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BUILDING TECHNOLOGIES PROGRAM

Commercial Building Energy Asset Rating Tool User's Guide

May 2012

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Prepared by Pacific Northwest National Laboratory
for the U.S. Department of Energy Building Technologies Program

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Prepared for
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Contents

Welcome to the Energy Asset Rating Tool

The U.S. Department of Energy's Commercial Building Energy Asset Rating Tool is a web-based system that is designed to allow building owners, managers, and operators to more accurately assess the energy performance of their commercial buildings. This fully integrated system combines energy simulation with automated life-cycle-cost (LCC) analysis to provide commercial building stakeholders with a free tool to:

- help collect and enter building data
- analyze the as-built systems of buildings
- identify potential energy-saving opportunities.

The energy asset rating tool is a web-based software designed to assess the energy efficiency resource potential of facilities ranging from a single building to a portfolio of buildings. After entering data about each building in a set of online forms, you can generate an energy asset rating report suitable for simple or detailed analysis of a building's energy assets, depending on how much detail you choose to enter in the data For a look at the energy asset rating report, see *Reading the Rating Report* (page 19).

Useful results with minimal inputs. More accurate results with detailed inputs. With minimal, high-level inputs that take advantage of default values provided by the software, the energy asset rating tool can be used for a top-down, first-pass energy systems analysis for commercial buildings. At the simple level, you would typically enter only high-level installation information (building type, age, size, structure type, and types of installed building systems) and leave the unrequired fields blank. An internal database in the energy asset rating tool that contains typical energy-system configurations will infer the missing building parameters to complete the energy model.. At an advanced level, you can generate more accurate results with more detailed inputs about your building(s). The report generated by the energy asset rating tool will be marked with "Preliminary." To receive a verified energy asset rating report, the entered data would need to be verified by a qualified professional. The U.S. Department of Energy (DOE) is developing a guideline on the required credentials of a qualified professional. The energy asset rating tool is now in the pilot phase of development. During this pilot phase, no data verification by a qualified professional is required, but the energy asset rating report obtained during the pilot cannot be used for official purposes, such as public display or real estate transaction. For more on the tool's status, see *Tool Status and Constraints* (page 2).

Reduced startup costs. The energy asset rating tool provides a centralized modeling capability. There are two main advantages in having a centralized asset rating tool. First, it increases the standardization of initiating an energy asset rating effort when compared with an approach that requires building stakeholders to obtain their own energy models. Second, the tool reduces the cost of building energy modeling for building owners. Building owners do not need to hire an expert energy modeler to perform a preliminary energy analysis to obtain a useful energy asset rating. The tool is aimed to provide value in the first step of assessing a building by identifying some possible upgrade opportunities. The energy asset rating tool is NOT intended to be a replacement for a full

energy audit of a building, and the results are NOT intended to be used to recommend the purchase of equipment or materials.

About the building energy modeling. The energy asset rating tool is built on an inference engine, an energy simulation engine, and an energy efficiency measure (EEM) finder. For more information on these components, see *Building Energy Modeling Methodology* (page 50).

System Requirements

- Internet Connection: 28.8 KBps speed or greater; 56 KBps recommended
- Web browser: Internet Explorer, Netscape Navigator 4.0 or later, Mozilla Firefox 1.0 or later, Safari 1.3 or later, or Google Chrome
- Adobe Flash Player installed.

Tool Status and Constraints

The commercial building energy asset rating program is an ongoing effort of the Commercial Building Initiative (CBI) under the Building Technologies Program sponsored by DOE's Office of Energy Efficiency and Renewable Energy (EERE). On the path to establishing a national standard for a voluntary commercial building asset rating program, DOE is providing the energy asset rating tool to enable building stakeholders to benchmark their buildings against others, facilitating cost-effective investment and energy efficiency in commercial buildings.

Supported Building Types. In this pilot phase of tool development, the tool addresses a limited number of the building types, including office, school, retail, and unrefrigerated warehouse. Mixed-use and more complex types of buildings will be addressed in later phases of development.

Limited Features. During this pilot phase, some features of the energy asset rating tool will be disabled ("grayed-out" in the data entry interface) or not present. For example, the tool's ultimate design includes the capability to define a building as composed of multiple "blocks" that each represents a part of the building with a specific physical configuration and, set of energy assets, and construction properties. This multi-block capability is not included in the pilot test of the energy asset rating tool, so a building's energy assets are defined and evaluated for only a single block.

Other constraints in the pilot test include the following:

- Fenestration (page 36): Skylight features are disabled.
- Mechanical systems (page 42): Only certain types of heating, ventilation, and air-conditioning (HVAC) systems are supported, as identified in the pop-up list of system types linked at the top of the Mechanical systems data entry tab.

These constraints will be address in the later phases of the tool development.

What's In This Guide

- ***Getting Started*** (page 4) – How to get a user account and log in to the energy asset rating tool, and an example of using the tool with a DOE reference office building
- ***Reading the Rating Report*** (page 19) – A sample of an energy asset rating report and explanations of report content
- ***Overview of Tool Workspaces*** (page 23) – A guide to the tool's workspaces for managing the buildings that you wish to rate and their data
- ***Building Data Entry Guide*** (page 27) – Reference descriptions of the building parameters to be entered for each building
- ***Building Energy Modeling Methodology*** (page 50) – An overview of the energy simulation and automated life-cycle-cost (LCC) analysis methods used by the tool.

Getting Started

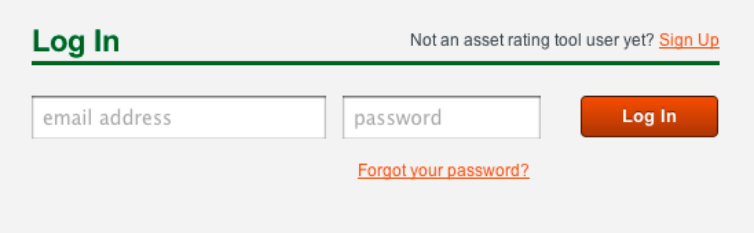
This section describes how to set up a user account, how to "create" a new building in the tool, and how obtain an energy asset rating report on your building.

Create Your User Account and Log In

The energy asset rating tool is free to any user but does require creating an online account with an email address so that the tool can notify you when your rating report is ready.

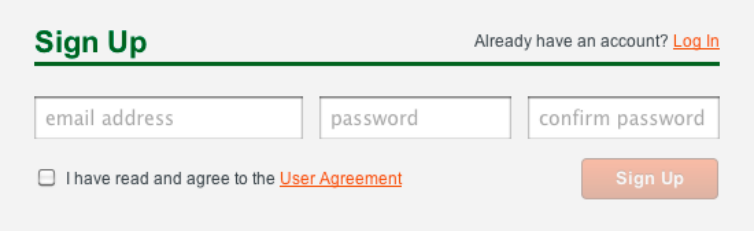
> ***Pilot Test Note:*** During the pilot test, the "Sign Up" page is disabled. All pilot participants will receive Log In information via email.

1. To access the online tool, visit https://assetrating.labworks.org/.



   If you already had a user account, you could just log in here.

2. As a first-time user, click "Sign Up" to display the Sign Up box:



3. Enter your email as user name, and set and confirm your password.
4. Click to read the "User Agreement," and then check "I have read and agree to the User Agreement."

   The User Agreement states the Security and Privacy Policy, Notice of Use, and General Information Disclaimer.

5. Click 

to complete your registration and begin using the energy asset rating tool.

Create Your Building

This section will use a DOE reference building[1] (medium office, new construction) as an example to go over the basic steps. A tutorial video is available on the tool's login page (https://assetrating.labworks.org/).

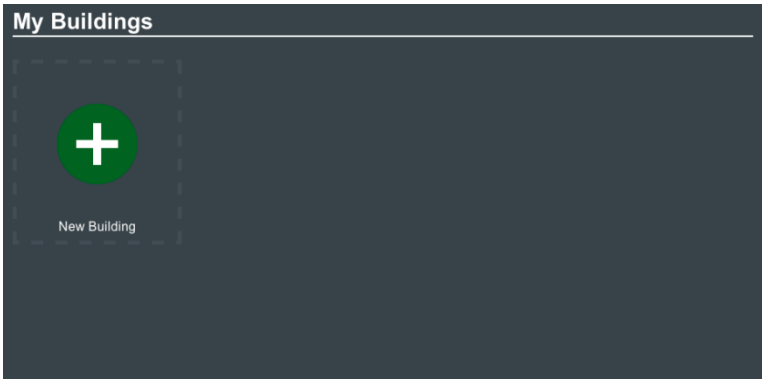
Description of Medium office reference building used in this example is shown below (Source: EnergyPlus software input file):

```
! DOE Commercial Reference Building
! Medium office, new construction 90.1-2004
! ASHRAE Standards 90.1-2004 and 62-1999
!
! Description:  Three story, 15 zone office building.
! Form:         Area = 4,982 m2 (53,628 ft2); Number of Stories = 3; Shape = rectangle,
!               Aspect ratio = 1.5
! Envelope:     Envelope thermal properties vary with climate according to ASHRAE Standard
!               90.12004. The medium office in this example is in climate zone 5.
!               Opaque constructions: steel frame walls; built-up flat roof (insulation above deck);
!               slab-on-grade floor
!               Windows: window-to-wall ratio = 33.0%, equal distribution of windows
!               Infiltration in perimeter zones only
!                                   = 0.4 cfm/ft2 above grade wall area at 0.3 in wc (75 Pa)
!                                   adjusted to 0.016 in wc (4 Pa).
!                                   25% of full value when ventilation system on.
!
! HVAC:         Packaged MZVAV with plenum zones, gas furnace, electric reheat
!               Economizer per 90.1-2004
!
! Int. gains:   lights = 10.76 W/m2 (1.0 W/ft2) (building area method);
!               elec. plug loads = 10.76 W/m2 (1.0 W/ft2)
!               gas plug load = 0 W/m2 (0 W/ft2)
!               people = 268 total; 5.38/100 m2 (5.0/1000 ft2)
!               elevators = 2 @ 20 HP each, 91% motor efficiency
!
! Detached Shading:          None
! Daylight:                  None
! Natural Ventilation:       None
! Zonal Equipment:           None
! Air Primary Loops:         VAV with electric reheat
! Purchased Cooling:         None
! Purchased Heating:         None
! Coils:                     Coil:Cooling:DX:TwoSpeed; Coil:Heating:Gas; Coil:Heating:Electric
! Pumps:                     Yes
! Boilers:                   None
! Chillers:                  None
```

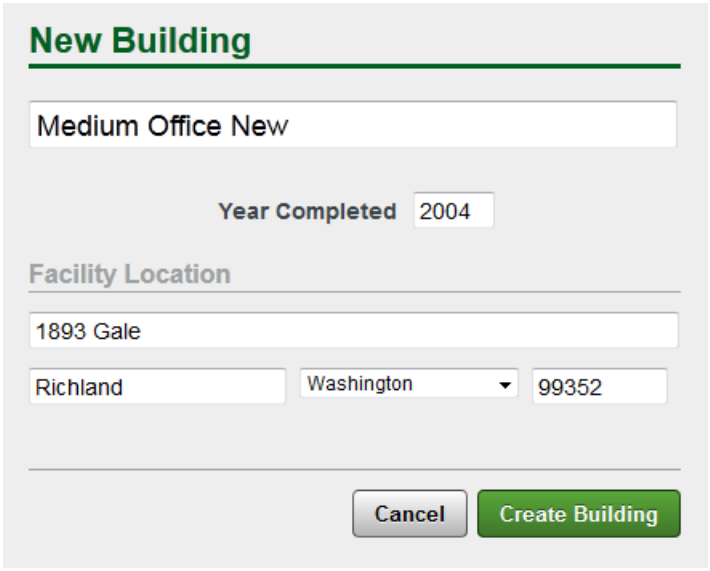
[1] http://www1.eere.energy.gov/buildings/commercial_initiative/reference_buildings.html

Step 1: Create a New Building

After login, the tool displays a list of your buildings—initially you will see a blank workspace as shown here:



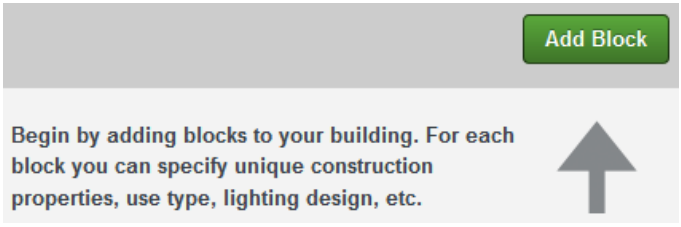
1. Click  to add a new building using this pop-up window:



2. Enter the building information, and click 

.

Step 2: Create a New Block



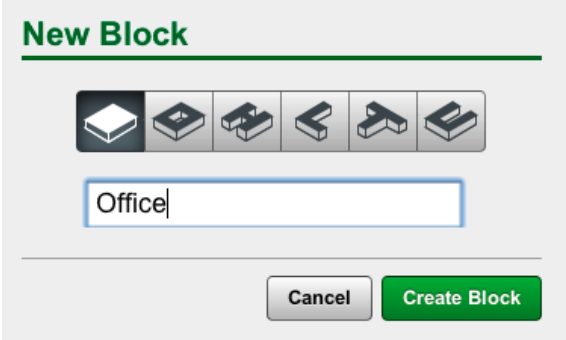
A *block* defines the general footprint and shape of the building.

> ***Pilot Test Note***: Although the energy asset rating tool is designed to permit modeling a building with multiple blocks that represent building parts with distinctly different energy assets or physical configurations, the option to model a building with multiple blocks is NOT available during the pilot test.

▶ To create a new block

1. Click 

to add a new block.
2. In the resulting pop-up window, choose the first option—a simple block—as the building footprint shape and enter the block name.

