



LEED and ASHRAE 90.1 2007 and 2010 App G PRM - User Guide

DesignBuilder v6.1



March 2019

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1. Introduction to DesignBuilder LEED

The DesignBuilder LEED modelling tool largely automates the baseline building creation from the proposed building and helps you to provide documentation for LEED credits EAp2 and EAc1. The assessment is based on the ASHRAE 90.1 Standard Appendix G Performance Rating Method (App G PRM).

As DesignBuilder only currently uses ASHRAE 90.1 App G PRM for LEED models, unless otherwise stated, the terms ASHRAE 90.1 App G PRM (or in short App G PRM) or simply ASHRAE 90.1 mean the same in this document.

This LEED Modelling Guide generally focuses only on LEED-specific functionality. It is assumed that the modeller has sufficient experience and knowledge of DesignBuilder regarding creation of the actual (Proposed) building model, which is typically created prior to the baseline building. More general (non-LEED specific) DesignBuilder information can be accessed from the [DesignBuilder Help](#) system.

The DesignBuilder App G PRM modelling tool is tightly integrated into the EnergyPlus modelling environment in the software. An App G PRM model looks very much like a standard DesignBuilder EnergyPlus model, but it includes various extra functionality that specifically meet ASHRAE 90.1 App G PRM requirements.

To use DesignBuilder LEED you will need the following licence modules:

- LEED
- Simulation,
- HVAC and
- Cost (for utility tariff).

These can be purchased most conveniently and cost-effectively through the [Engineering Essentials](#) package.

By following ASHRAE 90.1 App G PRM definitions, the DesignBuilder LEED tool generates data for LEED EAc1 and earns points based on energy cost saving from the proposed building over the baseline building. The baseline building can be automatically generated from the proposed building using two simple wizards.

2. Why DesignBuilder LEED?

The DesignBuilder LEED modelling tool is based on the following:

- LEED approved EnergyPlus simulation engine (refer to Clause G2.2 Simulation Program in ASHRAE 90.1 Standard 2007).
- The tool meets the Appendix G Performance Rating Method requirements of the ASHRAE 90.1 2007 and 2010 standards.
- A wide range of pre-configured templates and libraries to speed up model definition.
- To automate the baseline building generation the proposed model should be created first. The baseline building can be created first if required, but this is not the recommended workflow.
- DesignBuilder LEED includes two separate wizards. One baseline building wizard that deals with geometry and other non-HVAC related data, and a baseline HVAC wizard that sets up the HVAC system. Some further manual checks and changes to the baseline HVAC system are usually required.
- The proposed and baseline building models are stored and manipulated in a single project file, which provides an easy data check and more secure model quality.
- In cases where four rotated baseline building simulations are required, they are run simultaneously in parallel using DesignBuilder's Simulation Manager to speed up the simulations.
- DesignBuilder provides an output comparing proposed and aggregated baseline building results.

- A link to the LEPORT online post processing tools is provided to speed up the generation of LEED submission documentation.

3. DesignBuilder LEED Workflow

Figure 1 illustrates the workflow of a DesignBuilder LEED modelling project.

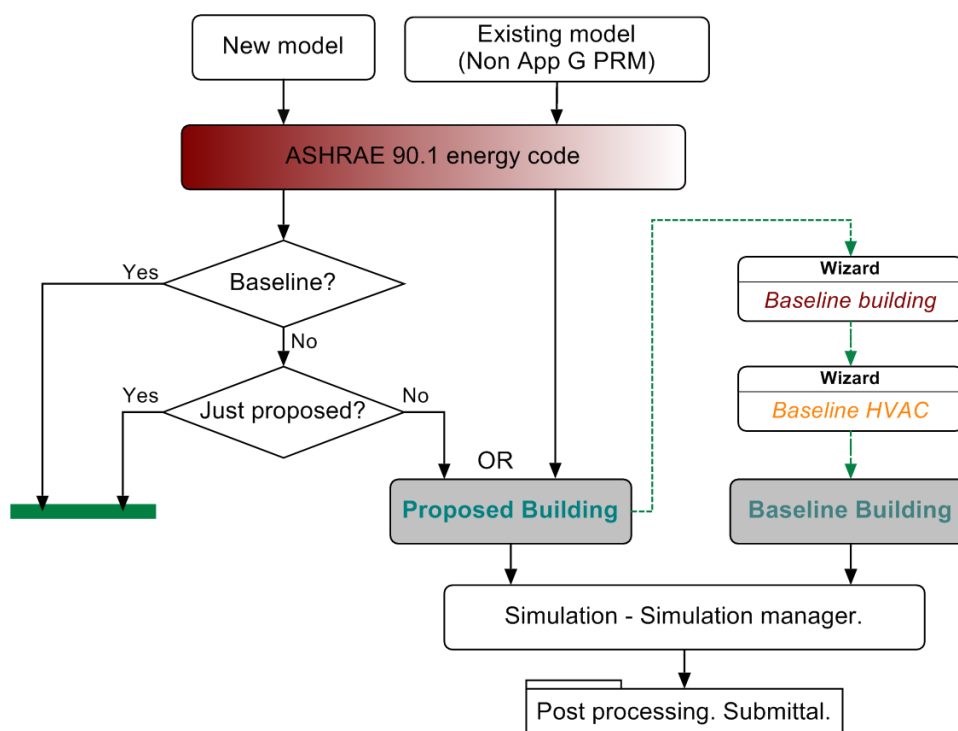


Figure 1 DesignBuilder LEED module structure and flowchart

The usual workflow is to create the proposed building model first and then automatically create the corresponding baseline model from that. In this case the two models are contained in the same dsb file. However, for cases where, for any reason, it is more convenient to use separate files for the two models DesignBuilder's LEED tool allows this. Figure 1 also shows that proposed building can be created either from scratch or converted from a non-ASHRAE 90.1 model.

This document describes the step by step process of modelling a full LEED project from proposed to baseline model within the same dsb file. It does not cover the process used for modelling baseline and proposed building in separate files.

4. Create a LEED Project – Proposed Building

A new LEED project will typically be created via the “New file” command.

Alternatively, if you already have a model that you wish to convert to a LEED model, you can change the energy code for the model by editing data at site level. DesignBuilder currently supports the “ASHRAE 90.1-2007” and “ASHRAE 90.1-2010” codes and the appropriate selection can be made in an existing model by changing the “Mandatory energy code” on the “Region” tab at site level (Figure 2). Selecting either “ASHRAE 90.1-2007” and “ASHRAE 90.1-2010” enables the model to be an ASHRAE 90.1 App G PRM model, and enables the additional LEED functionality described in this document.



Figure 2 ASHRAE 90.1 energy code to enable App G PRM model functionality

4.1 Units and Currency (Program Options)

Prior to starting the LEED model it is best to ensure the correct Program options are correctly set for your region. You can select either IP (imperial) or SI (metric) units and a wide range of common currencies including US dollars. Although units and currency can be changed at any time during any modelling process prior to simulations, DesignBuilder recommends making the appropriate selections in Program options before creating the model. To do this, use the Tools -> Program Options top menu option and choose the [International tab](#) (Figure 3).

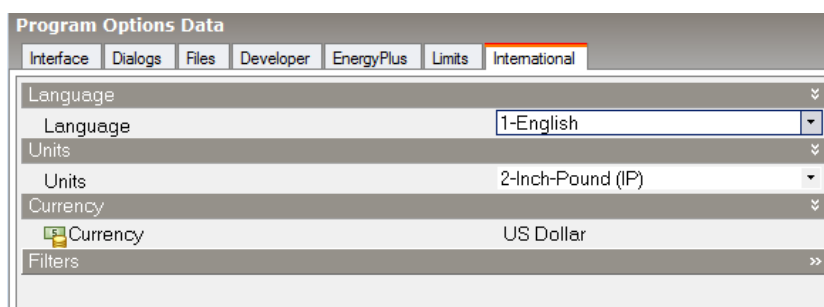


Figure 3 Options for choosing Units and currency (as well as interface language)

4.2 Proposed model setup for a new project

In the “New file” dialog input the Title and set the weather location. Retain the “Analysis type” as “1-EnergyPlus” (this is a mandatory requirement for LEED in DesignBuilder) and select either the ASHRAE 90.1-2007 or ASHRAE 90.1-2010 standards (highlighted in Figure 4).

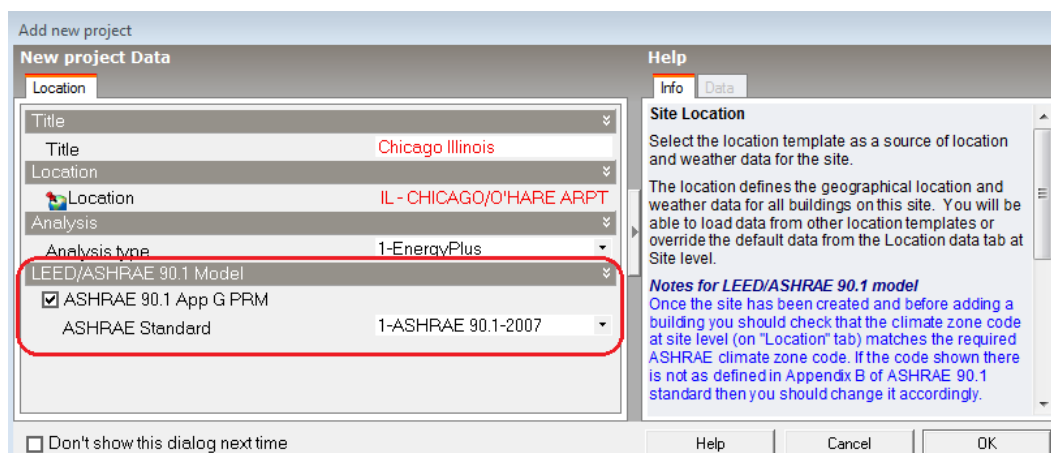


Figure 4 Add new LEED project

4.2.1 Location and ASHRAE climate zone

After a new project has been created, it is always possible to check or change the location, weather file, ASHRAE climate zone etc at site level on the “Location” tab (Figure 5).

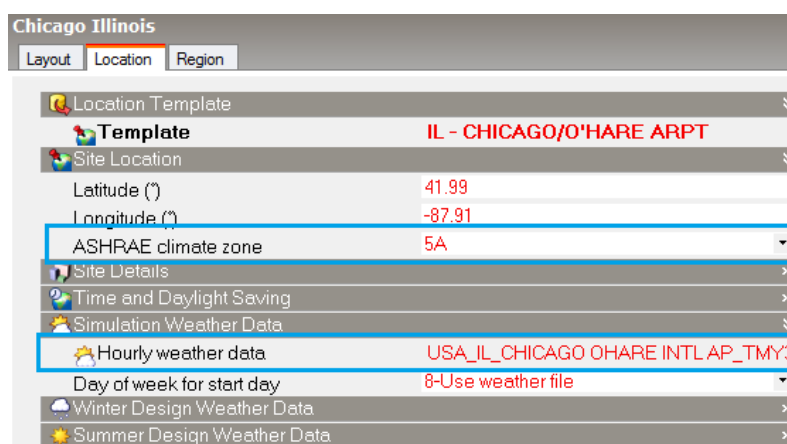


Figure 5 ASHRAE climate zone and simulation weather file

The climate zone setting in the model will affect the constructions and glazing selected when the baseline building is created using the baseline building wizard. It can also affect the selection of details in the baseline HVAC system. The ASHRAE climate zone shown on the interface is preloaded from the location template (Figure 6).

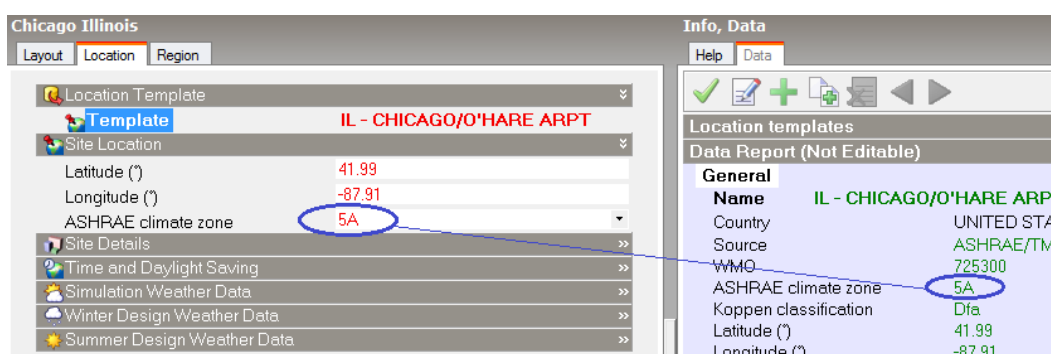


Figure 6 ASHRAE climate zone is preloaded from location template

In the unlikely event that the selected climate zone does not correspond with the climate zone specified by ASHRAE for the location, it should be changed manually. When making a change using the dropdown list, a message will alert the user of this change together with relevant baseline construction and glazing changes (Figure 7).

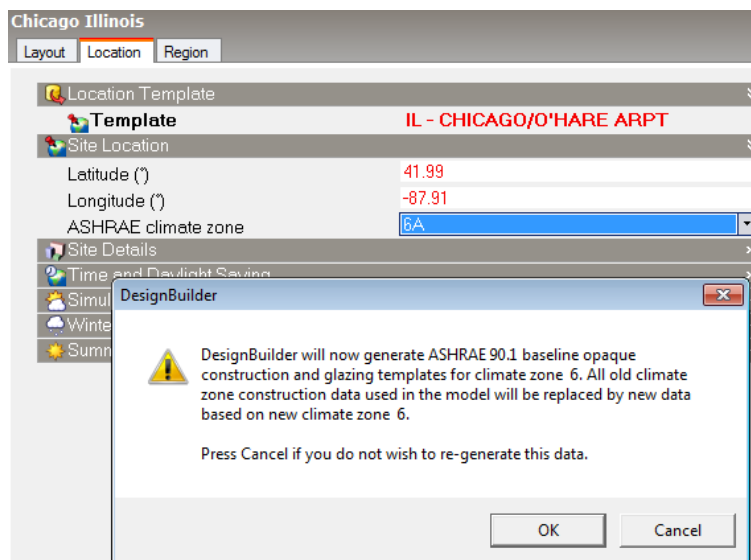


Figure 7 A confirmation message is shown when overriding the default climate zone

4.2.2 Add new building

A building can then be added into the empty project (site) using the “Add new building” command (Figure 8).

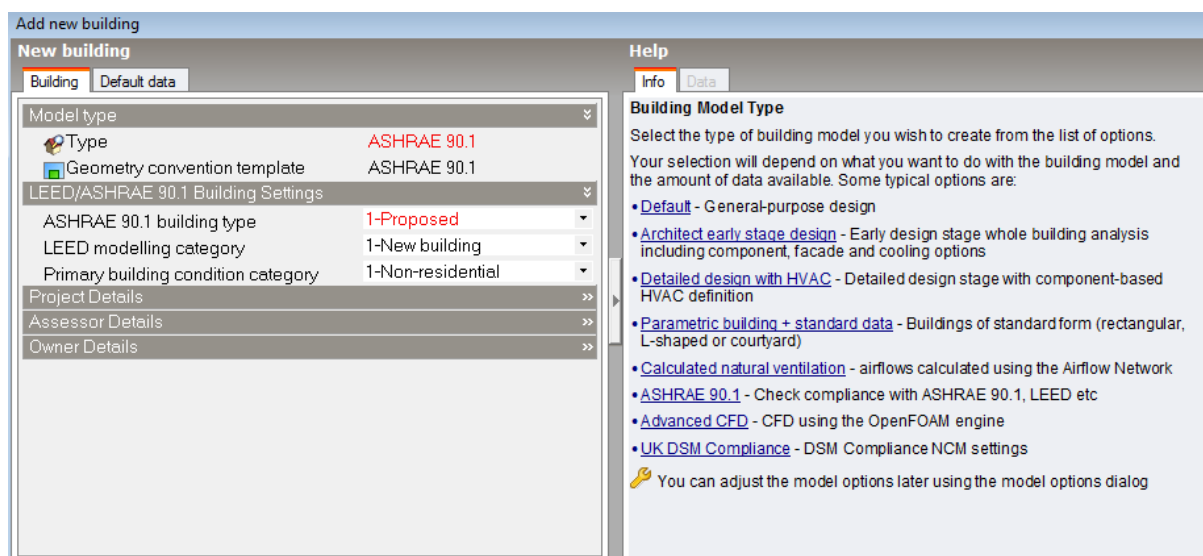


Figure 8 Add new building dialog

Although a baseline building could be modelled first, DesignBuilder recommends creating the proposed building first and then using the built-in wizards to generate the baseline building. This offers a much faster and more automated approach than manually creating the baseline model.

If the baseline building is created first, both baseline and proposed building models must be modelled manually, but this guide does not cover that workflow.

4.2.3 Model option - type

When the “Type” option under the “Model type” header is set to ASHRAE 90.1 there will be additional ASHRAE 90.1 model inputs visible. The “LEED/ASHRAE 90.1 Building Settings” options can be changed here or on the “Activity” tab later.

When the “ASHRAE 90.1” type is set DesignBuilder will load some appropriate model data settings such as detailed HVAC (a mandatory requirement for App G PRM models in DesignBuilder) and 6 time steps per hour for simulating the proposed and baseline building models.

4.2.4 Model option - Geometry convention

It is important for ASHRAE 90.1 App G PRM based-work that the proposed and baseline buildings have appropriately similar floor areas and zone volumes. The easiest way to ensure this is to use the “ASHRAE 90.1” geometry convention for both buildings (see Figure 9). Using this template the block geometry is drawn to the outside face of the external walls giving the correct surface geometry and zone volumes for the simulation according to ASHRAE 90.1. This convention also “disconnects” the construction data from the building geometry so that the baseline building zone geometry will be correct even after loading the baseline constructions, which will often have a different thickness.

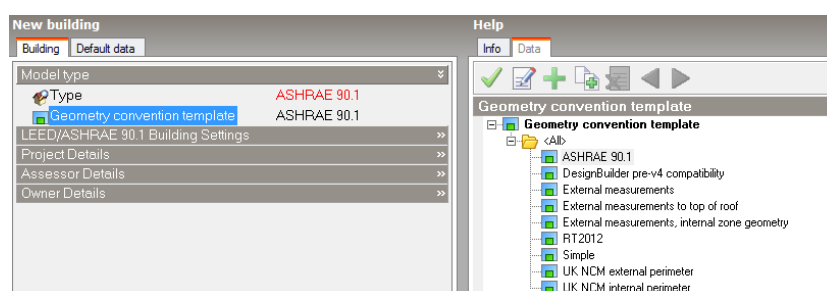


Figure 9 Use the ASHRAE 90.1 Geometry convention template

If you chose to use the “External measurements” template for example you will find that the baseline building surface areas, floor area and zone volumes are different after loading the baseline constructions because these generally have a different thickness to those selected for the proposed building. If you choose to use a geometry convention other than “ASHRAE 90.1” please refer to the Geometry conventions information in the Program Help and ensure you fully understand the implications of any alternative setting.

