML data for openings, and whether shading surface information is exported.

Simple Options

Choose one of the Simple options for typical/simple window shape and configurations:

- **Simple** - curtain walls and curtain systems are exported as a single opening (without individual panels).
- **Simple with shading surfaces** - same as simple, but with shading surface information exported.

Complex Options

Choose one of the Complex options for curtain wall windows or windows of complex shape:

- **Complex** - curtain walls and curtain systems are exported as multiple openings, panel by panel.
- **Complex with shading surfaces** - same as complex, but with shading surface information exported.
- **Complex with mullions and shading surfaces** - same as complex, but with mullion and shading surface information exported. Note that this option can lead to many unnecessary shading surfaces.

Sliver Space Tolerance

This data specifies a tolerance value for sliver spaces. All areas that are within the sliver space tolerance are considered sliver spaces.

For more on this see Accounting for the Volume of Cavities, Shafts, and Chases.

Although it is possible in Revit to specify various parameters for energy analysis, DesignBuilder is not able to read all of these parameters in the current version. The other fields and their respective data not mentioned above don't are loaded from gbXMl file to DesignBuilder model. Nevertheless you can prepare the building energy model by introducing the predefined data through the templates available on the plugin dialog or make these inputs directly in DesignBuilder.

It can be worth testing various of the above options to see which provide the best translation into DesignBuilder format.

CHECKING THE ANALYTICAL MODEL

Before exporting to gbXML you should check for possible problems that might affect the success of the transition process. It is also important to make sure that the model is correctly configured for export. We advise these checks on the Revit model before attempting the export:

1. Check Revit Rooms
2. Check individual zone volumes

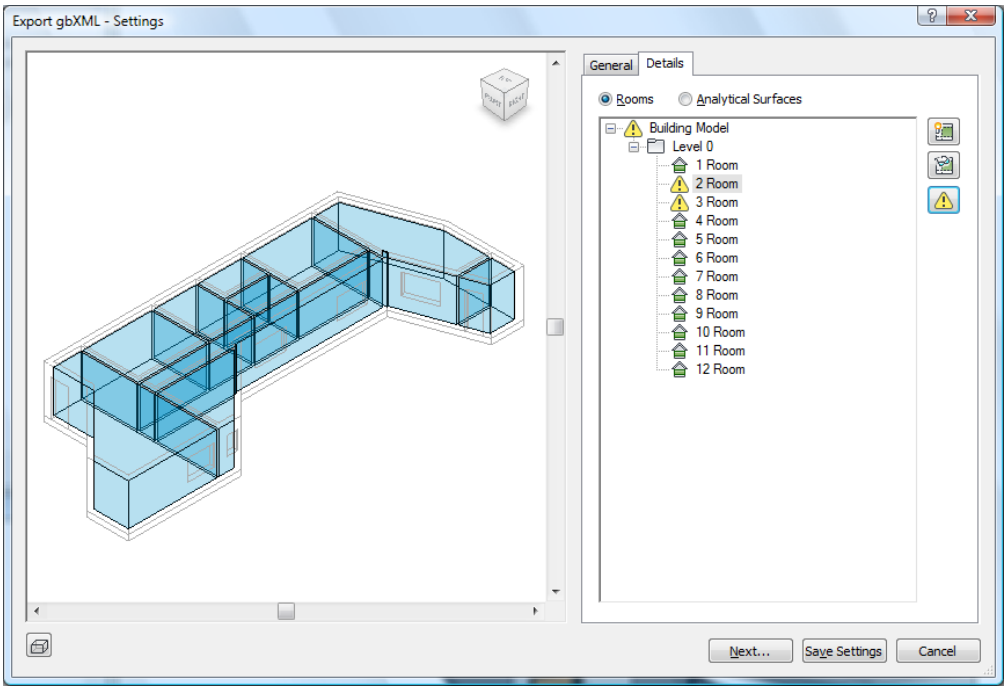
These are described below.