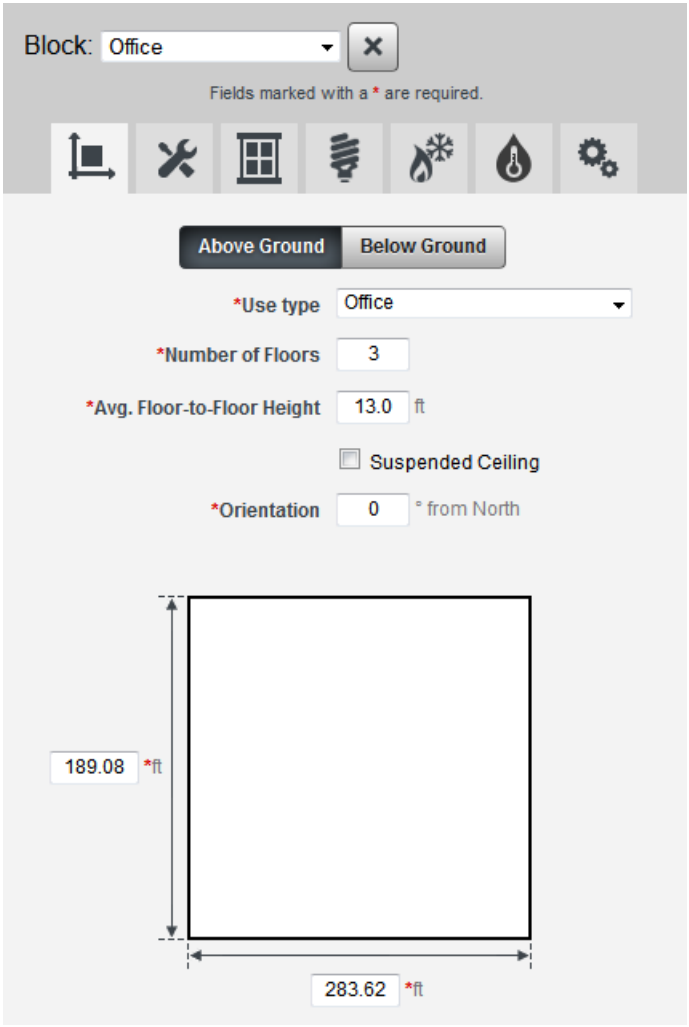


3. Click 

to create the new block.

Step 3: Enter Geometry and Footprint Information

After you create a block, the tool displays the data entry tab for general geometry information about that block:

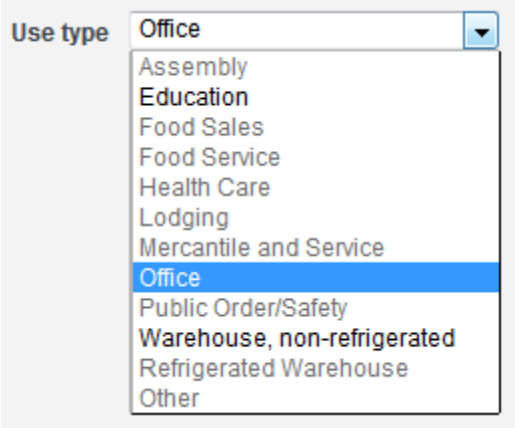


1. Enter or choose the block's information as shown in the example:

   Note: If any floor-related fields are left blank, the default or inferred value will be used in the energy model.

   - ❑ **Number of floors**
   - ❑ **Floor-to-floor height**: measured in feet from the surface of the finished lower floor to the surface of the finished upper floor
   - ❑ **Floor-to-ceiling height**: the distance between the finished floor and the ceiling
   - ❑ **Orientation**: The orientation of the building is defined as the counterclockwise deviation (in degrees) of the main entrance wall from North (at 0 degrees)—so if the main entrance wall is facing northwest, its orientation is 45 degrees from North.

- **Use type** (pull-down selection) to select **Office**:

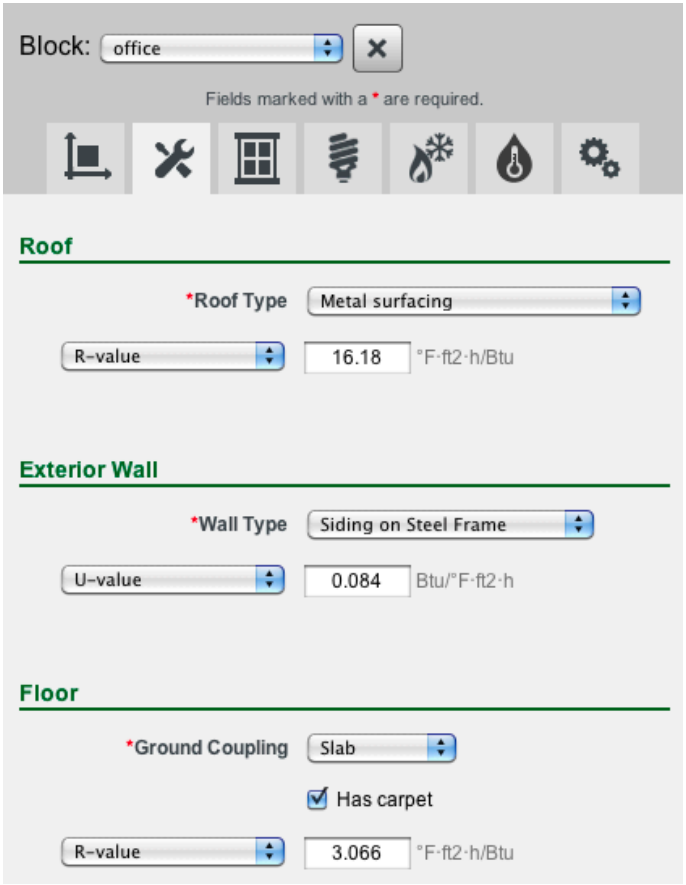


2. Enter footprint dimensions in feet* as shown.

> ***About Units in the Energy Asset Tool*:** All units in the tool are inch-pound (IP) units. For example:
>
> - Length (dimension) in ft
> - Energy in kBtu
> - Energy Use Intensity (EUI) in kBtu/ft^2
> - R-value (insulation) in h•ft²•°F/Btu
> - U-value (overall heat transfer coefficient) in Btu/h•ft²•°F

Step 4: Enter Construction Information

1. Click the construction tab  :



2. Enter or choose the block's envelope construction values as shown in the example:

Roof

- ❑ **Roof Type** (pull-down selection)
- ❑ **R-Value** / **Insulation Thickness** / **U-Factor**: Enter only R-value, Insulation Thickness, or U-Factor. If left blank, the insulation level will be inferred based on the building type, age, location, and roof type.

Wall

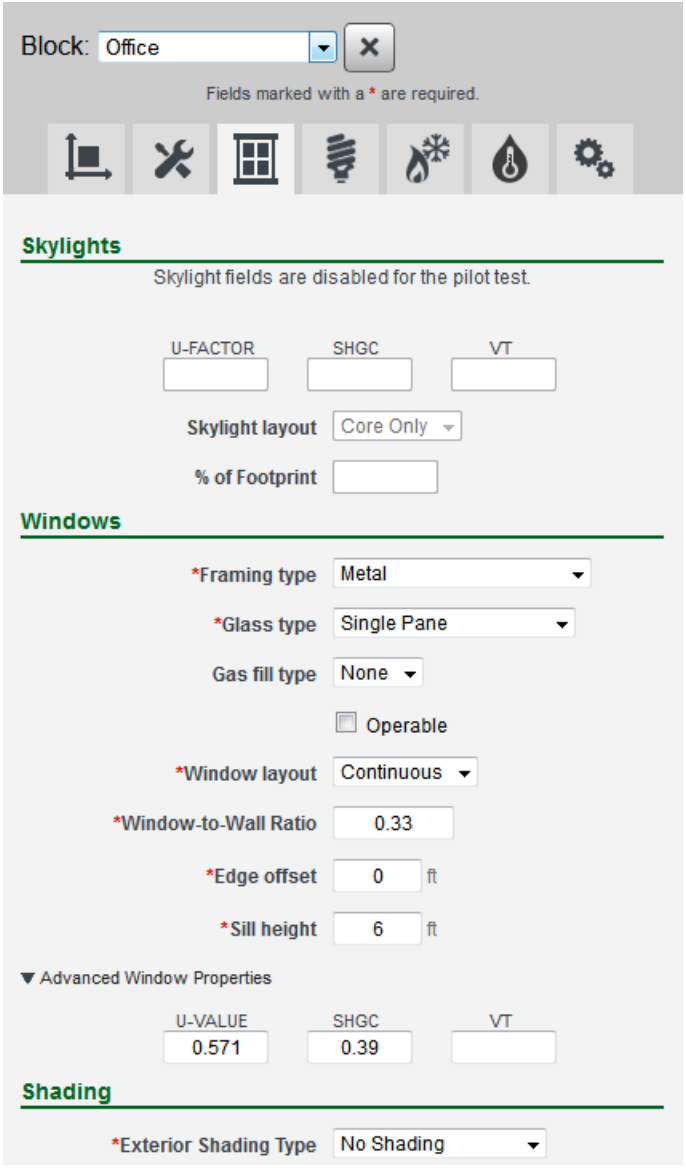
- ❑ **Wall Type** (pull-down selection)
- ❑ **R-Value** / **Insulation Thickness** / **U-Factor**: (see roof insulation instruction)

Floor

- ❑ **Floor Type** (pull-down selection): the type of ground floor
- ❑ **Has Carpet**: Check this if carpet is used on the ground floor.
- ❑ **R-Value** or **Insulation Thickness**

Step 5: Enter Fenestration Information

1. Click the fenestration tab  :



2. Enter or choose the block's glazing and fenestration values as shown in the example:

Skylights [*disabled for the pilot test*]

- ❑ **Skylight layout** (pull-down selection)
- ❑ **U-Factor** / **SHGC** (Solar Heat Gain Coefficient) / **VT** (Visible Light Transmittance)
- ❑ **% of Footprint**: the skylight area as a percentage of the block footprint

Windows

- ❑ **Framing type** (pull-down selection)

- ❑ **Glass type** (pull-down selection)
- ❑ **Glass fill type** (pull-down selection): only selectable when glass type is multi-pane.
- ❑ **Operable**: Check this if windows can be opened.
- ❑ **Window-to-wall ratio**: between 0 and 1

▼ **Advanced Window Properties** (Click ▼ to reveal)

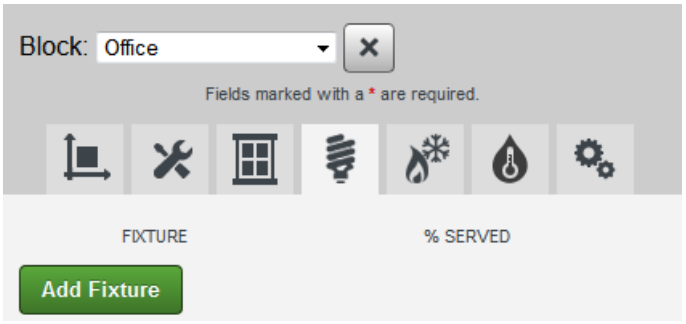
- ❑ **U-Factor** / **SHGC** (Solar Heat Gain Coefficient) / **VT** (Visible Light Transmittance)

▼ **Advanced Window Layout** (Click ▼ to reveal)

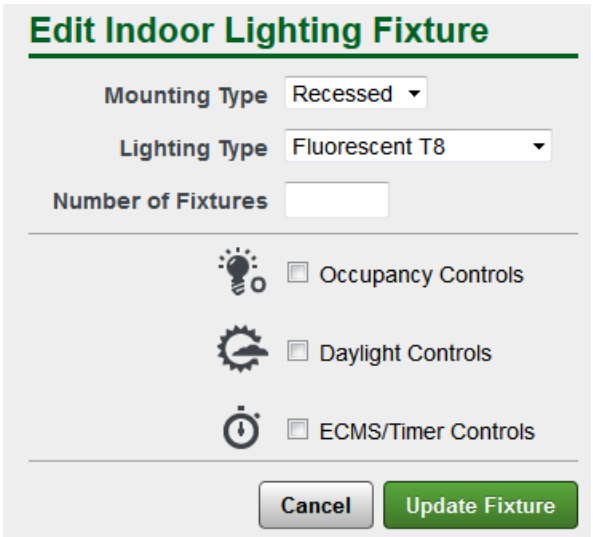
- ❑ **Window layout** (pull-down selection)
- ❑ **Edge Offset**: Refer to Building Data Entry Guide for more information
- ❑ **Sill Height**: Refer to Building Data Entry Guide for more information

Step 6: Enter Lighting Information

1. Click the lighting tab and then Add Fixture to add luminaires:

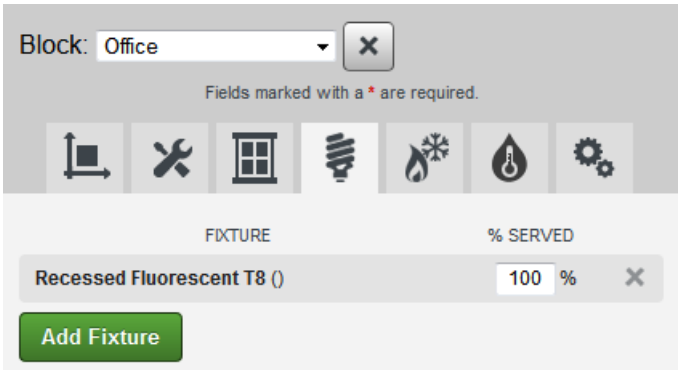


2. In the pop-up window, enter or choose the block's indoor lighting fixtures as shown in the example:



- ❑ **Mounting Type** (pull-down selection)
- ❑ **Lighting Type** (pull-down selection)
- ❑ **Number of Fixtures**
- ❑ **Occupancy Controls**:
- ❑ **Daylight Controls**:
- ❑ **ECMS/Timer Controls**:

3. Click Update Fixture to finish and add the fixture specification to lighting systems tab:

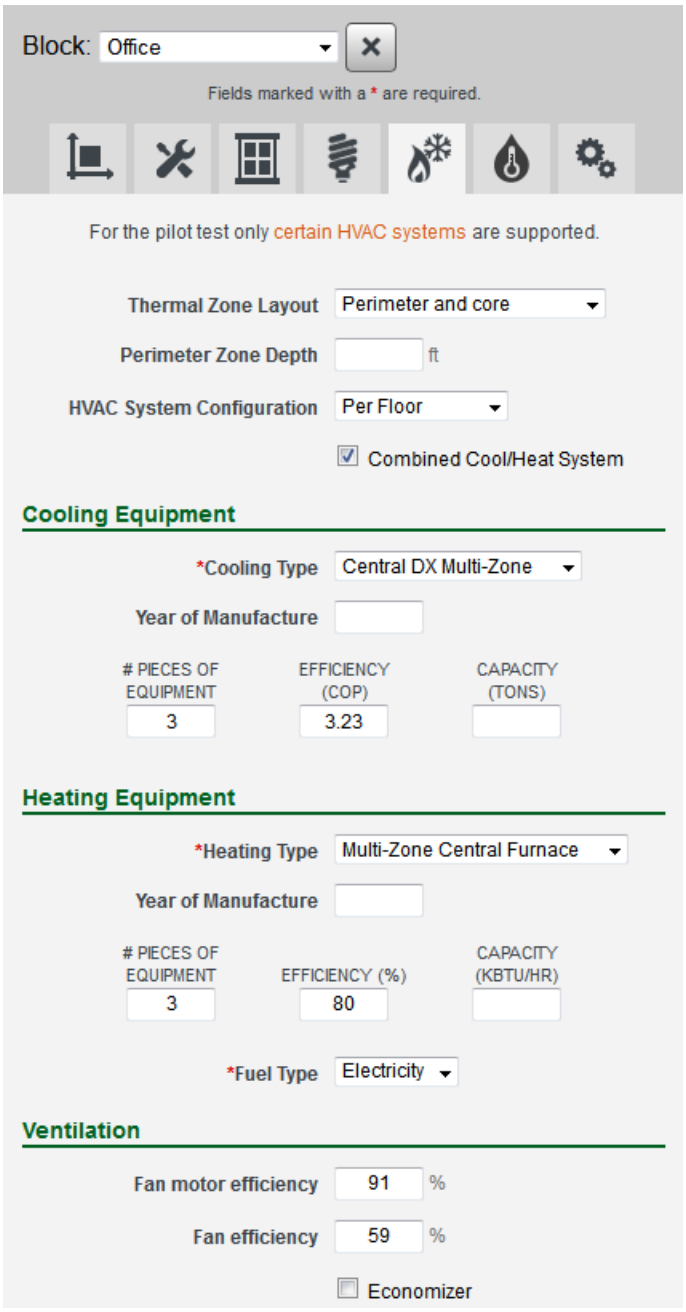


- ❑ **% Served**: the percent of the total building area served by the specified fixture type—used only if the number of fixtures is unavailable (left blank). If both **Number of Fixtures** and **% Served** are entered, the tool will use the number of fixtures rather than percent served.

Notes:
- To edit a listed fixture, click the fixture name to open a pop-up form.
- To delete a fixture type, click ✕ next to the fixture type.

Step 7: Enter Mechanical Systems (HVAC) Information

1. Click the mechanical systems tab  :



2. Enter or choose the block's mechanical systems details as shown in the example:
   - ❑ **Thermal Zone layout**
   - ❑ **Perimeter Zone Depth**
   - ❑ **HVAC Systems Configuration**

- ❑ **Combined Heating and Cooling System**: Check this if heating and cooling systems are integrated as one system (for example, heat pumps).

Cooling Equipment

- ❑ **Cooling Type** (pull-down selection)
- ❑ **Year of Manufacture**
- ❑ **# Pieces of Equipment** / **Efficiency** (COP) / **Capacity** (tons)

Heating Equipment

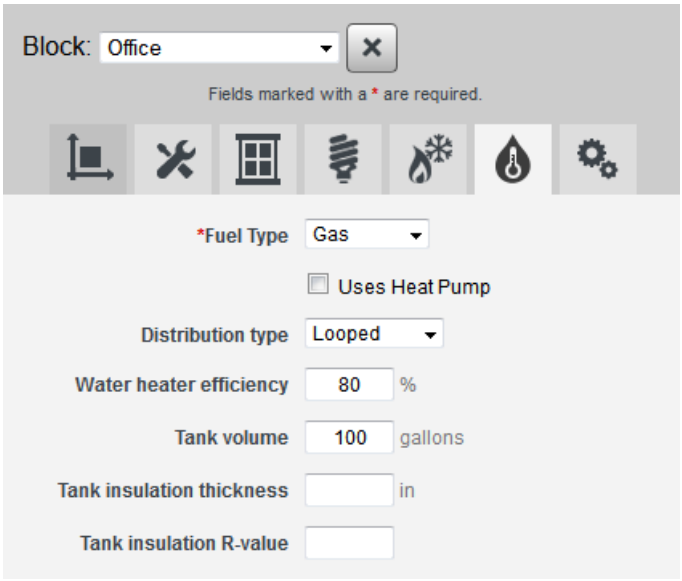
- ❑ **Heating Type** (pull-down selection)
- ❑ **Year of Manufacture**
- ❑ **# Pieces of Equipment** / **Efficiency** (%) / **Capacity** (kBtu/hr)
- ❑ **Fuel Type**

Ventilation

- ❑ **Fan motor efficiency** (%): Enter if known.
- ❑ **Fan efficiency** (%): Enter if known.
- ❑ **Economizer**: Check if an economizer is installed.

Step 8: Enter Service Water Heating Information

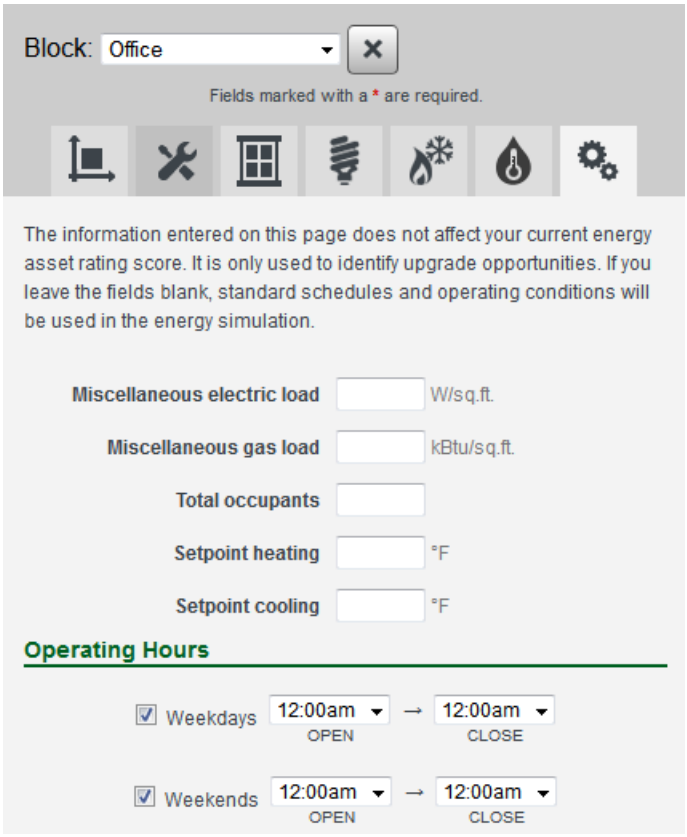
1. Click the service hot water tab  :



2. Enter or choose the block's service hot water information as shown in the example:
   - ❑ **Fuel Type** (pull-down selection)
   - ❑ **Uses Heat Pump**: Check if a heat pump is used for service hot water.
   - ❑ **Distribution Type** (pull-down selection)
   - ❑ **Water heater efficiency** (%)
   - ❑ **Tank Volume** (gallons)
   - ❑ **Tank insulation thickness** (inches)
   - ❑ **Tank insulation R-value**

Step 9: Enter Operation Conditions Information

1. Click the operation conditions tab  :



2. Enter or choose the block's operation conditions information as shown in the example:
   - ❑ **Miscellaneous electric load** (W/sq.ft.)
   - ❑ **Miscellaneous gas load** (kBtu/sq.ft.)
   - ❑ **Total Occupants**
   - ❑ **Setpoint heating** (°F)
   - ❑ **Setpoint cooling** (°F)

   ### Operating Hours

   - ❑ **Weekdays – Open** and **Close** (pull-down selection): time on the nearest half-hour
   - ❑ **Weekends – Open** and **Close** (pull-down selection): time on the nearest half-hour

Submit Your Building and Get the Energy Asset Rating Report

1. Click 

to save your building.
2. Click 

to send your building to the modeling engine.

   You will receive an email when the energy asset rating report is available to download.

The energy asset rating report generated by this *Getting Started* example is included in the following section, *Reading the Rating Report*.

Reading the Rating Report

The asset rating report includes three sections on three separate pages:

- Page 1: Energy Asset Rating Score
- Page 2: System Evaluation
- Page 3: Energy Savings Upgrade Opportunities.

Examples of each report section are presented on the following pages. These examples are based on the example inputs depicted in the *Getting Started* section of this guide (page 4).

Page 1: Energy Asset Rating Score

The primary modeling output of the asset rating tool is the energy use intensity (EUI), which is used to generate the asset rating score. No comparator buildings are needed because the calculated EUI is placed on a fixed scale. Three sets of ratings and associated modeled EUIs are presented on the same asset rating scale. They are a) current asset rating, b) reference building rating, and c) potential asset rating.

a) **Current Asset Rating**: An energy asset rating score of 100 represents a net-zero energy building; a score of 1 represents a very inefficient building in the current commercial building stock. To gain an extra point, you need to reduce your EUI by a certain amount (depending on building types).

b) **Reference Building Rating**: The rating of a reference building of the same use type and similar size and age is also presented on the scale as a reference for comparison to peer buildings. However, the score of a rated building is independent from the chosen reference point. DOE reference buildings are used to create the reference points. For example, 144 reference values are pre-simulated for office buildings of different size, age, and location (3 sizes × 3 vintages × 16 climate zones).

c) **Potential Asset Rating**: After a building upgrade package is identified, the energy asset rating tool will calculate the potential energy use after upgrades using standard operating conditions. Users are allowed to enter the actual operating condition in order to receive recommendations tailored to their buildings.

COMMERCIAL BUILDING ENERGY ASSET RATING REPORT/RATING

U.S. DEPARTMENT OF ENERGY

Building Name
1 Main Road
Chicago, IL 60601

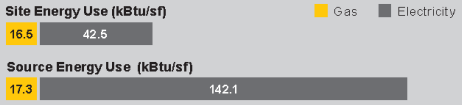
Building Type: **Office**
Gross Floor Area: **100,000 square feet**
Year Built: **2009**

Report #: **IL-1234567**
Award Year: **2011**

Model Standard Conditions

Total Number of Occupants:	**500**
Weekly Operating Hours:	**60**
Temperature Set Point:	**Cooling = 75°F, Heating = 70°F**
Electrical Plug Loads:	**1 W/sq ft**

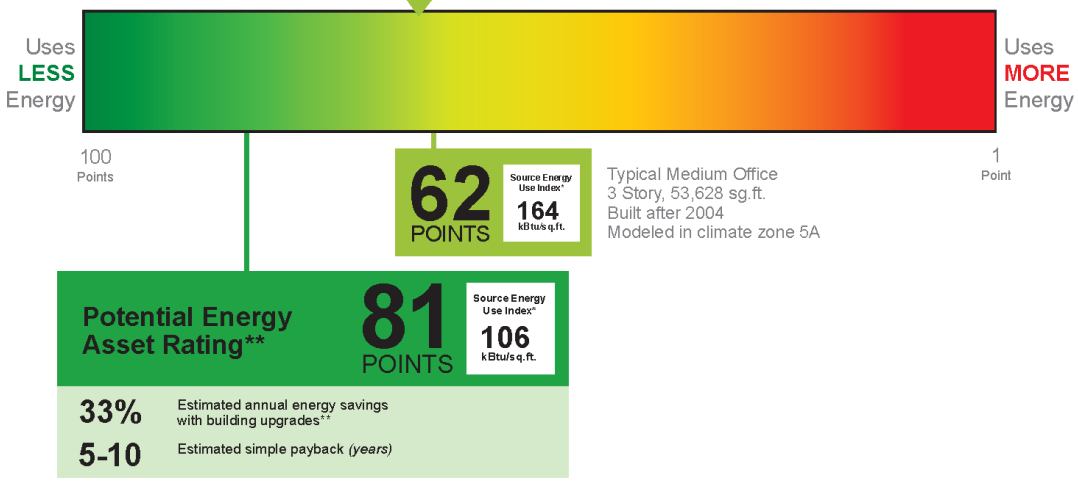
Energy Use Intensity by Fuel Type



Current Energy Asset Rating

63 POINTS

Source Energy Use Index*
159 kBtu/sq.ft.