4.3 Modelling data

There is a library of pre-created ASHRAE 90.1 model data and schedules to choose from in DesignBuilder database. Schedules are capable of representing variations in occupancy, lighting power, miscellaneous equipment power, thermostat setpoints and HVAC system operations. These schedules should generally be the same for the proposed building and baseline buildings. As the ASHRAE 90.1 standard indicates, the schedules shall be typical of the proposed building type as determined by the designer and approved by the rating authority.

4.3.1 ASHRAE Activity Template

The ASHRAE 62.1 activity templates in DesignBuilder are appropriate for use in App G PRM modelling based on the building type or space type of the model. Typically, they use ASHRAE 62.1 occupancy densities, ASHRAE 62.1 outdoor fresh air rates and schedules from ASHRAE 90.1 User’s manual (Table G-E through Table G-O in 2007 user’s manual). A screenshot of some ASHRAE 62.1 activity templates in DesignBuilder is shown in Figure 10.

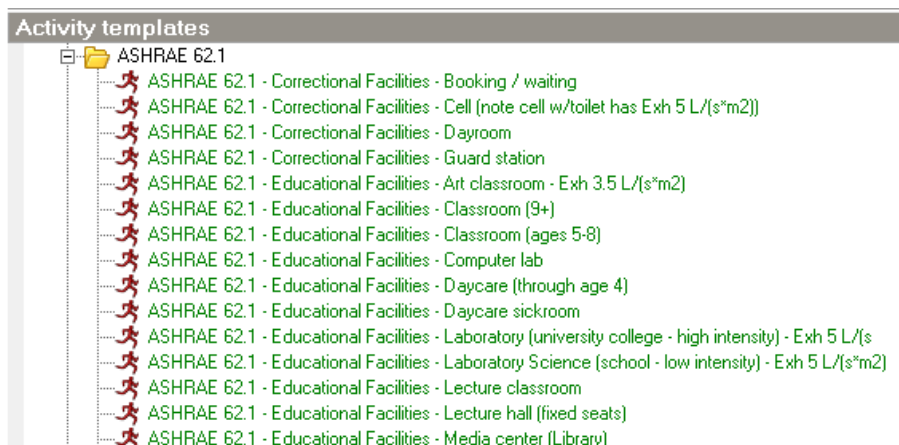


Figure 10 ASHRAE 62.1 activity templates ready for App G PRM use

4.3.2 ASHRAE 90.1 “Activity” tab settings

When the ASHRAE 90.1 model type is selected you will see additional “Activity” tab inputs specifically related to an ASHRAE 90.1 App G PRM model. Items shown on the “Activity” tab will differ according to the level the model is viewed at.

4.3.2.1 ASHRAE 90.1 Activity tab settings at Building Level

At the building level, the Activity tab shows the relevant ASHRAE 90.1 settings including the ASHRAE 90.1 building type, primary building condition category, heating source, ASHRAE 90.1 lighting category and ASHRAE 90.1 floor definition (Figure 11).

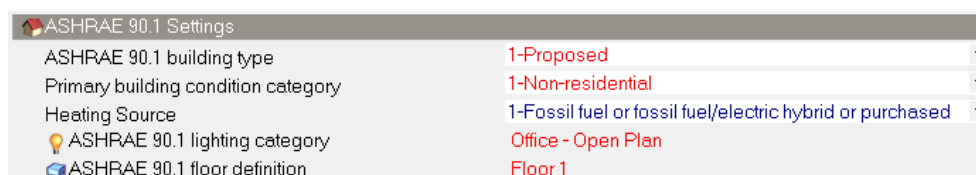


Figure 11 ASHRAE 90.1 settings at building level

The “ASHRAE 90.1 building type” defines whether the building is 1-Proposed or 2-Baseline. DesignBuilder does not recommend swapping ASHRAE 90.1 building type unless you understand the risk and there is a need to do so.

The “Primary building condition category” can be either 1-Non-residential or 2-Residential, which is used to define primary building use. This is especially useful when modelling mixed use buildings because it controls constructions, HVAC selections etc according to its condition category.

The “Heating source” defines the building’s heating use as either electric or fossil fuel. This will affect the baseline model HVAC system selection (Table G3.1.1A and Table G3.1.1B in ASHRAE 90.1 Standard).

The ASHRAE 90.1 lighting category and ASHRAE 90.1 floor definition input will be discussed in more detail below.

4.3.2.2 ASHRAE 90.1 settings on Activity tab at block and zone levels

The ASHRAE 90.1 lighting category and ASHRAE 90.1 floor definition input remains available at block and zone levels.

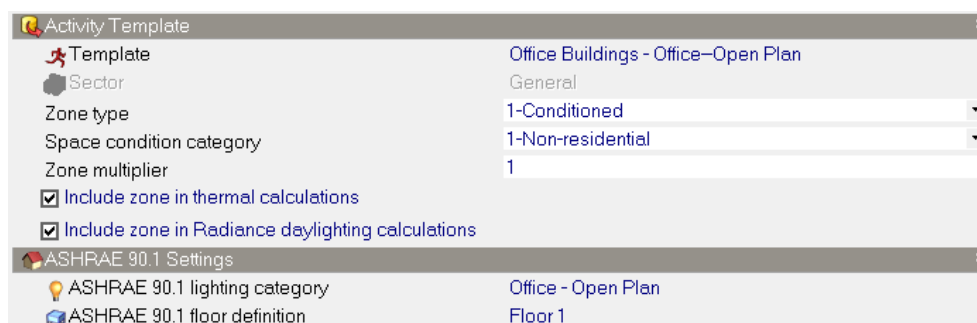


Figure 12 ASHRAE 90.1 settings at zone level

Additional inputs at block/zone levels define whether the current zone is conditioned, unconditioned or semi-heated (Figure 12). If the zone is conditioned, the space condition category must also be entered.

The non-residential or residential category denotes whether or not the zone falls under the building level primary building condition category. If it is the same at both zone and building level, the zone will fall into the primary condition category, otherwise the zone will fall into the non-predominant condition category.

4.3.2.3 ASHRAE 90.1 Lighting Category

The “ASHRAE 90.1 lighting category” reflects ASHRAE 90.1 Standard Table 9.6.1 (Figure 13), which affects lighting settings especially lighting power density (LPD) after the baseline building is created using DesignBuilder baseline building wizard.

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method

Common Space Types ^a	LPD, W/ft ²	Building-Specific Space Types	LPD, W/ft ²
Office—Enclosed	1.1	Gymnasium/Exercise Center	
Office—Open Plan	1.1	Playing Area	1.4
Conference/Meeting/Multipurpose	1.3	Exercise Area	0.9
Classroom/Lecture/Training	1.4	Courthouse/Police Station/Penitentiary	
For Penitentiary	1.3	Courtroom	1.9
Lobby	1.3	Confinement Cells	0.9
For Hotel	1.1	Judges’ Chambers	1.3
For Performing Arts Theater	3.3	Fire Stations	
For Motion Picture Theater	1.1	Engine Room	0.8
Audience/Seating Area	0.9	Sleeping Quarters	0.3
For Gymnasium	0.4	Post Office—Sorting Area	1.2
For Exercise Center	0.3	Convention Center—Exhibit Space	1.3
For Convention Center	0.7	Library	
For Penitentiary	0.7	Card File and Cataloging	1.1
For Religious Buildings	1.7	Stacks	1.7

Figure 13 Lighting power densities using space-by-space method in ASHRAE 90.1-2007 (IP Edition)

Users must ensure that the correct “ASHRAE 90.1 lighting category” is selected (Figure 14). If you are not able to find a perfectly matching record in the list, you could choose one that is closest to your application. This field will affect the baseline building lighting settings, especially LPD (lighting power density), which are specified in ASHRAE 90.1 Standard (Figure 13).

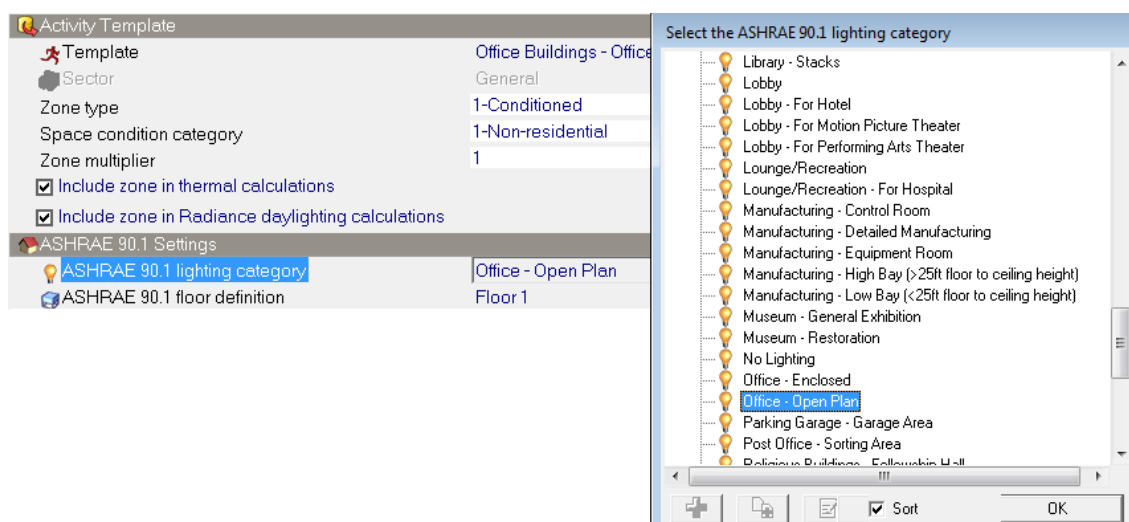


Figure 14 ASHRAE 90.1 lighting category in DesignBuilder

4.3.2.4 ASHRAE 90.1 floor definition

This gives an option for user defined floors to be included. The number of floors of the building affects baseline HVAC system selection and this definition is not always obvious, so it can be necessary for users to enter floors in accordance with project design document to override the number of floors automatically estimated by DesignBuilder.

The ASHRAE 90.1 floors will be used in baseline HVAC wizard discussed later.

4.3.3 Equipment loads

DesignBuilder breaks down the equipment load inputs into different categories, i.e. computers, office equipment, miscellaneous, catering and process.

Computers and office equipment always use electricity as fuel source, hence there is not a fuel type to choose from and subsequently there is not an end-use subcategory applied. They require input of just gain density and associated operational schedule (Figure 15).

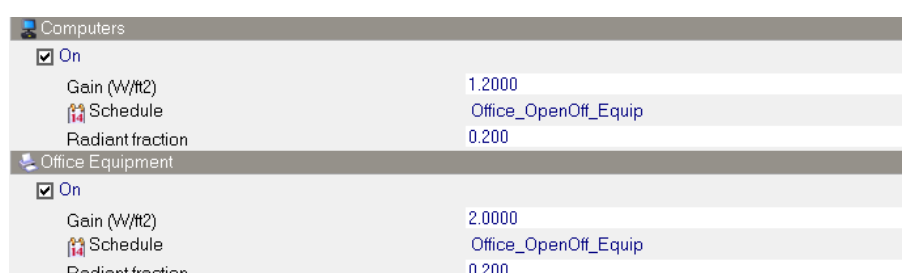
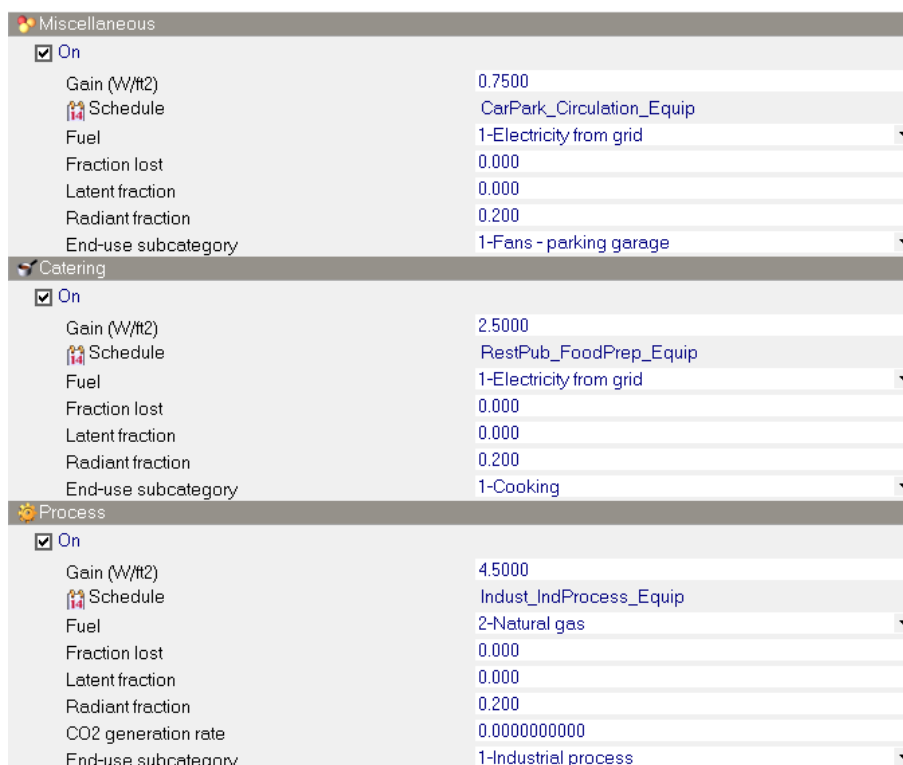


Figure 15 Computers and office equipment loads input on Activity tab

Miscellaneous, Catering and Process gains allow “Fans – Parking garage” and “Elevators and escalators” (under Miscellaneous load definition), “Cooking” (under Catering load definition) and “Industrial process” (under Process load definition) to define the end-use subcategory (Figure 16) for the input. These loads are reported in the LEED summary report after the simulation.



Category	Gain (W/ft2)	Schedule	Fuel	Fraction lost	Latent fraction	Radiant fraction	End-use subcategory
Miscellaneous	0.7500	CarPark_Circulation_Equip	1-Electricity from grid	0.000	0.000	0.200	1-Fans - parking garage
Catering	2.5000	RestPub_FoodPrep_Equip	1-Electricity from grid	0.000	0.000	0.200	1-Cooking
Process	4.5000	Indust_IndProcess_Equip	2-Natural gas	0.000	0.000	0.200	1-Industrial process

Figure 16 Other LEED required loads input on Activity tab

4.3.4 Opaque and Glazed constructions

Constructions and glazing should be modelled as shown on architectural drawings or as built for existing building envelopes. Local shading and window shading can be defined on the Openings tab.

When a site is created or when the climate zone is changed, the appropriate corresponding baseline construction and glazing templates are generated in DesignBuilder so that they can be assigned to the model when the baseline building is created. The ASHRAE 90.1 templates in the model could be copied and edited for use in the proposed building where appropriate.

4.3.4.1 Layer based constructions

DesignBuilder constructions are comprised of material layers (Figure 17) as required by EnergyPlus.

Constructions Data

Layers | Surface properties | Image | Calculated | Cost | Internal source | Condensation analysis

General

Name: Project wall

Source: [Empty]

Category: Walls

Region: New York

Definition

Definition method: 1-Layers

Calculation Settings

Layers

Number of layers: 4

Outermost layer

Material: Brickwork, Outer Leaf

Thickness (m): 0.1000

☐ Bridged?

Layer 2

Material: XPS Extruded Polystyrene - CO2 Blow

Thickness (m): 0.0795

☐ Bridged?

Layer 3

Material: Concrete Block (Medium)

Thickness (m): 0.1000

☐ Bridged?

Innermost layer

Material: Gypsum Plastering

Thickness (m): 0.0130

☐ Bridged?

Figure 17 Opaque construction built up by layers

A list of baseline wall constructions for climate zone 5 (CZ5) is shown in Figure 18 as an example.

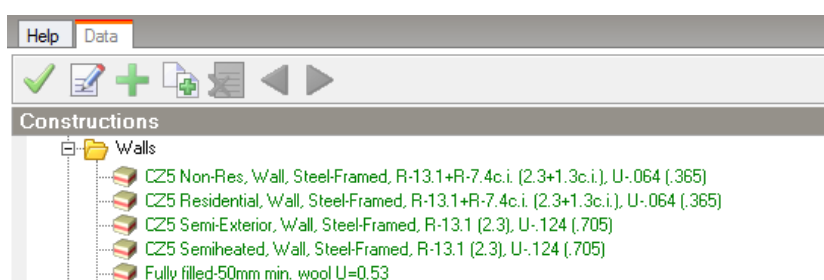


Figure 18 Baseline wall constructions

The terminology used in the ASHRAE 90.1 constructions list gives the climate zone, a description of the construction, insulated level(s) in IP units and the U-value in IP units and in brackets the values in SI units. For example construction

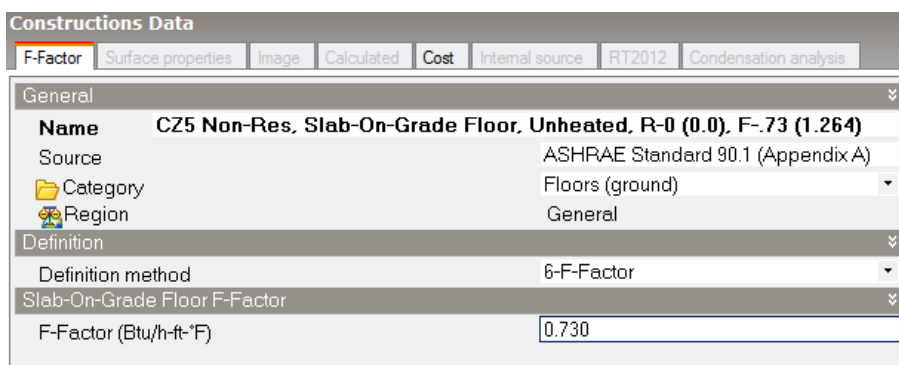
“CZ4 Non-Res, Wall, Steel-Framed, R-13.1+R-7.4 (2.3+1.3), U-.064 (.365)”

indicates a non-residential steel framed wall for climate zone 4 (CZ4) with internal insulation levels of two layers of minimum 13.1 and 7.4 ft²·°F/(Btu/hr) in IP units (2.3 and 1.3 m²·K/W in SI units) and a U-value of 0.064 Btu/hr·ft²·°F in IP units (0.365 W/m²·K in SI units).

