

CAE 465/526 Building Energy Conservation Technologies

Fall 2022

September 07, 2022

Intro to building energy simulation and
OpenStudio training

Built
Environment
Research

@ IIT



*Advancing energy, environmental, and
sustainability research within the built environment*

www.built-envi.com

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Illinois Institute of Technology

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ANNOUNCEMENTS

Announcements

ASHRAE IIT GENERAL BODY MEETING

WHEN

September 8th, 2022
12:40pm – 1:40pm

WHERE

John T. Rettaliata
Engineering Center,
RE 124

Lunch will be provided!

For more information, feel free to
contact ASHRAE official email
ashrae_iit@iit.edu

GENERAL BODY MEETING

- Introduction of upcoming events
- Socializing and Networking



Interested in Joining

Announcements



About ▾ Events ▾ Chapters ▾ Membe



HackSimBuild

HackSimBuild is a 24-hour hackathon where participants (you) develop and test creative new approaches to building performance simulation. This event will bring together modelers, programmers, students, academics, designers, and engineers of all types to collaborate in a design sprint. At the end of this fun and immersive event, we will award prizes to the teams with the most original, innovative, and market-ready tools, metrics, ideas, or other hacks they present to our industry-leading panel of jurors.

[Get The Details Here](#)

<https://www.ibpsa.us/hacksimbuild/>

Announcements

- ESD is looking for interns

Excellent! We are looking for 2 or 3 students initially that are 2nd year or later in school with a Mechanical or Electrical focus. We would like them to be able to work a minimum of 12 hours a week - we are flexible with scheduling, but we prefer no less than 4 hour shifts. Pay starts at \$20/ hour and goes up from there based on year in school / past work experience.

Is there a job posting site or something we should use? I don't have a flyer or anything to post right now, but can likely have our marketing team put something together if that is helpful.

Announcements

- Assignment 1 is due tonight
- Assignment 2 is posted

CLASS ACTIVITY

Class Activity

- Always consider looking at the architectural and mechanical drawings first:

Office		Classroom			Office	
Corridor						
Office	Storage	Auditorium	Restroom	Laboratory	Office	
Corridor						
Office		Classroom			Office	

Class Activity

- Propose thermal zones in the provided floorplans on blackboard

Class Activity

- If you need to catch up with loads or thermal zones, I recommend looking at the HVAC lecture notes:

Course Syllabus (updated as we go; includes current schedule)

- [Most recent syllabus, updated January 19, 2021](#)

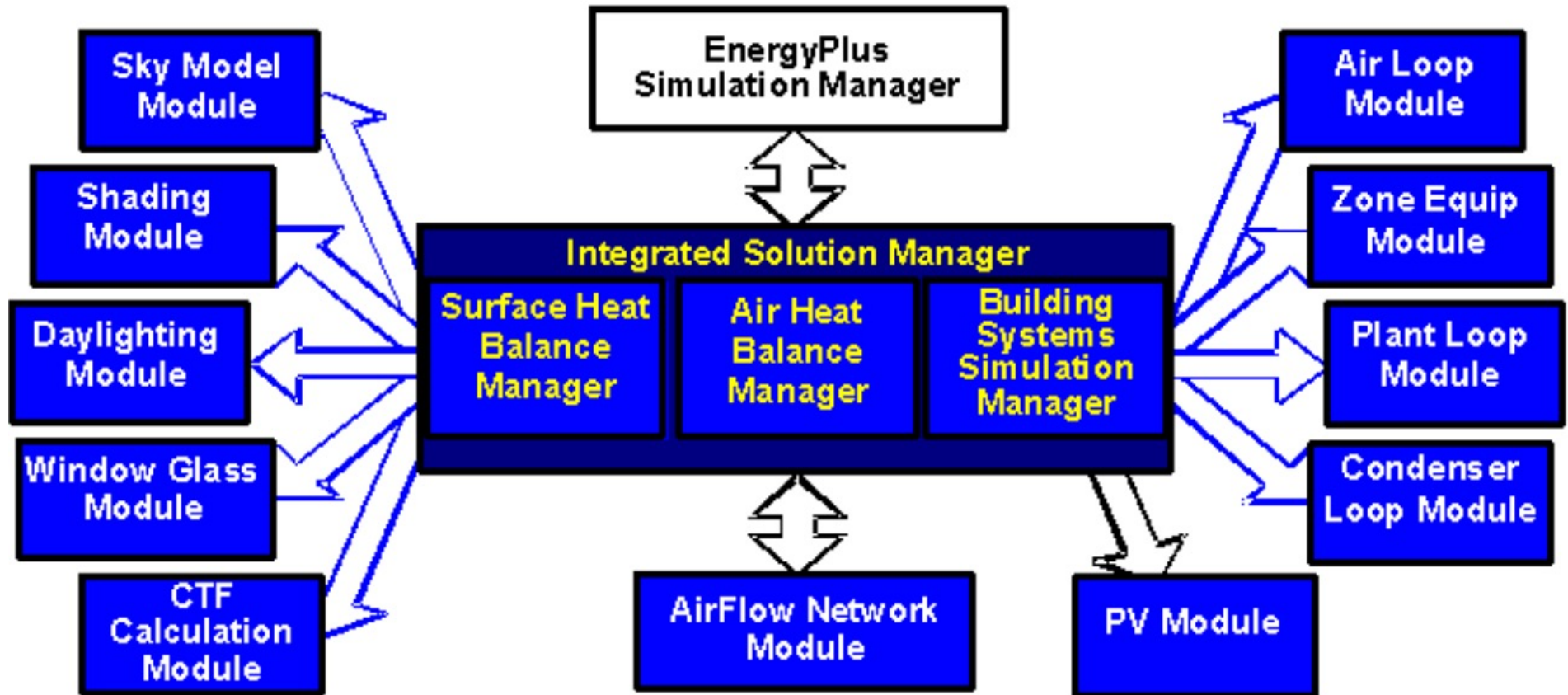
Lecture

- [Lecture 01: Course overview and introduction](#)
- [Lecture 02: Review of HVAC system drawings](#)
- [Lecture03: Installation](#)
- [Lecture 04: Psychrometrics processes and space conditioning](#)
- [Lecture 05: Design conditions and heating loads](#)
- [Lecture 06: Heating and cooling loads](#)
- [Lecture 07: Load calculation examples](#)
- [Lecture 08: OpenStudio training](#)
- [Lecture 09: Intro to fluid flow and ASHRAE 62.1](#)
- [Lecture 10: Air distribution systems: principles and air jets](#)
- [Lecture 11: Air distribution systems: classification of air diffusion](#)
- [Lecture 12: Air distribution systems: diffuser selection](#)
- [Lecture 13: Air distribution systems: diffuser selection examples and intro to pressure loss in ducts and fittings](#)
- [Lecture 14: Air distribution systems: course project and pressure loss in fittings](#)
- [Lecture 15: Air distribution systems: duct design methods](#)
- [Lecture 16: Air distribution systems: fan selection](#)
- [Lecture 17: Air distribution systems: fan selection example and air handling unit](#)

INTRO TO BUILDING ENERGY SIMULATIONS

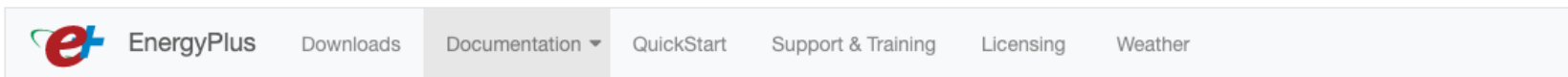
Building Energy Simulation

- EnergyPlus:



Building Energy Simulation

- EnergyPlus:



Documentation

PDF Documentation

PDF documentation can be downloaded from the following links.

[Download All PDFs](#)

[Acknowledgements](#)

[Auxiliary Programs](#)

[EMS Application Guide](#)

[EnergyPlus Essentials](#)

[Engineering Reference](#)

[External Interfaces Application Guide](#)

[Getting Started](#)

[Input Output Reference](#)

[Interface Developer](#)

[Module Developer](#)

[Output Details And Examples](#)

[Plant Application Guide](#)

[Tips and Tricks Using EnergyPlus](#)

[Using EnergyPlus for Compliance](#)

HTML Documentation

View [HTML documentation](#) for a HTML version of the EnergyPlus documentation.


Testing Documentation

View [testing reports](#) for current and past versions of EnergyPlus.

<https://energyplus.net/documentation>

Building Energy Simulation

- There are several graphical interface for EnergyPlus:



BEST Directory
Building Energy Software Tools
Formerly hosted by US Dept. of Energy

Home FAQ Software Listing Training About Contact

Find Software

Search


EnergyPlus

Capabilities

- Whole Building Energy Simulation
- Load Calculations
- HVAC System Selection and Sizing
- Parametrics and Optimization
- Energy Conservation Measures
- Code Compliance
- Ratings and Certificates
- Utility Bill and Meter Data Analysis
- Weather Data and Climate Analysis
- Building Automation
- Building Energy Auditing
- Building Energy Benchmarking
- Building Energy Monitoring
- Lighting Simulation
- Air Flow Simulation
- Life Cycle Analysis
- Solar and Photovoltaic Analysis
- Support Services
- Training Services
- Weather
- Other

Building Type

- Subsystem Level
- Commercial




Sefaira Systems

Sefaira Systems produces high-quality HVAC sizing and energy results directly from architectural Revit and SketchUp models, enabling users to rapidly compare design options and respond to architectural changes quicker than ever before.

Whole Building Energy Simulation | Load Calculations | HVAC System Selection and Sizing
Commercial, Residential, Multi Family

Last Software Update: 28 August 2015 | **Last Entry Update:** 20 September 2018

Ratings ★★★★★ | Reviews 0 | **Add to compare**



BuildSimHub

BuildSimHub provides a cloud-based energy model management platform and a variety of modeling toolset to streamline and automate modeling cycles for businesses who focus on building sustainability, saving up to 70% modeling time and cost.

Whole Building Energy Simulation | Parametrics and Optimization | Code Compliance | Other
Commercial, Residential, Industrial

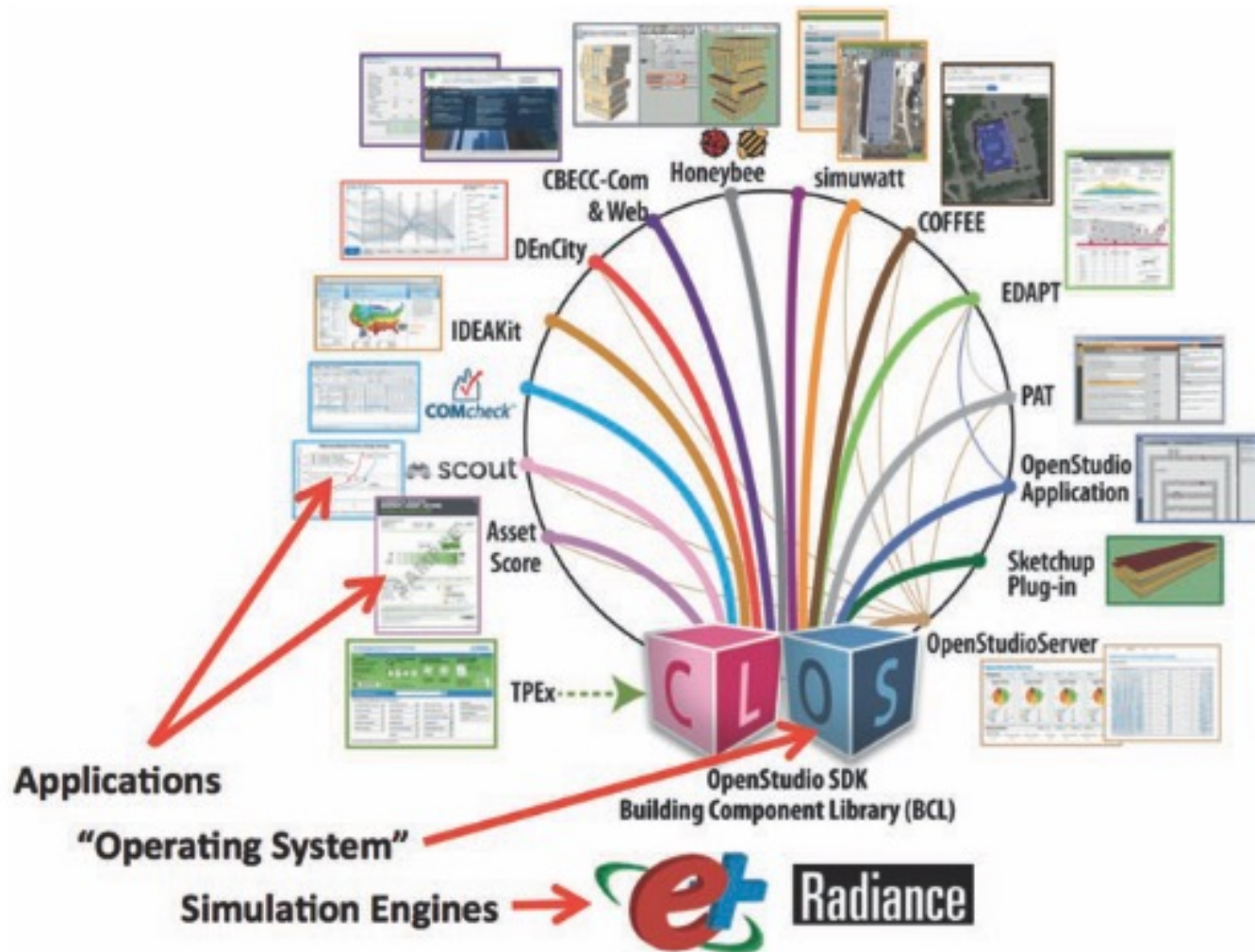
Last Software Update: 17 September 2018 |

Last Entry Update: 17 September 2018

Ratings ★★★★★ | Reviews 0 | **Add to compare**

Building Energy Simulation

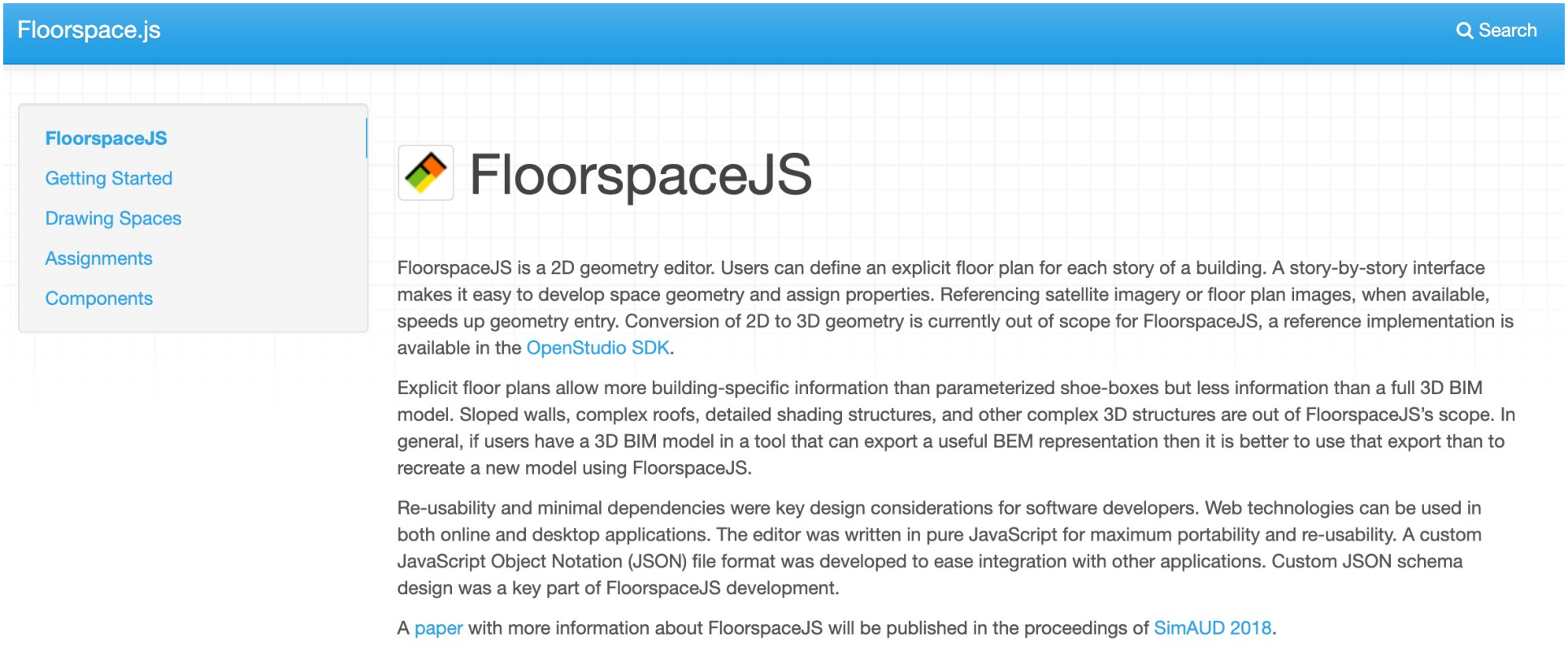
- OpenStudio as a BEM operating system



OPENSTUDIO INSTALLATION

OpenStudio Installation

- Model creation using FloorSpaceJS:



The screenshot shows the website for Floorspace.js. The header is blue with the text "Floorspace.js" on the left and a search icon with the word "Search" on the right. A left-hand navigation menu is visible, listing "FloorspaceJS", "Getting Started", "Drawing Spaces", "Assignments", and "Components". The main content area features the FloorspaceJS logo (a square with orange, green, and blue diagonal stripes) followed by the title "FloorspaceJS". Below the title, there is a paragraph of introductory text, a paragraph explaining the tool's capabilities and limitations, a paragraph discussing design considerations, and a final paragraph mentioning a paper.

Floorspace.js

Search


FloorspaceJS

Getting Started

Drawing Spaces

Assignments

Components

 FloorspaceJS

FloorspaceJS is a 2D geometry editor. Users can define an explicit floor plan for each story of a building. A story-by-story interface makes it easy to develop space geometry and assign properties. Referencing satellite imagery or floor plan images, when available, speeds up geometry entry. Conversion of 2D to 3D geometry is currently out of scope for FloorspaceJS, a reference implementation is available in the [OpenStudio SDK](#).

Explicit floor plans allow more building-specific information than parameterized shoe-boxes but less information than a full 3D BIM model. Sloped walls, complex roofs, detailed shading structures, and other complex 3D structures are out of FloorspaceJS's scope. In general, if users have a 3D BIM model in a tool that can export a useful BEM representation then it is better to use that export than to recreate a new model using FloorspaceJS.

