

Using Green Building Studio with Revit Architecture and Revit MEP

This document helps you get started with Autodesk® Green Building Studio® web service and presents the fundamental concepts of the product, including:

- Defining Autodesk Green Building Studio
- Why you should use Green Building Studio
- Common pitfalls, and making the most of Green Building Studio energy analysis
- How Green Building Studio works
- Registration and installation
- How to perform some common tasks in the product
- Energy results and what they mean

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Defining Autodesk Green Building Studio

Sustainable design is more important than ever. Building information modeling (BIM) solutions make sustainable design practices easier by enabling architects and engineers to more accurately visualize, simulate, and analyze building performance early in the design process. The intelligent objects in the building information model enable the advanced functionality of the Autodesk Green Building Studio web service.

Using Autodesk Green Building Studio, architects and designers can work toward carbon neutrality early in the design process.

The Autodesk Green Building Studio web service helps provide rapid, accurate energy use estimates for your building design within the building information model. It enables collaborative design, allowing you to share building information with other team members, streamline or eliminate plan take-off tasks, and transfer essential information about your building design to the applications used for engineering design or code analysis.

Welcome to whole building energy analysis!

Hints and Tips

One of the most important energy decisions an architect makes is selecting a design scheme early in the design process. Yet a vast majority of architects do not know the energy and carbon impact of their choice while making it.

Why You Should Use Green Building Studio

Good management of energy resources is fast becoming an essential factor in building design. Stakeholders want to know how the design will impact the environment, what lifecycle costs will arise from energy use, and if it is compliant with energy codes. The Autodesk Green Building Studio web service provides:

- Annual energy cost
- Lifecycle energy costs (30 year)
- Annual energy consumption (electric and gas)
- Peak electric energy demand (kW)
- Lifecycle energy consumption (electric and gas)
- Onsite energy generation from photovoltaic and wind systems
- Water use analysis
- Assistance with daylighting using glaze factor calculations
- Natural ventilation potential calculations
- Carbon emission calculations

The Autodesk Green Building Studio web service is designed to work within the familiar environment of your own design software. You can iteratively model the shell of your building, ask for an energy analysis, revise the design, and ask for a comparative analysis—enabling you to interactively explore the energy cost implications of your decisions.

It can also facilitate collaborative design, allowing you to share building information with other team members, streamline or eliminate plan take-off tasks, and transfer essential information on your building design to the applications used for engineering design or code analysis. The Autodesk Green Building Studio web service can help to change the way building energy analysis is used in the building design process.

How the Autodesk Green Building Studio Web Service Works

In a nutshell, the service provides a user-friendly front end to some of the world's most powerful building energy analysis software. The calculations that lie behind this interface require a significant amount of information that is both time consuming to collect and likely unfamiliar to most building designers. All of the computationally intensive hourly simulations are carried out on remote servers, and the results are provided to you in a web browser. Autodesk Green Building Studio aims to save you time and energy by automating as much of this process as possible, which is why the service can be used interactively from the beginning of the design process.

The analysis process will collect data from three sources:

1. **Your Revit® software model.** All the building geometry comes from your model, including the number of rooms, the connections between rooms and their relationship to the exterior, exposure, and aspect to the sun; and the shape and total area of built surfaces or openings. Refer to the “Making the Most of Green Building Studio Energy Analysis” section for more information.
2. **Your responses to a few basic questions.** In order to explain the building's use or context, you will need to select a building type from a drop-down menu and enter the postal code for the site. You will also have a chance to select a weather station for the project, although the closest one is selected to be the default.
3. **Regionalized databases.** Based on the above information, Autodesk Green Building Studio will extract additional information about local weather conditions, construction, and materials. The service will automatically add any information you have not provided, so it can seamlessly adapt to your requirements as your design evolves.

Making the Most of Green Building Studio Energy Analysis

This section describes the way you would ideally model a building and provides tips that can help you pinpoint problem areas.

Model Your Building

Energy analysis requires spatial information—it is essentially a simulation of energy movement in, out, and through the building. Which walls are exposed to the outside? How many are exposed to sunlight? What are the number, size, and orientation of openings? How much heat is generated by internal lighting and equipment?

In the past, this information was manually calculated from 2D drawings. An engineer would use building plans, elevations, and details to collate spaces (type, area, volume), surfaces (including adjacency and thermal properties), and shading. All this information is latent in a Revit model, and in a form that is much easier to interpret than 2D drawings. And, if the project is consistently structured, software such as Green Building Studio can help take the pain out of the process.

The net result is that a time-intensive task that might only be done once, very late in the design process, can realistically be repeated on demand innumerable times. This is a very important contribution to the design process at a stage when change is still possible.

Hints and Tips

The Autodesk Green Building Studio web service is designed to be used during your scheme selection process to evaluate every scheme you are considering.

Do not wait until you have made all your design decisions before using Green Building Studio as it is designed to provide you with the information to make informed decisions as they relate to energy.

There are some crucial things to note, however, and chief among them is how you go about modeling a building in your BIM tool. You must follow the crucial rules below if you are to get the most out of your BIM tool with Green Building Studio.

Create a Revit model very early in your design process. A simple model allows you to compare forms and gross amounts of glazing, orientation, and shading. Green Building Studio only requires surfaces, openings, and rooms to simulate your building. For example, create a building form with approximately the right glass area on each façade, but do not worry about the details of window sizes. For schematic purposes, a continuous ribbon of glass that has the same area as a series of punched windows provides enough detail to make decisions about glass area.

Do not use Revit software like a 2D CAD tool. This oversight generally occurs when users are looking for a set of construction documents (CDs)—floor plans and details. Consequently, floors, ceilings, roofs, sill heights, and so forth may not be modeled as they are not required in typical CDs. However, inclusion of these elements in your BIM model is crucial to the successful use of Green Building Studio.

Model floors, ceilings, and roofs, in addition to walls and windows. These are essential items when it comes to whole building energy analysis.

Model the windows and skylights that are possibilities. Glazed areas contribute the most to HVAC energy use. Do not worry about getting window and skylight sizes exactly right as Green Building Studio allows you to quickly resize or remove them by orientation.

Model significant spaces only. Do not spend time modeling small spaces, storage spaces, phone closets, and so on that will increase simulation time and model complexity, but not increase accuracy of your results. Think of your building in the context of space uses and placement. For example, create “rooms” that are on the perimeter of the building (approximately 15-feet deep), add core “rooms,” and only partition the interior if the core becomes very large or is influenced by the nearby perimeter.

Connect all walls, roofs, slabs, and ceilings. Be sure that your walls connect to each other as well as to their respective slabs, ceilings, and roofs. Do not leave gaps in your model.

Registration

Step One: The first step is to become a member of the Autodesk Green Building Studio web service. Go to greenbuildingstudio.com/default.aspx, click on the New User Registration link, and fill out the necessary information. Once you have agreed to the Terms of Use, an email will be sent to you to validate your email address. This is to be certain your email address is entered correctly.

Step Two: Once you receive the email, either click the button in the email or copy the URL in it to your browser's address bar. Both of these actions will return you to Green Building Studio software, at which point you just need to log in using the User Name and Password provided in the email. You are now a member of the Green Building Studio web service.

Note: It is possible that your validation email might be filtered by your domain administrator and routed to your Spam or Junk folder. If you do not receive your validation email within an hour, contact the Autodesk Green Building Studio team for assistance at support.gbs@autodesk.com.

Installation Guide for Green Building Studio Client

To run Autodesk Green Building Studio from within Autodesk® Revit Architecture software or Revit® MEP software, you will need to use the Green Building Studio Plug-in. It submits the green building XML (gbXML), files created by the Revit software to the Autodesk Green Building Studio web service.

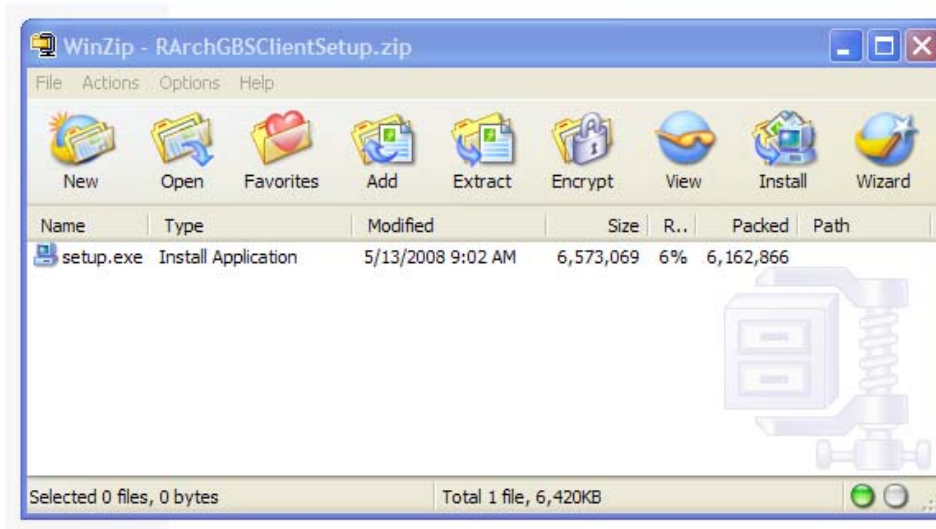
Step 1: Download the zip file containing the Green Building Studio Plug-in from the Green Building Studio download page as seen at left.

gbXML Plug-ins/Add-ons

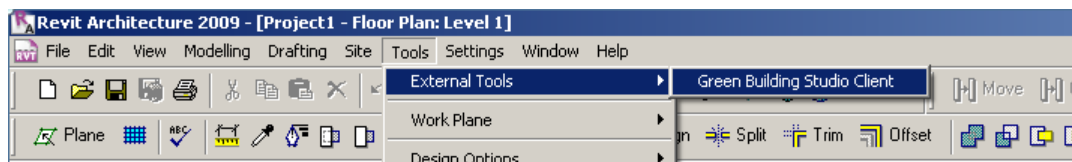
Autodesk

- Revit Architecture 2009 - [GBS Revit Plug-in](#)
- Revit MEP 2009 - [GBS Revit Plug-in](#)
- Revit Architecture & MEP 2008 & earlier and AutoCAD Architecture & MEP - [GBS Client](#)

Step 2: Unzip the file seen in the image below to a temporary directory and double-click the *setup.exe* file.



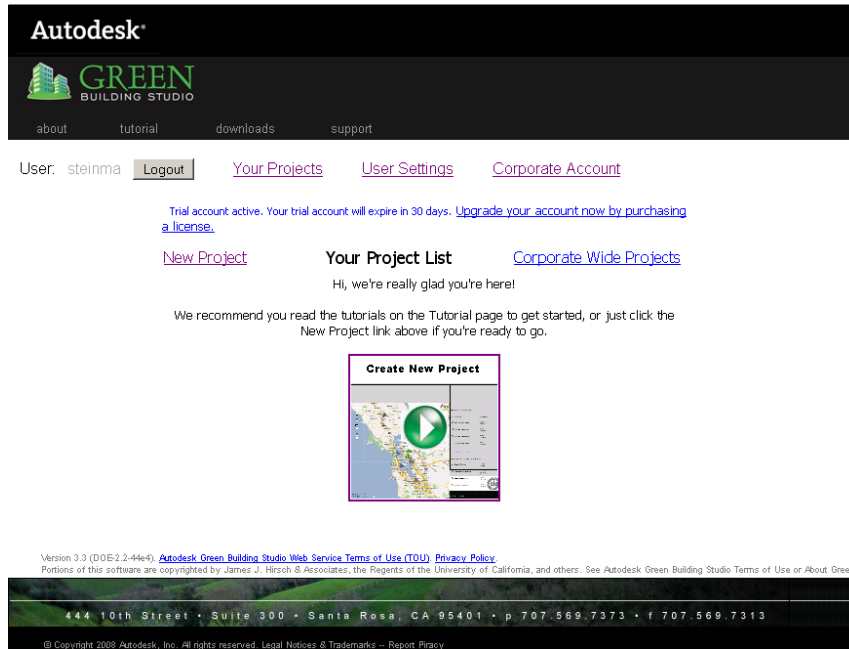
Step 3: Once installed you will find the Green Building Studio Plug-in under the menu Tools>External Tools>Green Building Studio Client, which can be accessed from any plan view.



