

# CAE 465/526 Building Energy Conservation Technologies

Fall 2023

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**October 26, 2023**

**Building Retrofit and Energy Efficiency Measures  
(EEMs) – Part 2**

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# **ANNOUNCEMENTS**

# Announcements

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- We are done with the assignments
- The project will be posted tomorrow
- Class will be ended today around 3:20 pm (in lieu of that you should watch the new LBT recording and the new documentation that were posted)

# Announcements

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- Midterm Exam (IPRO students)
  - ❑ Scheduled for 11/02 during the class time
  - ❑ IPRO students will present their progress so far as their midterm exam, especially on how the energy data and/or models will be used in the VR environment

# Announcements

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- Midterm Exam (CAE 526 students):
  - Scheduled for 11/02 (will be posted at 10 am)
  - The end of submission 11/06 (midnight)
  - CAE 526 students will take the midterm exam

# Announcements

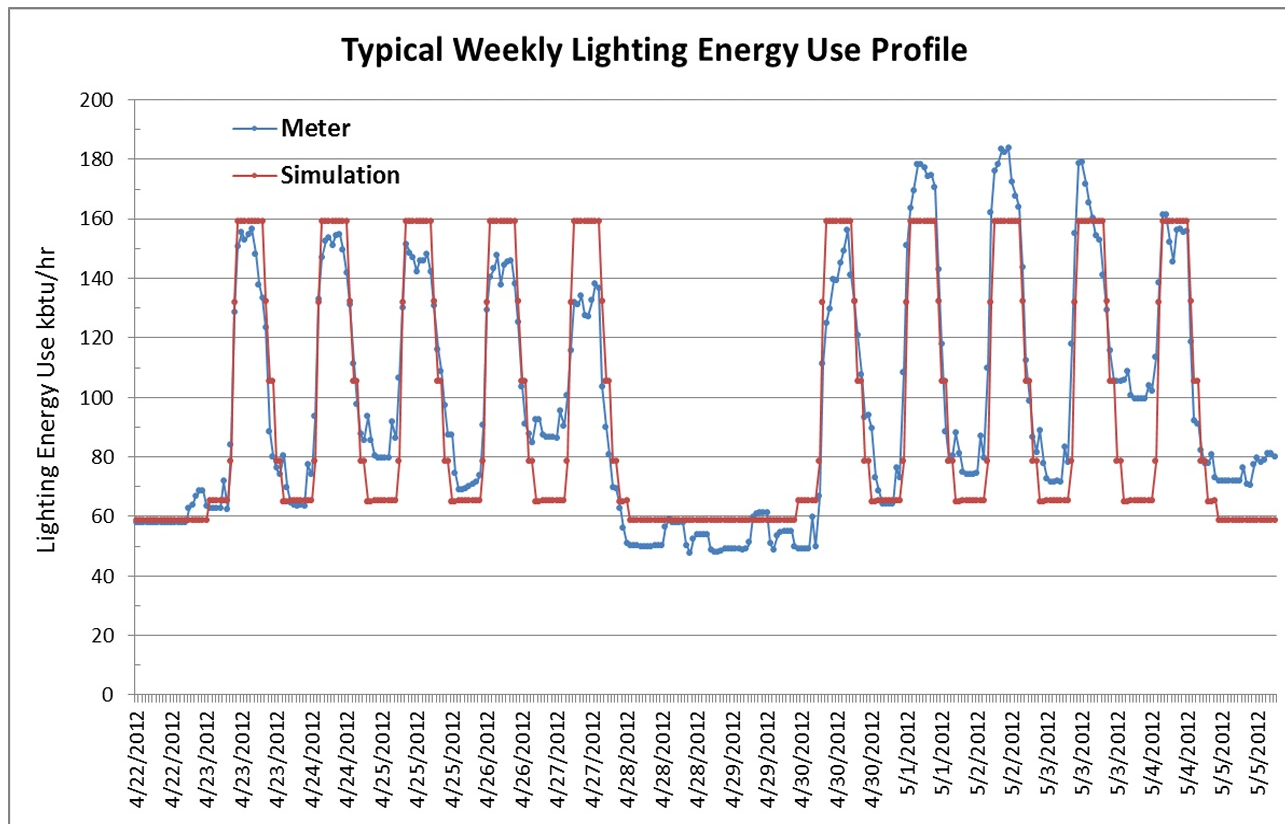
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- Midterm Exam
  - Past exams were posted
  - If you have any questions about the topics or OpenStudio you should ask before the exam

**LOOK AT THE RESULTS IN MORE  
DETAIL**

# QA / QC

- To make sense of the systems and the building operation, a lot of times, you should plot the hourly meter data (or variable data)

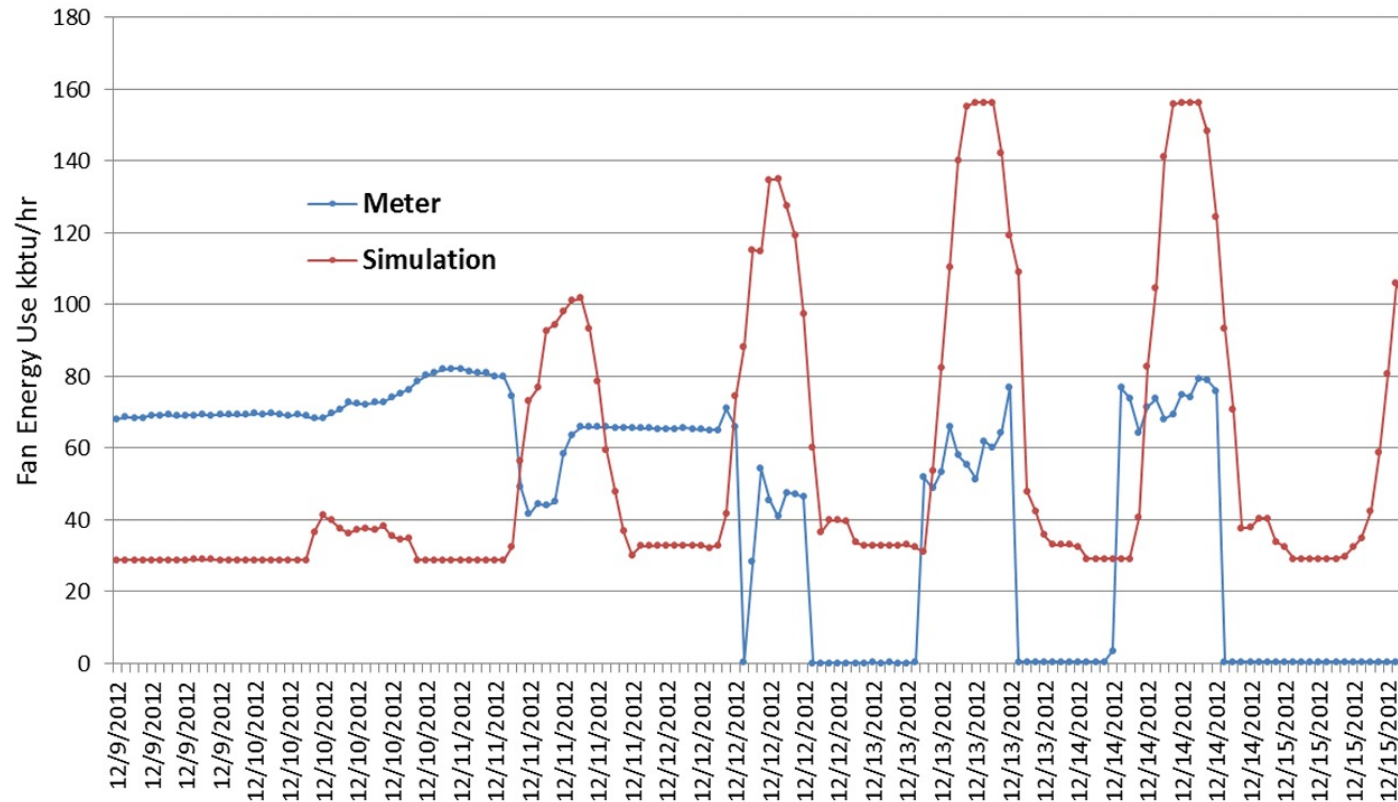




# QA / QC

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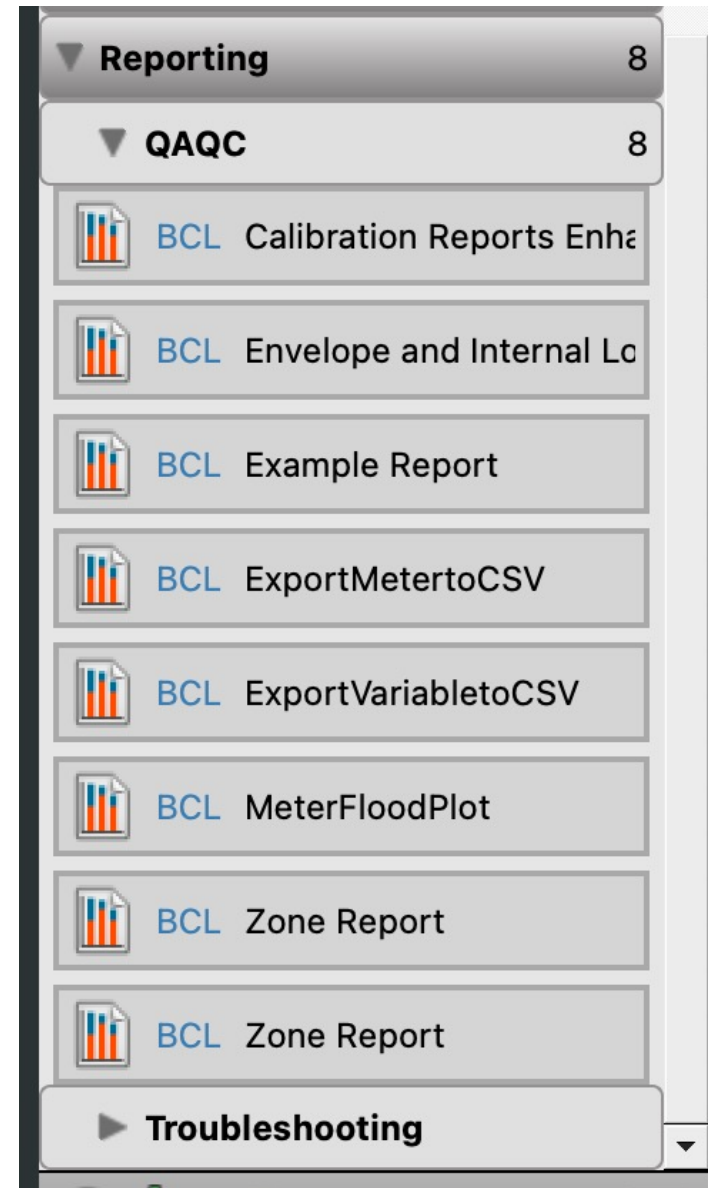
Fan Energy Calibration Divergence, December 2012



# **HOW TO EDIT OPENSTUDIO TEMPLATES**

# Add OpenStudio Results

- Go beyond the measures that I introduce in the class



# Add OpenStudio Results

The screenshot displays the 'Measures' panel in a software application. The panel is organized into three main sections: 'OpenStudio Measures', 'EnergyPlus Measures', and 'Reporting Measures'. Each section contains a placeholder text: 'Drop Measure From Library to Create a New Always Run Measure'. The 'Reporting Measures' section is highlighted with a red dashed box, and the 'OpenStudio Results' measure is selected, indicated by a red dashed arrow pointing to it. A red dashed line also points from the 'OpenStudio Results' measure in the 'Reporting Measures' section to the 'OpenStudio Results' measure in the 'Reporting' category of the right-hand sidebar. The sidebar is titled 'Library' and 'Edit' and lists various measure categories: 'Measures', 'Envelope', 'Electric Lighting', 'Equipment', 'People', 'HVAC', 'Refrigeration', 'Service Water Heating', 'Onsite Power Generation', 'Whole Building', 'Economics', 'Reporting', 'QAQC', and 'Troubleshooting'. The 'Reporting' category is expanded, showing 'BCL Set eplustbl to Specified' and 'BCL OpenStudio Results'. The 'BCL OpenStudio Results' measure is highlighted with a red box. A red box also highlights the 'Add Measure' icon (a hand holding a document) in the left-hand toolbar. Below the screenshot, the text 'Add the OpenStudio Results Measure' is written in red.

Add the OpenStudio Results Measure

# External Lights

The interface shows a navigation bar with tabs: Facility, Building, Stories, Shading, and Exterior Equipment. The 'Exterior Equipment' tab is active. Below the tabs, there are two buttons: 'Drop Exterior Lights' and 'Exterior Lights'. A table below lists light configurations with columns for Name, All, Definition, Schedule, Control Option, Multiplier, and End Use Subcategory. The first row is highlighted with a red box.

Exterior Lights Name	All	Exterior Lights Definition	Schedule	Control Option	Multiplier	End Use Subcategory
	<input type="checkbox"/>	Apply to Selected	Apply to Selected	Apply to Selected	Apply to Selected	Apply to Selected
Exterior Lights 1	<input type="checkbox"/>	Exterior Lights Definitio	Always On Discrete	AstronomicalClock	1.000000	General

# External Lights

- How to find out more information about the inputs

634

CHAPTER 1. INPUT-OUTPUT REFERENCE

## 1.16.1 Exterior:Lights

### 1.16.1.1 Inputs

#### 1.16.1.1.1 Field: Name

This descriptive name allows the values of exterior lights consumption to appear in the “normal” output variable list as well as the meters. It cannot be blank nor can it be duplicated by other Exterior:Lights statements.

#### 1.16.1.1.2 Field: Schedule Name

A schedule will allow the exterior lights consumption to be operationally different, hour to hour as well as seasonally. Fractional values in the basic schedule will be applied to the design level field below.

#### 1.16.1.1.3 Field: Design Level

This field (in Watts) is typically used to represent the maximum electrical input to exterior lighting fixtures that is then multiplied by a schedule fraction (see previous field). In EnergyPlus, this is slightly more flexible in that the lighting design level could be a “diversity factor” applied to a schedule of real numbers. Note that while the schedule value can vary from hour to hour and seasonally, the design level field is constant for all simulation environments.