Re-usability and minimal dependencies were key design considerations for software developers. Web technologies can be used in both online and desktop applications. The editor was written in pure JavaScript for maximum portability and re-usability. A custom JavaScript Object Notation (JSON) file format was developed to ease integration with other applications. Custom JSON schema design was a key part of FloorspaceJS development.

A [paper](#) with more information about FloorspaceJS will be published in the proceedings of [SimAUD 2018](#).

Getting Started

After loading FloorspaceJS, you will be prompted to create a new floorplan file, create a new floorplan file with a map background, or open an existing floorplan file. In this example we will choose to use the map background for reference.

<https://nrel.github.io/floorspace.js/docs/>

OpenStudio Installation

- Model creation using SketchUp (Not working on it at this time)

README.md

Important!

After the v1.0.0 final NREL software distribution (04/27/2020), the OpenStudio SketchUp Plug-in is now independently supported and maintained with open source contributions by The OpenStudio Coalition and members of the software community at the GitHub repository <https://github.com/openstudiocoalition/openstudio-sketchup-plugin>. The NREL OpenStudio SketchUp Plug-in repository no longer accepts new issues or pull requests. Please submit new issues or enhancement requests in the new OpenStudio Coalition repository at <https://github.com/openstudiocoalition/openstudio-sketchup-plugin/issues>.

OpenStudio SketchUp Plug-in

The OpenStudio SketchUp Plug-in is an extension to Trimble's popular 3D modeling tool that adds OpenStudio context to the SketchUp program. The Plug-in allows users to quickly create geometry needed for OpenStudio using the built-in functionality of Trimble SketchUp including existing drawing tools, integration with Google Earth, Building Maker, and Photo Match.

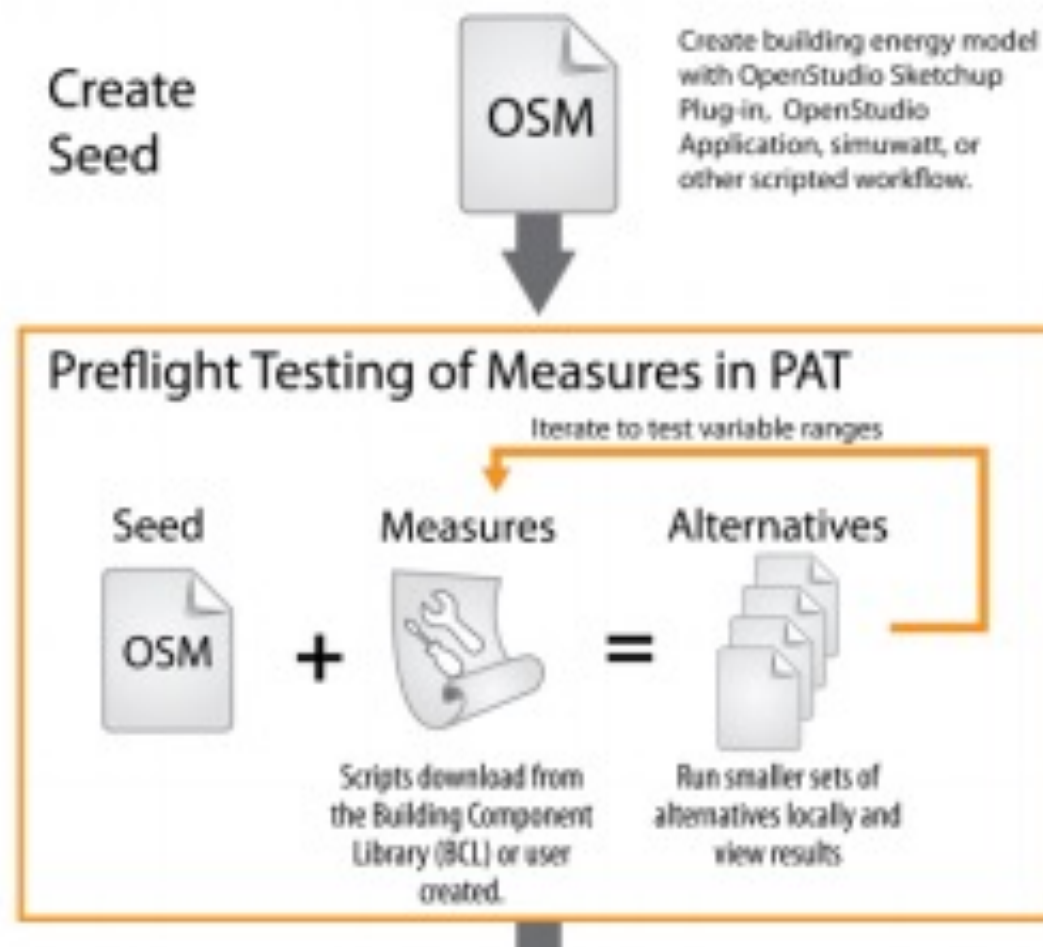
<https://github.com/openstudiocoalition/openstudio-sketchup-plugin>

OpenStudio Installation

- OpenStudio Page: <https://nrel.github.io/OpenStudio-user-documentation/>
- OpenStudio videos (The SketchUP part now is using FloorSpaceJS):
<https://www.youtube.com/user/NRELOpenStudio/videos?flow=grid&sort=dd&view=0>
- See existing questions or ask questions on unmethours:
<https://unmethours.com/questions/>

OpenStudio Installation

- Parametric Analysis Tool (PAT) allows installing different measures



OpenStudio Installation



Organization

Organization Resources

For More Information:

- For releases of the OpenStudio Application and the OpenStudio SketchUp Plug-in:

OpenStudio Application

SketchUp Plug-in

- For information about OpenStudio Measures and the OpenStudio SDK:

OpenStudio Project

- For community support, to post a question, or to search for answers to your energy modeling questions:

Unmet Hours

Introducing the OpenStudio Coalition

The OpenStudio Coalition is a newly formed organization founded to support the OpenStudio Application and to expand the use of energy modeling generally using the free and open source OpenStudio Application. The goals of the OpenStudio Coalition (OSC) include:

- **Keeping the OpenStudio Application Free and Readily Available:** Free to individual user energy modeling tools have been around for a long time, most notably eQUEST. These tools have made it easier to learn energy modeling and for energy models to be used in various publicly funded activities such as energy efficiency programs. A free and open version of the OpenStudio Application will help the EnergyPlus engine be adopted in these contexts. Similar to the OpenStudio Application, many energy modeling tools, including eQUEST, got their start with public funding and then transitioned to other forms of support.
- **Keeping OpenStudio Application Current and Functional:** As the OpenStudio SDK evolves, OSC will coordinate investments in the OpenStudio application to maintain the ability to work interchangeably in both environments. The OpenStudio Application is an important debugging tool for application developers and for those that need to evaluate the results from tools that use the OpenStudio SDK, such as energy program evaluators and model reviewers.
- **Supporting OpenStudio Application Use:** The energy modeling community benefits from access to a free and functional tool for new users of energy modeling tools. The Coalition plans to actively promote the use of the OpenStudio Application to potential energy modelers with the goal of expanding understanding of building performance and increasing the use of energy modeling. It is the intent of this effort to expand both the supply of energy modelers and the demand for energy modeling tools in general, not just for the OpenStudio Application.

Organization









The OpenStudio Coalition is managed by volunteers from the founding organizations, The Energy Coalition (TEC), Vermont Energy Investment Corporation (VEIC) and Performance Systems Development (PSD). These organizations have worked together over the past several years, supporting development of and using the OpenStudio/EnergyPlus framework and have now formed this new organization to help support the OpenStudio Application and the expansion of the value and adoption of energy modeling. These organizations have been joined by expert developers who can help support the continued evolution of the OpenStudio Application.

It is the intent of the founding members to seek external funding to support the goals of the organization. The primary focus of initial funding will be to fund incremental development of the OpenStudio application.

https://openstudiocoalition.org/about/openstudio_coalition/

OpenStudio Installation

- Download Version 1.4.0 from this link (If you have the new version, that's fine, but you cannot use your model in the computer lab) :

 OpenStudioApplication-1.4.0+e0fb8f854d-macOS10.14-x86_64.dmg	460 MB	Jun 08, 2022
 OpenStudioApplication-1.4.0+e0fb8f854d-macOS12.1-arm64.dmg	444 MB	Jun 08, 2022
 OpenStudioApplication-1.4.0+e0fb8f854d-Ubuntu20.04.deb	429 MB	Jun 08, 2022
 OpenStudioApplication-1.4.0+e0fb8f854d-Ubuntu20.04.tar.gz	429 MB	Jun 08, 2022
 OpenStudioApplication-1.4.0+e0fb8f854d-Windows.exe	261 MB	Jun 08, 2022
 OpenStudioApplication-1.4.0+e0fb8f854d-Windows.zip	347 MB	Jun 08, 2022
 Source code (zip)		Jun 08, 2022
 Source code (tar.gz)		Jun 08, 2022

<https://github.com/openstudiocoalition/OpenStudioApplication/releases/tag/v1.4.0>

OpenStudio Installation

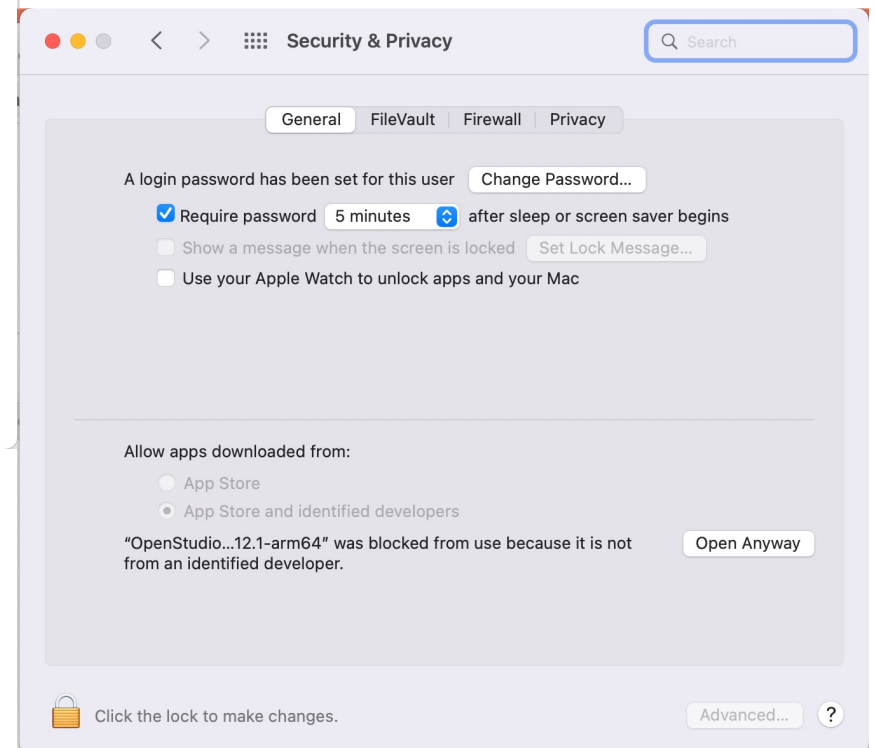
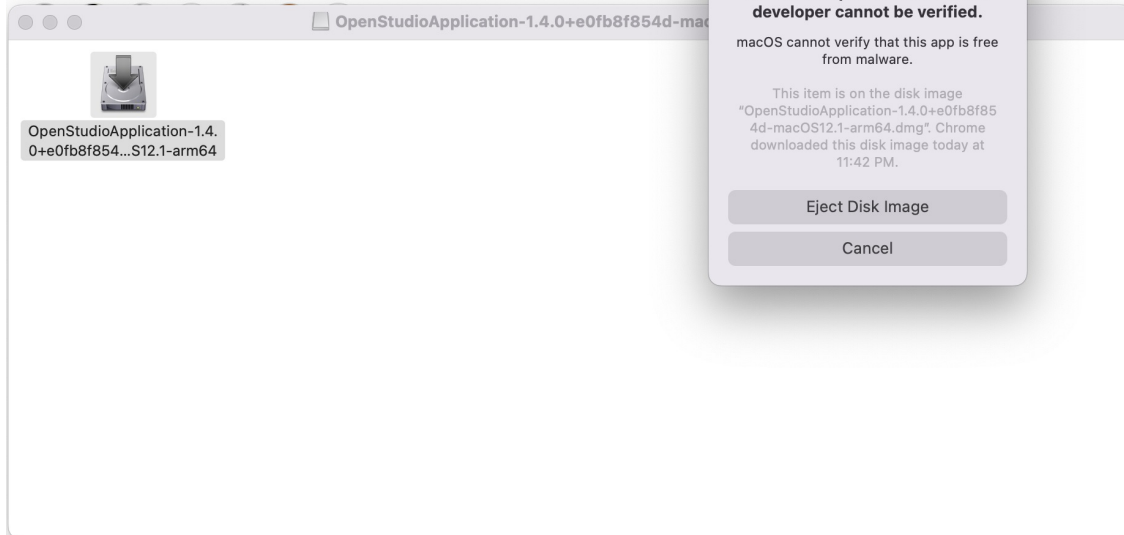
- In case you are using Mac, you might see this message when you click on the installer:

Total Open Issues: 131

Total Open Pull Requests: 3

► Click to see details

Contributors



OpenStudio Installation

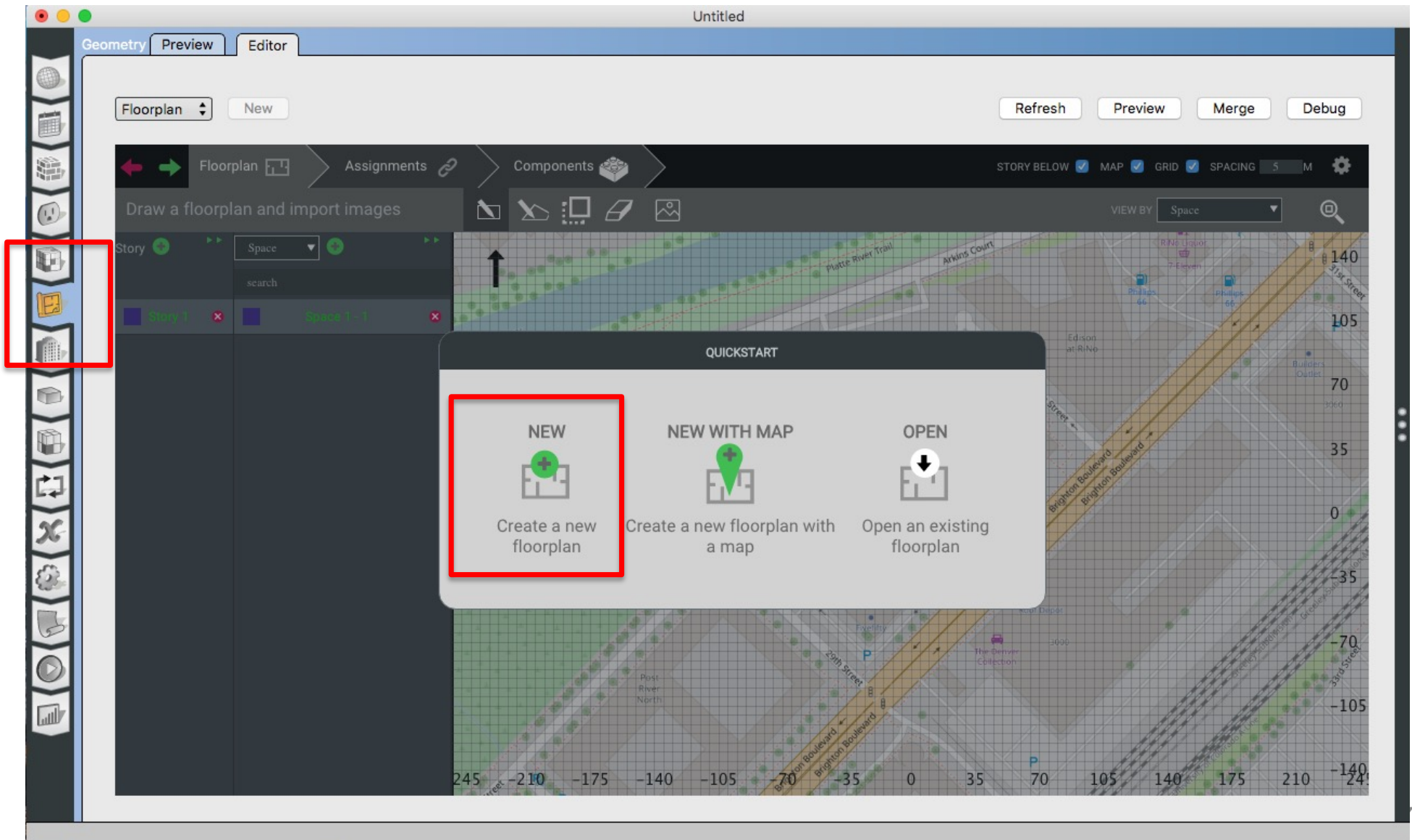
- Download weather data files
 - ❑ Download files from here:
[http://climate.onebuilding.org/WMO Region 4 North and Central America/USA United States of America/index.html](http://climate.onebuilding.org/WMO_Region_4_North_and_Central_America/USA_United_States_of_America/index.html)