After you have registered for Green Building Studio, you are ready to create new projects, make changes to your design in your Revit Architecture 2009 or Revit MEP 2009 software model, and analyze the performance of your design.

Creating New Projects

Once you log in you will be on the Project List page, and you are ready to add your first project. Just click the New Project link on the top left of the project list.



Hints and Tips

You must enter the Project Name and select a Building Type from the list of approximately 30 typologies and a unique building schedule, which is optional. There are two types of projects: Demonstration or Actual Building Design. Select Demonstration if you are sampling or a trial user of the service.

The choice you make for Building Type and Schedule can have a significant impact on your results. For example, if you are modeling a mixed-use building and choose Retail, the analysis will assume higher interior lighting loads than if you choose Office. Furthermore, the default schedules vary by building type. A retail store by default is assumed to be open more hours per year than an office building and hence will use more energy.

Name & Type	
Project Name	<input type="text"/>
Building Type*	<input type="text" value="Make Selection"/>
Schedule*	<input type="text" value="Default"/>
Project Type	<input type="radio"/> Actual Building Design Project <input checked="" type="radio"/> Demonstration Only

*These values can not be changed once runs are submitted to project.

Green Building Studio incorporates Google™ Maps to facilitate entry of a new project and select the appropriate weather file. Enter your project's address or the city and state or postal code in the Location text box, and click on the Find Location button. Move your green building icon to relocate. When satisfied with the selected location, check the checkbox below the map, and select the Next button.

Create New Project - Page 2 of 6

Enter address. If address does not yet exist, enter city, state and zip code. You may then drag the building marker to your physical location.

Location

Map Satellite Hybrid

1 California St, San Francisco, CA 94111, USA
Latitude: 37.793579, Longitude: -122.396448

500 ft
200 m

Map data ©2007 Sanborn, Tele Atlas

This is my correct project location

The next New Project screen will display all the weather files that the Autodesk Green Building Studio web service has in the vicinity of your project. Through this screen you can explore each weather file's degree day and design day characteristics and select the appropriate one, though by default the station closest to the building is selected.

Autodesk Green Building Studio Stations are based on recent "actual year" weather data rather than TMY2 and CZ2 stations, which are based on 30-year averages of weather data.

Simply select the radio button to the right of the map to select the desired weather file, and click the Next button.

Hints and Tips

C Design and H Design are the outdoor cooling and heating design temperatures typically used to size heating and cooling equipment. HDD and CDD are the heating and cooling degree day totals for the weather location you have chosen. Compare the design and CDD/HDD data for the available weather files to determine which weather file most closely approximates the weather for your site.

Create New Project - Page 3 of 6

Select a Weather Station by selecting it from the station list. You may view more detailed weather information by clicking on a station map marker.

The screenshot shows the 'Select Weather Station' interface. On the left is a map of the San Francisco Bay Area with a popup window for 'TMY2 -- San Francisco, CA (TMY2)'. The popup displays: 'Distance to your project 12.04 miles (19.38 km)' and 'Latitude= 37.6200, Longitude= -122.3800'. On the right is a list of stations. The 'Nearest GBS Stations' list includes GBS_R2044113 (3.1 mi), GBS_R2045113 (9.9 mi), GBS_R2044112 (10.8 mi), and GBS_R2044114 (14.3 mi). The 'Nearest TMY2 and CCZ Stations' list includes San Francisco, CA (TMY2) (12.0 mi), Zone 3 - Oakland (12.5 mi), Zone 4 - Sunnyvale (31.7 mi), and Zone 2 - Santa Rosa (45.1 mi). At the bottom are 'Reset', 'Back', and 'Next' buttons.

The next screen is where you specify additional address information as well as utility cost information. Make sure a postal code is entered, and click the Get Utility Cost button to retrieve the Autodesk Green Building Studio electric and fuel cost defaults. These are based on the previous year's state average prices for fuel and electricity that are published by the U.S. Department of Energy. Modify them if you have more relevant data.

Create New Project - Page 4 of 6

Please check location, weather file and utility cost information.

Location & Rates	
Latitude & Longitude*	Latitude <input type="text" value="37.793579"/> Longitude <input type="text" value="-122.396448"/>
Weather File	GBS_R2044113
Country*	<input type="text" value="United States"/>
State/Province	<input type="text" value="CA"/>
City	<input type="text" value="San Francisco"/>
Address	<input type="text" value="1 California St"/>
Postal Code*	<input type="text" value="94111"/>
Currency*	<input type="text" value="\$ - English (United States)"/>
Electric Utility*	<input type="text" value="California state average"/> <input type="button" value="Get Utility Cost"/>
Electric Cost*	<input type="text" value="0.131"/> \$0.00/kWh
Fuel Utility*	<input type="text" value="California state average"/>
Fuel Cost*	<input type="text" value="1.000"/> \$0.00/Therm

Hints and Tips

Your local utility may have its current rates posted on its website. In some cases, natural gas is priced per unit volume. If gas is priced per cubic foot, multiply the price per cubic foot by 100 to get the approximate price per therm.

1 therm = 100,000 Btu.

The price of natural gas can vary widely by season. Use the price of gas that is typical during the heating season if most of your gas use is for space heating.

*These values can not be changed once runs are submitted to project.

Autodesk Green Building Studio software enables you to share information about your project with design team members and Green Building Studio partners who may provide more information on how their products can fit with your building design. To ensure you are authorized to share project information, Green Building Studio needs to know who has authorized you to share project data if you are not the owner of the building information you are submitting. The authorizing agent you specify will also receive a copy of the Autodesk Green Building Studio Terms of Use (TOU).

Create New Project - Page 5 of 6

Please specify your preference for sharing your data and how our key partners may contact you. Our key partners have agreed to treat all data you give them access to as confidential. Our key partners include high performance building product manufacturers, providers of rebates and incentives (e.g., utilities, government, etc.), consultants, and others. Several offer free services to analyze your building design data to offer you custom solutions, highly accurate quotations, or other design alternatives you may not have considered.

Data Access Preference	<input type="radio"/> Do not share any data associated with this project <input type="radio"/> Share only summary data (e.g., bldg. type, floor area, etc.) <input type="radio"/> Share all project data.
Contact Preference	<input type="radio"/> Only GBS may contact me regarding this project. <input type="radio"/> GBS partners may contact me regarding this project
Autodesk Green Building Studio Web Service Terms of Use (TOU)	<input type="radio"/> I am not authorized to accept the terms of the TOU and share project data with the GBS web service. <input checked="" type="radio"/> I am authorized to accept the terms of the TOU and share project data with the GBS web service. <input type="radio"/> I was authorized by the individual below to accept the terms of the TOU and share project data with the GBS web service.

Reset

Back

Next

Finally, for new projects you need to specify the budget, current design phase, the estimated construction start date, and if the project has a green building goal.

Create New Project - Page 6 of 6

Please indicate project related information.

Total Construction Budget	Make Selection <input type="button" value="v"/>
Current Design Phase	Make Selection <input type="button" value="v"/>
Estimated Construction or Renovation Start Date	Make Selection <input type="button" value="v"/>
Green Building Goal	Make Selection <input type="button" value="v"/>
Notes	

You will be able to review and edit your project information from your Project List page

After you create a new project you will receive an email containing the TOU specific to this project for your records.

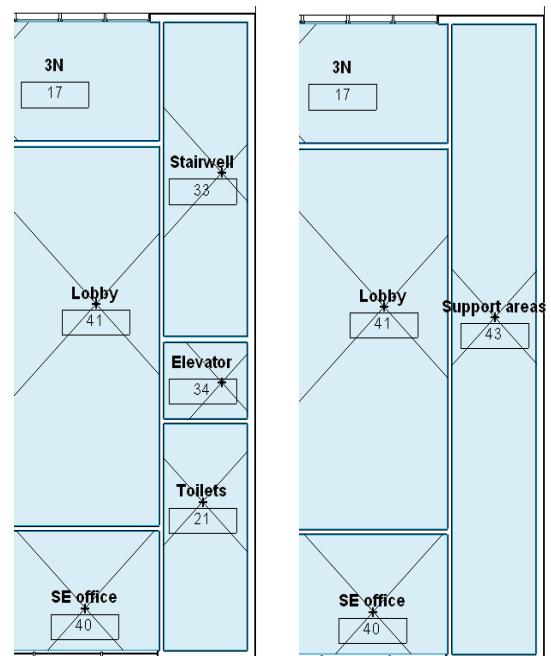
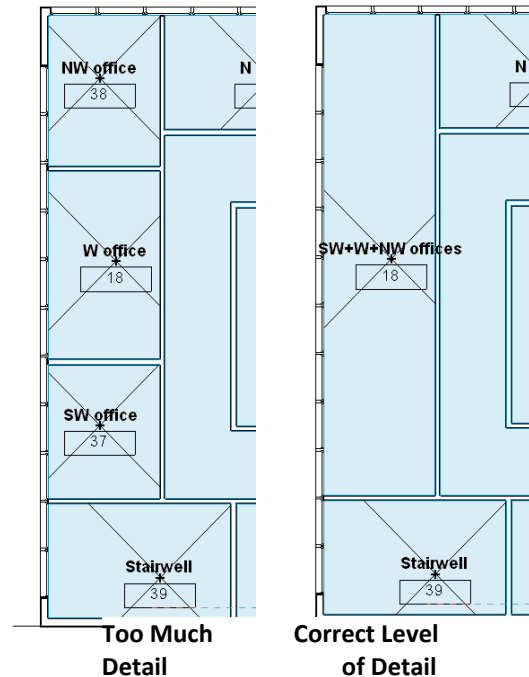
Revit BIM Model Development

The Autodesk Green Building Studio web service is designed to be used during the scheme selection process to ensure resource use information relating to energy, water, and other metrics is available and used during the scheme selection process. With this in mind, we recommend you keep your model as simple as possible. We recommend you only model major spaces and combine smaller spaces that represent key programmatic requirements of the project. Do not include all interior partitions that will eventually be part of the final building.

Adding more interior partitions than is required will create more work in the model, introduce potential errors, and slow the simulation without significantly improving the accuracy of the results

If you are familiar with a thermal zone layout of a building, we recommend your room layout be similar. Perimeter rooms facing the same direction should be grouped together. Core zones with little or no exterior exposure should be grouped together.

Similarly, unconditioned support spaces, such as restrooms, stairwells, elevator shafts, and storage spaces, should be grouped together. Work with your mechanical engineer for guidance on such a layout if you are not familiar with it.



Revit Architecture 2009 Room Object¹

Your Revit® Architecture software model must have Room objects defined for all rooms or group of rooms that you want to be exported to gbXML and analyzed by the Autodesk Green Building Studio web service. You must ensure that the Room object is positioned properly in the model and that the room is high enough to “touch” a bounding surface. In the next few pages we will describe how to ensure the Room object is being used correctly.

Adding Revit Room Objects

Revit Architecture allows you to add Room objects to your model at any time. It is fairly easy, but a new concept for most regular users of CAD.

- Open a plan view of the level you want to add rooms.
- Select the Room object from the Basics tab or the Room and Area tab.
- Click in the center area of the model area where you would like a room to be defined. Revit Architecture then highlights all the bounding walls that make up the room boundaries for the newly added room.
- All rooms should be in the New Construction phase. Choose Phases... under the Settings menu, and then combine all phases into New Construction.