#### 1.16.1.1.4 Field: Control Option

This field is used to determine how the exterior lights are controlled. There are currently two options, ‘ScheduleNameOnly’ and ‘AstronomicalClock.’ If this field is omitted or left blank then the program will default to Schedule Name Only mode. The ‘ScheduleNameOnly’ mode dictates that the exterior lights always follow the schedule named in the field above. The ‘AstronomicalClock’ mode dictates that despite what the schedule indicates, the exterior lights will not run when the sun is up. Using the Astronomical Clock mode makes it simple to model exterior lights that are controlled by a photocell or other controller that ensures that outdoor lights will not run during the daytime. However, the Astronomical Clock control works off of the position of the sun and therefore does not operate exactly like a photocell. During the night, the schedule values are still applied in the usual way.

# System Availability

Thermal Zones							
HVAC Systems	Cooling Sizing Parameters	Heating Sizing Parameters	Custom				
Name	All	Turn On Ideal Air Loads	Air Loop Name	Zone Equipment	Cooling Thermostat Schedule	Heating Thermostat Schedule	Humidifying Setpoint Schedule
Thermal Zone 1	<input type="checkbox"/>	<input type="checkbox"/>	VAV with Reheat	Duct VAV Reheat 11 <input type="text"/>	<input type="text" value="Cooling Sch"/>	<input type="text" value="Heating Sch"/>	<input type="text"/>
Thermal Zone 10	<input type="checkbox"/>	<input type="checkbox"/>	VAV with Reheat	Duct VAV Reheat 22 <input type="text"/>	<input type="text" value="Cooling Sch"/>	<input type="text" value="Heating Sch"/>	<input type="text"/>
Thermal Zone 11	<input type="checkbox"/>	<input type="checkbox"/>	VAV with Reheat	Duct VAV Reheat 9 <input type="text"/>	<input type="text" value="Cooling Sch"/>	<input type="text" value="Heating Sch"/>	<input type="text"/>
Thermal Zone 12	<input type="checkbox"/>	<input type="checkbox"/>	VAV with Reheat	Duct VAV Reheat 6 <input type="text"/>	<input type="text" value="Cooling Sch"/>	<input type="text" value="Heating Sch"/>	<input type="text"/>
Thermal Zone 13	<input type="checkbox"/>	<input type="checkbox"/>	VAV with Reheat	Duct VAV Reheat 14 <input type="text"/>	<input type="text" value="Cooling Sch"/>	<input type="text" value="Heating Sch"/>	<input type="text"/>

My Model | Library | Edit

Maximum Flow Fraction During Reheat  
 Hard Sized Autocalculate  
 Autosized Autosize

Maximum Reheat Air Temperature  
 94.99999999999999

Control For Outdoor Air  
 No

**OS:Coil:Heating:Water**

Name  
 Coil Heating Water 23

Availability Schedule Name  
 Always On Discrete

~~U-Factor Times Area Value~~  
 Hard Sized   
 Autosized Autosize

# System Availability



## Availability Schedule Name "Always On Discrete"

openstudio availability-schedule



What exactly does the Availability Schedule Name `Always On Discrete` mean? Can anyone illustrate with an example?

asked 7 years ago

tajjmann  
455 • 1 • 11

updated 7 years ago

Jamie Bull  
5032 • 6 • 24 <http://oco-carbon.com/>

add a comment

1 Answer

Sort by » [oldest](#) [newest](#) [most voted](#)



This is just a `ScheduleConstant` object. It has a single value all the time. It is made at times through the API, but isn't something you can inspect or alter in the GUI. It is the same as if you made a Ruleset Schedule with only the default profile and set it to always equal 1.

answered 7 years ago

David Goldwasser  
20035 • 92 • 14  
<http://www.openstudio.net/>

Here is what the object looks like. It is typically used for availability schedules.

```
OS:Schedule:Constant,  
{966ffa9b-9939-4499-a950-d82bd2f10042}, !- Handle  
Always On Discrete, !- Name  
{07123e75-72aa-4cb6-b376-38f41b9624e3}, !- Schedule Type Limits Name  
1; !- Value
```

add a comment

link

### Training Workshops

### Training Workshops



EnergyPlus

[Webinars, Oct 24 - Nov 10](#)

### Question Tools

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### Stats

Asked: 7 years ago

Seen: 968 times

Last updated: Aug 07 '15

### Related Questions

[Linux OpenStudio can't find Qt5](#)

[How to get Maximum Flow Rate](#)



# Economizer or Demand Control Ventilation

The screenshot displays a software interface for configuring HVAC systems. The main title is "HVAC Systems". Below the title, there are three tabs: "Layout", "Control", and "Grid". The "Control" tab is selected. The system being configured is "VAV with Reheat". The cooling type is "Chilled Water" and the heating type is "Hot Water".

The "Time of Operation" section is highlighted with a red box. It contains the "HVAC Operation Schedule" section, which has two options: "Always On" and "Discrete". The "Use Night Cycle" section is set to "Follow the HVAC Operation Schedule".

The "Supply Air Temperature" section is also highlighted with a red box. It contains the "Supply Air Temperature Schedule" section, which has one option: "Deck\_Temperati".

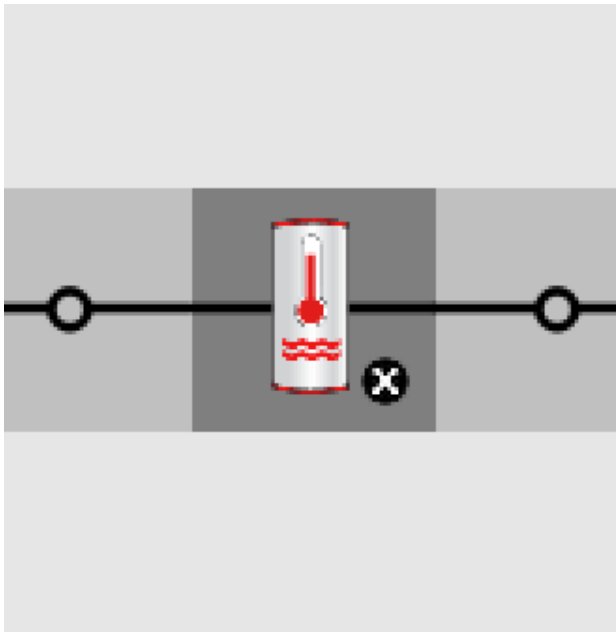
The "Mechanical Ventilation" section is highlighted with a red box. It contains the "Economizer" section, which is set to "No Economizer". The "Demand Controlled Ventilation" section is set to "off".

The "Availability Managers" section is also highlighted with a red box. It contains the "Availability Managers from highest precedence to lowest" section, which has a "Drag From Library" button.

# **SERVICE HOT WATER**

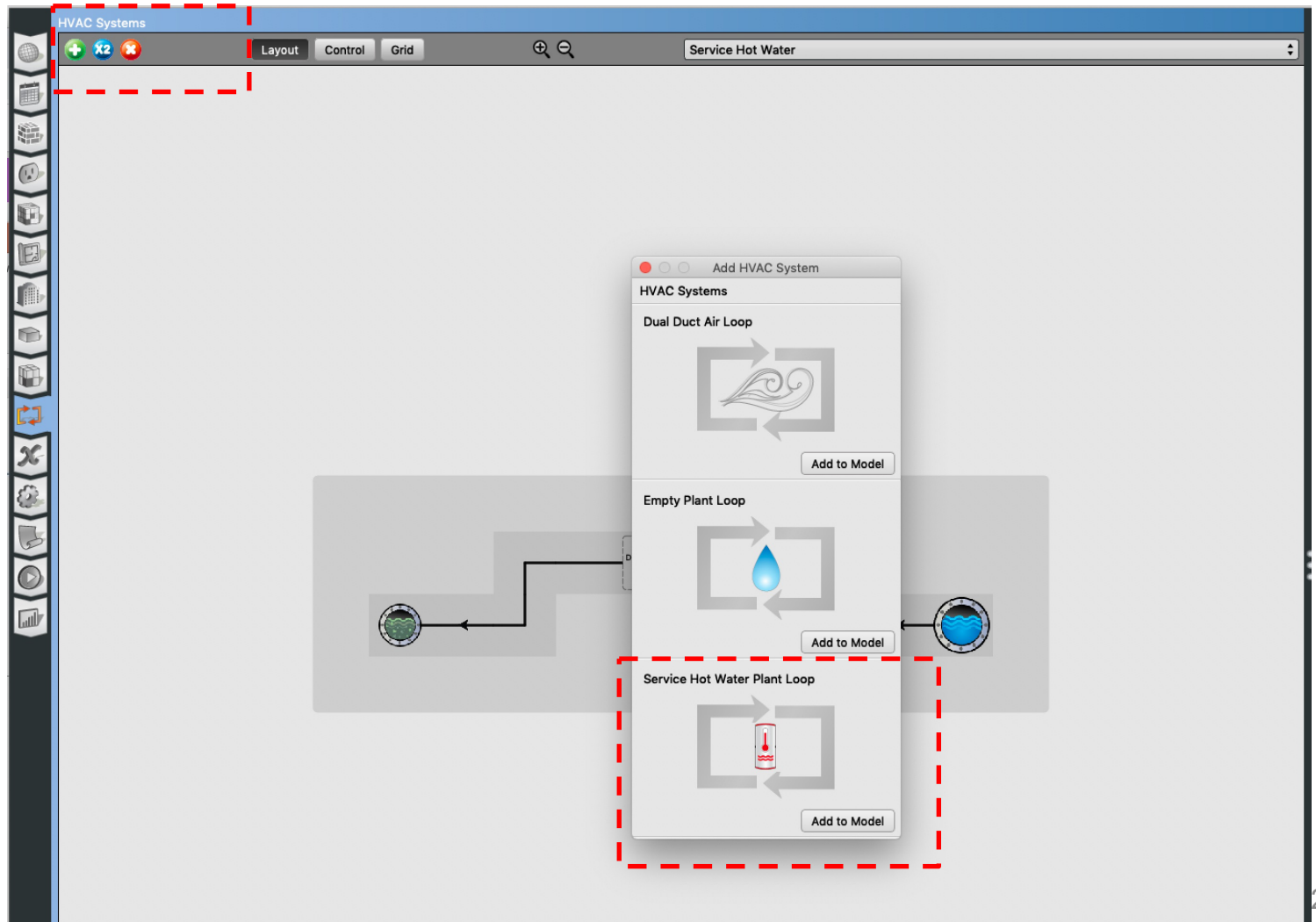
# Service Hot Water

---



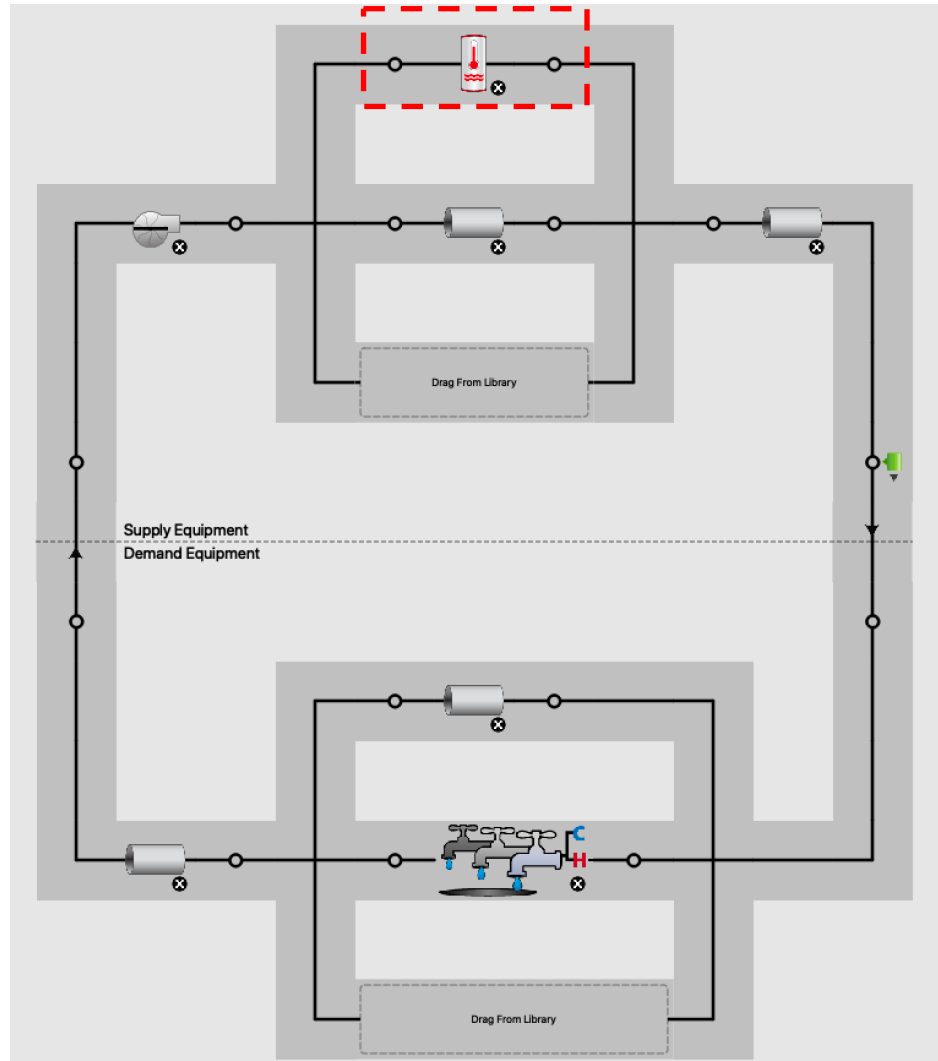
# Service Hot Water

- Add a water heater tank to a plant loop:



# Service Hot Water

- Add service hot water plant loop:



# Service Hot Water

- Add a fixture:

HVAC Systems

Water Use Connection Service Hot Water

The screenshot displays a software interface for configuring a Service Hot Water system. The main workspace shows a schematic diagram with a central box labeled "Drag Water Use Equipment from Library". Below this box is a sink fixture. The diagram includes several pipes and loops, with arrows indicating flow direction. A "Loop" label is visible on the left and right sides of the diagram. The interface includes a top menu bar with "My Model", "Library", and "Edit" options. A vertical toolbar on the left contains various icons for system components. A right-hand sidebar lists available equipment options, including "Availability Manager Hybrid Ventilation", "Availability Manager Night Ventilation", "Availability Manager Night Cycle", "Availability Manager Optimum Start", "Availability Manager Differential Thermostat", "Availability Manager High Temperature Turn Off", "Availability Manager High Temperature Turn On", "Availability Manager Low Temperature Turn Off", "Availability Manager Low Temperature Turn On", "Availability Manager Scheduled Off", "Availability Manager Scheduled On", "Availability Manager Scheduled", "AirLoopHVAC Unitary VAV Changeover Bypass", and "AirLoopHVAC Unitary System".

