

Daylighting Guide




The **Daylighting Guide** is also available within the Simergy Help CHM file that is available within Simergy , and is located in the Introduction chapter.

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Simergy Daylighting Controls Guide

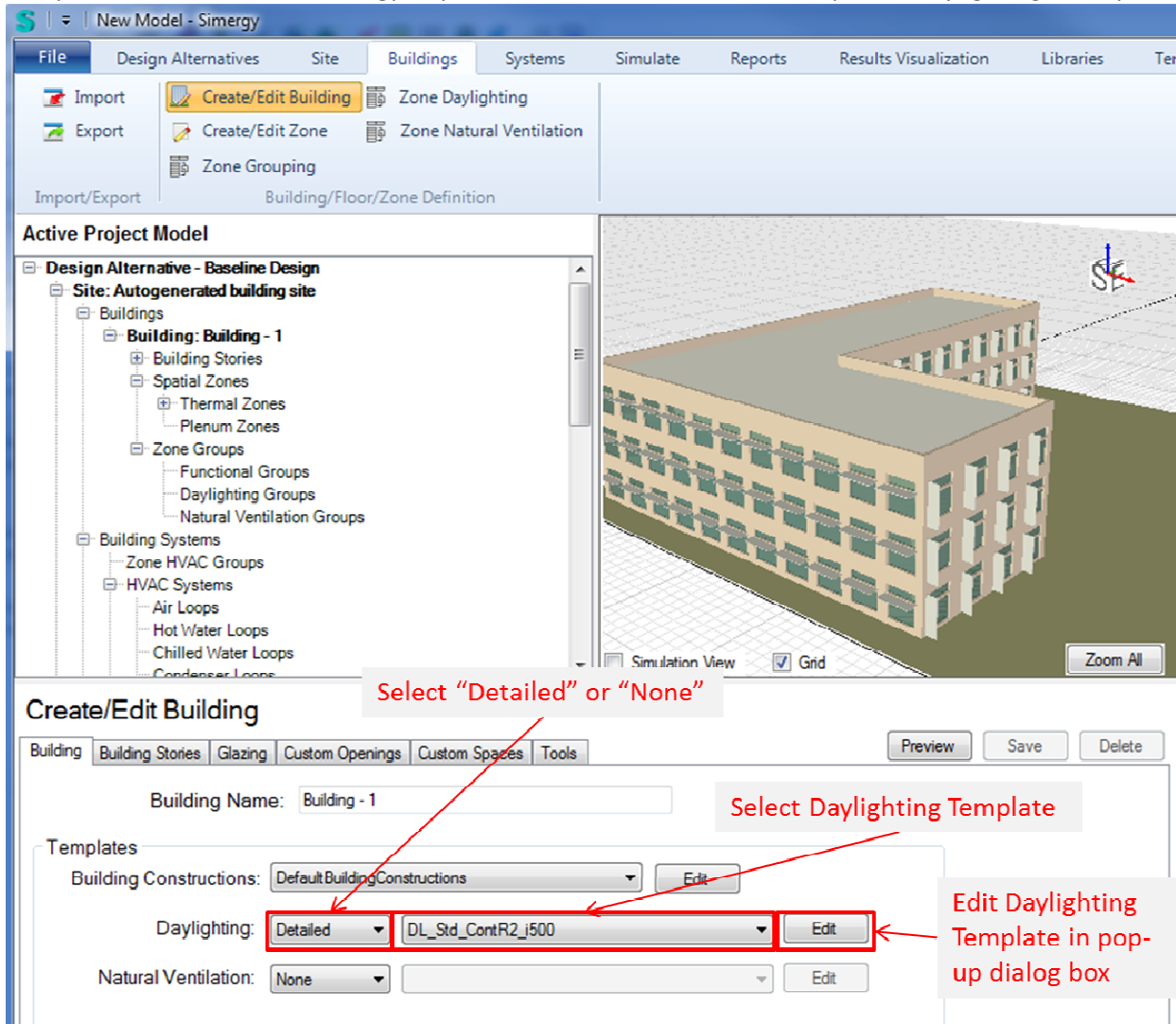
Simergy version 1 allows users to analyze daylighting dimming strategies at the overall building level as well as for specific portions and zone groups of the building. The Daylighting Guide walks through the steps to incorporate Daylighting Controls into your BEM. Other key topics include:

- Naming Conventions for Templates and Libraries of Simergy Content
- Daylighting Outputs
- Links to other relevant topics within the Simergy Help
- Links to relevant topics within the EnergyPlus Input Output Reference Guide

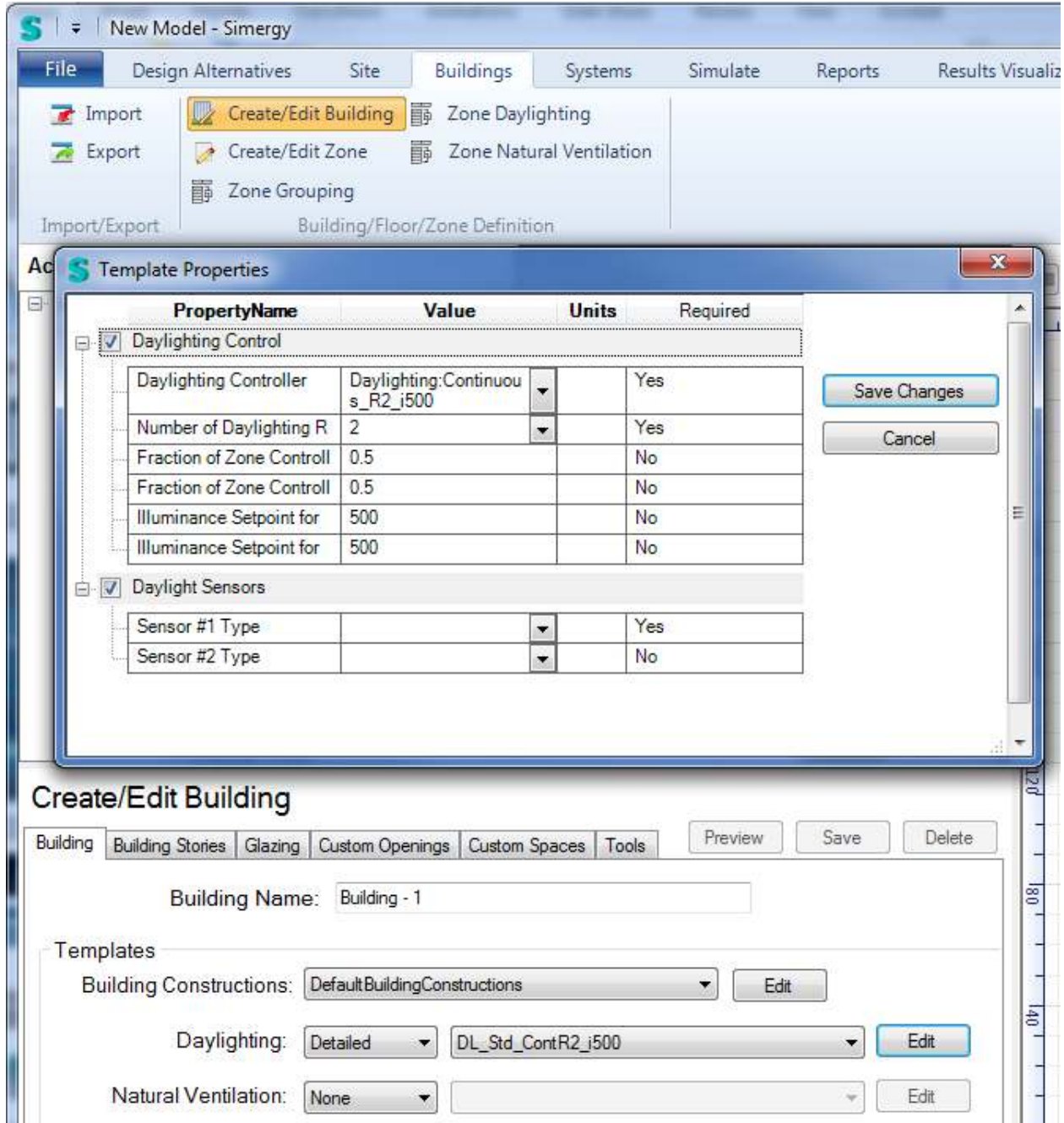
First Step = Make Daylighting Active

Workspace = Buildings > Create/Edit Building > Building Section

There is only one Daylighting Method implemented in Simergy, so to make daylighting active Detailed in the first drop down list. Next select a daylighting template from the second drop down list. A set of Templates is installed with Simergy or you can create or edit them in *Templates>Daylighting workspace*.