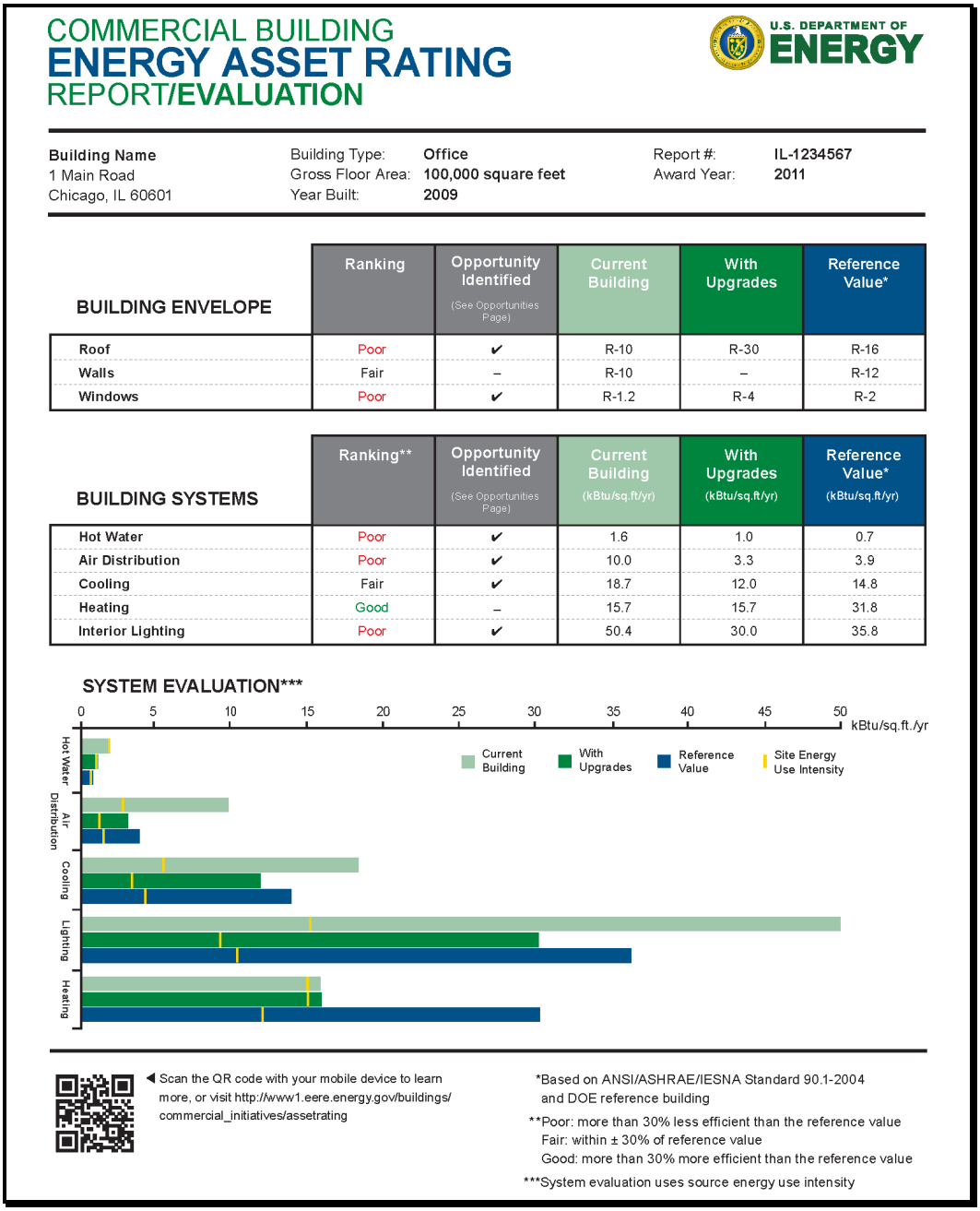
◀ Scan the QR code with your mobile device to learn more, or visit http://www1.eere.energy.gov/buildings/commercial_initiatives/assetrating

*Modeled energy use assumes standard operating and normal weather conditions as defined in Model Standard Conditions.

**The saving is based on standard operating condition as defined in Model Standard Conditions and reflects source energy saving. The upgrade opportunities are identified on Opportunities page.

Page 2: System Evaluation

System evaluations are provided for the building envelope (roof, wall, window) and the lighting, HVAC, and service hot water systems. This information can help identify the parts of the building in need of attention. For two buildings with the same asset rating, the system-level evaluations can help you gain insights into the existing problems and potential improvements of the two buildings.



COMMERCIAL BUILDING
ENERGY ASSET RATING
REPORT/EVALUATION

U.S. DEPARTMENT OF ENERGY

Building Name 1 Main Road Chicago, IL 60601	Building Type: Gross Floor Area: Year Built:	**Office** **100,000 square feet** **2009**	Report #: Award Year:	**IL-1234567** **2011**	

BUILDING ENVELOPE	Ranking	Opportunity Identified (See Opportunities Page)	Current Building	With Upgrades	Reference Value*
Roof	Poor	✔	R-10	R-30	R-16
Walls	Fair	–	R-10	–	R-12
Windows	Poor	✔	R-1.2	R-4	R-2

BUILDING SYSTEMS	Ranking**	Opportunity Identified (See Opportunities Page)	Current Building (kBtu/sq.ft/yr)	With Upgrades (kBtu/sq.ft/yr)	Reference Value* (kBtu/sq.ft/yr)
Hot Water	Poor	✔	1.6	1.0	0.7
Air Distribution	Poor	✔	10.0	3.3	3.9
Cooling	Fair	✔	18.7	12.0	14.8
Heating	Good	–	15.7	15.7	31.8
Interior Lighting	Poor	✔	50.4	30.0	35.8

SYSTEM EVALUATION***

◀ Scan the QR code with your mobile device to learn more, or visit http://www1.eere.energy.gov/buildings/commercial_initiatives/assetrating

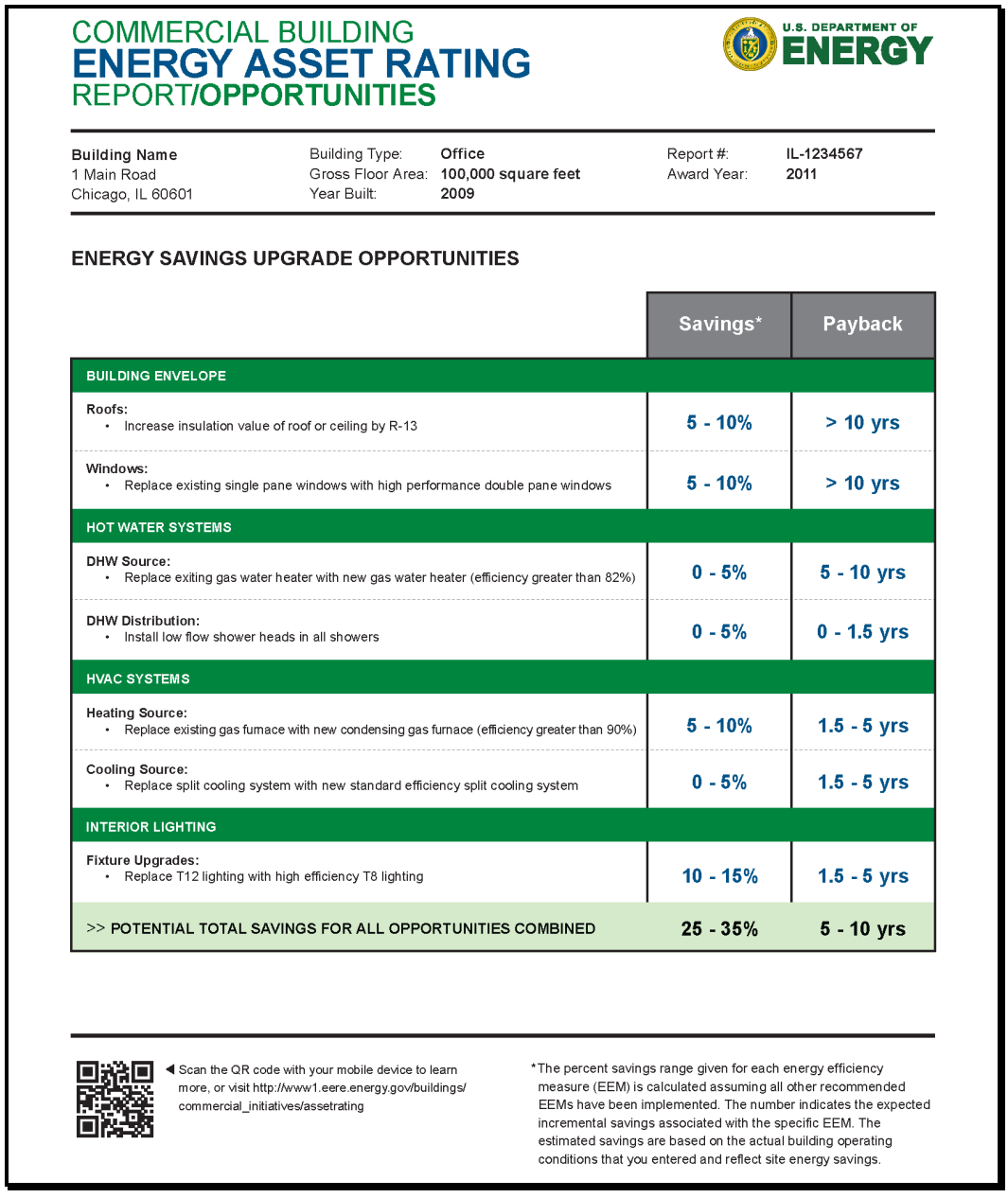
*Based on ANSI/ASHRAE/IESNA Standard 90.1-2004 and DOE reference building

**Poor: more than 30% less efficient than the reference value
Fair: within ± 30% of reference value
Good: more than 30% more efficient than the reference value

***System evaluation uses source energy use intensity

Page 3: Energy Savings Upgrade Opportunities

Based on the entered building information, the asset rating tool will identify potential upgrade opportunities in areas of heating, cooling, and ventilation equipment, envelope, glazing, service hot water, lighting, and electric motors. The upgrade opportunities are identified based on life-cycle-cost (LCC) analysis using the actual operating conditions of your building. A building may have different upgrade potentials if it operates in a different way. For example, a cost-effective lighting upgrade for a building operated 60 hours per week may not be cost-effective for the same building operated 30 hours per week. If no actual operating conditions are entered into the energy asset rating tool, the standard operating conditions are used in the LCC analyses.



COMMERCIAL BUILDING
ENERGY ASSET RATING
REPORT/OPPORTUNITIES

U.S. DEPARTMENT OF ENERGY

Building Name 1 Main Road Chicago, IL 60601	Building Type: Gross Floor Area: Year Built:	**Office** **100,000 square feet** **2009**	Report #: Award Year:	**IL-1234567** **2011**	

ENERGY SAVINGS UPGRADE OPPORTUNITIES

	Savings*	Payback
BUILDING ENVELOPE		
Roofs: • Increase insulation value of roof or ceiling by R-13	5 - 10%	> 10 yrs
Windows: • Replace existing single pane windows with high performance double pane windows	5 - 10%	> 10 yrs
HOT WATER SYSTEMS		
DHW Source: • Replace exiting gas water heater with new gas water heater (efficiency greater than 82%)	0 - 5%	5 - 10 yrs
DHW Distribution: • Install low flow shower heads in all showers	0 - 5%	0 - 1.5 yrs
HVAC SYSTEMS		
Heating Source: • Replace existing gas furnace with new condensing gas furnace (efficiency greater than 90%)	5 - 10%	1.5 - 5 yrs
Cooling Source: • Replace split cooling system with new standard efficiency split cooling system	0 - 5%	1.5 - 5 yrs
INTERIOR LIGHTING		
Fixture Upgrades: • Replace T12 lighting with high efficiency T8 lighting	10 - 15%	1.5 - 5 yrs
>> POTENTIAL TOTAL SAVINGS FOR ALL OPPORTUNITIES COMBINED	25 - 35%	5 - 10 yrs

◀ Scan the QR code with your mobile device to learn more, or visit http://www1.eere.energy.gov/buildings/commercial_initiatives/assetrating

*The percent savings range given for each energy efficiency measure (EEM) is calculated assuming all other recommended EEMs have been implemented. The number indicates the expected incremental savings associated with the specific EEM. The estimated savings are based on the actual building operating conditions that you entered and reflect site energy savings.