My Model Library Edit

Availability Manager Hybrid Ventilation

Availability Manager Night Ventilation

Availability Manager Night Cycle

Availability Manager Optimum Start

Availability Manager Differential Thermostat

Availability Manager High Temperature Turn Off

Availability Manager High Temperature Turn On

Availability Manager Low Temperature Turn Off

Availability Manager Low Temperature Turn On

Availability Manager Scheduled Off

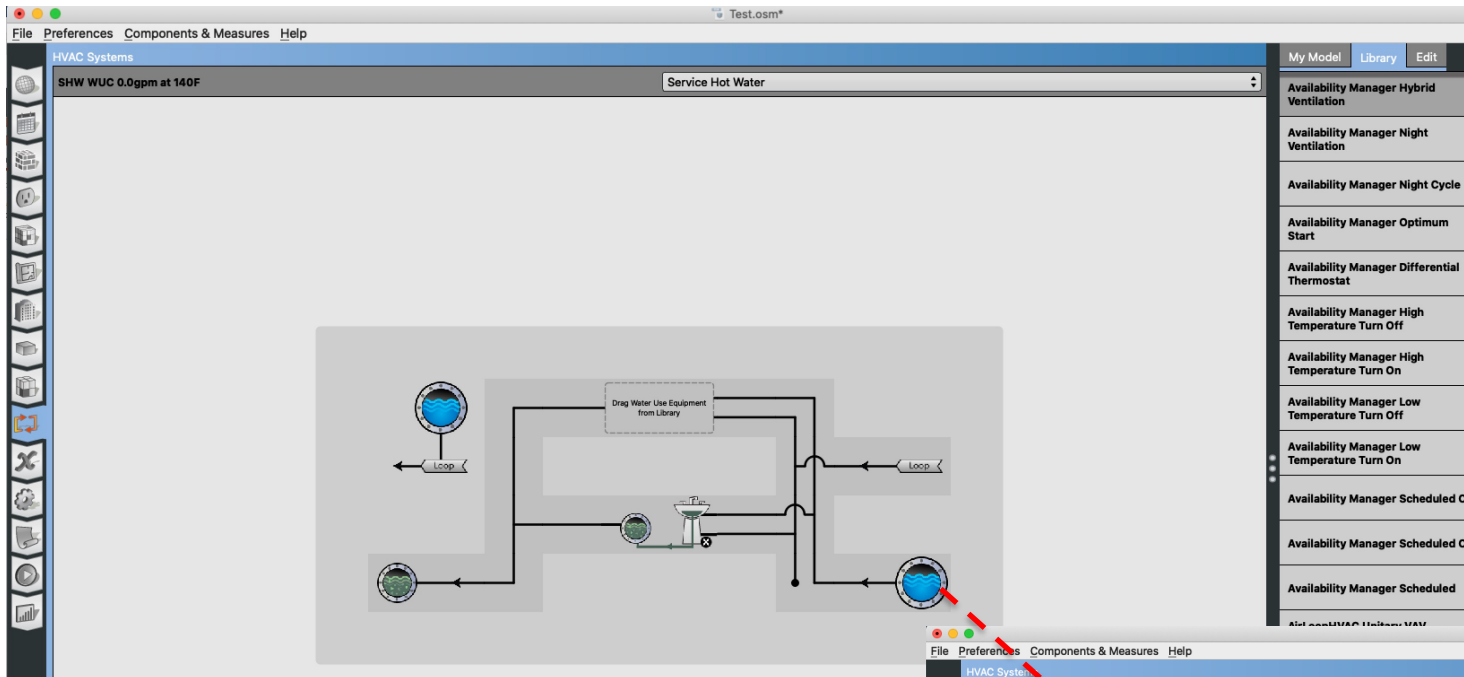
Availability Manager Scheduled On

Availability Manager Scheduled

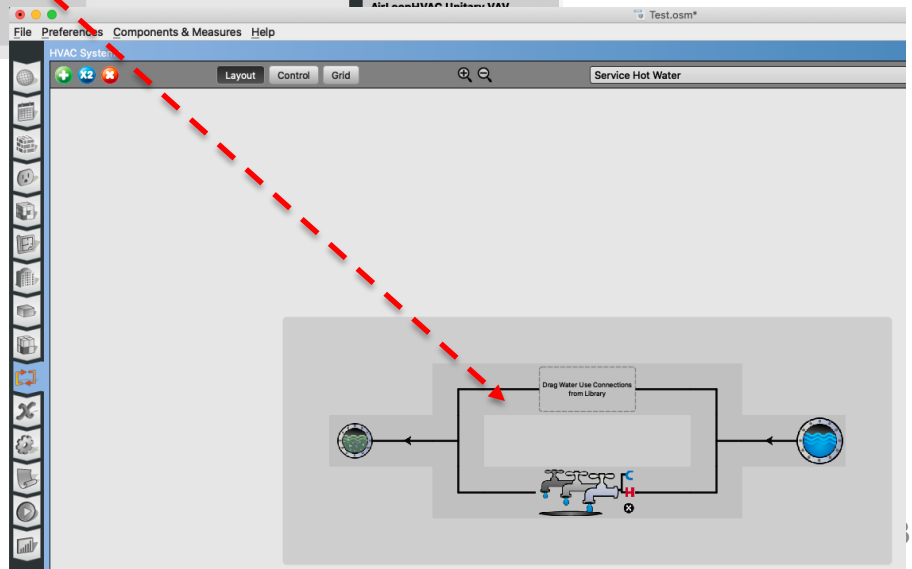
AirLoopHVAC Unitary VAV Changeover Bypass

AirLoopHVAC Unitary System

# Service Hot Water



- My Model
- Library
- Edit
- Availability Manager Hybrid Ventilation
- Availability Manager Night Ventilation
- Availability Manager Night Cycle
- Availability Manager Optimum Start
- Availability Manager Differential Thermostat
- Availability Manager High Temperature Turn Off
- Availability Manager High Temperature Turn On
- Availability Manager Low Temperature Turn Off
- Availability Manager Low Temperature Turn On
- Availability Manager Scheduled Off
- Availability Manager Scheduled On
- Availability Manager Scheduled



# Service Hot Water

- Add service hot water definition

The screenshot shows a software interface for defining service hot water loads. The main window is titled "Loads" and contains a list of definition categories on the left and a configuration panel on the right. The "Water Use Equipment Definitions" category is selected, and the "Water Fixture Definition" item is highlighted. The configuration panel for "Water Fixture Definition" includes the following fields:

- Name:** Water Fixture Definition
- End Use Subcategory:** General
- Peak Flow Rate:** 1.000155 gal/min
- Target Temperature Schedule:** Drag From Library
- Sensible Fraction Schedule:** Drag From Library
- Latent Fraction Schedule:** Drag From Library

The "Water Fixture Definition" item in the list is highlighted with a red dashed border. The "Target Temperature Schedule" and "Latent Fraction Schedule" fields are also highlighted with red dashed borders. The right sidebar shows a list of construction and schedule categories, including "Ruleset Schedules", "Compact Schedules", "Constant Schedules", "Year Schedules", "Fixed Interval Schedules", "Variable Interval Schedules", "Constructions", "Internal Source Constructions", "C-factor Underground Wall Constructions", "F-factor Ground Floor Constructions", and "Window Data File Constructions".



# Service Hot Water

- DOE Reference Buildings
  - Section 5.1.6 Service Water Heater Demand

**Table 11 Peak Service Hot Water Demand and Data Sources**

Space Type	Use Rate		Temp. at Fixture		Data Sources
	gal/h	L/h	°F	°C	
Guest room (small hotel)	1.75	6.6	110	43	Jiang et al. 2008, ASHRAE 2007
Guest room (large hotel)	1.25	4.7	110	43	Jiang et al. 2008, ASHRAE 2007
Laundry (small hotel)	67.5	255.5	140	60	Jiang et al. 2008, ASHRAE 2007
Laundry (large hotel)	156.6	592.8	140	60	Jiang et al. 2008, ASHRAE 2007
Restrooms (primary school)	56.5	214.0	110	43	ASHRAE 2007
Restrooms (secondary school)	104.4	395.0	110	43	ASHRAE 2007
Gym (secondary school)	189.5	717.2	110	43	ASHRAE 2007
Small office	3.0	11.4	110	43	Jarnagin et al. 2006, ASHRAE 2007
Medium office (per floor)	9.9	37.5	110	43	Jarnagin et al. 2006, ASHRAE 2007
Large office (per floor)	21.3	80.6	110	43	Jarnagin et al. 2006, ASHRAE 2007
Apartment	3.5	13.2	110	43	Gowri et al. 2007
Outpatient healthcare	30.0	113.5	110	43	Doebber et al. 2009
Hospital					
ER waiting room	1.0	3.8	120	49	Engineering judgment
Operating/surgical cystoscopic	2.0	7.6	120	49	Engineering judgment
Laboratory	2.0	7.6	120	49	Engineering judgment
Patient room	1.0	3.8	120	49	Engineering judgment

# Service Hot Water

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- Make reasonable assumptions for the water heater temperature:
  - Most households require about 120 °F
  - Some manufacturers set water heater thermostats at 140 °F, which also slows mineral buildup and corrosion in your water heater and pipes
  - Water heated at 140 °F also poses a safety hazard (scalding)

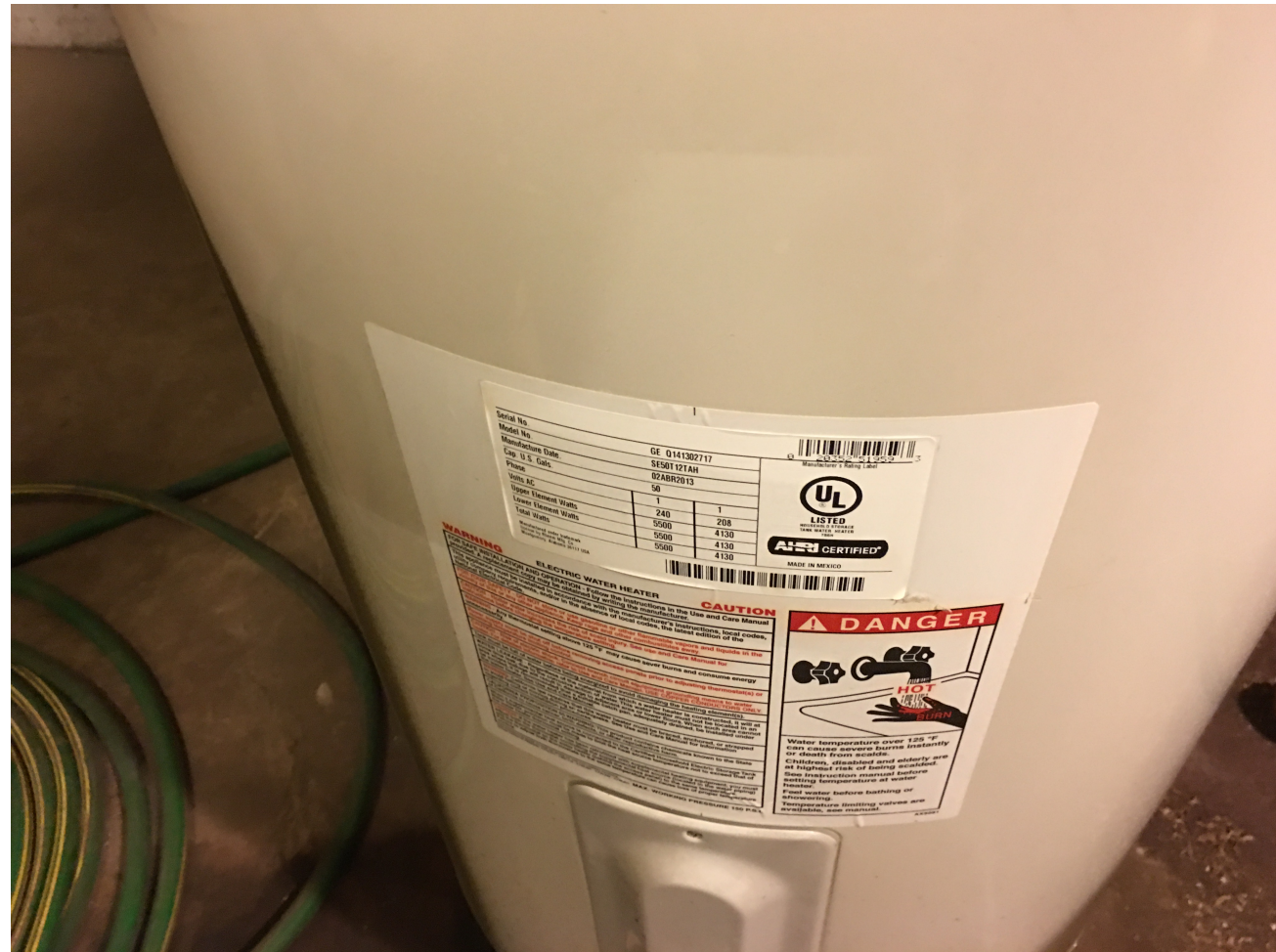
# Service Hot Water

---

- Make reasonable assumptions for the flow rates and sizes. For example, for residential units:
  - Small size: A 50 to 60-gallon storage tank is usually sufficient for 1 to 3 people
  - Medium size: A 80-gallon storage tank works well for 3 to 4 people
  - Large size: A large tank is appropriate for four to six people