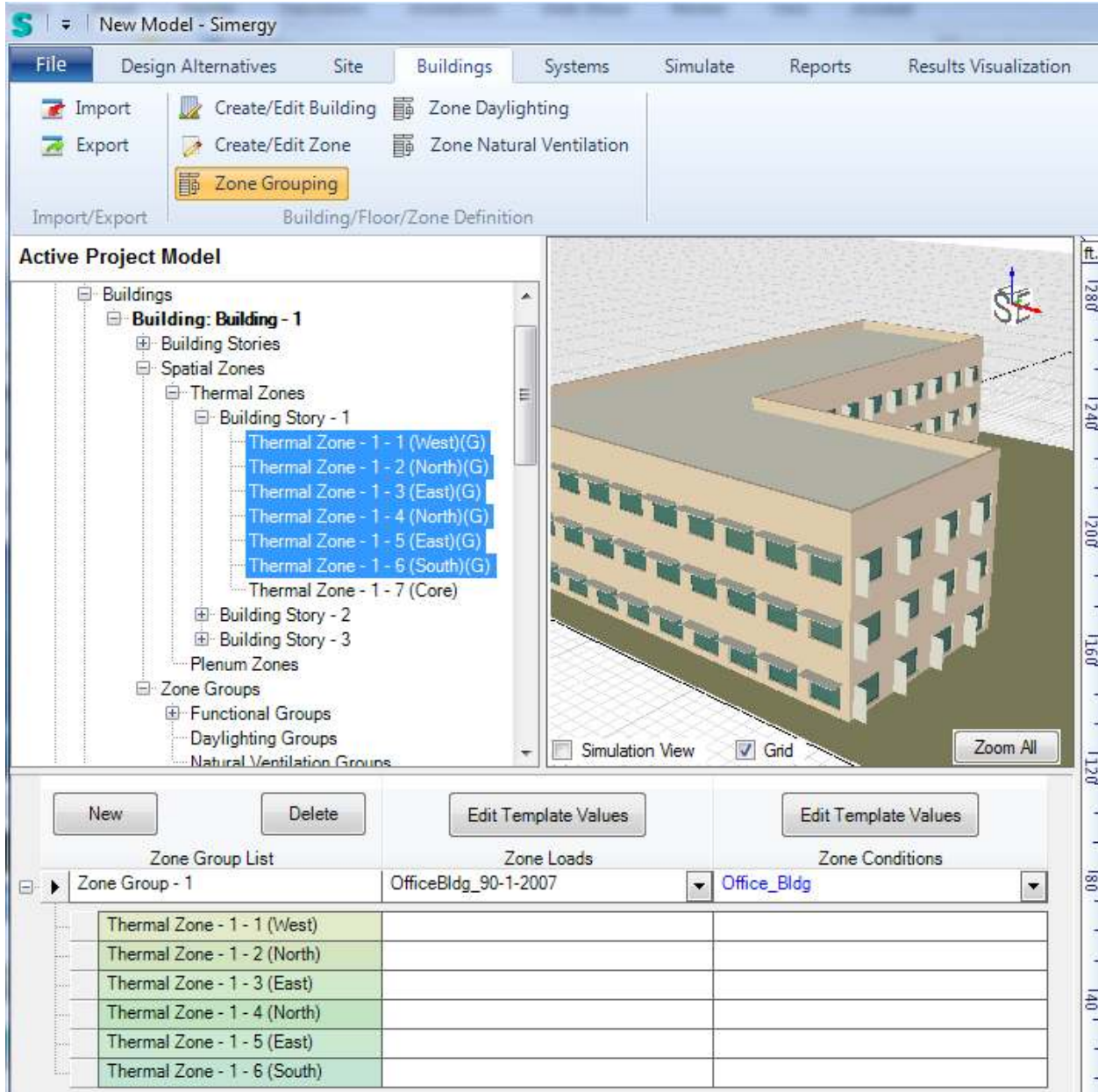
In addition you can view and make changes to the [Detailed Daylighting Template](#) by selecting Edit, which will open a pop-up dialog box, which provides the same capability as if you were working in the Templates > Daylighting workspace. Each drop down list in the value column of the table is linked to a Libraries category that is the source for the list. You can either select a library entry from the available set packaged with the Simergy installation or create your own within the Libraries category. The [Detailed Daylighting Template](#) topic identifies the drop down list source for each row and provides links to descriptions.



Assign Thermal Zones to Zone Groups

The thermal zones are assigned to either a single Zone Group or multiple Zone Groups. This stage is important because it is where the Zone Loads Templates are assigned, which determines the lighting load that will be associated with each Zone Group, in addition to People and Equipment.

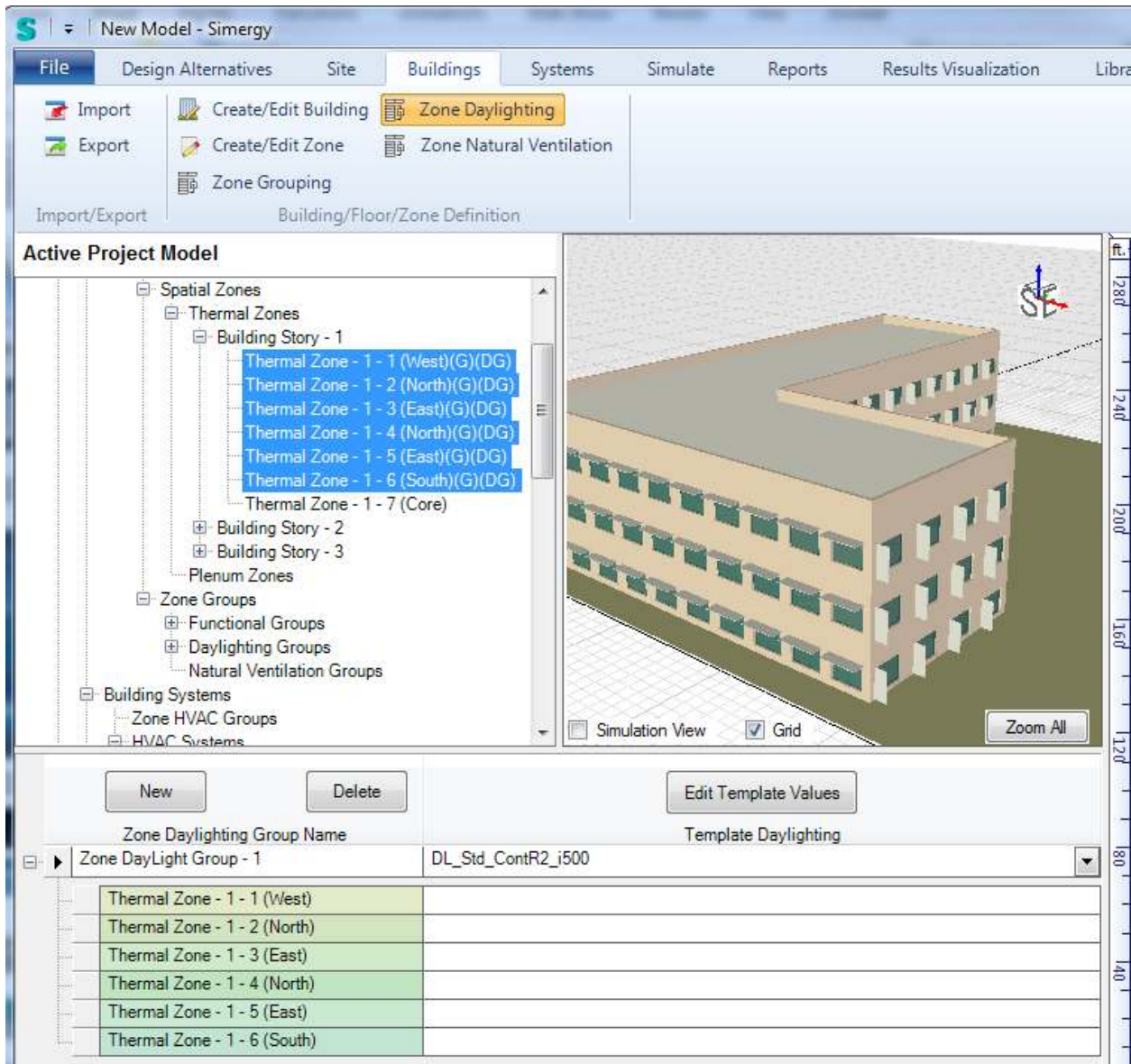
Note: At this stage Daylighting Controls can be analyzed at the overall building level, because they have been assigned to each zone within the model. If the intent is to analyze Daylighting Controls for certain thermal zones, then the user can set up Zone Daylighting Groups.



Setup and Assign Thermal Zones to Zone Daylighting Groups

To assign Daylighting Controls to individual thermal zones or groups of thermal zones, the user can create a new Zone Daylighting Group, drag and drop thermal zones from the Project Tree into the Zone Daylighting Group to assign them, and then select a Daylighting Template from the drop down list.

Note: After thermal zones have been associated with a group type, abbreviations will appear behind the thermal zone name.



Setup and Run Simulation

At this point, if the rest of the relevant inputs for the BEM are complete, the user can setup the simulation(s) and choose which output variables to associate with the simulation, run the simulation(s), and then evaluate the results.

