phius

REVIVEcalc

USER HANDBOOK

OCTOBER 2024
V24.2.0

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Phius

October 2024

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Phius REVIVEcalc Modeling Process & Protocol

When all the Databases are complete, REVIVEcalc v24.2.0 is used to generate a Runlist of cases to assess the performance of different retrofit scenarios. A Geometry file is also required for successful Simulation. When done correctly, the tool will generate the Results Table which is used to determine the final design approach. A full walkthrough of the tool from download to results is available here: Training Videos. Individual training videos are linked under their corresponding sections below.

Getting Started

Refer to the following training videos to get started:

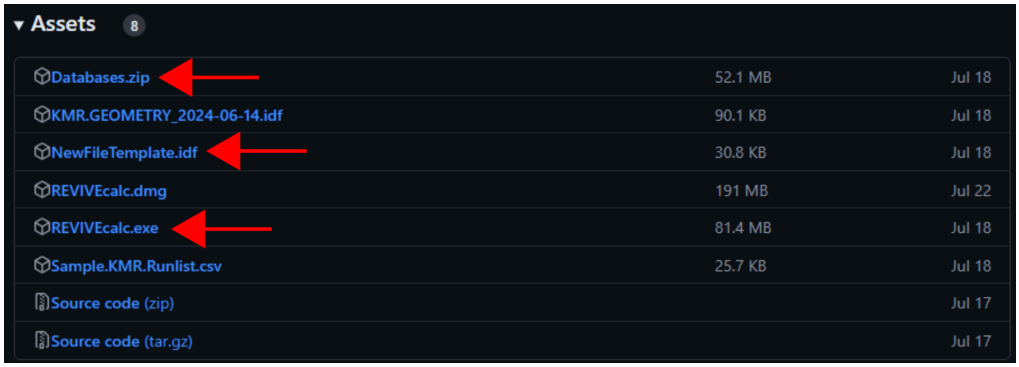
- Introduction
- REVIVEcalc Tour

Visit the Phius Github Repository and download / install the following tools:

- Euclid (SketchUp[1] Plugin)
- EnergyPlus 9.5.0

From the Asset Library, the following files will also need to be downloaded.

- Databases.zip
  - Contains all databases needed for successful simulation
- NewFileTemplate.idf
  - See Starting a New File for guidance how to properly locate this file on your Windows machine
- REVIVEcalc.exe
  - The REVIVEcalc tool itself



Process Tip: Create a project folder on your device to keep all of the REVIVEcalc files in. Add to this folder only as instructed below. The Databases folder can be installed somewhere centrally on your device and be used in multiple projects.

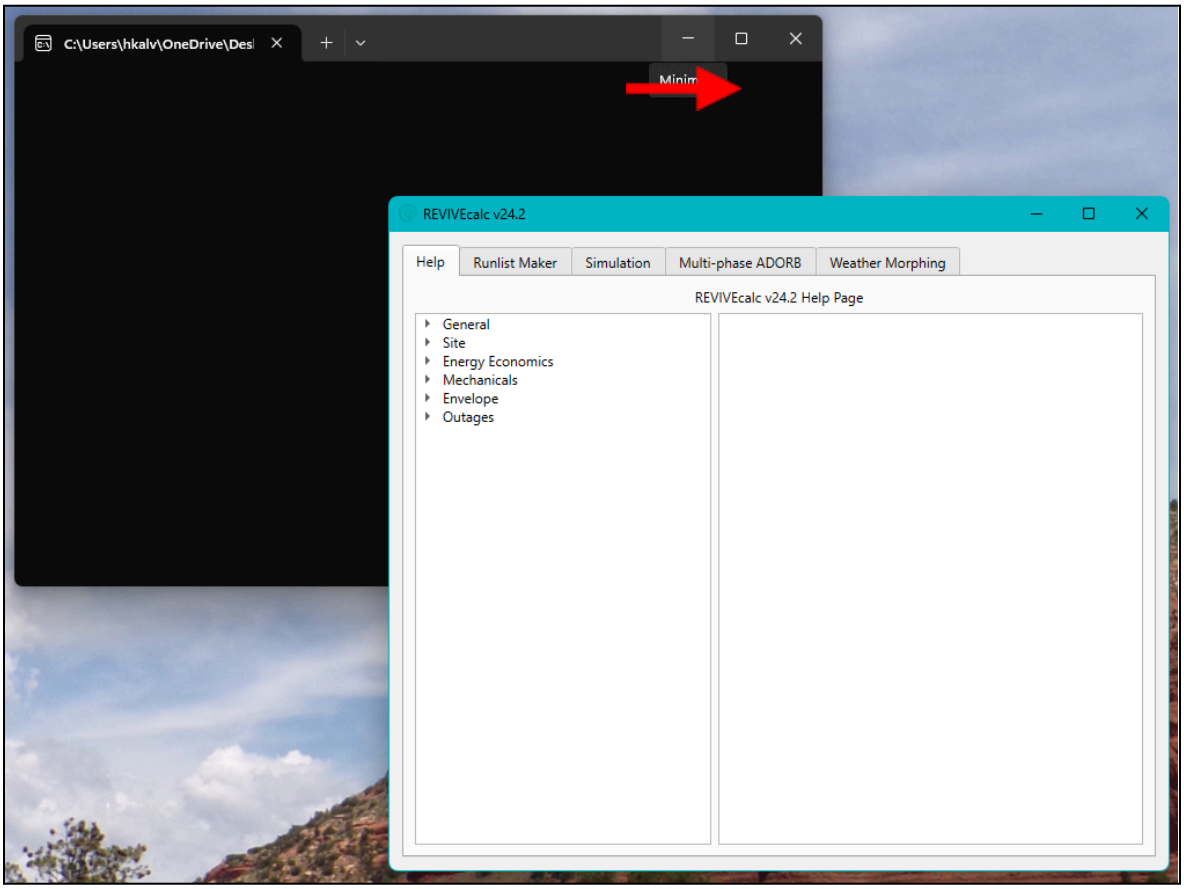
Navigating REVIVEcalc

REVIVEcalc will download as an application. The thumbnail is the Phius logo with a ribbon that indicates the version number of the tool:

[1] Refer to Appendix B for guidance on software compatibility and known issues with specific versions of SketchUp

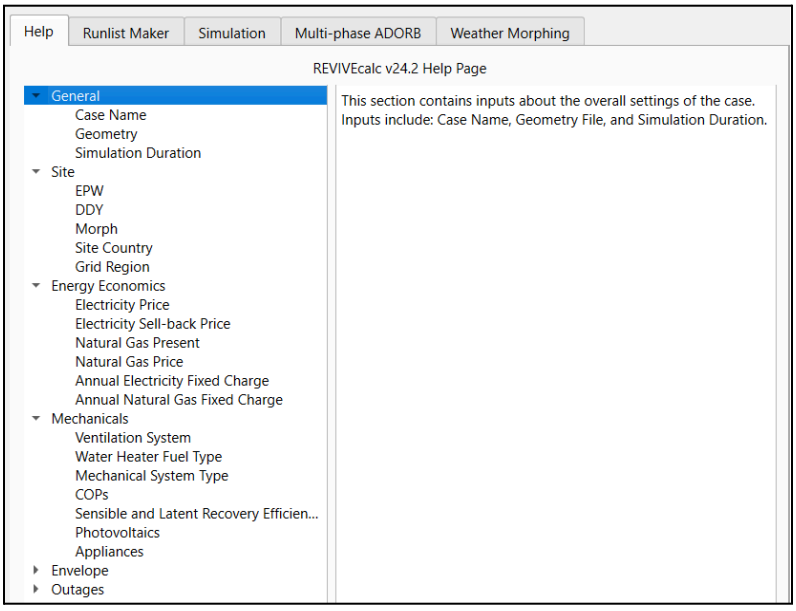
Launcher Introduction

Upon launching the application, two windows will appear: the terminal window and the tool itself. Minimize the terminal window and allow it to run in the background. The following sections will give a brief overview of each of the tabs within the REVIVEcalc tool. Detailed guidance on how to use each tab during the modeling process is given later in this handbook.



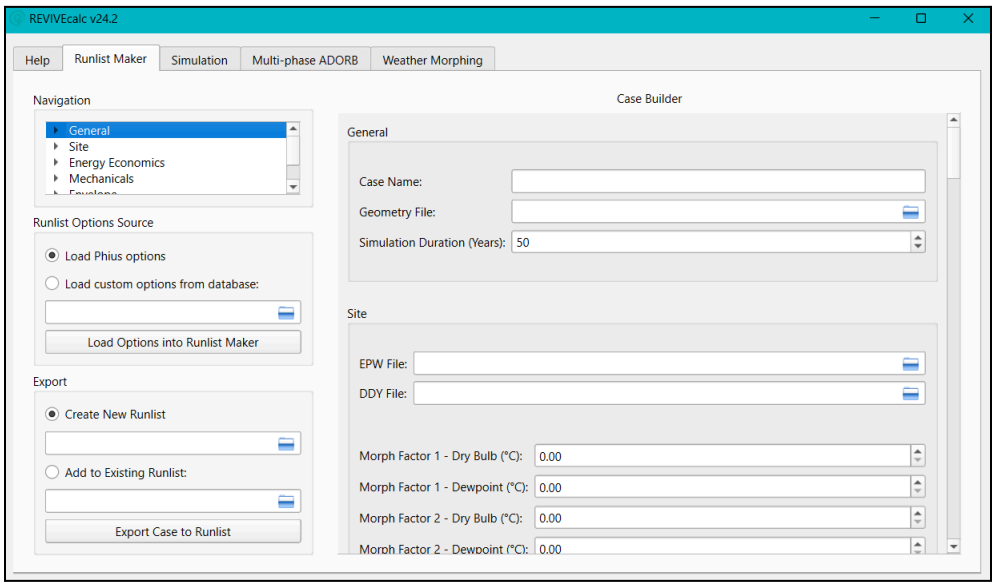
Help

The 'Help' tab provides definitions and general instructions for every input required within the 'Runlist Maker' tab. All of the definitions can also be found in the [Phius REVIVE 2024 Standard Document].