Overview of Tool Workspaces

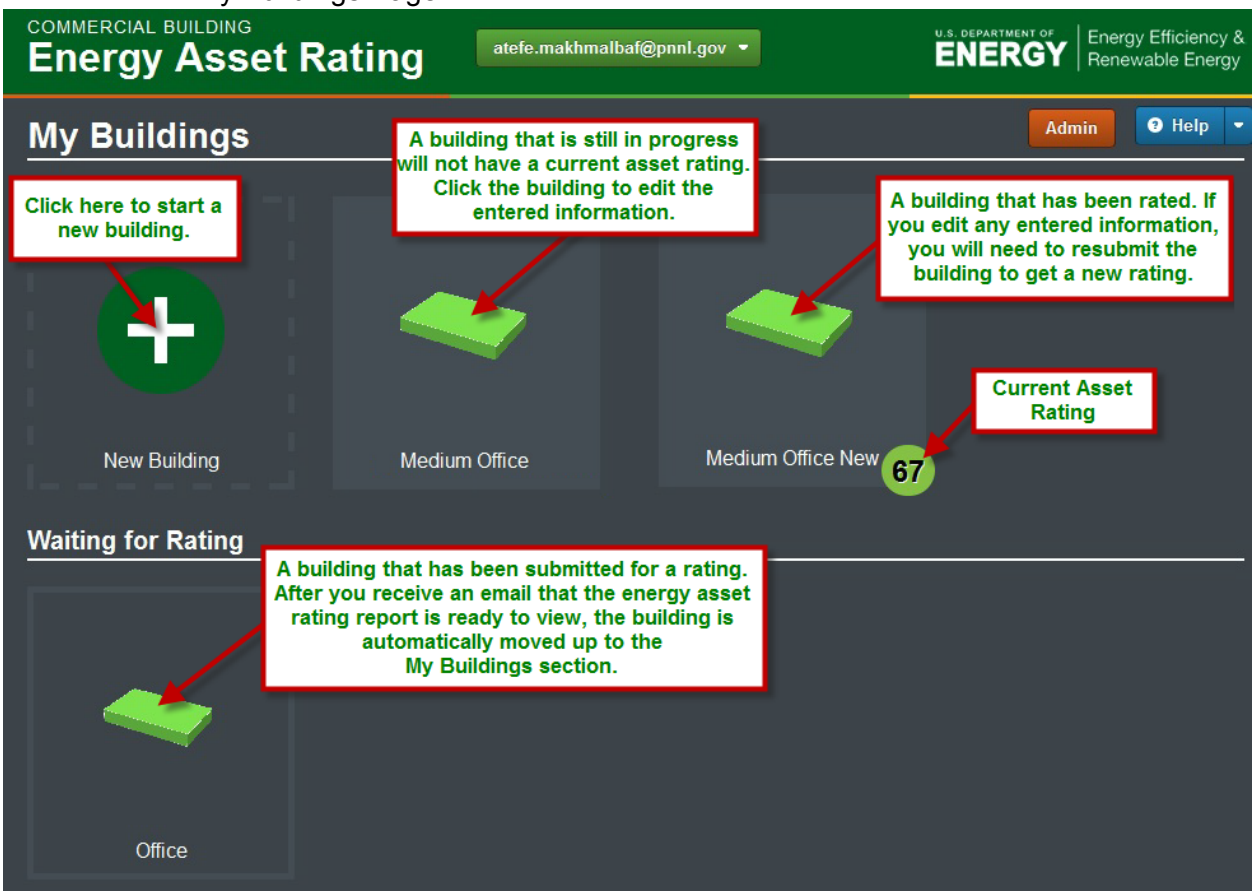
The energy asset rating tool has only two workspaces (web pages) that provide the means for you to 1) manage a set of buildings that you want to be rated and 2) enter building data that will be used for the energy modeling:

- The ***My Buildings*** page is a location where you can initiate a building in the system, view what buildings you have in the system, or select a building for data entry.
- The ***building data entry*** page provides forms for entering information about a selected building and a manupulatable visual representation of the building "block" for which the building information applies. A *block* in the energy asset rating tool is a part of the building with a specific physical configuration, set of energy assets, and construction properties.

My Buildings Page

After login, the energy asset ratings tool displays the ***My Buildings*** page, which includes displays iconic representations of your buildings in the tool. By looking at the building icons, you can distinguish buildings that have been submitted for rating from other buildings that have not been submitted—as indicated in the following figure.

My Buildings Page



▶ To start a new building in the tool

1. Click the **New Building** button  .

   You will then see a pop-up window for specifying a building name for use in the tool as well as date of construction and location.

2. Enter the building information, and click 

.

   This creates an empty icon box on the ***My Buildings*** page.

Building Data Entry Page

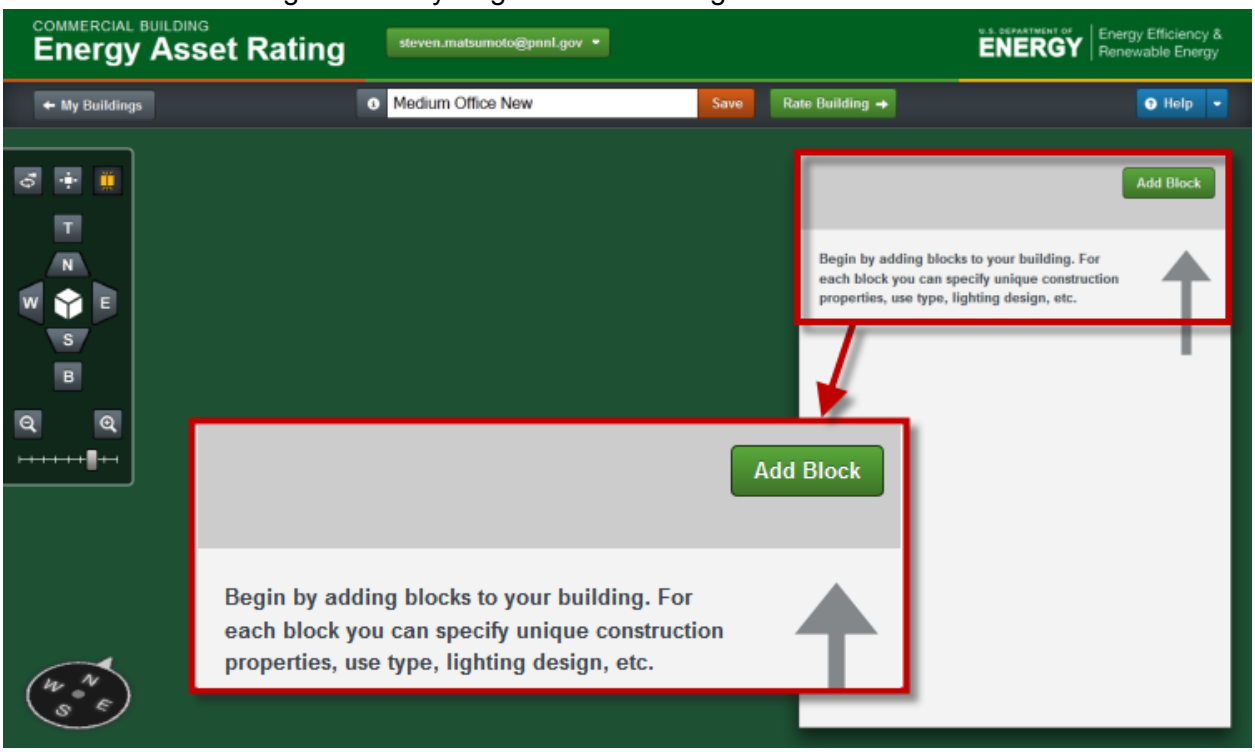
This page is the main workspace for entering building data that will be used in the tool's energy model and for submitting the completed building data to the modeling engine.

▶ To display the *building data entry* page

❑ Click on the icon of one of your buildings on the ***My Buildings*** page.

- If the building is new to the energy asset rating tool, the tool displays the instruction to add a new block by specifying a physical configuration and name for the block. See the figure: *Building Data Entry Page – New Building*.
- If the building already has a block created in the tool, the tool displays a graphic representation of the block and a set of tabbed forms for entering building data inputs. See the figure: *Building Data Entry Page – Building in Progress*.

Building Data Entry Page – New Building



▶ To begin building data entry for a new building

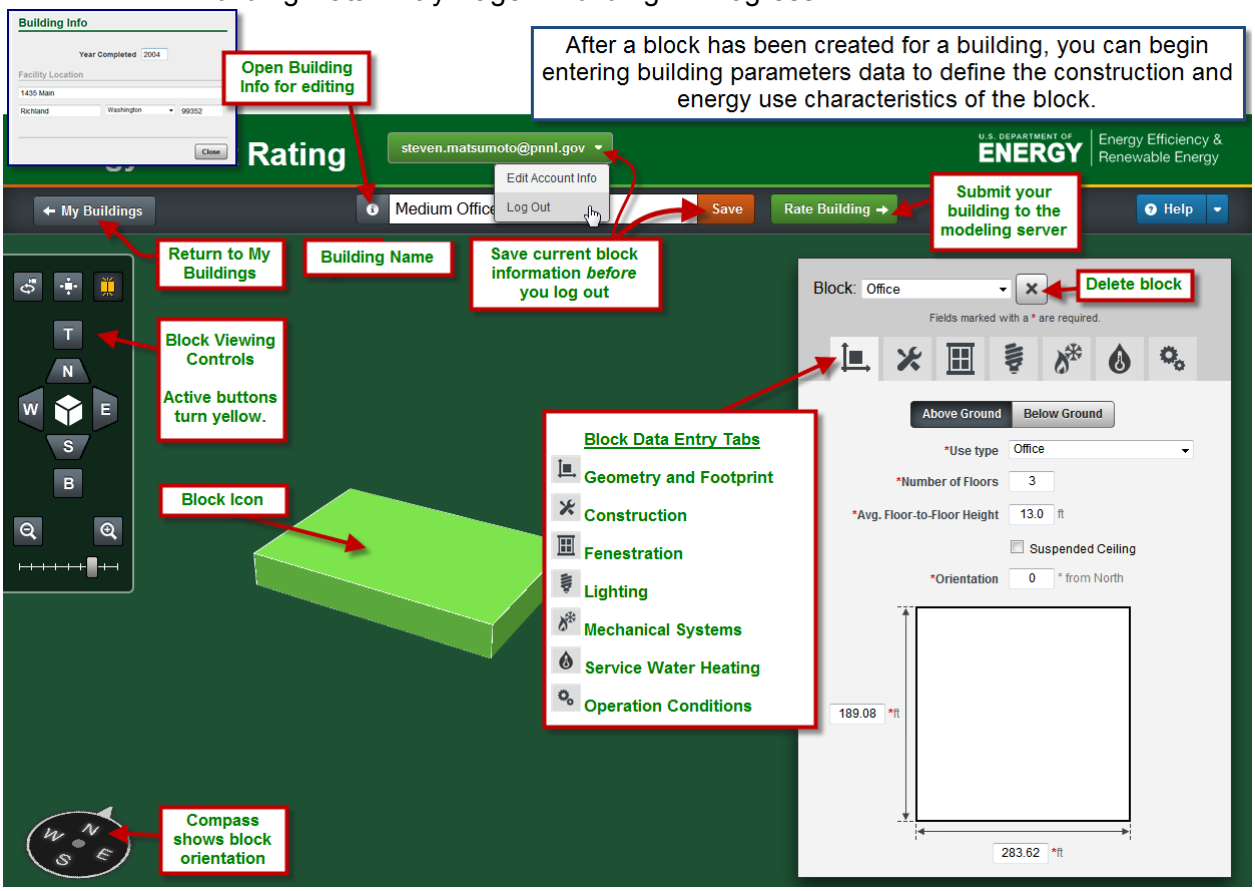
1. Click Add Block to display a pop-up window for choosing a building footprint shape and entering the block name.

> ***Pilot Test Note***: Although the energy asset rating tool is designed to permit modeling a building with multiple blocks that represent building parts with distinctly different energy assets or physical configurations, the option to model a building with multiple blocks is NOT available during the pilot test. For the pilot test, 1 building = 1 block.

2. In the resulting pop-up window, choose a building footprint shape, enter the block name, and click Create Block to create the new block.

   An iconic representation of the building block then displays on the ***building data entry*** page. A set of tabbed data entry forms provides fields and selections for specifying the building parameters that apply to the new block. To better identify what these parameters are, refer to the *Building Data Entry Guide* (page 27) for parameter descriptions.

Building Data Entry Page – Building in Progress



▶ To save your data and submit a building to the modeling engine

1. Click Save to save your building.
2. Click Rating to send your building to the modeling engine.

   You will receive an email when the energy asset rating report is available to download. For an example report and a description of report content, see *Reading the Rating Report* (page 19).

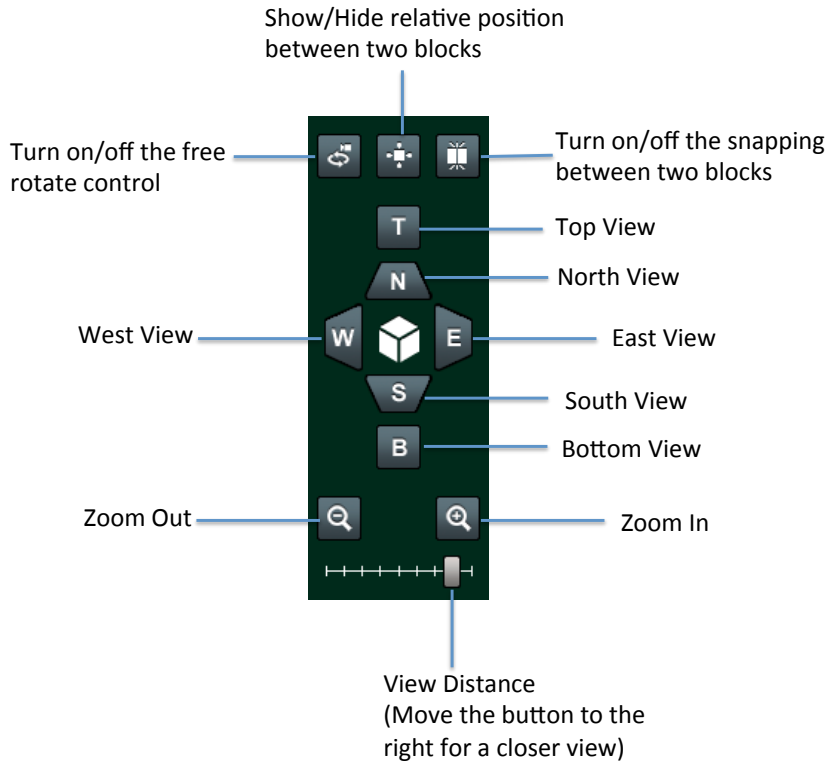
   After submitting the building for rating, you will be unable to edit the building data further until you receive notification that the report is ready. After you receive the report, you can again edit the building parameters, but you must resubmit the building for a new result.

Block Viewing Controls

On the left side of the ***building data entry*** page are interactive controls for manipulating the display of the block icon that appears in the central part of the page. As indicated by the figure depicting the controls below, you can click control buttons to snap to a specific perspective view, zoom in and out, change the perceived viewing distance, or even permit free rotation by dragging the mouse cursor across the block icon.