Daylighting Output Variables

Although there are a number of different types of output variables that would be interesting for users to associate with their models, there are three main category types for Daylighting - Daylighting Outputs, Lighting Outputs and Meters for Lights Outputs.

Daylighting Outputs

The following displays daylighting outputs that can be associated with models. Detailed explanations for each are in the Daylighting Output section of the EnergyPlus Input Output Reference. The units shown are SI, but the user can change to Imperial Units by selecting File/Options/User Interface Measure Units and selecting Imperial Units.

<i>Zone,Average,Exterior Beam Normal Illuminance [lux]</i>
<i>Zone,Average,Exterior Horizontal Beam Illuminance [lux]</i>
<i>Zone,Average,Exterior Horizontal Illuminance From Sky [lux]</i>
<i>Zone,Average,Luminous Efficacy of Beam Solar Radiation [lum/W]</i>
<i>Zone,Average,Luminous Efficacy of Sky Diffuse Solar Radiation [lum/W]</i>
<i>Zone,Average,Sky Clearness for Daylighting Calculation []</i>
<i>Zone,Average,Sky Brightness for Daylighting Calculation []</i>
<i>Surface,Average,Daylight Luminance of Window As Viewed From Ref Point 1 [cd/m2]</i>
<i>Surface,Average,Daylight Illum at Ref Point 1 from Window [lux]</i>
<i>Zone,Average,Daylight Illum at Ref Point 1 [lux]</i>
<i>Zone,Average,Glare Index at Ref Point 1 []</i>
<i>Zone,Sum,Time Exceeding Glare Index Setpoint at Ref Point 1 [hr]</i>
<i>Zone,Sum,Time Exceeding Daylight Illuminance Setpoint at Ref Point 1 [hr]</i>
<i>Surface,Average,Daylight Luminance of Window As Viewed From Ref Point 2 [cd/m2]</i>
<i>Surface,Average,Daylight Illum at Ref Point 2 from Window [lux]</i>
<i>Zone,Average,Daylight Illum at Ref Point 2 [lux], if applicable</i>
<i>Zone,Average,Glare Index at Ref Point 2 [], if applicable</i>
<i>Zone,Sum,Time Exceeding Glare Index Setpoint at Ref Point 2 [hr]</i>
<i>Zone,Sum,Time Exceeding Daylight Illuminance Setpoint at Ref Point 2 [hr]</i>
<i>Zone,Average,Ltg Power Multiplier from Daylighting []</i>

Lighting Outputs

Note: If daylighting controls are operating in the zone, all of the Lights objects with a Fraction Replaceable greater than zero will be reduced by a multiplicative factor that accounts for how much the electric lighting is lowered due to daylighting.

Detailed explanations for each are in the Lighting Output section of the EnergyPlus Input Output Reference. The units shown are SI, but the user can change to Imperial Units by selecting File/Options/User Interface Measure Units and selecting Imperial Units.

Lights objects have output variables for individual objects and for zone totals.

<i>Zone,Average,Lights Electric Power [W]</i>
<i>Zone,Sum,Lights Radiant Heat Gain [J]</i>
<i>Zone,Average,Lights Radiant Heat Gain Rate [W]</i>
<i>Zone,Sum,Lights Visible Heat Gain [J]</i>
<i>Zone,Average,Lights Visible Heat Gain Rate [W]</i>

<i>Zone,Sum,Lights Convective Heat Gain [J]</i>
<i>Zone,Average,Lights Convective Heat Gain Rate [W]</i>
<i>Zone,Sum,Lights Return Air Heat Gain [J]</i>
<i>Zone,Average,Lights Return Air Heat Gain Rate [W]</i>
<i>Zone,Sum,Lights Total Heat Gain [J]</i>
<i>Zone,Average,Lights Total Heat Gain Rate [W]</i>
<i>Zone,Sum,Lights Electric Consumption [J]</i>
<i>Zone,Average,Zone Lights Electric Power [W]</i>
<i>Zone,Sum,Zone Lights Radiant Heat Gain [J]</i>
<i>Zone,Average,Zone Lights Radiant Heat Gain Rate [W]</i>
<i>Zone,Sum,Zone Lights Visible Heat Gain [J]</i>
<i>Zone,Average,Zone Lights Visible Heat Gain Rate [W]</i>
<i>Zone,Sum,Zone Lights Convective Heat Gain [J]</i>
<i>Zone,Average,Zone Lights Convective Heat Gain Rate [W]</i>
<i>Zone,Sum,Zone Lights Return Air Heat Gain [J]</i>
<i>Zone,Average,Zone Lights Return Air Heat Gain Rate [W]</i>
<i>Zone,Sum,Zone Lights Total Heat Gain [J]</i>
<i>Zone,Average,Zone Lights Total Heat Gain Rate [W]</i>
<i>Zone,Sum,Zone Lights Electric Consumption [J]</i>

Meters for Lights Outputs

Meter Name	Scope	Lights Specifies
Electricity:Facility	Entire Facility	All
Electricity:Building	All Zones	All
Electricity:Zone:<Zone Name>	Specific Zone	All
Interior Lights: Electricity	All Zones	Lights Use
Interior Lights: Electricity:Zone:<Zone Name>	Specific Zone	Lights Use
<End-Use Subcategory>:Interior Lights: Electricity	Specific Subcategory	Lights Use

Daylighting Controllers Naming Convention

The intent is to convey key performance characteristics about the library entry within the name, so that the user has some insight into what these key input values are when they are selecting the library entry, so they don't have to go back to that workspace to look at the property input values.

Example Name = *Daylighting:Continuous_R2_i500*

- Daylighting = Daylighting
- Continuous = Continuous; Stepped = Stepped; Cont-OnOff = Continuous On/Off
- R2 = (2) reference points; R1 = (1) Reference Point
- i500 = illuminance level of 500 lux for the reference point(s); i400 = illuminance level of 400 lux at the reference point(s)

Templates - Daylighting Naming Convention

The intent is to convey key performance characteristics about the template within the name, so that the user has some insight into what these key input values are when they are selecting the template, so they don't have to go back to that workspace to look at the property input values.

Example Name = DL_Std_ContR2_i500

- DL = Daylighting
- Std = The Standard Method for calculations, which is equivalent to the Detailed Method in EnergyPlus
- Cont = Continuous; Step = Stepped; ContOnOff = Continuous On/Off
- R2 = (2) reference points; R1 = (1) Reference Point
- i500 = illuminance level of 500 lux for the reference point(s); i400 = illuminance level of 400 lux at the reference point(s)

Daylighting Modeling Scenarios

The table identifies different types of daylight modeling that are possible within Simergy. In addition it identifies a recommended set of output variables and provides a description of where and what steps are involved in Simergy. Some of the options are discussed in more detail below and contain links within the table.

Modeling Option	Description
Daylight a Thermal Zone	You can do this to all thermal zones by ' making daylight active ', but you can also do it for a single or set of zones by including them in a zone daylighting group .
Specify Visible Transmittance for Glazing	The visible transmittance is specified at the Libraries:Materials level. The Materials library entry is then associated with a Mat'l/Glazing Layer to set the depth of the glazing. Then it is associated with a Mat'l/Glaz Layer Set to establish the 'layered assembly' and then it is associated with a Window library entry. The final stage is a Construction Template that assembles the selections for the opaque and fenestration constructions in one place.
Use Electrochromic Glazing to control glare	Electrochromic Glazing (Switchable Glazing) contains a "Dark State" and a "Clear State". A Shading Control Controller defines the "Dark State", and is where you can set "Glare Control Is Active" to "Yes". The "Clear State" is defined in the properties of the Window itself, which is where the Shading Control Controller that has been created can be selected as well.
Adjust Electrochromic Glazing to meet daylighting illuminance Setpoint	Set up a Shading Control Controller for Heating_Cooling Loads (Sub Type). Set the Shading Control Type Property to "MeetDaylightIlluminanceSetPoint" for the Shading Type = Switchable Glazing . The Illuminance Setpoint is not defined within this library entry, the Illuminance Setpoint

	<p>looks to what has been defined in Daylighting Template. When you have activated Daylighting and selected the Daylighting Template, then when you define the Window type that contains the Shading Control property the model is ready.</p>
<p>Control Electric Lighting Response to Daylight Illuminance Level</p>	<p>You will need to set up or select a Daylighting Controller to be part of a Daylighting Template that specifies the number of sensor reference points, targeted illuminance level at those sensors and other properties.</p>
<p>Model daylighting through double facade</p>	<p>The EnergyPlus Daylighting:Controls (Detailed Method) is incorporated into Simergy. This method enables the ability to model daylight through a double facade (exterior window through a space, through an interior window and into a space). It does not calculate daylight passing through more than one interior window. Care should be taken to position the reference points, but no specific inputs are required to enable this capability.</p>
<p>Add diffusing (translucent glass)</p>	<p>Diffusing glass can be specified initially at the Glazing Material level (Solar Diffusing Property for Material:Glazing), and then that glazing material will have a thickness provided (Mat'l/Glazing Layer), be included in a layer set (Mat'l/Glaz Layer Sets), and then included in a window (Windows).</p> <p><i>Note: Solar Diffusing should only be used on the innermost pane of glass in an exterior window; it does not apply to interior windows</i></p>