Check Revit Rooms

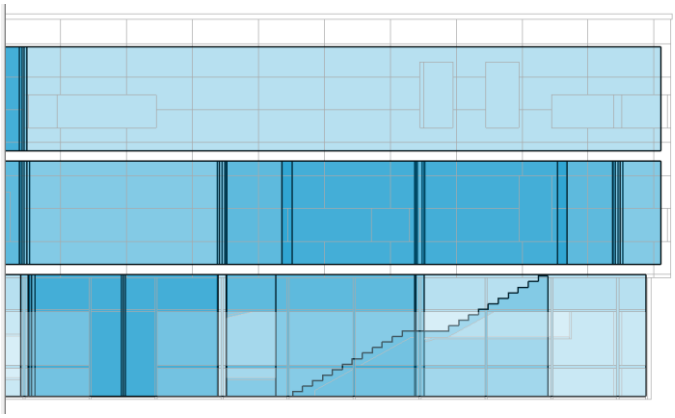
The first test allows you to verify the model through Export gbXML dialog. A dialog is with two tab models, General and Details, in the right upper corner clicking on the Export gbXML in menu File. On the Details tab it is possible check for possible warnings.

If a warning is displayed for the Room, you should check the cause (see figure below), cancel and correct the problem in the building model. Review and correct warnings until all have been resolved throughout the model; otherwise the problem will carry through to the DesignBuilder file.

For example, in the figure below warnings in the Room 2 and Room 3 are shown on the dialog details tab.



You can use the gbXML Export dialog to detect gaps between zones in the analytical model. You should generally aim to avoid gaps in the analytical model to ensure correct zone volumes and adjacencies in the DesignBuilder model. For example in the model below you can see gaps (shown in white) between the 3 floors of the model.



In this case the gaps were eliminated from the analytical model by using the steps explained in the Room Boundaries section.

Check Zone Volumes

This more detailed check can be carried out by analysts with access to both Revit and DesignBuilder. The aim is to check that the resultant zones in DesignBuilder have the same volume as the equivalent rooms in Revit. To accomplish this is necessary to perform two tasks:

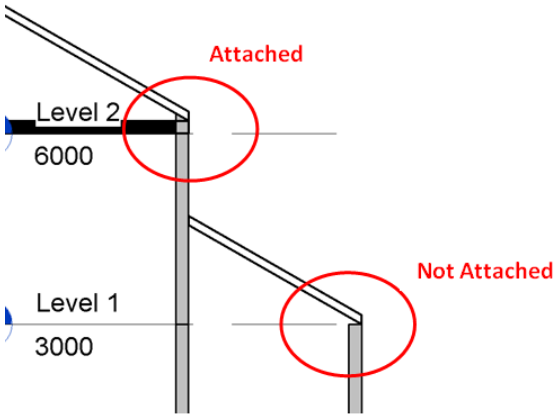
1. Create a Room volume schedule in Revit;

