Energy Analysis Workflows for Sustainability

Technical Note

Autodesk Revit-based product to Autodesk Green Building Studio to eQUEST Workflow

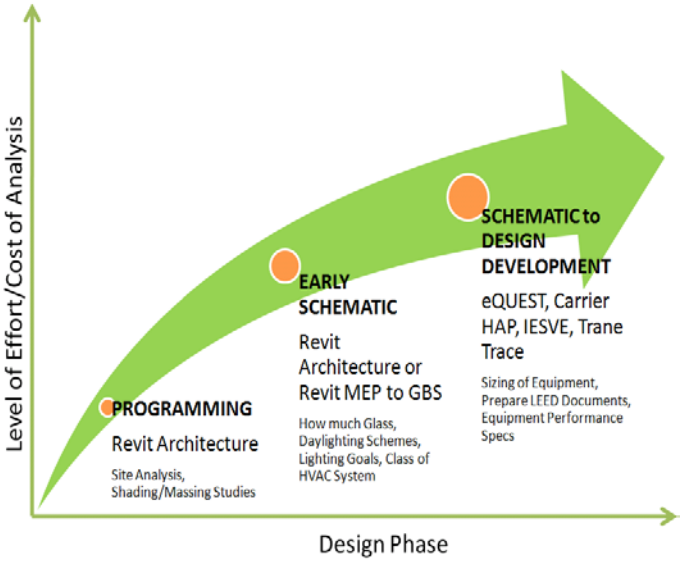
Overview

This document describes the workflow associated with an architectural or engineering user of an Autodesk® Revit®-based product who wishes to utilize eQUEST® software to carryout detailed energy simulations for the purposes of LEED® documentation and other energy analysis initiatives. The document describes how a user would utilize a combination of a Revit-based product, Autodesk® Green Building Studio® (GBS) web service and eQUEST to carry out energy (and other) analyses designed to help owners and their consultants design energy-, water- and resource-efficient buildings.

The Process

Autodesk® Revit® Architecture and Autodesk® Revit® MEP software provide numerous energy analysis capabilities. Starting with the most conceptual, a Revit-based product allows users to study shading and site issues. The next step is to combine a Revit-based product with GBS for early schematic studies. Finally, at later stages of design, more detailed sizing and analysis tools will be employed. This paper focuses on the early schematic and Design Development stages of design using a Revit-based product, GBS and eQUEST.

The earliest analyses use GBS to study building form, glazing quantities and classes of envelope, HVAC and lighting systems while these design decisions are still malleable. Earlier analyses identify the potential for saving energy or generating onsite renewable energy. GBS uses the DOE 2.2 simulation engine and carries out the simulations on remote servers when initiated from a Revit model. eQUEST and other engineering software such as Carrier HAP, Trane Trace and IES are powerful, complex programs that are used by engineers to carry out detailed energy analyses and equipment sizing. These tools have great input flexibility which, as a result, require more detailed inputs to use. LEED submittals require a detailed “as-built” energy model be provided to document that the design has meet LEED EA1 and potentially other credits.



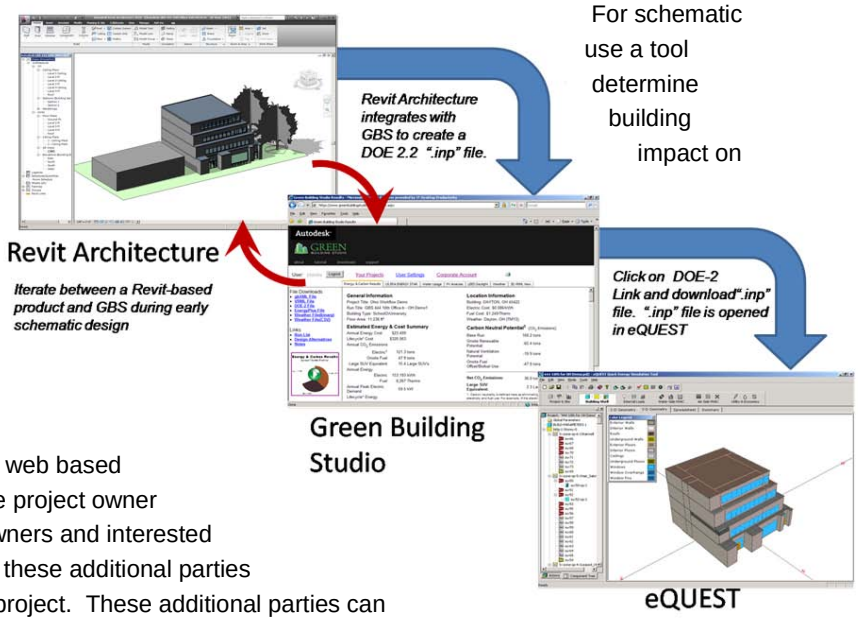
Use of Building Information Modeling for Energy