4.3.4.2 F-factor and C-factor constructions

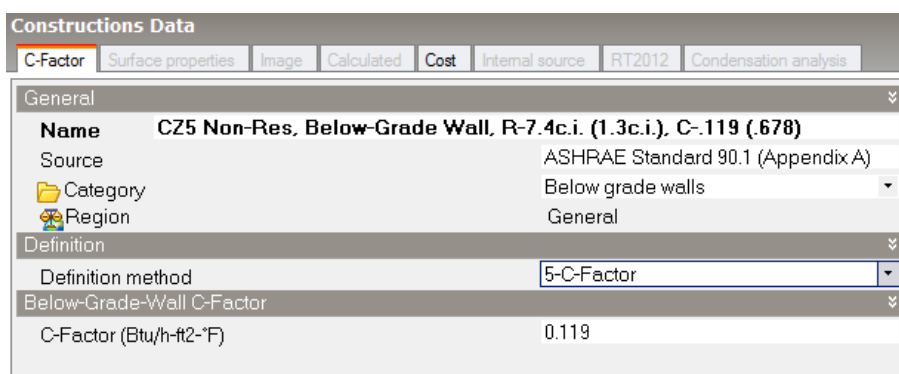
The ASHRAE 90.1 Standard requires two special opaque construction types: F-factor slab on grade ground floors (Figure 19), and C-factor below-grade walls (Figure 20). These differ from conventional layered constructions as they do not use layers of materials but instead the overall thermal properties are defined as an F-factor (for slab

on grade floors) or a C-factor (for below grade walls). EnergyPlus uses these factors to generate equivalent layered constructions. During the simulation these surfaces exchange heat with the FCFactor ground temperatures only (Figure 21).



Constructions Data	
F-Factor Surface properties Image Calculated Cost Internal source RT2012 Condensation analysis	
General	
Name	CZ5 Non-Res. Slab-On-Grade Floor, Unheated, R-0 (0.0), F-.73 (1.264)
Source	ASHRAE Standard 90.1 (Appendix A)
Category	Floors (ground)
Region	General
Definition	
Definition method	6-F-Factor
Slab-On-Grade Floor F-Factor	
F-Factor (Btu/h-ft²-F)	0.730

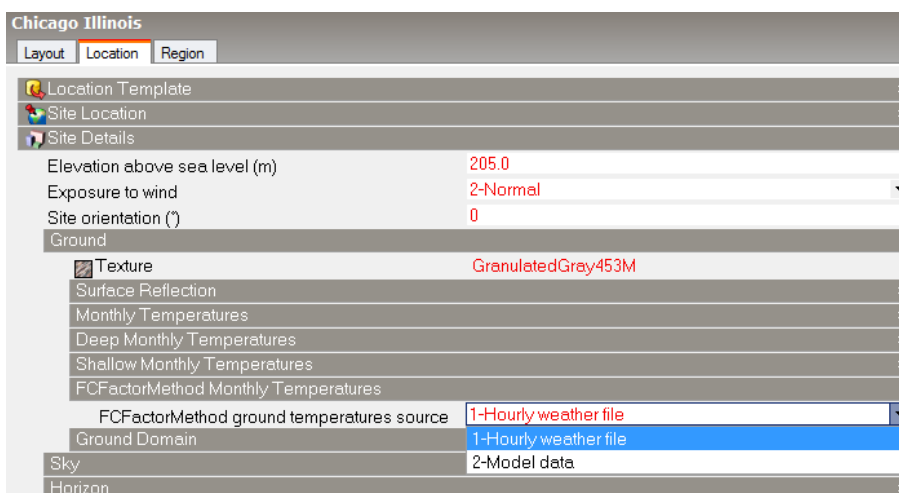
Figure 19 Slab on grade F-factor construction



Constructions Data	
C-Factor Surface properties Image Calculated Cost Internal source RT2012 Condensation analysis	
General	
Name	CZ5 Non-Res. Below-Grade Wall, R-7.4c.i. (1.3c.i.), C-.119 (.678)
Source	ASHRAE Standard 90.1 (Appendix A)
Category	Below grade walls
Region	General
Definition	
Definition method	5-C-Factor
Below-Grade-Wall C-Factor	
C-Factor (Btu/h-ft²-F)	0.119

Figure 20 Below grade wall C-factor construction

When running Heating or Cooling design calculations, if the “FCFactorMethod ground temperatures source data” at site level has “1-Hourly weather file” selected, the calculations will use the undisturbed ground temperature data contained within the weather file. This will be automatically downloaded (if not yet in your weather file folder on your computer) prior to the calculations. If “2-Model data” is selected, the Heating and Cooling design calculations do not require the weather file (Figure 21).



Chicago Illinois	
Layout Location Region	
Location Template	
Site Location	
Site Details	
Elevation above sea level (m)	205.0
Exposure to wind	2-Normal
Site orientation (°)	0
Ground	
Texture	GranulatedGray453M
Surface Reflection	
Monthly Temperatures	
Deep Monthly Temperatures	
Shallow Monthly Temperatures	
FCFactorMethod Monthly Temperatures	
FCFactorMethod ground temperatures source	1-Hourly weather file
Ground Domain	1-Hourly weather file
Sky	2-Model data
Horizon	

Figure 21 FCFactorMethod ground temperature source at site level

4.3.4.3 Glazing constructions

Likewise, the baseline glazing constructions (skylight for example) are stored in DesignBuilder's glazing database (Figure 22) ready for assigning in the model.

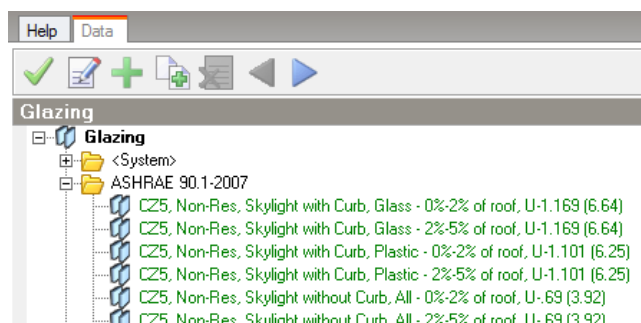


Figure 22 Baseline glazing constructions

4.3.5 Lighting

Lighting including lighting power density (LPD) should be input from the actual lighting or as designed for each zone (Figure 23).

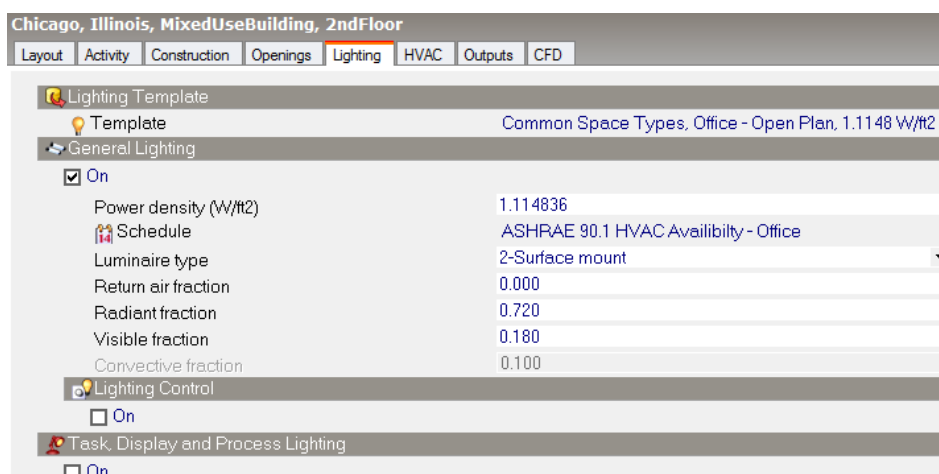


Figure 23 Lighting settings

For modelling the proposed building, DesignBuilder provides a set of predefined lighting templates (these are the ones used in the baseline building when it is generated) that can be used directly or copied and edited as required (Figure 24).

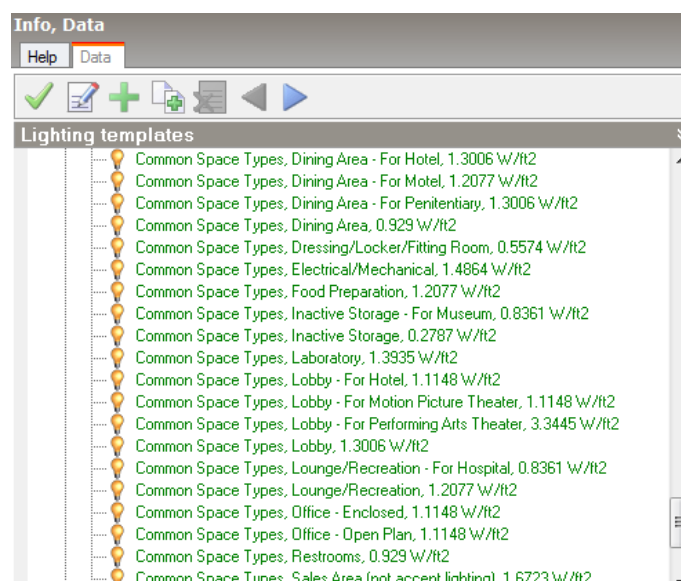


Figure 24 Predefined ASHRAE 90.1 lighting templates

Table G3.1-6 in ASHRAE 90.1 Standard indicates that credit may be taken for the use of automatic controls for daylight utilization. In DesignBuilder, the automatic daylight control can be modelled in the proposed building using the lighting control settings (Figure 25).

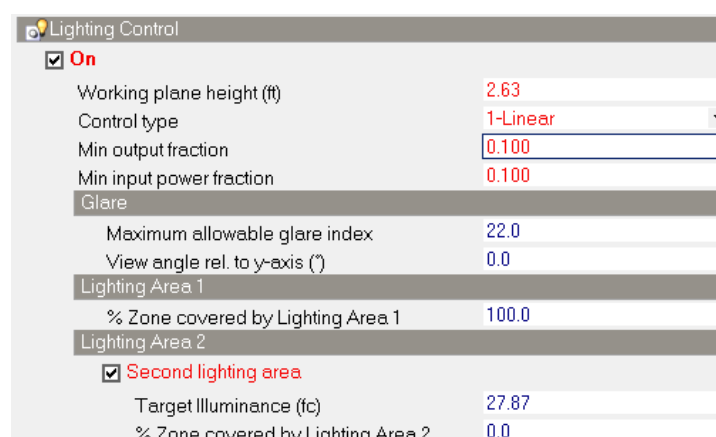


Figure 25 Automatic lighting control settings

The exterior lighting load is a simple input (total load) modified by a schedule and daylight override on the “Lighting” tab (Figure 26). This input is available at building level only.

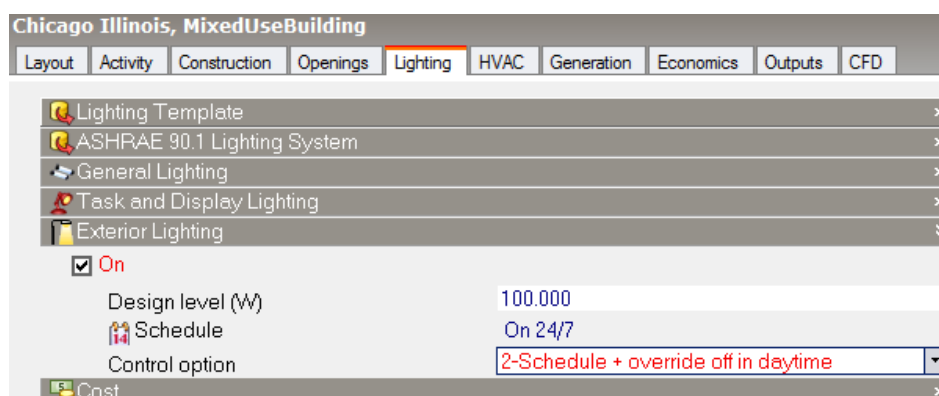


Figure 26 Exterior lighting input

4.3.6 Costs - Utility rates/Tariffs input

The “Economics” tab is available at building level only. Note that it is only visible when detailed HVAC is selected. It enables the model to use utility rates (tariffs) for calculating operational energy costs in electricity, gas or other energy sources (Figure 27). Up to 5 tariffs can be loaded into one building model.

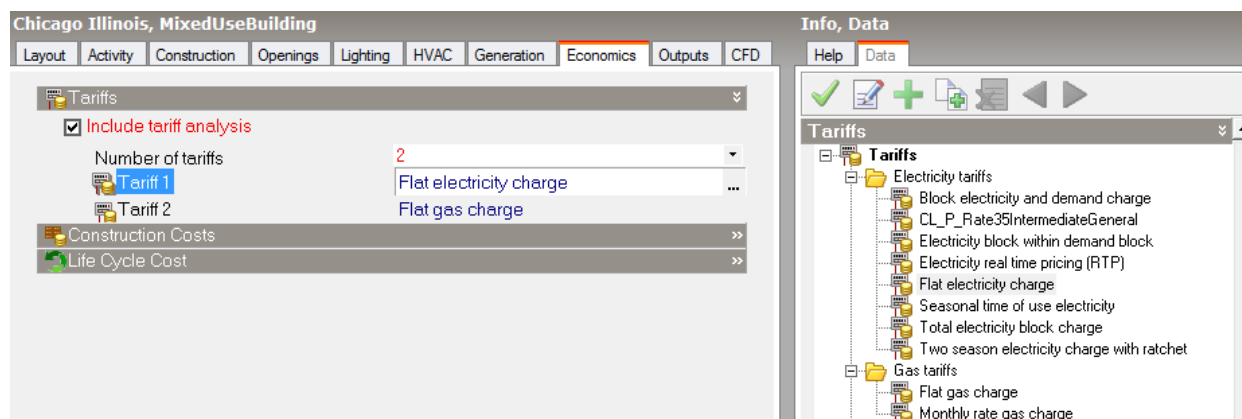


Figure 27 Utility rates (tariffs) input from Economics tab

As a minimum, data on the Tariff tab (Figure 28) and Charge tab (Figure 29) should be set up for utility cost calculations to work. On the Tariff tab, users need to input general tariff settings, such as the output meter used, schedules for defining seasonal or time of day charges, monthly service charge and minimum monthly charge etc.

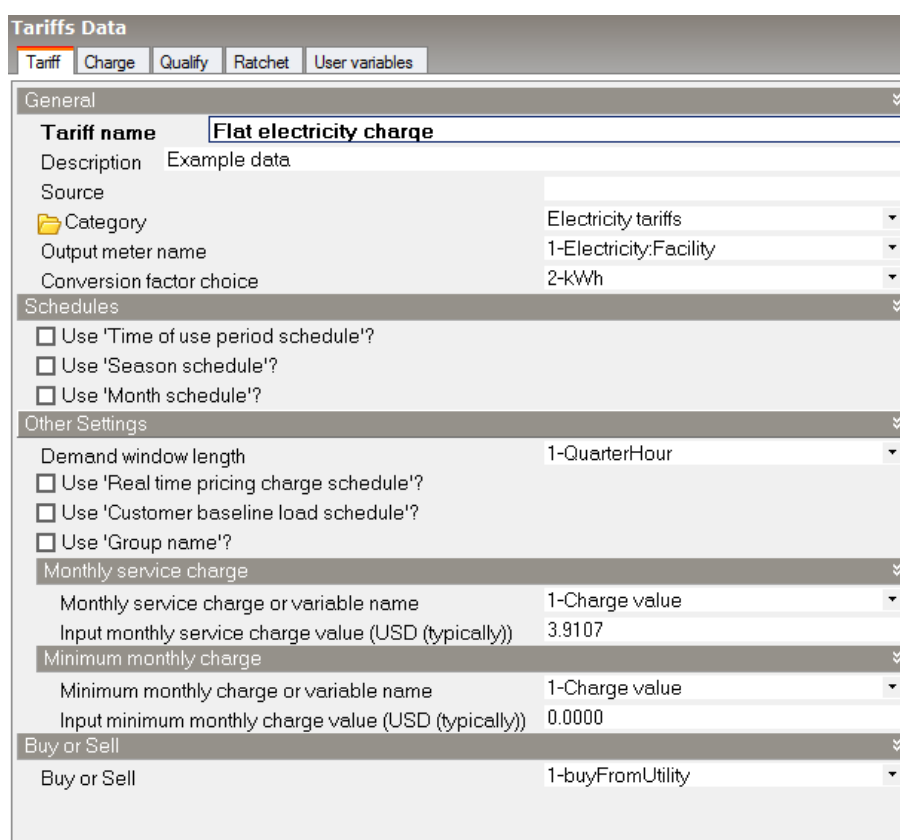
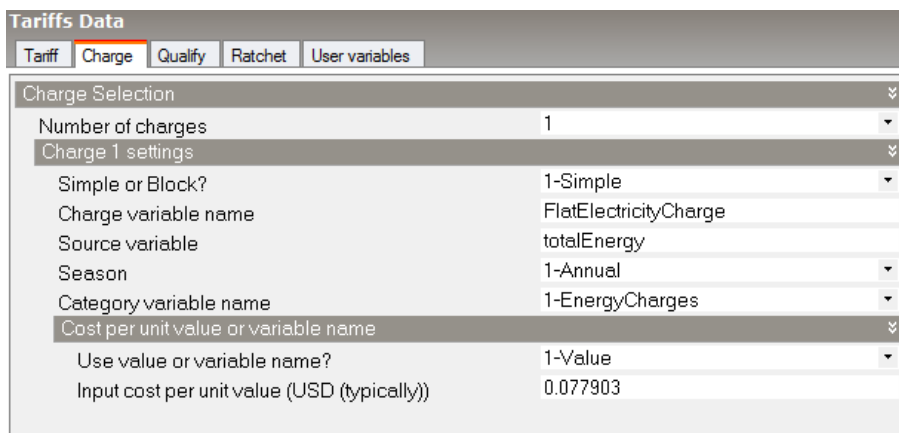


Figure 28 Tariff tab data input

The charge tab provides options to input simple or complex charges from the utility company. A maximum of 10 charges can be input as a combination of either the simple charge format or the block charge format, which

provides more complex charge patterns. The charge can apply on both energy and demand readings depending on the source variable to be used.