Zone Daylighting

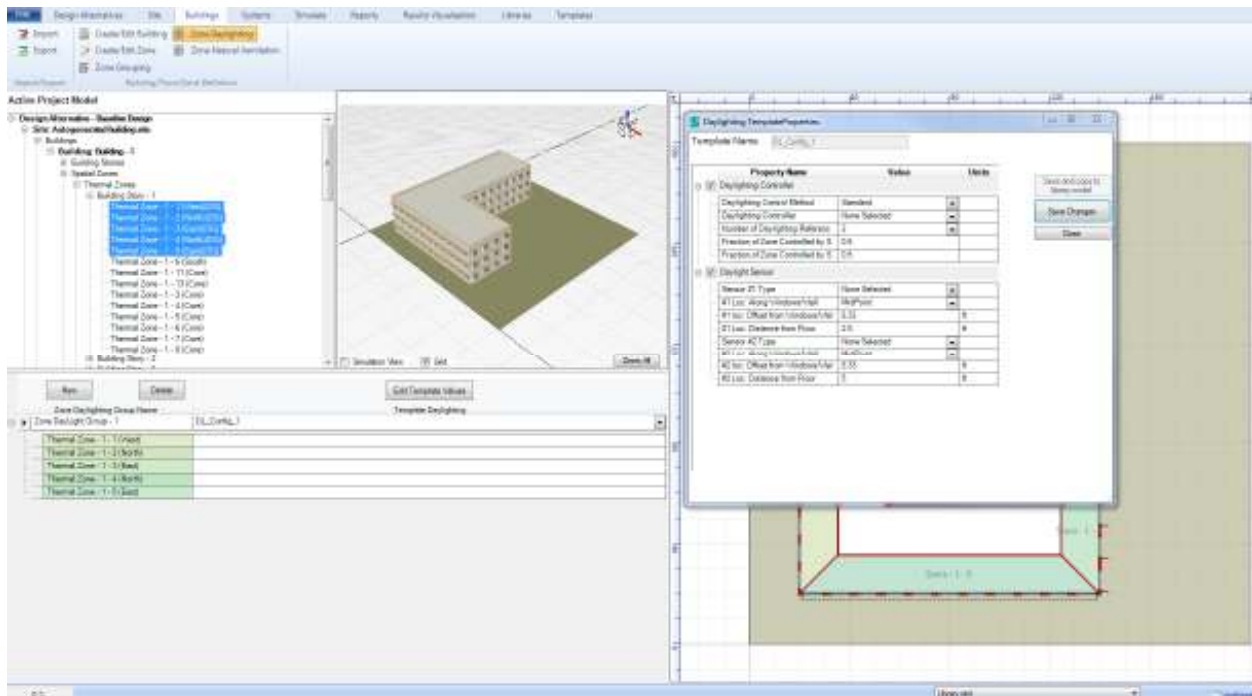
Workspace: Buildings-Building/Floor/Zone Definition-Create/Zone Daylighting

Workspace Areas: Active Project Model Tree - 3d view - 2d view

Related Workspaces: Zone Daylighting - Zone Natural Ventilation

The strategy is to allow the user to set up different Zone Groups within the model to assign Daylighting templates to, so that they can leverage commonality among thermal zones for these property categories and reduce the number of times the information needs to be assigned. The user can also access and edit the templates selected directly from this workspace, versus having to go to the templates and/or libraries tabs.

Note: A user could have the same thermal zone within a Zone Group, a Zone Daylighting Group and a Zone Natural Ventilation Group. A thermal zone can only be in one Group within a type. This provides the user substantial flexibility in how thermal zones can be grouped and input values assigned.



When a user has assigned a thermal zone to a Zone Daylighting Group, the letters (DG) will appear at the end of the thermal zone listing on the Project Tree.

Zone Daylighting Table

At a basic level, the table contains two columns. Once a Zone Daylighting Group has been created (New) the user can then select single or multiple thermal zones from the Project Tree and drag and drop them into the table and associate them with a specific Zone Group.

Tip: When dragging and dropping thermal zones from the Project Tree, make sure to drop them on the Zone Group name.

Zone Daylighting Group Name

The unique name that is assigned by default or is entered by the user. The name entered is the one that will appear in the Project Tree under Zone Groups/Daylighting Groups.

Note: The user can select within the cell and edit the text directly to create a new name and/or edit the existing.

Template Daylighting

[drop down list] The user can select a [Daylighting Template](#) from the drop down list. The options available are dependent upon the Source Library that is active. The [Daylighting Template](#) contains input properties for Daylighting Controllers and Daylight Sensors.

New

Creates a new row in the table, and provides a default unique (sequential) name in the Zone Group List column.

Delete

The user can select a Zone Group and then by selecting delete they can remove that Zone Group from the model.

Edit Template Values - Daylighting

By selecting the user can directly access the selected [Daylighting Template](#) via a pop-up window as shown in the image above. Within the pop-up window the user can make changes to the template just as they would if they went to the Templates/Data Templates/Daylighting workspace. Within the pop-up dialog, if the user makes changes they have two "save options"

Save Changes

Saves the template changes to the Project Model Source Library associated with the project.

Save and Copy to Library Model

Saves the template changes to the source library that the Template was created/is currently associated with.

Tip: If just reviewing the Templates content and no changes have been made, just select the red X in the upper right of the pop-up dialog to close it.

Daylighting

Location = Templates/Data Templates/Daylighting

The Daylighting Data Template allows the user to set or review the properties associated with the Daylighting Controller and Daylight Sensor. The Property Values table contains a set of properties that present either a defined set of input value options that are available within EnergyPlus or allow the user to select Library Entries included in the active Source Library that have been created by them or are included with Simergy.

PropertyName	Value	Units
Daylighting Control		
Daylighting Controller	Daylighting:Continuous_R2_i500	
Number of Daylighting Reference Points	2	
Fraction of Zone Controlled by Sensor #1	0.5	
Fraction of Zone Controlled by Sensor #2	0.5	
Illuminance Setpoint for Sensor #1	500	
Illuminance Setpoint for Sensor #2	500	
Daylight Sensors		
Sensor #1 Type	LuxSensor	
#1 Loc: Along Windows/Wall	MidPoint	
#1 loc: Offset from Windows/Wall	2540	mm
#1 Loc: Distance from Floor	762	mm
Sensor #2 Type	LuxSensor	
#2 Loc: Along Windows/Wall	MidPoint	
#2 loc: Offset from Windows/Wall	2540	mm
#2 Loc: Distance from Floor	1524	mm

The image displays that there are two main workspaces:

- Data Template Naming/Selection
- Data Template Property Table

Property Values Table Value Sources

The table below maps the drop down list sources for each row of the Value column in the property table that is displayed in the image below. It addresses two questions; 1) Where does the list shown come from? 2) What does the user need to go to add to the list or edit library entries? The hyperlinks in the Value Sources column go to the description of the library category.

Tip: If a value source is not included it means the field is predefined selections determined by EnergyPlus, and cannot be edited by the user in Simergy.

Property Category	Property Name	Value Sources
Daylighting Controller	Daylighting Controller	Controller/Daylighting/Standard
	Number of Daylighting Reference Points	1 or 2
	Fraction of Zone Controlled by Sensor #1	between 0 to 1
	Fraction of Zone Controlled by Sensor #2	between 0 to 1
	Illuminance Setpoint for Sensor #1	manual input (lux)
	Illuminance Setpoint for Sensor #2	manual input (lux)
Daylight Sensor	Sensor #1 Type	Sensor/LuxSensor/Default

#1 Loc: Along Windows/Wall	<i>Midpoint</i>
#1 loc: Offset from Windows/Wall	<i>distance to be entered</i>
#1 Loc: Distance from Floor	<i>distance to be entered</i>
Sensor #2 Type	Sensor/LuxSensor/Default
#2 Loc: Along Windows/Wall	<i>Midpoint</i>
#2 loc: Offset from Windows/Wall	<i>distance to be entered</i>
#2 Loc: Distance from Floor	<i>distance to be entered</i>

Daylighting Controller (Property Set)

Daylighting Controller

The drop down list source is Libraries/Controls and Performance Data/ [Controller/Daylighting/Standard](#), which establishes the number of reference points, the illuminance setpoint at those reference points, the lighting control type (continuous or stepped) and glare parameters.

Number of Daylighting Reference Points

Allowed values are 1 or 2. This the number of reference points in the zone at which horizontal daylighting illuminance will be calculated based on input for the following fields. It is assumed that the photocells that control the overhead electric lighting respond to the light levels at the specified reference points.

Fraction of Zone Controlled by Sensor #1

The fraction of the zone’s floor-area whose electric lighting is controlled by the daylight illuminance at the First Reference Point. If there is only one reference point then a fraction equal to 1.0 - (Fraction of Zone Controlled by First Reference Point)

Fraction of Zone Controlled by Sensor #2

The fraction of the zone’s floor-area whose electric lighting is controlled by the daylight illuminance at the Second Reference Point. Required if Total Daylighting Reference Points = 2.