2. Generate a summary report from DesignBuilder-Revit plugin. Then compare the results of both.

TIPS

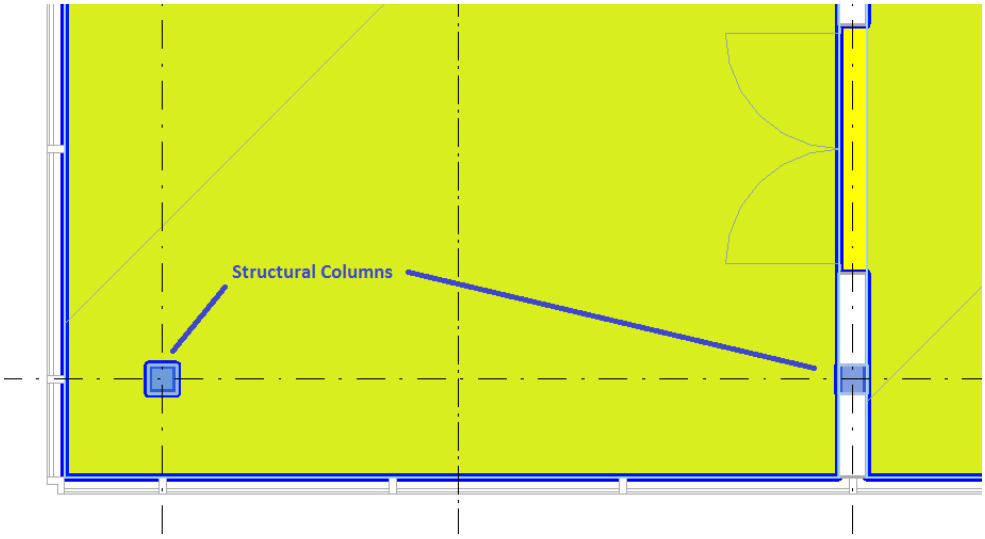
Ensuring Rooms are Enclosed

Rooms in Revit must have a properly enclosed region. When Revit fails to identify a room as expected, the first step is usually to check the surrounding elements. For example, the figure below shows a case of a non-enclosed region that was solved by attaching the walls to the pitched roof.



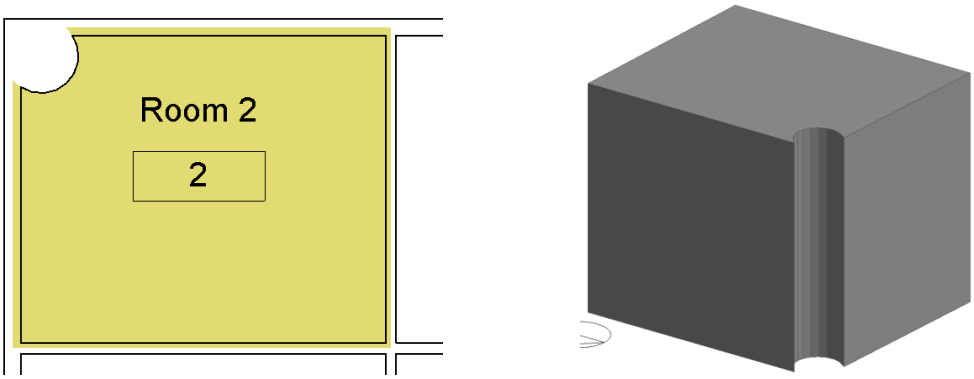
Excluding elements from the energy model

Some elements should not be included as part of the energy model. In Revit, you can switch on/off the Room Bounding parameter of many elements. In the example below it is recommended to switch off the room-bounding of the structural columns to avoid problems.



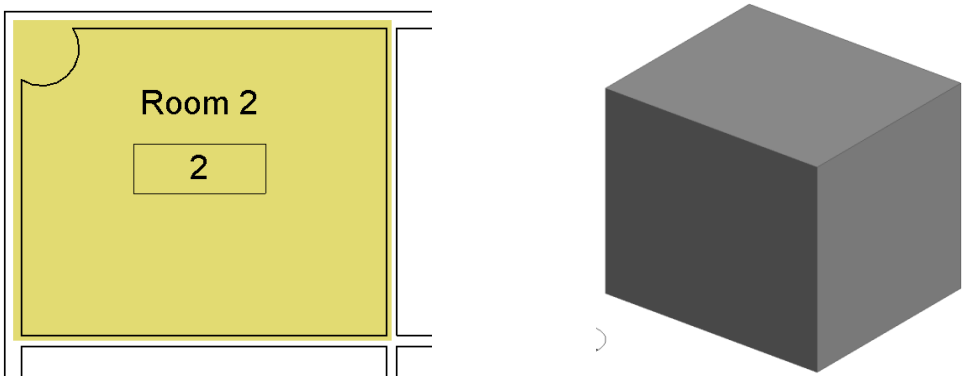
In this transition process the geometric model should be as simple as possible. Another example is shown below where the round column on the corner was switched off by de-selecting “room bounding” on the properties dialog to avoid complex surfaces in the energy model.

Before Fix



The Revit model and the corresponding DesignBuilder model before the change, with the column being a room bounding element.