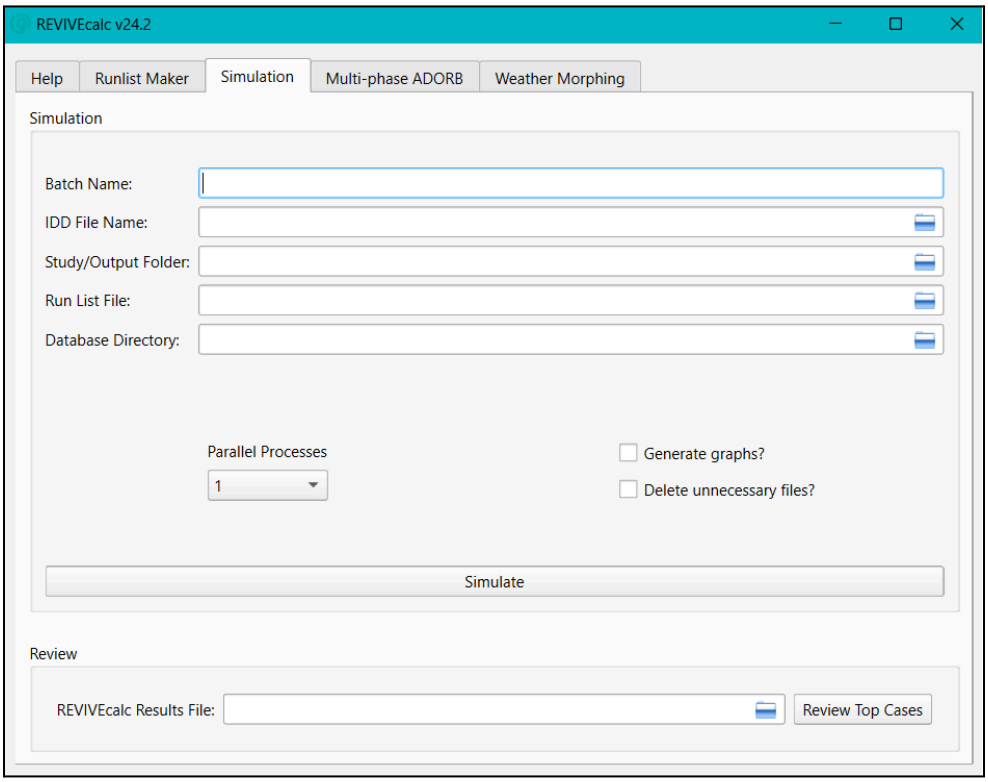
Runlist Maker

This tab is used to build the Runlist of unique cases for use later in the 'Simulation' tab. All project information will be input here, including geometry, climate data, energy economics, mechanical systems, envelope, and outages periods for the resilience analysis.



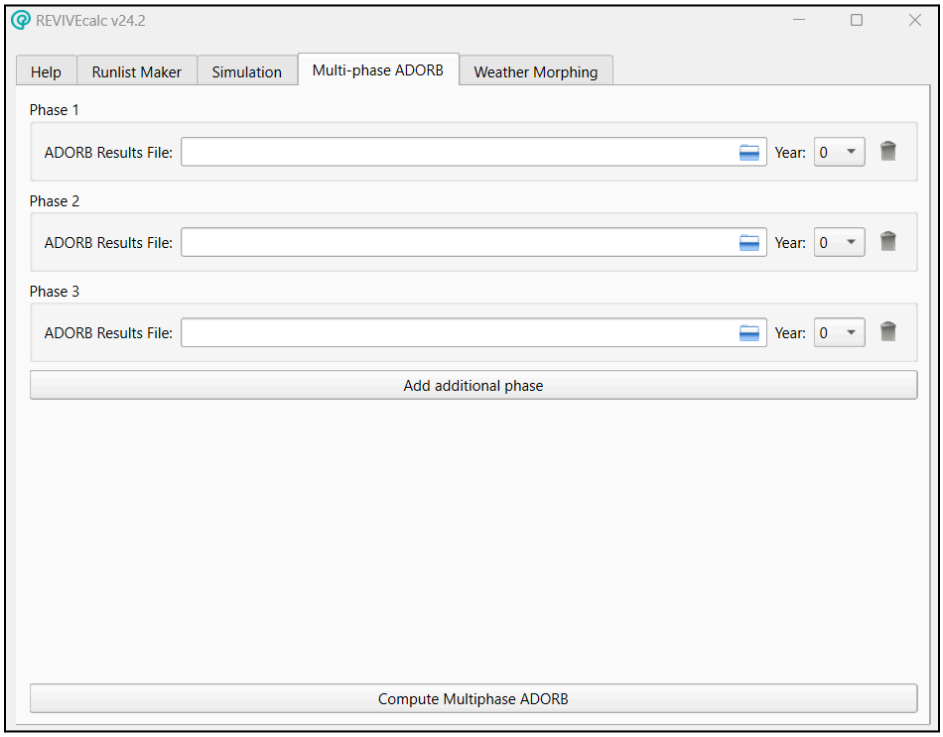
Simulation

Once all of the desired cases have been added to the Runlist, the Simulation tab is used to calculate the results of all of the cases simultaneously. If simulation is successful, the Results Table will generate and produce the top-5 cases. All of the cases within the results table are eligible to use for Certification.



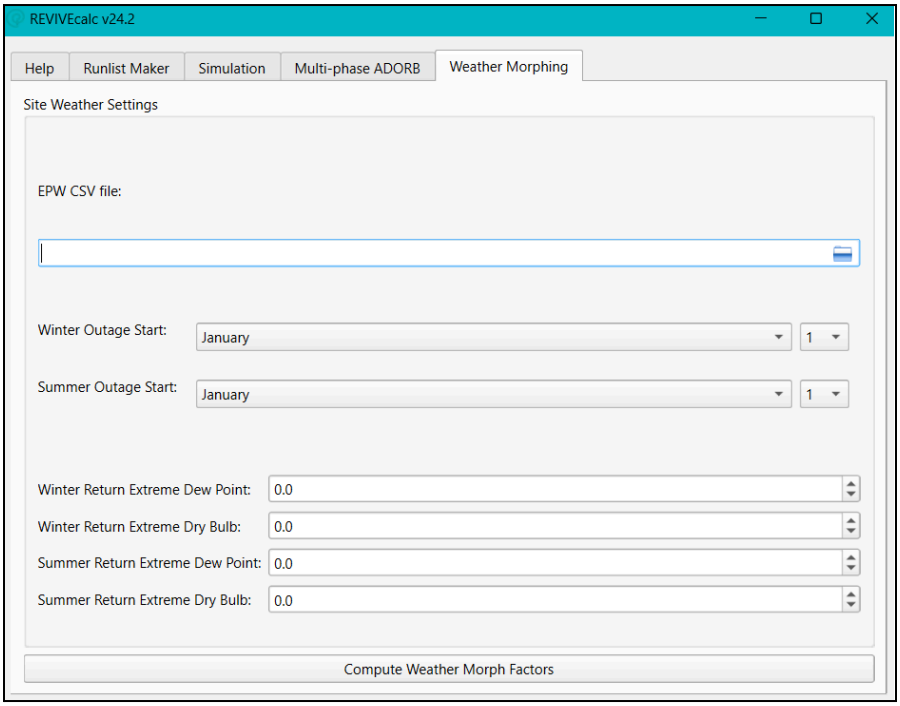
Multi-Phase ADORB

The Multi-Phase ADORB tab is used to determine the lifecycle cost of a project that is multiphase. Each phase should be modeled as a separate cases, and then stitched together using this tab. Phase 1 must start in year 0, but the remaining cases (up to 5) can be started in the appropriate year. Click on Compute Multiphase ADORB to create a total ADORB cost of the phased project.



Weather Morphing

This tab is used to acquire the Morph Factors for input in the Runlist based on the climate data set being used for the project. Typically, Phius will provide the morph factors to project teams to use along with the required climate data files.



Geometry

The geometry file can come from any tools that make an ".idf" file for use in EnergyPlus, as long as the naming conventions listed below are followed. The recommended tool is Sketchup using the Euclid plugin, described below.