OPENSTUDIO TRAINING FROM EXISTING MODELS

CREATE GEOMETRY

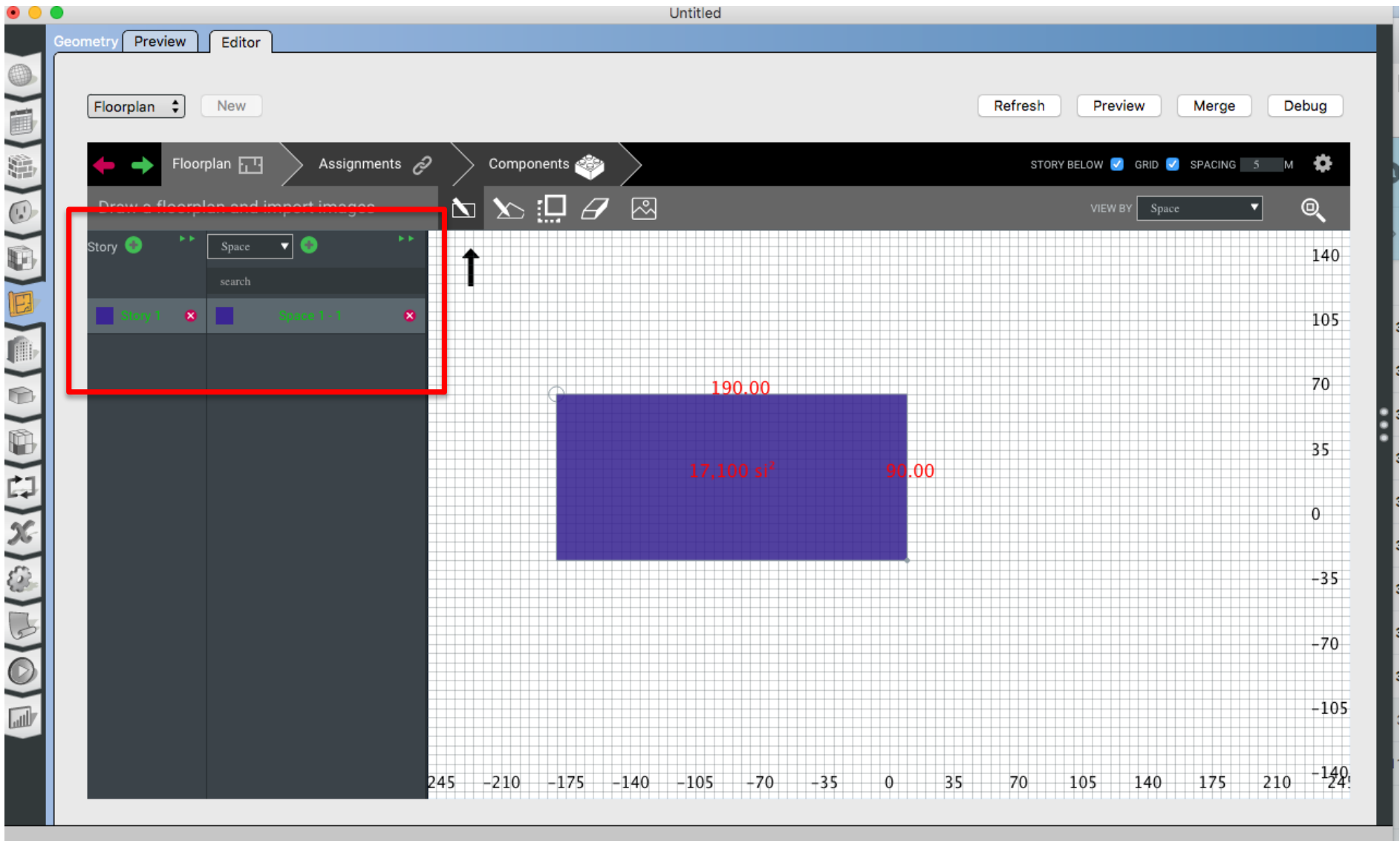
OpenStudio Training

- Step 1: Create or Import Floor Plan



OpenStudio Training

- Step 2: Add Spaces and Stories



OpenStudio Training

- Step 3: Add the height

The screenshot displays the OpenStudio software interface. The top panel shows the 'Floorplan' tab with a 'New' button and a 'Draw a floorplan and import images' toolbar. A red box highlights the 'Space' dropdown menu. Below this is a table of space properties for 'Space 1 - 1' on 'Story 1'. A second red box highlights the 'Below Floor Plenum Height', 'Floor to Ceiling Height', and 'Above Ceiling Plenum Height' columns, which are currently set to 0. The bottom panel shows a 2D grid view of the space, with a blue rectangular area representing the space footprint. The grid axes range from -285 to 135 on the x-axis and -30 to 60 on the y-axis. The text 'Space 1 - 1' is visible in red on the grid.

Name	Story	Building Unit	Thermal Zone	Space Type	Construction Set	Below Floor Plenum Height	Floor to Ceiling Height	Above Ceiling Plenum Height	Floor Offset
Space 1 - 1	Story 1	(none)	(none)	(none)	(none)	0	0	0	0

OpenStudio Training

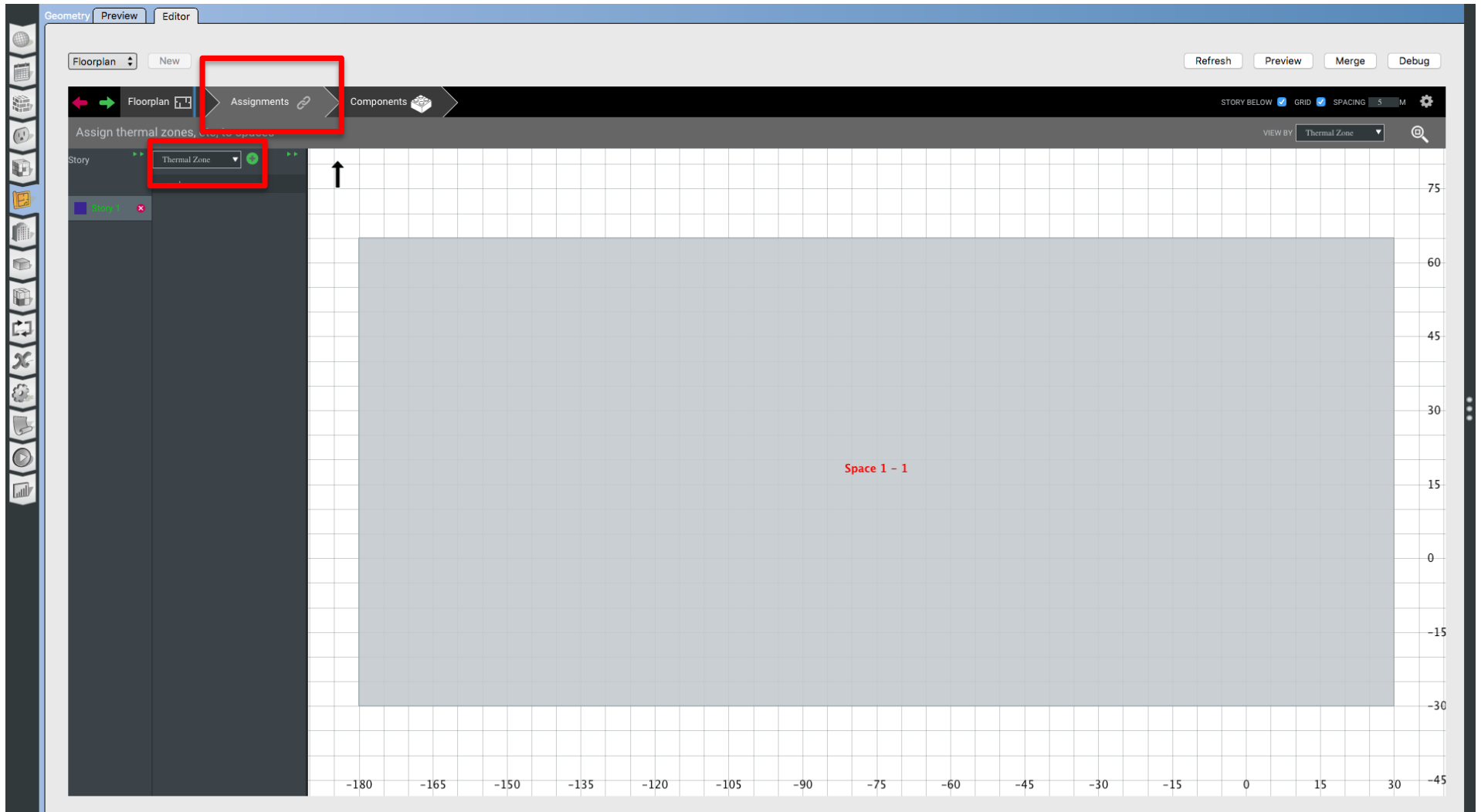
- Step 3: Add the height

The screenshot displays the OpenStudio software interface. The top panel shows the 'Floorplan' view with a 'Space' dropdown menu highlighted by a red box. Below this, the 'Properties' panel is visible, with the 'Height' property highlighted by a red box. The 'Height' property is currently set to 0, and a blue box highlights the input field where the value '3' has been entered. The 'Below Floor Plenum Height' is set to 0, and the 'Above Ceiling Plenum Height' is set to 0. The 'Open To Below' property is set to 'False'. The bottom panel shows a 2D grid view of the space, with a blue rectangular area labeled 'Space 1 - 1'.

Property	Value
Below Floor Plenum Height	0
Floor to Ceiling height	3
Above Ceiling Plenum Height	0
Floor Offset	0
Open To Below	False

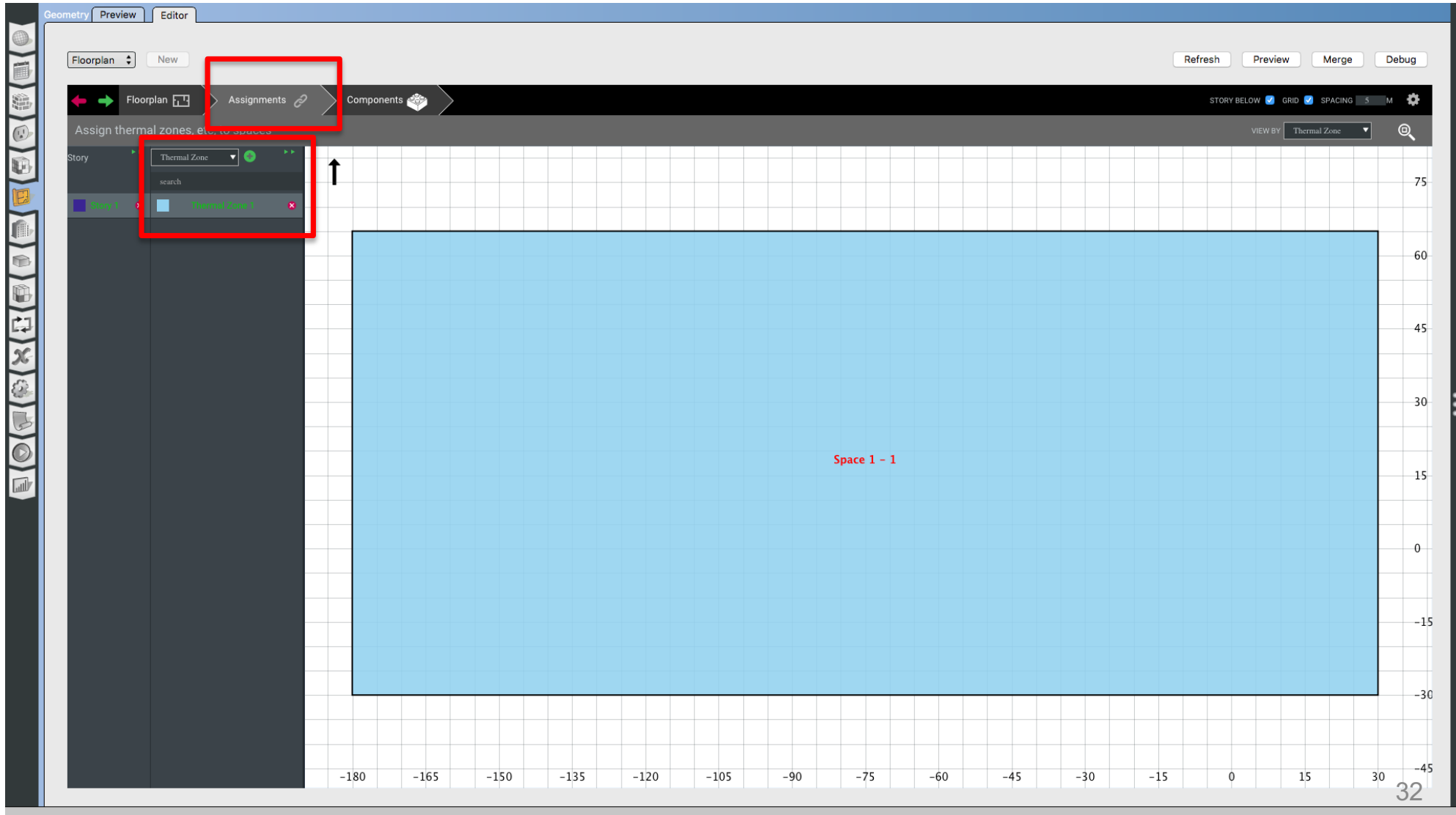
OpenStudio Training

- Step 4: Add Thermal Zone(s)



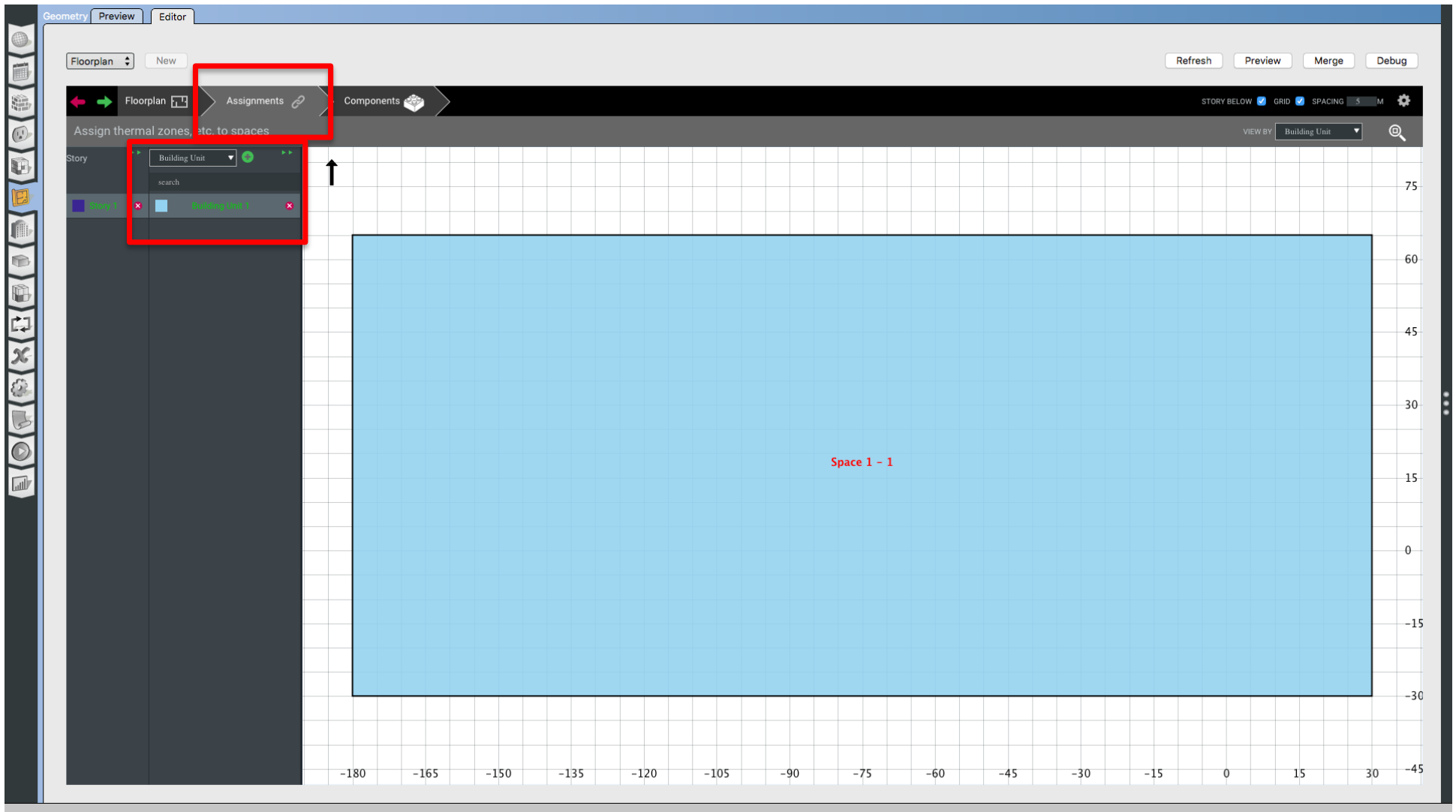
OpenStudio Training

- Step 4: Add Thermal Zone(s)



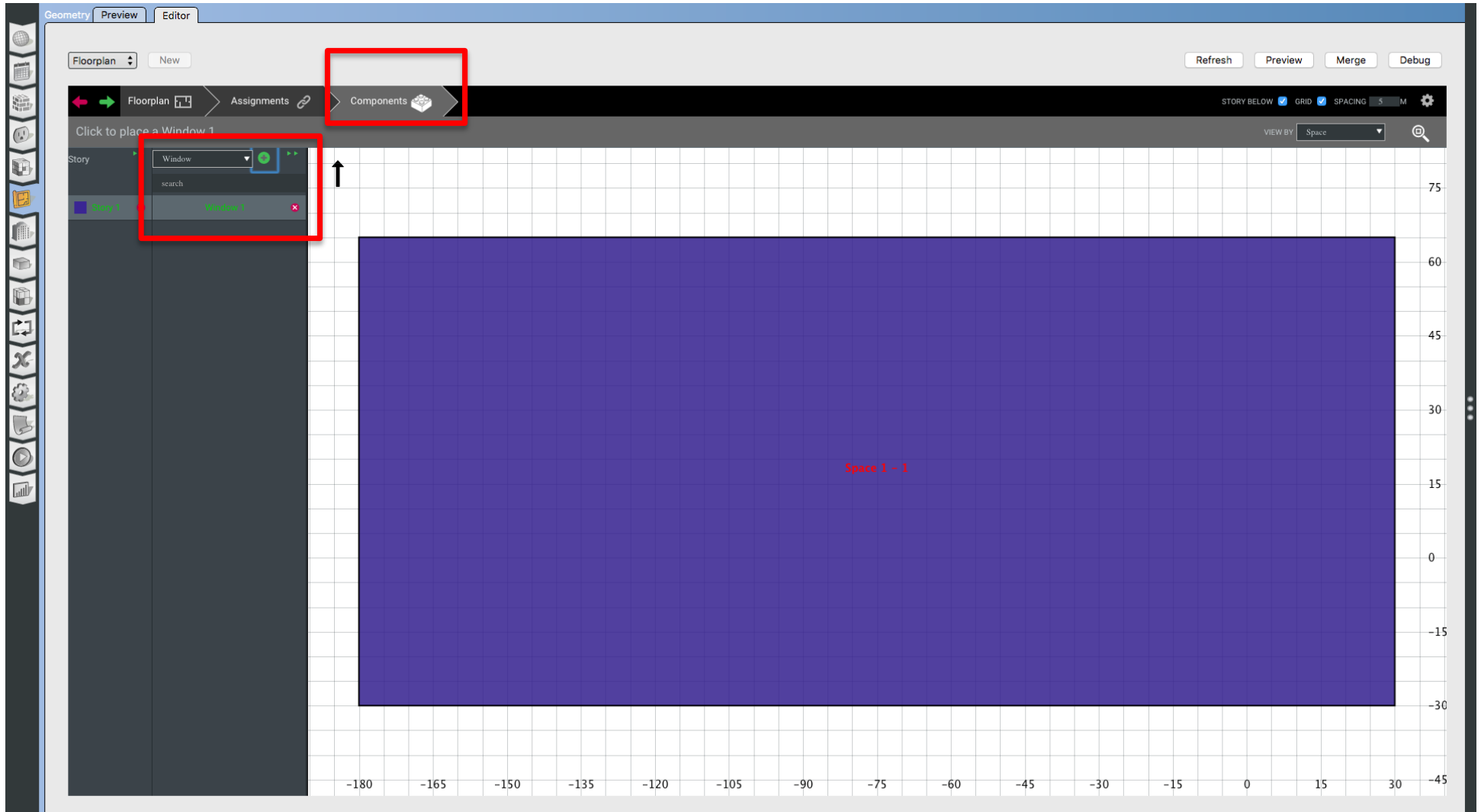
OpenStudio Training

- Step 5: Add Building Unit



OpenStudio Training

- Step 6: Add Windows (WWR or Individual)



OpenStudio Training

- Step 6: Add Windows (WWR or Individual)

The screenshot displays the OpenStudio software interface. The 'Components' menu is highlighted with a red box. Below it, the 'Window' dropdown menu is also highlighted with a red box. A table below the menu shows the properties for a window named 'Window 1'. The 'Window to Wall ratio' column is highlighted with a red box, showing a value of 0.4. The table has the following columns: Name, Mode, Window to Wall ratio, Height, Width, Sill Height, Spacing, Window Type, Overhang Projection Factor, and Fin Projection Factor.