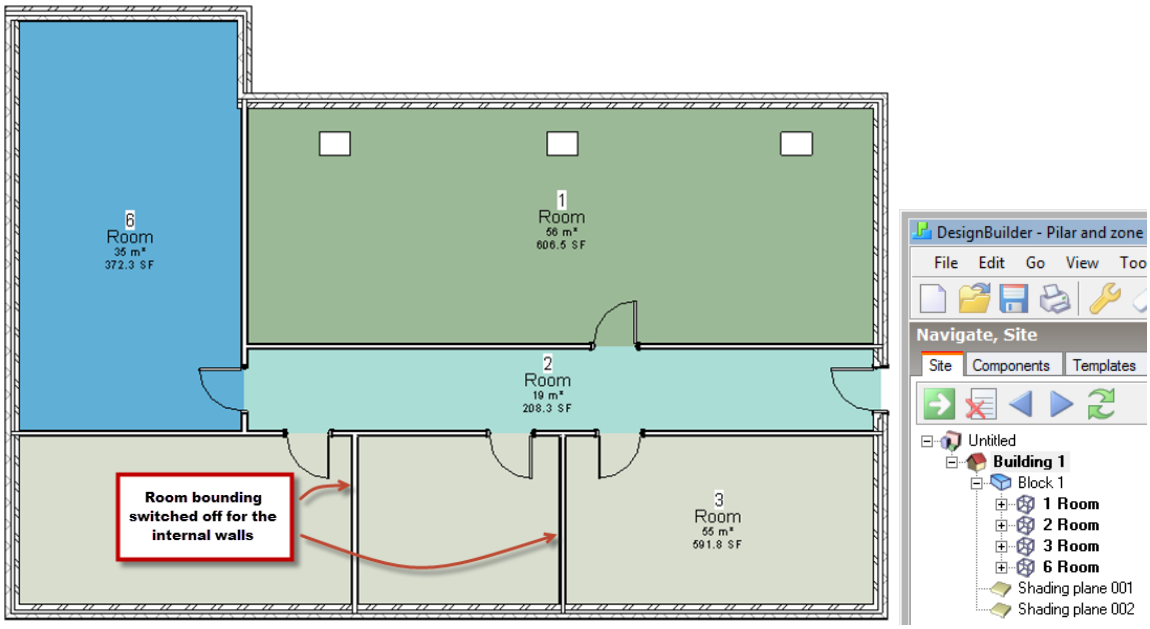
After Fix



The Revit room and the corresponding DesignBuilder zone after de-selecting the column as a room bounding element. The DesignBuilder model following the fix will be more accurate and because there are less surfaces, calculations will run faster.

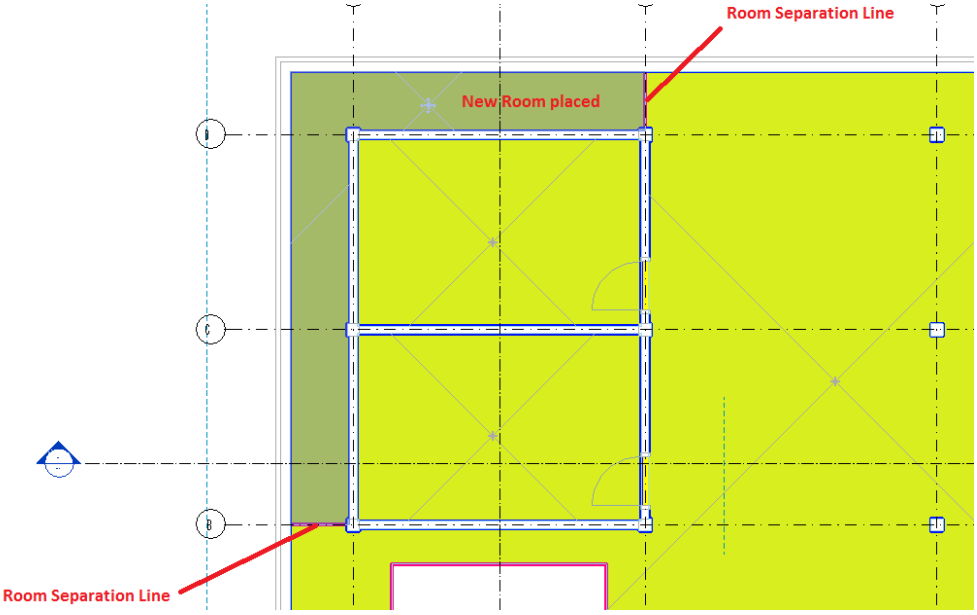
Merging Zones

It is possible to merge multiple similar zones by switching off the elements between the Rooms. In the model below, Rooms 3, 4 and 5 have been merged into 1 Room by switching of the “Room bounding” element property of the walls between them. The merged zone is shown in grey in the figure below. This method is useful for a preliminary thermal zoning for large models. Note in the DesignBuilder navigator panel (below right) just four zones were created from this model.