> ***Pilot Test Note***: The control buttons that deal with multiple blocks are disabled for the pilot test.

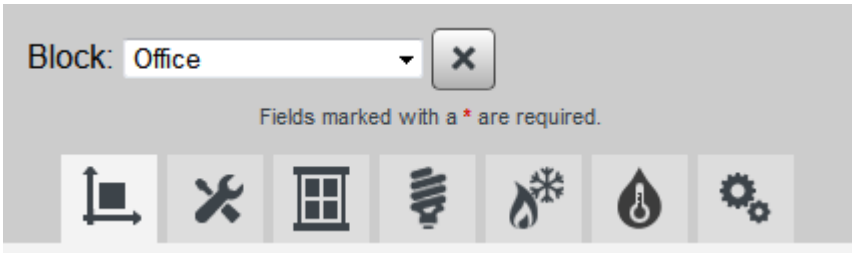
Block Viewing Controls



Building Data Entry Guide

The purpose of this section is to provide definitions of the building parameters that you will specify in the energy asset rating tool to obtain an energy asset rating report. Most building information is entered or selected in the tool's tabbed data entry area, where clicking a tab displays the data entry fields and selections for one aspect of the building's energy assets. This section will also provide instructions on how to select or enter data.

Data Entry Tabs for a Building Block



 Geometry and Footprint

 Construction

 Fenestration

 Lighting

 Mechanical Systems

 Service Water Heating

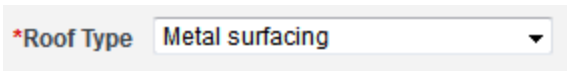
 Operation Conditions

These tabs appear in the tool only after you have added a building block for which to define energy assets and construction properties. See *Create Your Building* (page 5).

Required Data and Inferred Values

Required data fields and selections are marked with a red asterisk (*).

Example of a Required Selection



Other data fields are optional and may be left blank for a less rigorous energy asset rating. If optional items are left blank, then the tool uses its internal database of typical energy-system configurations and performance data to infer likely building parameters and use those inferred values for the energy simulation model.

Building Parameter Descriptions and Definitions

The building parameters in this *Building Data Entry Guide* section are defined and described specifically for the purpose of the energy asset rating tool. These definitions and descriptions have been adapted from the following sources:

- ANSI/ASHRAE 90.1-2010 (I-P). 2010. *Energy Standard for Buildings Except Low-Rise Residential Buildings*, American Society of Refrigerating and Air-Conditioning Engineers, Inc.
- EERE - Office of Energy Efficiency and Renewable Energy. 2012. *Energy Savers*. "Determining Energy Efficiency of Storage, Demand, and Heat Pump Water Heaters." Accessed April 24, 2012 at http://www.energysavers.gov/your_home/water_heating/index.cfm/mytopic=13000 (last updated February 9, 2011).
- EERE - Office of Energy Efficiency and Renewable Energy. 2012. *Building Technologies Program: Building Energy Codes. "*Building Energy Codes Online Training, COM*check* 201: Resources." Accessed April 20, 2012 at http://www.energycodes.gov/moodle/mod/resource/index.php?id=51 (undated webpage)
- EnergyPlus. 2011. *Input Output Reference, The Encyclopedic Reference to EnergyPlus Input and Output*. University of Illinois and Lawrence Berkeley National Laboratory.
- EnergyPlus. 2011. *EnergyPlus Engineering Reference, The Reference to EnergyPlus Calculations*. University of Illinois and Lawrence Berkeley National Laboratory.

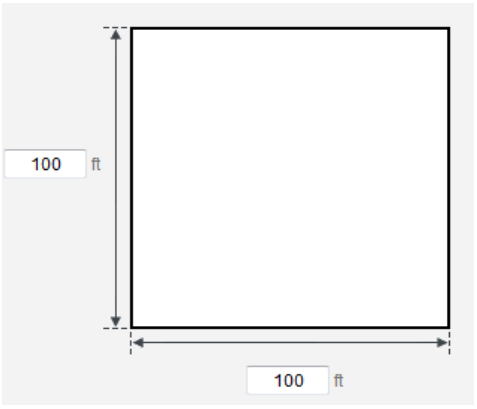
Geometry and Footprint

Item / Control	Description
Above Ground | Below Ground	Click one button to indicate whether the block is above or below ground.
Number of Floors	Number of floors in each block
Avg. Floor-to-floor Height	Distance between the surface of one finished interior floor and the surface of the next successive finished interior floor
Orientation	Counterclockwise deviation (in degrees) of the main window wall from north (0 degrees). For example:

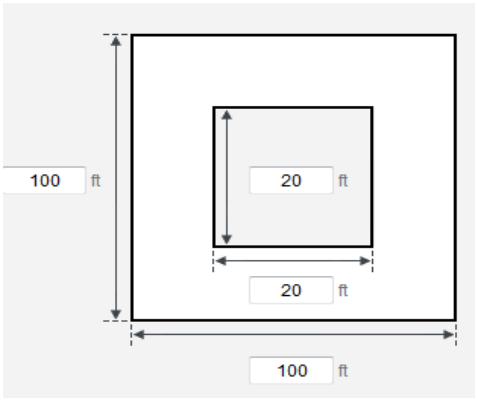
Main Entrance Wall	Orientation
N	0
NW	45
W	90
SW	135
S	180
SE	225
E	270
NE	315

<table>
<tr><th>Item / Control</th><th>Description</th></tr>
<tr><td>Use Type</td><td>Pull-down menu selection:
<table>
<tr><th>If the building is used for:</th><th>Then Select:</th></tr>
<tr><td>• Administrative/professional
• Bank/other financial
• Government
• Medical non diagnostic
• Mixed use</td><td>Office</td></tr>
<tr><td>• College/university
• Elementary/middle school
• High school
• Preschool/daycare
• Other classroom</td><td>Education</td></tr>
<tr><td>• Strip shopping mall
• Enclosed mall
• Other than mall
• Vehicle Dealership/showroom
• Non-mall other</td><td>Retail</td></tr>
<tr><td>• Non-refrigerated
• Distribution/shipping center
• Self-storage</td><td>Warehouse</td></tr>
</table>
Pilot Test Note: Grayed-out options in the pull-down menu indicate that those options are not enabled in the pilot software.</td></tr>
</table>

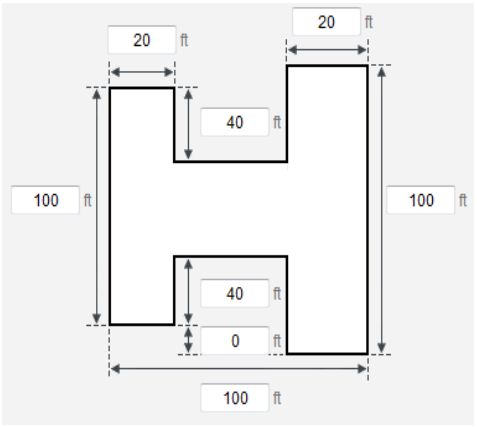
Item / Control	Description
Footprint Dimensions	Enter the dimensions (feet) of the block's footprint as specified on the corresponding footprint diagram.



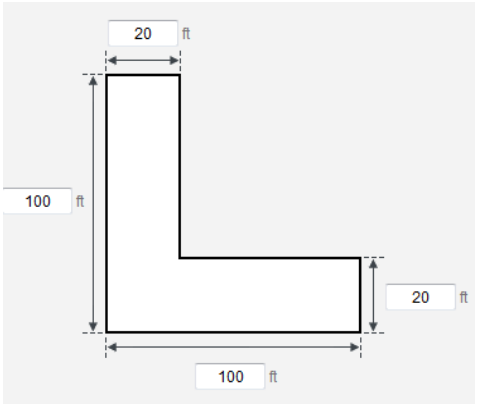
Rectangular



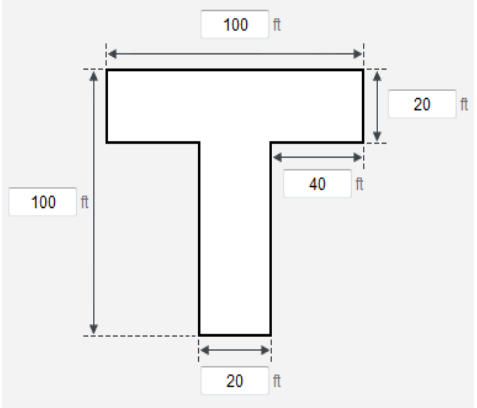
Courtyard



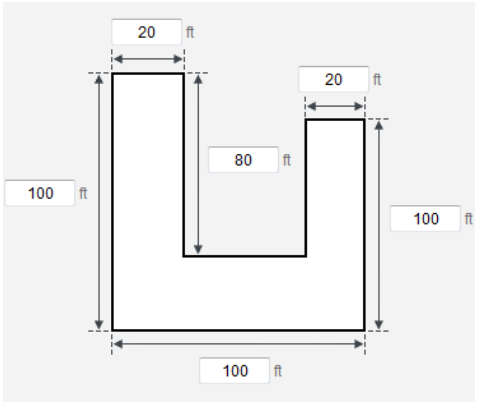
H Shape



L Shape



T Shape



U Shape

Construction

Building envelope is the exterior plus the semi-exterior portions of a building. For the purposes of determining building envelope requirements, the classifications are defined as follows:

- Building envelope's exterior are the elements of a building that separate conditioned spaces from outside.
- Building envelope's semi-exterior are the elements of a building that separate conditioned space from unconditioned space or that enclose semi heated spaces through which thermal energy may be transferred to or from the exterior, or to or from unconditioned spaces, or to or from conditioned spaces.

Roof

The *roof* is the upper portion of the building envelope, including opaque areas and fenestration, that is horizontal or tilted at an angle of less than 60° from horizontal.

Item / Control	Description
Roof Type	Pull-down menu selections:
Metal surfacing	Constructed with a metal, structural, weathering surface that has no ventilated cavity and has the insulation entirely below deck and its structure consists of one or more of the following configurations: • metal roofing in direct contact with the steel framing members • insulation between the metal roofing and the steel framing members • insulated metal roofing panels installed
Shingles/shakes	A series of overlapping rows of roofing material, including wood, plastic, fiber glass, baked clay, tile, slate, asbestos, asphalt, and aluminum
Built-up/EPDM w/metal deck	Built up is composed of several layers of roofing felts reinforced with asphalt and covered by a heavy asphalt coat embedded with gravel. Ethylene Propylene Diene Monomer (EPDM) is a thermoset type of flexible single ply sheet used as a common roofing material in low slope roofing applications. This option should be selected if roof type is built up or EPDM with metal deck.

Item / Control	Description
Built-up/EPDM w/concrete deck	See description of built-up and EPDM above. This option should be selected if roof type is built up or EPDM with concrete deck.
Built-up/EPDM w/wood deck	See description of built-up and EPDM above. This option should be selected if roof type is built up or EPDM with wood deck.
R-VALUE[(a)]	Measure of thermal resistance: the reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions. *R-values* are given in units of ft²·°F·h/Btu.
INSULATION THICKNESS[(a)]	Thickness of insulating material used in units of inches
U-VALUE[(a)]	Measure of thermal transmittance per unit time per unit area of the roof material and the boundary air films, induced by unit temperature difference between the environments on each side. U-value is inverse of R-value. *U-values* are given in units of Btu/ft²·°F·h.
(a) If R-Value, Insulation Thickness, and U-Value are all entered, the calculation will be only based on one value in the following order: U-Value, R-value, and Insulation Thickness	

Exterior Wall

An *exterior wall* is that portion of the building envelope, including opaque area and fenestration, that is vertical or tilted at an angle of 60° from horizontal or greater. This includes above- and below-grade walls, between-floor spandrels, peripheral edges of floors, and foundation walls.

Item / Control	Description
Wall Type	Pull-down menu selections:
Metal panel/ Curtain Wall	The base assembly of the wall consists of metal spanning members supported by steel structural members with insulation between metal framing.
Siding on wood frame	The base assembly consists of conventional framed wood with insulation installed between. The exterior finish is siding.
Brick/Stone on wood frame	The base assembly consists of conventional framed wood with insulation installed between. The exterior finish is brick or stone.
Brick/Stone on steel frame	The base assembly consists of a cavity separated by steel framing members (such as typical steel stud walls and curtain wall systems). The exterior finish is brick or stone.
Brick/Stone on masonry	The base assembly consists of individual units (such as clay brick, concrete units) laid in and bound together. The exterior finish is brick or stone.
R-VALUE[(a)]	Measure of thermal resistance: the reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions. *R-values* are given in units of ft²·°F·h/Btu
INSULATION THICKNESS[(a)]	Thickness of insulating material used in units of inches
U-VALUE[(a)]	Measure of thermal transmittance per unit time per unit area of the wall material and the boundary air films, induced by unit temperature difference between the environments on each side. U-value is inverse of R-value: *U-values* are given in units of Btu/ft²·°F·h.
(a) If R-Value, Insulation Thickness, and U-Value are all entered, the calculation will be only based on one value in the following order: U-Value, R-value, and Insulation Thickness	

Floor

The *floor* is that lower portion of the building envelope, including opaque area and fenestration, that has conditioned or semi-heated space above and is horizontal or tilted at an angle of less than 60 degrees from horizontal but excluding slab-on-grade floors. For the purposes of determining building envelope requirements, the classifications are defined as follows.