Tariffs Data	
Tariff Charge Qualify Ratchet User variables	
Charge Selection	
Number of charges	1
Charge 1 settings	
Simple or Block?	1-Simple
Charge variable name	FlatElectricityCharge
Source variable	totalEnergy
Season	1-Annual
Category variable name	1-EnergyCharges
Cost per unit value or variable name	
Use value or variable name?	1-Value
Input cost per unit value (USD (typically))	0.077903

Figure 29 Charge tab data input

ASHRAE 90.1 indicates that annual energy costs shall be determined using either actual rates for purchased energy or state average energy prices published by DOE's Energy Information Administration (EIA) for commercial building customers. However rates from different sources may not be mixed in the same project.

4.4 Detailed HVAC system

The HVAC system type and all related performance parameters in the proposed design, such as equipment capacities and efficiencies shall reflect the actual system type using actual component capacities and efficiencies where a complete HVAC system exists. For the system under design, the HVAC system shall be consistent with design documents. The ASHRAE 90.1 Standard section 6.4.1 defines the adjustment on equipment efficiencies from actual design conditions to the standard rating conditions.

4.4.1 Using HVAC templates or add loop/components tools

DesignBuilder's Detailed HVAC model option must be selected for LEED modelling to enable the HVAC requirements specified by ASHRAE 90.1 to be reflected in the model. DesignBuilder has a large range of pre-defined common HVAC system templates which can be used as a starting point for the proposed building model (Figure 30).

For example, a graphical layout of a "VAV Reheat, Water-cooled Chiller" system is illustrated in Figure 31, which includes a chilled water loop, a condenser loop a hot water loop, and an air loop that contains an air handling unit (AHU).

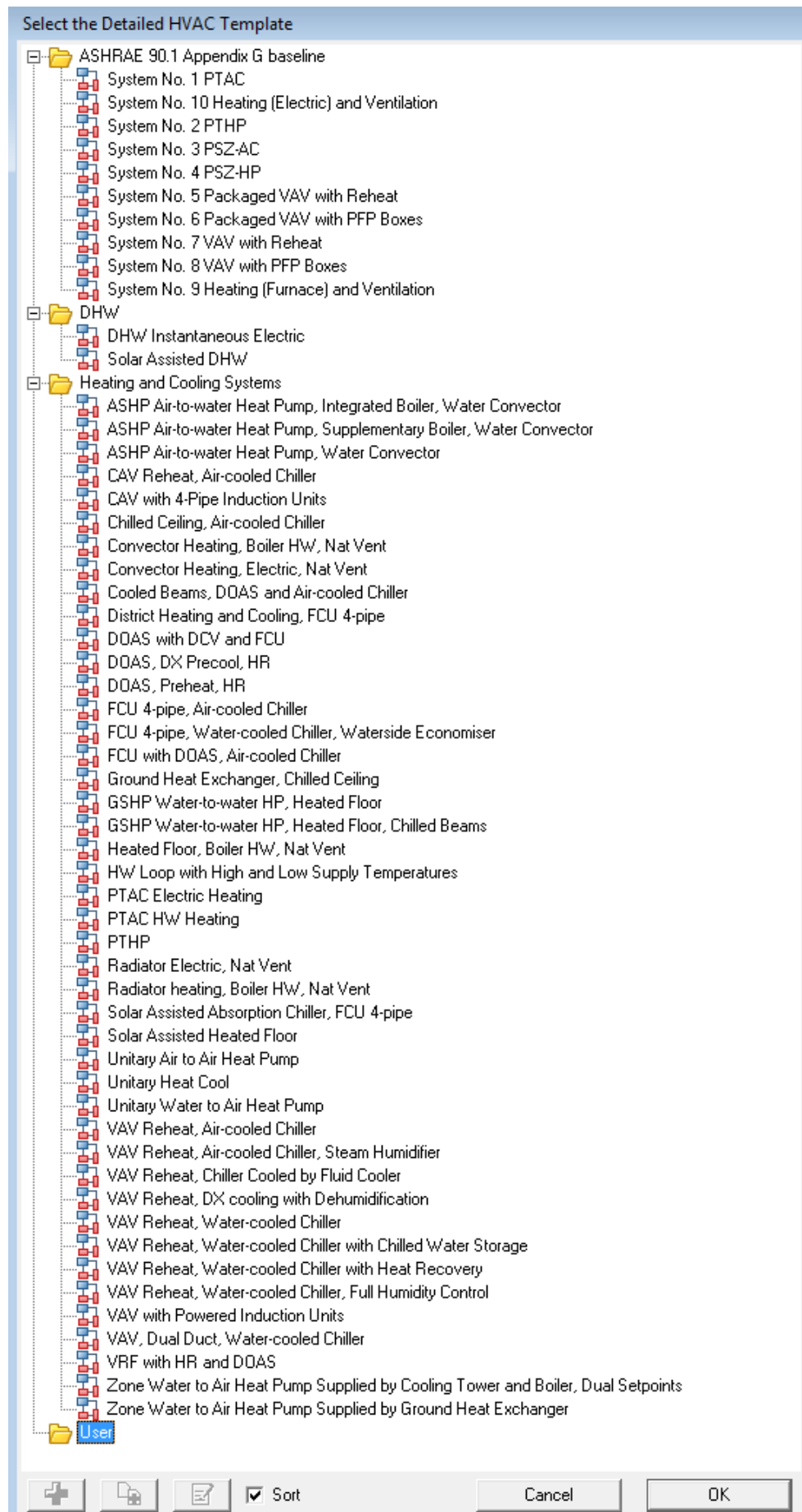


Figure 30 List of predefined detailed HVAC systems (templates) in DesignBuilder

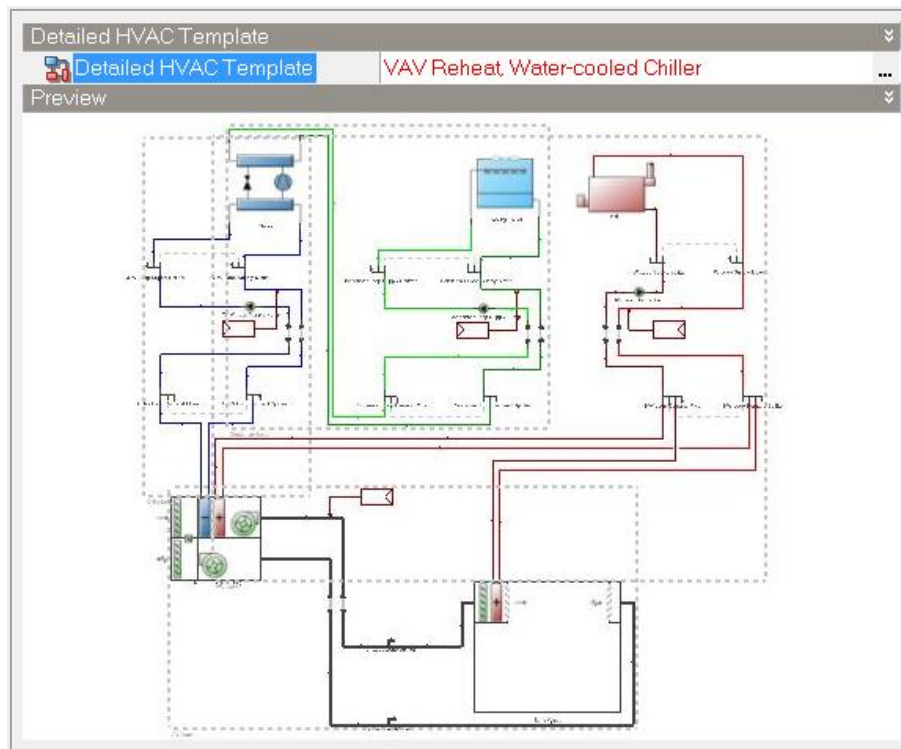


Figure 31 Graphical layout of detailed HVAC system

To set up the HVAC system exactly as required, including service hot water or SHW systems (called domestic hot water or DHW systems in DesignBuilder), users need to edit the Loop and component dialogs to define the performance characteristics and controls. Users can modify a pre-defined template to represent their design system or create a system from scratch by adding loops and components using the HVAC tools in DesignBuilder (Figure 32 and Figure 33).

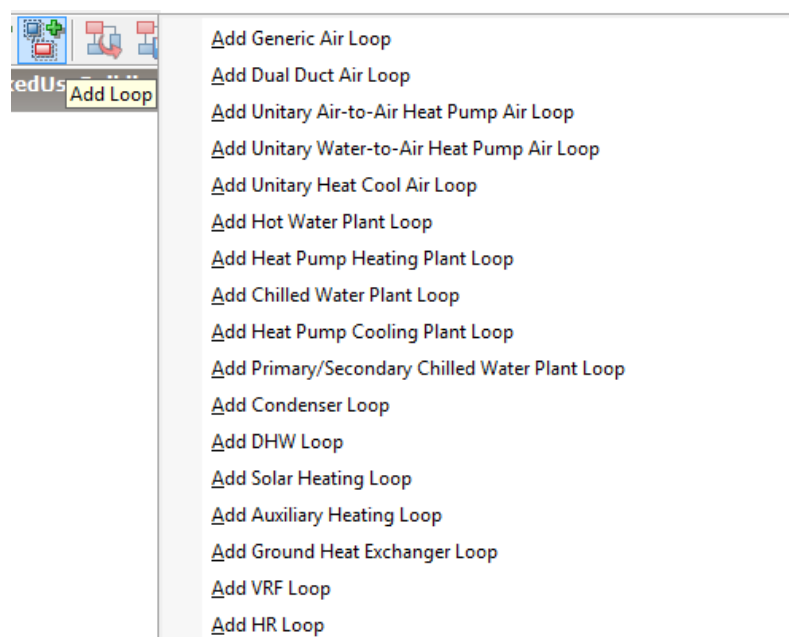


Figure 32 Add Loop function to help build up HVAC system manually

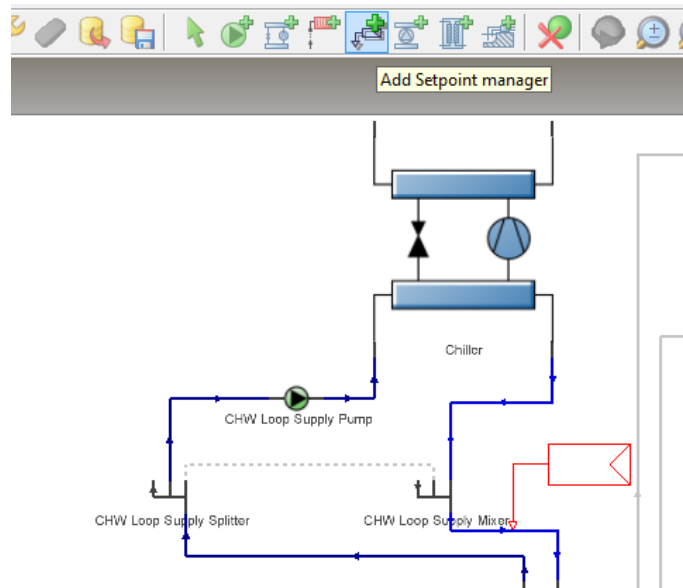


Figure 33 Add HVAC Component tool to help configure HVAC system manually

4.4.2 Variety of pre-configured HVAC systems including GSHP and VRF

DesignBuilder Detailed HVAC template database contains a wide range of predefined HVAC systems (Figure 30) that are ready to be loaded into the model. In addition to common fan coil unit system and constant air or variable air systems, water-to-air and air-to-water heat pump systems are on the HVAC template list. Also, ground source heat pump (GSHP) systems and variable refrigerant flow (VRF) systems can be modelled in DesignBuilder, where the templates based on the typical use of these components are also pre-defined, which helps set up proposed HVAC systems quickly (Figure 34 and Figure 35 illustrate the layout of these two systems respectively as examples).

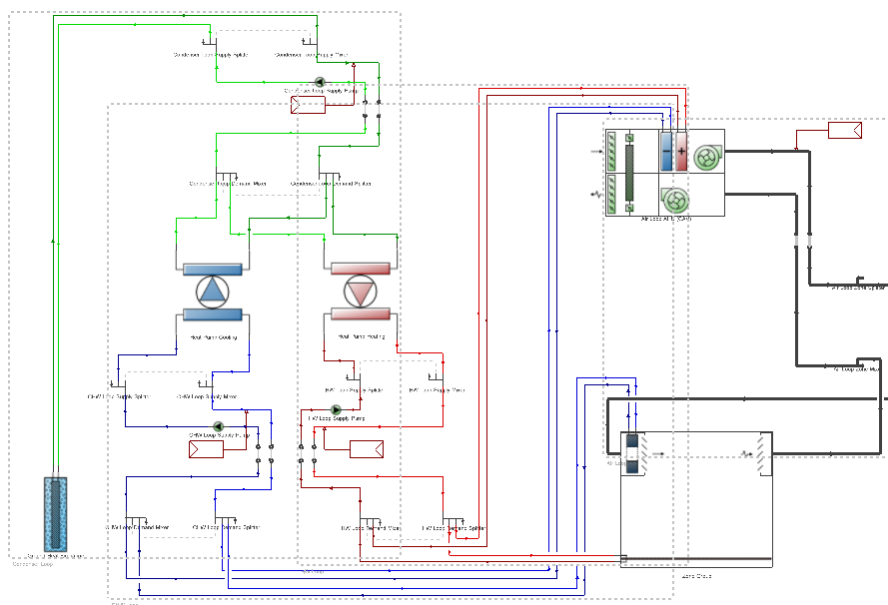


Figure 34 GSHP Water-to-water HP with heated floor and chilled beams

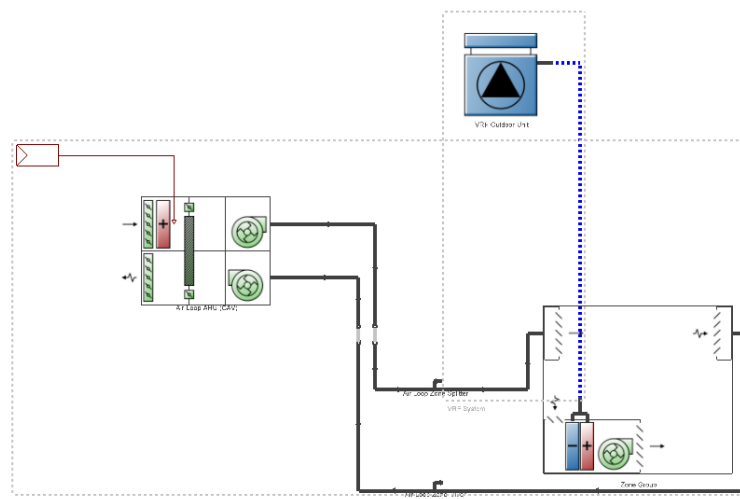



Figure 35 VRF with heat recovery and DOAS

Although a number of GSHP and VRF template data sets from different manufacturers are already incorporated into the GSHP and VRF database to speed up data entry, DesignBuilder also offers GSHP and VRF performance curve tools to help you generate performance curves for systems such as VRF and GSHP from manufacturer's catalogue data, where available.

5. Convert an Existing Model to App G PRM Model

It can sometimes be useful to use an existing model for LEED modelling and so DesignBuilder provides a mechanism to convert an existing model to ASHRAE 90.1 App G PRM format. The conversion process is as follows.

- (1) Navigate to site level.
- (2) Choose "Region" tab.
- (3) Click to select the "Mandatory energy code" item.
- (4) Choose the "ASHRAE 90.1-2007" or "ASHRAE 90.1-2010" energy code from the US category (alternatively, you can use browse mode to locate the right item and apply it; if this is a case, the step 5 below is omitted).
- (5) Click "Apply" button  or double click the selected energy code.

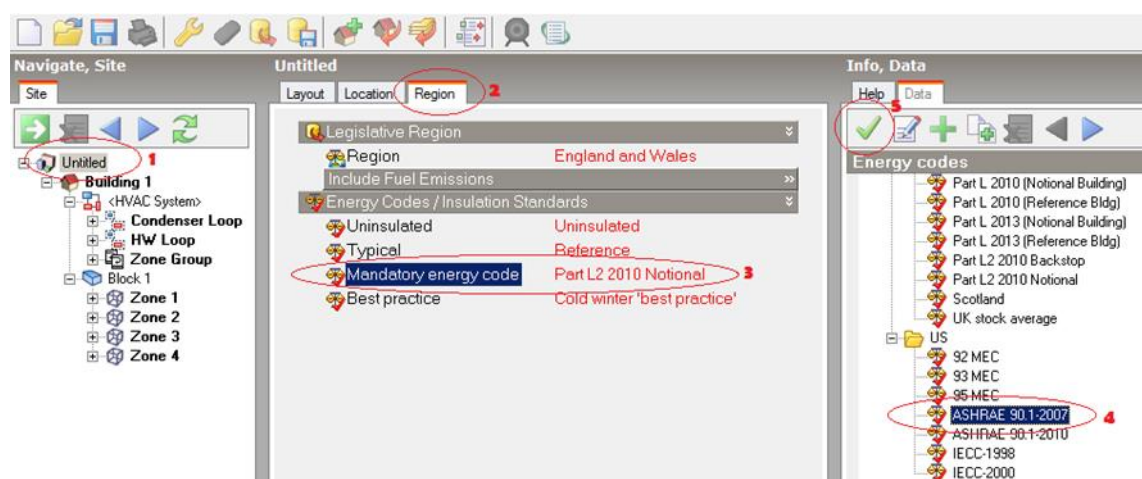


Figure 36 Convert an existing model to ASHRAE 90.1 model

Click “Yes” in response to the pop up message box (Figure 37) to confirm that you understand the impact of the conversion and are happy to continue, otherwise click “No” to keep the old energy code without converting.

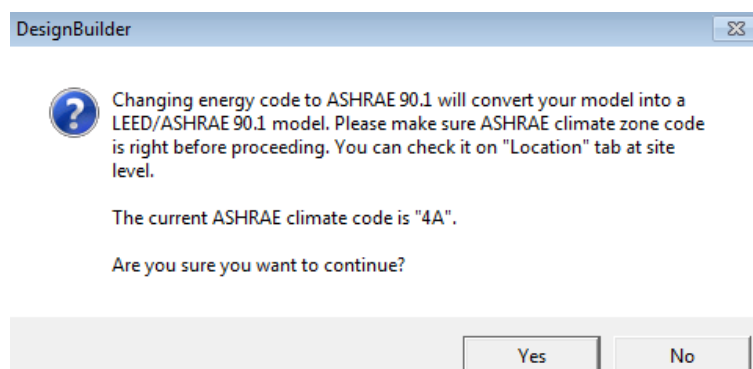


Figure 37 Prompt for confirmation of conversion

After the conversion the remaining steps of LEED modelling are as described above.