Name	Mode	Window to Wall ratio	Height	Width	Sill Height	Spacing	Window Type	Overhang Projection Factor	Fin Projection Factor
Window 1	Window to Wall Ratio	0.4	(none)	(none)	0.9144000000000000	(none)	Fixed	(none)	(none)

The bottom part of the screenshot shows a grid view of a floor plan. A large blue rectangle is placed on the grid, representing the window. The grid has x-axis labels from -285 to 135 and y-axis labels from -30 to 60. A red arrow points to the top-left corner of the blue rectangle.

OpenStudio Training

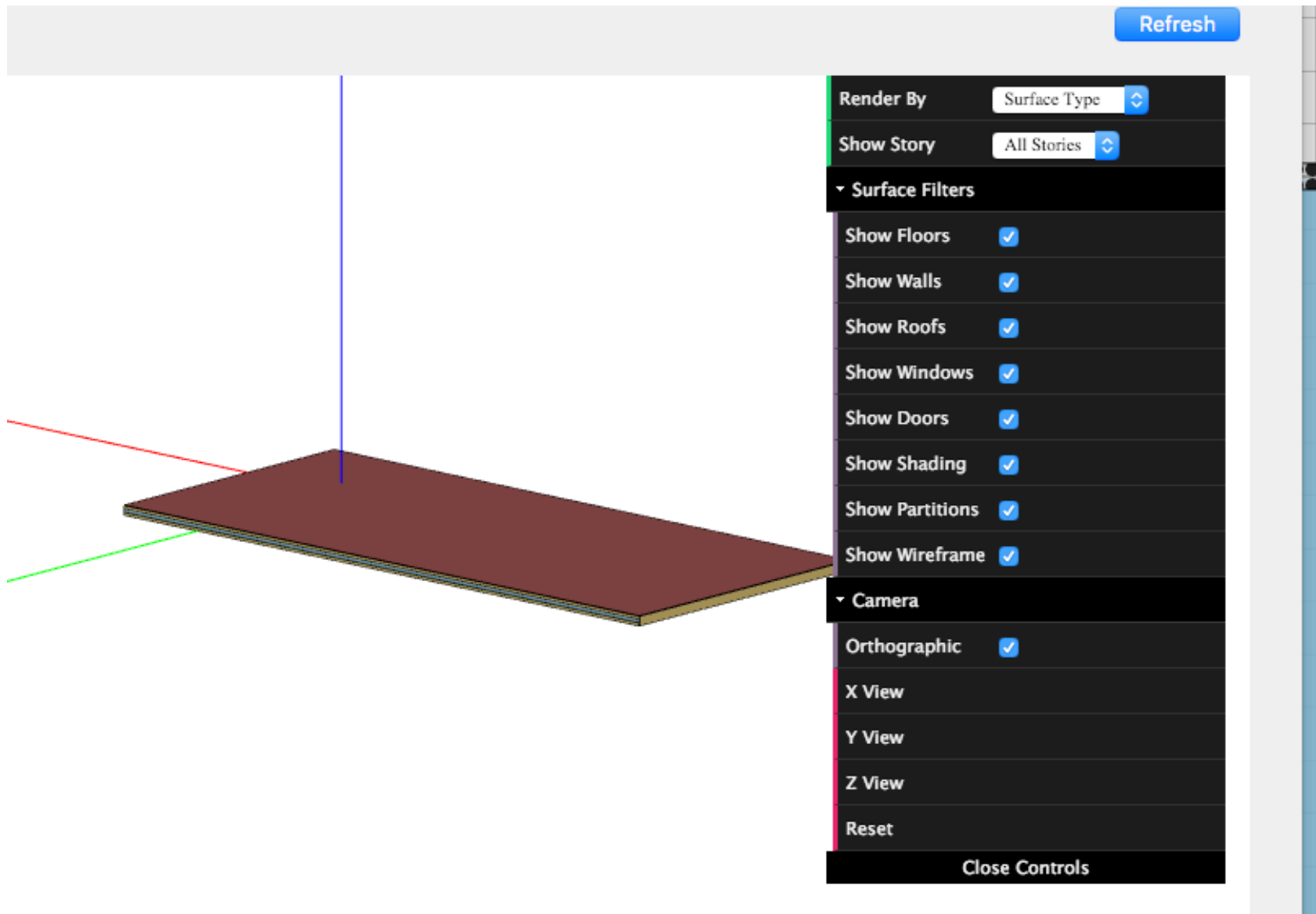
- Step 7: Merge & Preview

The screenshot displays the OpenStudio software interface. At the top, there are tabs for 'Geometry', 'Preview', and 'Editor'. Below these, a toolbar contains buttons for 'Floorplan', 'New', 'Refresh', 'Preview', 'Merge', and 'Debug'. The 'Merge' and 'Preview' buttons are highlighted with a red rectangular box. The main workspace is divided into a top panel for 'Story' and a bottom panel for a grid view. The 'Story' panel shows a table with columns for 'Name', 'Mode', 'Window to Wall ratio', 'Height', 'Width', 'Sill Height', 'Spacing', 'Window Type', 'Overhang Projection Factor', and 'Fin Projection Factor'. The 'Window to Wall ratio' column is highlighted in blue, and its value '0.4' is also highlighted. The grid view below shows a blue rectangular area representing a window on a grid. The grid has x-axis labels from -285 to 135 and y-axis labels from -30 to 60.

Name	Mode	Window to Wall ratio	Height	Width	Sill Height	Spacing	Window Type	Overhang Projection Factor	Fin Projection Factor
Window 1	Window to Wall Ratio	0.4	{none}	{none}	0.9144000000000000	{none}	Fixed	{none}	{none}

OpenStudio Training

- Step 7: Merge & Preview



**ADD DEFAULT VALUES TO TEST THE
MODEL**

OpenStudio Training

- Step 8: Add Default Values

The screenshot displays the OpenStudio software interface. The main window is titled 'Building' and contains several configuration sections:

- Name:** A text field containing 'Building 1'.
- Measure Tags (Optional):** A section with a dropdown menu for 'Standards Building Type' and a 'Relocatable' checkbox set to 'false'.
- Nominal Floor to Ceiling Height:** A text input field followed by 'm'.
- Nominal Floor to Floor Height:** A text input field followed by 'm'.
- Standards Number of Stories:** A text input field.
- Standards Number of Above Ground Stories:** A text input field.
- Standards Number of Living Units:** A text input field.
- North Axis:** A text input field containing '0.000000' followed by 'deg'.
- Space Type:** A dashed box containing the text 'Drag From Library'.
- Default Construction Set:** A dashed box containing the text 'Drag From Library'.
- Default Schedule Set:** A dashed box containing the text 'Drag From Library'.

The right-hand sidebar is titled 'My Mode' and has a 'Library' tab selected. The sidebar contains a list of 'Space Types' under the 'Construction Sets' category, including:

- 189.1-2009 - CZ1 - Office
- 189.1-2009 - CZ2 - Office
- 189.1-2009 - CZ3 - Office
- 189.1-2009 - CZ4 - Office
- 189.1-2009 - CZ5 - Office
- 189.1-2009 - CZ6 - Office
- 189.1-2009 - CZ7-8 - Office

Red boxes highlight the 'Library' tab in the sidebar, the 'Standards Building Type' dropdown, and the 'Standards Number of Stories' input field in the main window.

OpenStudio Training

- Step 8: Add Default Values

The screenshot displays the OpenStudio software interface. The main window is titled 'Building' and contains several configuration sections:

- Name:** A text field containing 'Building 1'.
- Measure Tags (Optional):**
 - Standards Building Type:** A dropdown menu.
 - Relocatable:** A checkbox labeled 'false'.
 - Nominal Floor to Ceiling Height:** A text field with 'm' as a unit.
 - Nominal Floor to Floor Height:** A text field with 'm' as a unit.
 - Standards Number of Stories:** A text field.
 - Standards Number of Above Ground Stories:** A text field.
 - Standards Number of Living Units:** A text field.
- North Axis:** A text field containing '0.000000' and 'deg'.
- Space Type:** A dashed box containing the text 'Drag From Library'.
- Default Construction Set:** A dashed box containing a selection of '189.1-2009 - CZ2 - Office' with a close button (X).
- Default Schedule Set:** A dashed box containing the text 'Drag From Library'.

On the right side of the interface, there is a vertical panel titled 'Space Types' with a dropdown arrow. This panel lists various space types, each with a small icon and a text label. The top two items are highlighted with a red box:

- 189.1-2009 - Office - BreakRoom - CZ1-3
- 189.1-2009 - Office - BreakRoom - CZ4-8

Other visible space types include: 189.1-2009 - Office - ClosedOffice - CZ1-3, 189.1-2009 - Office - ClosedOffice - CZ4-8, 189.1-2009 - Office - Conference - CZ1-3, 189.1-2009 - Office - Conference - CZ4-8, 189.1-2009 - Office - Corridor - CZ1-3, 189.1-2009 - Office - Corridor - CZ4-8, 189.1-2009 - Office - Elec/MechRoom - CZ1-3, 189.1-2009 - Office - Elec/MechRoom - CZ4-8, 189.1-2009 - Office - IT_Room - CZ1-3, 189.1-2009 - Office - IT_Room - CZ4-8, 189.1-2009 - Office - Lobby - CZ1-3, 189.1-2009 - Office - Lobby - CZ4-8, 189.1-2009 - Office - OpenOffice - CZ1-3, and 189.1-2009 - Office - OpenOffice - CZ4-8.

OpenStudio Training

- Step 8: Add Default Values

The screenshot displays the OpenStudio software interface for configuring a building's default values. The main workspace is divided into several sections:

- Name:** Building 1
- Measure Tags (Optional):** Standards Building Type (dropdown), Relocatable (false), Nominal Floor to Ceiling Height (input), Nominal Floor to Floor Height (input), Standards Number of Stories (input), Standards Number of Above Ground Stories (input), Standards Number of Living Units (input).
- North Axis:** 0.000000 deg
- Space Type:** Office - ClosedOffice
- Default Construction Set:** 189.1-2009 - CZ2 - Office
- Default Schedule Set:** Drag From Library

The right-hand sidebar shows the 'Library' tab with a list of 'Schedule Sets' for various room and zone configurations, including Office, BreakRoom, ClosedOffice, Conference, Corridor, and MechRoom. A red box highlights the 'Schedule Sets' section in the sidebar, and another red box highlights the 'Space Type' and 'Default Construction Set' fields in the main workspace.

TEST MODEL WITH IDEAL AIR LOOP

OpenStudio Training

- Step 9: Run Ideal Air Loop

The screenshot shows the 'Thermal Zones' interface in OpenStudio. The main table has the following columns: Name, All, Turn On Ideal Air Loads, Air Loop Name, Zone Equipment, Cooling Thermostat Schedule, Heating Thermostat Schedule, Humidifying Setpoint Schedule, Dehumidifying Setpoint Schedule, and Multiplier. The 'All' column for 'Thermal Zone 1' is checked. A red box highlights the 'All' column and the 'Thermal Zone 1' row. Another red box highlights the 'Run Ideal Air Loop' icon in the left sidebar.

Name	All	Turn On Ideal Air Loads	Air Loop Name	Zone Equipment	Cooling Thermostat Schedule	Heating Thermostat Schedule	Humidifying Setpoint Schedule	Dehumidifying Setpoint Schedule	Multiplier
Thermal Zone 1	<input checked="" type="checkbox"/>	<input type="checkbox"/>	None	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	1

Right sidebar menu items:

- Schedule Rulesets
- Compact Schedules
- Zone Ventilation Design Flow Rate
- Unit Ventilator
- Unit Heater
- High Temp Radiant
- Low Temp Radiant Electric
- Low Temp Radiant Variable Flow
- Low Temp Radiant Constant Flow
- PTAC
- Water To Air HP
- PTHP
- Water Heater - Heat Pump - Wrapped Condenser
- Water Heater - Heat Pump
- Fan Zone Exhaust
- Four Pipe Fan Coil
- ERV
- Dehumidifier - DX
- Baseboard Radiant Convective Water
- Baseboard Radiant Convective Electric
- Baseboard Convective Water

ADD WEATHER DATA

OpenStudio Training

- Step 10: Add Weather Data Files

The screenshot shows the 'Weather File & Design Days' tab in the OpenStudio software. The 'Weather File' section is highlighted with a red box, showing the following details:

- Name: Chicago Ohare Intl Ap
- Latitude: 41.98
- Longitude: -87.92
- Elevation: 201
- Time Zone: -6
- Download weather files at www.energyplus.net/weather

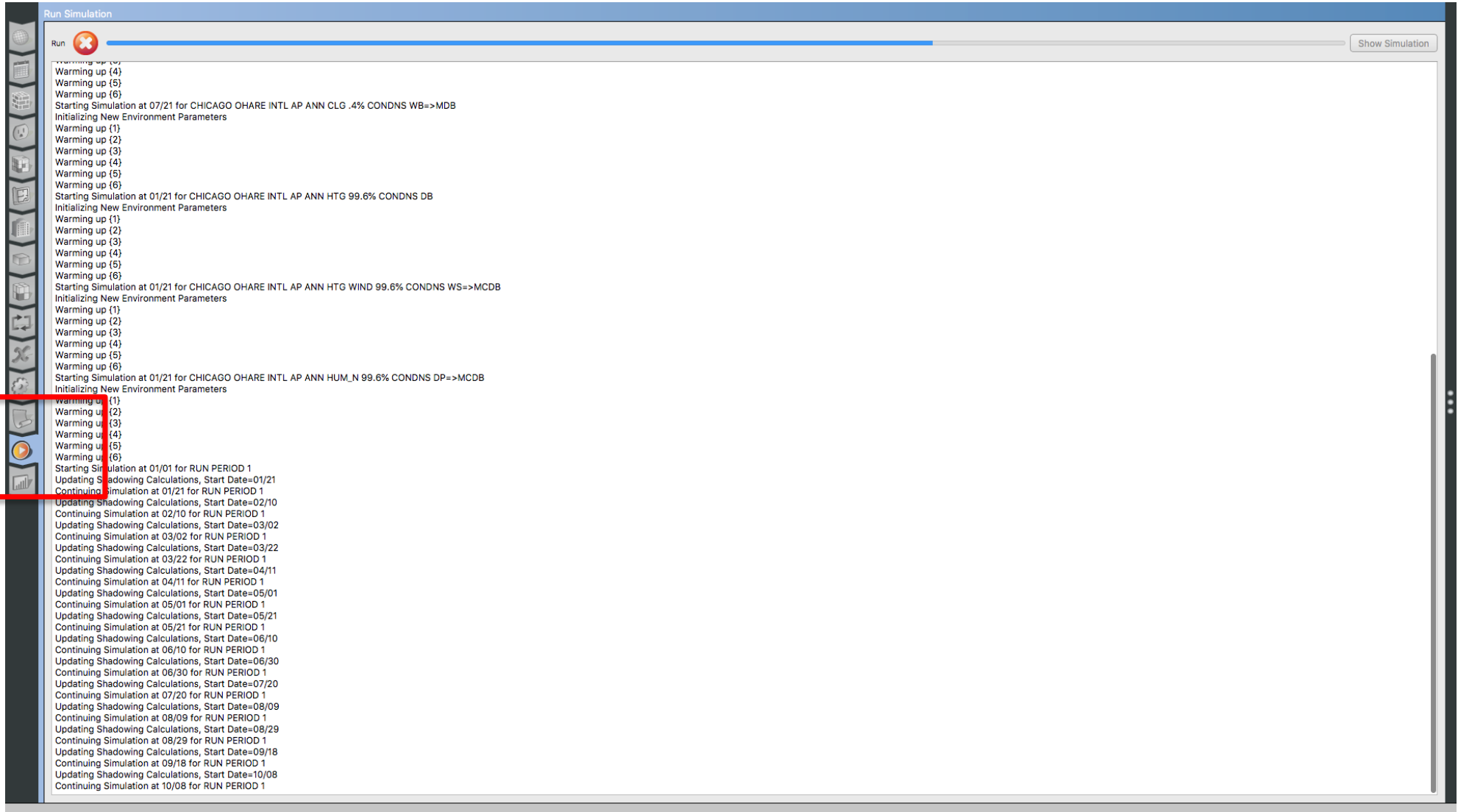
The 'Design Days' section is also highlighted with a red box, showing a table of design days. The table has columns for Date, Temperature, Humidity, Pressure Wind Precipitation, Solar, and Custom. The table lists several design days for Chicago Ohare Intl Ap, including summer and winter design days.