Item / Control	Description
Ground Coupling	Pull-down menu selections:
Slab	A concrete slab, which is formed from a mold set into the ground, serves as the foundation for the structure
Basement	One or more floors of a building are completely or partially below the ground level.
Crawlspace	A shallow and uninhabitable space between the soil and the first floor of the building
Has Carpet	(Check box) should be checked if ground floor is covered by carpet
R-VALUE	Measure of thermal resistance: the reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions. *R-values* are given in units of $ft^2 \cdot °F \cdot h/Btu$.
INSULATION THICKNESS	Thickness of insulating material used in units of inches

Fenestration

Fenestration is all areas (including the frames) in the building envelope that let in light, including windows, plastic panels, clerestories, skylights, doors that are more than one-half glass, and glass block walls. (See *building envelope* and *door.*)

Skylights

A *skylight* is a fenestration surface having a slope of less than 60° from the horizontal plane. Other fenestration, even if mounted on the roof of a building, is considered *vertical fenestration*. (See *Windows* below.)

> *Note*: Although data inputs are planned for skylights, the fields for entering that data were disabled in the initial implementation of the energy asset rating tool.

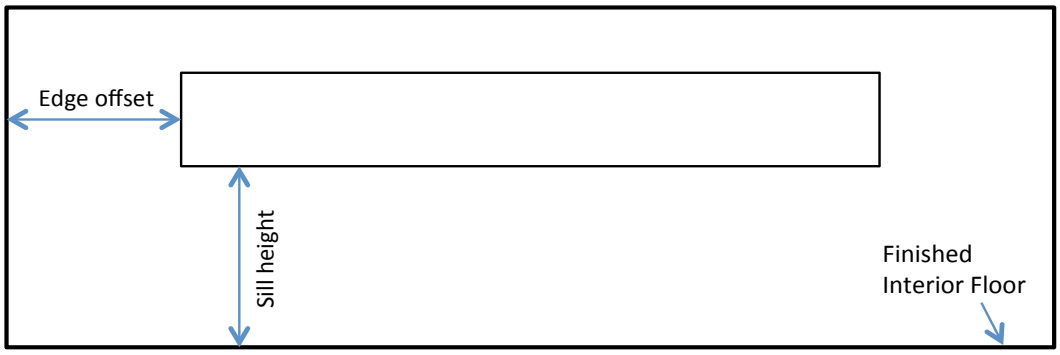
Windows

Vertical fenestration is all fenestration other than *skylights*. Trombe wall assemblies, where glazing is installed within 300 mm of a mass wall, are considered walls, not fenestration.

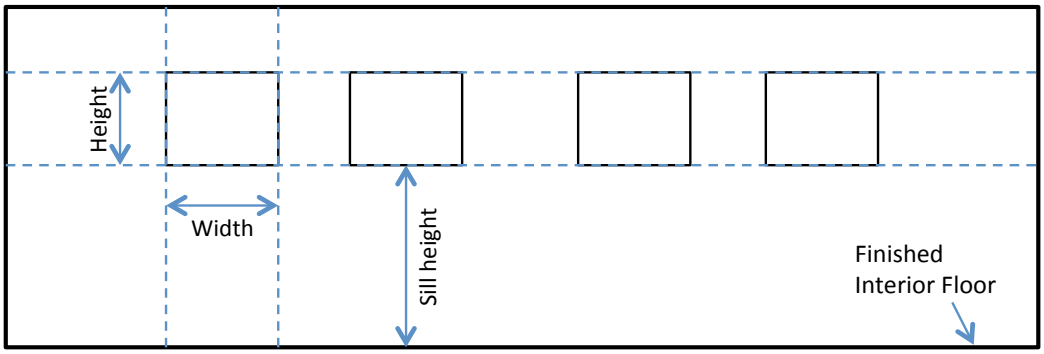
Item / Control	Description
Framing type	Pull-down menu selections:
Metal	Window frames made of aluminum or metal that are strong and maintenance-free but make poor insulating material
Metal with thermal breaks	Thermal breaks are insulating plastic strips used in metal frames to reduce heat flow.
Wood/Vinyl/ Fiberglass	Wood, vinyl and fiberglass window frames are better insulating materials used in window frames.
Glass type	Pull-down menu selections:
Single Pane	Only one layer of glazing with no insulation
Double Pane	Insulated glazing that consists of double panes filled with air or other gas in between to reduce heat loss
Double Pane w/ Low E	A double-pane window with low-emissivity coating, which reduces radiant heat transfer to increase efficiency of the window. The metal coating reflects warmth inside in the winter while reducing solar heat gain in summer.
Triple Pane	Insulated glazing that consists of three panes separated by air or other gas between the panes to reduce heat transfer between inside and outside

Item / Control	Description
Triple Pane w/ Low E	A triple-pane window with low-emissivity coating to increase efficiency of the window. The metal coating reflects warmth inside the building in the winter while reducing heat gain in summer.
Gas fill type	(Disabled for the pilot test) Pull-down menu selections: Air, Other, None
Operable	(Check box) should be checked if occupants can open the window.
Advanced Window Properties	Optional inputs:
U-VALUE	Thermal transmittance per unit time per unit area of *the whole window* and the boundary air films, induced by unit temperature difference between the environments on each side. U-value is inverse of R-value. *U-values* are given in units of Btu/ft²·°F·h
SHGC	Solar heat gain coefficient is the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.
VT	Visible transmittance: indicates the amount of visible light transmitted.
Advanced Window Layout	Optional inputs: **Window layout** (**Continuous** or **Discrete**), **Edge offset** (feet), **Sill height** (feet). See the accompanying Window Layout figures.

Window Layout (**Continuous**)



Window Layout (**Discrete**)

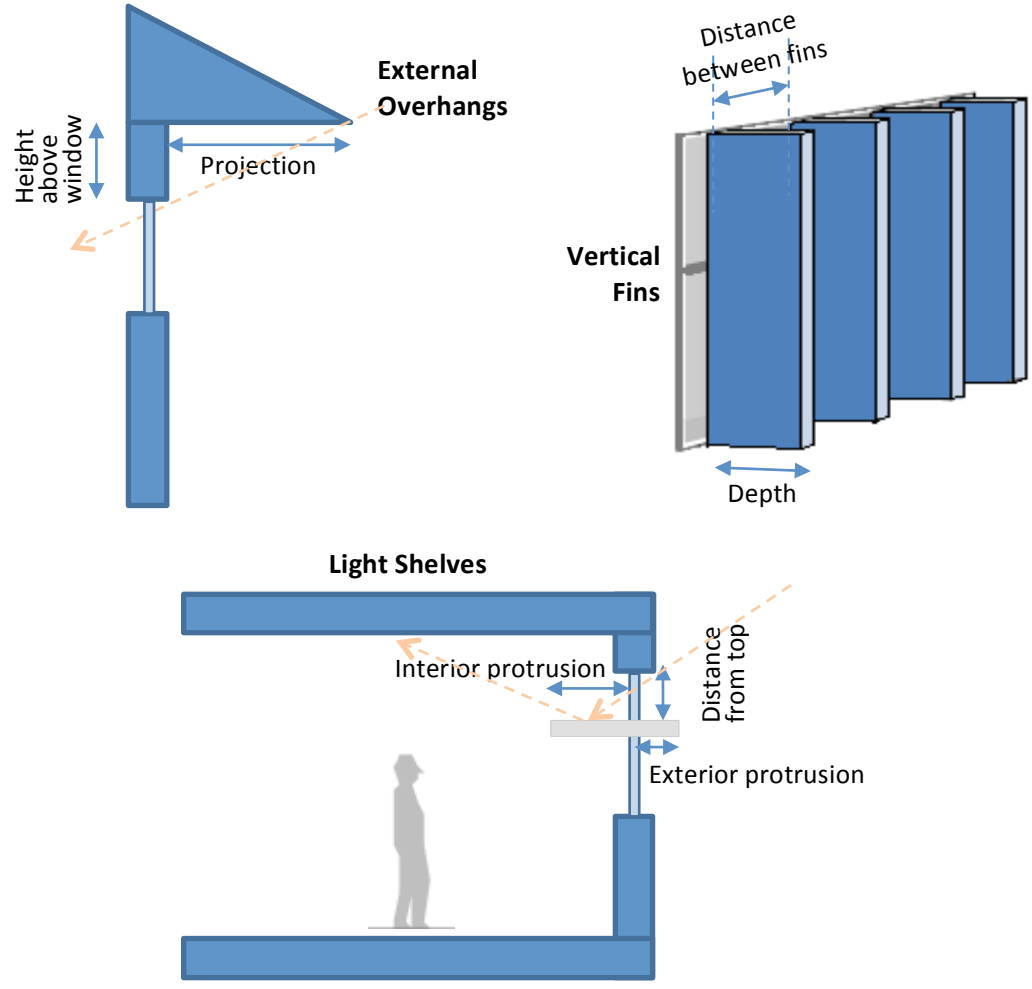


Shading

Item / Control	Description
Exterior Shading Type	Pull-down menu selections: includes **No Shading**
External Overhangs	An overhang above the wall is used to control the amount of seasonal sun exposure by decreasing exposure in the summer when the sun is high in the sky and heating is not required, yet still allowing for full exposure in the winter when the sun is low in the sky and heating is desirable (see the *Shading Types* figure).
Vertical Fins	A vertical fin will cast a shadow whether the sun is on the left side or right side of the fin (see the *Shading Types* figure)
Light Shelves	A device for bringing more daylight into a building. Installed as an accessory to a window, light shelves work by reflecting exterior light onto the ceiling of a room. Light shelves can have an inside shelf, an outside shelf, or both (see the *Shading Types* figure).[2]

[2] From *EnergyPlus Input Output Reference*.

Shading Types



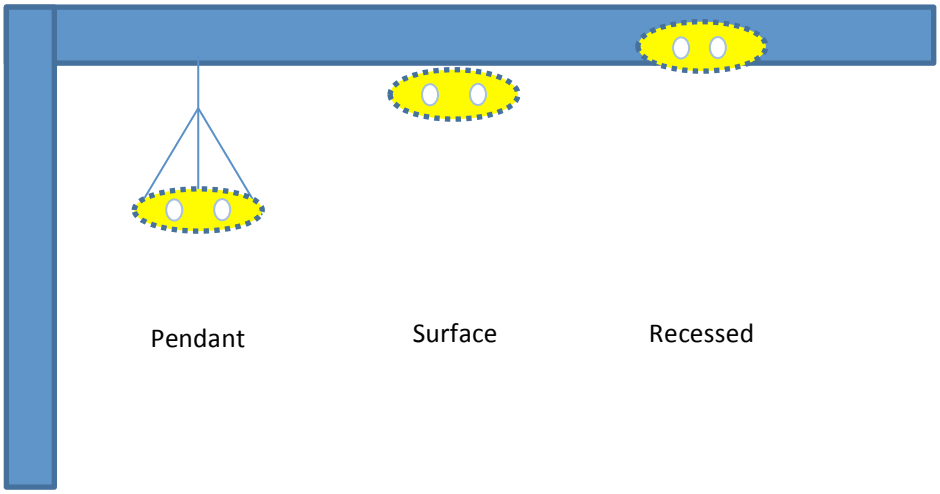
Lighting

The Add Fixture button opens a pop-up window with data entry fields and choices for the following items.

Item / Control	Description
Mounting type	Pull-down menu selections: **Recessed**, **Surface**, and **Pendant** (see the *Mounting Types* figure)
Lighting Type	Pull-down menu selections:
Incandescent/ Halogen	A lamp that produces light by a filament heated to incandescence by an electric current
Compact Fluorescent	A fluorescent lamp of a small compact shape, with a single base that provides the entire mechanical support function
Fluorescent Lamp	A low-pressure electric discharge lamp in which a phosphor coating transforms some of the ultraviolet energy generated by the discharge into light. These lamps are available in T5, T8, T12 technologies. "T" stands for "tubular" and indicates the diameter of the fluorescent lamp tube.
Metal Halide	A type of high-intensity discharge lamps producing light by an electric arc through a gaseous mixture. The lamp consists of an arc tube within an outer bulb.
High-Pressure Sodium	A type of high-intensity discharge lamps producing light from sodium in an excited state. The light usually appears yellow.
Number of Fixtures	Number of luminaire components that house the lamp or lamps, positions the lamp, shields it from view, and distributes the light. The fixture also provides for connection to the power supply, which may require the use of a ballast.
Occupancy Controls	(Check box) should be checked if occupancy sensor lighting is installed to automatically turn lights on—and keep them on—while the controlled space is occupied
Daylight Controls	(Check box) should be checked if automated integration of daylight and electric light sources are provided to deliver a comfortable and visually interesting environment

Item / Control	Description
ECMS/Timer Controls	(Check box) – should be checked if lighting goes on for a scheduled period of time in a controlled space

Mounting Types



The Update Fixture button then displays the specified lighting fixures on the lighting systems tabs with the following data entry field:

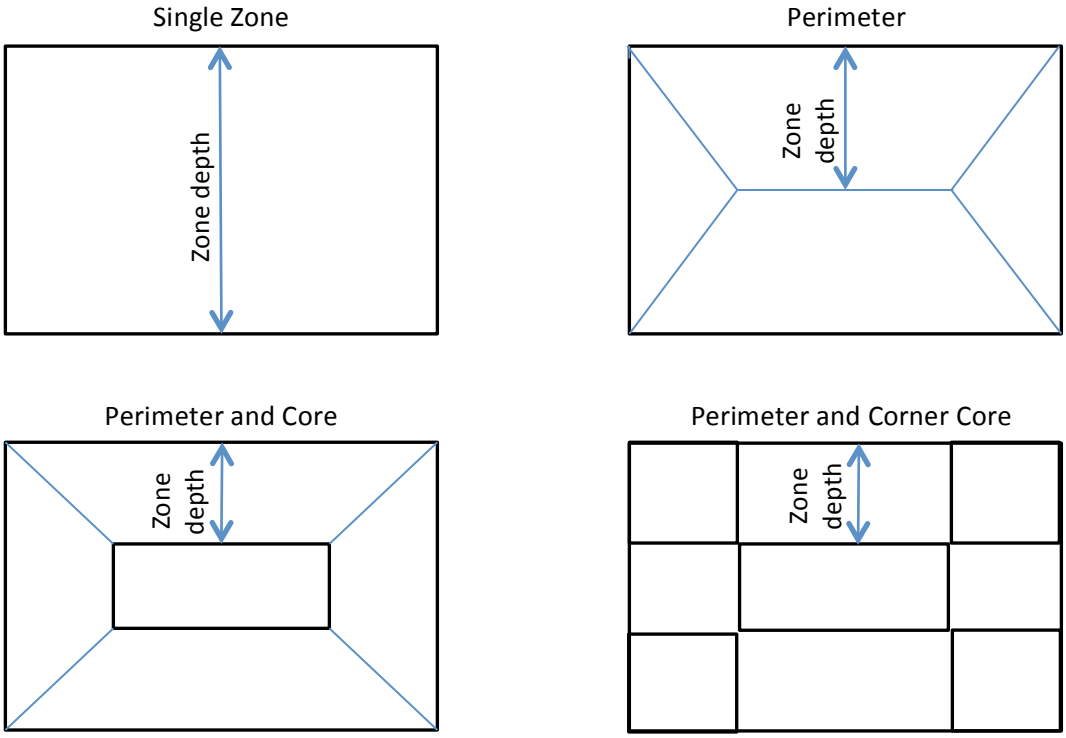
Item	Description
% Served	percent of lighted space served by total number of fixtures

Mechanical Systems

During the pilot test only certain types of heating, ventilation, and air conditioning (HVAC) are supported by the energy asset rating tool, as identified in the pop-up list of systems linked at the top of the HVAC systems tab.