Hints and Tips

Room objects will be placed at the level on which you are working on. By default the upper limit and the level will be the same. Default room height is captured using the Limit Offset and is typically 8 feet.

Take advantage of the Revit Architecture parametric capabilities, and use the level above your current level as the upper limit rather than relying on the limit offset. If levels are later changed, the room height will be automatically adjusted, and you will not have to individually modify each room's height.

¹ If you are using Revit® MEP 2009 software, please skip ahead to the section named “Revit MEP Space and HVAC Zone Objects.”

Checking Room Object Height

The best way to view a Revit Architecture room object's height is viewing it in section. First you have to ensure the Visibility of the room object's Interior Fill is selected. You can access the Visibility/Graphic Overrides dialog box using the View>Visibility/Graphics menu.

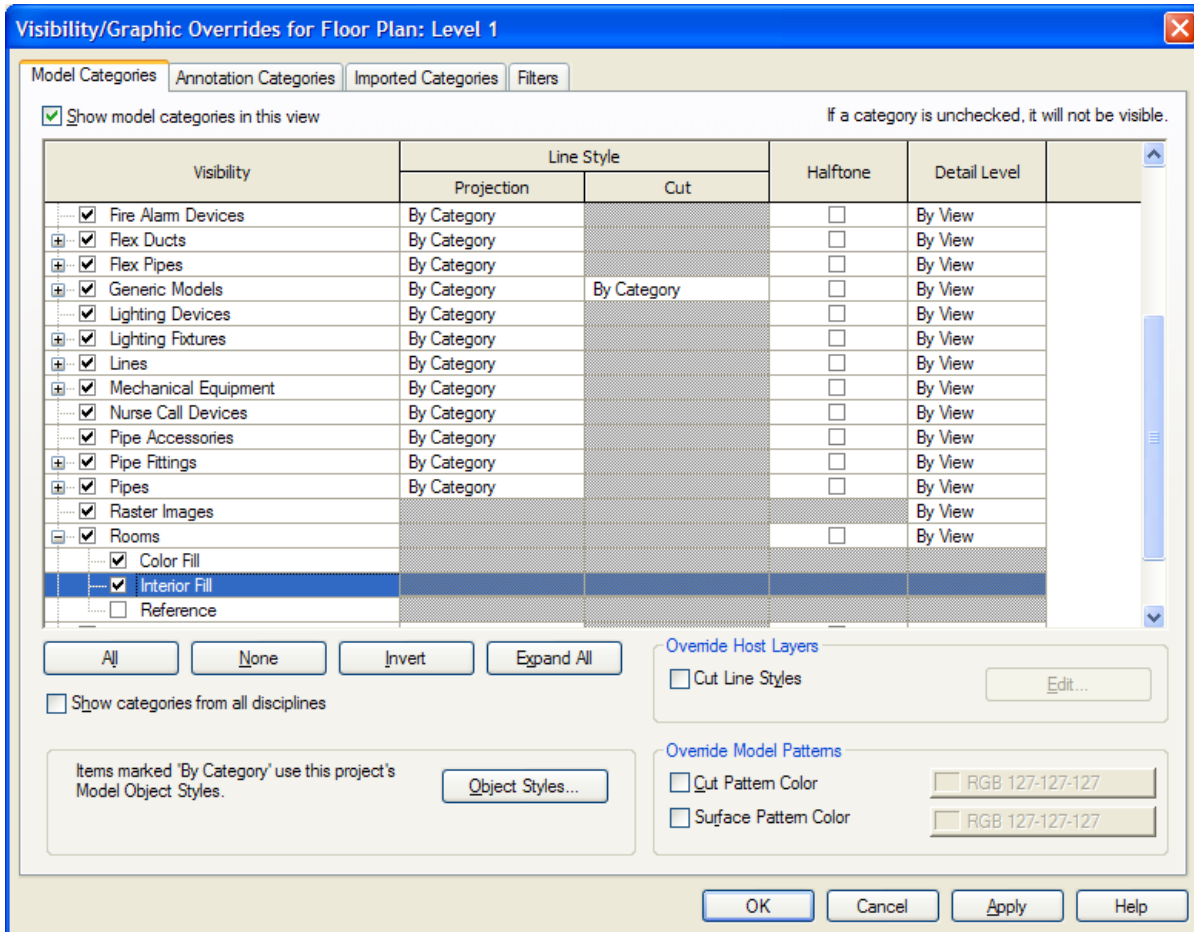


Figure 1—Revit Visibility/Graphic Dialog

Once you have enabled the Interior Fill for Rooms to be visible, you will see the room object in section view.

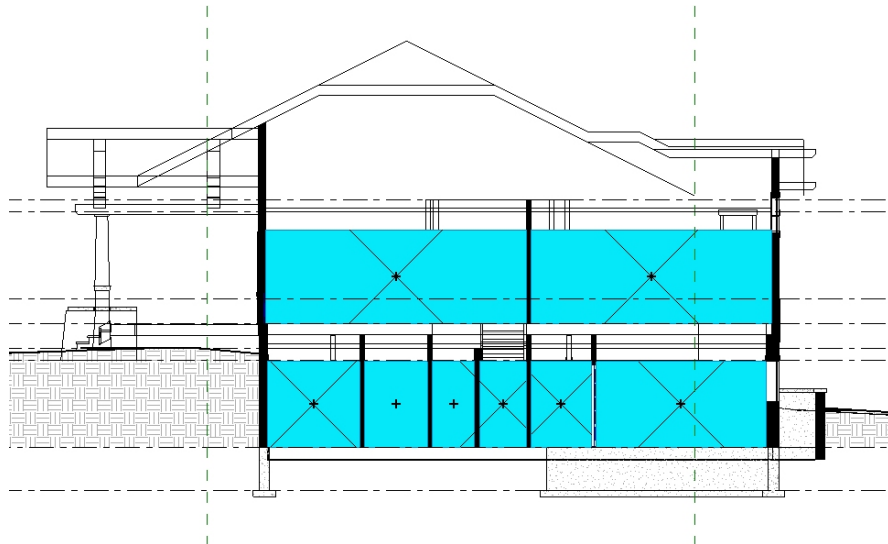
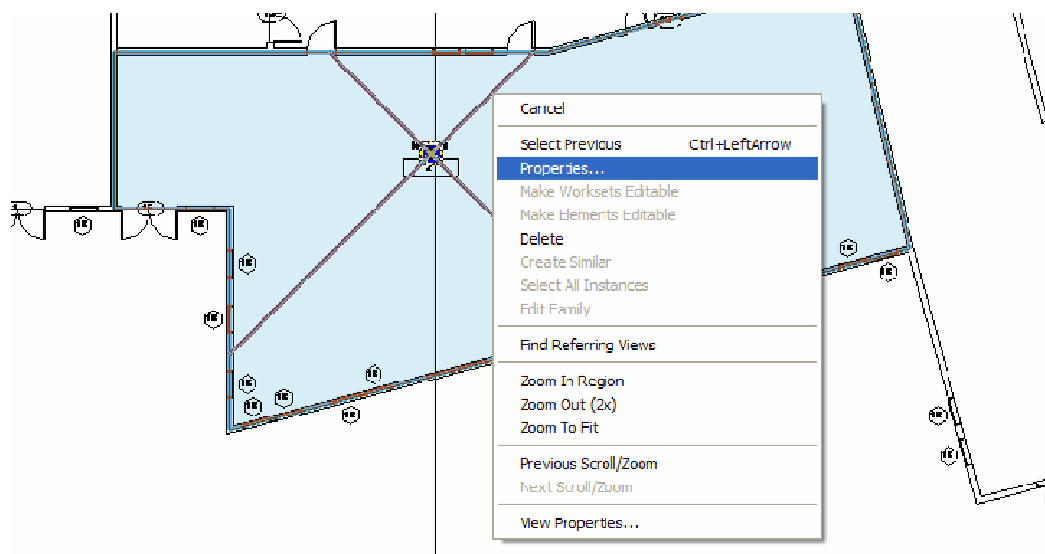


Figure 2—Revit Section View: Height of Room Objects Incorrectly Defined

If your room object is not touching the entire roof or ceiling in the room, then not all of that roof or ceiling will be exported to the gbXML file. By default, the room height is 8-feet above the base level. The file will still run, but will not be thermally correct. Figure 2 above illustrates room objects on the lower floor that are incorrect because they are not in contact with the ceiling.

The room objects on the second floor are incorrect because they are not in contact with the roof. Walls, roofs, columns, curtain systems, building pads, and room separator lines can be made to be room bounding objects by changing element properties. Floors and ceilings are always room bounding.

The way to fix these types of issues is to select the Room object by right-clicking the X over the Room object when it appears and selecting the Properties menu item, as seen below.



In the properties window for the room, change the Upper Limit to the level of the roof or ceiling and add a Limit Offset, if necessary, to increase the room object height to enclose the entire roof. Then go back to the section view to confirm the roof or ceiling is now fully enclosed in the room object. Figure 3 below illustrates the room object now correctly defined. The rooms on the lower floor are now in contact with the ceiling and the rooms on the upper floor are fully in contact with the roof. Although the upper-floor rooms graphically extend above some of the roof surfaces, the room volumes will still be computed correctly.

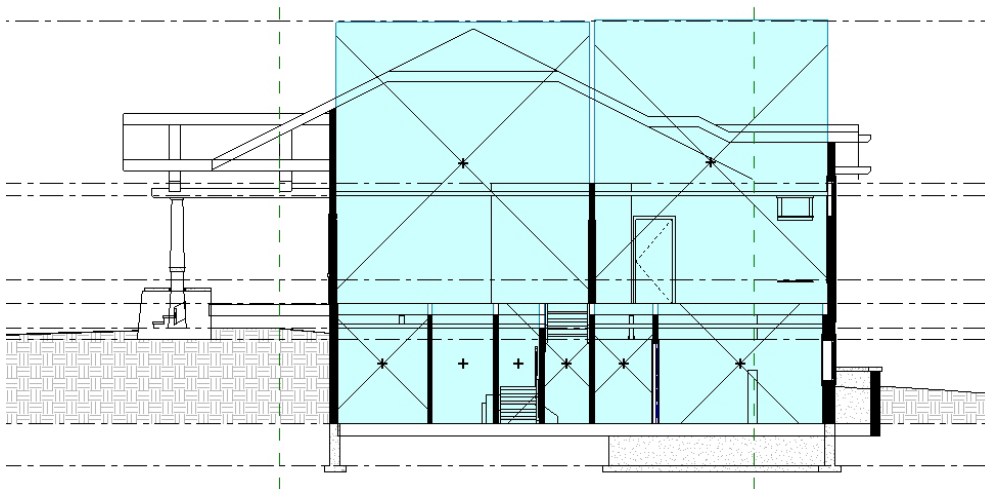

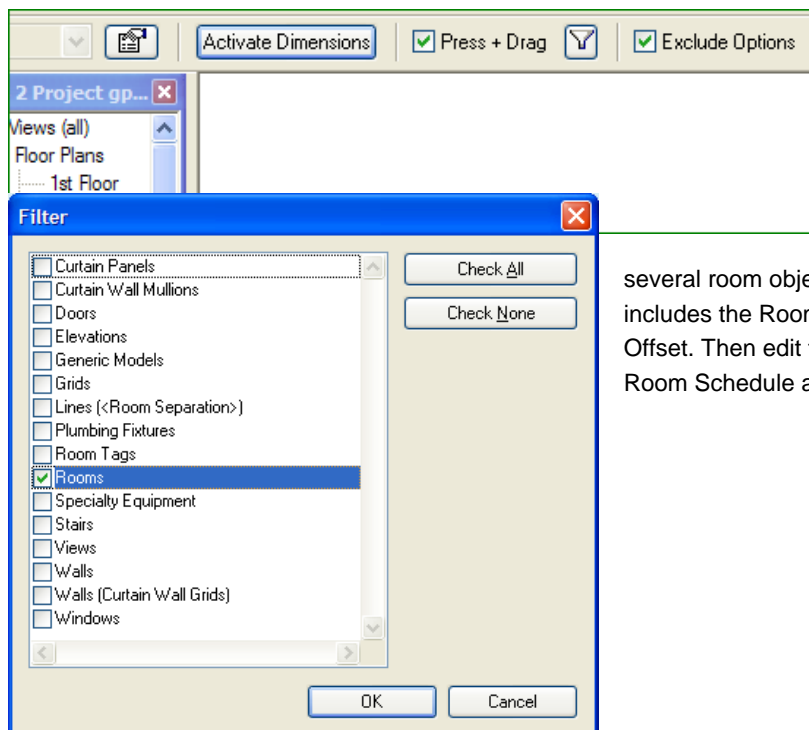


Figure 3—Revit Section View: Height of Room Objects Correctly Defined

Changing the Height of Multiple Room Objects

The best way to change multiple room heights is to select them all on a floor plan. In the Floor Plan view, select all items on that floor by clicking and dragging the selection box over the entire floor or area of desired rooms. Click the Filter  button on the toolbar as seen at left. Then uncheck all items except the Rooms on the Filter dialog.