6. Create Baseline Building Model Using Wizards

Once the proposed building is complete, DesignBuilder recommends using the built-in wizards to automatically generate the baseline building from the proposed building. DesignBuilder has two ASHRAE 90.1 baseline wizards to generate the baseline building model. The baseline building wizard deals with building fabric, geometry and other non-HVAC related data and the baseline HVAC wizard handles the baseline HVAC systems.

6.1 Create Baseline Building from Proposed Building using Baseline Building Wizard

This section demonstrates how to use DesignBuilder’s baseline building wizard step-by-step.

6.1.1 Access to the Wizard

When viewing the proposed building at building level the “Create Baseline Building” icon  is visible in the toolbar (Figure 38).

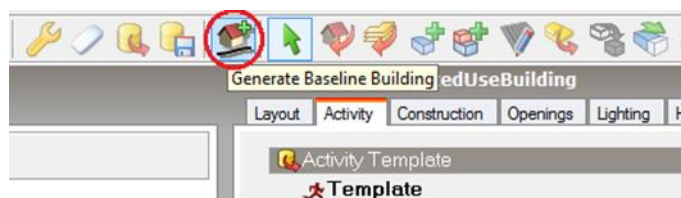


Figure 38 Baseline building wizard icon available at proposed building level

ASHRAE 90.1 covers buildings except low-rise residential buildings, e.g. dwellings with less than 4 floors. To ensure the building modelled fulfils ASHRAE 90.1 Standard definitions, DesignBuilder issues a warning message for low-rise residential buildings before baseline building wizard runs (Figure 39). Normally, when this warning message pops up, DesignBuilder highly recommends clicking “No” to close the message box and go back to model to check and make changes where appropriate. However, this is based on the estimated number of floors by the software, if it differs with the project designation due to the complexity of defining right floor numbers. If this is the case, you can click “Yes” to continue loading Baseline Building Wizard.

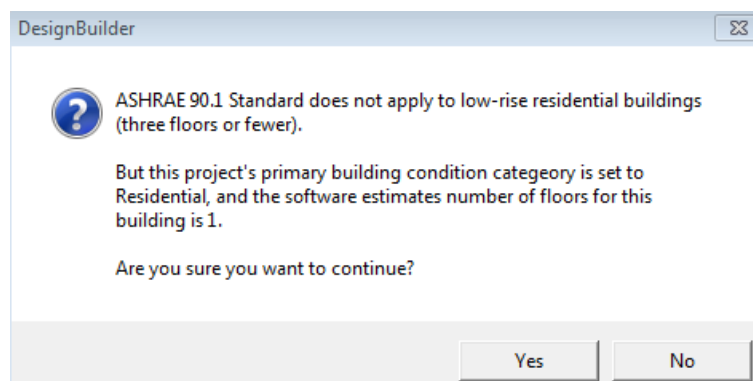


Figure 39 Exception of low-rise residential building

6.1.2 The Baseline Building Wizard

Clicking the “Create Baseline Building” icon initiates the Baseline building wizard containing three pages of information gathered from the proposed building model (Figure 40). The summary data shown on the wizard is displayed to enable you to check the key details before creating the baseline.

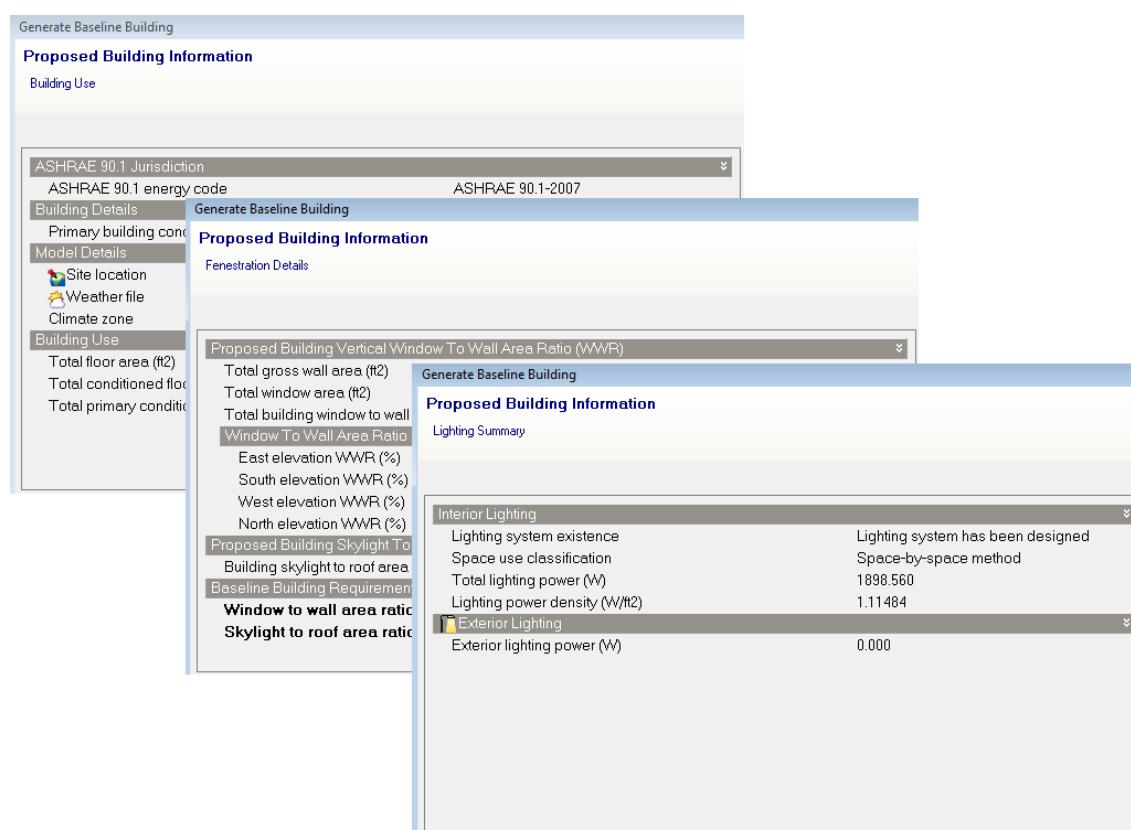


Figure 40 Baseline Building Wizard information displayed

If any of the summary information is incorrect you should cancel the wizard, edit the model and then re-run the wizard.

Of the information displayed on the wizard, perhaps the most important is the summary of the window to wall ratio and skylight to roof area ratio of the proposed building. This indicates the glazing ratios that will be used for the baseline building in accordance with the criteria defined in Table G3.1 section 5 of ASHRAE 90.1 App G. The baseline building vertical fenestration and skylight window to surface ratios should follow:

- Vertical fenestration areas for new buildings and additions shall equal that in the proposed design or 40% of gross above-grade wall area, whichever is smaller, and shall be distributed on each face of the building in the same proportions as in the proposed design.
- Skylight area shall be equal to that in the proposed building design or 5% of the gross roof area that is part of the building envelope, whichever is smaller. If the skylight area of the proposed building design is greater than 5% of the gross roof area, baseline skylight area shall be decreased by an identical percentage in all roof components in which skylights are located to reach the 5% skylight-to-roof ratio. Skylight orientation and tilt shall be the same as in the proposed building design.

If all data on the wizard is correct, click the “Finish” button (on final page) and DesignBuilder will generate a baseline building so that both buildings are displayed in the model side by side (Figure 41).

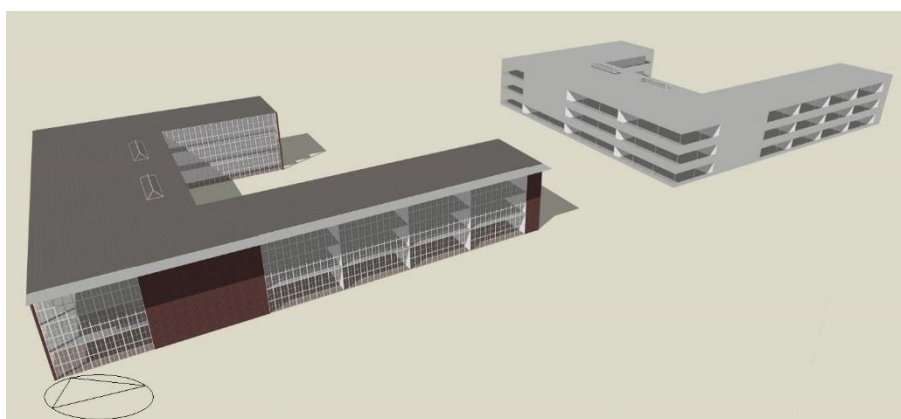


Figure 41 Baseline building generated from wizard sits with proposed building side by side

6.1.3 Checking the baseline building model

After the baseline building has been created, the data on the “Activity”, “Construction”, “Openings” and “Lighting” tabs should be checked to ensure that the automatic assignment has been carried out correctly and manual changes made as required. The appearance of the baseline building should also be checked in the Layout window.

Depending on the proposed building details, various changes in the baseline building relative to the proposed building will generally be seen:

- Constructions/glazing will be assigned constructions with names starting CZ# (# denotes the climate zone number) in the constructions title/name.
- Lighting settings, especially LPD, will be set based on the proposed building’s “ASHRAE 90.1 Lighting category” input on the Activity tab.
- Window to wall ratio will be either the ratio from proposed building or 40%, whichever is the smallest.
- Skylight to roof area ratio will be either the ratio from proposed building or 5%, whichever is the smallest.
- Window local shadings are removed.
- Standard component blocks are removed.

Note: If significant changes need to be made to the proposed building after the baseline building has been created DesignBuilder recommend that the baseline building be deleted, the proposed building be edited and the baseline generation wizard is re-run.

6.1.3.1 Activity and ASHRAE 90.1 settings

The Baseline Building Type is shown as “2-Baseline” in the Activity tab at building level as shown in Figure 42.

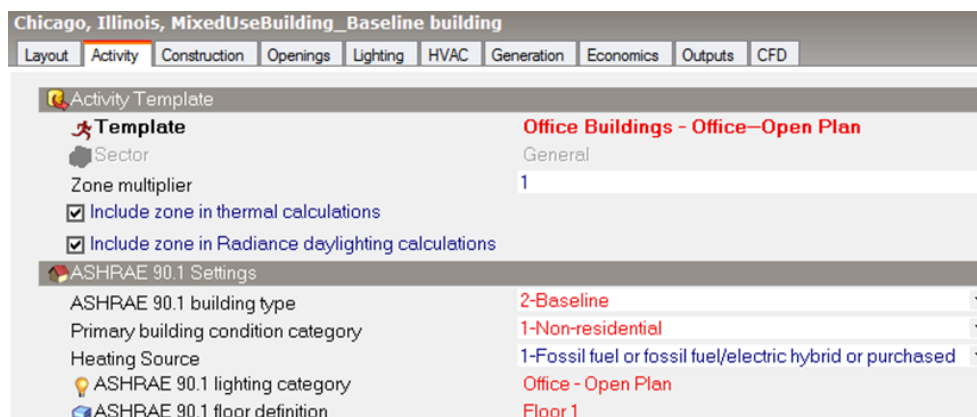


Figure 42 ASHRAE 90.1 settings on activity tab at building level of baseline building

At zone level (Figure 43 below) of the baseline building the data shown is similar to that of the proposed building (Figure 12).

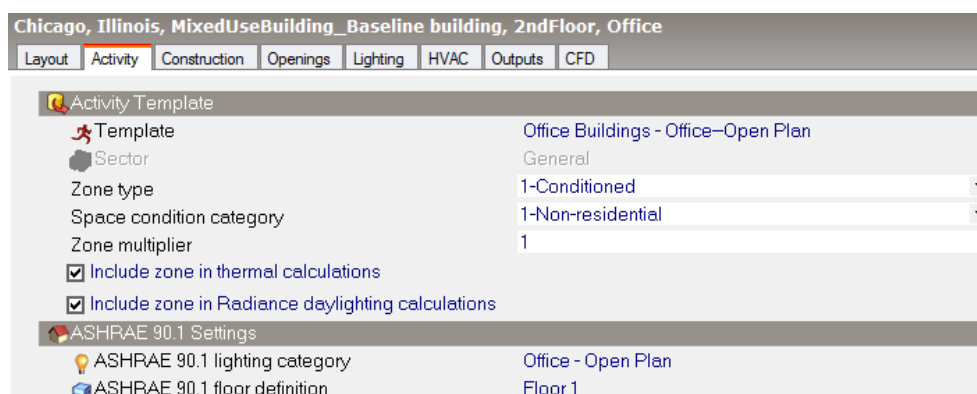


Figure 43 Activity tab at zone level of baseline building

6.1.3.2 Opaque constructions

The Construction tab shows that the relevant baseline constructions following ASHRAE 90.1 Table G3.1-5 and Tables 5.5-1 through 5.5-8 have been applied in the model (Figure 44).

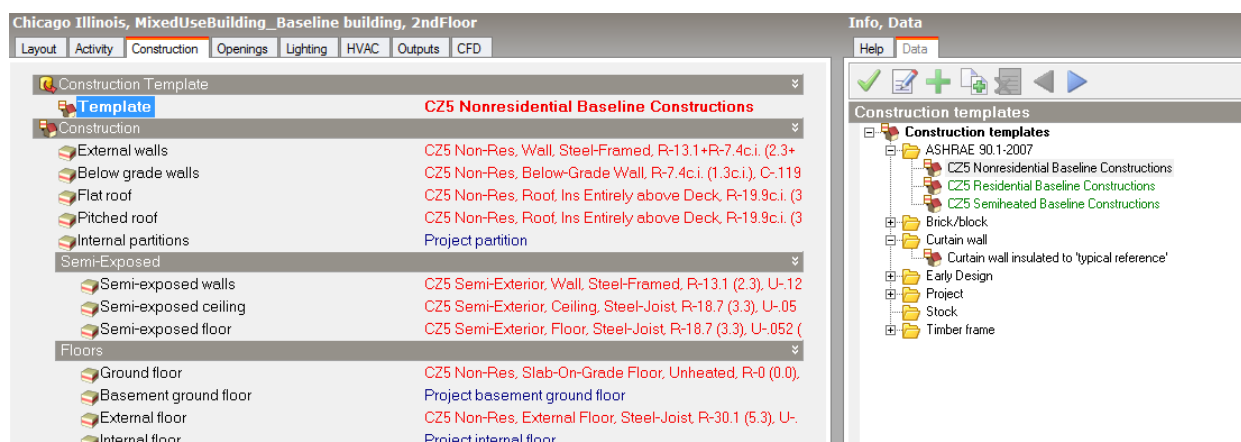


Figure 44 Opaque constructions

Constructions such as internal partitions that are not covered by ASHRAE 90.1, are modelled per the proposed building.

6.1.3.3 Glazing constructions

The baseline glazing constructions will be shown in the Openings tab (again following ASHRAE 90.1 Table G3.1-5 and Tables 5.5-1 through 5.5-8) (Figure 45).

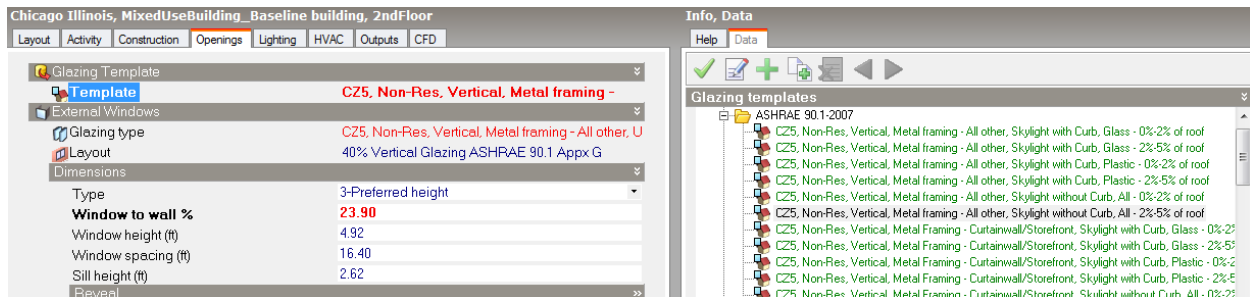


Figure 45 Glazing constructions

6.1.3.4 Lighting

The lighting power density is now set in the Lighting tab based on the ASHRAE 90.1 lighting category selected in the "Activity" tab (Figure 46).

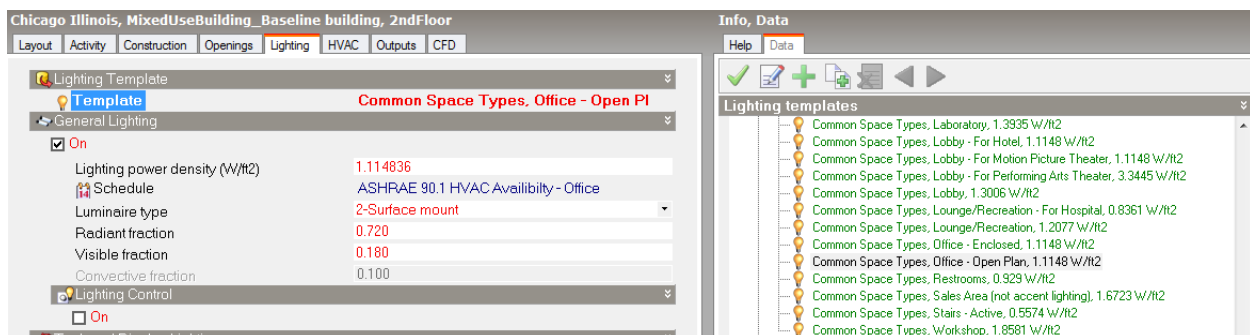


Figure 46 Lighting template and lighting power density (LPD)

6.1.3.5 Utility rates (tariffs)

The utility rates (tariffs) stay the same as those for the proposed building.

6.2 Set up baseline HVAC systems using baseline HVAC wizard

The Baseline HVAC system type is based on building use (residential or non-residential), number of floors, heating source etc. Eight different baseline HVAC system can be chosen from ASHRAE 90.1 2007, with 2 more to choose from in the 2010 version. For mixed use buildings there is additional information to define non-predominant systems based on the conditioned floor area.

DesignBuilder includes templates for all baseline HVAC systems and the Baseline HVAC wizard helps choose the right HVAC template for primary conditioned zones. However, for non-predominant zones, users currently need to select and add the system manually.

6.2.1 Run the Baseline HVAC wizard

The Baseline HVAC wizard opens automatically when navigating to the <HVAC System> node under the baseline building in the navigation panel for the first time. Otherwise, you can click Load HVAC template top menu icon (Figure 47) if the wizard is not automatically displayed or you want to re-run the wizard.