# Service Hot Water

- Service Hot Water



# Service Hot Water

- Service Hot Water

*Photo Not Available*

GE® Electric Water Heater  
Model #: SE50T12TAH |

[About This Product](#) [Related Products](#) [Spec](#)

## CAPACITY

Unit Capacity	50 Gallons
---------------	------------

## FEATURES

Fuel Type	Electric
-----------	----------

Height Description	Tall
--------------------	------

## POWER / RATINGS

First Hour Delivery GPH	67.0 gal/h
-------------------------	------------

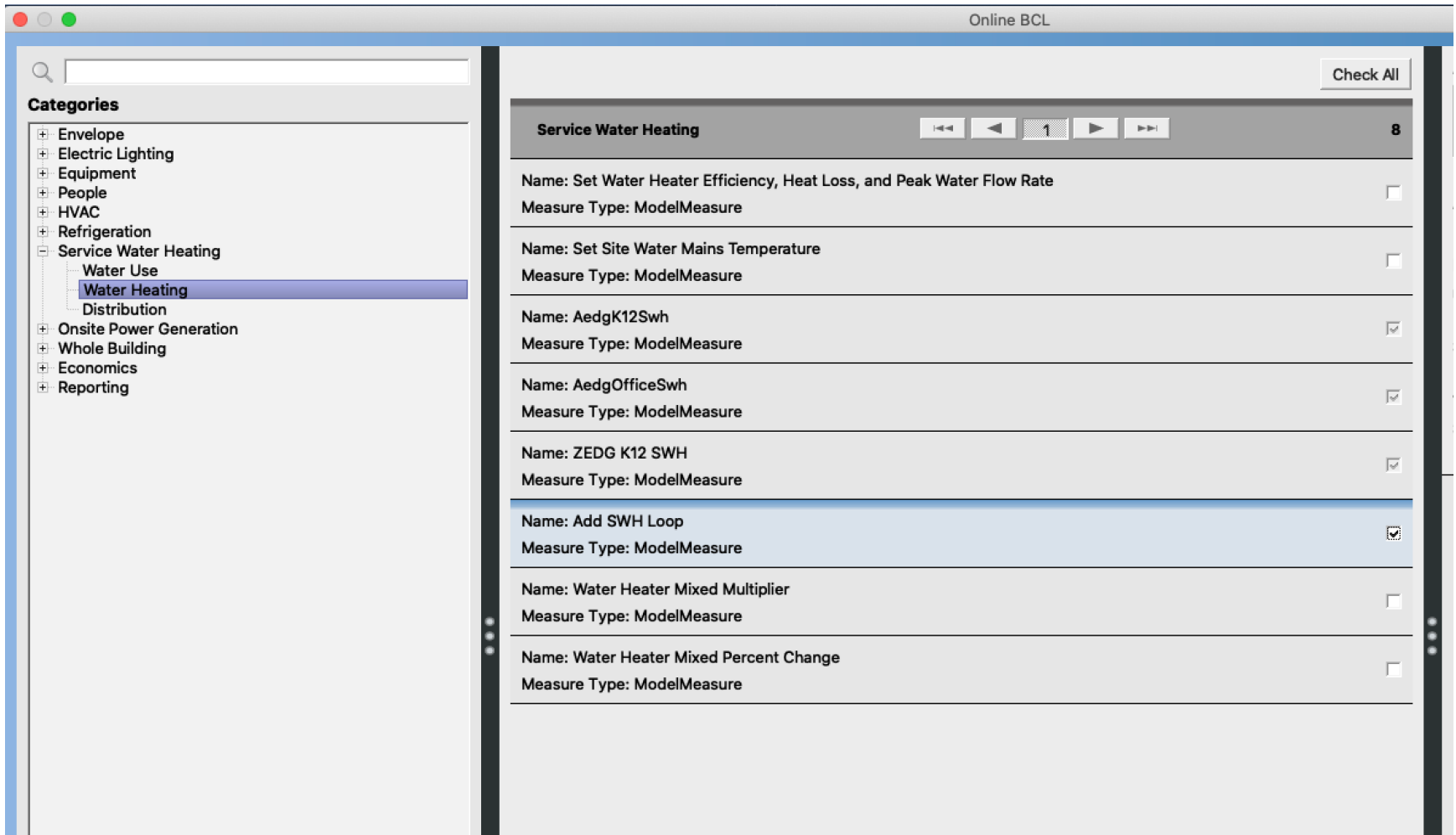
Heating - Electric - Heater Watts	5500
-----------------------------------	------

Integrated Energy Factor	0.94
--------------------------	------

Voltage (MAX)	240.0 V
---------------	---------

# Service Hot Water

- You can use the OpenStudio measures:



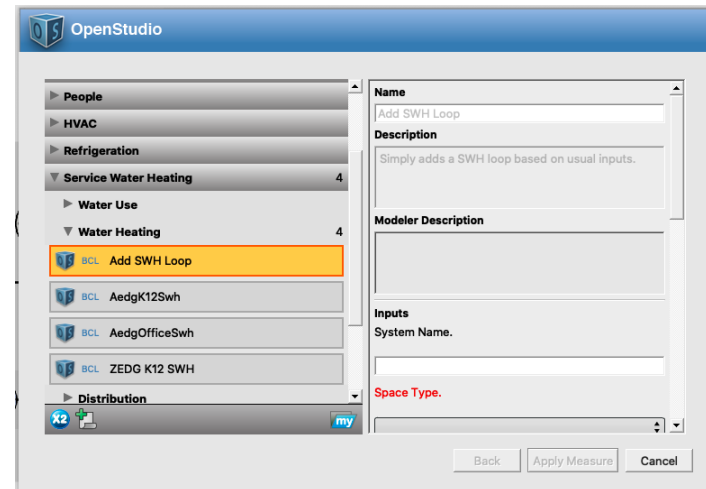
The screenshot shows the OpenStudio Online BCL interface. On the left, a 'Categories' sidebar lists various building systems, with 'Service Water Heating' expanded to show 'Water Heating' selected. The main panel displays a list of measures under the heading 'Service Water Heating'. A 'Check All' button is in the top right. The list includes:

Measure Name	Measure Type	Checked
Name: Set Water Heater Efficiency, Heat Loss, and Peak Water Flow Rate	ModelMeasure	<input type="checkbox"/>
Name: Set Site Water Mains Temperature	ModelMeasure	<input type="checkbox"/>
Name: AedgK12Swh	ModelMeasure	<input checked="" type="checkbox"/>
Name: AedgOfficeSwh	ModelMeasure	<input checked="" type="checkbox"/>
Name: ZEDG K12 SWH	ModelMeasure	<input checked="" type="checkbox"/>
Name: Add SWH Loop	ModelMeasure	<input checked="" type="checkbox"/>
Name: Water Heater Mixed Multiplier	ModelMeasure	<input type="checkbox"/>
Name: Water Heater Mixed Percent Change	ModelMeasure	<input type="checkbox"/>

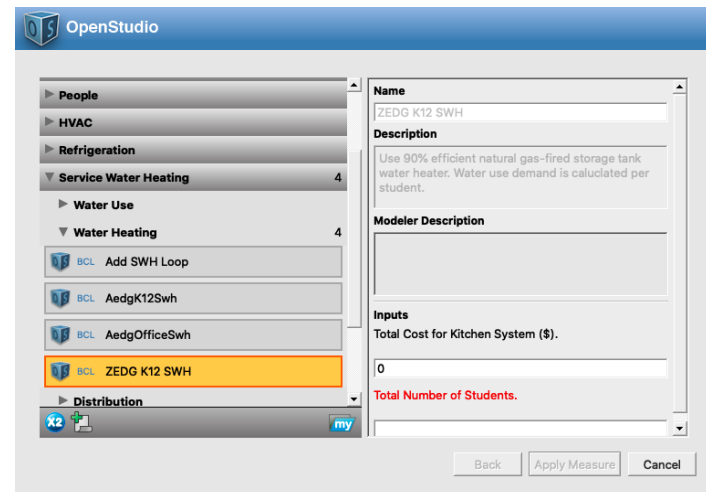
# Service Hot Water

- You can use the OpenStudio measures:

- First, use “Add SHW Loop”



- Second, use “ZEDG K12 SHW”

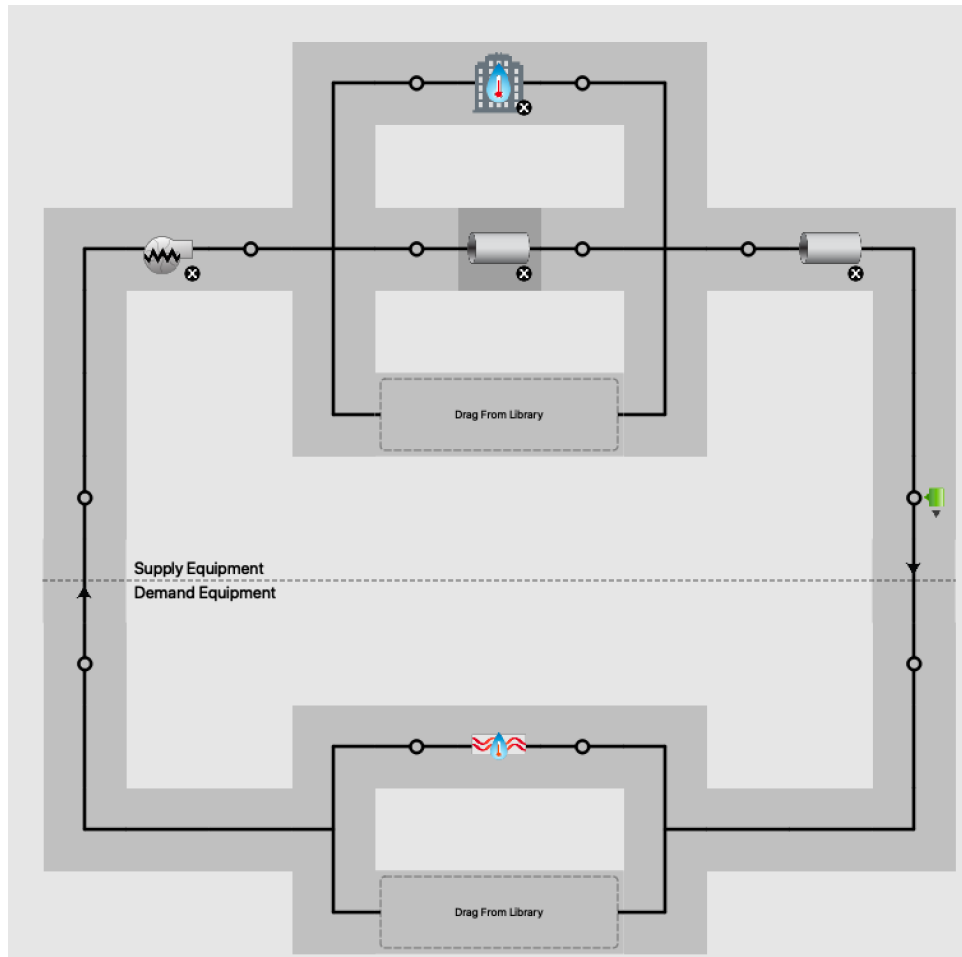


# **BASEBOARD**








# Baseboard

- Follow the hot water loop from the HVAC templates
- Add a district heating or a boiler to the empty plant loop



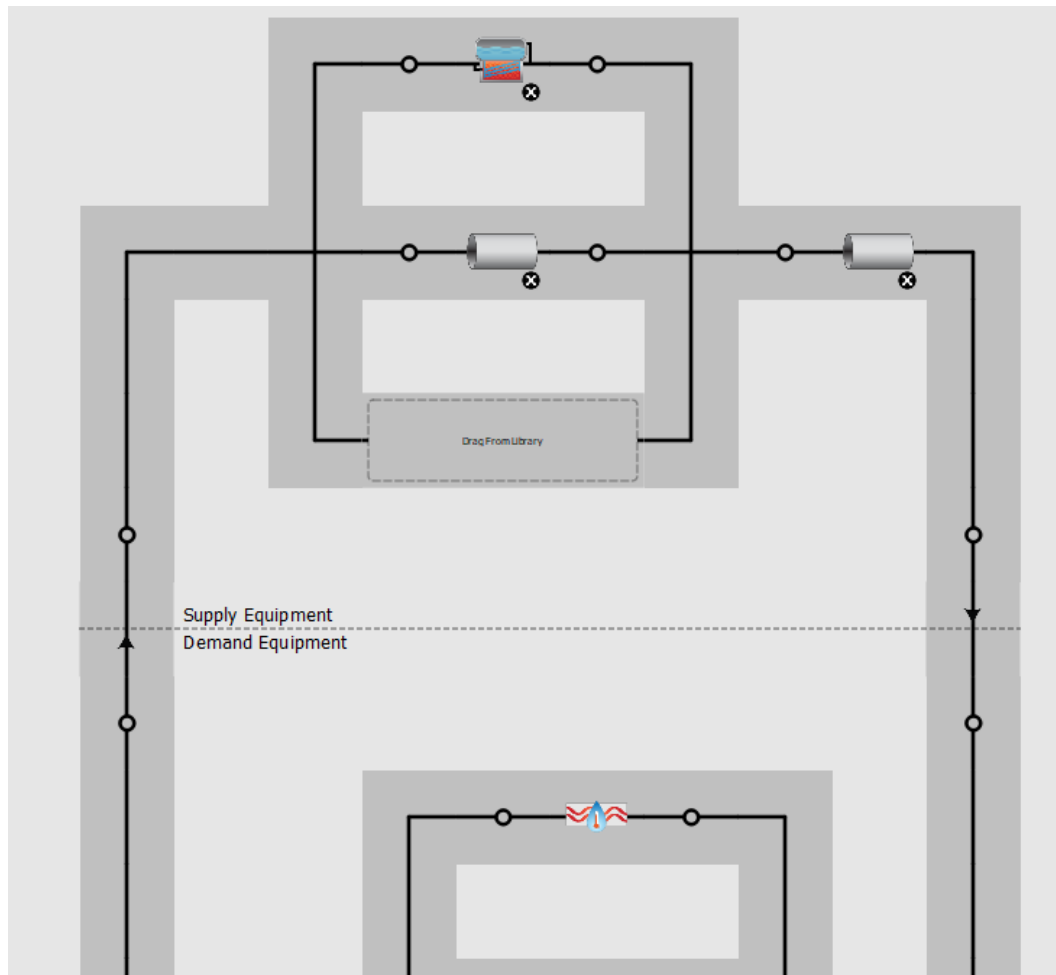
# Baseboard

- Add the convector and assign it to a loop

HVAC Systems		Cooling Sizing Parameters	Heating Sizing Parameters	Custom					
Name	All	Rendering Color	Turn On Ideal Air Loads	Air Loop Name	Zone Equipment	Cooling Thermostat Schedule	Heating Thermostat Schedule	Humidifying Setpoint Schedule	
	<input type="checkbox"/>		<input type="checkbox"/>		<input type="button" value="Apply to Selected"/>	<input type="button" value="Apply to Selected"/>	<input type="button" value="Apply to Selected"/>	<input type="button" value="Apply to Selected"/>	
Thermal Zone 1	<input type="checkbox"/>		<input type="checkbox"/>		HW Baseboard 	LargeHotel ClgSetp 	LargeHotel Corridor Htg 		

# Baseboard

- Make sure all the components are in the loop
- Review the error messages for feedback



# **OPENSTUDIO (HVAC SIZING)**

# HVAC Sizing

- What does autosizing and hard sizing mean?