Design Day Name	All	Day Of Month	Month	Day Type	Daylight Sav
Chicago Ohare Intl Ap Ann Clg .4% Condns DB=>MWB	<input type="checkbox"/>	21	7	SummerDesignDay	
Chicago Ohare Intl Ap Ann Clg .4% Condns DP=>MDB	<input type="checkbox"/>	21	7	SummerDesignDay	
Chicago Ohare Intl Ap Ann Clg .4% Condns Enth=>MDB	<input type="checkbox"/>	21	7	SummerDesignDay	
Chicago Ohare Intl Ap Ann Clg .4% Condns WB=>MDB	<input type="checkbox"/>	21	7	SummerDesignDay	
Chicago Ohare Intl Ap Ann Htg 99.6% Condns DB	<input type="checkbox"/>	21	1	WinterDesignDay	
Chicago Ohare Intl Ap Ann Htg Wind 99.6% Condns WS=>MCDB	<input type="checkbox"/>	21	1	WinterDesignDay	
Chicago Ohare Intl Ap Ann Hum_n 99.6% Condns DP=>MCDB	<input type="checkbox"/>	21	1	WinterDesignDay	

RUN MODEL

OpenStudio Training

- Step 11: Run the Model



VISIT RESULTS

OpenStudio Training

- Step 12: Visualize the Results

Results Summary

Reports: OpenStudio Results Refresh Open DView for Detailed Reports

OpenStudio Results

Model Summary

Building Summary

Data	Value
Building Name	Building 1
Total Site Energy	4,560,744 kBtu
Total Building Area	214,740 ft ²
Total Site EUI	21.24 kBtu/ft ²
OpenStudio Standards Building Type	n/a

Weather Summary

	Value
Weather File	Chicago Ohare Intl Ap IL USA TMY3 WMO#=725300
Latitude	41.98
Longitude	-87.9
Elevation	659 (ft)
Time Zone	-6.0
North Axis Angle	0.00
ASHRAE Climate Zone	

Sizing Period Design Days

	Maximum Dry Bulb (F)	Daily Temperature Range (R)	Humidity Value	Humidity Type	Wind Speed (mph)	Wind Direction
--	----------------------	-----------------------------	----------------	---------------	------------------	----------------

TEST A ZONE LEVEL HVAC SYSTEM

OpenStudio Training

- Step 13: Add PTHP

The screenshot displays the 'Thermal Zones' interface in OpenStudio. The interface is divided into several sections:

- Top Navigation:** 'My Model', 'Library', and 'Edit' tabs. The 'Library' tab is active, and the 'Schedule Rulesets' dropdown is open, showing a list of HVAC equipment types.
- Equipment Selection:** A list of equipment types on the right side of the interface. The 'PTHP' (Pump-Towered Heat Pump) option is highlighted with a red box.
- Thermal Zones Table:** A table with columns for 'Name', 'All', 'Turn On Ideal Air Loads', 'Air Loop Name', 'Zone Equipment', 'Cooling Thermostat Schedule', 'Heating Thermostat Schedule', 'Humidifying Setpoint Schedule', 'Dehumidifying Setpoint Schedule', and 'Multiplier'. The 'Zone Equipment' column for 'Thermal Zone 1' is highlighted with a red box, and the 'PTHP' option is selected from the dropdown menu in this column.
- Left Sidebar:** A vertical toolbar with various icons. The 'Add' icon (a plus sign) is highlighted with a red box.

Name	All	Turn On Ideal Air Loads	Air Loop Name	Zone Equipment	Cooling Thermostat Schedule	Heating Thermostat Schedule	Humidifying Setpoint Schedule	Dehumidifying Setpoint Schedule	Multiplier
Thermal Zone 1	<input type="checkbox"/>	<input type="checkbox"/>	None	<input type="text" value="PTHP"/>	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>	<input type="text" value=""/>	1

OpenStudio Training

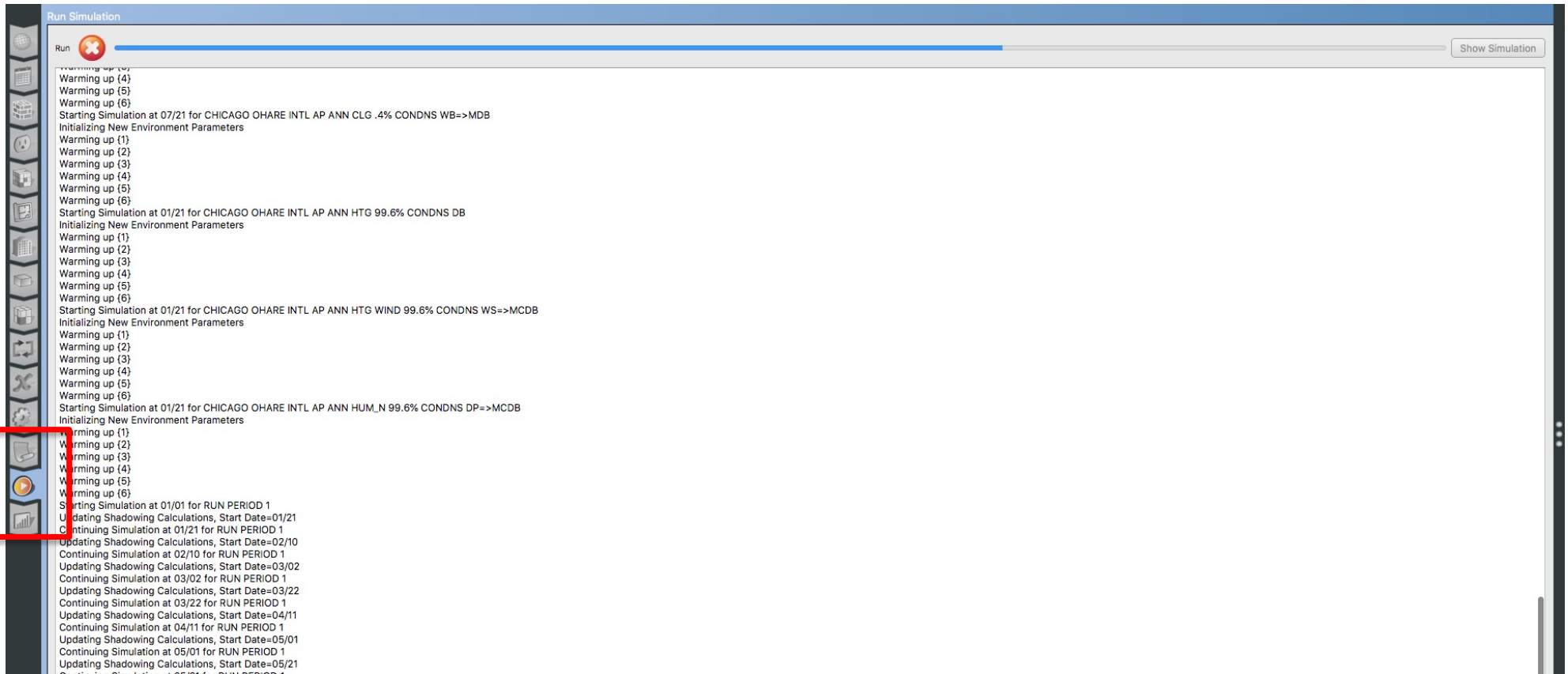
- Step 13: Add heating and cooling setpoints

The screenshot displays the 'Thermal Zones' configuration window in OpenStudio. The interface is divided into several sections:

- Top Bar:** Contains tabs for 'My Model', 'Library', and 'Edit'. Below these are buttons for 'HPWH Setpoint', 'HPWH Stratified - Wrapped Cond - Amb Temp', 'HPWH Stratified - Wrapped Cond - Heater 1 Setpoint', and 'HPWH Stratified - Wrapped Cond - Heater 2 Setpoint'.
- Navigation Panel:** A vertical toolbar on the left side with various icons for navigation and editing.
- Table:** A table with columns for 'Name', 'All', 'Turn On Ideal Air Loads', 'Air Loop Name', 'Zone Equipment', 'Cooling Thermostat Schedule', 'Heating Thermostat Schedule', 'Humidifying Setpoint Schedule', 'Dehumidifying Setpoint Schedule', and 'Multiplier'. The row for 'Thermal Zone 1' shows 'None' for Air Loop Name, 'PTHP' for Zone Equipment, and 'Large Office ClgSetp' for Cooling Thermostat Schedule and 'Large Office HtgSetp' for Heating Thermostat Schedule. Red boxes highlight these two schedule cells.
- Component Library:** A vertical list on the right side containing various components. The 'Large Office ClgSetp' and 'Large Office HtgSetp' items are highlighted with red boxes.

OpenStudio Training

- Step 14: Run the Model



TEST A LOOP HVAC SYSTEM

OpenStudio Training

- Step 15: Add System #5

The screenshot displays the OpenStudio software interface during the process of adding a new HVAC system. The main workspace shows a schematic diagram of a service hot water system with a central boiler and two radiators. A dialog box titled "Add HVAC System" is open in the center, listing three options:

- Packaged Rooftop Unit
- Packaged Rooftop Heat Pump
- Packaged DX Rooftop VAV with Reheat

The "Packaged DX Rooftop VAV with Reheat" option is highlighted with a red box. The software interface includes a top menu bar with "Layout", "Control", and "Grid" tabs, and a search bar containing "Service Hot Water". A left toolbar contains various icons, with a red box highlighting the "Add HVAC System" icon. A right sidebar displays a list of HVAC system types, 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", "AirLoopHVAC Unitary System", "AirLoopHVAC Outdoor Air System", "Air Terminal Dual Duct VAV Outdoor Air", "Air Terminal Dual Duct VAV", "Air Terminal Dual Duct Constant Volume", "AirTerminal Single Duct Uncontrolled", "AirTerminal Single Duct VAV NoReheat", and "AirTerminal Heat and Cool No".

OpenStudio Training

- Step 15: Add System #5

The screenshot displays the OpenStudio HVAC Systems interface. The main workspace shows a schematic diagram of a heating system. The diagram is divided into two sections: "Supply Equipment" at the top and "Demand Equipment" at the bottom. The supply side includes a boiler, a pump, and a control valve. The demand side includes a radiator and a control valve. A dashed line separates the two sections. A box labeled "Drag From Library" is positioned below the demand equipment. A red box highlights a dropdown menu in the top right corner, which lists the following options:

- ✓ Packaged Rooftop VAV with Reheat
- Hot Water Loop
- Service Hot Water
- Refrigeration
- VRF

The right sidebar contains a list of HVAC components under the "Library" tab. The components listed are:

- 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
- AirLoopHVAC Outdoor Air System
- Air Terminal Dual Duct VAV Outdoor Air
- Air Terminal Dual Duct VAV
- Air Terminal Dual Duct Constant Volume
- AirTerminal Single Duct Uncontrolled
- AirTerminal Single Duct VAV NoReheat
- AirTerminal Heat and Cool No

OpenStudio Training

- Step 16: Add a thermal zone to the air loop

The screenshot displays the OpenStudio interface for configuring an HVAC system. The main workspace shows a schematic diagram of a 'Packaged Rooftop VAV with Reheat' system. The diagram is divided into 'Supply Equipment' and 'Demand Equipment' sections. A red box highlights the 'Packaged Rooftop VAV with Reheat' title bar at the top. Another red box highlights the 'Library' tab in the top right corner. A third red box highlights a 'zone' component within the demand equipment section of the schematic. A fourth red box highlights a 'Drag From Library' placeholder at the bottom of the schematic. On the right-hand side, a vertical menu lists various HVAC components. A red box highlights the 'Thermal Zone' category, which is expanded to show 'Thermal Zone 1' as an available option.

OpenStudio Training

- Step 17: Automatically added to the zone level

The screenshot displays the 'Thermal Zones' configuration window in OpenStudio. The interface includes a top navigation bar with 'My Model', 'Library', and 'Edit' tabs. Below this, there are tabs for 'HVAC Systems', 'Cooling Sizing Parameters', 'Heating Sizing Parameters', and 'Custom'. The main area is a table with columns for 'Name', 'All', 'Turn On Ideal Air Loads', 'Air Loop Name', 'Zone Equipment', 'Cooling Thermostat Schedule', 'Heating Thermostat Schedule', 'Humidifying Setpoint Schedule', 'Dehumidifying Setpoint Schedule', and 'Multiplier'. The 'Zone Equipment' column for 'Thermal Zone 1' is highlighted with a red box, showing 'PTHP' and 'Single Duct VAV Reheat 1'. The 'Cooling Thermostat Schedule' column for 'Thermal Zone 1' shows 'Large Office ClgSetp' and 'Large Office HtgSetp'. The 'Multiplier' column for 'Thermal Zone 1' shows '1'. On the right side, there is a 'Library' panel with a list of HVAC equipment types, including 'Schedule Rulesets', 'Compact Schedules', 'Zone Ventilation Design Flow Rate', 'Unit Ventilator', 'Unit Heater', 'High Temp Radiant', 'Low Temp Radiant Electric', 'Low Temp Radiant Variable Flow', 'Low Temp Radiant Constant Flow', 'PTAC', 'Water To Air HP', 'PTHP', 'Water Heater - Heat Pump - Wrapped Condenser', 'Water Heater - Heat Pump', 'Fan Zone Exhaust', 'Four Pipe Fan Coil', 'ERV', 'Dehumidifier - DX', 'Baseboard Radiant Convective Water', 'Baseboard Radiant Convective Electric', and 'Baseboard Convective Water'. The bottom of the window has a toolbar with icons for adding, deleting, and refreshing.

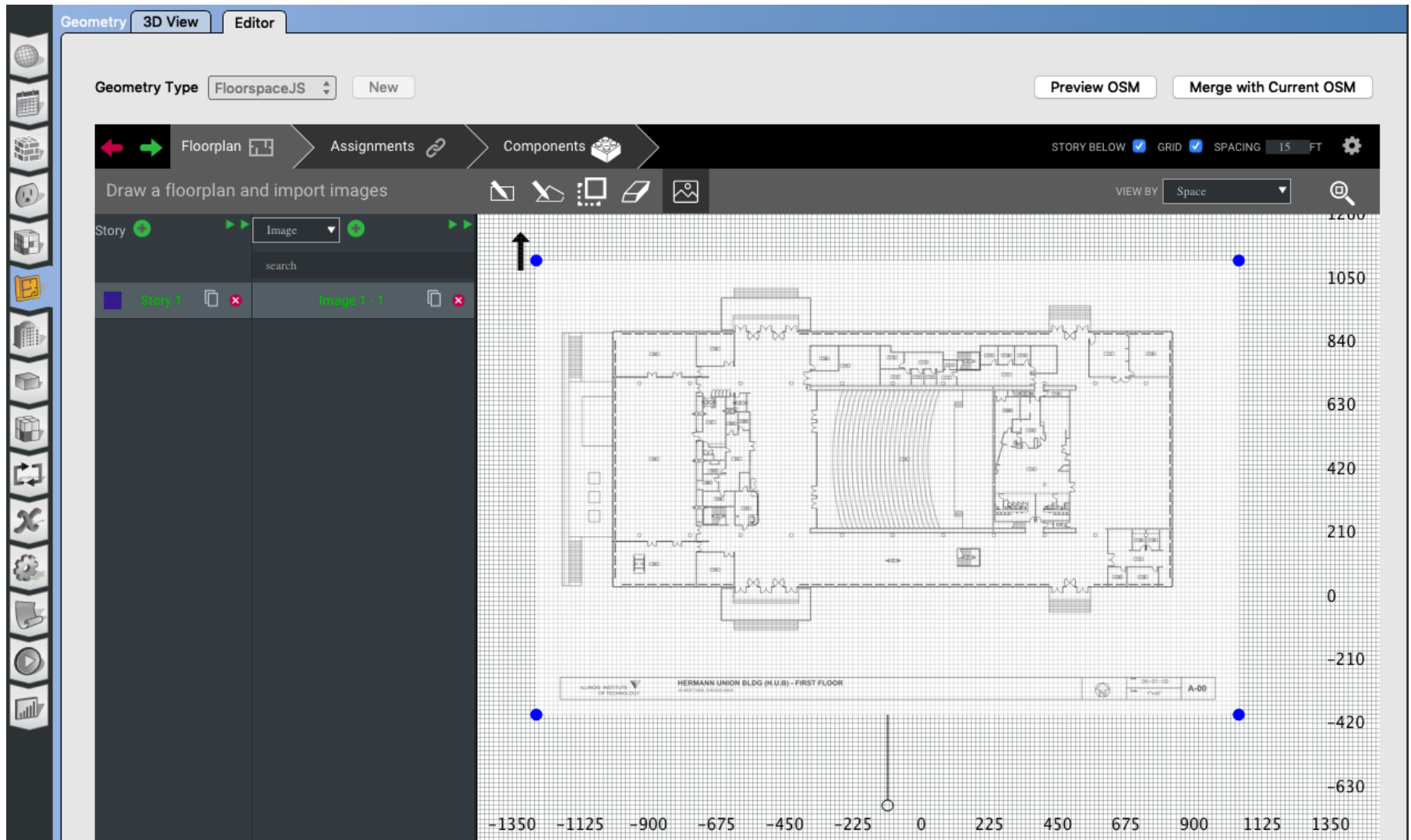
Name	All	Turn On Ideal Air Loads	Air Loop Name	Zone Equipment	Cooling Thermostat Schedule	Heating Thermostat Schedule	Humidifying Setpoint Schedule	Dehumidifying Setpoint Schedule	Multiplier
Thermal Zone 1	<input type="checkbox"/>	<input type="checkbox"/>	Rooftop VAV with Reheat	PTHP Single Duct VAV Reheat 1	Large Office ClgSetp	Large Office HtgSetp			1