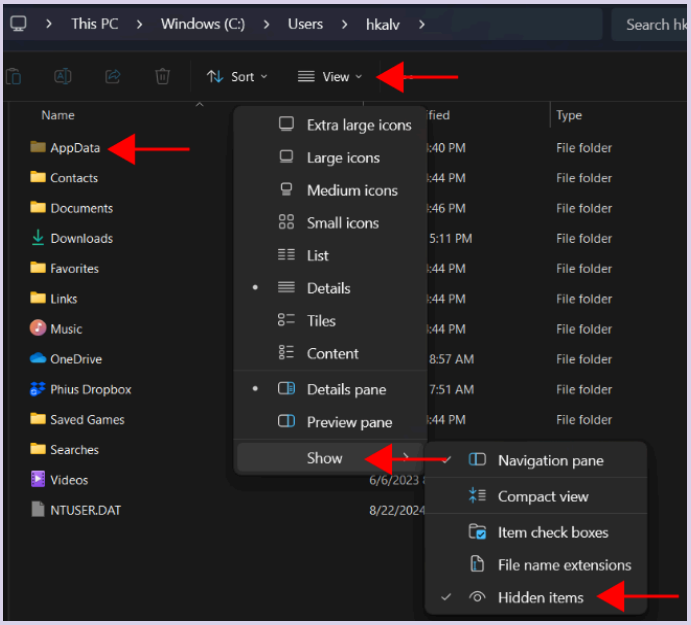
Starting a New File

First, the 'NewFileTemplate.idf' downloaded previously must be moved to its proper location. This is a critical step in order to be able to tag the geometry components in SketchUp. The Euclid plugin must be installed prior to moving the file. Once installed, open File Explorer on your device, and navigate to the following folder:

- C:\Users\JDoe\AppData\Roaming\SketchUp\SketchUp2024\SketchUp\Plugins\euclid\lib**legacy_openstudio**
- Replace the existing 'NewFileTemplate.idf' file with the new file

Process Tips:

- "JDoe" will instead be your unique computer username
- If several versions of SketchUp are installed, make sure to select the folder for the version that you will be working in to create the geometry (example above shows SketchUp 2024)
- The "AppData" folder is hidden by default and must be unhidden to move forward to the "Roaming" folder:

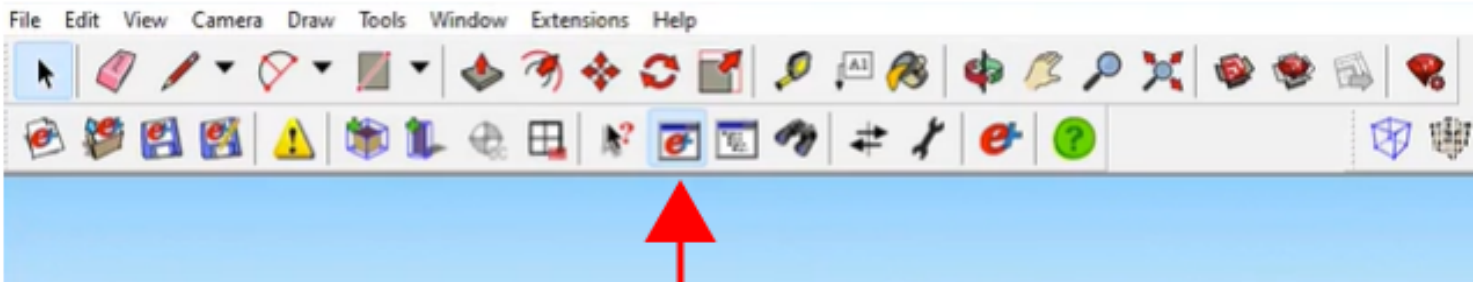


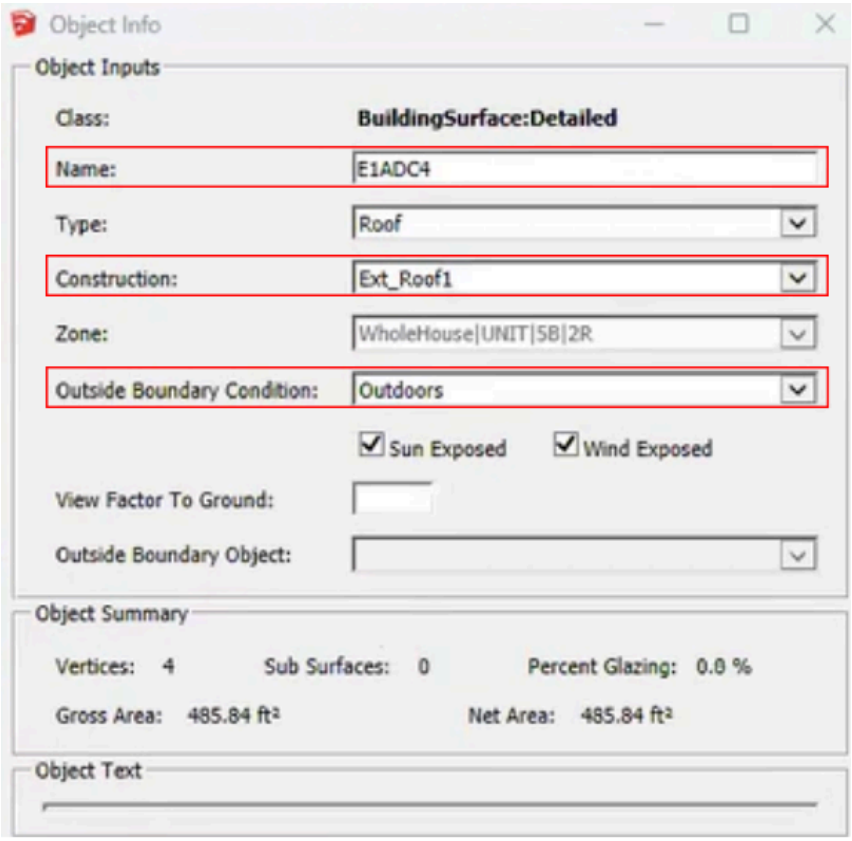
Once the steps above are complete, refer to the following training video for guidance on building geometry in SketchUp: Euclid Geometry Input. Make sure to create a new zone to draw the geometry in before getting started:

Process Tip: Use the same protocol for modeling geometry as required for WUFI passive.

Naming Conventions & Tagging

After the geometry is modeled, the following parameters must be assigned for all surfaces in the model using the Energy+ Object Info viewer. Review the sections that follow for guidance.





Name

This input only needs to be modified for foundation interfaces, and the overall zone.

Process Tip: It is best practice to name the other surfaces with a unique identifier for cases where the detailed results will be looked at so that the surfaces are easily identified.

Foundation Interface

For each piece of geometry in contact with the ground, the name MUST be either:

- Slab
- Basement
- Crawlspace

Overall Zone

The main Zone that contains the geometry must be named according to the following naming convention:

- UniqueZoneName|Space type|#B|#R
  - "UniqueZoneName" can be anything helpful to identify the zone being modeled (i.e. WholeHouse, Unit102, etc)
  - "SpaceType" MUST be either[2]:
    - UNIT
    - CORRIDOR
  - #B - Replace # with the quantity of bedrooms
  - #R - Replace # with the quantity of bathrooms

Process Tip: There should be NO spaces in any of the naming conventions. CamelCase[3] is recommended to maintain readability. The vertical lines must be included. You may copy and paste the example below, then modify it to suit your specific project.

Example: A single family project names the modeled zone:

- SampleHouse|UNIT|2B|2R

Type

This information will be automatically pulled in based on the modeled geometry. Do not modify this input unless the plugin fails to correctly identify the surface type (i.e. if a wall is set to 'roof' as the type).

Construction

Choose the construction tag from the built-in options. Multiple construction types can be assigned when multiple assemblies exist. The runlist will assign the specific assembly called from the database to each of these tags.

Example: A project has a combination of fixed and operable glazing types. In the geometry, the fixed windows could be assigned as 'Ext_Window1', the operable windows as 'Ext_Window2' and glazed doors as 'Ext_Window3'.

Outside Boundary Condition

Select the appropriate boundary condition for each modeled component. In general, the only options that should be used are:

- Adiabatic
  - Used when in contact with adjacent conditioned space that is not being certified
- Surface
  - Used when in contact with an adjacent zone that is being certified
- Outdoors
  - Used when in contact with outer air
- Foundation
  - Single family & Small multifamily ONLY (6-flat / 3 stories or smaller)
  - Used for all components in contact with the ground
- Ground
  - Larger buildings w/ multiple zones

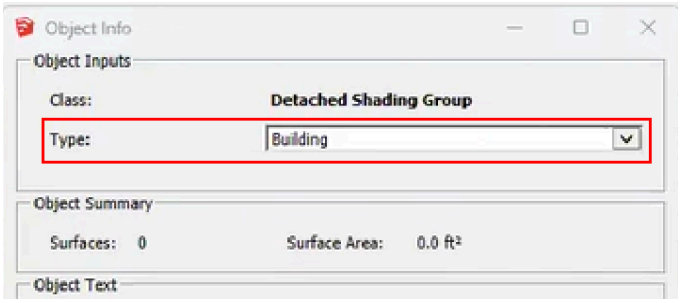
[2] REVIVEcac v24.2.0 only. More space types will be added as the tool is developed further

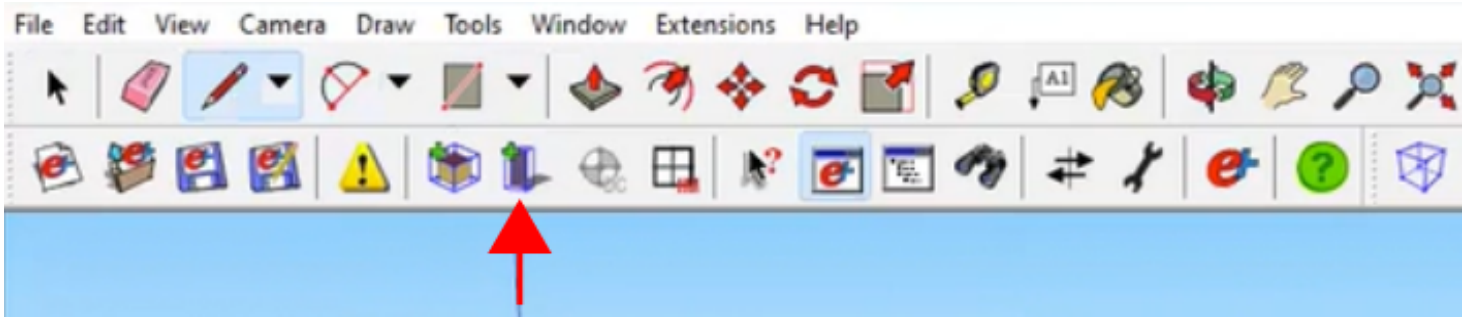
[3] A style of naming convention where each new word is capitalized with no spaces in between them.