At this point, all rooms from your selection will be selected. Right-click on a selected room object and select Properties from the menu. Set the Upper Limit and Limit Offset to the desired values.

You can also change the height of several room objects by creating a Room Schedule that includes the Room Name, Level, Upper Limit, and Limit Offset. Then edit the Upper Limit and the Limit Offset in the Room Schedule as needed.

Revit MEP 2009 Space and HVAC Zone Objects²

Unlike Revit Architecture 2009, Revit[®] MEP 2009 software does not require the definition of rooms for successful analysis by Autodesk Green Building Studio; however, Revit MEP models must have Space and HVAC Zone objects defined.

You must manually add space objects within your project. By default, Revit MEP will automatically create one HVAC Zone for the entire building and assign all of your spaces to that HVAC Zone. You must manually create additional HVAC Zones if appropriate for your project.

When exported to Green Building Studio, the gbXML file automatically groups multiple spaces assigned to one HVAC Zone into one space (this is due to the limitations of the DOE-2.2 simulation engine used by Green Building Studio). This may not be problematic for your project unless you have a mixture of conditioned and unconditioned spaces grouped together under one HVAC Zone. The Green Building Studio analysis will be unable to properly analyze mixed conditioning types within one HVAC Zone. In order to retain the proper condition type (conditioned, unconditioned, and so on) for your spaces, you must assign spaces of similar condition type to each HVAC Zone within Revit MEP 2009. This topic will be covered in more detail in the section below called “Adding Revit MEP 2009 HVAC Zone Objects.”

Adding Revit MEP 2009 Space Objects

After adding the space object, you must ensure that it is positioned properly in the model for the best results. Over the next few pages we will describe how to ensure the space object is being used properly. The process for defining space objects in Revit MEP is very similar to the process for defining room objects in Revit Architecture.

1. Open a plan view of the level you want to add spaces.
2. Select the space object from the Mechanical tab.
3. Click in the center area of the model area where you would like a space to be defined.

Revit MEP should then highlight all the bounding walls that make up the space boundaries for the space you just added.

Hints and Tips

Only surfaces in contact with the space object will be exported to gbXML.

² This section only applies to Revit MEP 2009. If you are using an earlier version of Revit MEP or any version of Revit Architecture, please review the section named “Revit Architecture 2009 Room Objects.”

Checking Space Object Height

The best way to view a Revit MEP space object's height is to view it in section. First you have to ensure the Visibility of the space object's Interior Fill is selected. You can access the Visibility/Graphic Overrides dialog box using the View/Visibility>Graphics menu.

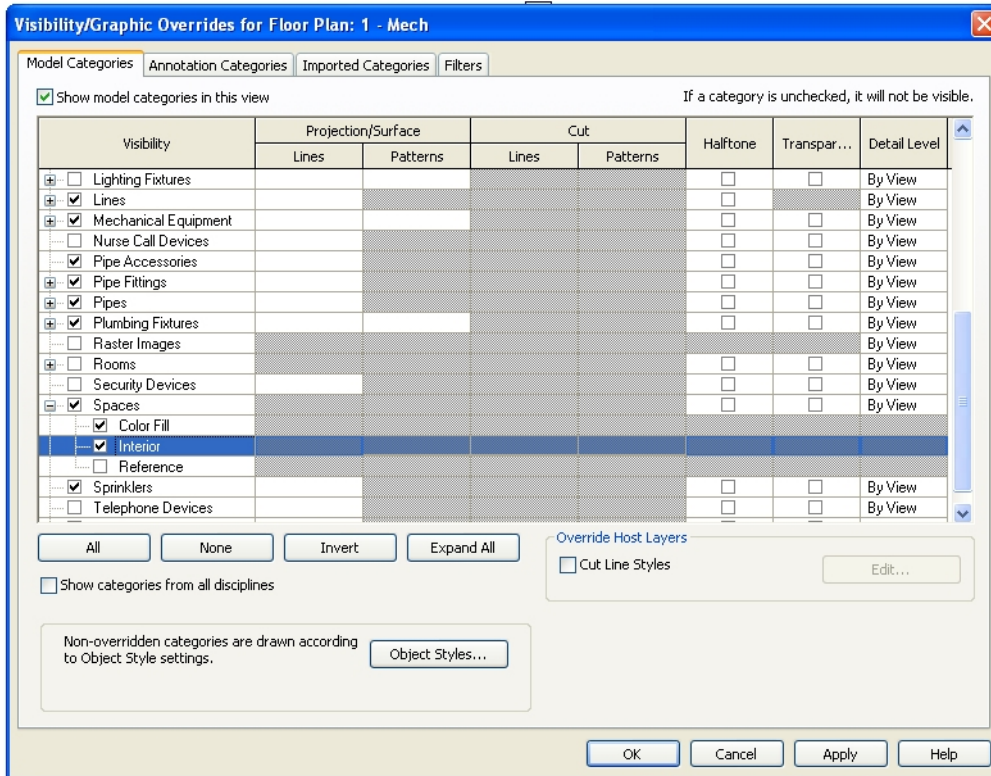


Figure 4—Revit MEP Visibility/Graphic Dialog

Once you have enabled the Interior Fill for spaces to be visible, you will see the space object in section view.

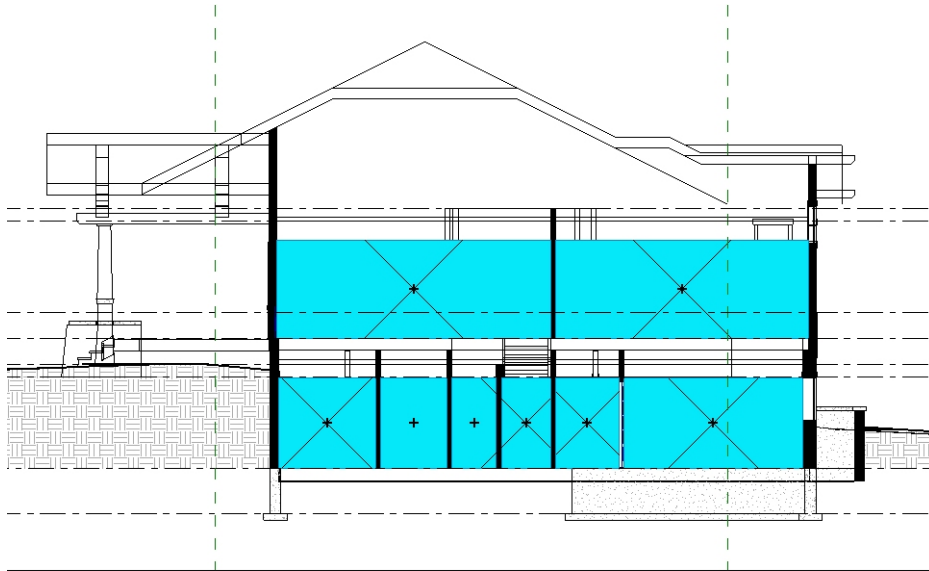
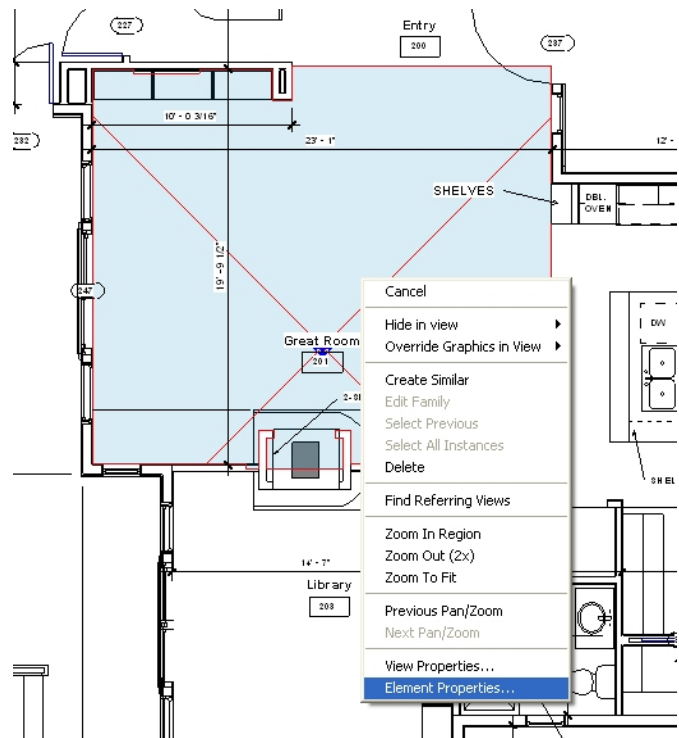


Figure 5—Revit MEP 2009 Section View: Height of Space Objects Incorrectly Defined

If your space object is not touching the entire roof or ceiling in the room, then not all of that roof or ceiling will be exported to the gbXML file. Figure 5 above illustrates that the space objects on the lower floor are incorrect because they are not in contact with the ceiling. The space objects on the second floor are incorrect because they are not in contact with the roof.

Walls, roofs, columns, curtain systems, building pads, and room separator lines can be made to be room bounding objects by changing element properties. Floors and ceilings are always room bounding.

To fix these types of issues, select the space object by right-clicking the X over the space object when it appears, and then select the Properties menu item, as seen here.



In the Element Properties window for the space object, change the Upper Limit to the level of the roof or ceiling and add a Limit Offset that will increase the space object height to enclose the entire roof. Then go back to the section view to confirm the roof or ceiling is now fully enclosed in the space object. Figure 6 below illustrates the space objects now correctly defined. The spaces on the lower floor are now in contact with the ceiling and the spaces on the upper floor are fully in contact with the roof. Although the upper-floor spaces graphically extend above some of the roof surfaces, the space volumes will still be computed correctly.