Daylighting Sensor (Property Set)

Sensor #1 Type

The source of the drop down list is Libraries/Controls and Performance Data Sensor/LuxSensor/Default. The library entry defines the actual location of the sensor (X,Y,Z coordinates) and also establishes the Illuminance Setpoint at that reference point.

#1 Loc: Along Windows/Wall

Currently the only selection option is MidPoint

#1 Loc: Offset from Windows/Wall

The offset distance (mm or inches) from the exterior wall into the space.

#1 Loc: Distance from Floor

The location in height (mm or inches) from the floor to the sensor.

Sensor #2 Type

The source of the drop down list is Libraries/Controls and Performance Data Sensor/LuxSensor/Default. The library entry defines the actual location of the sensor (X,Y,Z coordinates) and also establishes the Illuminance Setpoint at that reference point.

#2 Loc: Along Windows/Wall

Currently the only selection option is MidPoint

#2 Loc: Offset from Windows/Wall

The offset distance (mm or inches) from the exterior wall into the space.

#2 Loc: Distance from Floor

The location in height (mm or inches) from the floor to the sensor.

Controllers

Location = Libraries/Controls and Performance Data/Controllers

EnergyPlus = Group-Controllers

Simergy in 3s Reminder:

- **Controllers** reference schedules, control schemes, and potentially control scheme lists
- **Control Schemes** reference schedules
- **Control Scheme Lists** Reference Control Schemes

The Controllers Libraries Workspace is where the user can review and create a number of different types of controllers enabling different control schemes to be incorporated in the BEM. Controllers can reference either Control Schemes, Control Scheme Lists or Schedules, so the user should pay close attention to the properties for the Type and Sub Type selected. For example, the following Controller Type and Sub Type combinations reference Control Scheme Lists:

- Type = SupplyAir; Sub Type = Temperature
- Type = SupplyWater; Sub Type = Temperature
- Type = OperationManager; Sub Type = Plant Loop
- Type = ThermalStorage; Sub Type = ThermalEnergyStorageTank

Users can specify controllers in different locations in Simergy. Common locations include:

- Air Loop and Water Loop Diagrams
- Air Loop and Water Loop Level Controls
- Zone Conditions Templates

Each Type in the Type and Sub Type table contains a section that displays a screenshot of the Property Values Table showing the properties associated with the Type and Sub Type. In the case where the Sub Types have the same properties only one example of the Property Values table is shown. See Property Values Table to learn about how to interact with the table.

Note: *Although not yet fully implemented the intent is that for each section there will be links directly to the EnergyPlus Input Output Reference. In addition the links will also be included in the Type and Sub Type Mapping Table.*

Type and Sub Type Mapping

The table displays the Controller Type and Sub Type options that can be selected from the drop down lists in that area of the workspace, which filter the Source Library to display the variables the user can select to include, along with a value, in a Library Entry.

Note: *The links within the table are to the EnergyPlus Input Output Reference and the explanations of the objects.*

Type Options	Sub Type Options	EnergyPlus Objects (IO Reference links)
Shading Control	On_off Heating_Cooling Loads Window	WindowProperty:ShadingControl WindowProperty:ShadingControl WindowProperty:ShadingControl

	Temp_Solar	
Daylighting	Standard	Daylighting:Controls
Zone Control Humidity	Humidistat Humidistat 1Zone	ZoneControl:Humidistat ZoneControl:Humidistat
Zone Control Temperature	Thermostat Thermostat Thermal Comfort Thermostat 1Zone Thermostat Thermal Comfort 1Zone	ZoneControl:Thermostat ZoneControl:Thermostat:ThermalComfort ZoneControl:Thermostat ZoneControl:Thermostat:ThermalComfort
Ventilation	Contaminant Control	ZoneControl:ContaminantController
Outdoor Air	Economizer Control	Controller:OutdoorAir
Mechanical Ventilation	Economizer with Demand Controlled Ventilation	Controller:MechanicalVentilation
Supply Air	Temperature, Humidity	Controller:AirTemperature
Supply Water	Temperature	Controller:WaterTemperature
Operation Manager	Plant Loop	OperationManager:Controller
Thermal Storage	Thermal Energy Storage Tank	Controller:ThermalStorage

Shading Control (Type)

On_off (Sub Type)

Heating_Cooling Loads (Sub Type)

Window Temp_Solar (Sub Type)

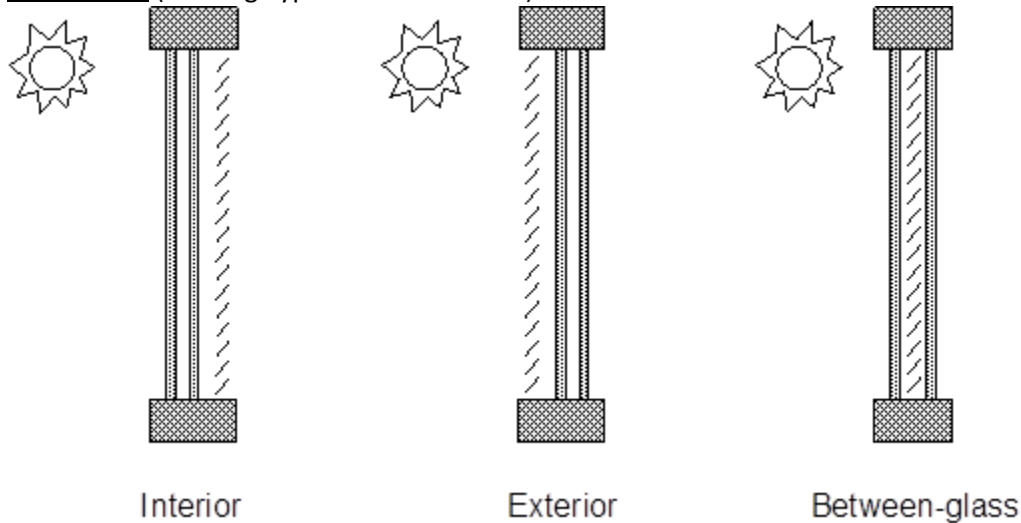
WindowProperty: Shading Control (Property Category)

Note: All three sub types have the same properties available (see table above), however they have different selection options for Shading Control Type that are outlined in the table below.

Window shading with coverings like drapes, blinds, screens or pull-down shades can be used to reduce the amount of solar radiation entering the window or reduce daylighting glare. It can also be used to reduce heat loss through the window (movable insulation). Leaving the window covering open in the winter can maximize solar heat gain and thereby reduce heating loads.

Specify the type and location of the shading device, what variable or combination of variables controls deployment of the shading device, and what the control setpoint is. If the shading device is a blind, you also specify how the slat angle is controlled.

A shading device can be inside the window (Shading Type = InteriorShade or InteriorBlind), outside the window (Shading Type = ExteriorShade or ExteriorBlind), or between panes of glass (Shading Type = BetweenGlassShade or BetweenGlassBlind). The exception is window screens which can only be outside the window (Shading Type = ExteriorScreen).



When a shading device is present it is either retracted or activated. When it is retracted it covers none of the window. When it is activated it covers the entire glazed part of the window (but not the frame). Whether the shading device is retracted or activated in a particular timestep depends on the control mechanism. To model a case in which the shading device, when activated, covers only **part** of the window you will have to divide the window into two separate windows, one with the shading device and one without the shading device.

A shading device can also be of a kind in which the optical properties of the glazing switch from one set of values to another in order to increase or decrease solar or visible transmittance (Shading Type = SwitchableGlazing).

Controllers

EnergyPlus SimModelProperties IFCProperties

Property	Value	Unit
[-] [x] WindowProperty:ShadingControl0		
Shading Type		▼
Construction with Shading Name		▼
Shading Control Type		▼
Schedule Name		▼
Setpoint		n/a
Shading Control Is Scheduled		▼
Glare Control Is Active		▼
Shading Device Material Name		▼
Type of Slat Angle Control for Blinds		▼
Slat Angle Schedule Name		▼
Setpoint 2		unknown

Property Category	Property Name	Value Sources
Shading Control Type	Shading Type	<i>SwitchableGlazing</i> <i>InteriorShade</i> <i>ExteriorShade</i> <i>BetweenGlassShade</i> <i>ExteriorScreen</i> <i>InteriorBlind</i> <i>ExteriorBlind</i> <i>BetweenGlassBlind</i>
	Construction with Shading Name	Mat'l/Glaz Layer Sets
	Shading Control Type (Sub Type = On_Off)	<i>AlwaysOn</i> <i>AlwaysOff</i> <i>OnIfScheduleAllows</i>
	Shading Control Type (Sub Type = Heating_CoolingLoads)	<i>OnNightAndOnDayIfCoolingAndHighSolarOnWindow</i> <i>OffNightAndOnDayIfCoolingAndHighSolarOnWindow</i> <i>OnNightIfHeatingAndOnDayIfCooling</i> <i>OnNightIfLowOutdoorTempAndOnDayIfCooling</i> <i>OnNightIfHeatingAndOffDay</i> <i>OnNightIfLowInsideTempAndOffDay</i> <i>OnNightIfLowOutsideTempAndOffDay</i> <i>MeetDaylightIlluminanceSetpoint</i>