- Used for all components in contact with the ground

Shading

Detached shading groups can be added to draw building shading and site context. These elements should be modeled as separate groups and assigned to their corresponding 'Type' in the Energy+ Object Info viewer (i.e. window overhangs = 'Building', trees/adjacent structures = 'Site').

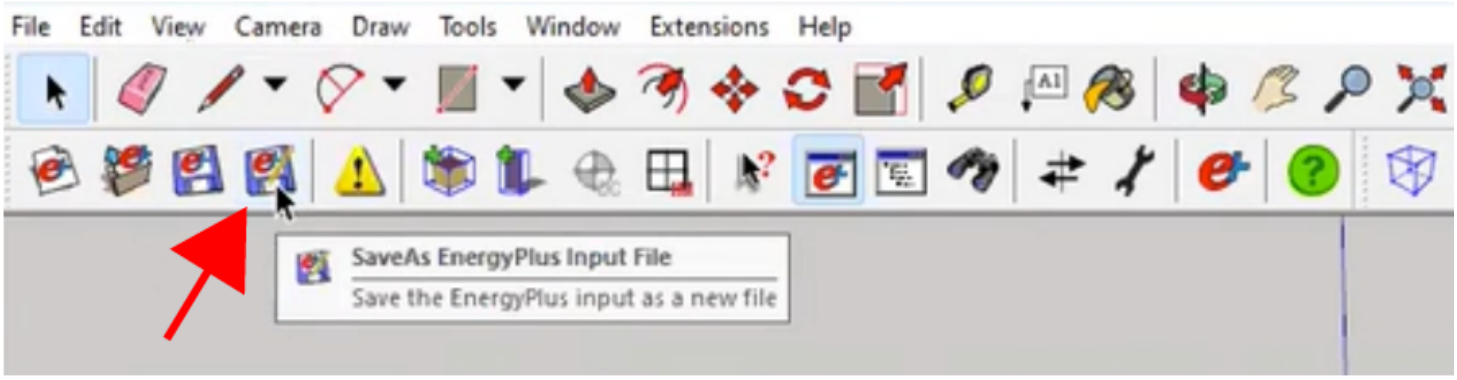




Process Tip: This feature eliminates the need to add the 1" gap between pieces of geometry, which is typically necessary for successful geometry importing in WUFI Passive.

Saving the Geometry File

When the model is complete, save it as an 'EnergyPlus Input File'.



Process Tip: When naming the file, ".idf" must be manually added to the end of the naming convention. Save the file to the REVIVEcalc folder that was created when Getting Started.

Databases

All database files are contained in the "Databases.zip" folder that was downloaded from the Asset Library previously. This folder contains .csv files, some of which are static, and others that are user-editable to create fine-tuned custom scenarios. Refer to the following training video for guidance:

- User Editable Databases

Process Tip: All databases should be kept in a folder following the same format as the one downloaded (i.e. do NOT move files within or outside of the folder). The individual databases can be modified as needed within the folder. The folder will initially download as a .zip file. After downloading, extract the entire folder to the REVIVEcalc folder that was created when Getting Started.

User Editable Databases (Editing optional)

Carbon Correction Database

This database accounts for any physical carbon correction factors applied to the project (hard costs). This includes the Level 2 embodied carbon measure required per Section 6.5.2.2 of the Phius REVIVE 2024 Standard. The main carbon correction factors include:

- Embodied decarbonization measures
    - Business practice change
    - Personal (owner) lifestyle change

Example: A project team chooses to use a solar generator rather than a gas generator during construction. The estimated carbon savings can be calculated and entered here.

Required Fields

Unique name

Enter a unique name for each Carbon Correction item (i.e. HP Replace 1, Solar Generator, etc.)

Year

Enter the number of years post-retrofit that the embodied carbon measure will be implemented. This value should NOT exceed the Simulation Duration (70 years for Phius certification)

Cost ($)

The total cost of the Carbon Correction item (including hard and soft costs). The entered value should either be positive or negative to represent either:

- (+) Estimated cost of service OR
- (-) Estimated savings (as a result of the chosen L2 embodied carbon measure)

Carbon emissions (kg CO_2)

REVIVEcalc v24.2.0 does not currently account for this entry. Pending future updates to the tool.

The estimated CO_2 emissions or savings for each Carbon Correction item. The entered value should either be positive or negative to represent either:

- *(+) Estimated carbon emissions OR*
- *(-) Estimated carbon savings (as a result of the chosen L2 embodied carbon measure)*

Country

Define the country in which the project is located. USA is the default.

Labor fraction

The percentage of total cost (defined above) that will go towards labor.

- For projects in the US, a default of 0.4 may be used for any items that will incur additional cost for labor (i.e equipment replacement)

- Business practice changes that do not have a labor cost associated with them (i.e. Vegan bike riding carpenters) should use a default of 1

Process Tip: Negative costs can represent practices that reduce emissions (L2 embodied carbon measures), while positive costs represent additional emissions (regular equipment replacement).

Nonperformance Carbon Correction Database

This database accounts for any non-physical carbon correction factors applied to the project (soft costs). This could include costs associated with consulting or commissioning fees. All required inputs are identical to those defined in the Carbon Correction Database above.

Window Database

Defines the inputs for windows used in the project. For REVIVEcalc v24.2.0, these values should represent the whole-window performance at NFRC standard size[4]. The required inputs are as follows:

- Unique name (i.e. Casement Window Option 1)
- U-Factor [$W/m^2°K$]
- SHGC [0.0 < 1.0]

Material Database

Contains all of the materials used to build out opaque assemblies in the Construction Database. Each material entered into this database needs the following information to be valid. All inputs are in SI units.

Required Fields

Unique Name

Each material should be given a unique name that makes the material easy to quickly identify (i.e. EPS 2in, EPS 4in, FG Attic R-19, etc.)

Roughness

Use the default database information when creating unique materials (if needed). This is an EnergyPlus text input used in convective heat transfer calculations. The options are as follows:

- “VeryRough”
- “Rough”
- “MediumRough”
- “MediumSmooth”
- “Smooth”
- “VerySmooth”

Thickness [m]

The thickness of the material in meters

Conductivity [W/m°K]

The conductivity of the material in W/m°K

[4]If windows in the project vary greatly from the NFRC standard size, an additional calculation must be completed to determine the U-factor and SHGC of the specific window.

Density[5] [kg/m^3]

The density of the material in kg/m^3

Specific heat capacity[3] (J/kgK)

The density of the material in kg/m^3

Process Tip: If multiple thicknesses of the same material are used for different assemblies, each will require its own unique material. Similarly, if the same insulation type has varying conductivities, densities, or specific heat capacities depending on the application, unique assemblies should be made for each unique case. The default database already defines most typical materials, including their respective 'roughness'. Review the entire list before deciding whether a new material must be made. Cladding materials SHOULD be included, as Energy+ uses them to calculate solar gains on the envelope.

Example 1: A 1" thick layer of EPS would be a material with a thickness of 0.0254 m

- If a separate 4" thick layer of EPS is used elsewhere in the project, a unique material must be created within the Material Database with its respective thickness (0.1016 m)

Example 2: A datasheet for cellulose specifies different conductivities for wall applications (i.e. dense-pack) vs. roof applications (i.e. blown-in). Two different layers for cellulose should be included in the database with their respective conductivities and densities. Remember to assign a unique name that clearly identifies the application for each material.

Construction Database

Defines information about the envelope, including all assemblies, glazing units, and airtightness, as well as appliance and lighting loads, and mechanical and renewable systems. The default database already contains a variety of typical options. Review the entire list before deciding whether a unique entry must be created.

Assemblies

Required Fields

Unique Name - Column B:

Each assembly should have be given a unique name that makes it easy to quickly identify (i.e. Ext wall type 1A, Slab on grade, Basement slab, etc.)

Type - Column C:

The component type must be defined for each assembly. The naming convention must align with the component Type within the project geometry file. The options are:

- Roof
- Exterior Wall
- Exterior Floor
- Interior Floor
- Exterior Door
- Window
- Thermal Mass

CO_2e Per Area [kg/m^2] - Column D:

[5]Used to calculate the overall thermal mass of the project. Can use data from technical datasheets, or database defaults. The ASHRAE Handbook of Fundamentals contains a comprehensive material database.

REVIVEcalc v24.2.0 does not currently account for this entry. Pending Phuture updates to the tool.
Use the BEAM Estimator to determine the estimated carbon emissions for each defined assembly.

Cost Per Area [$/m^2] - Column E:
Develop an estimation for cost per square meter for each assembly. This could be done by the contractor, or by using online resources to research material costs within the project location. Make sure to document and save screenshots and external calculations for each assembly to verify the inputs in the construction database.

Assembly Layers (Outside Layer - Layer10) - Columns F-O:
Similar to WUFI Passive, opaque assembly layers must be input from outside to inside in homogenous layers. For glazing elements, only the 'Outside Layer' should be used. The entered layers will reference materials in both the Window Database and the Material Database. Information should ONLY be input for as many layers as required by the assembly. The rest should be left blank.

Process Tip: The naming convention for each layer in the construction database must match the corresponding material, or window, name as it appears in their respective databases. Use the copy+paste function when creating unique entries to ensure they match exactly. Cladding materials SHOULD be included, as Energy+ uses them to calculate solar gains on the envelope.

Lifetime - Column U:
The lifetime in years for each assembly before it must be replaced. Use the default database to determine these inputs when creating unique assemblies.