The image shows a software interface for HVAC system design. The main window displays a schematic diagram of a VAV system with PFP boxes and reheat. The diagram includes a supply equipment section (top left) and a demand equipment section (bottom right). A fan is connected to the supply equipment, and the system is controlled by a VAV box and a reheat coil. The fan is labeled "OS:Fan:VariableVolume".

The properties panel on the right is titled "OS:Fan:VariableVolume" and contains the following settings:

- Name: Fan Variable Volume 1
- Availability Schedule Name: Always On Discrete
- Fan Total Efficiency: 0.8045
- Pressure Rise: 500
- Maximum Flow Rate:
  - Hard Sized
  - Autosized (highlighted with a red dashed box)
- Fan Power Minimum Flow Rate Input Method: FixedFlowRate
- Fan Power Minimum Flow Fraction: 0
- Fan Power Minimum Air Flow Rate: (empty field)

# HVAC Sizing

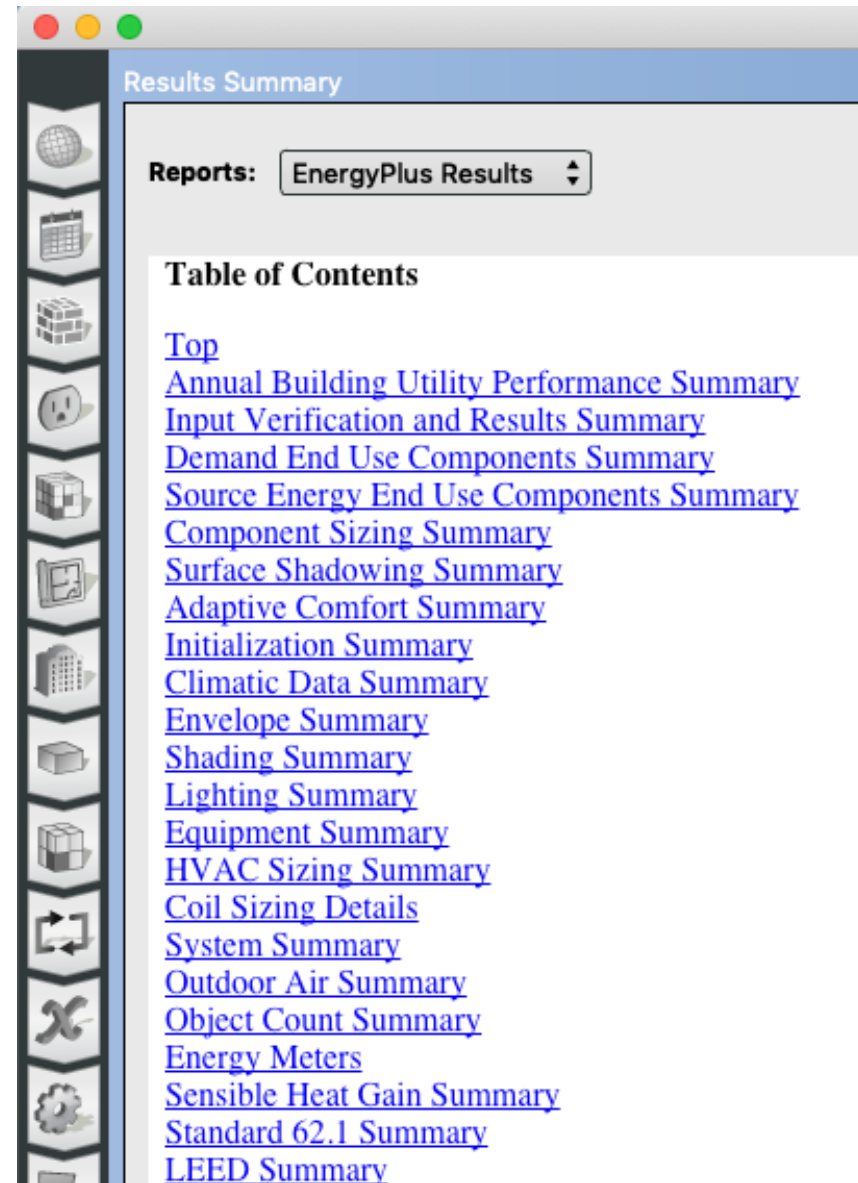
- You can find the autosize fields in advance:

```
Fan:VariableVolume,
  Supply Fan 1,                !- Name
  FanAvailSched,              !- Availability Schedule Name
  0.7,                        !- Fan Efficiency
  600.0,                      !- Pressure Rise {Pa}
  autosize,                   !- Maximum Flow Rate {m3/s}
  autosize,                   !- Minimum Flow Rate {m3/s}
  0.9,                        !- Motor Efficiency
  1.0,                        !- Motor In Airstream Fraction
  0.35071223,                 !- Fan Coefficient 1
  0.30850535,                 !- Fan Coefficient 2
  -0.54137364,                !- Fan Coefficient 3
  0.87198823,                 !- Fan Coefficient 4
  0.000,                      !- Fan Coefficient 5
  Main Heating Coil 1 Outlet Node, !- Air Inlet Node Name
  VAV Sys 1 Outlet Node;      !- Air Outlet Node Name

FanPerformance:NightVentilation,
  Supply Fan 1,                !- Fan Name
  0.7,                        !- Fan Total Efficiency
  67.0,                       !- Pressure Rise {Pa}
  autosize,                   !- Maximum Flow Rate {m3/s}
  0.9,                        !- Motor Efficiency
  1.0;                        !- Motor in Airstream Fraction
```

# HVAC Sizing

- Approach 1:
  - ❑ Find from EnergyPlus results

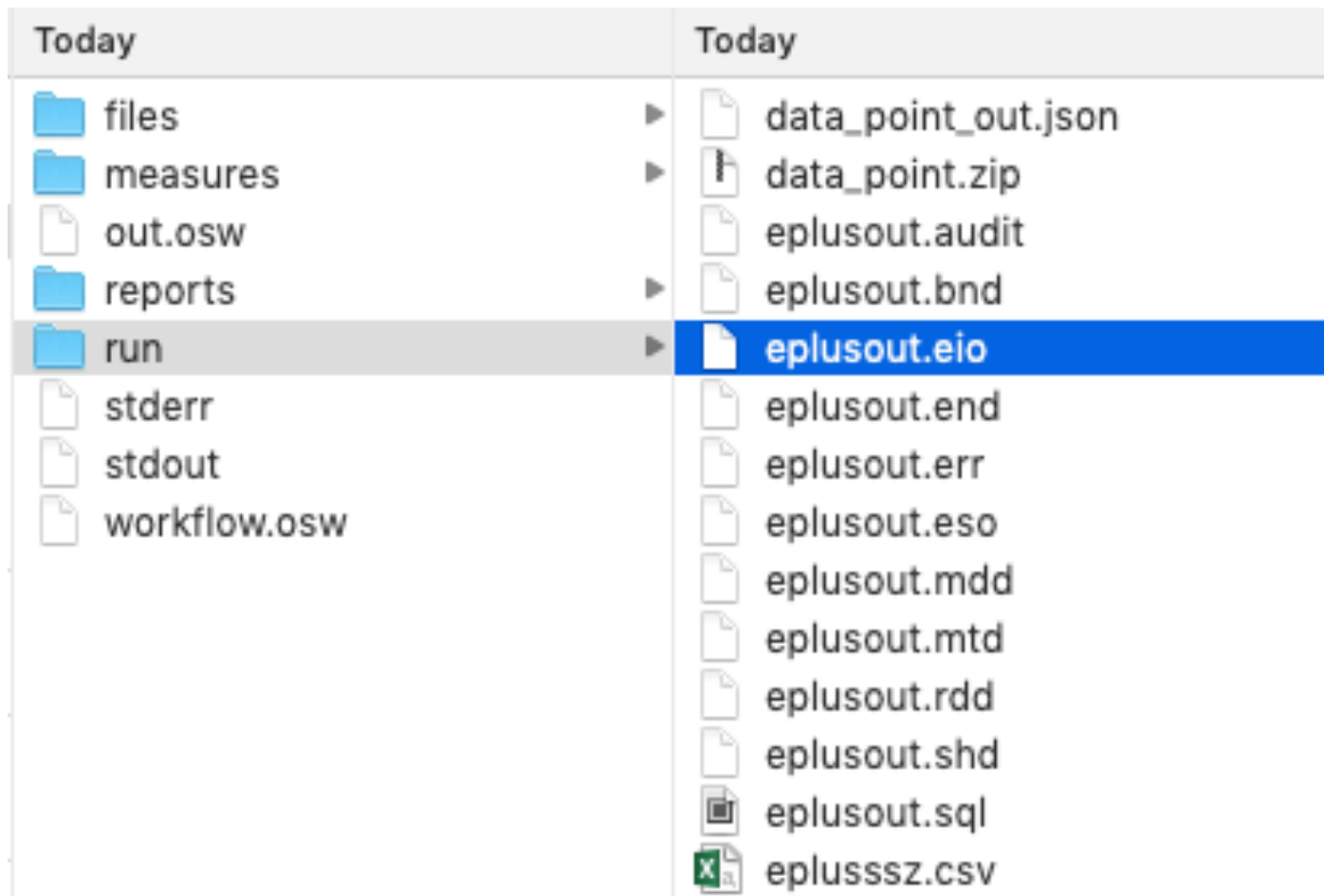


The screenshot shows a software window titled "Results Summary". At the top, there is a "Reports:" dropdown menu currently set to "EnergyPlus Results". Below this is a "Table of Contents" section listing various summary reports. The list includes:

- [Top](#)
- [Annual Building Utility Performance Summary](#)
- [Input Verification and Results Summary](#)
- [Demand End Use Components Summary](#)
- [Source Energy End Use Components Summary](#)
- [Component Sizing Summary](#)
- [Surface Shadowing Summary](#)
- [Adaptive Comfort Summary](#)
- [Initialization Summary](#)
- [Climatic Data Summary](#)
- [Envelope Summary](#)
- [Shading Summary](#)
- [Lighting Summary](#)
- [Equipment Summary](#)
- [HVAC Sizing Summary](#)
- [Coil Sizing Details](#)
- [System Summary](#)
- [Outdoor Air Summary](#)
- [Object Count Summary](#)
- [Energy Meters](#)
- [Sensible Heat Gain Summary](#)
- [Standard 62.1 Summary](#)
- [LEED Summary](#)

# HVAC Sizing

- Approach 2:
  - Open the EIO extension file





# HVAC Sizing

- Approach 2:
  - Find the autosize values

```
875 | <System Sizing Information>, System Name, Load Type, Peak Load Kind, User Design Capacity, Calc Des Air Flow Rate [m3/s], User Des
Air Flow Rate [m3/s], Design Day Name, Date/Time of Peak
876 System Sizing Information, VAV WITH REHEAT, Cooling, Sensible, 3874937.65, 145.49122, 145.49122, MD_COLLEGE-PARK ANN CLG 0.4% CONDNS
DB=>MCMB, 7/21 08:00:00
877 System Sizing Information, VAV WITH REHEAT, Heating, Sensible, 1095941.11, 44.72717, 44.72717, MD_COLLEGE-PARK ANN HTG 99.6% CONDNS
DB, 1/21 08:00:00
878 | <Component Sizing Information>, Component Type, Component Name, Input Field Description, Value
879 Component Sizing Information, AirTerminal:SingleDuct:VAV:Reheat, AIR TERMINAL SINGLE DUCT VAV REHEAT 2, Design Size Maximum Air Flow
Rate [m3/s], 0.36239
880 Component Sizing Information, AirTerminal:SingleDuct:VAV:Reheat, AIR TERMINAL SINGLE DUCT VAV REHEAT 2, Design Size Constant Minimum
Air Flow Fraction, 8.33684E-002
881 Component Sizing Information, AirTerminal:SingleDuct:VAV:Reheat, AIR TERMINAL SINGLE DUCT VAV REHEAT 2, User-Specified Constant
Minimum Air Flow Fraction, 0.30000
882 Component Sizing Information, AirTerminal:SingleDuct:VAV:Reheat, AIR TERMINAL SINGLE DUCT VAV REHEAT 2, Design Size Minimum Air Flow
Rate [m3/s], 0.16872
883 Component Sizing Information, AirTerminal:SingleDuct:VAV:Reheat, AIR TERMINAL SINGLE DUCT VAV REHEAT 2, Design Size Maximum Flow per
Zone Floor Area during Reheat [m3/s-m2], 2.74205E-003
884 Component Sizing Information, AirTerminal:SingleDuct:VAV:Reheat, AIR TERMINAL SINGLE DUCT VAV REHEAT 2, Design Size Maximum Flow
Fraction during Reheat [], 0.30000
885 Component Sizing Information, AirTerminal:SingleDuct:VAV:Reheat, AIR TERMINAL SINGLE DUCT VAV REHEAT 2, Design Size Maximum Reheat
Water Flow Rate [m3/s], 6.54338E-005
```

# HVAC Sizing

- Hard size all components

The image displays a software interface for HVAC system design, showing a schematic diagram and a properties panel.