OPENSTUDIO TRAINING FROM EXISTING MODELS

GEOMETRY EDITOR

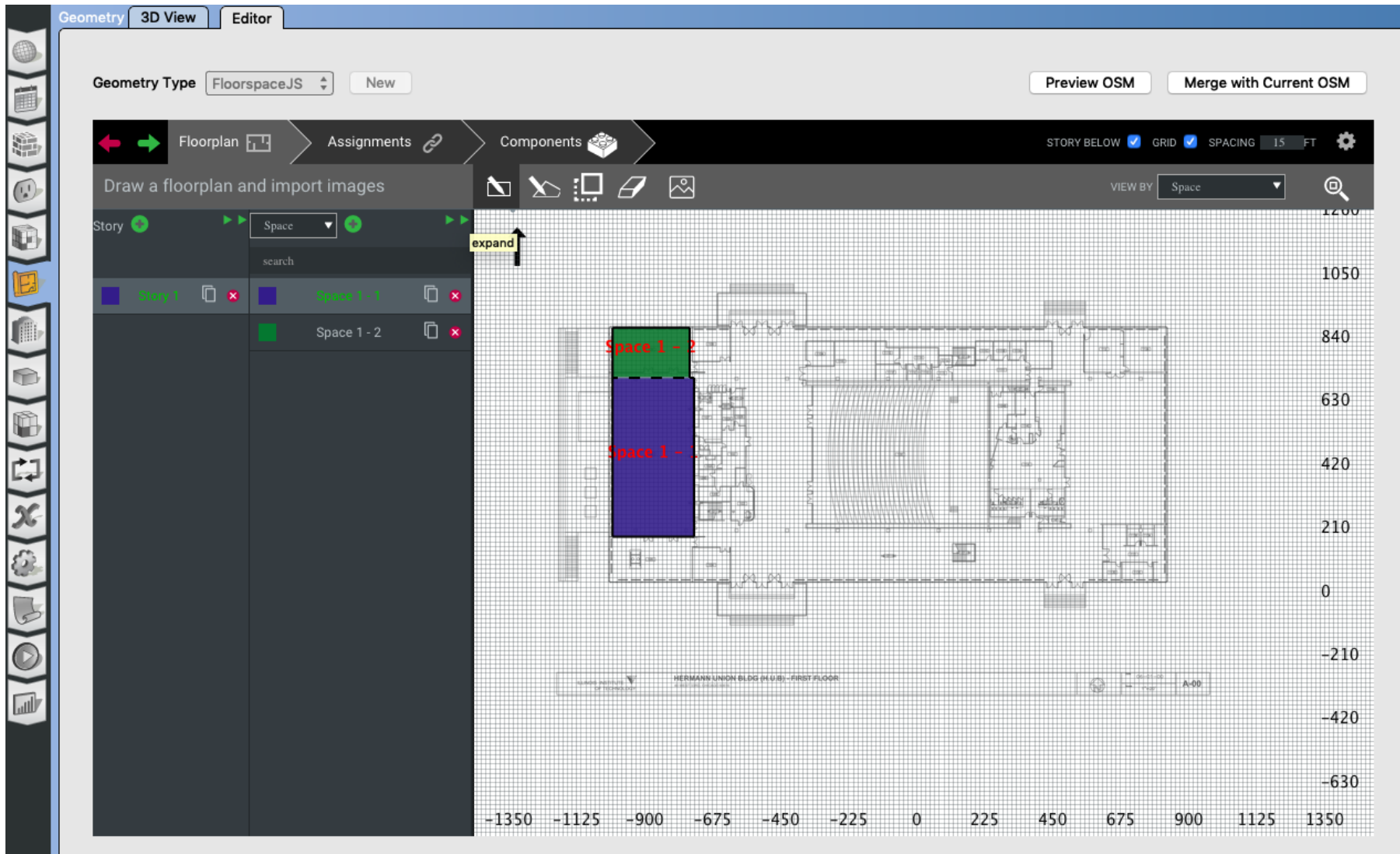
Draw From Floor Plan

- Import the floorplan using figure files



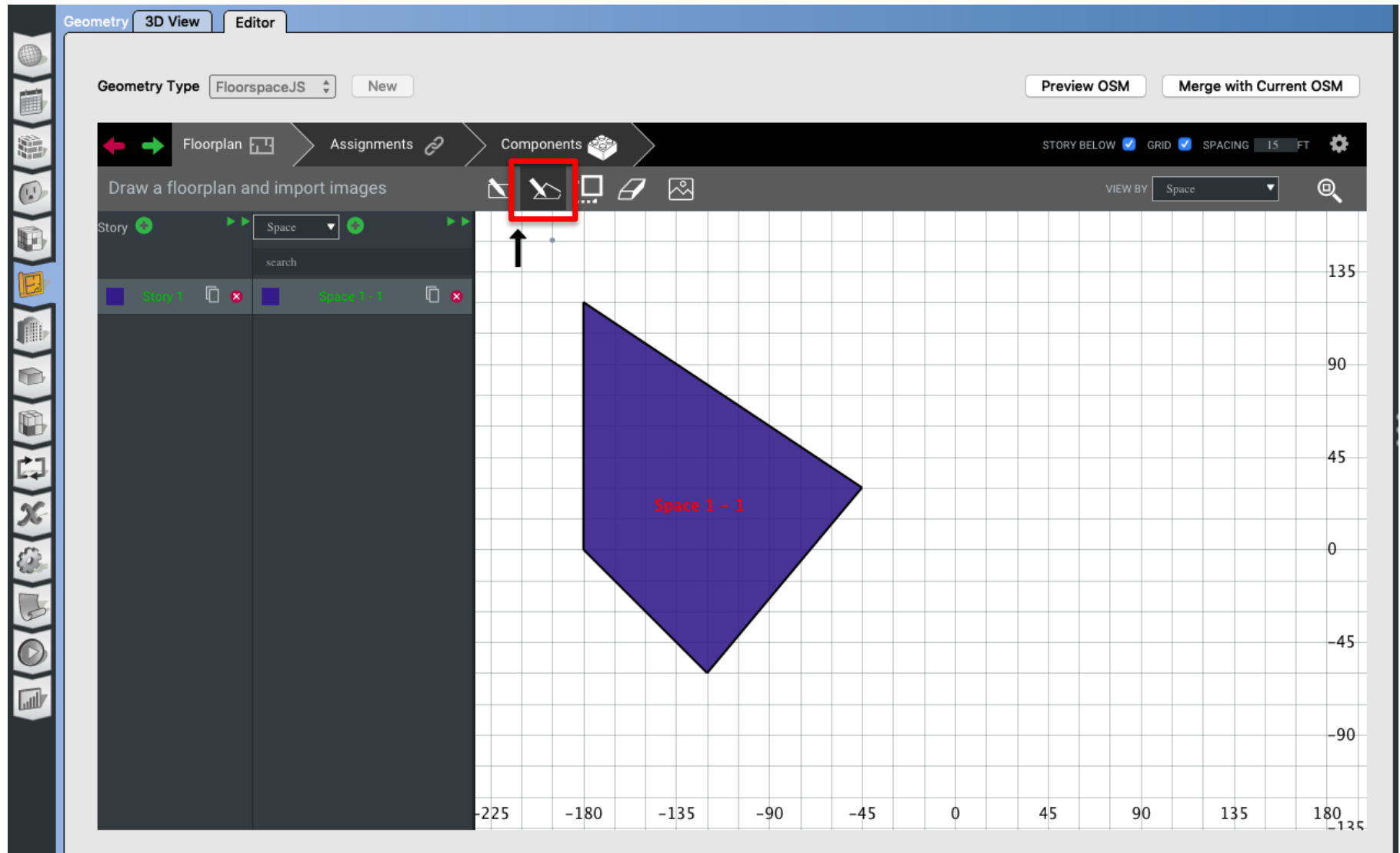
Draw From Floor Plan

- Build the spaces from the floorplan



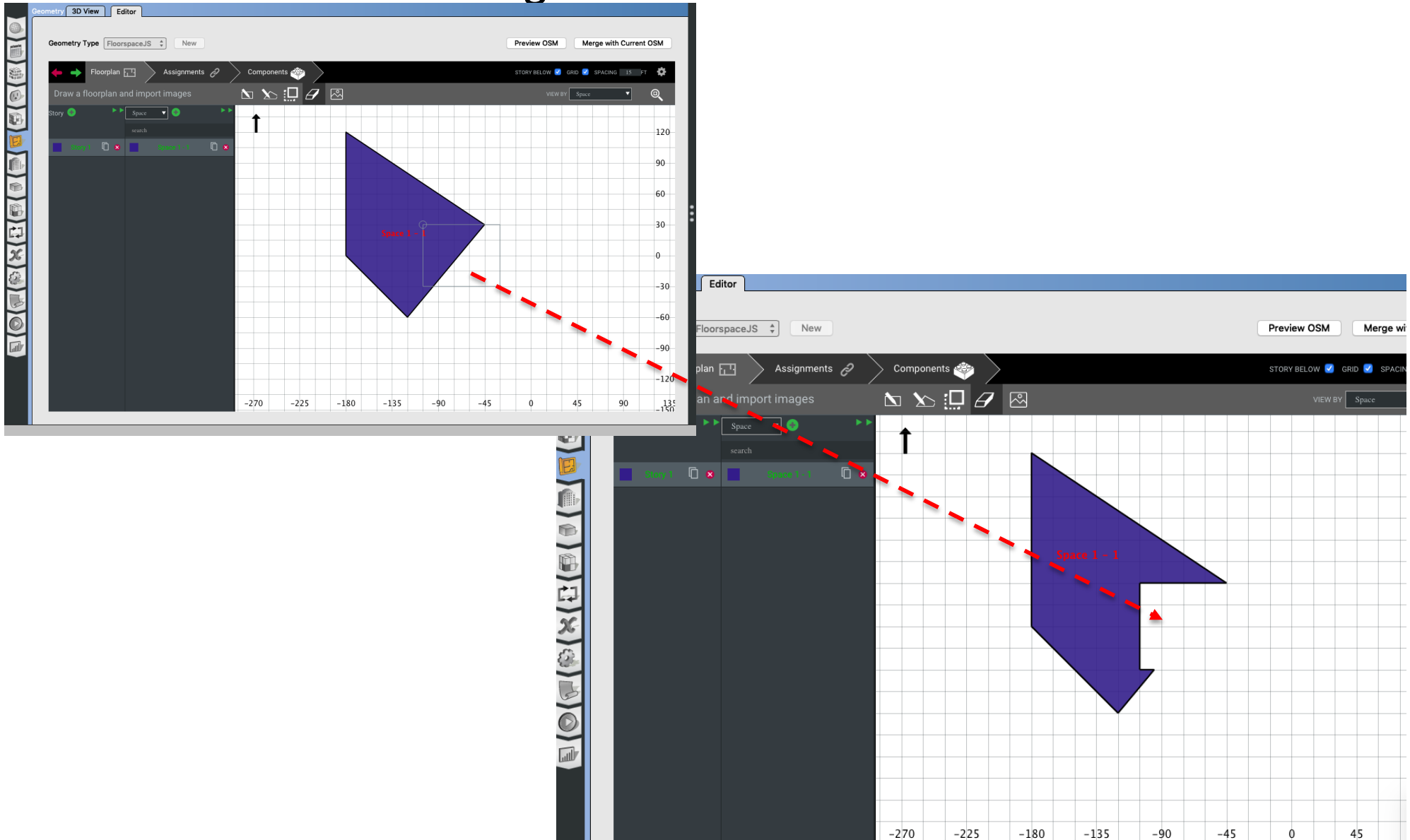
Draw Irregular Shapes

- Click on the irregular shape icon:



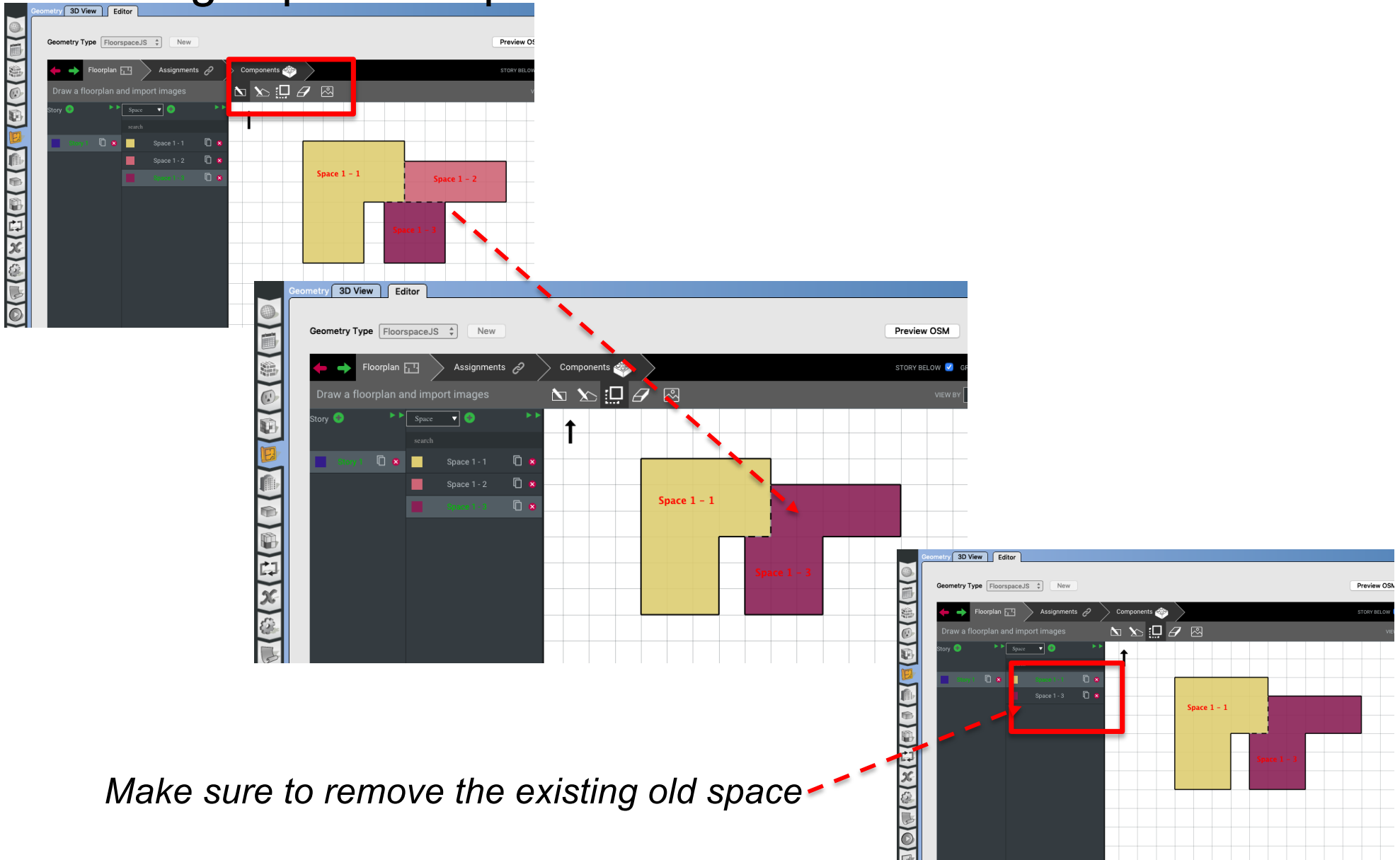
Cut Through the Space

- Select the cut through section:



Merge Spaces

- Merge spaces requires careful consideration:



Make sure to remove the existing old space

TEMPLATES / LIBRARIES

Templates / Libraries

The screenshot shows a software interface with a menu bar at the top: File, Preferences, Components & Measures, Help. Below the menu bar are tabs for Design Days, Life Cycle Costs, and Utility Bills. The 'File' menu is open, showing options: New (⌘N), Open (⌘O), Revert to Saved (⌘R), Save (⌘S), Save As (⇧⌘S), Import, Export, Load Library (highlighted in blue), Examples, and Exit (⌘Q). A red box highlights the 'Import', 'Export', 'Load Library', and 'Examples' options. Below the menu bar, there are sections for 'Measure Tags (Optional)' with dropdowns for ASHRAE Climate Zone and CEC Climate Zone, and a 'Design Days' section with an 'Import From DDY' button. On the right, there are settings for 'Select Year by' (Calendar Year: 2000, First Day of Year: UseWeatherFile) and 'Daylight Savings Time' (off). Below these are 'Starts' and 'Ends' sections with dropdowns for defining by Day of The Week And Month or Date. At the bottom, there is a table for 'Design Days' with columns for Date, Temperature, Humidity, Pressure Wind Precipitation, Solar, and Custom. The table has a header row and a data row with buttons for 'Apply to Selected'.

File Preferences Components & Measures Help

New ⌘N Open ⌘O Revert to Saved ⌘R Save ⌘S Save As ⇧⌘S

Import Export Load Library Examples

Exit ⌘Q

Design Days Life Cycle Costs Utility Bills

Weather File

files at www.energyplus.net/weather

Measure Tags (Optional):

ASHRAE Climate Zone

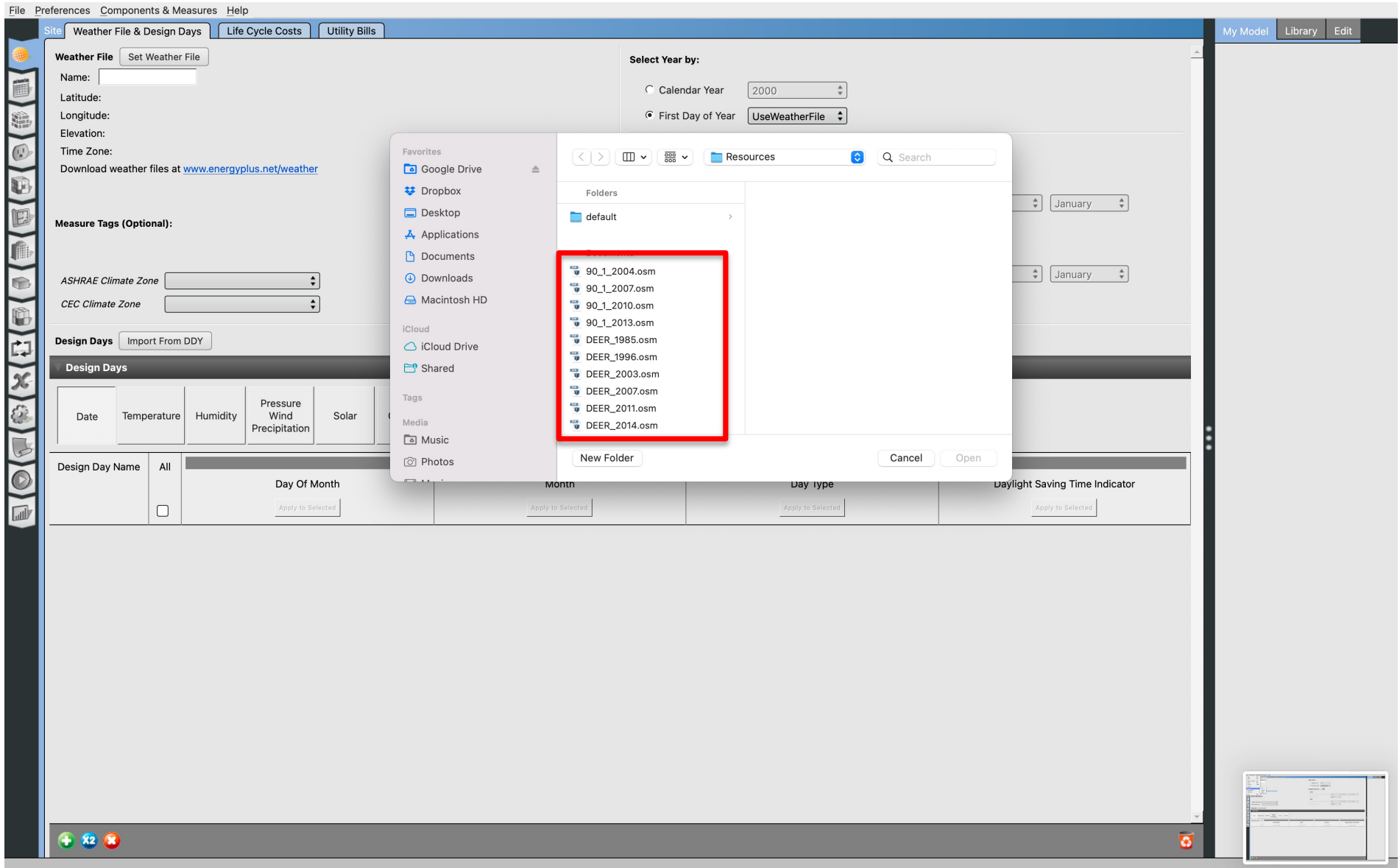
CEC Climate Zone

Design Days Import From DDY

Design Days

Date	Temperature	Humidity	Pressure Wind Precipitation	Solar	Custom
Design Day Name	All	Day Of Month	Month	Day Type	Daylight Saving Time Indicator
	<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"/>