Labor Fraction - Column V:
Similar to the labor fraction defined in the Carbon Correction Database, the labor fraction represents the percentage of total cost estimated to go towards labor.

- For opaque assemblies, assume 0.3 as a default
- For glazing elements, assume 0.5 as a default

Air Sealing

Required Fields

Unique Name - Column B:
Multiple levels of air sealing can be entered to assess the impact of each. For each level, enter the numeric value that reflects the airtightness in **cfm50/ft^2(env.)**. At a minimum, two options should be defined:

- Existing airtightness (measured or estimated)
- Target airtightness

Other recommended options include:

- Phius CORE Prescriptive airtightness (0.04 cfm50/sf)
- Phius CORE 2024 New Construction airtightness (0.06 cfm50/sf)
- IECC 2021 Required airtightness (varies by project climate zone. These requirements are in ACH50 and will need to be converted.)

Type - Column C:
The type should always be defined as "Air Sealing".

Air Sealing Cost [$/ft^2] - Column P:

For each level of airtightness, enter the estimated **cost/ft^2(iCFA)**.

Process Tip: Get an estimate from the project contractor or other experienced professional, or use the default database estimates until actual construction costs are available. DO NOT enter a labor fraction for air sealing.

Appliances & Lighting Loads

Required Fields

Unique Name - Column B:

Enter the appliance name followed by the energy consumption in kWh/yr (i.e. DISHWASHER 269). For lights, enter use the fraction of high efficiency.[6]

Type - Column C:

Enter the general appliance / load type. The options are:

- Fridge
- Dishwasher
- Clotheswasher
- Clothesdryer
- Range
- Lights

Mechanical Cost [$/W] - Column S:

Enter the total cost in dollars per Watt, including soft costs (labor).

Appliance Rating [kWh/yr OR Fraction of high efficiency] - Columns S-T:

Enter the energy consumption of each appliance in kWh/yr. For lighting, enter the fraction of high efficiency.

Lifetime - Column U:

Enter the estimated lifetime for each appliance or lighting entry. Use the values in the default database.

Labor Fraction - Column V:

Enter the estimated labor fraction for the installation of each appliance. Use the values in the default database until actual implementation costs are available.

Mechanical Systems

Required Fields

Unique Name - Column B:

Enter a unique name for each mechanical device that covers:

- Heating/cooling
- Domestic hot water
- Mechanical ventilation

Process Tip: Create line items for the baseline existing systems first (if applicable). Then, enter the various upgrade options.

Type - Column C:

Enter the device type according to the following options:

- Mechanical

[6] LED lighting = 1; Standard non-LED lighting (i.e. incandescent) = 0.6

- DHW

Mechanical Cost - Column S:
Enter the total cost of the system, including soft costs (labor).

Lifetime - Column U:
Enter the estimated lifetime of the device. Use the values in the default database.

Labor Fraction - Column V:
Enter the estimated labor fraction for each system. Use the values in the default database until actual implementation costs are available.

Renewables & Battery Storage

Required Fields

Unique Name - Column B:
Enter the unique name of the renewable system's components (i.e. Onsite PV, Battery storage, etc.).

Battery Cost [$/kWh] / PV Cost [$/W]- Columns Q / R:
Enter the cost of the battery backup (if applicable) in dollars per kWh. For PV, enter the cost in dollars per Watt. Include soft costs (labor) for both.

Lifetime - Column U:
Enter the estimated lifetime for the batteries and PV modules. Use the values in the default database.

Labor Fraction - Column V:
Enter the estimated labor fraction for the installation of the batteries and PV modules. Use the values in the default database until actual implementation costs are available.

Static Databases (Do NOT Edit)

Cambium Factors

This is related to the annual carbon emissions calculations for electricity. These files contain the hourly emissions factors for each of the grid regions[7]. All years between 2023 and 2111 are included in this folder.

Country Emission Database

This database contains the emissions from various countries around the world. Labor costs and emissions costs for different products will be referenced.

Weather Data Database

There are two types of weather files required. Both are referenced in the Runlist for each case:

1. .epw files contain the annual data
2. .ddy files contain the design day information (for system sizing)

Climate Data & Weather Morphing

The weather morphing factors are based on historical returns within the Energy+ (.epw) weather file. The primary climate data in this file contains monthly data based on the most "average" month in the last 30

[7]Calculated using the Cambium tool from the National Renewable Energy Laboratory for each year

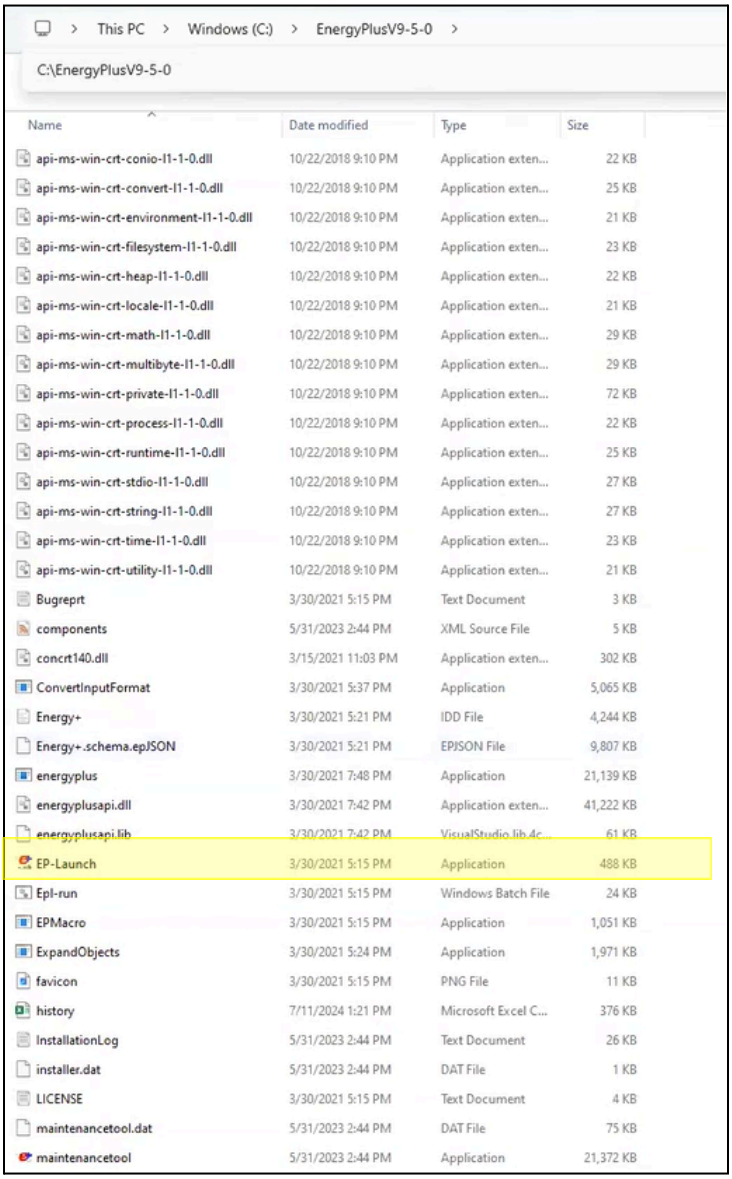
years (i.e. January 2002, February 1997, etc.). Because this data doesn't include historical extreme periods, the following Weather Morphing Protocol must be used in order for the tool to appropriately assess resilience during the winter and summer Outage periods. Follow the steps below to complete the 'Weather Morphing' tab in REVIVEcalc. Refer to the following training video for additional guidance:

- Weather Morphing

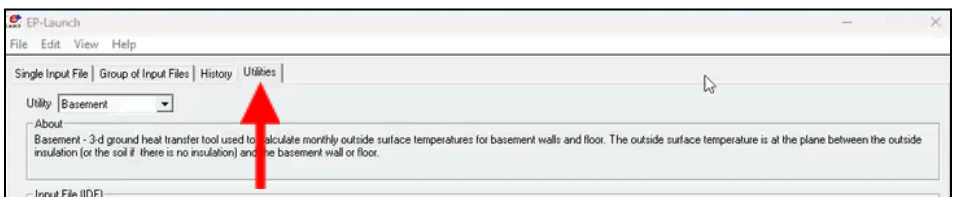
IMPORTANT NOTE: It is the intention of Phius to provide project teams with the morph factors along with the necessary climate data files for use in REVIVEcalc. If the morph factors were given or are already known, skip to Runlist. The following sections describe the process of acquiring the morph factors for a specific location.

Converting EPW Data to .STAT & .CSV Files

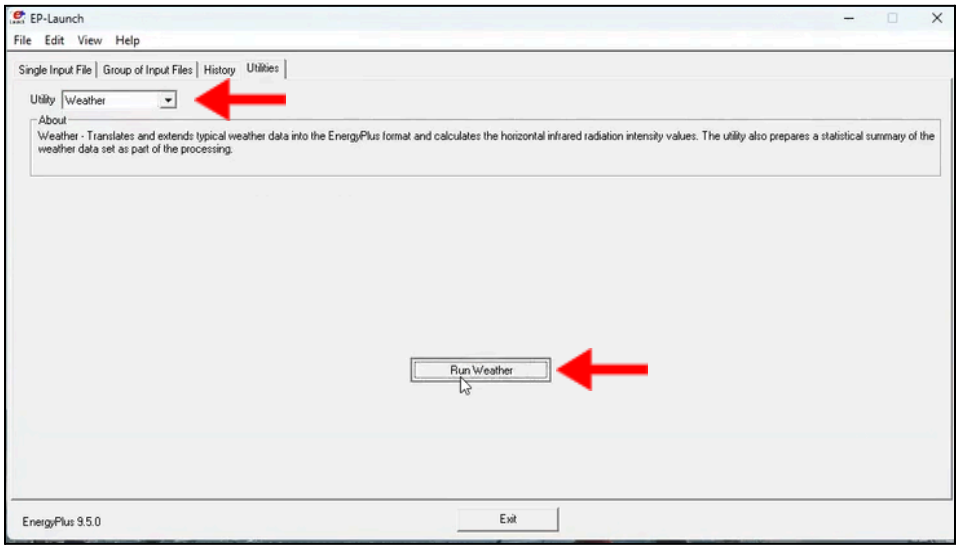
Step 1: Launch Energy+ by locating the 'EP-launch' Application. It is located within the 'EnergyPlusV9-5-0' folder that was created when E+ was installed when Getting Started.