Revit Architecture and Revit MEP are software tools that create building information models (BIM) which contain a wealth of building and design-specific information. The exact information that is contained in the model varies depending upon the tool used to create it and the user-inputted level of detail. At a minimum, the Revit model should contain information about building surfaces, openings, and simplified room, space and/or HVAC representations. Depending on the tool, information may also exist about lighting power

loads, internal loads and schematic HVAC requirements. For early stages of design, when decisions about massing, glazing amounts, orientation and site placement are being made, Revit models should be kept simple. Multiple Revit models representing multiple design schemes are encouraged rather than just a single model. It is assumed that at this preliminary phase, multiple studies are being carried out to compare the impact of building height and orientation, glass quantity and placement, building form and more on building performance. It is usually possible to improve the performance of walls, windows or HVAC equipment by specifying higher performance components, but it is not possible at a late-stage design development to re-orient a building to account for prevailing winds, specify a different building form that will allow natural or mixed mode ventilation, or change the footprint of the building to allow deeper daylight penetration.

How Can I Carry Out Energy Simulations When So Little is Known About the Building?

All simulation tools, including eQUEST and GBS, make assumptions that can later be changed by the user. The assumptions include envelope and equipment performance, occupancy levels and schedules, internal gains, etc. GBS assumes that the envelope and other unknown or unspecified design parameters will meet ASHRAE 90.1-2004 levels of performance unless the user has specified different values. For schematic design it is appropriate to use a tool iteratively to help determine which changes to the building design have the largest impact on the energy performance of the building. The graphic summarizes the work flow associated with the use of a Revit-based product, GBS and eQUEST.



It is important to note that GBS is a web based tool with an interface that allows the project owner to "invite" additional consultants, owners and interested parties to the project. The rights of these additional parties are assigned by the initiator of the project. These additional parties can review early results and provide information to the owner much earlier in the process, at lower cost. The lighting designer might supply additional information regarding the degree to which they can "beat" the ASHRAE 90.1 lighting targets, the PV contractor may say that they will choose a more efficient panel that will increase PV output, and the mechanical engineer may provide input on glazing specifications or the potential for a mixed mode ventilation scheme. All of these items can be analyzed earlier in the project using this workflow.