Templates / Libraries



Templates / Libraries



U.S. Department of Energy Commercial Reference Building Models of the National Building Stock

Michael Deru, Kristin Field, Daniel Studer,
Kyle Benne, Brent Griffith, and Paul Torcellini
National Renewable Energy Laboratory

Bing Liu, Mark Halverson, Dave Winiarski,
and Michael Rosenberg
Pacific Northwest National Laboratory

Mehry Yazdanian
Lawrence Berkeley National Laboratory

Joe Huang
Formerly of Lawrence Berkeley National Laboratory

Drury Crawley
Formerly of the U.S. Department of Energy

OPENSTUDIO (SURFACE)

Construction Materials

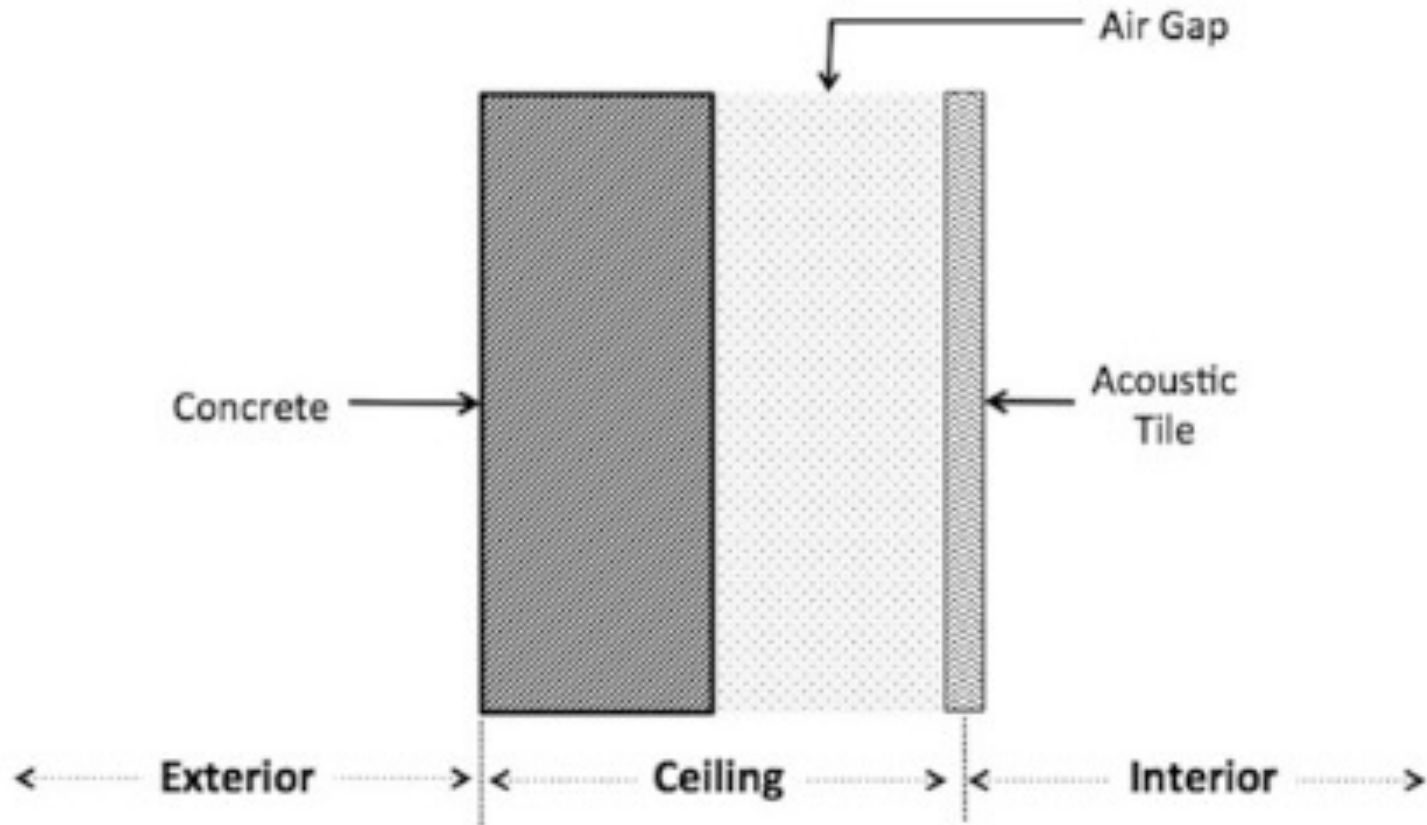
- Two types of surfaces:
 - Exterior
 - Interior surfaces
- Constructions are composed of layers of materials
- Surfaces with same orientation/properties are lumped into one surface for a thermal zone
 - e.g. combine windows facing same direction

Construction Materials

- Two types of surfaces:
 - Exterior
 - Interior surfaces

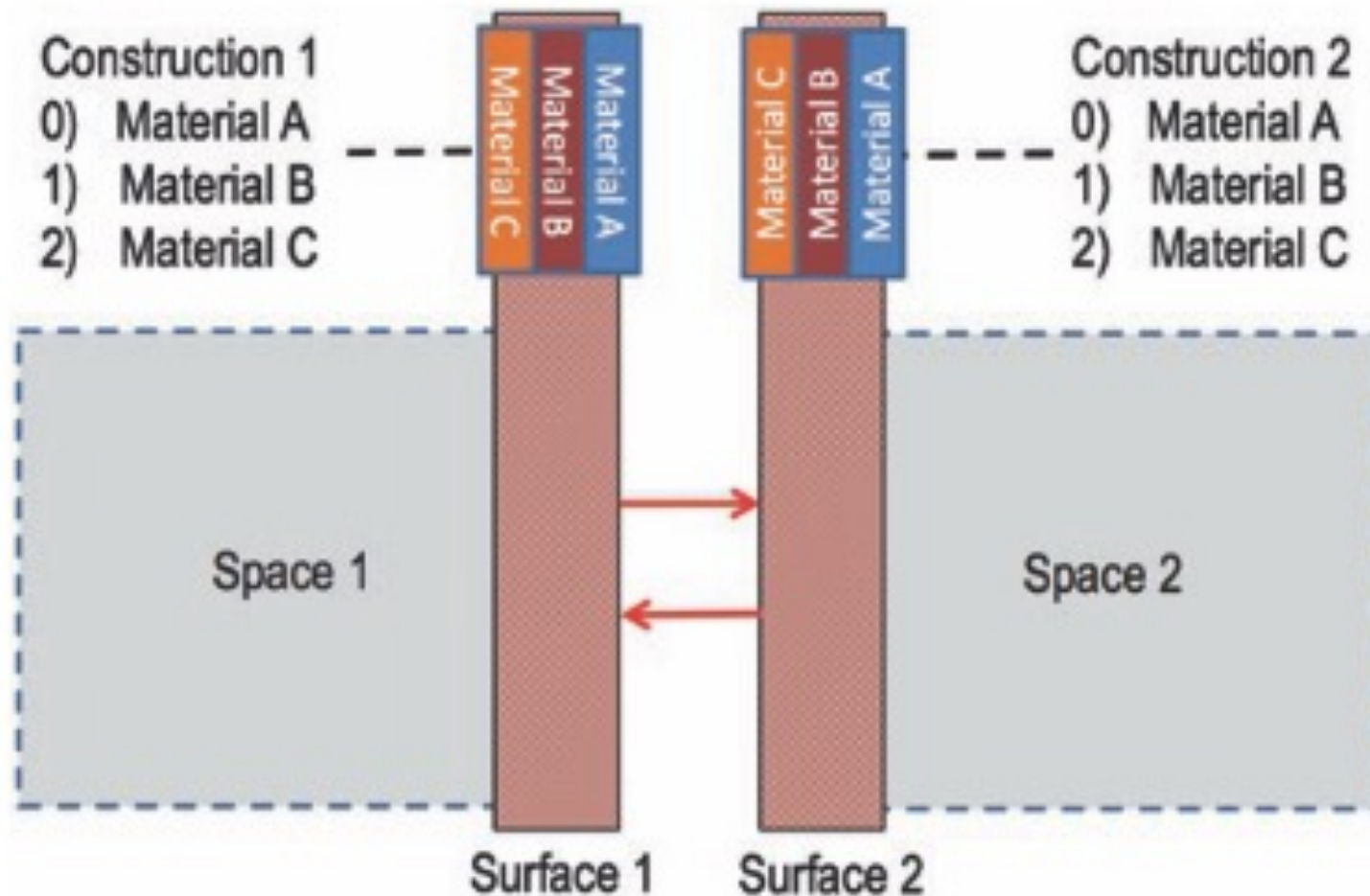
Constructions

- Constructions are composed of layers of materials



Constructions

- Constructions are composed of layers of materials



Add A New Material

- Add a new material

The screenshot displays the 'Materials' configuration window in a software application. The interface is divided into several sections:

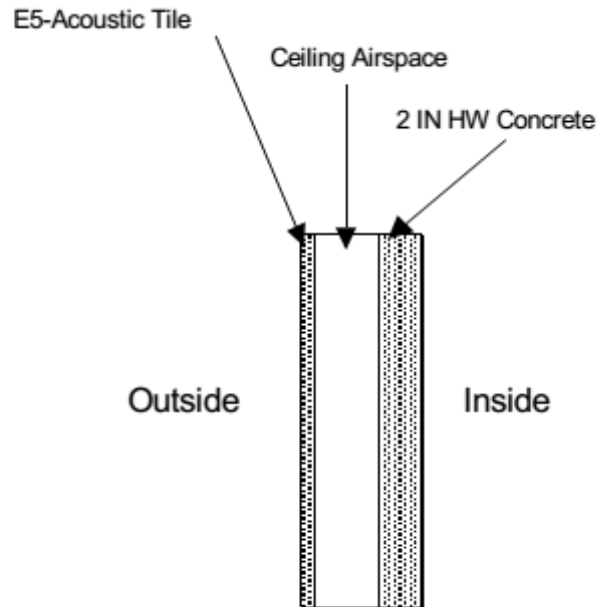
- Top Navigation:** Includes tabs for 'Constructions', 'Construction Sets', 'Constructions', and 'Materials'. On the right, there are sub-tabs for 'My Model', 'Library', and 'Edit'.
- Left Panel (Constructions):** A list of material types, including 'ext-slab-mass', 'Typical IEAD Roof', 'Typical Insulated Basement Mass Wall', 'Typical Insulated Exterior Mass Floor', 'Typical Insulated Exterior Mass Wall R-6.41 4', 'Typical Insulated Exterior Mass Wall R-6.41 5', 'Typical Insulated Metal Door', and 'Typical Insulated Steel Framed Exterior Wall R-6.41 1'. A 'Drag From Library' button is located at the bottom of this list.
- Main Configuration Area:**
 - Name:** A text input field containing 'Typical Insulated Exterior Mass Wall R-6.41 Modified'.
 - Measure Tags (Optional):** A section with various dropdown menus and checkboxes:
 - Standard:** A dropdown menu.
 - Standard Source:** A dropdown menu.
 - Intended Surface Type:** A dropdown menu set to 'ExteriorWall'.
 - Standards Construction Type:** A dropdown menu set to 'Mass'.
 - Fenestration Type:** A dropdown menu.
 - Fenestration Assembly Context:** A dropdown menu.
 - Fenestration Number of Panes:** A dropdown menu.
 - Fenestration Frame Type:** A dropdown menu.
 - Fenestration Divider Type:** A dropdown menu.
 - Fenestration Tint:** A dropdown menu.
 - Fenestration Gas Fill:** A dropdown menu.
 - Fenestration Low Emissivity Coating:** A toggle switch set to 'off'.
 - Layer:** A section titled 'Outside' containing a list of materials:
 - '1IN Stucco 1' with a delete icon (X).
 - 'CONCRETE' with a delete icon (X).
- Right Panel (Library):** A vertical list of material categories, including 'Materials', 'No Mass Materials', 'Air Gap Materials', 'Air Wall Materials', 'Infrared Transparent Materials', 'Roof Vegetation Materials', 'Simple Glazing System Window Materials', 'Glazing Window Materials', 'Gas Window Materials', 'Gas Mixture Window Materials', 'Daylight Redirection Device Window Materials', 'Blind Window Materials', 'Screen Window Materials', and 'Shade Window Materials'.
- Bottom Left:** A red dashed box highlights a toolbar with icons for adding (+), deleting (X), and refreshing (refresh icon).

Construction Materials

- Constructions are composed of layers of materials (EnergyPlus)

An IDF example:

```
Material,A2 - 4 IN DENSE FACE BRICK, ! Material Name
Rough, ! Roughness
0.1014984 , ! Thickness (m)
1.245296 , ! Conductivity {W/M*K}
2082.400 , ! Density {Kg/M**3}
920.4800 , ! Specific Heat {J/Kg*K}
0.9000000 , ! Thermal Absorptance
0.9300000 , ! Solar Absorptance
0.9300000 ; ! Visible Absorptance
```



IDF Example (floor construction):

```
Construction, FLOOR38, ! Material layer names follow:
E5 - ACOUSTIC TILE,
E4 - CEILING AIRSPACE,
C12 - 2 IN HW CONCRETE;
```

Figure 22. Example Floor Construction illustration.

Inheritance

Priority	Level	Construction
1	Surface	Construction
2	Space	Default Construction Set
3	Story	Default Construction Set
4	Building	Default Construction Set

Facility Building Stories Shading Exterior Equipment

Name:
Building 1

Measure Tags (Optional):

Standards Building Type: Relocatable: false

Nominal Floor to Ceiling Height: m Nominal Floor to Floor Height: m

Standards Number of Stories: Standards Number of Above Ground:

Standards Number of Living Units:

North Axis: 0.000000 deg

Space Type:

Default Construction Set:

Default Schedule Set:

Inheritance

- Why do we see the “green color” text?

The screenshot displays the Revit software interface for a project named 'HW3 TZ1 PTHP.osm'. The 'Surfaces' tab is active, showing a table of surface properties for 'Space 1 - 1'. The table has columns for Space Name, Surface Name, Surface Type, Construction, Outside Boundary Condition, and Outside Boundary Condition C. The 'Construction' column contains text in green dashed boxes, indicating inheritance or specific material assignments. A right-hand sidebar shows a 'Constructions' library with various material options.

Space Name	Surface Name	Surface Type	Construction	Outside Boundary Condition	Outside Boundary Condition C
Space 1 - 1	Face 3	Wall	Typical Interior Wall	Surface	Face 10
	Face 2	Wall	Typical Insulated Baser	Ground	
	Surface 12	RoofCeiling	Typical Interior Ceiling	Surface	Face 26
	Surface 13	RoofCeiling	Typical Interior Ceiling	Surface	Surface
	Face 5	Wall	Typical Insulated Baser	Ground	
	Face 6	Wall	Typical Insulated Steel	Outdoors	
	Face 0	Floor	ext-slab-mass	Ground	
	Face 1	RoofCeiling	Typical Interior Ceiling	Surface	Surface 1
	Face 4	Wall	Typical Interior Wall	Surface	Face 19
	Surface 8	RoofCeiling	Typical Interior Ceiling	Surface	Face 34
	Surface 3	RoofCeiling	Typical Interior Ceiling	Surface	Face 86
	Surface 1	RoofCeiling	Typical Interior Ceiling	Surface	Face 70
	Face 18	Wall	Typical Insulated Baser	Ground	
	Face 19	Wall	Typical Interior Wall	Surface	Face 4

Inheritance

- Replace the construction from “My Model”

The screenshot shows a software interface with a table of surface properties and a list of construction types. The table has columns for Space Name, Surface Name, Surface Type, Construction, and Outside Boundary Condition. The 'Construction' column contains various types like 'Typical Interior Wall', 'Typical Insulated Baser', 'Typical Interior Ceiling', 'Typical Insulated Exteri', 'ext-slab-mass', and 'Typical Interior Wall'. The 'Outside Boundary Condition' column contains 'Surface', 'Ground', 'Outdoors', and 'Surface'. The 'Constructions' list on the right contains various construction types, with a red dashed box highlighting 'Typical Insulated Exterior Mass Wall R-6.41 4' and 'Typical Insulated Exterior Mass Wall R-6.41 5'.