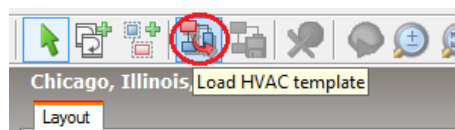


Figure 47 Baseline HVAC wizard is using Load HVAC template icon

6.2.1.1 General procedure

The wizard starts by summarising the data that will be used to guide the HVAC system selection (see Figure 48 below).

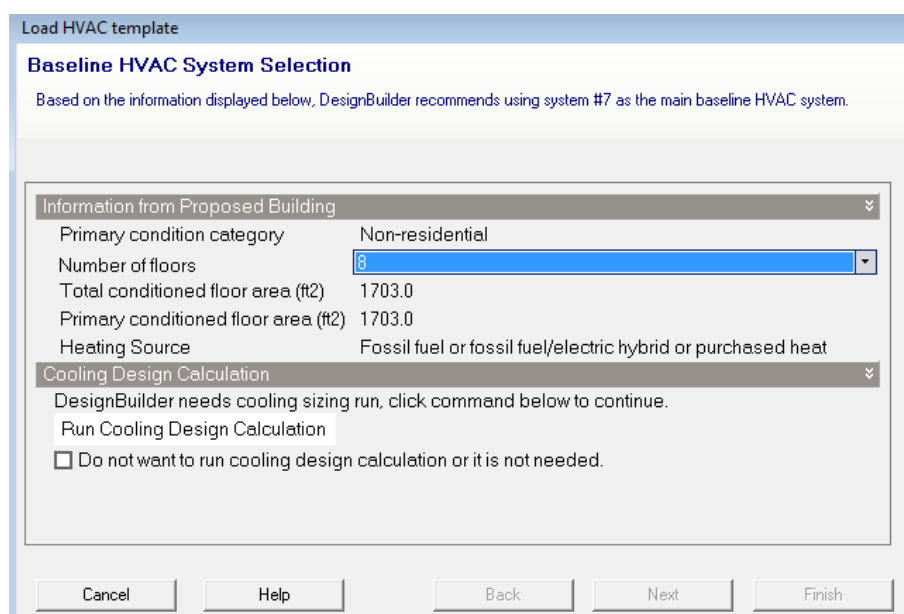


Figure 48 Baseline wizard has been called

At the top of the wizard DesignBuilder recommends a HVAC system for use in the baseline building model. The recommendation is based on the information shown on this page. If system #7 or #8 is recommended, the wizard will show a cooling design calculation section (if this cooling design calculation has not been run prior to calling the baseline HVAC wizard). The cooling design calculation will define how many chillers are needed for system #7 or #8. The Next button is greyed out so that you cannot continue until the cooling design calculation has been run.

If neither system #7 or #8 is recommended by DesignBuilder, or system #7 or #8 is recommended but the cooling design calculation has been run, the cooling design calculation section will not show on HVAC wizard page (Figure 49).

Load HVAC template

Baseline HVAC System Selection

Based on the information displayed below, DesignBuilder recommends using system #7 as the main baseline HVAC system.

Information from Proposed Building	
Primary condition category	Non-residential
Number of floors	8
Total conditioned floor area (ft2)	1703.0
Primary conditioned floor area (ft2)	1703.0
Heating Source	Fossil fuel or fossil fuel/electric hybrid or purchased heat

Figure 49 Next button is enabled after cooling design calculation run


The number of floors shown on the page is an estimated figure based on the calculation using total building height dividing by a calculated average floor height from modelled building. This field is editable so users can change it to a number that matches the building design specifications of the project. But be aware that the change to this number will sometimes result in a change of HVAC system type.

The recommended HVAC system will preload and show on the second wizard page (Figure 50). You can change the baseline HVAC system manually here should you need to.

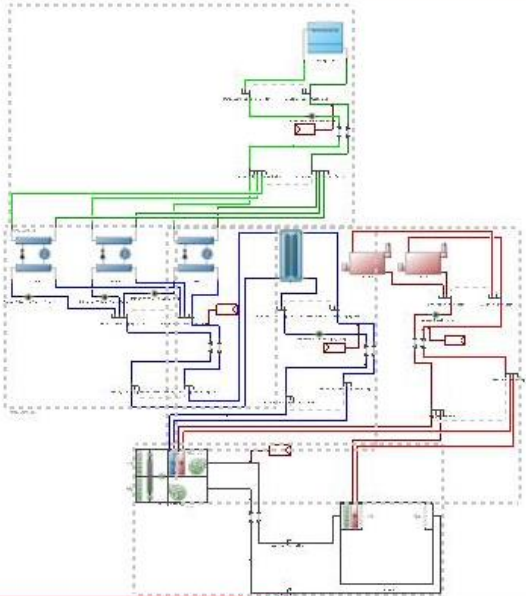
HVAC Template Selection

DesignBuilder recommends using system #7 as main baseline HVAC system.
You can override this setting by choosing another system or press Cancel to create one from scratch.

Detailed HVAC Template

 Detailed HVAC Template **System No. 7 VAV with Reheat**

Preview



ASHRAE 90.1 Primary HVAC System

☒ Use as primary HVAC system

Summary of Equipment

Figure 50 Second page of wizard shows system name and layout

The “Use as primary HVAC system” option on the baseline HVAC wizard is useful in helping process LEPORT (LEED Energy Performance Online Reporting Tool) data if the user chooses to use this online data processing tool after the simulations. LEPORT is described in detail at the end of this document. After running the Baseline HVAC wizard, this primary HVAC system selection is stored and displayed on HVAC tab at building level (Figure 51).

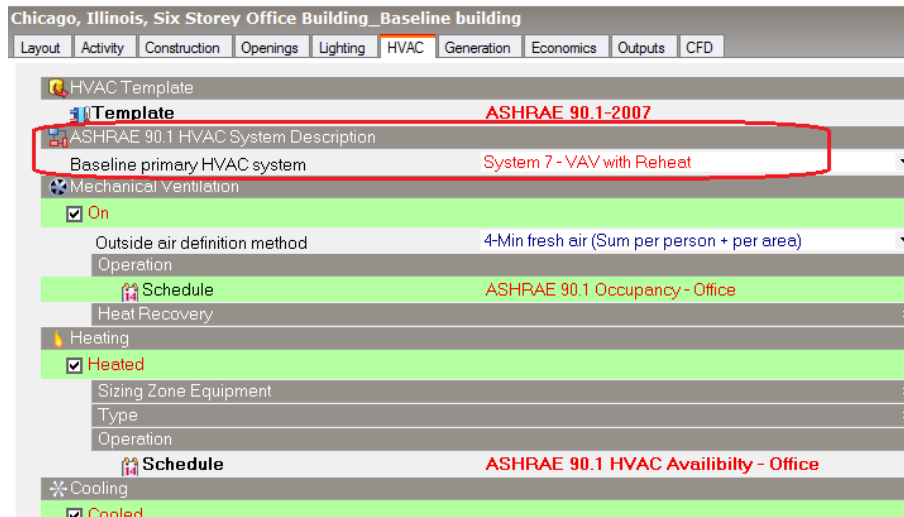


Figure 51 Building level HVAC tab stores Baseline primary HVAC system information

Once the baseline HVAC system is selected, you must assign zones to be served by the HVAC system and click the Finish button to complete the wizard (Figure 52). The selected zones will be grouped and assigned to an HVAC zone group or multi zone groups depending on which HVAC system is finally adopted.

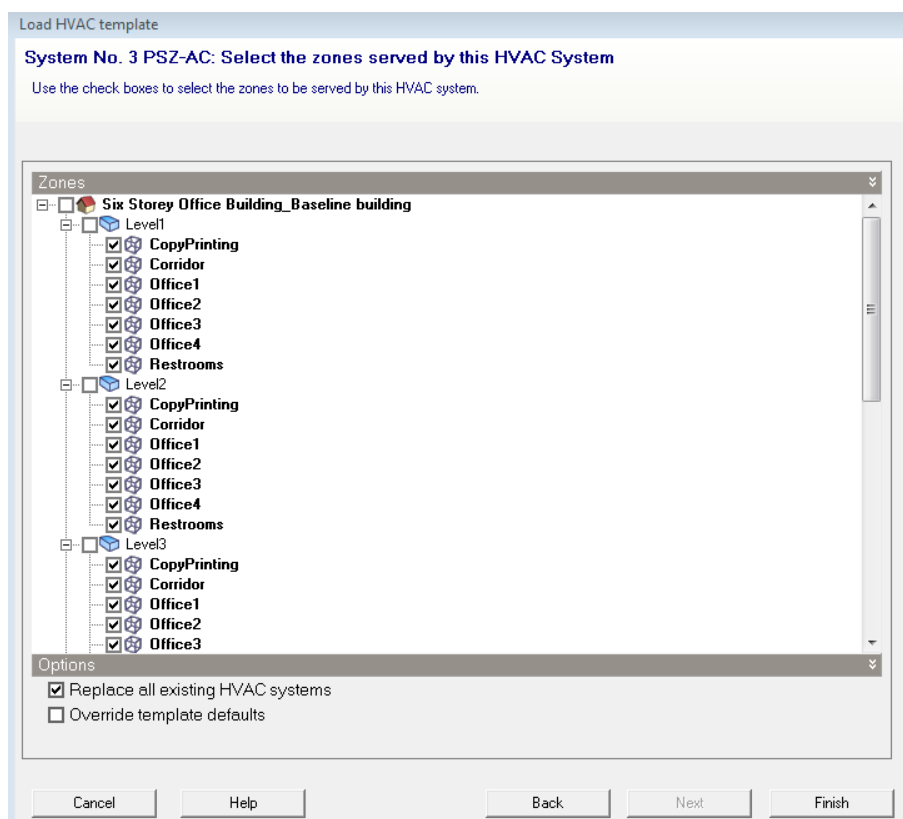


Figure 52 Assign zones and then finish

Click the Finish button to close the wizard and load the HVAC system to the layout screen. The behaviour of the Load HVAC Template wizard depends on the baseline HVAC system selected as described below.

6.2.1.2 Systems No.3 and No.4 - single zone systems

The Baseline HVAC Wizard has a special treatment when systems No.3 or No.4 are selected as they are single zone systems, i.e. each HVAC zone is assigned with the same independent HVAC system. DesignBuilder automatically sets this arrangement up as shown below.

When system No.3 has been selected as the baseline HVAC system, the example screenshot below shows four zones selected to be served by this system on the zones page (Figure 53).

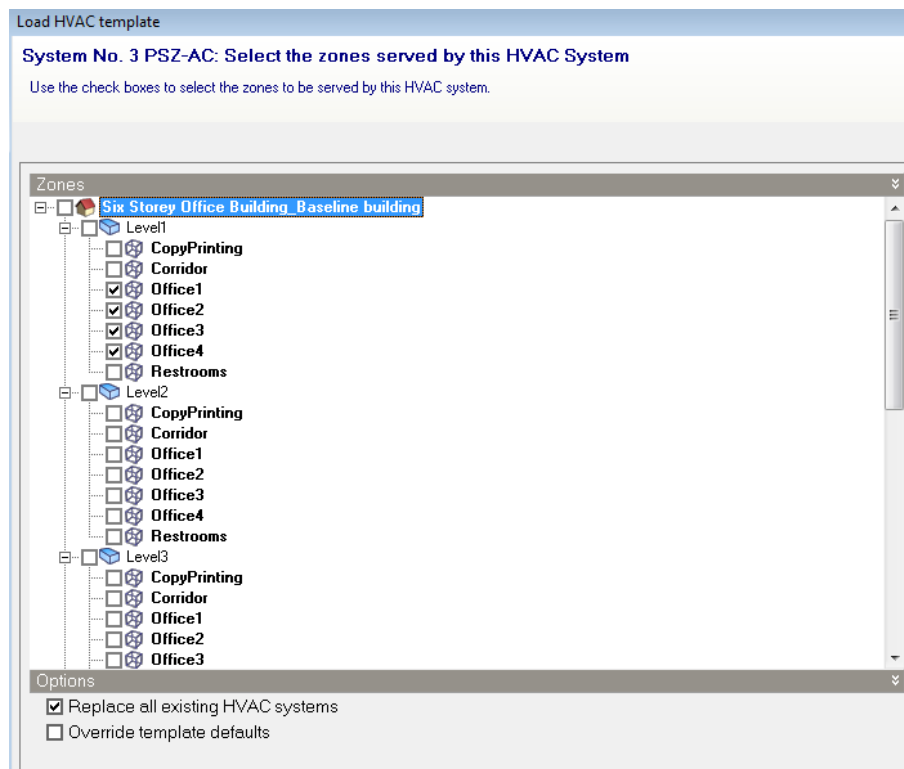


Figure 53 Four zones served by single zone system No.3

After running the wizard, the layout window shows four separate HVAC system for 4 zone groups with each containing a single zone (Figure 54).

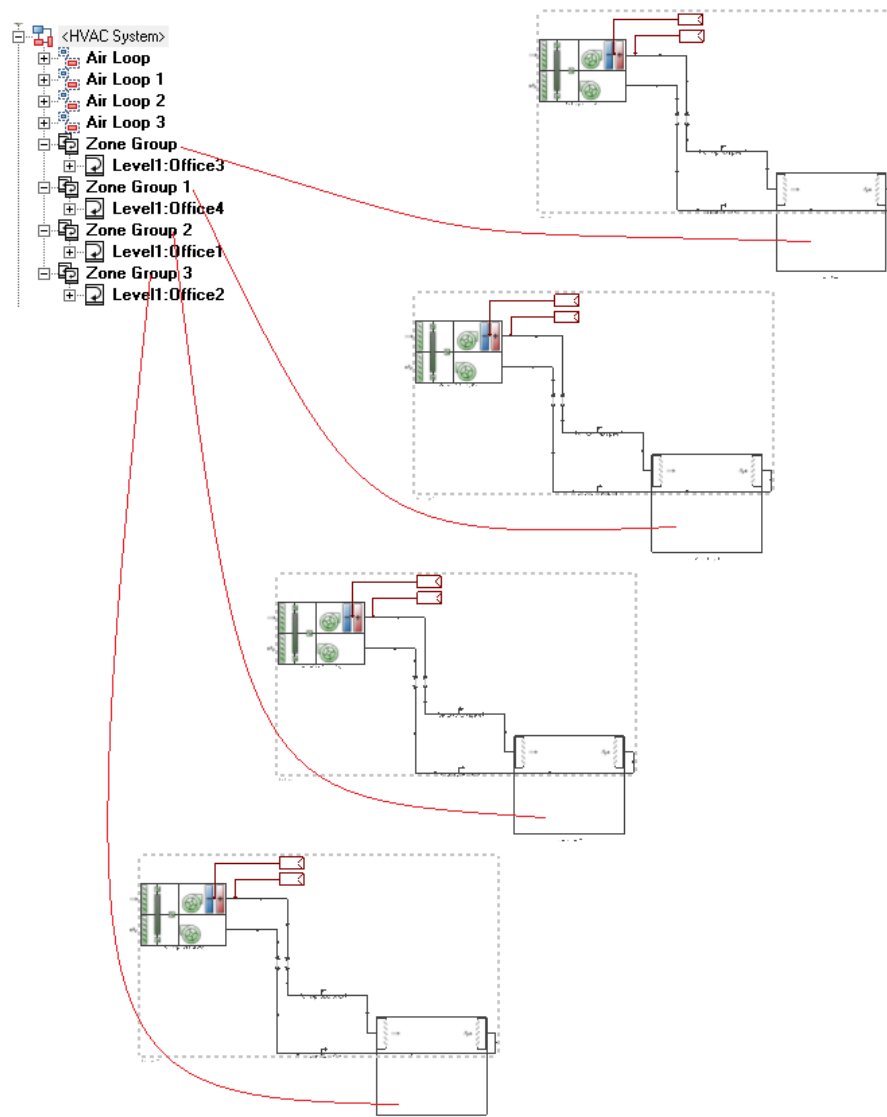


Figure 54 Layout of single zone HVAC system

6.2.1.3 Systems No.5 – No.8 – each floor to have a separate HVAC system

If one of the systems No.5 to No.8 is selected, there is an additional option to select how floors are to be defined. This instructs the wizard to generate zone groups from checked zones based on the option selected (Figure 55).

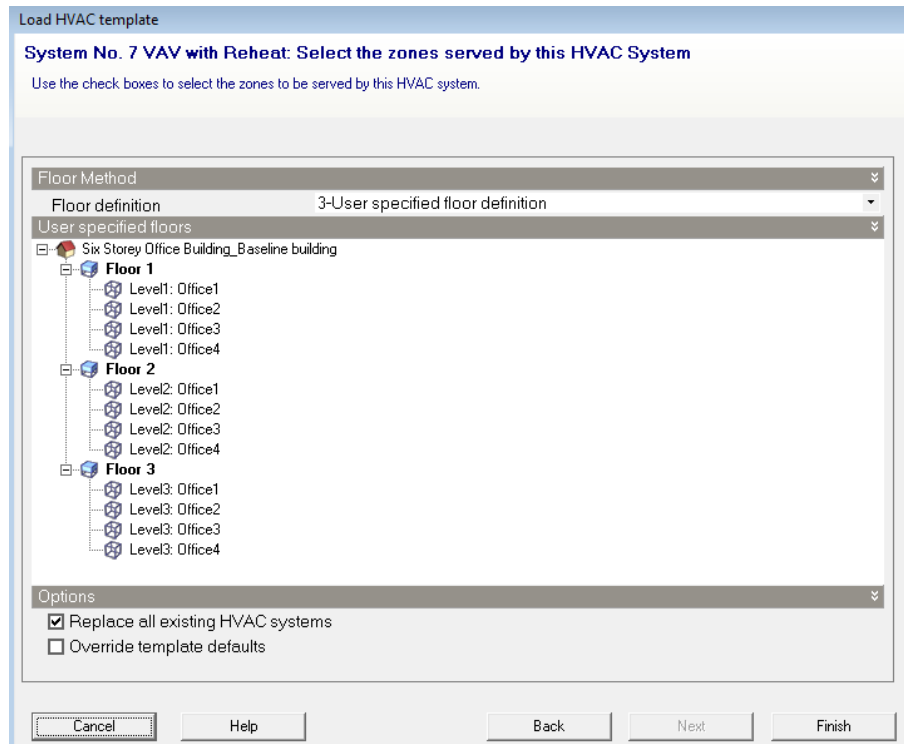


Figure 55 Zones list based on user specified floor definition

For option “3-User specified floor definition”, please refer to section 4.3.2.4 ASHRAE 90.1 floor definition for how user specified floors are defined.