Item / Control	Description
Thermal Zone Layout	A *thermal zon*e is an air volume at uniform temperature plus all the heat transfer and heat storage surfaces bounding or inside of that air volume. It is not a geometric concept. Pull-down menu selections: (see the *Thermal Zone Layout* figure)
Single Zone	the floor is an open space served by single HVAC system
Perimeter	the floor is divided into four perimeter zones
Perimeter and core	the floor is divided into four perimeter zones and one core zone
Perimeter, corner, and core	the floor is divided into four perimeter zones, one core and four corner zones
Perimeter Zone Depth	See the *Thermal Zone Layout* figure.
HVAC System Configuration	Pull-down menu selections:
Per Zone	If a single HVAC system or equipment serves a single zone
Per Floor	If a single HVAC system or equipment serves a single floor
Per Orientation	If a single HVAC system or equipment serves one orientation
Per Block	If a single HVAC system or equipment serves a single block
Per Building	If a single HVAC system or equipment serves the whole building
Combined Cooling and Heating System	(Check box) should be checked if same system provides both heating and cooling, such as a heat pump

Thermal Zone Layout



Cooling Equipment

Cooling equipment here refers to assemblies that normally include an evaporator or cooling coil and a compressor and condenser combination.

Item / Control	Description
Cooling Type	Pull-down menu selections: match your installed system to one of the systems listed below and select the cooling type accordingly.
No Cooling	If no mechanical cooling equipment is installed
Terminal DX	• Packaged terminal air-conditioner (PTAC) • Packaged terminal heat pump (PTHP) • Window air conditioners • Through-the-wall room HVAC units
Central DX Single Zone	• Packaged rooftop air conditioner (PSZ-AC) serving single zone • Packaged rooftop heat pump (PSZ-HP) serving single zone

Item / Control	Description
Central DX Multi Zone	• Packaged rooftop Variable Air Volume (VAV) with reheat serving multi zones • Packaged rooftop Constant Volume (CV) with reheat serving multi zones
Chiller	• Water-cooled compressor • Air-cooled compressor
Year of Manufacture	Year of production/assembly from manufacturing specifications
# Pieces of Equipment	Total number of equipment pieces serving the whole building
Efficiency	Efficiency of the cooling system in *Coefficient of performance* (COP) is the ratio of the rate of heat removed to the rate of energy input, in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions. *Notes*: • If you have multiple instances of cooling equipment with different levels of performance, enter the efficiency for the equipment that serves major zones. • *Energy efficiency ratio* (EER) is the ratio of net cooling capacity in kWh to total rate of electric input in watts under designated operating conditions.
Capacity	Output capacity of the system/cooling equipment in tons

Heating Equipment

Item / Control	Description
Heating Type	Pull-down menu selections: **No Heating** or match your installed system to one of the systems listed below.
Single Zone Central Furnace	Furnace heats air, and heated air is distributed through the house using ducts. Select this if a furnace is serving one single thermal zone.

Item / Control	Description
Multi Zone Central Furnace	Furnace heats air, and heated air is distributed through the house using ducts. Select this if a furnace is serving multiple thermal zones.
Heat Pump	One or more factory-made assemblies that normally include an indoor conditioning coil, compressor(s), and an outdoor refrigerant-to-air coil or refrigerant-to-water heat exchanger. These units provide both heating and cooling functions.
Boiler	A closed vessel in which water or other fluid is heated. The heated liquid or steam is circulated to air handling units, reheat coils in VAV boxes, or radiators to heat the space.
Radiator	A heat distributing device in which hot water or steam generated by a boiler circulates through fins and tubes to transfer heat to the space by thermal radiation and convection
Space Heater	A variety of devices/appliances that are typically used to heat an enclosed area. Some of them heat air by means of hot-water coils and are used in conjunction with boilers. Some heat space by means of a fuel-fired heat exchanger and others fire directly into the heated space.
Year of Manufacture	Year of production/assembly from manufacturing specifications
# Pieces of Equipment	Total number of equipment pieces serving the whole building
Efficiency (%)	The percentage of the rate of heat delivered to the rate of energy input – If the equipment is a heat pump, then the COP of heating is the ratio of the rate of heat delivered to the rate of energy input. *Note*: If you have multiple instances of heating equipment with different levels of performance, enter the efficiency for the equipment that serves major zones.
Capacity	Output capacity of the system/heating equipment in kBtu/hr
Fuel Type	The type of fuel used for heating: **Gas**, **Electricity**, or **Oil**.

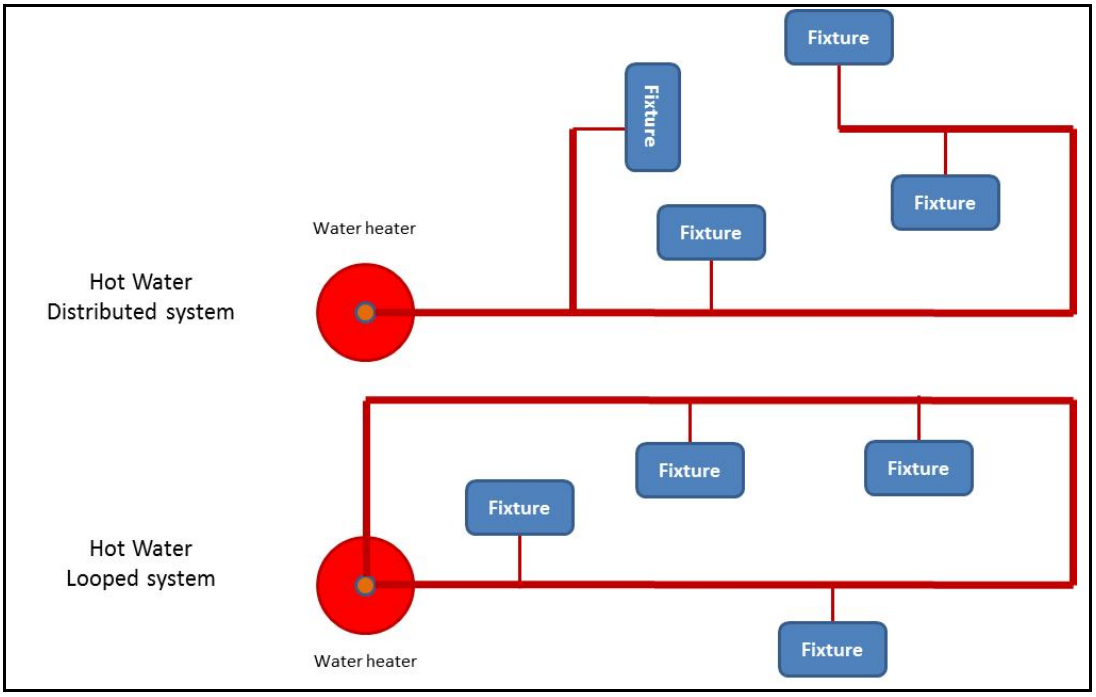
Ventilation

Item / Control	Description
Fan motor efficiency	*Motor efficiency* is the power delivered to the shaft divided by the electrical power input to the motor
Fan efficiency	*Fan efficiency* is the power delivered to the air divided by the shaft power (from EnergyPlus *Input Output Reference*).

Service Water Heating

Item / Control	Description
Fuel Type	The type of fuel used to heat water: **Gas**, **Electricity**, or **Oil**.
Distribution Type	Pull-down menu selections: **No Cooling** or match your installed system to one of the systems listed below.
Distributed	The hot water is distributed without being recirculated; i.e., in form of a trunk and branch distribution system arrangement. (See *Hot Water Distribution Types* figure.)
Looped	The hot water pipe is installed in a loop throughout the building, and hot water is constantly circulating through this loop by a circulation pump. In this distribution system the hot water reaches the valve in a fraction of a second. (See *Hot Water Distribution Types* figure.)
Water heater efficiency	Energy efficiency of storage, demand, and heat pump water heaters is determined by energy factor, which indicates the overall efficiency of the water heater and is based on the amount of hot water produced per unit of fuel consumed over a typical day. This includes recovery efficiency, standby losses, and cycling losses *Note*: The heater thermal efficiency is the thermal conversion efficiency from fuel energy to heat energy for the heater element or burner. This is not the same as the overall efficiency of the water heater
Tank volume	Volume of the storage tank in gallons
Tank insulation thickness	Thickness of insulating material used in units of inches
Tank insulation R-value	Measure of thermal resistance: the reciprocal of the time rate of heat flow through a unit area induced by a unit temperature difference between two defined surfaces of material or construction under steady-state conditions. *R-value* is in units of $ft^2 \cdot °F \cdot h/Btu$

Hot Water Distribution Types



Operation Conditions

As noted on the data input tab, the operation conditions entered on this tab do not affect the energy asset rating score, but they will be used to identify upgrade opportunities. If you leave fields blank, standard schedules and operating conditions will be used in the energy simulation. Standard operating conditions are derived from COMNET Appendix B Modeling Data[3] (Architectural Energy Corporation 2010). COMNET modeling data are consistent with the Performance Rating Method in Appendix G of ASHRAE Standard 90.1-2007. COMNET also establishes baselines for receptacle power density and refrigeration power density, which do not exist in ASHRAE 90.1 standard.

Item / Control	Description
Miscellaneous electric load	Electric loads resulting from electric devices not responsible for space heating, cooling, lighting, and water heating
Miscellaneous gas load	Gas loads resulting from gas devices not responsible for space heating and water heating
Total occupants	Total number of people in the building
Setpoint heating	Point at which the desired temperature of the heated space is set
Setpoint cooling	Point at which the desired temperature of the cooled space is set
Operating Hours	The period when the building is occupied and heating/cooling is required
Weekdays: Open and **Close**	Pull-down selection: time on the nearest half-hour
Weekends: Open and **Close**	Pull-down selection: time on the nearest half-hour

[3] Architectural Energy Corporation. 2010. *COMNET: Commercial Buildings Energy Modeling Guidelines and Procedures.* Commercial Energy Services Network. Architectural Energy Corporation, Boulder, Colorado. Available from http://www.comnet.org/sites/default/files/images/COMNET-MGP-2.pdf (March 2012).

Building Energy Modeling Methodology

The energy asset rating tool combines energy simulation with automated life-cycle-cost (LCC) analysis. The tool is built on an inference engine, an energy efficiency measure (EEM) finder, and an energy simulation engine:

- The inference and EEM functions are built upon the existing algorithm and database of Facility Energy Decision System (FEDS)[4].
- The energy simulation is run on the EnergyPlus[5] energy simulation program.

Energy Asset Rating – The resulting energy asset rating evaluates the physical characteristics of a building "as built" and its overall energy efficiency independent of its occupancy and operational choices. The energy model takes into account the building envelope, the mechanical and electrical systems, and other major energy-using equipment that are built into the building. The energy asset rating tool will identify potential cost-effective opportunities for efficiency improvements and note what impact those opportunities might have on the potential asset ratings score of a building.

Life-Cycle-Cost Analysis – The LCC analysis uses the federally mandated LCC methodology, as specified in 10 CFR Part 436, to combine the retrofit capital cost, operations and management (O&M) cost changes, and changes in the energy costs to determine the cost effectiveness of potential retrofits. NIST (National Institute of Standards and Technology) building LCC analysis algorithms are used to rank EEMs. All interactive effects between energy systems are explicitly modeled. Regional energy and equipment costs are used. Energy costs are based on COMNET default time-of-use (TOU) prices. Materials and labor costs are adjusted for state-level differences.

Energy Efficiency Measure – The estimate of energy costs and savings CANNOT be compared directly with the utility bills for a building because the energy model is based on the assumptions that the building is fully occupied, operated for a certain number of hours per week (typical operating hours for the building type), and has standard miscellaneous loads—for example, numbers of computers and vending machines. Users can override standard assumptions to generate a customized EEM package. This customized EEM package will be modeled under standard assumptions again to calculate the potential energy asset rating after upgrades.

[4] PNNL. 2008. *Facility Energy Decision System User's Guide* (Release 6.0). PNNL-17848, Pacific Northwest National Laboratory, Richland, Washington.

[5] http://apps1.eere.energy.gov/buildings/energyplus/

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