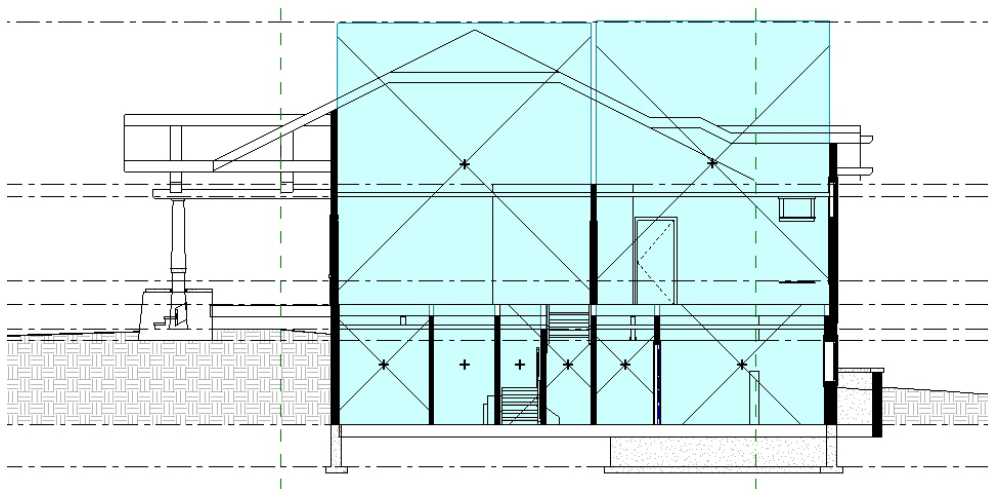

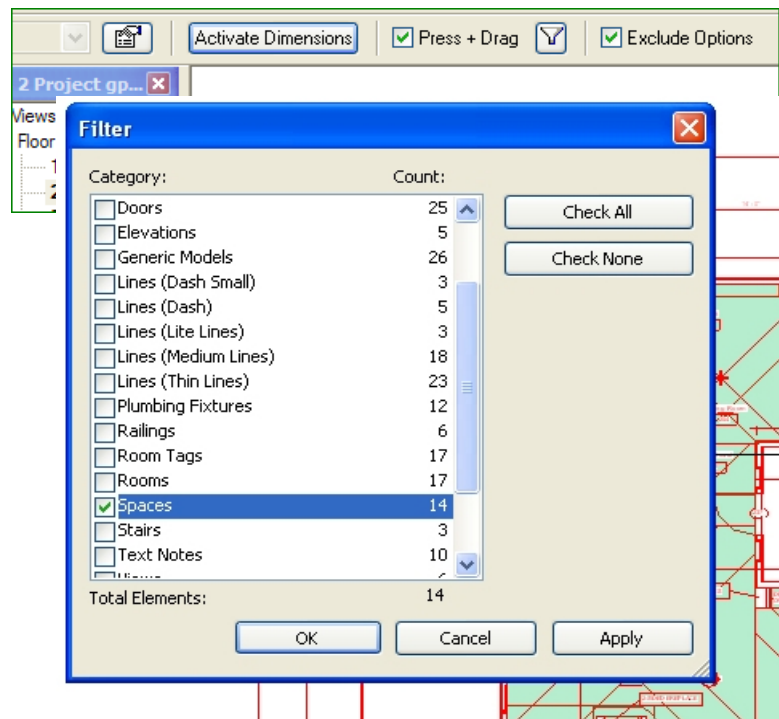


Figure 6—Revit MEP 2009 Section View: Height of Space Objects Correctly Defined

Changing the Height of Multiple Space Objects

The best way to change the height of multiple spaces simultaneously is to select them all on a floor plan. In the Floor Plan view, select all items on that floor by clicking and dragging the selection box over the entire floor or area of desired rooms. Click the Filter  button on the tool bar as seen at right. Then uncheck all items except Spaces on the Filter dialog.

At this point all spaces from your selection will be selected. Right-click on a selected space object, and select Properties from the menu. Set the Upper Limit and Limit Offset to the desired values. That's it.



You can also change the height of several space objects by creating a Space Schedule that includes the Space Name, Level, Upper Limit, and Limit Offset. Then edit the Upper Limit and the Limit Offset in the Space Schedule as needed (see below).

Space Schedule			
Name	Level	Upper Limit	Limit Offset
Kitchen	Upper Floor	Roof	8' - 0"
Dining Room	Upper Floor	Roof	8' - 0"
Living Room	Upper Floor	Roof	8' - 0"
Bath	Upper Floor	Roof	8' - 0"
Master Bedroom	Upper Floor	Roof	8' - 0"
Family Room	Upper Floor	Roof	8' - 0"
Bedroom	Upper Floor	Roof	8' - 0"
Study	Upper Floor	Roof	8' - 0"
Bedroom	Ground Floor	Upper Floor	0' - 0"
Washroom	Ground Floor	Upper Floor	0' - 0"
Bath	Ground Floor	Upper Floor	0' - 0"
Game Room	Ground Floor	Upper Floor	0' - 0"

Adding Revit MEP 2009 HVAC Zone Objects

Revit MEP 2009 software automatically creates one HVAC Zone for the entire project and names it Default. You can verify this by creating an HVAC Zone Schedule (see below). The Level category is blank in this example because the Default HVAC Zone encompasses all the spaces on multiple levels of this project.

HVAC Zone Schedule		
Name	Level	Occupied Area
Default		2516

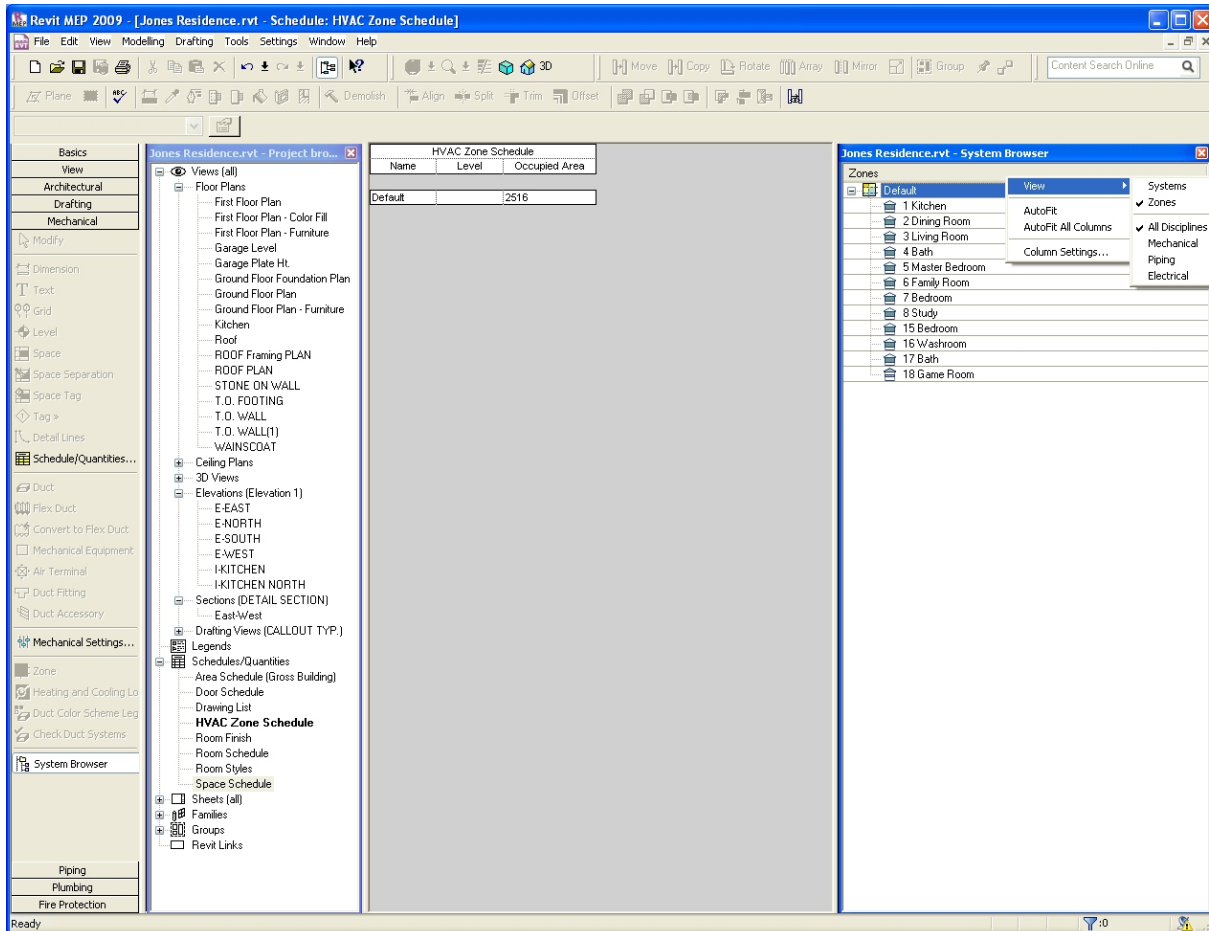
In order to verify which spaces are associated with which HVAC Zones

1. Select the Mechanical Tab
2. At the very bottom, click on System Browser
3. Right-click on the System Browser window (on the right side of your screen)
4. Choose View
5. Select Zones

In the example below, you can see that there are 18 spaces within the Default HVAC Zone. You may export your file to the Autodesk Green Building Studio web server at this point; however, the gbXML file will group multiple spaces assigned to each HVAC Zone into one space (this is due to the limitations of the DOE-2.2 simulation engine used by Green Building Studio).

HEADER IS DOCUMENT TITLE

The Green Building Studio simulation will run if your project consists of only conditioned spaces grouped together under one HVAC Zone. However, it is usually not reasonable to combine all the spaces in a building into one thermal HVAC zone and will typically cause inaccurate results. If your project contains a combination of conditioned and unconditioned zones, and in order to retain the proper conditioning type of your spaces for the Green Building Studio analysis, you will need to group conditioned spaces together in conditioned space zones, and unconditioned spaces together in unconditioned space zones.



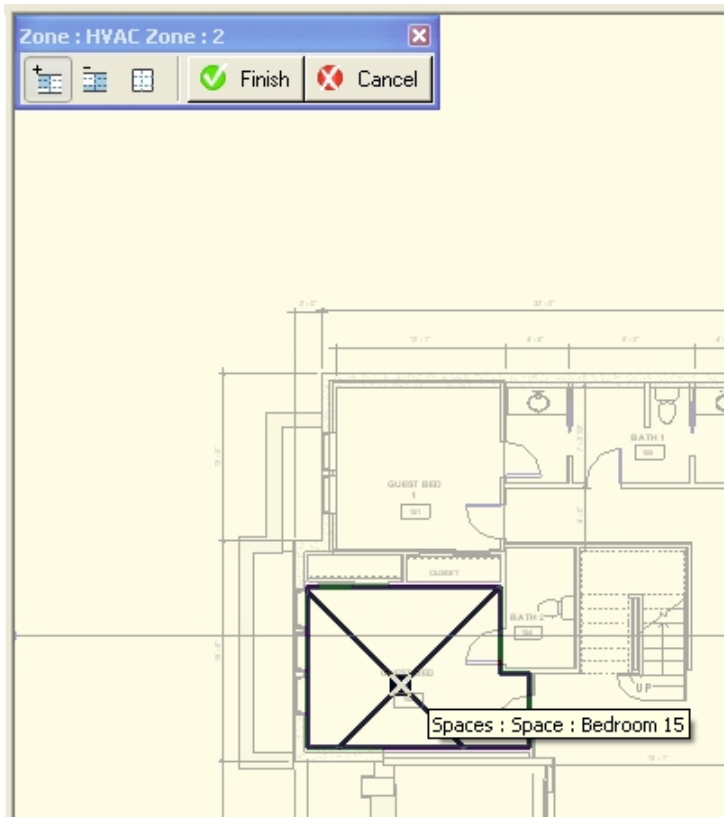
Assigning Revit MEP 2009 Spaces to HVAC Zone Objects

To create an HVAC Zone, go to the Mechanical tab and choose Zone. A small Zone window will appear with three icons plus Finish and Cancel buttons. In the example below, the HVAC Zone has automatically been named 2. To add a space to the HVAC Zone 2, move your cursor over the appropriate space, left-click, then click on the Finish button. To add multiple spaces to one HVAC Zone, continue clicking on the desired spaces before clicking on the Finish button. Revit MEP 2009 will automatically name your new HVAC Zones beginning with the numeral 1.