Using the example shown in Figure 55, the HVAC system will be generated on the layout screen with three HVAC zone groups, each containing four zones under each floor definition. The number of chillers and boilers will be correctly set (Figure 56) based on ASHRAE 90.1 App G Sections G3.1.3.2 and G3.1.3.7. DesignBuilder currently supports maximum three chillers. If more than three chillers are required for large buildings, the extra chiller(s) can be added manually by navigating to the chilled water loop supply side.

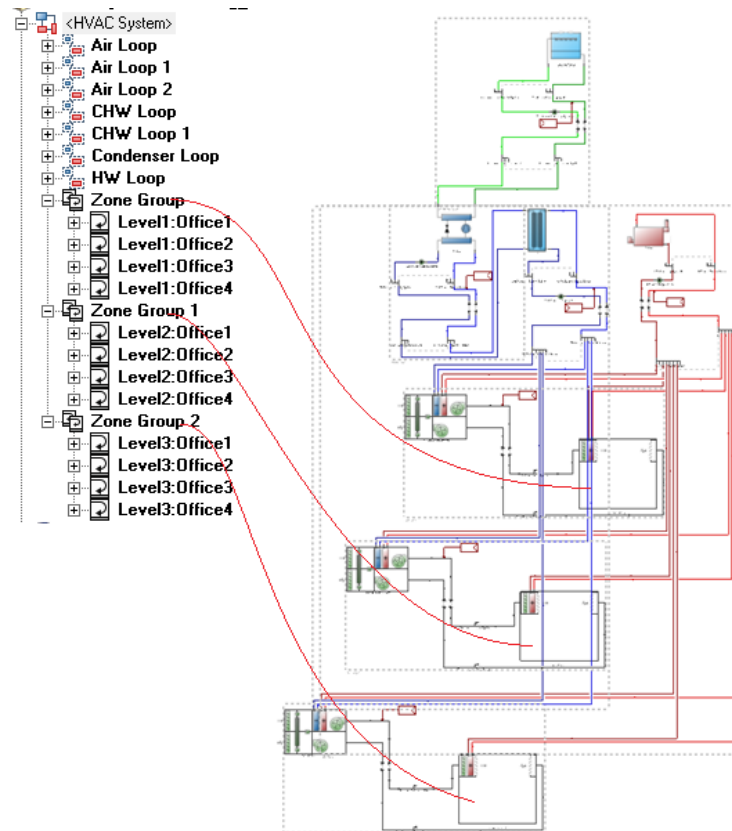


Figure 56 System No.7 applies to three different floors

Note: Normally, the user needs to enable the “Override template defaults” option, which is shown as the second checkbox in Figure 53 and Figure 55 above, and then set the relevant parameter(s) in the wizard pages that follow. This will be discussed in detail in the following section.

It is worth noting that the HVAC wizard can be run multiple times to override the existing system or to add more systems, such as non-predominant HVAC systems, service hot water (SHW) a.k.a. domestic hot water (DHW) systems etc.

6.2.1.4 Override template defaults

To ensure that the Baseline HVAC Wizard generates an HVAC system that complies with the ASHRAE 90.1 Standard Appendix G baseline HVAC definitions, it is important to use the “Override template defaults” option (Figure 57).

Note: Any further modifications required to the baseline system can be made manually to HVAC system components after the selected system has been loaded to the model.

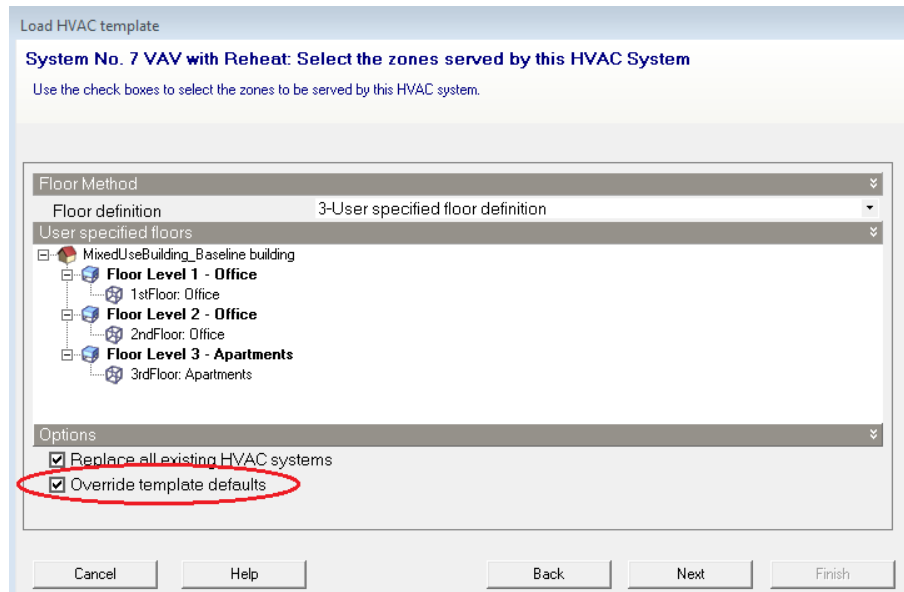


Figure 57 Enable Override template defaults option for Baseline HVAC Wizard

Figure 58 shows how the default input to the air handling unit can be changed, if required, by ASHRAE 90.1 Standard definitions.

The system fan power defined in ASHRAE 90.1 Standard Appendix G (in short App G) G3.1.2.9 together with Table G3.1.2.9 is already included in the default normalised fan pressure rise input setting in DesignBuilder. This is equivalent to the fan power to air flow rate ratio. However, if the fan pressure drop adjustments defined in ASHRAE 90.1 Standard section 6.5.3.1.1 are to be considered, then users need to calculate a revised fan pressure rise and enter it here.

Outdoor air economizers must be included in baseline HVAC Systems 3 to 8 if the climate zone meets the conditions specified in App G Table G3.1.2.6A. Baseline HVAC systems 1 or 2 do not require an outdoor air economizer. The requirement for the economizer and high-limit shutoff to be dry-bulb switch with setpoint temperatures in accordance with the values in App G Table G3.1.2.6B is automatically set in the software. Of course users can make changes here if they don't agree with the default settings proposed by the wizard.

App G G3.1.2.10 section requires a complex check (normally based on the known design supply air capacity) to decide whether or not the exhaust air energy recovery is needed.

Note: DesignBuilder sets heat recovery to be on with an effectiveness of 0.5 by default. However a manual check on these settings is required and changes are usually needed.

Load HVAC template

System No. 7 VAV with Reheat: Air Handling Unit

Enter details on the Air System

AHU Fans	
Supply Fan	
Pressure rise (Pa)	1439.298
Fan total efficiency	0.60
<input checked="" type="checkbox"/> Part-load performance	Fan Part-Load Power, ASHRAE 90.1-2007 Appendix G
Extract Fan	
<input type="checkbox"/> Include extract fan	
Recirculation	
<input checked="" type="checkbox"/> On	
Economiser (Free Cooling)	
Economiser control type	2-Fixed dry bulb
High-limit shutoff DB (°C)	21.11
Heat Recovery	
<input checked="" type="checkbox"/> On	
Sensible effectiveness	0.50
Latent effectiveness	0.000

Cancel Help Back Next Finish

Figure 58 Override air handling unit default settings


The hot water system default settings are shown in Figure 59 below.

Hot water pump power for baseline HVAC systems 1, 5 and 7 (other systems do not have hot water loops), is defined in App G G3.1.3.5, which requires baseline building design hot-water pump power to be 19 W/gpm. This figure is included into DesignBuilder pump head input which represents the pump power to water flow rate ratio.

Load HVAC template

System No. 7 VAV with Reheat: Hot Water System

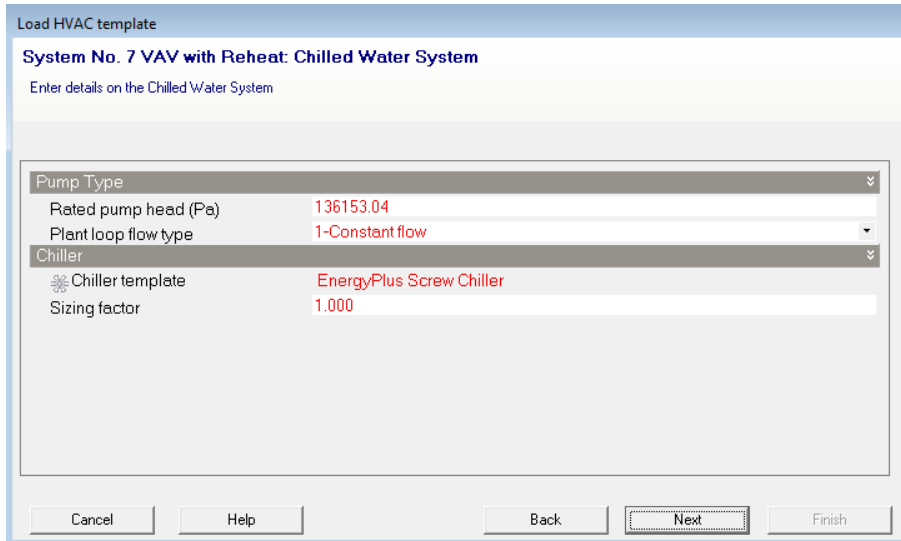
Enter details on the Hot Water System

Pump Type	
Rated pump head (Pa)	235241.37
Plant loop flow type	2-Variable flow
<input checked="" type="checkbox"/> Performance curve template	Pump Part-Load Power, Default Variable Speed
Boiler	
 Boiler template	ASHRAE 90.1 Appendix G baseline boiler.
Design capacity (W)	Autosize

Cancel Help Back Next Finish

Figure 59 Override hot water system default settings

Similar to the hot water system, chilled water system pump head includes consideration of the 22W/gpm for baseline building design pump power required by App G G3.1.3.10 (Figure 60).



Load HVAC template

System No. 7 VAV with Reheat: Chilled Water System

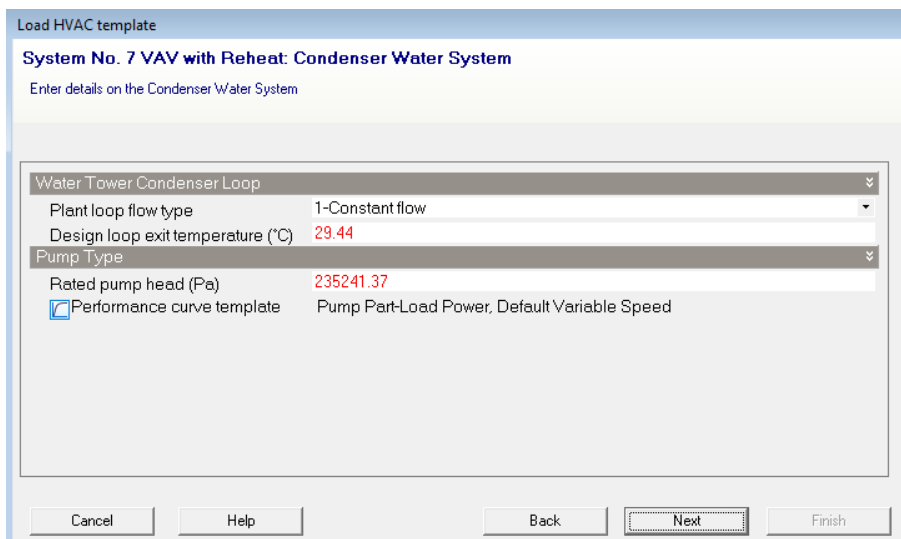
Enter details on the Chilled Water System

Pump Type	
Rated pump head (Pa)	136153.04
Plant loop flow type	1-Constant flow
Chiller	
Chiller template	EnergyPlus Screw Chiller
Sizing factor	1.000

Cancel Help Back **Next** Finish

Figure 60 Override chilled water system default settings

Likewise, the condenser pump head includes consideration of the 19W/gpm for baseline building design condenser-water pump power defined in App G G3.1.3.11 (Figure 61).



Load HVAC template

System No. 7 VAV with Reheat: Condenser Water System

Enter details on the Condenser Water System

Water Tower Condenser Loop	
Plant loop flow type	1-Constant flow
Design loop exit temperature (°C)	29.44
Pump Type	
Rated pump head (Pa)	235241.37
<input checked="" type="checkbox"/> Performance curve template	Pump Part-Load Power, Default Variable Speed

Cancel Help Back **Next** Finish

Figure 61 Override condenser water system default settings

The final page of the wizard allows a simple HVAC template to be set (Figure 62). This updates the data on the HVAC tab for consistency with the Detailed HVAC system most recently loaded. This is especially important for running cooling or heating design calculations.

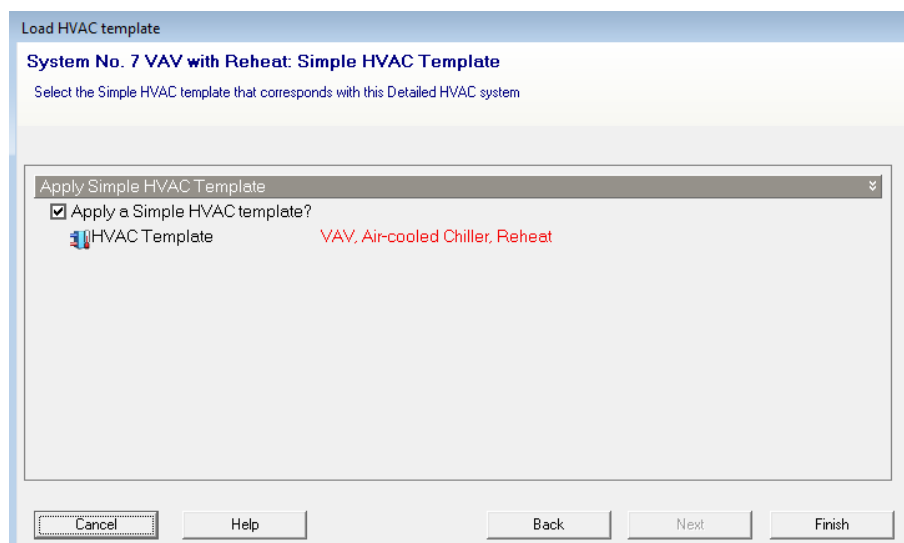


Figure 62 Simple HVAC template page

Note: After the HVAC system has been loaded for baseline building, further changes can be made by manually editing data on HVAC loops and components.

6.2.2 Fine tuning (manual adjustment)

The DesignBuilder guided HVAC selection described above, allows you to quickly and easily select and load the correct system as a starting point. However, once this has been loaded, the system should be manually checked to ensure full compliance with ASHRAE 90.1 App G rules. For example, you may need to run cooling and heating design calculations in order to get zone sizing data; or you may need to run a test simulation to acquire plant and equipment sizing data from EnergyPlus outputs (obtainable via the “Summary” simulation results tab or through reading the E+ output eio file for example).

Here is a list of key items to check:

- Check the equipment minimum efficiencies required by Appendix G clause G3.1.2.1 together with section 6.4 of ASHRAE 90.1 Standard.
- Check whether preheat coils are required in the baseline HVAC system based on Clause G3.1.2.3.
- Check whether the baseline HVAC system needs to enable exhaust air energy recovery following the definitions of G3.1.2.10. Input in the air handling unit (AHU) dialog “Outdoor Air System” tab
- Set the baseline HVAC hot water pump type to either variable speed or constant speed per appendix G section G3.1.3.5. Likewise, set the chilled water pump type to either variable or constant speed per section G3.1.3.10.
- If the baseline HVAC system is either #7 or #8, set the chiller heat rejection requirements per section G3.1.3.11.
- If applicable, set the baseline chiller condenser heat recovery per section 6.5.6.2.1.

Whilst we consider these to be the main manual interventions that are likely to be required, you should check the whole HVAC system to ensure it fully meets ASHRAE 90.1 requirements.

7. Simulations

The proposed and baseline building simulations are run individually as they are separate buildings. DesignBuilder strongly advises that you undertake appropriate Quality Control checks prior to running the final proposed and baseline building simulations for ASHRAE 90.1 purposes. This is discussed in more detail in section 9.

7.1 ASHRAE 90.1 simulations

ASHRAE 90.1 simulations are run from the “ASHRAE 90.1” tab on the “Simulation” screen (Figure 63). The simulation options for ASHRAE 90.1 purposes are restricted to ensure that the correct comparison between the proposed and baseline buildings can be made in accordance with ASHRAE 90.1 requirements.

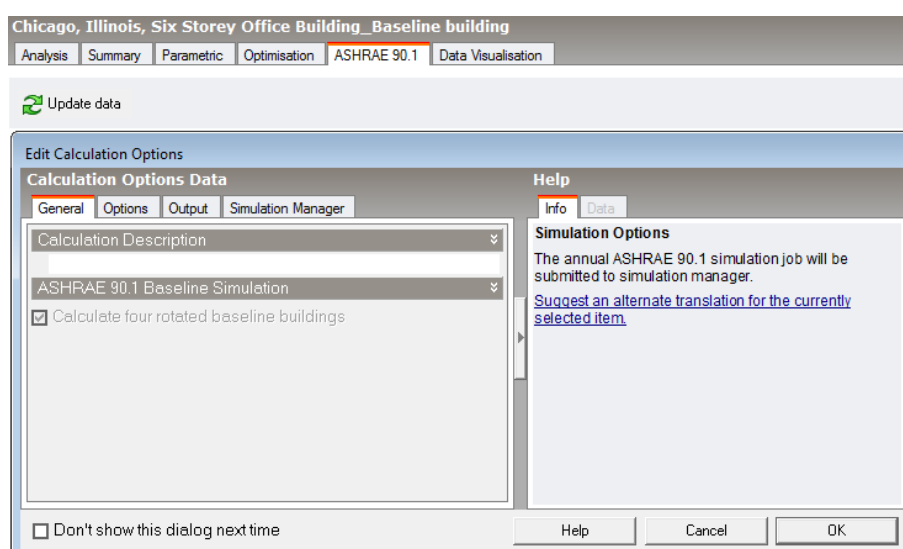


Figure 63 Calculation Options for ASHRAE 90.1 simulations

DesignBuilder advises running the first simulation for the Proposed building level to generate those results, then selecting the Baseline building model to run the 4 automated baseline building simulations.

Note: There is an exemption for LEED v4, that uses ASHRAE 90.1 Standard 2010, to run the baseline simulation without rotation if certain criteria for window to wall ratios are met. This exemption is handled automatically by DesignBuilder.

7.2 Using the Simulation Manager

The ASHRAE 90.1 simulations are always run using the Simulation Manager. The “Simulation Manager” tab on the Calculation options dialog (screenshot in Figure 64 below) provides options for either a local or a remote job server.