	<i>OnIfScheduleAllows</i> <i>OnIfHighSolarOnWindow</i> <i>OnIfHighHorizontalSolar</i> <i>OnIfHighOutdoorAirTemperature</i> <i>OnIfHighZoneAirTemperature</i> <i>OnIfHighZoneCooling</i> <i>OnIfHighGlare</i>
Shading Control Type (Sub Type = WindowTemp_Solar)	<i>OnIfHighZoneAirTempAndHighHorizontalSolar</i> <i>OnIfHighZoneAirTempAndHighSolarOnWindow</i> <i>OnIfHighOutdoorAirTempAndHighHorizontalSolar</i> <i>OnIfHighOutdoorAirTempAndHighSolarOnWindow</i>
Schedule Name	Schedules
Setpoint	<i>value</i>
Shading Control is Scheduled	<i>Yes/No</i>
Glare Control is Active	<i>Yes/No</i>
Shading Device Material Name	Materials/Glazing Materials
Type of Slat Angle Control for Blinds	<i>Block Beam Solar</i> <i>Scheduled Slat Angle</i> <i>Fixed Slat Angle</i>
Slat Angle Schedule Name	Schedules
Setpoint 2	<i>only used for certain types of shading control types</i>

Table - Shading Control Type Properties. The Field Properties are listed in the 2nd column, and the 3rd column identifies the options for selection within the drop down lists.

Field: Shading Type

The type of shading device. The choices are:

- *InteriorShade*: A diffusing shade is on the inside of the window. (In the shaded Construction the shading layer must be a WindowMaterial:Shade.)
- *ExteriorShade*: A diffusing shade is on the outside of the window. (In the shaded Construction the shading layer must be a WindowMaterial:Shade.)
- *BetweenGlassShade*: A diffusing shade is between two glass layers. (In the shaded Construction the shading layer must be a WindowMaterial:Shade.) This shading type is allowed only for double- and triple-glazing. For triple-glazing the shade must be between the two inner glass layers.
- *ExteriorScreen*: An insect screen is on the outside of the window. (In the shaded Construction the shading layer must be a WindowMaterial:Screen.)
- *InteriorBlind*: A slat-type shading device, such as a Venetian blind, is on the inside of the window. (In the shaded Construction the shading layer must be a WindowMaterial:Blind.)
- *ExteriorBlind*: A slat-type shading device is on the outside of the window. (In the shaded Construction the shading layer must be a WindowMaterial:Blind.)
- *BetweenGlassBlind*: A slat-type shading device is between two glass layers. (In the shaded Construction the shading layer must be a WindowMaterial:Blind.) This shading type is allowed only for double- and triple-glazing. For triple-glazing the blind must be between the two inner glass layers.
- **SwitchableGlazing**: Shading is achieved by changing the characteristics of the window glass, such as by darkening it. An example is electrochromic glazing in which the transmittance and reflectance of the glass is controlled electronically. For example, you could have electrochromic glazing switch from clear (high transmittance) to dark (low transmittance) to control solar gain.

If you choose the Shading Type = SwitchableGlazing option for ShadingControl, the unswitched (clear) state is specified by the Construction referenced by the Window and the switched (dark) state is specified by the Construction referenced by ShadingControl (Library Entry) for that Window. For example, if you specify Shading Type = SwitchableGlazing and Shading Control Type = OnIfHighSolarOnWindow, then the glazing will switch to the dark state whenever the solar radiation striking the window exceeds the Setpoint value.

Note: For Shading Type = SwitchableGlazing the state of the window is either clear (unswitched) or dark (fully switched) for all Shading Control Types except MeetDaylightIlluminanceSetpoint. In this case, the transmittance of the glazing is adjusted to just meet the daylight illuminance set point at the first daylighting reference point (Daylighting must be active). This type of control assures that there is just enough solar gain to meet the daylighting requirements in a zone, and no more, thus reducing the cooling load.

Selection: Switchable Glazing

An example of switchable glazing is electrochromic glazing in which the transmittance and reflectance of the glass is controlled electronically. For example, you could have electrochromic glazing switch from clear (high transmittance) to dark (low transmittance) to control solar gain. The dark (low transmittance) state is defined by the "Construction with Shading Name" property selection (next field done), while the clear (high transmittance) state is defined by the

If you choose the Shading Type = SwitchableGlazing option for Window:ShadingControl, the unswitched (clear) state is specified by the Construction referenced by the window and the switched (dark) state is specified by the Construction referenced by WindowProperty:ShadingControl for that window. For example, if you specify Shading Type = SwitchableGlazing and Shading Control Type = OnIfHighSolarOnWindow, then the glazing will switch to the dark state whenever the solar radiation striking the window exceeds the Setpoint value.

For Shading Type = SwitchableGlazing the state of the window is either clear (unswitched) or dark (fully switched) for all Shading Control Types except MeetDaylightIlluminanceSetpoint. In this case, the transmittance of the glazing is adjusted to just meet the daylight illuminance set point at the first daylighting reference point (see Daylighting). This type of control assures that there is just enough solar gain to meet the daylighting requirements in a zone, and no more, thus reducing the cooling load

Field: Construction with Shading Name

Name of the window Construction that has the shading in place. The properties of the shading device are given by the shading material referenced in that Construction (ref: Construction, WindowMaterial:Shade, WindowMaterial:Screen and WindowMaterial:Blind). For Shading Type = SwitchableGlazing, this is the name of the Construction that corresponds to the window in its fully-switched (darkest) state.

Specifying "Name of Construction with Shading" is required if Shading Type = BetweenGlassShade, BetweenGlassBlind, or SwitchableGlazing. For other Shading Types, you may alternatively specify "Material Name of Shading Device" (see below).

Field: Shading Control Type

Specifies how the shading device is controlled for the different sub type selections, i.e., it determines whether the shading device is "on" or "off." For blinds, screens and shades, when the device is "on" it is assumed to cover all of the window except its frame; when the device is "off" it is assumed to cover

none of the window (whether “on” or “off” the shading device is assumed to cover none of the wall that the window is on).

For switchable glazing, “on” means that the glazing is in the fully-switched state and “off” means that it is in the unswitched state; for example, for electrochromic glazing, “on” means the glazing is in its darkest state and “off” means it is in its lightest state.

The choices for Shading Control Type are the following. If SetPoint is applicable its units are shown in parentheses.

Note: For exterior window screens AlwaysOn, AlwaysOff, and OnIfScheduleAllows are the only valid shading control types.

- **AlwaysOn:** Shading is always on.
- **AlwaysOff:** Shading is always off.

The following six control types are used primarily to reduce zone cooling load due to window solar gain.

Note: Additional combinations of the options described below are included in the drop down list as well.

- **OnIfScheduleAllows:** Shading is on if schedule value is non-zero. Requires that Schedule Name be specified and Shading Control Is Scheduled = Yes. *Note: For exterior window screens AlwaysOn, AlwaysOff, and OnIfScheduleAllows are the only valid shading control types.*
- **OnIfHighSolarOnWindow:** Shading is on if beam plus diffuse solar radiation incident on the window exceeds SetPoint (W/m²) and schedule, if specified, allows shading.
- **OnIfHighHorizontalSolar:** Shading is on if total (beam plus diffuse) horizontal solar irradiance exceeds SetPoint (W/m²) and schedule, if specified, allows shading.
- **OnIfHighOutdoorAirTemperature:** Shading is on if outside air temperature exceeds SetPoint (C) and schedule, if specified, allows shading.
- **OnIfHighZoneAirTemperature:** Shading is on if zone air temperature in the previous timestep exceeds SetPoint (C) and schedule, if specified, allows shading.
- **OnIfHighZoneCooling:** Shading is on if zone cooling rate in the previous timestep exceeds SetPoint (W) and schedule, if specified, allows shading.
- **OnIfHighGlare:** Shading is on if the total daylight glare index at the zone’s first daylighting reference point from all of the exterior windows in the zone exceeds the maximum glare index specified in the daylighting input for zone (ref: Group – Daylighting). Applicable only to windows in zones with daylighting.
- **MeetDaylightIlluminanceSetpoint:** Used only with Shading Type = SwitchableGlazing in zones with daylighting controls. In this case the transmittance of the glazing is adjusted to just meet the daylight illuminance set point at the first daylighting reference point. Note that the daylight illuminance set point is specified within the [Daylighting Template](#) that can be selected in the Buildings>Create/Edit Building Workspace on the Building Tab. *Note: When the glare control is active, if meeting the daylight illuminance set point at the first daylighting reference point results in higher discomfort glare index (DGI) than the specified zone’s maximum allowable DGI for either of the daylight reference points, the glazing will be further dimmed until the DGI equals the specified maximum allowable value.*
- **OnNightIfLowOutdoorTempAndOffDay:** Shading is on at night if the outside air temperature is less than SetPoint and schedule, if specified, allows shading. Shading is off during the day.
- **OnNightIfLowInsideTempAndOffDay:** Shading is on at night if the zone air temperature in the previous timestep is less than SetPoint and schedule, if specified, allows shading. Shading is off during the day.