If you choose to rename the HVAC Zones, you can do so by creating an HVAC Zone Schedule and editing the HVAC Zone name within the Schedule.

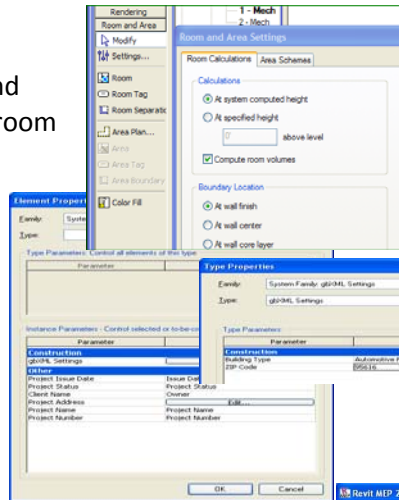
Hints and Tips

Your HVAC Zone name must *not* contain any spaces within the text or the Green Building Studio run will fail. For example, the name "Zone 1" will cause the Green Building Studio run to fail, but the name "Zone1" will run successfully.



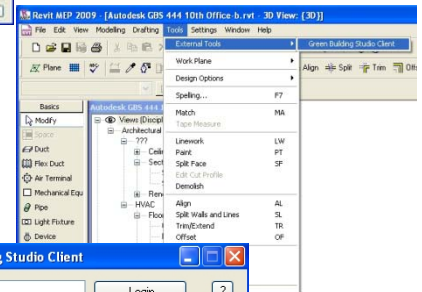
Exporting to Green Building Studio from Revit Line of Products

Step 1: Under the Room and Area Design Bar, select the Settings... icon to open the Room and Area Settings dialog box. Check the Compute room volumes check box.



Step 2: Specify a zip code for your building's location and the Building Type under the Setting>Project Information... menu and gbXML Settings parameter.

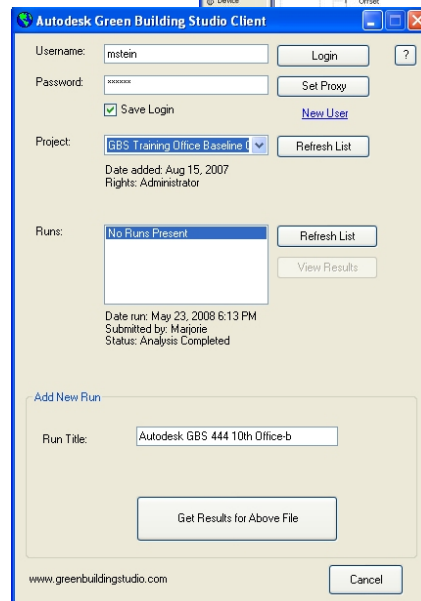
Step 3: Select the Green Building Studio Client menu item under the Tools>External Tools menu.



Step 4: Enter your Green Building Studio Username and Password and click the Login button. You must be connected to the Internet for this to work.

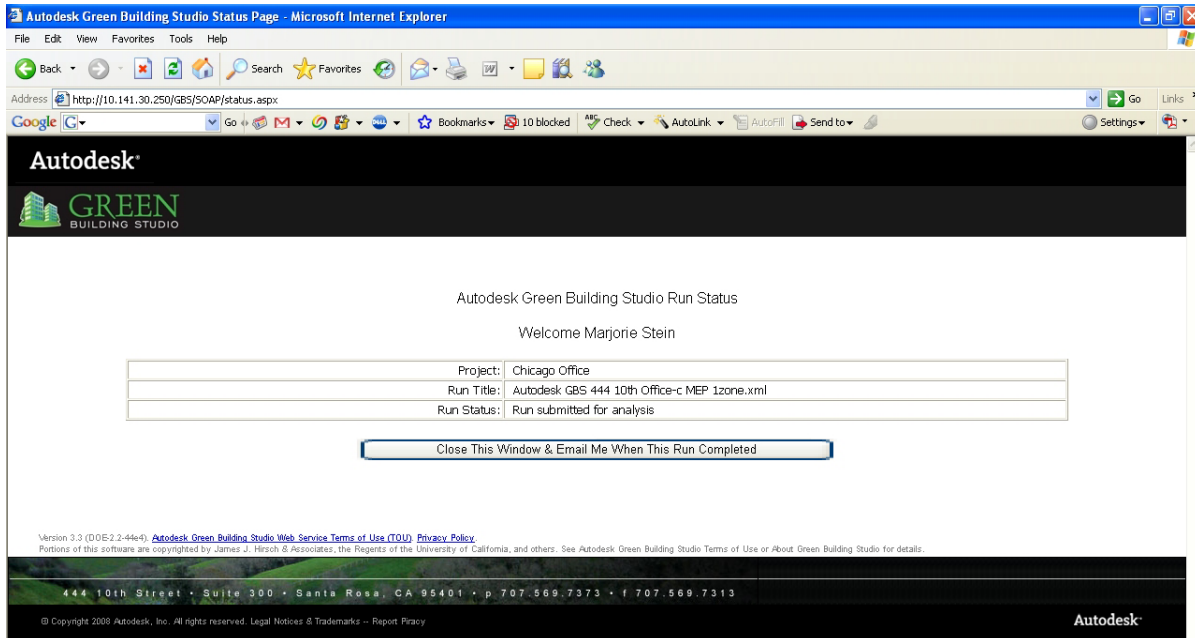
Step 5: If you have projects in your Green Building Studio account, they will be listed in the Project list. Simply select the project to which this model is assigned.

Step 6: Click on Get Results for Above File to initiate the simulations and get results.



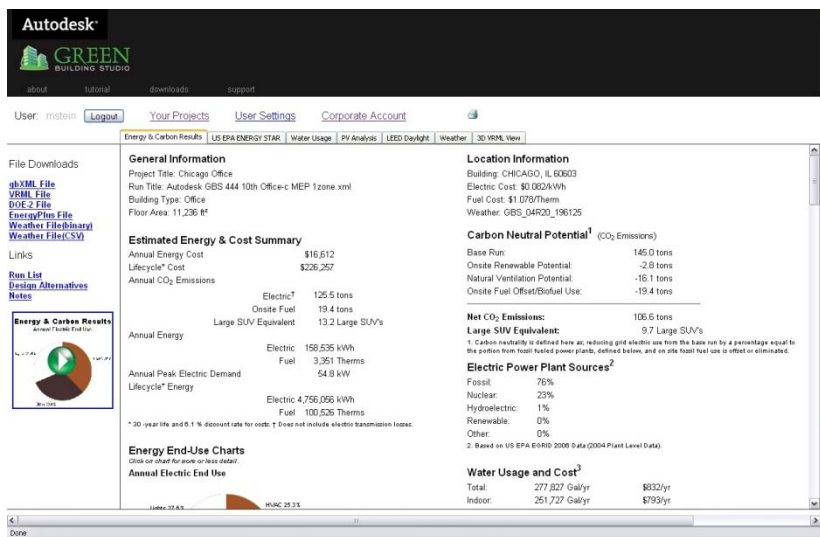
HEADER IS DOCUMENT TITLE

Green Building Studio software will first check your Revit model for missing data or errors, and if problems are found, an error message will appear. Assuming there are no errors, a browser window will open similar to the one below presenting you with the status of your Green Building Studio whole building energy and carbon analysis.



The length of time it takes to run the Green Building Studio simulations typically varies from less than a minute to 5 or 10 minutes. The run time depends on the server traffic, complexity of the mode, and the number of surfaces, windows, rooms, spaces, and zones. Typical schematic models will run in less than a minute. Most runs are complete within minutes. Very large models (with gbXML files more than 8 to 12 MB) may take up to an hour to run. This is another reason to simplify your model if possible, especially when a project is in the early stages of design.

Once your run is complete you will see a screen similar to the one below.



Analysis Results

The Green Building Studio results pages provide accurate yet easy-to-understand summary information on building energy and resource use, carbon emissions, simulation assumptions, performance metrics, and costs that can be used immediately to compare the energy costs of multiple building design scenarios at the conceptual design stage. The following discussion serves as a guide to interpreting the results effectively. Screenshots from various parts of the page are used to illustrate the results.

Energy and Carbon Results

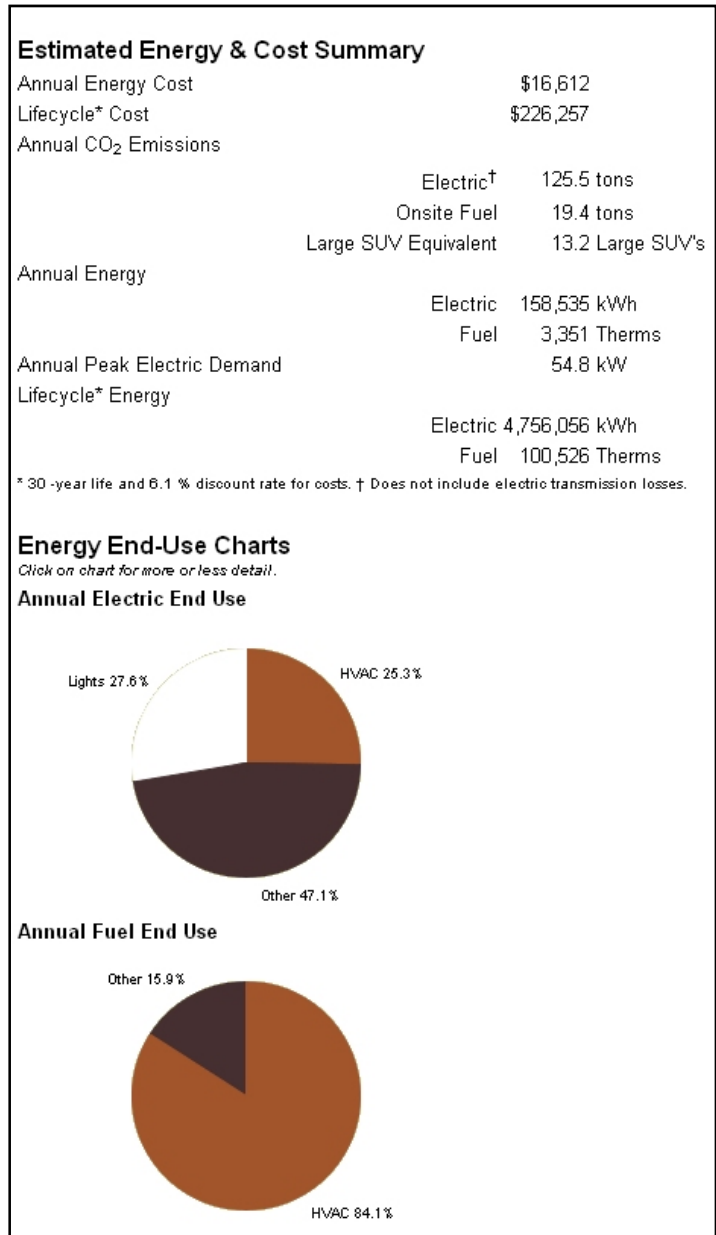
General Information: The general information section at the top of the page describes the project scenario, building type, geographic location, and gross floor area.

Estimated Energy and Cost Summary: Most building energy cost comparisons and early compliance decisions can be made using annualized energy cost and consumption information. Costs are estimated using statewide average utility rates, or the customized rates you may have applied to the project.

The following information is provided:

- Annual energy cost.
- Lifecycle energy costs (30 year).
- Annual energy consumption (electric and gas).
- Peak electric demand (kW).
- Lifecycle energy consumption (electric and gas).
- CO₂ emissions are based on the onsite fuel use and the fuel sources for the electricity in the region.
- An equivalency using an SUV (driven 15,000 miles/year) is given to put the building's CO₂ emissions into perspective.