Step 2: Navigate to the 'Utilities' tab in Energy+

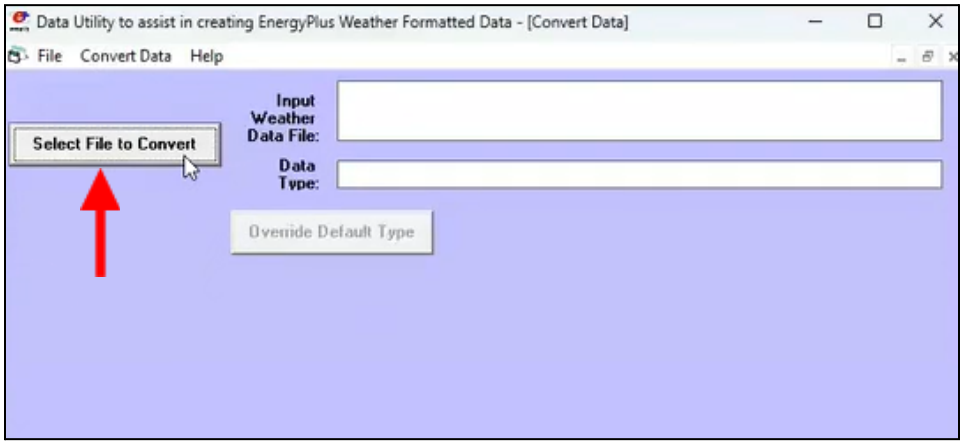


Step 3: Select 'Weather' from the Utility dropdown options. Click 'Run weather' when it appears to launch the file converter

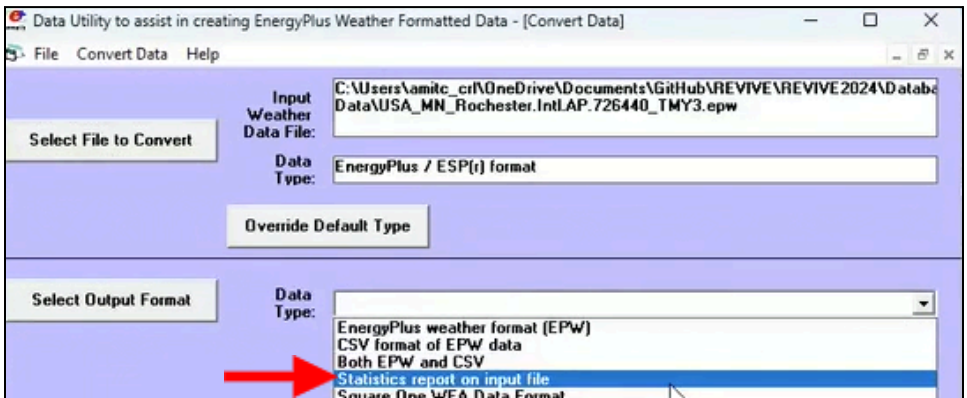


Step 4: Click 'Select File to Convert'. Navigate to the [Weather Data Database] folder on your device and locate the EPW file for the project location.

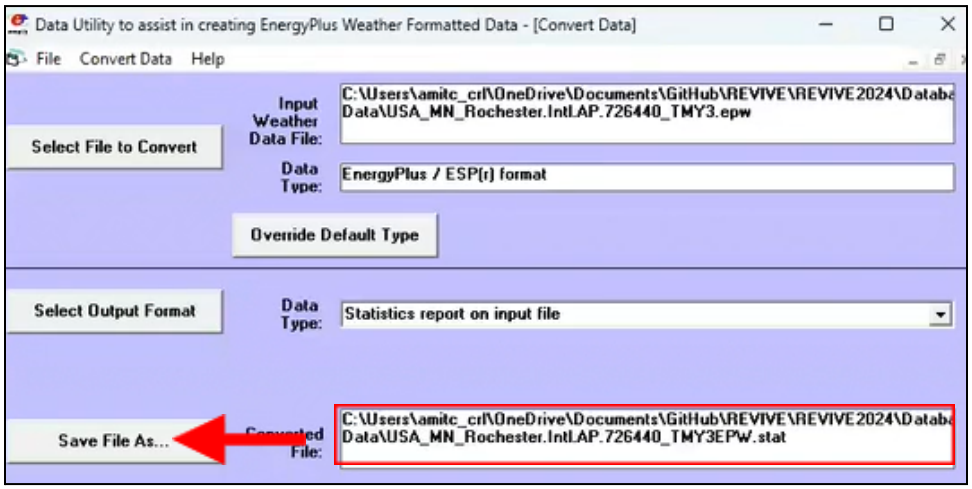
Process Tip: The weather station of the climate dataset used must fall within 50 linear miles AND 400' in elevation of the project location.



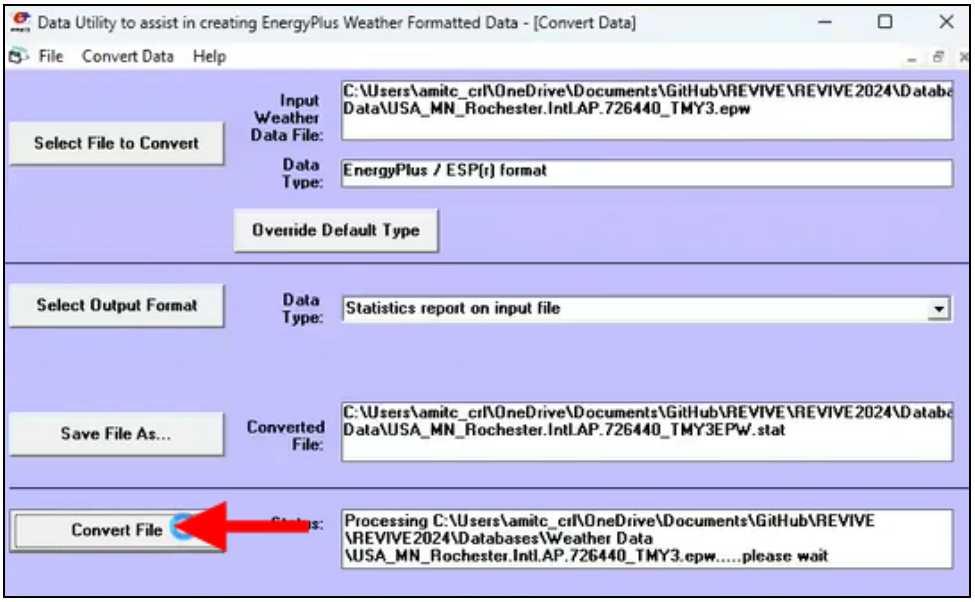
Step 5: Select the Output Format by selecting 'Statistics report on input file' from the dropdown associated with 'Data Type'



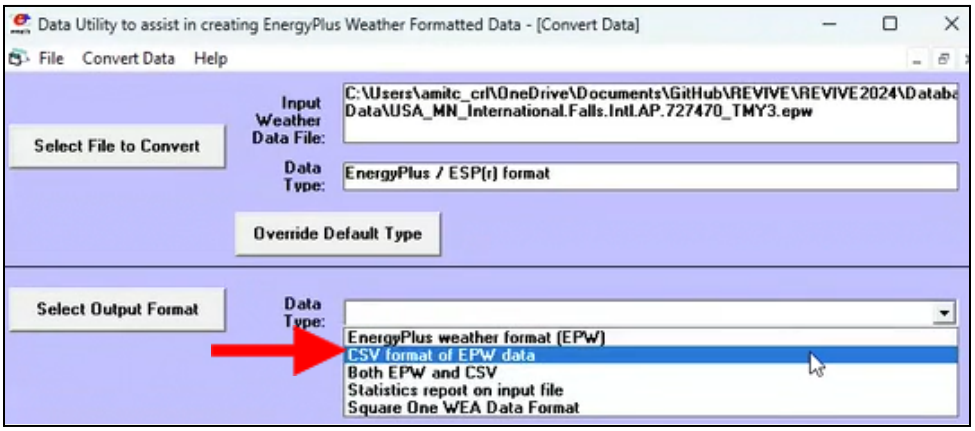
Step 6: Use the 'Save File As…" button that will appear after the output format is defined. Navigate back to the Weather Data Database and click 'Open' in the bottom right corner for the file explorer. The file path will populate in corresponding field in Energy+



Step 7: Click 'Convert File' once the button appears after defining the file path in the previous step.