Nested Spaces

GbXML does not currently support "nested" spaces, i.e. spaces wholly contained within another space. It is necessary to split the surrounding room in order to avoid the nested room problem. The way that this is done is shown below; you can use the "Room separation line" to split them. After this you must place a new room in the separated area.

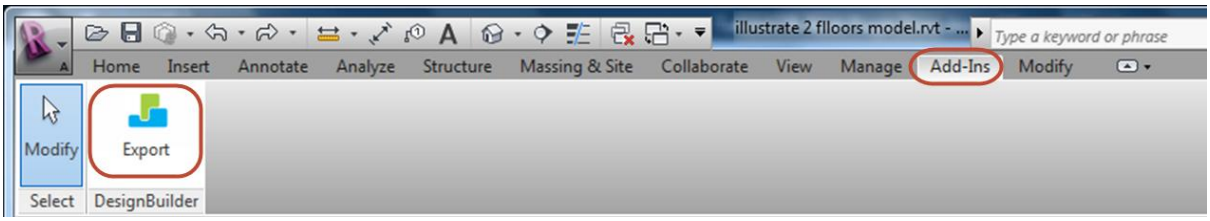


Exporting to DesignBuilder

Once you have correctly set up the analytical model as described above you are ready to export to DesignBuilder. As mentioned earlier there are 2 ways to export Revit models to DesignBuilder and these are both described below.

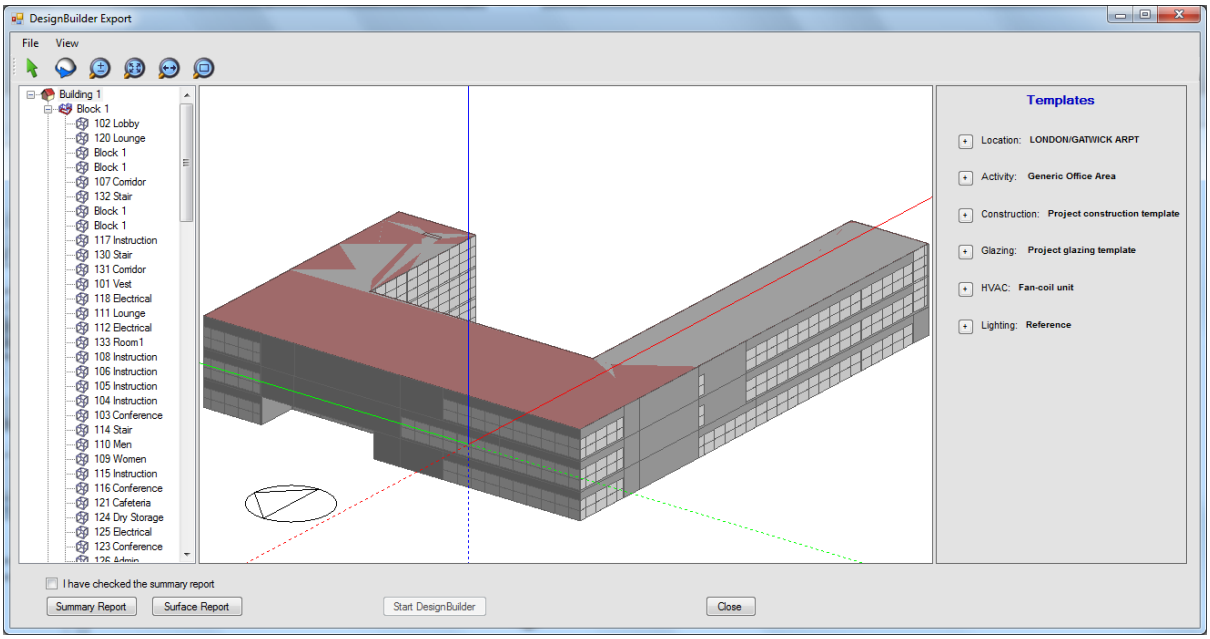
DESIGNBUILDER PLUGIN

The DesignBuilder-Revit plugin uses the gbXML open schema which facilitates the transfer of the 3-D model geometry and some building properties stored in the Revit BIM to DesignBuilder. The plugin allows Revit models to be exported directly to DesignBuilder. The "Export - DesignBuilder" toolbar icon is found on the menu Add-Ins of the Revit software as shown below.