Energy End-Use Charts: Further breakdowns of energy use for major electric and gas end uses such as lighting, HVAC, and space heating are provided in graphical format. Additional details associated with each category can be seen by clicking on the pie charts.



In addition to energy use and cost, Green Building Studio software provides additional information required to design a carbon neutral building. This additional information includes the following:

Carbon Neutral Potential: This section will summarize the CO₂ emissions for your building design and identify the options to reduce them. If your net CO₂ emissions are less than zero, there is a high potential for this building to be carbon neutral.

Electric Power Plant Sources: The U.S. Environmental Protection Agency has historical records for all the fuel and emissions of all power plants in the United States. This section summarizes the fuel sources for electricity generated in this region. In order for a project to be carbon neutral, electricity consumption must be reduced or offset using renewables by an amount equal to the portion of the electricity that comes from fossil fuels.

Water Usage and Cost: A summary is given of the estimated water use in the building based on the number of people in the building as well as the building type. Note that the water consumption is not related to the number of fixtures.

Photovoltaic Potential: Green Building Studio software automatically analyzes every exterior surface of the building, including roofs, walls, and windows, for their potential to generate electricity using photovoltaics. Exterior shades are not currently included in the photovoltaic analysis. The results of this analysis are summarized in this section. Note that this analysis assumes that PVs can be installed on vertical as well as horizontal surfaces as long as the surface generates significant amounts of PV power. See the PV tab for details on the surfaces that are analyzed.

Carbon Neutral Potential¹ (CO₂ Emissions)

Base Run:	264.3 tons
This Run:	216.7 tons
Onsite Renewable Potential:	-6.3 tons
Natural Ventilation Potential:	-19.8 tons
Onsite Fuel Offset/Biofuel Use:	-30.9 tons

Net CO₂ Emissions:	159.7 tons
Large SUV Equivalent:	14.5 Large SUV's

1. Carbon neutrality is defined here as eliminating or offsetting fossil based electricity and fuel use. For example, if the electricity grid is 60% fossil fuel and 40% hydroelectric, reducing grid electricity use by 60% from the base run and eliminating/offsetting on-site fuel use make the project carbon neutral. Use any combination of efficiency, natural ventilation, renewable energy, carbon credits and biofuels to reach this goal. Renewable potential is the sum of photovoltaic and wind potential shown below.

Electric Power Plant Sources²

Fossil:	55%
Nuclear:	42%
Hydroelectric:	1%
Renewable:	2%
Other:	0%

2. Based on US EPA EGRID 2006 Data (2004 Plant Level Data).

Water Usage and Cost³

Total:	1,817,452 Gal/yr	\$6,676/yr
Indoor:	1,795,252 Gal/yr	\$6,642/yr
Outdoor:	22,200 Gal/yr	\$33/yr

3. Based on AWWA Research Foundation 2000 Residential / Commercial and Institutional End Uses of Water.

Photovoltaic Potential⁴

Annual Energy Savings:	2,911 kWh
Total Installed Panel Cost:	\$18,952
Nominal Rated Power:	2 kW
Total Panel Area:	184 ft ²
Maximum Payback Period:	49 yrs @ \$0.08 / kWh

4. Results based on all exterior surfaces being analyzed. Escalation rate of 2% applied to electric rate. Payback calculation does not include federal or state incentives, loan information, or tax breaks.

LEED Glazing Score: The LEED glazing score is the percentage of regularly occupied floor area that has a Glazing Factor greater than 0.02. Note that the tool assumes the entire floor area of your project to be regularly occupied unless you have defined some spaces through Revit MEP as restrooms, corridors, storage, mechanical rooms, or conference rooms (spaces not considered to be regularly occupied by LEED). The score must be more than 75 percent to score LEED points and achieve full benefit from daylighting controls throughout the building.

Wind Energy

Potential: The annual amount of electricity that can be generated from one 15-foot-diameter wind turbine of conventional design.

Natural Ventilation

Potential: The tool calculates the annual operating hours and energy

required to mechanically cool and ventilate the building. It also estimates the annual number of hours that outdoor air could be used to naturally ventilate the building. Potential energy savings associated with not running the mechanical cooling and ventilation system during this period are projected, and finally, the net hours that cooling is required, even with natural ventilation, are estimated.

Building Summary: Detailed statistics, assumptions, and information on building constructions are also provided. This information allows the building designer to get an early assessment of code compliance and rough estimates of equipment sizing requirements for heating, cooling, and water heating, as well as window, wall, and floor area breakdowns.

LEED Daylight⁵

Area w/ Glazing Factor > 2%: 17.5% - No LEED Credit
 5. Qualifies if glazing factor is > 2% in a minimum of 75% occupied areas.

Wind Energy Potential⁶

Annual Electric Generation: 3,550 kWh
 6. A single 15 ft diameter turbine, with cut-in and cut-out winds of 6 mph and 46 mph respectively, and located at the coordinates of the weather data.

Natural Ventilation Potential⁷

Total Hours Mech. Cooling Required: 3,213 Hours
 Possible Natural Ventilation Hours: 2,037 Hours
 Possible Annual Electric Energy Savings: 20,342 kWh
 Possible Annual Electric Cost Savings: \$1,668
 Net Hours Mech. Cooling Required: 1,176 Hours
 7. Assumes natural ventilation only during comfort zone periods and air changes per hour are less than 20 ACH. Building form & opening design must be able to allow stack effect or cross ventilation.

Building Summary

Quick Stats

If values are red or blue they appear to be higher or lower than typical ranges, respectively.

Number of People	39 people
Average Lighting Power Density	1.15 W/ft ²
Average Equipment Power Density	1.59 W/ft ²
Specific Fan Flow	0.8 cfm/ft ²
Specific Fan Power	0.900 W/cfm
Specific Cooling	390 ft ² /ton
Specific Heating	28 ft ² /kBtu
Total Fan Flow	9,160 cfm
Total Cooling Capacity	29 tons
Total Heating Capacity	396 kBtu/h

Export Files and Navigation Links from the Results Screen

Autodesk Green Building Studio software provides the user with file download capabilities that can be used to share information with other members of the design team who are performing detailed engineering analyses, such as equipment sizing or design. The user simply clicks on the links to access these items to download or navigate. Each file or link is described below.

Export Files

gbXML File: This link is to the fully populated gbXML file that contains all the building information necessary for an advanced energy simulation as well as the results from the Autodesk Green Building Studio simulation. The gbXML file also includes information on the BIM model and the local assumptions and building code information brought in through Green Building Studio. This file can be used with design tools such as Trane's Trace 700 application.

VRML File: Click this link to open the 3D VRML view in a new window or right-click it and choose Save Target As... to download the file. See the 3D VRML View section below for more information.

DOE-2 File: This link exports the geometrically accurate DOE-2.2 input file that was generated by Green Building Studio for the energy simulation. It can be used downstream as the starting point for other more detailed engineering analysis. This file can be directly imported into the free eQUEST DOE-2 application at www.doe2.com.

EnergyPlus File: This link exports the geometrically accurate EnergyPlus™ file that was generated by Green Building Studio. It can be used as a starting point for more detailed engineering analyses. The EnergyPlus simulation program can be downloaded for free* at www.energyplus.gov.

Weather File (Binary and CSV): The DOE-2 binary weather file used in the simulation can be downloaded for further analysis off-line using eQUEST. The comma separated values (CSV) file can also be downloaded for use in other applications as well as conversion to other simulation engine weather formats such as EnergyPlus.

Navigation Links

Run List Link: This link returns you to the list of runs for this project.

Design Alternatives Link: This link will take you to the design alternative screen where you can change design assumptions for this run and determine the impact of those changes. See the next section for details on the Design Alternative feature of Green Building Studio.

Notes Link: If you want to make or view comments about this run, click here.

about

User: jfk86d

File Downloads

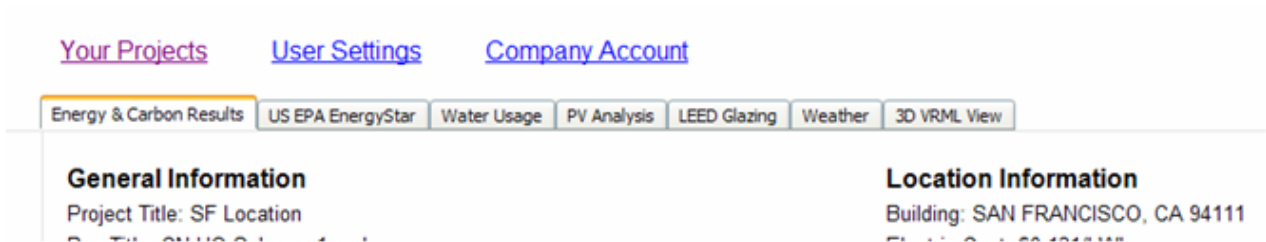
- [gbXML File](#)
- [VRML File](#)
- [DOE-2 File](#)
- [EnergyPlus File](#)
- [Weather File\(binary\)](#)
- [Weather File\(CSV\)](#)

Links

- [Run List](#)
- [Design Alternatives](#)
- [Notes](#)

Navigation Tabs

At the top of each results page are navigation tabs that allow the user to view additional information about their building design. These tabs are discussed on the following pages.



U.S. EPA ENERGY STAR: This tab will display the ENERGY STAR score and associated data that can be used to benchmark the building design total energy use performance relative to the U.S. EPA’s ENERGY STAR requirements. Buildings that receive an ENERGY STAR score above 75 qualify for “Designed to earn the ENERGY STAR” and recognition from the EPA.

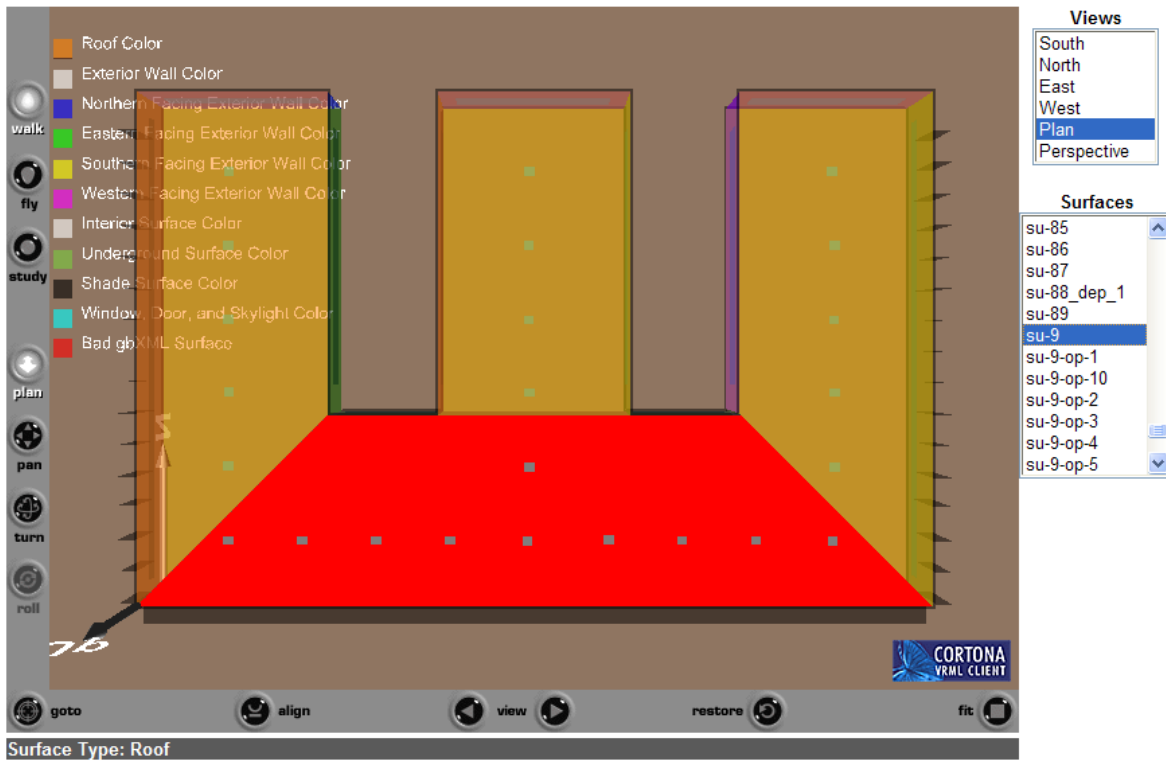
Water Usage: The water usage tab allows the user to apply a variety of water saving measures, including efficient fixtures, water catchments, native vegetation, and others. It also summarizes the potential LEED points available for these measures.