- **OnNightIfHeatingAndOffDay:** Shading is on at night if the zone heating rate in the previous timestep exceeds SetPoint and schedule, if specified, allows shading. Shading is off during the day.

The following two control types can be used to reduce zone heating and cooling load. They are applicable to any Shading Type except ExteriorScreen but are most appropriate for translucent interior or exterior shades with high insulating value ("translucent movable insulation").

- **OnNightIfLowOutdoorTempAndOnDayIfCooling:** Shading is on at night if the outside air temperature is less than SetPoint. Shading is on during the day if the zone cooling rate in the previous timestep is non-zero. Night and day shading is subject to schedule, if specified.
- **OnNightIfHeatingAndOnDayIfCooling:** Shading is on at night if the zone heating rate in the previous timestep exceeds SetPoint. Shading is on during the day if the zone cooling rate in the previous timestep is non-zero. Night and day shading is subject to schedule, if specified.

The following control types can be used to reduce zone cooling load. They are applicable to any Shading Type except ExteriorScreen but are most appropriate for interior or exterior blinds, interior or exterior shades with low insulating value, or switchable glazing.

- **OffNightAndOnDayIfCoolingAndHighSolarOnWindow:** Shading is off at night. Shading is on during the day if the solar radiation incident on the window exceeds SetPoint and if the zone cooling rate in the previous timestep is non-zero. Daytime shading is subject to schedule, if specified.
- **OnNightAndOnDayIfCoolingAndHighSolarOnWindow:** Shading is on at night. Shading is on during the day if the solar radiation incident on the window exceeds SetPoint and if the zone cooling rate in the previous timestep is non-zero. Day and night shading is subject to schedule, if specified. (This Shading Control Type is the same as the previous one, except the shading is on at night rather than off.)
- **OnIfHighOutdoorAirTempAndHighSolarOnWindow:** Shading is on if the outside air temperature exceeds the Setpoint and if the solar radiation incident on the window exceeds SetPoint 2.
- **OnIfHighOutdoorAirTempAndHighHorizontalSolar:** Shading is on if the outside air temperature exceeds the Setpoint and if the horizontal solar radiation on the window exceeds SetPoint 2.

Note: Unlike other Shading Control Types, glare control is active whether or not a schedule is specified.

Field: Schedule Name

Required if Shading Control Is Scheduled = Yes. If schedule value > 0, shading control is active, i.e., shading can be on only if the shading control test passes. If schedule value = 0, shading is off whether or not the control test passes. If Schedule Name is not specified, shading control is assumed to be active at all times.

Field: Setpoint

The setpoint for activating window shading. The units depend on the type of trigger:

- W/m² for solar-based controls
- W for cooling- or heating-based controls
- Degrees C for temperature-based controls

SetPoint is unused for Shading Control Type = OnIfScheduleAllows, OnIfHighGlare and DaylightIlluminance.

Field: Shading Control Is Scheduled

Accepts values YES and NO. The default is NO. Not applicable for Shading Control Type = OnIfHighGlare and should be blank in that case.

If YES, Schedule Name is required and that schedule determines whether the shading control specified by Shading Control Type is active or inactive (see Schedule Name, above).

If NO, Schedule Name is not applicable (should be blank) and the shading control is unscheduled. Shading Control Is Scheduled = YES is required if Shading Control Type = OnIfScheduleAllows.

Field: Glare Control Is Active

Accepts values YES and NO. The default is NO.

If YES and the window is in a daylight zone, shading is on if the zone's discomfort glare index exceeds the maximum discomfort glare index specified in the Daylighting object referenced by the zone. For switchable windows with *MeetDaylightIlluminanceSetpoint* shading control, if Glare Control is active, the windows are always continuously dimmed as necessary to meet the zone's maximum allowable DGI while providing appropriate amount of daylight for the zone.

The glare test is OR'ed with the test specified by Shading Control Type. For example, if Glare Control Is Active = YES and Shading Control Type = OnIfHighZoneAirTemp, then shading is on if glare is too high OR if the zone air temperature is too high.

Glare Control Is Active = YES is required if Shading Control Type = OnIfHighGlare.

Field: Shading Device Material Name

The name of a Shade, Screen or Blind.

Note: Required if "Name of Construction with Shading" is not specified.

Not applicable if Shading Type = BetweenGlassShade, BetweenGlassBlind or SwitchableGlazing and should be blank in this case.

Note: If both "Name of Construction with Shading" and "Material Name of Shading Device" are entered the former takes precedence.

Field: Type of Slat Angle Control for Blinds

Applies only to Shading Type = InteriorBlind, ExteriorBlind or BetweenGlassBlind. Specifies how the slat angle is controlled. The choices are FixedSlatAngle, ScheduledSlatAngle and BlockBeamSolar.

- If FixedSlatAngle (the default), the angle of the slat is fixed at the value input for the WindowMaterial:Blind that is contained in the construction specified by Name of Construction with Shading or is specified by Material Name of Shading Device.
- If ScheduledSlatAngle, the slat angle varies according to the schedule specified by Slat Angle Schedule Name, below.
- If BlockBeamSolar, the slat angle is set each timestep to just block beam solar radiation. If there is no beam solar on the window the slat angle is set to the value input for the WindowMaterial:Blind that is contained in the construction specified by Name of Construction with Shading or is specified by Material Name of Shading Device. The BlockBeamSolar option prevents beam solar from entering the window and causing possible unwanted glare if the beam falls on work surfaces while at the same time allowing near-optimal indirect radiation for daylighting.

Field: Slat Angle Schedule Name

This is the name of a schedule of slat angles that is used when Type of Slat Angle Control for Blinds = ScheduledSlatAngle. You should be sure that the schedule values fall within the range given by the Minimum Slat Angle and Maximum Slat Angle values entered in the corresponding Blind. If not, the program will force them into this range.

Field: Setpoint 2

Used only as the second setpoint for the following two-setpoint control types:

- OnIfHighOutdoorAirTempAndHighSolarOnWindow

- OnIfHighOutdoorAirTempAndHighHorizontalSolar
- OnIfHighZoneAirTempAndHighSolarOnWindow,
- OnIfHighZoneAirTempAndHighHorizontalSolar

Daylighting (Type)

Standard (Sub Type)

Daylighting:Controls (Property Category)

In this method daylighting illuminance levels are calculated and then used to determine how much the electric lighting can be reduced. The daylight illuminance level in a zone depends on many factors, including sky condition; sun position; calculation point; location, size, and glass transmittance of windows; window shading devices; and reflectance of interior surfaces. Reduction of electric lighting depends on daylight illuminance level, illuminance set point, fraction of zone controlled and type of lighting control.

Property	Value	Unit
Lighting Control Type	1	
Glare Calculation Azimuth Angle of View Direction Clockwise from Zone y-Axis	90	deg
Maximum Allowable Discomfort Glare Index	22	
Minimum Input Power Fraction for Continuous Dimming Control	0.3	
Minimum Light Output Fraction for Continuous Dimming Control	0.2	
Number of Stepped Control Steps	1	
Probability Lighting will be Reset When Needed in Manual Stepped Control	1	
Availability Schedule Name		

Field: Lighting Control Type

The type of overhead electric lighting control. All reference points specified are assumed to have this type of control.

- **For Lighting Control Type = 1 (continuous)**, the overhead lights dim continuously and linearly from (maximum electric power, maximum light output) to (minimum electric power, minimum light output) as the daylight illuminance increases. The lights stay on at the minimum point with further increase in the daylight illuminance.
- **For Lighting Control Type = 2 (stepped)**, the electric power input and light output vary in discrete, equally spaced steps. The number of steps is given by Number of Steps (Excluding Off) of Stepped Control. For example, if Number of Steps = 3 and Illuminance Setpoint = 600, then the following table shows the fraction of the lights that are on vs. daylight illuminance.

Daylight illuminance	Fraction of lights that are on
0-200	1.0
200-400	2/3
400-600	1/3
600 and above	0.0

- **Lighting Control Type = 3 (continuous/off)** is the same as Lighting Control Type = 1 except that the lights switch off completely when the minimum dimming point is reached.

Field: Glare Calculation Azimuth Angle of View Direction Clockwise from Zone y-Axis

Daylight glare from a window depends on occupant view direction. It is highest when you look directly at a window and decreases as you look away from a window. This field specifies the view direction for calculating glare. It is the angle, measured clockwise in the horizontal plane, between the zone y-axis and the occupant view direction.

Field: Maximum Allowable Discomfort Glare Index

If a daylit zone has windows with shading devices (except exterior screens), the shades will be deployed if the daylight glare at the First Reference Point exceeds the value of this field. To get this type of glare control you have to specify Glare Control for the library type ([Window Shading Control Type](#)) for one or more windows in the zone (see WindowProperty:ShadingControl).