Space Name	Surface Name	Surface Type	Construction	Outside Boundary Condition
Space 1 - 1	Face 3	Wall	Typical Interior Wall	Surface
	Face 2	Wall	Typical Insulated Baser	Ground
	Surface 12	RoofCeiling	Typical Interior Ceiling	Surface
	Surface 13	RoofCeiling	Typical Interior Ceiling	Surface
	Face 5	Wall	Typical Insulated Exteri	Ground
	Face 6	Wall	Typical Insulated Exteri	Outdoors
	Face 0	Floor	ext-slab-mass	Ground
	Face 1	RoofCeiling	Typical Interior Ceiling	Surface
	Face 4	Wall	Typical Interior Wall	Surface
	Surface 8	RoofCeiling	Typical Interior Ceiling	Surface
	Surface 3	RoofCeiling	Typical Interior Ceiling	Surface
	Surface 1	RoofCeiling	Typical Interior Ceiling	Surface
	Face 18	Wall	Typical Insulated Baser	Ground
	Face 19	Wall	Typical Interior Wall	Surface

The 'Constructions' list on the right includes the following items:

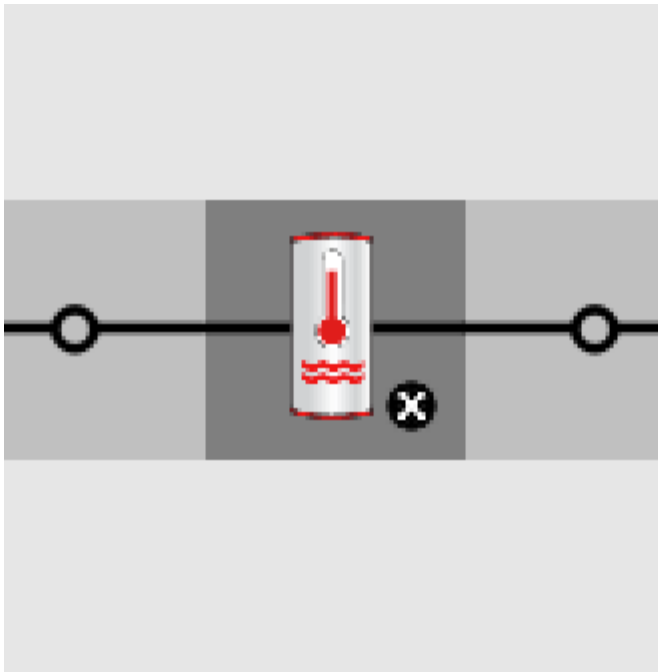
- ext-slab-mass
- Typical IEAD Roof
- Typical Insulated Basement Mass Wall
- Typical Insulated Exterior Mass Floor
- Typical Insulated Exterior Mass Wall R-6.41 4
- Typical Insulated Exterior Mass Wall R-6.41 5
- Typical Insulated Metal Door
- Typical Insulated Steel Framed Exterior Wall R-6.41 1
- Typical Interior Ceiling

Other Inputs

- Plug Load Density, Schedule
- Occupancy Density, Schedule, Metabolic Rate
- Domestic Hot Water Rate, Schedule
- Lighting Level
- Temperature/Humidity Control, Schedule
- Ventilation

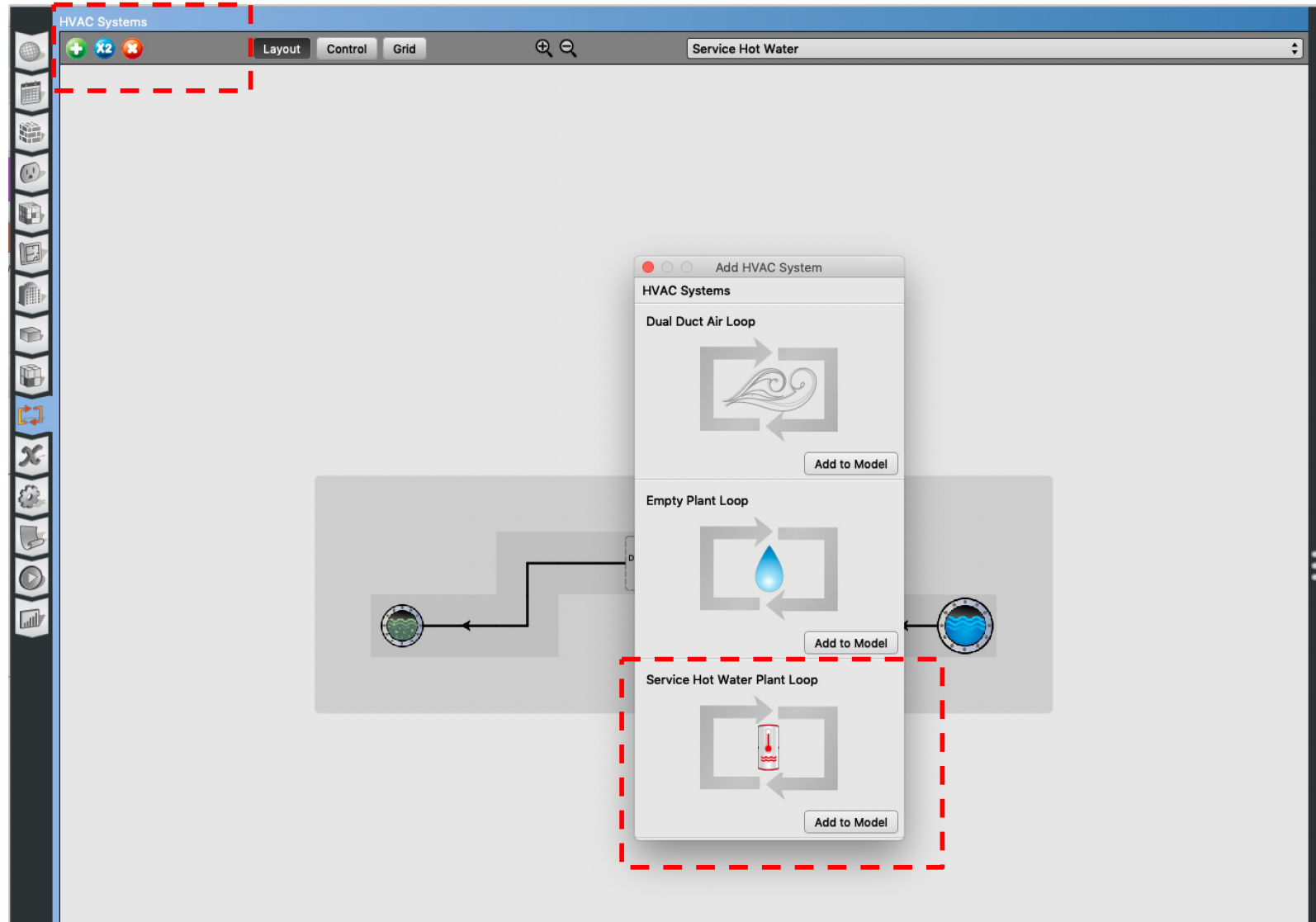
SERVICE HOT WATER

Service Hot Water



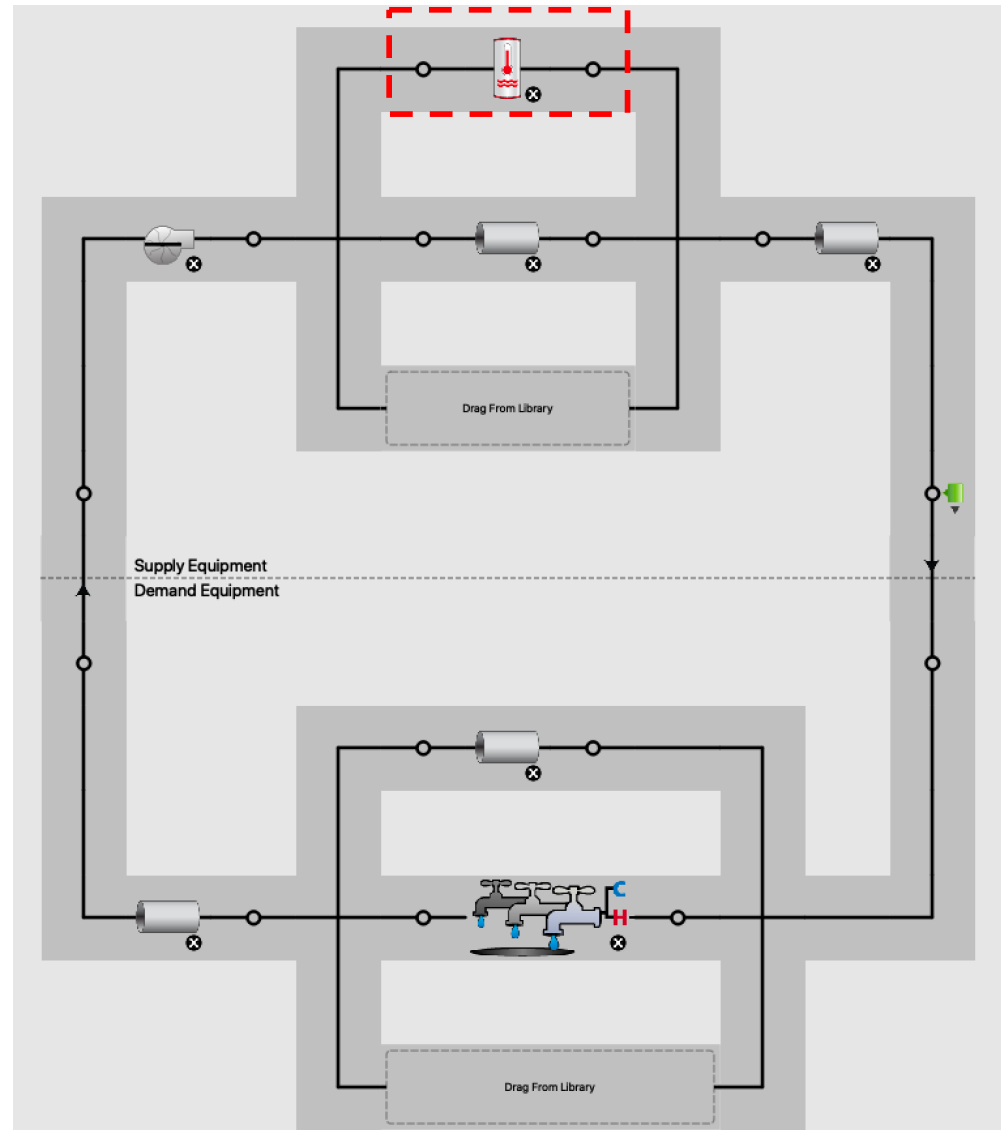
Service Hot Water

- 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

Drag Water Use Equipment from Library

Loop

Loop

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

The image displays two screenshots of a software interface for modeling HVAC systems, specifically focusing on Service Hot Water (SHW) systems. The top screenshot shows a schematic diagram of a SHW system with the title "SHW WUC 0.0gpm at 140F" and "Service Hot Water". The diagram includes a central "Drag Water Use Equipment from Library" component connected to two "Loop" components. The bottom screenshot shows a more detailed schematic of a SHW system with the title "Service Hot Water". This diagram includes a central "Drag Water Use Connections from Library" component connected to two "Loop" components. A red dashed arrow points from the top schematic to the bottom schematic, indicating a transition or comparison between the two views. The interface includes a menu bar (File, Preferences, Components & Measures, Help) and a toolbar on the left side.

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 has tabs for "My Model", "Library", and "Edit". On the left, a vertical toolbar contains icons for various load types. The main area is divided into two columns. The left column lists load categories: People Definitions, Lights Definitions, Luminaire Definitions, Electric Equipment Definitions, Gas Equipment Definitions, Steam Equipment Definitions, Other Equipment Definitions, Internal Mass Definitions, and Water Use Equipment Definitions. The right column contains input fields for the selected "Water Fixture Definition": 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), and Latent Fraction Schedule (Drag From Library). A red dashed box highlights the Peak Flow Rate and Target Temperature Schedule fields. The right sidebar lists various construction and schedule options: 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

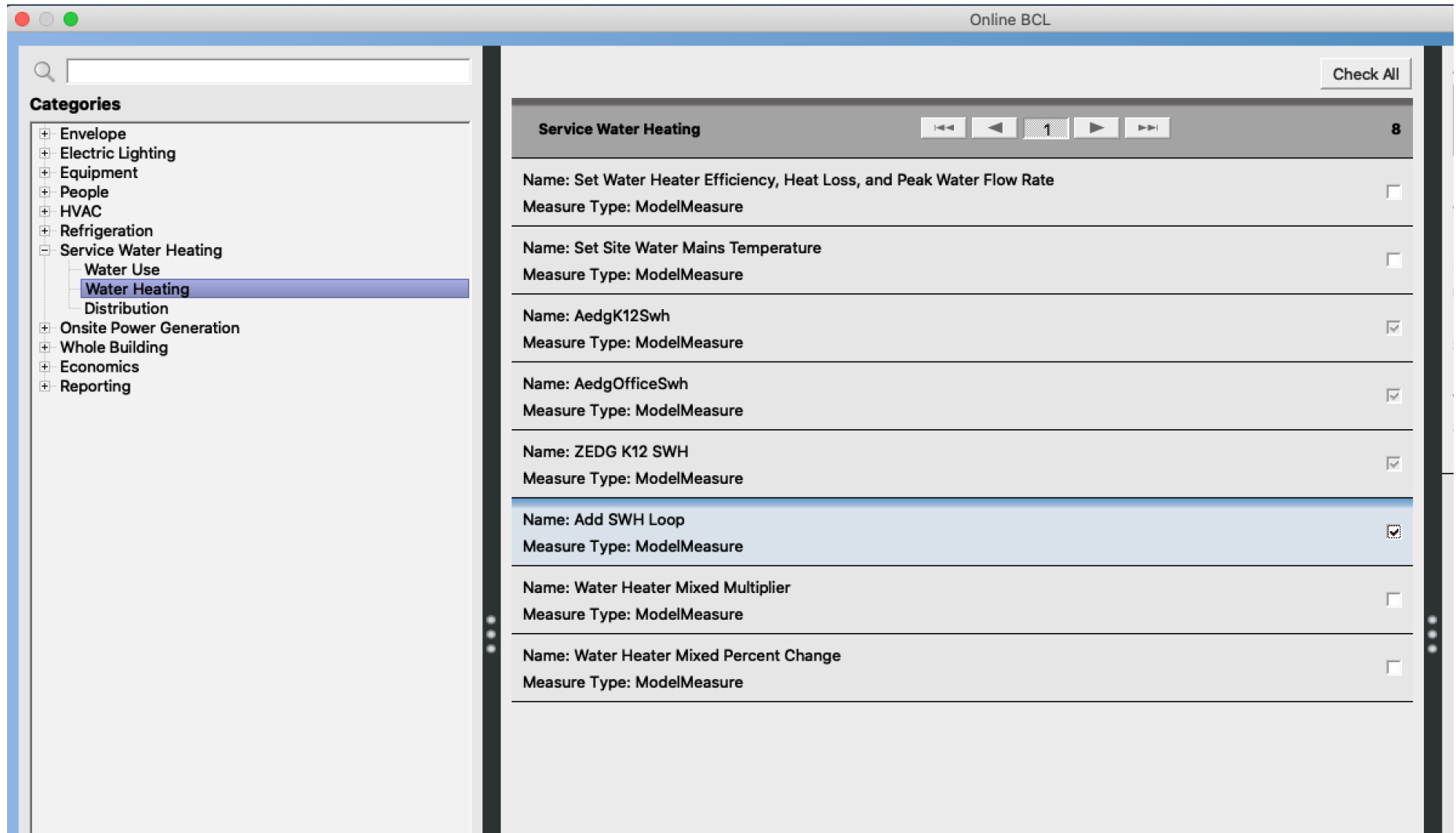
- Make reasonable assumptions for the water heater temperature:
 - Most households require about 120 °F
 - Some manufacturers set water heater thermostats at 140 °F, which also slows mineral buildup and corrosion in your water heater and pipes
 - Water heated at 140°F also poses a safety hazard (scalding)

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

- You can use the OpenStudio measures:



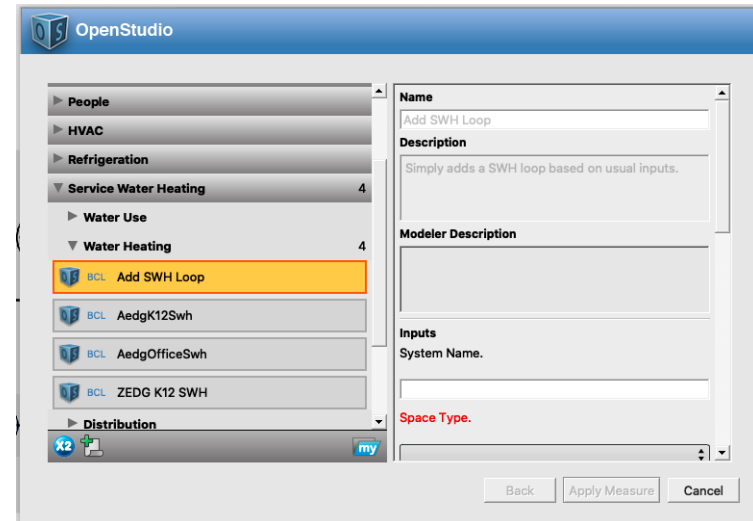
The screenshot shows the OpenStudio Online BCL interface. On the left, a 'Categories' sidebar lists various building systems, with 'Service Water Heating' expanded to show 'Water Heating' selected. The main panel displays a list of measures under the heading 'Service Water Heating'. The list includes:

Name	Measure Type	Checked
Set Water Heater Efficiency, Heat Loss, and Peak Water Flow Rate	ModelMeasure	<input type="checkbox"/>
Set Site Water Mains Temperature	ModelMeasure	<input type="checkbox"/>
AedgK12SwH	ModelMeasure	<input checked="" type="checkbox"/>
AedgOfficeSwH	ModelMeasure	<input checked="" type="checkbox"/>
ZEDG K12 SWH	ModelMeasure	<input checked="" type="checkbox"/>
Add SWH Loop	ModelMeasure	<input checked="" type="checkbox"/>
Water Heater Mixed Multiplier	ModelMeasure	<input type="checkbox"/>
Water Heater Mixed Percent Change	ModelMeasure	<input type="checkbox"/>

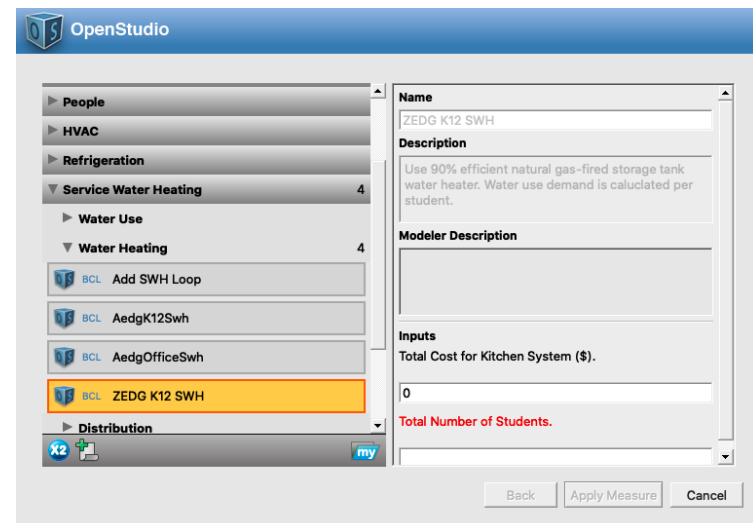
Service Hot Water

- You can use the OpenStudio measures:

- First, use “Add SHW Loop”



- Second, use “ZEDG K12 SHW”



DISTRICT HEATING AND COOLING

District Heating and Cooling

- District heating and cooling:
 - ❑ No assumption required on:
 - ❑ Steam
 - ❑ Chilled water generation