The schematic diagram illustrates a VAV with Reheat system. It features a supply equipment section (indicated by a red dashed box) and a demand equipment section. The supply equipment section includes a fan, a coil, and a reheat coil. The demand equipment section consists of three zones, each with its own VAV terminal unit and reheat coil. The system is connected to a supply air loop and a return air loop.

The properties panel on the right shows the configuration for the outdoor air system and controller. The "OS:AirLoopHVAC:OutdoorAirSystem" section is titled "Air Loop HVAC Outdoor Air System 1". The "OS:Controller:OutdoorAir" section is titled "Controller Outdoor Air 1". The "Minimum Outdoor Air Flow Rate" is set to "Hard Sized" at 0 cfm. The "Maximum Outdoor Air Flow Rate" is set to "Autosized". The "Economizer Control Type" is set to "NoEconomizer" and the "Economizer Control Action Type" is set to "ModulateFlow".

Property	Value	Unit
Name	Air Loop HVAC Outdoor Air System 1	
Name	Controller Outdoor Air 1	
Minimum Outdoor Air Flow Rate	0	cfm
Maximum Outdoor Air Flow Rate	Autosized	cfm
Economizer Control Type	NoEconomizer	
Economizer Control Action Type	ModulateFlow	
Economizer Maximum Limit Dry-Bulb Temperature	82.399999999999935	F
Economizer Maximum Limit Enthalpy	27.515047291487534	Btu/lb <sub>m</sub>
Economizer Maximum Limit Dewpoint Temperature		F
Economizer Minimum Limit Dry-Bulb Temperature	-148.00000000000006	F

# HVAC Sizing

- Hard size all components

The screenshot displays a software interface for HVAC system design. The main window shows a schematic diagram of a VAV with Reheat system. The diagram includes a supply equipment section (indicated by a dashed line) and demand equipment sections (indicated by solid lines). A red dashed box highlights a specific air terminal component in the demand equipment section.

The properties panel on the right side of the interface is titled "OS:AirTerminal:SingleDuct:VAV:Reheat". It contains the following settings:

- Name: Air Terminal Single Duct VAV Reheat 30
- Availability Schedule Name: Always On Discrete
- Air Inlet Node Name: {0be6dd1a-bb4a-475b-bd4e-add0db656cfa}
- Maximum Air Flow Rate:  Hard Sized  Autosized (Autosize)
- Zone Minimum Air Flow Input Method: Constant
- Constant Minimum Air Flow Fraction:  Hard Sized (0.2999999999999999)  Autosized (Autosize)
- Fixed Minimum Air Flow Rate:  Hard Sized (0)  Autosized (Autosize)
- Minimum Air Flow Fraction Schedule Name: [Empty]
- Reheat Coil Name: Coil Heating Water 32
- Maximum Hot Water or Steam Flow Rate:  Hard Sized  Autosized (Autosize)

# HVAC Sizing

- Hard size all components

The screenshot displays the HVAC Systems software interface. The main window shows a schematic of a Chilled Water Loop. The loop includes a chiller (highlighted with a red dashed box), a pump, and various piping and valves. A dashed box labeled "Drag From Library" is positioned in the center of the loop. The interface includes a top menu bar with "Layout", "Control", and "Grid" options, and a search bar containing "Chilled Water Loop".

The right-hand panel shows the properties for the selected component, "OS:Chiller:Electric:EIR". The properties are as follows:

Property	Value
Name	Chiller Electric EIR 1
Reference Capacity	<input checked="" type="radio"/> Hard Sized 2038062.0634066698 Btu/h <input type="radio"/> Autosize Autosize
Reference COP	5.5
Reference Leaving Chilled Water Temperature	44.005999999999965 F
Reference Entering Condenser Fluid Temperature	84.519999999999988
Reference Chilled Water Flow Rate	<input type="radio"/> Hard Sized <input type="text"/> gal/min <input checked="" type="radio"/> Autosize Autosize
Reference Condenser Fluid Flow Rate	<input type="radio"/> Hard Sized <input type="text"/> gal/min <input checked="" type="radio"/> Autosize Autosize
Cooling Capacity Function of Temperature Curve Name	Curve Biquadratic 1
Electric Input to Cooling Output Ratio Function of Temperature Curve Name	Curve Biquadratic 2
Electric Input to Cooling Output Ratio Function of Part Load Ratio Curve Name	Curve Quadratic 1

# HVAC Sizing

- Hard size all components

The screenshot displays the HVAC Systems software interface. The main window shows a schematic of a condenser water loop, titled "Condenser Water Loop 1". The diagram includes a central cooling tower, two pumps, and various piping connections. A red dashed box highlights the cooling tower component in the diagram. The right-hand side of the interface shows the "Properties" panel for the selected component, "OS: Cooling Tower: Single Speed". The panel is titled "OS: Cooling Tower: Single Speed" and contains several settings:

- Name: Cooling Tower Single Speed 2
- Design Water Flow Rate:  Hard Sized  Autosized
- Design Air Flow Rate:  Hard Sized  Autosized
- Fan Power at Design Air Flow Rate:  Hard Sized  Autosized
- U-Factor Times Area Value at Design Air Flow Rate:  Hard Sized  Autosized
- Air Flow Rate in Free Convection Regime:  Hard Sized  Autosized
- U-Factor Times Area Value at Free Convection Air Flow Rate:  Hard Sized  Autosized
- Performance Input Method: UFactorTimesAreaAndDesignWaterFlowRate
- Nominal Capacity:  Btu/h

A red dashed box highlights the "Autosized" radio buttons for Design Water Flow Rate, Design Air Flow Rate, Fan Power at Design Air Flow Rate, U-Factor Times Area Value at Design Air Flow Rate, Air Flow Rate in Free Convection Regime, and U-Factor Times Area Value at Free Convection Air Flow Rate. This indicates that these components are currently set to be autosized, which contradicts the slide's instruction to "Hard size all components".

# HVAC Sizing

- Hard size all components

The screenshot displays a software interface for HVAC sizing, divided into a main table and a detailed property panel on the right.

**Thermal Zones Table:**

Name	All	Rendering Color	Turn On Ideal Air Loads	Air Loop Name	Zone Equipment	Cooling Thermostat Schedule	Heating Thermostat Schedule	Humidifying Setpoint Schedule	Dehumidify Schedule
Thermal Zone 1	<input type="checkbox"/>	Blue	<input type="checkbox"/>	VAV with Reheat 1	HW Baseboard Single Duct VAV Reheat 60	Medium Office ClgSetp	Medium Office HtgSetp		
Thermal Zone 10	<input type="checkbox"/>	Dark Blue	<input type="checkbox"/>	VAV with Reheat 1	HW Baseboard 67 Single Duct VAV Reheat 61	Medium Office ClgSetp	Medium Office HtgSetp		
Thermal Zone 11	<input type="checkbox"/>	Green	<input type="checkbox"/>	VAV with Reheat 1	HW Baseboard 54 Single Duct VAV Reheat 62	Medium Office ClgSetp	Medium Office HtgSetp		
Thermal Zone 12	<input type="checkbox"/>	Olive Green	<input type="checkbox"/>	VAV with Reheat 1	HW Baseboard 57 Single Duct VAV Reheat 63	Medium Office ClgSetp	Medium Office HtgSetp		
Thermal Zone 13	<input type="checkbox"/>	Light Blue	<input type="checkbox"/>	VAV with Reheat 1	HW Baseboard 63 Single Duct VAV Reheat 64	Medium Office ClgSetp	Medium Office HtgSetp		

**Property Panel (OS: AirTerminal:SingleDuct:VAV:Reheat):**

- Name: Air Terminal Single Duct VAV Reheat 60
- Availability Schedule Name: Always On Discrete
- Air Inlet Node Name: {1ca7d805-4099-4d6b-877c-ced44a01dba}
- Maximum Air Flow Rate:
  - Hard Sized
  - Autosized (Autosize)
- Zone Minimum Air Flow Input Method: Constant
- Constant Minimum Air Flow Fraction:
  - Hard Sized (0.2999999999999999)
  - Autosized (Autosize)
- Fixed Minimum Air Flow Rate:
  - Hard Sized (0)
  - Autosized (Autosize)
- Minimum Air Flow Fraction Schedule Name: (empty)
- Reheat Coil Name: Coil Heating Water 62
- Maximum Hot Water or Steam Flow Rate:
  - Hard Sized (0)

# **BUILDING RETROFIT EEMS**

# Building Retrofit EEM

- Window replacement in AM Hall:
  - Remove the old windows
  - Build a temp wall within the spaces approximately 10-12 inch off the window/brick wall





# Building Retrofit EEM



# Building Retrofit EEM

- Window replacement in AM Hall:



# Building Retrofit EEM

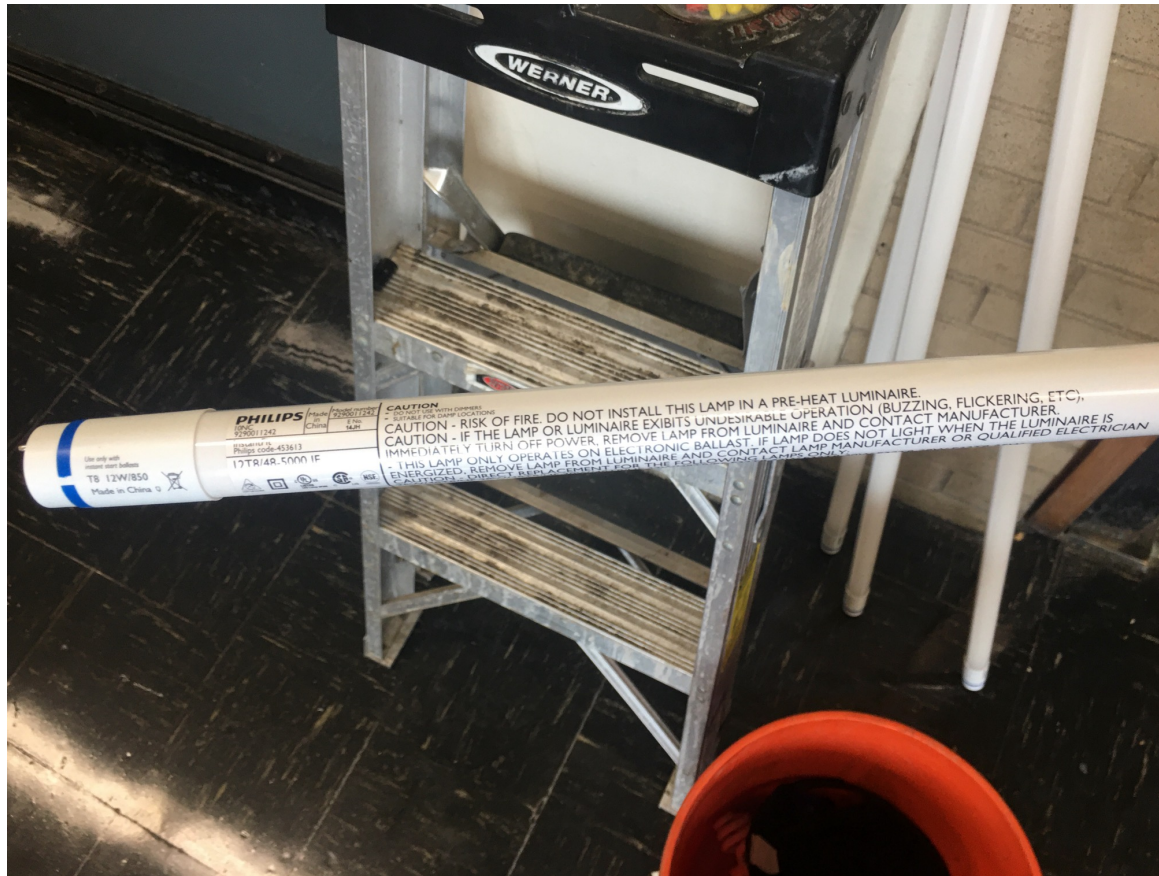
---

- We looked at the new window installed on campus



# Building Retrofit EEM

- We looked at lighting EEMs



# Building Retrofit EEM

- You can find the datasheet

## LED InstantFit Lamps

### 12T8/48-5000 IF 10/1

Philips LED T8 InstantFit Lamps are an ideal energy saving choice for existing linear fluorescent fixtures.