PV Analysis: The details of the photovoltaic (PV) potential analysis are listed in this tab showing the individual PV potential for every exterior surface in the building. Price per watt for the PV system can be made on this tab to account for rebates or other regional differences that affect PV system cost. See the VRML view tab to determine the building surface associated with each result.

LEED Glazing: This tab lists all the spaces in the building and their individual Glaze Factor value. This data can be used to determine what spaces in the building could qualify for LEED daylighting credits.

Weather: This tab contains a variety of weather data graphs and charts. These graphs can also be set for specific data types over specific periods of time.

3D VRML View: The 3D VRML View tab allows the building designer to review the gbXML geometry data in 3D, and rotate it to review the placement of walls, windows, floors, and other spaces. It requires a VRML Viewer program that is available for free* in the public domain, such as the free Cortona VRML client at www.parallelgraphics.com for Windows® operating systems and the FreeWRL VRML/X3D Viewer at www.apple.com for Mac® operating systems to view these files. Click on the surfaces in the list at the right of the window to identify them. When selected, a surface will highlight in red in the 3D view, and its surface type will be displayed at the bottom of the window.








Design Alternatives

The Green Building Studio Design Alternative (DA) feature allows you to modify the base case assumptions and simulate the impact of these modifications on energy efficiency. It is a very powerful feature that allows significant design decisions to be made in very little time.

The Green Building Studio Design Alternative feature can be accessed from the main "Energy and Carbon" results page link as described in the previous section or on the Run List page blue icon adjacent to the Run title as seen in the image to the left. The green icon can be used to see run values relative to the selected run.

For every project in your list, three icons are available to access additional information. The first blue icon lets you customize project defaults such as internal gains, construction materials, glazing type, cooling and heating set points, and so on. This can be useful when using Green Building Studio software to analyze an existing building that has less efficient systems or less insulation, or if the default values do not represent your project. The second blue icon allows you to view and edit project information. The third icon facilitates managing project team members. You can invite other members of your design team to participate in the analysis, and you can individually assign them rights to the project (Read-Only, Download and Read-Only, Add Runs or Manager).

Clicking on either the Energy and Carbon results page Design Alternative link or the Run List page DA link will take you to the Design Alternative page shown below. The top portion of the table has standard links to the Run List, the results page for the base run associated with these Design Alternatives. The section directly below lists the values for all the parameters that have been modified for the currently modified design alternative or the design alternative selected by the user.

School example		Run List
Previous Next		
Runs	Date	U
<input type="checkbox"/>   OK_2	Aug 23 06 2:54 AM	jfl
<input type="checkbox"/>   OK_1	Aug 22 06 6:30 PM	jfl
Previous Next		
 For Version 2+ runs this icon is dis		

Your Project List [Corporate](#)

Title	Location	Runs Completed
  	FORTUNA, CA	2

Logout [Your Projects](#) [User Settings](#) [Corporate Account](#)

Design Alternatives

Select parameters from tabs below, enter alternative name, then Add. After all alternatives added, click Submit to run them.

Project: Chicago Office	Run List	Base Run: Autodesk GBS 444 10th Office-c MEP 1zone.xml, Energy Cost: \$16,612	Project settings			
General	Lighting	Roof	Northern Walls	Southern Walls	Western Walls	Eastern Walls
Rotation 0 HVAC No Change	Lighting Efficiency No change Lighting Control No change	Construction No Change	Construction No Change Glazing Type No Change Glass Amount No change	Construction No Change Glazing Type No Change Glass Amount No change	Construction No Change Glazing Type No Change Glass Amount No change	Construction No Change Glazing Type No Change Glass Amount No change

1. Select Changes Below. 2. Enter Alternative Name: 3. Add Alternative 4. Run Added Alternatives

Reset Dropdown Selections Below Save Added & Unrun Alternatives Cancel & Don't Save Added Alternatives

General	Lighting	Roof	Northern Walls	Southern Walls	Western Walls	Eastern Walls
Alternatives	Annual Energy Cost	Lighting Efficiency	Lighting Control	Delete		
Reduce Lighting Power	\$15,884	LPD 20% less than base run	No change	<input type="checkbox"/>	<input type="checkbox"/>	

Adding Design Alternatives

To add a design alternative, go to the Design Alternative screen associated with the run (shown on the previous page). Begin making the modifications you would like to analyze by selecting a tab and choosing the drop-down list value you would like to be applied for this alternative. Enter an Alternative name, and then click the Add Alternative button.

Continue doing this until all the desired Design Alternatives are added.

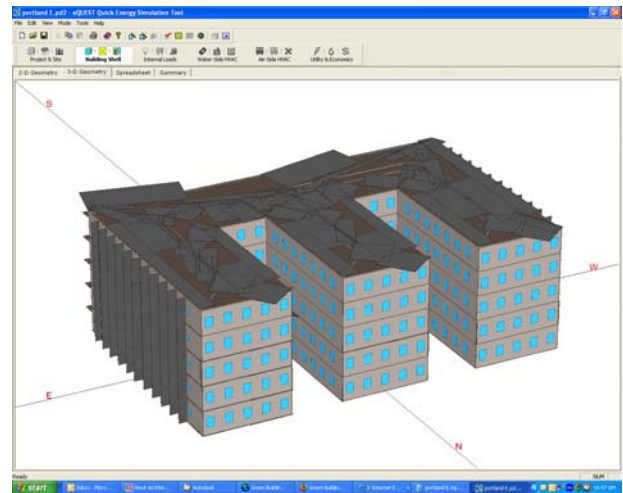
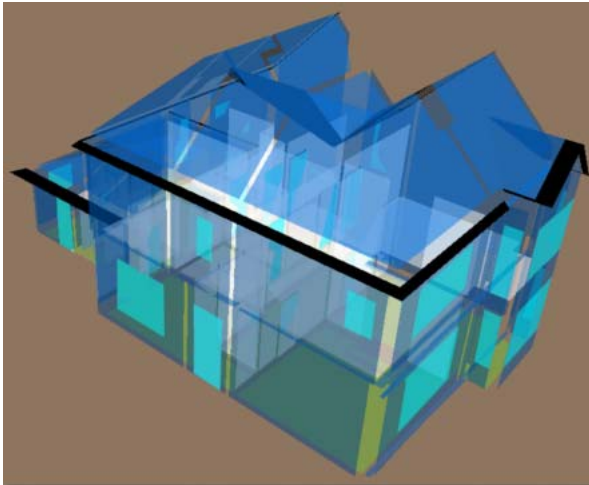
At this point you can select the Run Added Alternatives button to place the DAs in the run queue. Depending on the model complexity, server load, and the number of alternatives you are analyzing, it will take between a few minutes and an hour to complete your runs. Users can also add and run alternatives individually as they are defined or as described above, add a group of alternatives and run the group at one time.

Once all the DAs are run, you can review their results either on the DA web page or the Run List page.

Hints and Tips

If your model is large and complex it will take longer to run. Try submitting design alternatives individually as they are defined. While that alternative is running, define and submit additional design alternatives.

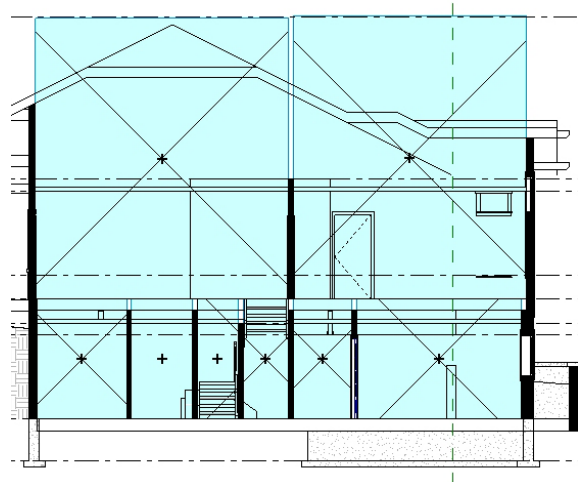
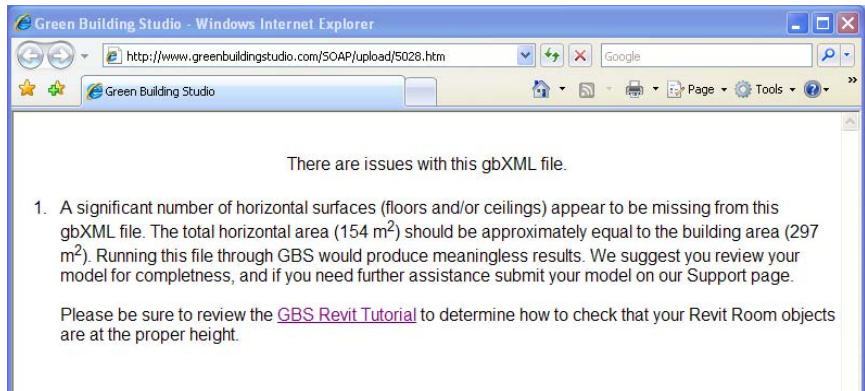
The VRML Model



One of the download formats available on the Green Building Studio results web page is a VRML file (see example above, left). This is a 3D model that shows what the gbXML export has extracted from your project. Viewing the VRML file is a useful way of establishing that your simulation is an accurate representation of the whole building. Rooms or surfaces that are missing or that have been incorrectly identified (for example, a roof shown as a shading surface) will be apparent in this model. In the VRML example, the black edges along the roof have been exported to Green Building Studio as shading surfaces and not roof surfaces. The image above right is an example of a DOE-2 file opened in eQUEST. Notice there are several shades on the roof—this is because the upper limit of the room objects on the top floor is not high enough to contact the roof. To solve this, extend the room object's top surface to above the roof's top surface.

Tips

- At the earliest “massing” stages of design, define glazing areas in the Revit model as “ribbons” of glass around the building, rather than individual punched windows. This is easier to model in Revit Architecture or Revit MEP, will reduce the simulation time in Green Building Studio, and will provide enough accuracy to analyze the energy impact of different glazing schemes.
- If the gbXML file produces a message stating that horizontal surfaces are missing, it is likely caused by room objects not being in contact with the surfaces above them. Adjust room or space objects accordingly. See the message below and the Revit Architecture 2009 Room Object section for further details.
- While using Revit Architecture, plenums and other interstitial areas should have a room object placed in them for them to be properly exported to gbXML. Any room or space less than 2-meters high is assumed to be unconditioned.
- If the DOE-2 file is opened in eQUEST and there are several shades on the roof, it is because the upper limit of the room objects on the top floor is not high enough to contact the roof. To solve this, extend the room object’s top surface to above the roof’s top surface (as shown on the right)
- Design Alternatives drop-down list rollover information may not be fully visible. Highlight the text surrounding the drop-down lists, copy and paste to a text editor or spreadsheet to view.
- Enhanced 3D VRML View legend may not be fully visible. View the page on a screen size greater than 1,024 by 768, or open the VRML File link on the left sidebar.



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