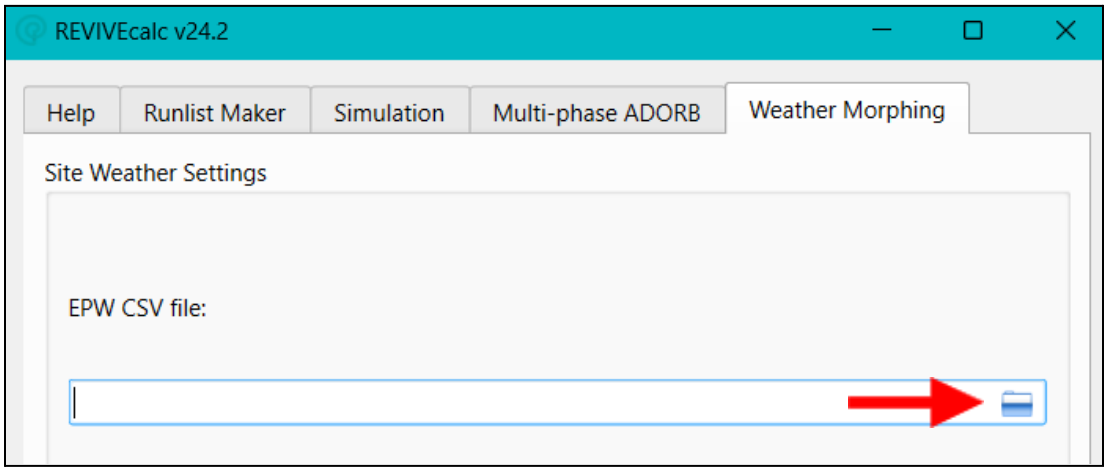


Step 8: The .STAT file is now complete. For the .CSV file, repeat Steps 1-7 **except** for Step 6, the 'Output Format' will be 'CSV format of EPW data'.



Process Tip: Launch REVIVEcalc now if it is not already open, as the remaining steps pertain to completing the necessary inputs within the tool for successful simulation.

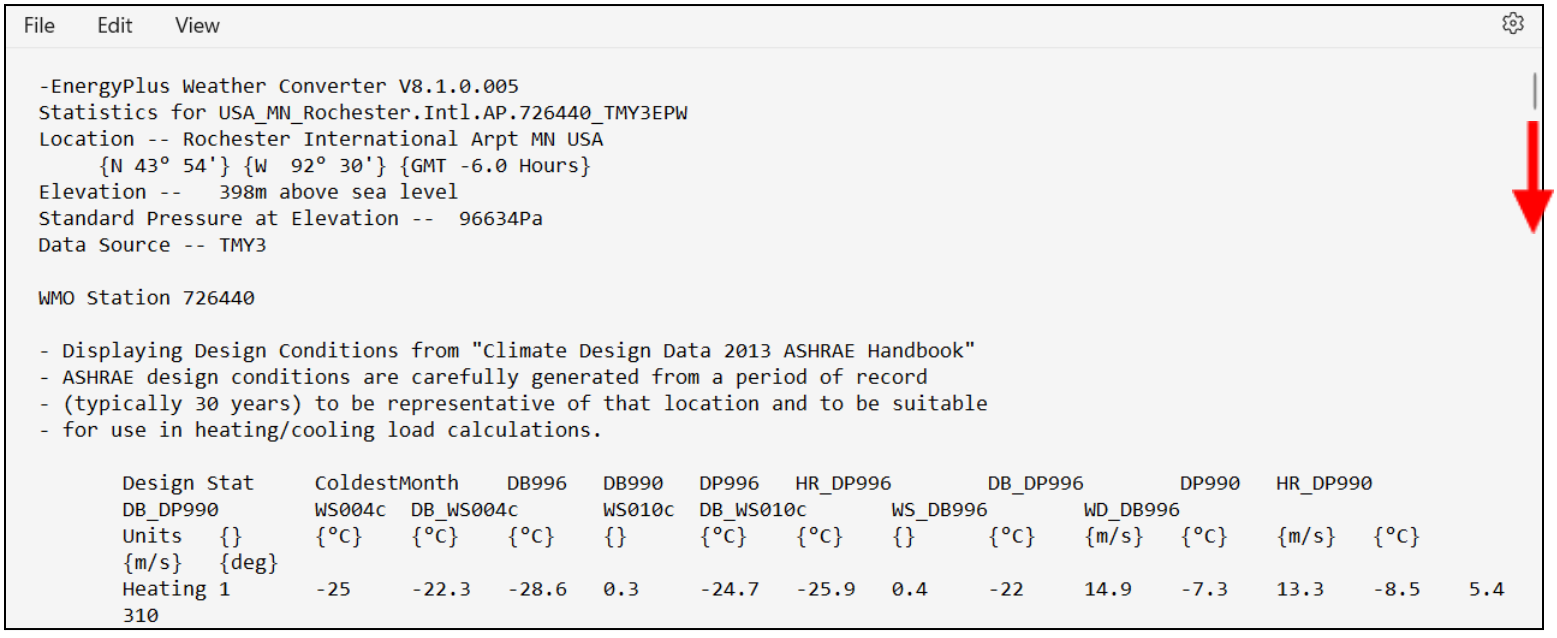
Step 9: Navigate to the 'Weather Morphing' tab of REVIVEcalc. Use the folder icon under 'EPS CSV file' to load the .CSV file that was created in the steps above. This file should be located in the Weather Data Database.

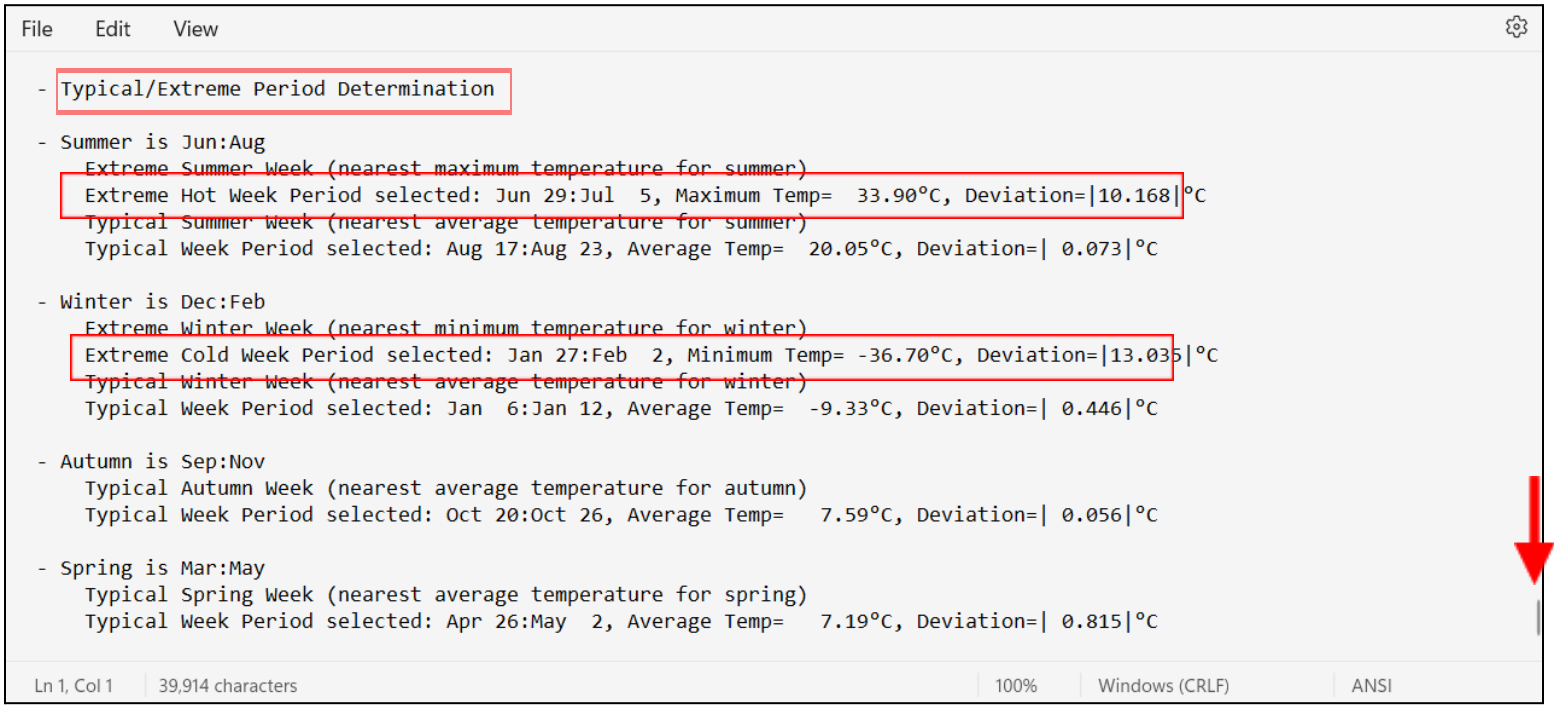


Winter & Summer Outage Start Dates

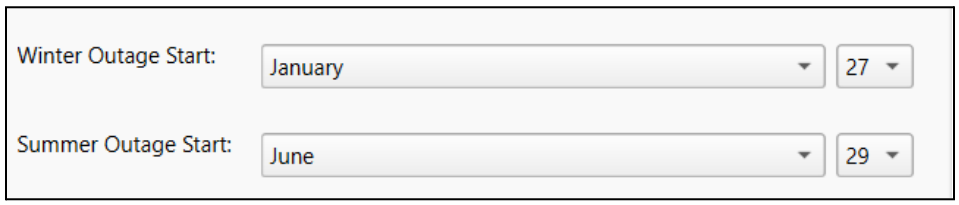
Step 1: Navigate to and open the .STAT file that was created in the steps above. The file will open in a text editor or coding tool (if you don't have a specific text editor installed, open the file in 'Notepad' when prompted)

Step 2: Scroll to the bottom of the file to the 'Typical/Extreme Period Determination'





Step 3: Define the Winter and Summer Outage start dates in the 'Weather Morphing' tab of REVIVEcalc using the dates for 'Extreme Hot Week' and 'Extreme Cold Week' as shown above and below. Only the start date of each outage period is required.