#### Product data

##### General Information

Cap-Base	G13 [ Medium Bi-Pin Fluorescent]
Main Application	Industrial
Nominal Lifetime (Nom)	50000 h
Switching Cycle	50000X
B50L70	50000 h

##### Light Technical

Color Code	850 [ CCT of 5000K]
Beam Angle (Nom)	160 °
Luminous Flux (Nom)	1650 lm
Luminous Flux (Rated) (Nom)	1650 lm
Rated Beam Angle	160 °
Correlated Color Temperature (Nom)	5000 K
Color Consistency	<5
Color Rendering Index (Nom)	82
LLMF At End Of Nominal Lifetime (Nom)	70 %

##### Operating and Electrical

Input Frequency	50 to 60 Hz
Power (Rated) (Nom)	12 W
Lamp Current (Max)	150 mA
Lamp Current (Min)	60 mA
Starting Time (Nom)	0.5 s
Warm Up Time to 60% Light (Nom)	0.1 s

Power Factor (Nom)	0.9
Voltage (Nom)	120-277 V

##### Temperature

T-Ambient (Max)	45 °C
T-Ambient (Min)	-20 °C
T-Storage (Max)	65 °C
T-Storage (Min)	-40 °C
T-Case Maximum (Nom)	40 °C

##### Controls and Dimming

Dimmable	No
----------	----

##### Mechanical and Housing

Product Length	1200 mm
----------------	---------

##### Approval and Application

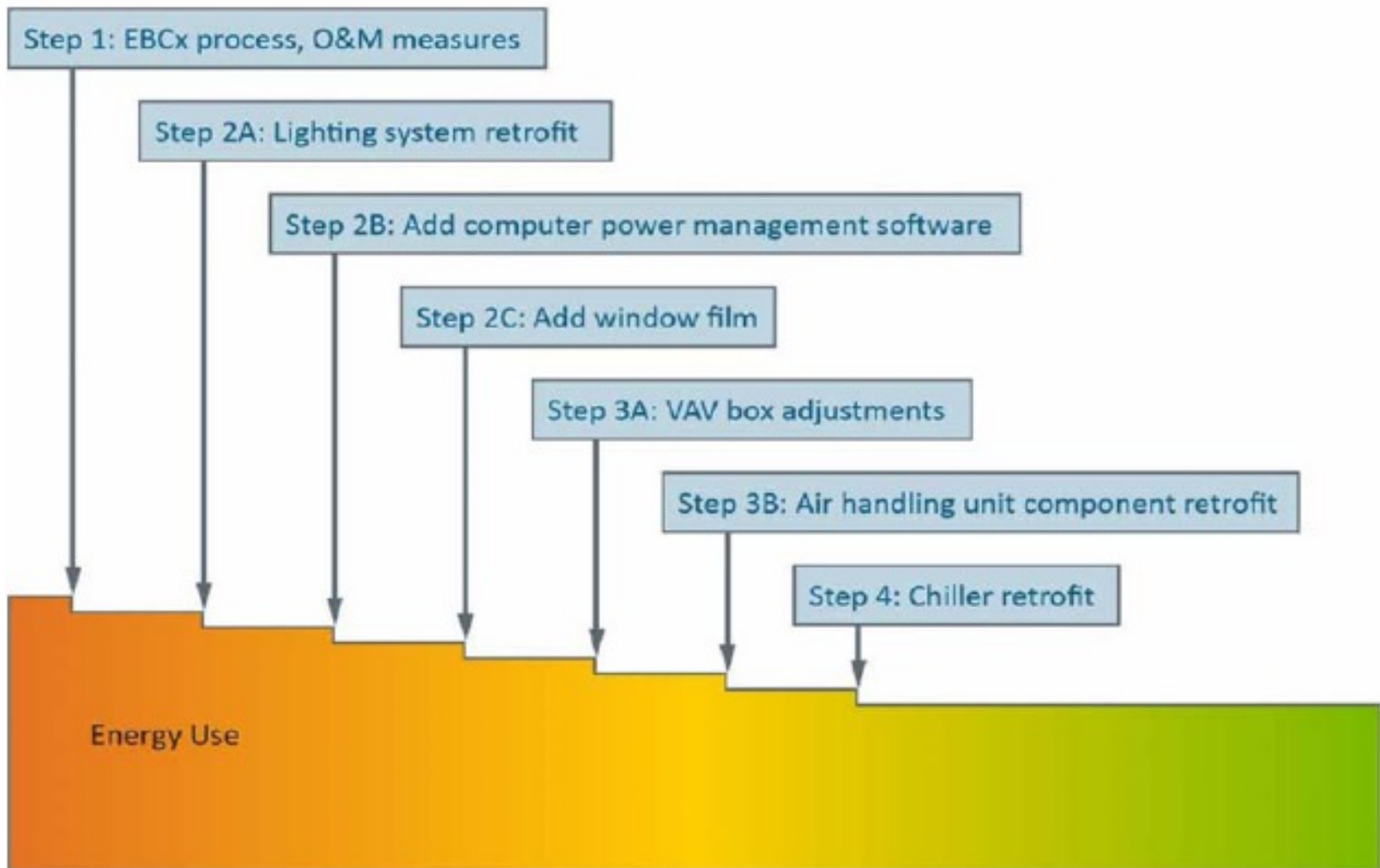
Energy Saving Product	Yes
Approval Marks	UL certificate RoHS compliance KEMA Keur certificate DLC compliance
Energy Consumption kWh/1000 h	14.5 kWh

##### Product Data

Order product name	12T8/48-5000 IF 10/1
EAN/UPC - Product	046677453619

# Building Retrofit EEM

- You need to develop your building retrofit path:



# **PAYBACK PERIOD EXAMPLES**

# Payback Period Examples

- An example of short payback period in Dayton Ohio:

	<i>AR No.</i>	<i>Description</i>	<i>Payback (yrs)</i>
<i>Lighting</i>	1	Replace Metal Halide Lamps with T-8 Fluorescent Fixtures	2.3
	2	Install Photosensor Controls to Utilize Daylight	0.6
<i>Space Conditioning</i>	3	Install Programable Thermostat in the Office	0.2
	4	Adjust the Year Round Thermostat Set Points in the Office	0.2
<i>Compressed Air</i>	5	Reduce Overall Pressure in Compressed Air System	0.2
	6	Reduce Leaks in Compressed Air System	1.1
	7	Eliminate use of Air Motors on Pipe Turners	1.0

	<i>AR No.</i>	<i>Description</i>	<i>Cost-Benefit Analysis Results</i>	<i>Simple Payback (yrs)</i>
<i>Lighting</i>	1	Replace 8' T-12 Bulbs with 8' T-8 Bulbs	1.085	3.6
	2	Install Photo Sensor Controls	0.525	2.0
<i>Comp Air</i>	3	Lower Air Compressor Discharge Pressure	0.093	0.3
<i>Space Conditioning</i>	4	Install Programmable Thermostats	0.128	0.4
	5	Increase Air Conditioning Thermostat Set Points	0.012	0.0
<i>Other Rec.</i>		Replace 4' T-12 Lamps with 4' T-8 Lamps	1.881	4.9



# Payback Period Examples

---

- Building: Liberty Tower (Dayton, Ohio)
  - ❑ 85-year-old
  - ❑ 114,000 ft<sup>2</sup>
- Three energy efficiency measures are:
  - ❑ Steam boiler replaced with vertical fire tube boilers
  - ❑ Replace interior and exterior with LEDs
  - ❑ Building control upgrade



# Payback Period Examples

---

- Building: Liberty Tower (Dayton, Ohio)
  - ❑ LEDs consume 60% less energy
  - ❑ Add controls to dim or turn off the lights
  - ❑ LED lights fail in a different way, so control may be an important factor in the light selection

# Payback Period Examples

---

- Building: Liberty Tower (Dayton, Ohio)
  - ❑ Total cost: \$870,000
  - ❑ Annual utility cost savings \$99,000
  - ❑ Payback period:

$$\text{Payback} = \frac{870,000}{99,000} = 8.8 \text{ years}$$

- ❑ The project has received \$70,000 in utility rebates, making the economic case more practical

$$\text{Payback} = \frac{(870,000 - 70,000)}{99,000} = 7.8 \text{ years}$$

# Payback Period Examples

---

- Long payback period for building envelopes:
  - ❑ It is hard to do a building envelope retrofit since owners only 60% of the commercial floorspaces
  - ❑ They do not have a good payback period
  - ❑ Usually there are different motivations to conduct a building envelope retrofit

# Payback Period Examples

EEM	Cost / Unit	Cost	Source
Occupancy Sensors	\$1.06/ft <sup>2</sup>	\$ 44,991	RSMeans, "5 fixtures per 1000 S.F., including occupancy and time switching"
Condensing Boiler	\$20,706 + \$13.82/MBH	\$ 31,401	RSMeans, commercial gas boilers
Light Power Density Reduction	\$4.78/ft <sup>2</sup>	\$ 202,886	RSMeans, "Fluorescent high-bay 4 lamp fixture, 1W/sf,59FC, 4 fixtures per 1000 S.F."
Condensing Unit Replacement	\$7,909 + \$766/ton	\$ 132,687	RSMeans, packaged air-cooled refrigerant compressor and condensor
Window Film	\$18.93/ft <sup>2</sup> glazing	\$ 182,311	RSMeans, "Solar Films on Glass" average of min/max value
Wall Insulation	\$4.78/ft <sup>2</sup> wall area	\$ 927,930	RSMeans, "4 in. EPS insulation, Commercial renovation Exterior Insulation and Finish System",

# Payback Period Examples

---

<b>Energy Efficiency Measures</b>	<b>Simple Payback</b>
<b>Condensing Boiler</b>	9.4
<b>Occupancy Sensors</b>	10.4
<b>Light Power Density Reduction</b>	32.4
<b>Condensing Unit Replacement</b>	41.2
<b>Window Film</b>	70.7
<b>Wall Insulation</b>	247.0

---

# **CLASS ACTIVITY**

# Class Activity

---

- Spend 10 to 20 minutes to propose a few EEMs
  - Enclosure
  - Window
  - Lighting
  - Plug load
  - HVAC
- Complete this table:
  - <https://docs.google.com/spreadsheets/d/1eUYbP00uv7EYI3cB5poRmNHMOfJb292LX-gPeIbX1Yo/edit#gid=532010071>



# **AERG EXAMPLE (K-12)**

# AERG Example


## Advanced Energy Retrofit Guides

Buildings

Buildings » Commercial Buildings » Design & Decision Support Guides » Advanced Energy Retrofit Guides







The Advanced Energy Retrofit Guides (AERGs) were created to help decision makers plan, design, and implement energy improvement projects in their facilities. With energy managers in mind, they present practical guidance for kick-starting the process and maintaining momentum throughout the project life cycle. These guides are primarily reference documents, allowing energy managers to consult the particular sections that address the most pertinent topics. Useful resources are also cited throughout the guides for further information. Each AERG is tailored specifically to the needs of a specific building type, with an emphasis on the most effective retro-commissioning and retrofit measures identified by experts familiar with those unique opportunities and challenges. The guides present a broad range of proven practices that can help energy managers take specific actions at any stage of the retrofit process, resulting in energy savings for many years to come.



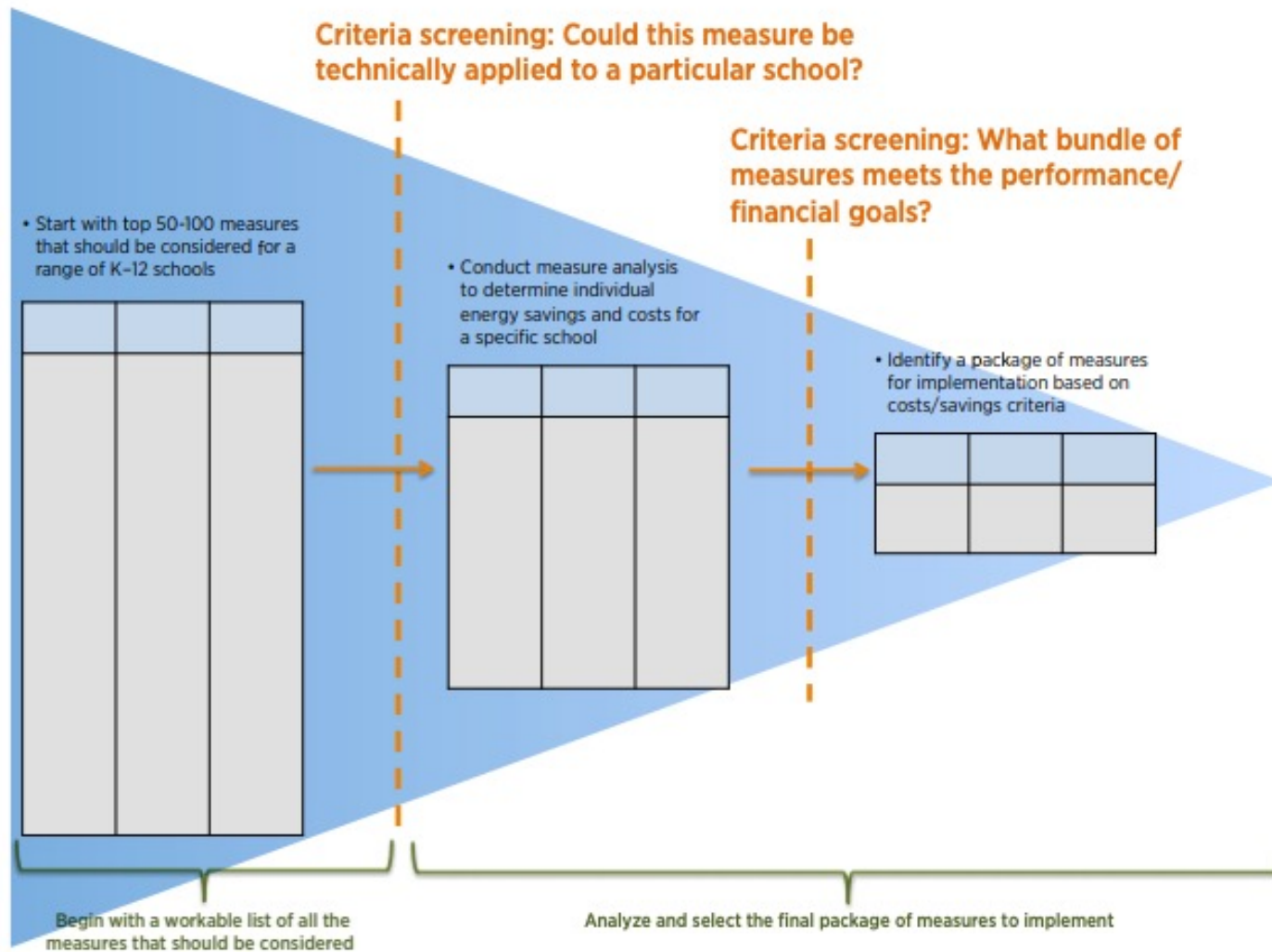
 The Advanced Energy Retrofit Guides (AERGs) help building owners and managers as well as design and construction professionals plan, design, and implement energy-efficiency upgrades in commercial buildings.