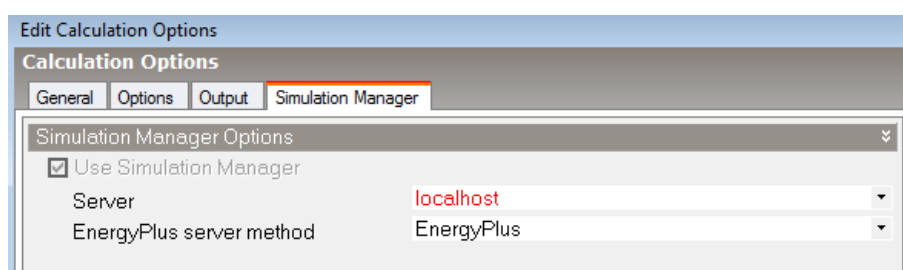


Figure 64 Simulation manager used for ASHRAE 90.1 simulations

The Simulation Manager allows the four rotated baseline buildings (if they are needed) to be run simultaneously in parallel and fully automates that process.

7.3 Simulation options

For the baseline building, the solar distribution is automatically set to “1-Minimal shadowing” (Figure 65), in line with ASHRAE 90.1 Table G3.1-5 (Baseline section) “The baseline building shall be modelled so that it does not shade itself”.

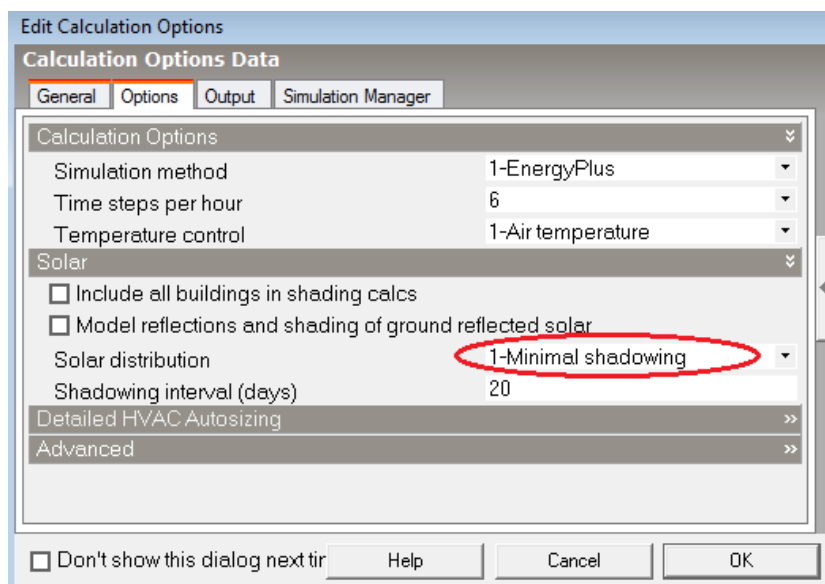


Figure 65 Calculation Options

7.4 Simulation output options

DesignBuilder recommends that the LEED Summary, Annual Building Utility Performance Summary (ABUPS) and Demand End Use Components Summary reports are checked as a minimum in order to check LEED related output summary reports after the simulations.

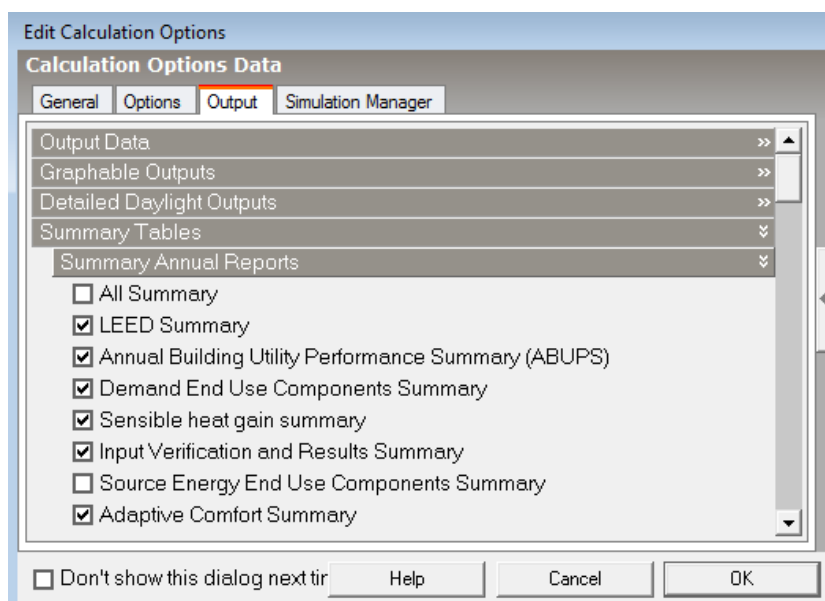


Figure 66 Important Summary Annual Reports setting

7.5 Simulated data

After ASHRAE 90.1 simulations have been run, the simulated results data is transferred and stored in a folder on the local drive:

`C:\Users\(\username)\AppData\Local\DesignBuilder\EnergyPlus\ASHRAE901`

Four different rotated baseline buildings have a suffix related to each of their output results, i.e. _B000, _B090, _B180 and _B270 that indicate the baseline building has been rotated for 0°, 90°, 180° and 270° respectively (Figure 67), while proposed building results are differentiated with a suffix of _p000.

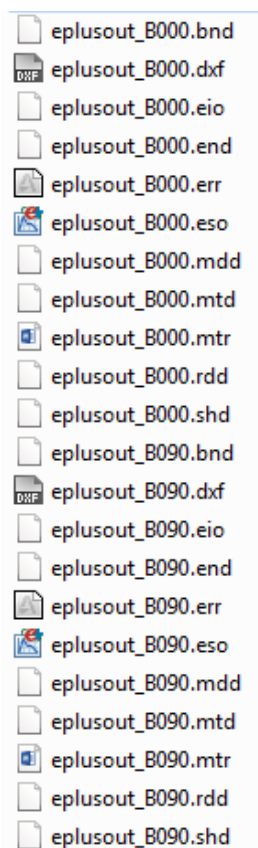


Figure 67 Simulated data stored on the local drive

8. Outputs and Post Processing

DesignBuilder LEED recommends running standard simulations on the “Analysis” tab before running ASHRAE 90.1 simulations to address any issues that either stop simulations from running or cause unrealistic outputs.

DesignBuilder strongly advises that you undertake appropriate Quality Control checks prior to running the final proposed and baseline building simulations for ASHRAE 90.1 purposes. As a minimum, we advise that you check all model data inputs then run shorter test simulations to check key sub-hourly results. Examples include design summer and winter week simulations to check cooling and heating plant operation, and swing season weeks to check whether controls that should prevent inappropriate simultaneous heating and cooling are operating correctly. The DesignBuilder Results Viewer tool can help visualise correct operation at the HVAC node level. Then finally run an annual simulation to view annual and monthly results to “sanity-check” key energy consumption values and unmet load hours against appropriate metrics.

The LEED-specific summary report outputs described above should be reviewed. Examples of these are shown in Tables 1, 2 and 3 below. DesignBuilder results can also be displayed in “Grid” form and exported to a spreadsheet in .csv format for further analysis if required.

EAp2-4/5. Performance Rating Method Compliance

	Electric Energy Use [kWh]	Electric Demand [W]	Natural Gas Energy Use [therm]	Natural Gas Demand [Btu/h]	Additional Energy Use [kBtu]	Additional Demand [Btu/h]
Interior Lighting	34413.18	7290.92	0.00	0.00	0.00	0.00
Exterior Lighting	0.00	0.00	0.00	0.00	0.00	0.00
Space Heating	0.00	0.00	3010.54	428082.85	0.00	0.00
Space Cooling	3462.43	4395.25	0.00	0.00	0.00	0.00
Pumps	4908.23	1802.36	0.00	0.00	0.00	0.00
Heat Rejection	211.43	853.99	0.00	0.00	0.00	0.00
Fans-Interior	10290.68	1155.93	0.00	0.00	0.00	0.00
Fans-Parking Garage	0.00	0.00	0.00	0.00	0.00	0.00
Service Water Heating	0.00	0.00	0.00	0.00	0.00	0.00
Receptacle Equipment	11873.28	4328.98	0.00	0.00	0.00	0.00
Interior Lighting (process)	0.00	0.00	0.00	0.00	0.00	0.00
Refrigeration Equipment	0.00	0.00	0.00	0.00	0.00	0.00
Cooking	0.00	0.00	0.00	0.00	0.00	0.00
Industrial Process	0.00	0.00	0.00	0.00	0.00	0.00
Elevators and Escalators	0.00	0.00	0.00	0.00	0.00	0.00
Total Line	65159.22		3010.54		0.00	

Table 1 LEED EAp2-4/5 PRM Compliance

EAp2-6. Energy Use Summary

	Process Subtotal [GJ]	Total Energy Use [GJ]
Electricity	2202.59	5482.13
Natural Gas	0.00	233.54
Total	2202.59	5715.67
Additional	0.00	0.00

Table 2 LEED Energy Use Summary

EAp2-7. Energy Cost Summary

	Process Subtotal [\$]	Total Energy Cost [\$]
Electricity	30606.07	76176.92
Natural Gas	0.00	2291.71
Other		0.00
Total	30606.07	78468.63
Additional	0.00	

Process energy cost based on ratio of process to total energy.

Table 3 LEED Energy Cost Summary

LEED EAp2-4/5 (Table 1), EAp2-6 (Table 2) and EAp2-7 (Table 3) are examples (from a proposed building simulation) of how EnergyPlus output summaries fit the LEED EA Prerequisite 2: Minimum Energy Performance document.

8.1 Unmet load hours

To verify that the baseline building and the proposed building have reasonable equipment sizes and are controlled correctly, a check should be made to check unmet load hours, i.e. hours during the simulation period when loads are not met. High unmet load hours indicate that the equipment is undersized and/or incorrectly controlled.

8.1.1 Unmet hours for LEED

LEED summary table EAp2-2 Advisory Messages summarizes the unmet hours from the simulation (Figure 68).

EAp2-2. Advisory Messages

	Data
Number of hours heating loads not met	0.00
Number of hours cooling loads not met	0.00
Number of hours not met	0.00

Figure 68 LEED summary table EAp2-2 shows unmet hours

The “Unmet hours” of a building are the summation of the number of hours when the heating or the cooling set point temperature of a zone is not met either by the HVAC system or by the plant.

8.1.2 Manipulate model to address unmet load hours

Maintaining unmet load hours below the criteria set in ASHRAE 90.1 is mandatory unless it can be proven that exceeding the limit does not unduly impact on building performance.

8.1.2.1 Unmet hours criteria from ASHRAE 90.1 Standard

In order for equipment to be acceptably sized under the rules of the building performance rating method, two conditions must be met:

- The unmet load hours for both the proposed design and the baseline building design shall not exceed 300 hours per year (of the 8760 hours simulated).
- The unmet load hours for the proposed design shall not exceed the number of unmet load hours for the baseline building design by more than 50.

8.1.2.2 Dealing with unmet hours that exceed the limits

If unmet load hours in the proposed building exceed the unmet load hours in the baseline building by more than 50, then the size of equipment in the baseline building shall be reduced incrementally, until the condition is satisfied.

If unmet load hours for either the proposed design or baseline building design exceed 300, then the simulated capacities shall be increased incrementally, and the building with unmet loads shall be re-simulated until the unmet load hours are reduced to 300 or less. For the proposed building, this means that the construction drawings may need to be modified and larger equipment specified.

Alternatively in some cases, unmet load hours exceeding these limits may be accepted at the discretion of the rating authority provided that sufficient justification is given indicating that the accuracy of the simulation is not significantly compromised by these unmet loads.

However, in all cases it is important that the unmet load hours of the proposed design do not exceed that of the baseline design by more than the stated 50 hours. This is to ensure that energy savings are not claimed in the proposed design by providing a lower level of performance than in the baseline building.

8.2 Annual energy consumption

After both the proposed and baseline building simulations have been run, the comparison between baseline and proposed building results for annual energy end uses is shown on the “ASHRAE 90.1” tab. The data is broken

down by end use categories, such as heating, cooling, interior lighting, exterior lighting and interior equipment and so on (Figure 69).

The comparison based on energy costs can also be viewed (Figure 70) by selecting “2-Costs” for the “Show” setting in the Display Options panel which is located at the left bottom corner of DesignBuilder screen (Figure 71). To ensure the view of cost comparison, the tariff (utility rate) definitions on Economics tab at building level should be enabled and configured prior to simulations.

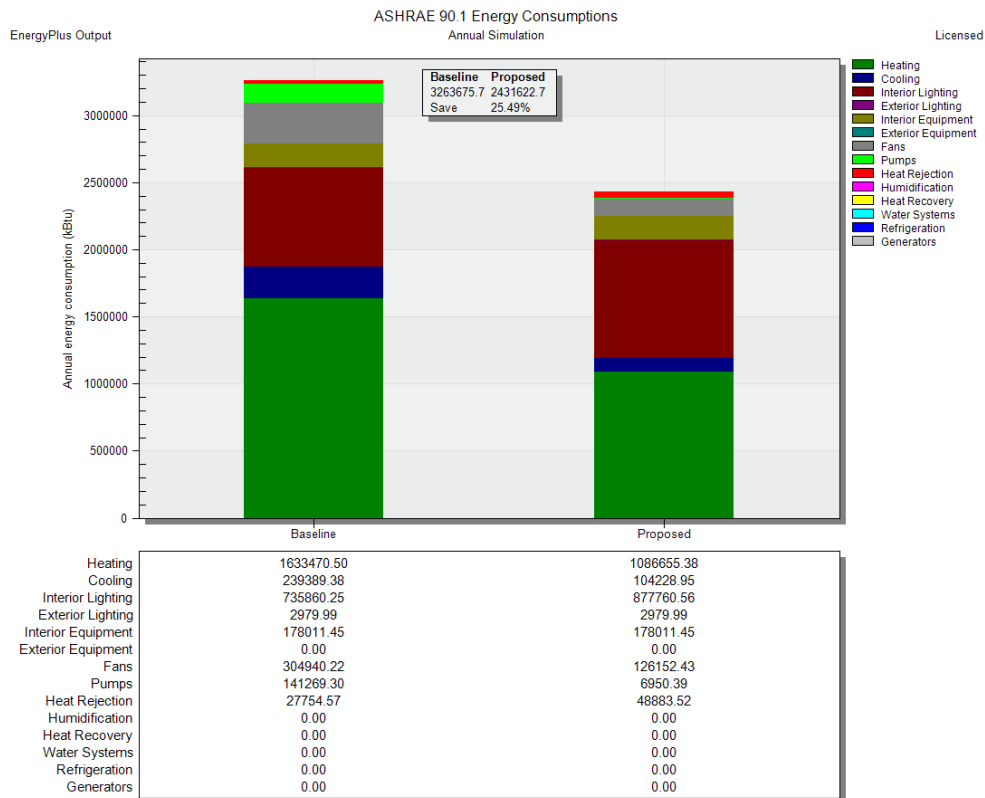


Figure 69 Output results in terms of annual energy end uses

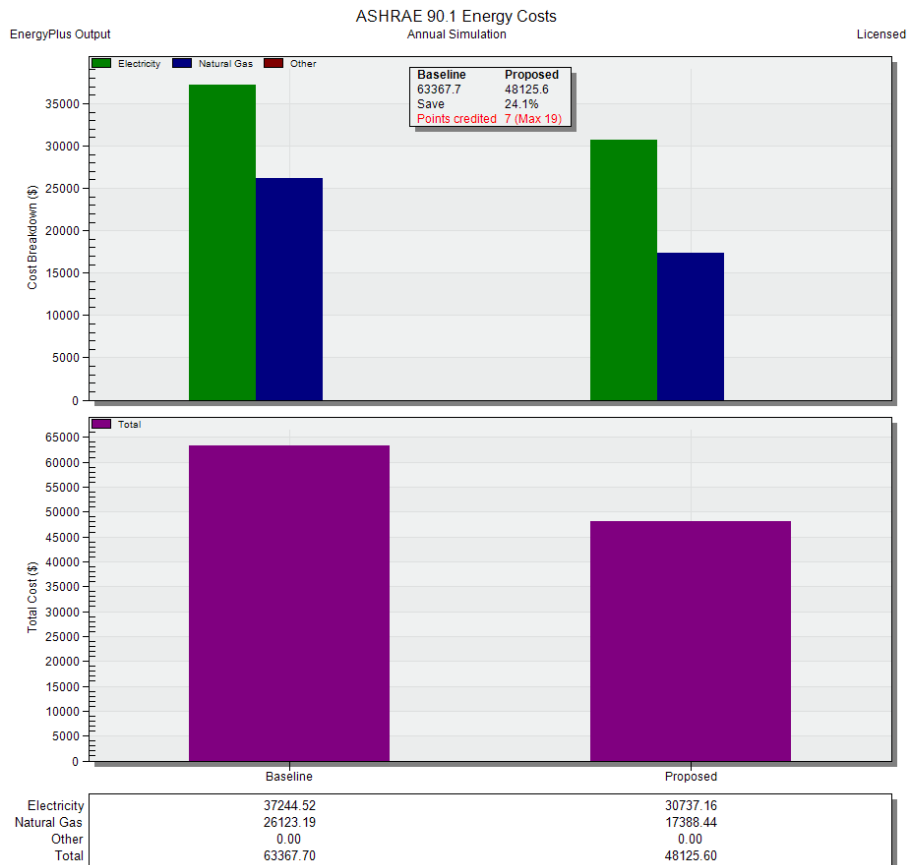


Figure 70 Output results in terms of annual energy costs

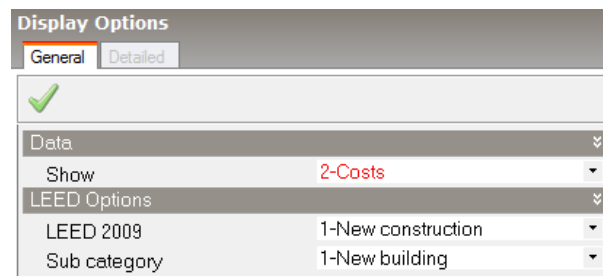


Figure 71 Display options that allow show energy costs comparison

On the energy costs comparison graph, points credited are proposed based on the energy costs saving percentage shown on the same graph as well as LEED options selected from Display Options (Figure 71).

8.3 Data post processing using LEPORT

Users are free to choose any method to post process simulation results in order to prepare the reports/documents to be submitted to GBCI (Green Building Certification Institute).

DesignBuilder v6.0 provided a set of online tools called LEPORT (LEED Energy Performance Online Reporting Tool). These early test tools have been withdrawn for v6.1 in preparation for a new set of tools to be released with v6.2.