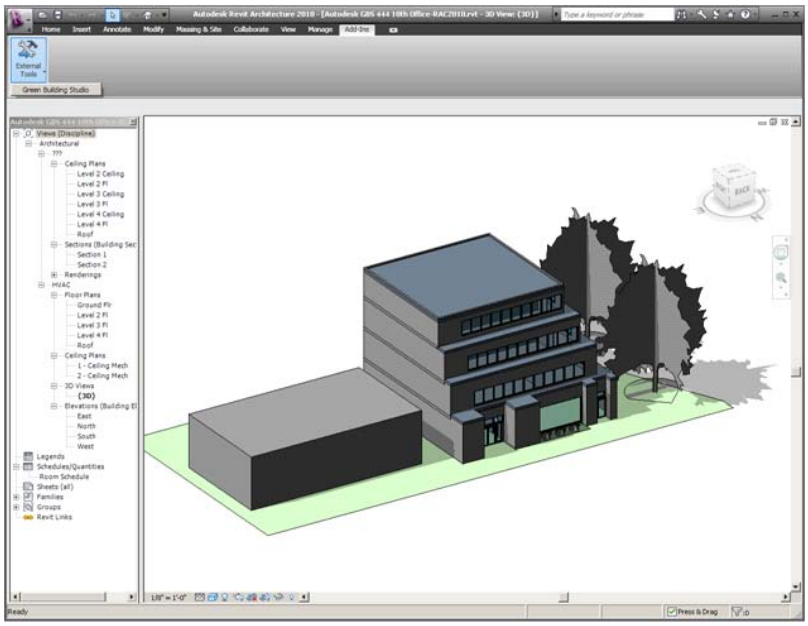
The First Round of Energy Analysis

Using both a Revit-based product and GBS is the first step in performing whole building energy analysis. This step is also required to automatically generate the eQUEST model that can be used to supply detailed documentation for EA1, EA2 and other LEED credits. GBS allows the user, usually an architect in the early phases of design, to investigate the energy and other resource impacts of early and important design decisions. For example, the building form is typically determined early in the design process. Choosing the building form determines what the daylighting and views potential will be for this building, which surfaces will be shaded and which are inappropriate for photovoltaic power production, what the potential will be for natural ventilation, and more. For example, what are the heating, lighting and cooling

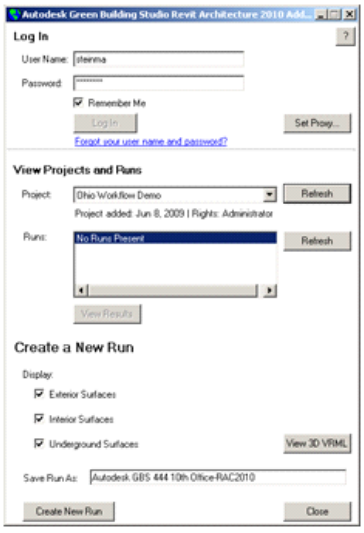
implications of utilizing enough glass so that natural light can be used in place of electrical light for most months of the year? This is especially critical for buildings such as schools and offices that are used primarily during daylight hours.

The Schematic Decisions Have Been Made, What is the Specific Process for Using eQUEST with a Revit-based product?

After iterating between a Revit-based product and GBS several times, and involving various members of the team, the form of the proposed building is substantially fixed. At this point it is appropriate to move to more detailed analyses required for LEED submittals and final product sizing and selections. The following list describes how to migrate from a Revit-based product to eQUEST.