If a zone has two or more windows with glare control, the shading devices will be deployed one by one in the order in which the windows are input until the glare level at each reference point falls below Maximum Allowable Discomfort Glare Index or is as close as possible to it.

Field: Minimum Input Power Fraction for Continuous Dimming Control

For Lighting Control Type = 1 (continuous), the lowest power the lighting system can dim down to, expressed as a fraction of maximum input power (see figure, below). For Lighting Control Type = 3 (continuous/off) this is the power fraction reached just before the lights switch off completely.

Field: Minimum Light Output Fraction for Continuous Dimming Control

For Lighting Control Type = 1 (continuous), the lowest lighting output the lighting system can dim down to, expressed as a fraction of maximum light output (see figure, above). This is the fractional light output that the system produces at minimum input power. For Lighting Control Type = 3 (continuous/off) this is the power fraction reached just before the lights switch off completely.

Field: Number of Stepped Control Steps

The number of steps, excluding off, in a stepped lighting control system (see figure, below). Required and must be >0 if Lighting Control Type = 2. The steps are assumed to be equally spaced.

Field: Probability Lighting will be Reset When Needed in Manual Stepped Control

May be specified if a stepped lighting control system (Lighting Control Type = 2) is manually operated, such as in a simple, one-step (on-off) system. Gives the probability the occupants of a daylit zone will set the electric lights to the correct level to obtain the required illuminance. The rest of the time the lights are assumed to be set one step too high. For example, consider an on-off lighting system (Number of Steps = 1) with a set point of 600 lux and 0.7 reset probability. Then, when daylighting exceeds 600 lux, the electric lights will be off 70% of the time and on 30% of the time.

Field: Availability Schedule Name

Determines the Daylighting Controls Schedule, which is defined by the schedule created in Libraries/Controls and Performance Data/Schedules .

Zone Control Humidity**Humidistat (Sub Type)****ZoneControl:Humidistat (Property Category)**

Controllers

EnergyPlus | SimModelProperties | IFCProperties

Property	Value	Unit
[-] ZoneControl:Humidstat0		
Dehumidifying Relative Humidity Setpoint Schedule Na		

Zone Control Temperature

Thermostat (Sub Type)

ZoneControl:Thermostat (Property Category)

Controllers

EnergyPlus | SimModelProperties | IFCProperties

Property	Value	Unit
[-] ZoneControl:Thermostat:ThermalComfort0		
Averaging Method		
Specific People Name		
Minimum Dry-Bulb Temperature Setpoint	32	F
Maximum Dry-Bulb Temperature Setpoint	122	F
Thermal Comfort Control Type Schedule Name		
Thermal Comfort Control [1-4] Name		

Ventilation

Contaminant Control (Sub Type)

ZoneControl:Contaminant Control (Property Category)

Controllers

EnergyPlus SimModelProperties IFCProperties

Property	Value	Unit
ZoneControl:ContaminantController0		
Carbon Dioxide Control Availability Schedule Name		
Carbon Dioxide Setpoint Schedule Name		
Minimum Carbon Dioxide Concentration Schedule Name		
Generic Contaminant Control Availability Schedule Name		
Generic Contaminant Setpoint Schedule Name		

Outdoor Air

Economizer Control (Sub Type)

Controller:OutdoorAir (Property Category)

Controllers

EnergyPlus SimModelProperties IFCProperties

Property	Value	Unit
Controller:OutdoorAir0		
Minimum Outdoor Air Flow Rate A/S		cfm
Maximum Outdoor Air Flow Rate A/S		cfm
Economizer Control Type		
Economizer Control Action Type		
Economizer Maximum Limit Dry-Bulb Temperature		F
Economizer Maximum Limit Enthalpy		Btu/lb
Economizer Maximum Limit Dewpoint Temperature		F
Electronic Enthalpy Limit Curve Name		
Economizer Minimum Limit Dry-Bulb Temperature		F
Lockout Type		
Minimum Limit Type		
Minimum Outdoor Air Schedule Name		
Minimum Fraction of Outdoor Air Schedule Name		
Maximum Fraction of Outdoor Air Schedule Name		
Mechanical Ventilation Controller Name		
Time of Day Economizer Control Schedule Name		
High Humidity Control		
High Humidity Outdoor Air Flow Ratio	1	
Control High Indoor Humidity Based on Outdoor Humi		
Heat Recovery Bypass Control Type		

Mechanical Ventilation

Economizer Demand Controlled Ventilation (Sub Type)

Controller:MechanicalVentilation (Property Category)

Controllers

EnergyPlus | SimModeProperties | IFCProperties

Property	Value	Unit
Controller:MechanicalVentilation0		
Availability Schedule Name		
Demand Controlled Ventilation		
System Outdoor Air Method		
Zone Maximum Outdoor Air Fraction	1	
Zone [1-50] Name		
Design Specification Outdoor Air Object Name [1-50]		
Design Specification Zone Air Distribution Object Name		

Supply Air

Temperature (Sub Type)

Controller:AirTemperature (Property Category)

Controllers

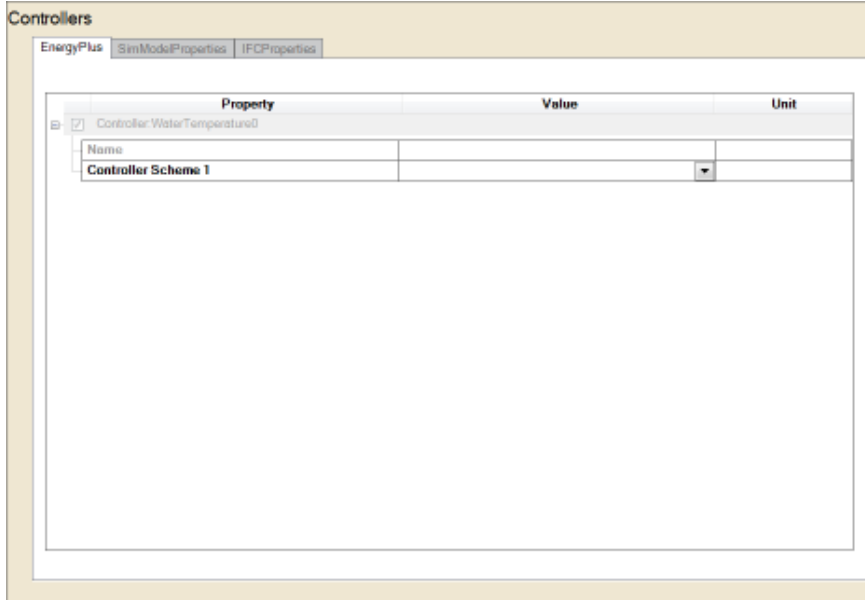
EnergyPlus | SimModeProperties | IFCProperties

Property	Value	Unit
Controller:AirTemperature0		
Name		
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Supply Water

Temperature (Sub Type)

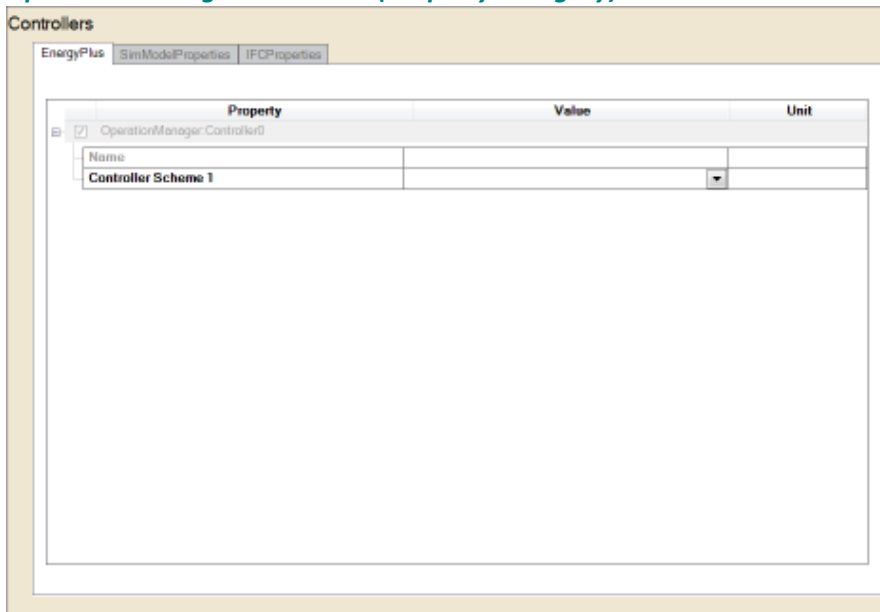
Controller:WaterTemperature (Property Category)



Operation Manager

Plant Loop (Sub Type)

OperationManager:Controller (Property Category)



Thermal Storage

Thermal Energy Storage Tank (Sub Type)

Controller:Thermal Storage (Property Category)

Controllers

EnergyPlus | SimModelProperties | IFCProperties

Property	Value	Unit
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