<https://www.energy.gov/eere/buildings/advanced-energy-retrofit-guides#:~:text=The%20Advanced%20Energy%20Retrofit%20Guides,throughout%20the%20project%20life%20cycle.>

# AERG Example

	 Energy Manager	 Custodial Staff	 School Board or Financial Manager	 Teachers and Students	 Community and Parents	 Utilities and Auditors
1 Introduction	●	●	●	●	●	●
2 Overview: Plan, Execute, Follow Up	●		●			
3 Existing Building Commissioning	●	●		●		●
4 Building Retrofits	●		●			●
5 Measurement and Verification	●	●				
6 Operations and Maintenance	●	●				
7 Conclusion	●	●	●	●	●	●

# AERG Example



# AERG Example

## Case Study 1: Vigo County School Corporation

### Quick Facts

- Facility Name: Vigo County School Corporation
- Facility Type: K-12 Schools
- Location: Terre Haute, Indiana
- Number of Buildings: 29

### Project Description

The Vigo County School Corporation (VCSC) in Terre Haute, Indiana, and under the leadership of Superintendent Daniel Tanoos, partnered with Energy Systems Group to develop and implement comprehensive energy savings performance contracts. VCSC is made up of 3 high schools, 2 alternative schools, 6 middle schools, and 18 elementary schools.

In 1999, VCSC decided to take control over rising operating costs with an assessment of its utility costs, which at the time averaged \$0.845/ft<sup>2</sup>. This was compared to other Indiana school facilities that had installed energy retrofits resulting in energy costs as low as \$0.65/ft<sup>2</sup>. Of the 19 VCSC schools surveyed, 9 were operating at more than \$0.90/ft<sup>2</sup>.

In 2000, VCSC and Energy Systems Group entered into an initial agreement to provide energy-related upgrades at 20 of its facilities. This initial project resulted in a



Photo from NAESCO

guaranteed cost reduction of more than \$1 million per year over the term of the agreement. To date, Energy Systems Group has met its savings guarantee.

VCSC has implemented more than \$29 million in comprehensive energy improvements and renovation projects in six phases which are estimated to save close to \$35 million over the terms of the contracts.

### Environmental Benefits

1. *Removes emissions equivalent to more than 5,200 passenger vehicles per year.*
2. *Creates enough electricity to provide power for more than 3,800 homes per year.*
3. *Planting more than 6,500 acres of forests annually.*

# AERG Example

## Key EEMs:

- Comprehensive HVAC improvements and replacements
- Lighting systems redesigns and retrofits
- First school in Indiana to be 100% retrofitted with light-emitting diodes (LEDs)
- Electrical system upgrades
- District-wide EMS
- Window replacements
- Hot water pump replacements
- 1.5-kW wind turbine with curriculum for science students
- High school pool improvements.

Installation Costs	M&V Costs	Total Cost Without Incentives	Financial Incentives	Actual Project Costs
\$29,922,466	\$75,477	\$29,977,943	\$60,000	\$29,862,466
Energy \$ Savings	O&M \$ Savings	Capital Cost Avoidance	Total Annual \$ Savings	
\$592,321/year	\$1,395,838/year	\$1,206,457/year	\$3,194,616	
Energy Cost Intensity Pre-Retrofit	Energy Cost Intensity Post-Retrofit	Energy Cost Intensity ASHRAE 90.1-2004	Simple Payback (years) (Excluding Incentives)	
\$0.84/ft <sup>2</sup>	\$0.70/ft <sup>2</sup>	\$1.40/ft <sup>2</sup>	9.3 (9.4)	

# AERG Example

System	EEM Description	Applicable to:				
		Hot-Humid	Hot Dry	Marine	Cold	Very Cold
Lighting	Replace incandescent lamps in exit signs with LEDs	✓	✓	✓	✓	✓
	Replace T12 fluorescent lamps and magnetic ballasts with high- efficiency T8 lamps and instant-start electronic ballasts	✓	✓	✓	✓	✓
	Replace incandescent lamps with compact fluorescent lamps (CFLs)	✓	✓	✓	✓	✓
	Install wireless motion sensors for lighting in rooms that are used intermittently	✓	✓	✓	✓	✓
	Install photosensors and dimming ballasts to dim lights when daylighting is sufficient	✓	✓	✓	✓	✓
	Replace high intensity discharge (HID) lights with T5 high- output (HO) fluorescents in gymnasiums	✓	✓	✓	✓	✓
	Install more efficient exterior lighting for façades and parking lot	✓	✓	✓	✓	✓
Plug and process loads	Replace cafeteria appliances with ENERGY STAR models	✓	✓	✓	✓	✓
	Install VSD demand control for kitchen hood exhaust fans	✓	✓	✓	✓	✓

# AERG Example

System	EEM Description	Applicable to:				
		Hot-Humid	Hot Dry	Marine	Cold	Very Cold
Envelope	Add reflective roof covering	✓	✓		✓	
Service water heating	Install low-flow showerheads in locker rooms	✓	✓	✓	✓	✓
HVAC Heating and cooling	Add evaporative precooling of condenser supply air		✓			
	Add a small condensing boiler to handle the base load and summer load, with current inefficient boiler operating when heating loads are highest	✓	✓	✓	✓	✓
	Install VSDs on chilled-water and hot water pumps	✓	✓	✓	✓	✓
	Replace standard furnace with a high-efficiency condensing furnace	✓	✓	✓	✓	✓
	Install an EMS and replace pneumatic controls with direct digital controls (DDCs)	✓	✓	✓	✓	✓
	Replace oversized, inefficient fans and motors with rightsized National Electric Manufacturers Association (NEMA) premium efficiency models	✓	✓	✓	✓	✓
	Convert CV or dual-duct air handling system to variable air volume (VAV) (add dampers, VSD fan motors)	✓	✓	✓	✓	✓
	Install VSDs on cooling tower fans	✓	✓	✓	✓	✓
HVAC Ventilation	Install a dry-bulb airside economizer	✓	✓	✓	✓	✓
	Upgrade to DCV to reduce OA flow during partial occupancy	✓	✓	✓	✓	✓
	Add heat/energy recovery to the ventilation system	✓	✓	✓	✓	✓



# AERG Example

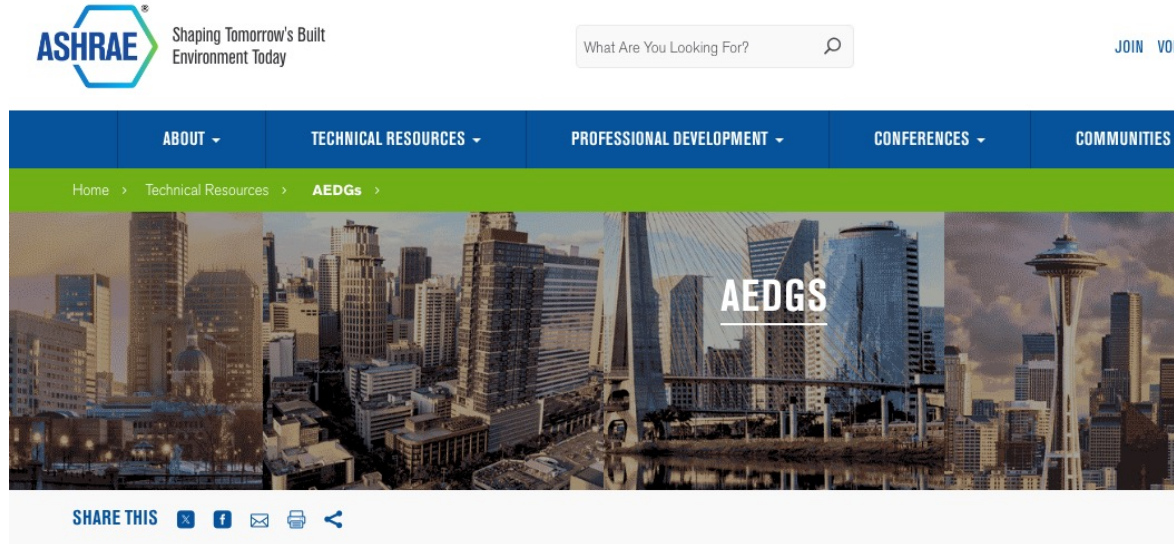
**Table E-2 Recommended Temperature Setbacks and Setups for U.S. Climate Zones**

Climate Zone	Massive Building		Metal Building	
	Heating Setback (°F)	Cooling Setup (°F)	Heating Setback (°F)	Cooling Setup (°F)
1A	4.3	10.4	4.1	7.7
2A	9.4	13.9	10.1	11.2
3A	9.4	13.1	13.3	12.9
4A	19.4	16.4	20.7	15.3
5A	18	10.8	22.1	13.5
6A	20.5	10.4	23.9	12.7
2B	9.7	20.5	8.6	15.5
3B	7.9	14.2	12.1	13.5
4B	20.7	16.5	21.9	15.8
5B	19.4	10.6	22.1	12.1
6B	19.4	10.3	22.3	12.1
7	20.7	8.8	6.3	11.5
8	22.3	5	23	7.9

# **CLASS ACTIVITY**

# Class Activity

- Download the K-12 or office building AEDG



## Advanced Energy Design Guides

### Free Download or [Purchase From Bookstore](#)

To promote building energy efficiency, ASHRAE and its partners are making the Advanced Energy Design Guides available for free download (PDF). The zero energy Guides offer designers and contractors the tools needed for achieving zero energy buildings. The 50% Guides offer designers and contractors the tools needed for achieving a 50% energy savings compared to buildings that meet the minimum requirements of Standard 90.1-2004, and the 30% Guides offer a 30% energy savings compared to buildings that meet the minimum energy requirements of Standard 90.1-1999.

ASHRAE, in collaboration with AIA (American Institute of Architects), IES (Illuminating Engineering Society), USGBC (U.S. Green Building Council) and the DOE (Department of Energy) continues to develop the Advanced Energy Design Guide (AEDG) Series.

<https://www.ashrae.org/technical-resources/aedgs>

# Class Activity

---

- Summarize and compare the lighting recommendations
  - ❑ <https://docs.google.com/spreadsheets/d/1eUYbP00uv7EYI3cB5poRmNHMOfJb292LX-gPelbX1Yo/edit#gid=1106944457>

# **OPENSTUDIO MEASURES**

# OpenStudio Measures

## Parametric Analysis Tool (PAT) Interface Guide

PAT removes the need to hand edit each model to try out different architectures, energy efficiency measures, and mechanical systems. PAT applies scripts to your baseline model and lets you quickly compare many alternatives. OpenStudio has developed a workflow that allows energy modelers to create and run a customized parametric analysis using commercially available cloud computing services. This workflow will enable anyone to perform powerful parametric studies in a reasonable time for a relatively low cost.

Creating a Project  
Loading a Baseline Model  
Organize and Edit Measures for Project  
Select Measures and Create Design Alternatives  
Run Simulations  
Create and View Reports  
Running on the Cloud  
Viewing Results  
Publications

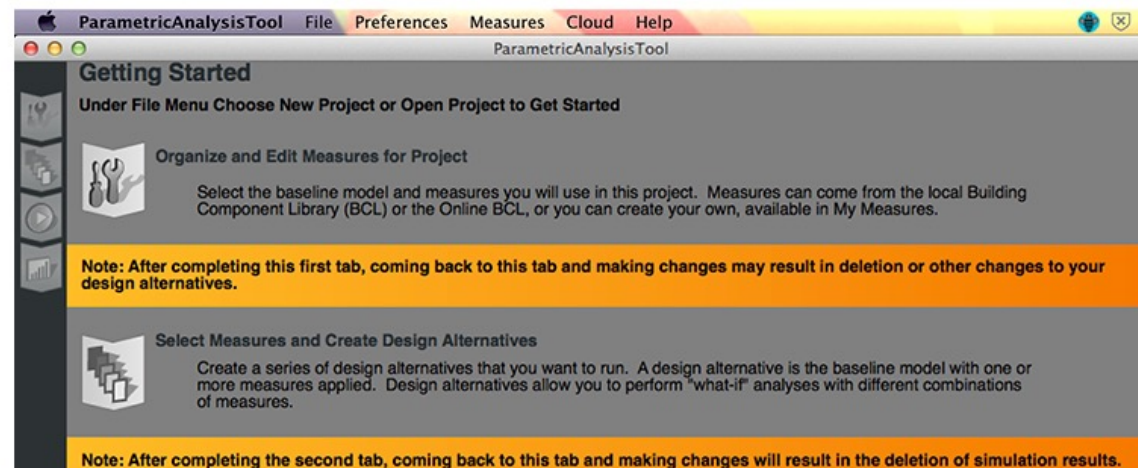
[Back to OpenStudio®](#)

### Creating a Project

The [Parametric Analysis Tool Quick Start Guide \(PDF\)](#) provides an introduction to the interface and workflow for creating multiple design alternatives from a seed model.

When you first open PAT you will see the screen below. It shows the workflow:

1. Organize and edit measures for project
2. Select measures and create design alternatives
3. Run simulations
4. Create and view reports



# OpenStudio Measures



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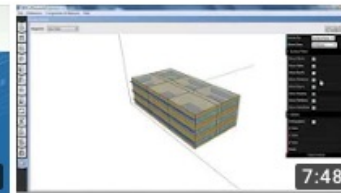
Baseline Model Automation  
1.7K views • 2 years ago



Create DOE Prototype  
Building - OpenStudio 1.11.1  
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Writing Custom OpenStudio  
Reporting Measures  
959 views • 2 years ago



OpenStudio 1.9.0 New  
Features (View Data...  
6K views • 3 years ago



OpenStudio 1.9.0 New  
Features (Facility, Spaces,...  
8.8K views • 3 years ago



***How many of you have watched any videos related to OpenStudio?***

<https://www.youtube.com/user/NRELOpenStudio/videos>

# OpenStudio Measures

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- Useful links:

- ❑ [https://www.youtube.com/watch?v=3rmEIK\\_OB28](https://www.youtube.com/watch?v=3rmEIK_OB28)
- ❑ <https://www.youtube.com/watch?v=4g5nJzDoh58>
- ❑ <https://www.youtube.com/watch?v=9WgUhiJ785I>
- ❑ <https://www.youtube.com/watch?v=0IINfGNe5x0>



# OpenStudio Measures