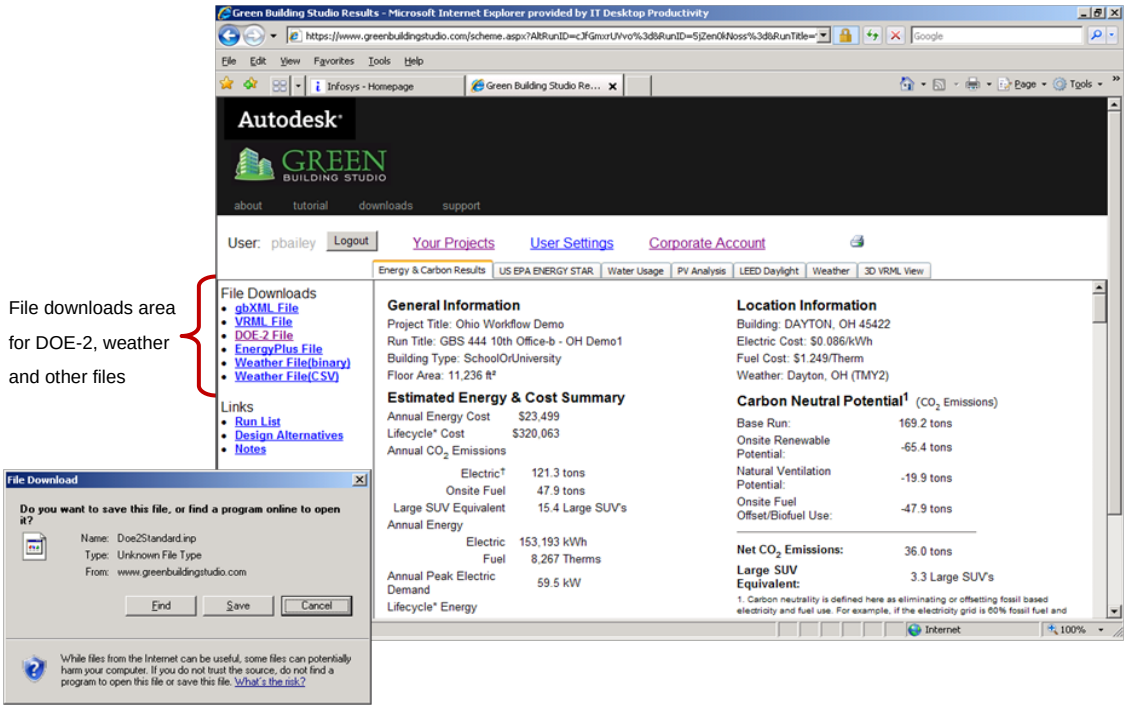
1. Submit the form of your building to GBS from Revit Architecture or Revit MEP. The first step is to become a member of the GBS web service. Go to http://www.autodesk.com/greenbuildingstudio and log in or register as a new user. You must then install the appropriate GBS Add-in for your Revit-based product (available at: (https://www.greenbuildingstudio.com/downloads2.aspx) to do this. Once you have installed the add-in, go to the main menu in the Revit-based product; select Add-ins|External Tools|Green Building Studio as shown at the right. The project will be submitted to the GBS web service and the add-in window will appear on your screen. Prior to this you will have logged on to GBS and created a project, in this case named the Ohio Workflow Demo.



2. From the GBS Add-in, enter your User Name and Password and choose the project to which this run will be assigned. Each project has a specific location and building type associated with it. From within the add-in, fill in the Run Title and click the “Create New Run” button as shown on the right. This will initiate a process which creates and runs a DOE 2.2 simulation of your project on remote servers. DOE 2.2 is the underlying simulation engine used by both GBS and eQUEST.

3. Depending on the complexity of the model, it may take less than a minute to several minutes to complete the DOE 2.2 simulation and other analyses. The user will then be able to view the results on a web page that is automatically opened as shown on the next page.

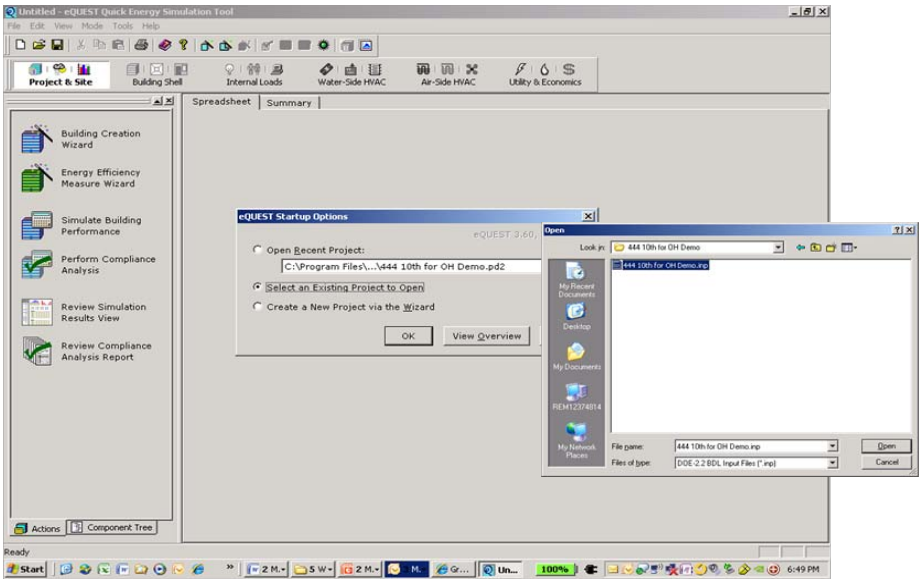
4. Note that the results screen provides links on the upper left corner of the screen showing the DOE-2