Note: The plugin toolbar icon "Export - DesignBuilder" will only be available on the menu Add-Ins of Revit after you install DesignBuilder.

When you click on the toolbar icon the DesignBuilder plugin dialog below is shown.



File

You can export the 3-D architectural models created in formats:

- DesignBuilder (.dsb)
- Gbxml

View

This menu also provides options to generate and save the summary report.

A number of view controls are provided to allow you to change the view mode for the model:

- Dynamic orbit
- Zoom in out
- Fit to screen

- Pan view
- Zoom window

Templates

The DesignBuilder Revit plugin provides templates that are databases of typical generic data. You can use one of the available templates to quickly load data into your model. The templates data options are:

- Location
- Activity
- Construction
- Glazing
- HVAC
- Lighting

Template data can be loaded at site, building, block and zone levels.

Summary report

The summary report provides the geometric information such as volume, floor area, external wall area, glazing area, etc. See the example below:

Summary Surface Report for Building Building 1

Zone	Volume (m3)	Floor Area (m2)	Ceiling Area (m2)	Ext Wall Area (m2)	Int Wall Area (m2)	Glazing Area (m2)	Ratio Volume to Area	Ratio Floor to Ceiling	Ratio Exterior Wall to Floor	Ratio Window to Wall
Block 1 : 2 Zone A	90.489	31.815	31.815	74.200	31.683	0.000	2.844	1.000	2.332	0.000
Block 1 : 3 Zone B	69.286	24.745	24.745	70.280	0.000	0.000	2.800	1.000	2.840	0.000
Block 2 : 2 Zone A	102.763	0.132	31.815	84.800	31.683	0.000	776.155	240.295	640.483	0.000
Block 2 : 4 Zone C	135.744	42.420	42.420	91.520	0.000	0.000	3.200	1.000	2.157	0.000
Block 2 : 5 Zone D	69.488	21.715	21.715	78.400	0.000	0.000	3.200	1.000	3.610	0.000
Block 3 : Block 3	105.398	26.764	30.906	99.957	0.000	0.000	3.938	1.155	3.735	0.000
Block 4 : Block 4	105.203	73.730	85.136	28.371	0.000	0.000	1.427	1.155	0.385	0.000
Totals	678.371	221.322	268.552	527.528	63.365	0.000				

Surface report

The surface report provides information about the surface such as type, areas, adjacent zone, orientation, etc.

Surface Report for Building Building 1

Zone: Block 1 : 2 Zone A

Surface type	Area (m2)	Adjacency	Adjacent Zone	Orientation	Slope	Other
Ground Floor Element	31.815	External		0	180	
Ceiling Element	0.132	Internal	Block 2 : 2 Zone A	0	0	
Hole	31.683	Internal	Block 2 : 2 Zone A	0	0	
Wall	0.132	External		90	90	
Wall	8.820	External		0	90	
Wall	28.280	Internal	Block 1 : 3 Zone B	270	90	
Wall	8.820	External		180	90	
Wall	28.148	Internal	Block 3 : Block 3	90	90	

Start DesignBuilder

This command allows you to generate your .dsb file and open it directly in DesignBuilder. This feature is only available after you tick the “I have checked the summary report” checkbox.

REVIT GBXML EXPORT

The second option is to export your design as a gbXML using the Export gbXML dialog built into Revit. Once the gbXML file has been exported you can import it into DesignBuilder to perform an energy analysis. Although it is more involved, this method is more flexible than using the plugin because it allows more options in the gbXML generation and subsequent reading in DesignBuilder.