and weather files that were used by GBS. Click on the “DOE-2” file link. This will initiate a download of the DOE-2 file created by a Revit-based product and GBS to provide the information on this screen. If the user wishes to use the weather file for their eQUEST simulation analysis, they can click on the “Weather File (binary)” link and download a DOE-2 weather file that can be used in eQUEST.

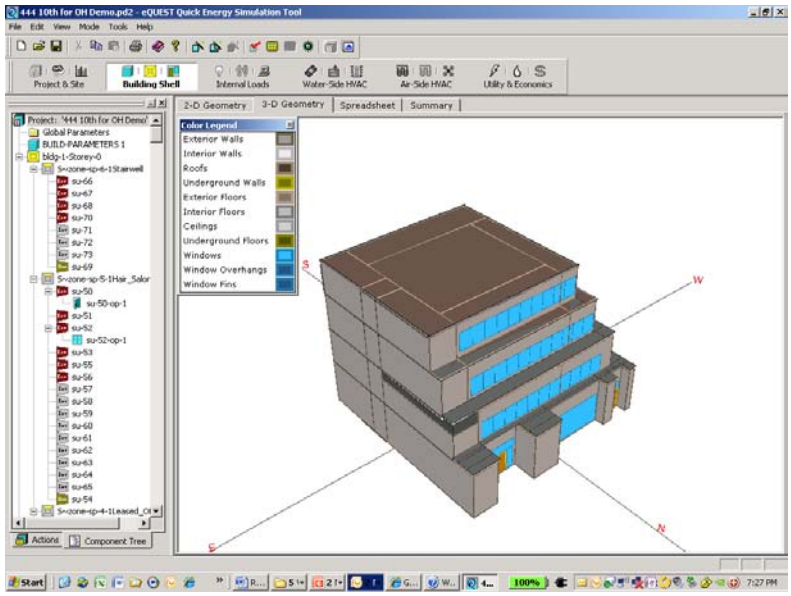
5. Download the DOE-2 and weather file to be used in eQUEST. Save the DOE-2 file to the eQUEST projects directory using an appropriate filename.

6. Open eQUEST. On the first screen as shown below choose “Select an Existing Project to Open”, click OK and in the screen that appears change the “Files of Type” drop down choice to “DOE-2.2 BDL Input Files (*.inp). eQUEST will open the “.inp” file that was downloaded from GBS. Once the “.inp” file has been opened, it can be manipulated like any other eQUEST file. The graphic on the following page shows the eQUEST file in its 3-D viewer as opened in eQUEST.



7. There are several items worth noting in the eQUEST file.

   a. The adjacent building shown in the original Revit file is not exported to eQUEST. If the user wishes to export an adjacent building for shading purposes, a wall surface can be created in the Revit file, and that wall will be exported to eQUEST as a shading surface.



   b. Use Room/Space names in the Revit-based product which will be useful in eQUEST so that navigating the eQUEST model is simpler.

   c. All building surfaces that are defined as “Room Bounding” in the Revit model are present in the eQUEST model. If a Revit model includes all interior spaces such as janitor closets, mechanical rooms and other small spaces the eQUEST model will become unnecessarily complex.

   d. The DOE-2 file that is created by a Revit-based product and GBS will contain comments (text preceded by a $) that may be useful to the energy analyst or engineer using eQUEST. These can be accessed by opening the .inp file in a text editor. However, these comments are removed by eQUEST when the file is opened for the first time.

Conclusion

This document describes the workflow of transferring a Revit Architecture or Revit MEP building information model to an eQUEST energy simulation to produce results used for building energy compliance. Revit-based products and GBS can also be used to make earlier estimates of LEED credits associated with water efficiency, renewable energy, daylighting and views, and much more.