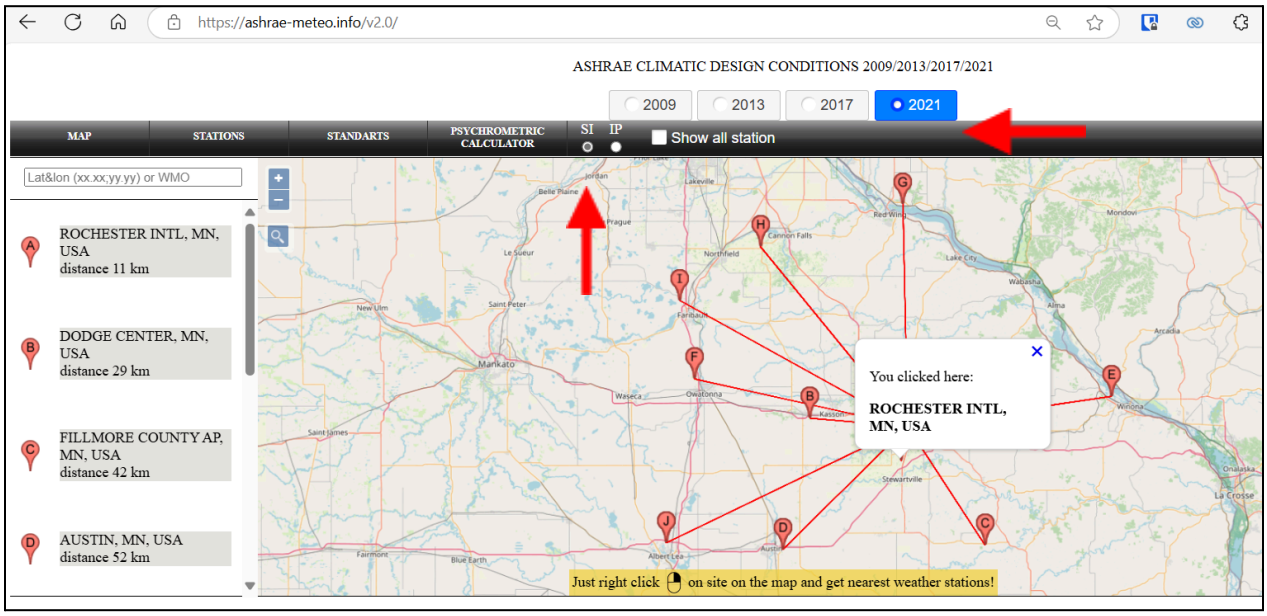


Winter & Summer Extreme Temperatures

Step 1: Navigate to the project's climate data location using the following tool:

- ASHRAE climatic design conditions 2009/2013/2017/2021

Process Tip: Make sure the tool is set to SI units and that the most recent data is being used (currently 2021).



Step 2: Scroll down to view the numeric data and locate the 'Extreme Annual Design Conditions' section. Also take note of the elevation of the dataset (in meters), which will be needed in **Step 4** below.

2021 ASHRAE Handbook - Foundamentals (SI)

ROCHESTER INTL, MN, USA (WMO: 726440)

Lat:**43.904N** Long:**92.492W** Elev:**398** StdP: **96.64** Time zone:**-6.00 (NAC)** Period:**94-19** WBAN:**14925** Climate zone:**6A**

Annual Heating, Humidification, and Ventilation Design Conditions

Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB		WSF
			99.6%			99%			0.4%		1%				
	99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD	
1	-24.9	-22.3	-28.3	0.3	-24.5	-25.8	0.4	-21.9	14.2	-10.6	12.7	-9.0	5.0	310	0.645

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB	
		0.4%		1%		2%		0.4%		1%		2%			
		DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD
7	10.1	31.0	23.1	29.3	22.1	27.9	21.4	25.0	29.0	23.7	27.7	22.7	26.5	6.1	200

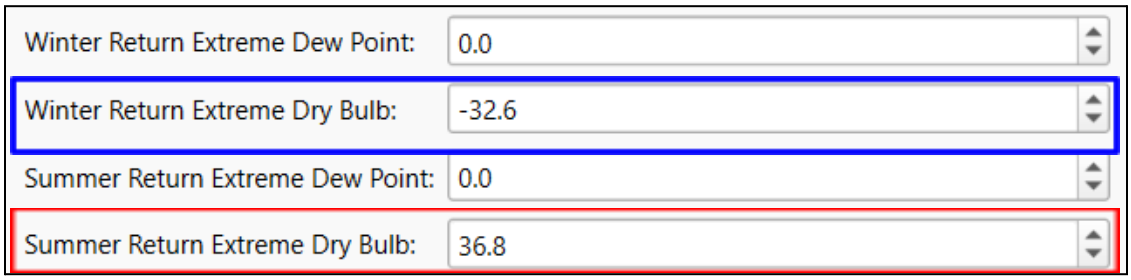
Dehumidification DP/MCDB and HR									Enthalpy/MCDB						Extreme Max WB
0.4%			1%			2%			0.4%		1%		2%		
DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB	
23.6	19.4	27.8	22.4	17.9	26.5	21.3	16.8	25.3	78.1	29.0	73.0	27.7	68.9	26.4	29.5

Extreme Annual Design Conditions

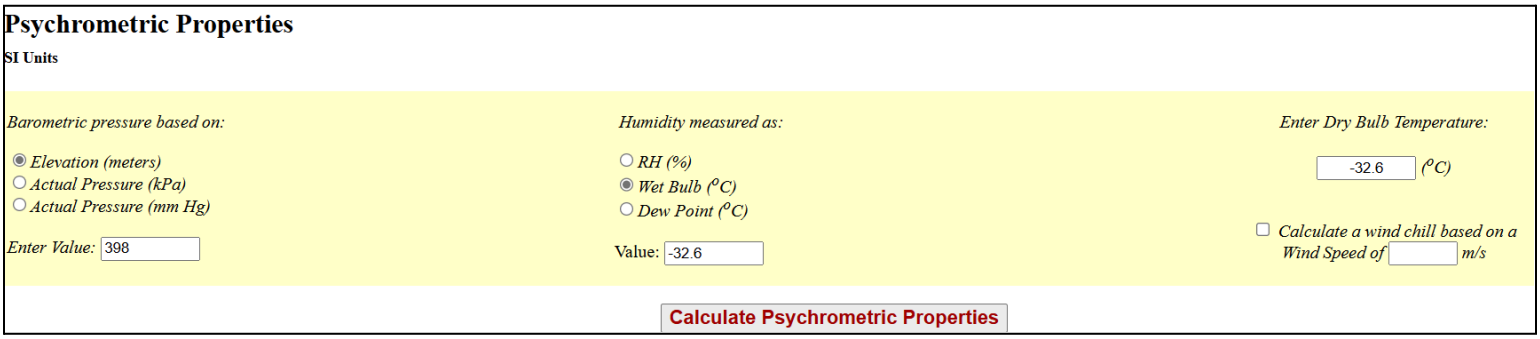
Extreme Annual WS				Extreme Annual Temperature				n-Year Return Period Values of Extreme Temperature							
				Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years	
1%	2.5%	5%		Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
12.5	11.2	10.1	DB	-28.5	33.7	3.2	1.6	-30.8	34.9	-32.6	35.9	-34.4	36.8	-36.8	38.0
			WB	-28.5	26.6	2.9	1.2	-30.6	27.5	-32.3	28.2	-34.0	28.9	-36.1	29.7

Step 3: In REVIVEcalc, input the 10-year return dry bulb temperature for winter, and 20-year return dry bulb temperature for summer as indicated below.

	Extreme Annual Temperature				n-Year Return Period Values of Extreme Temperature							
	Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
DB	-28.5	33.7	3.2	1.6	-30.8	34.9	-32.6	35.9	-34.4	36.8	-36.8	38.0
WB	-28.5	26.6	2.9	1.2	-30.6	27.5	-32.3	28.2	-34.0	28.9	-36.1	29.7

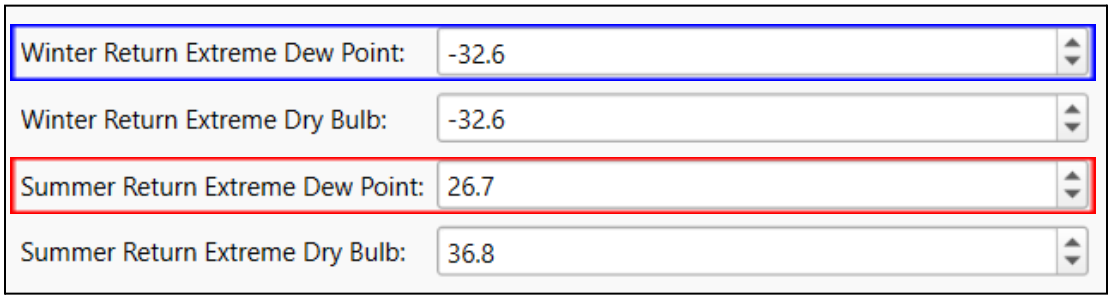


Step 4: Use the following tool to calculate the dew point based on the wet bulb and dry bulb temperatures for input in REVIVE calc: [On-Line Psychrometrics - SI]. The calculation requires input of the project elevation as noted in **Step 2**, as well as the DB and WB temperatures shown in **Step 3** above for the 10-year and 20-year winter and summer returns. Hit 'Calculate Psychrometric Properties' once all required inputs are complete. Note that this calculation must be run twice - once with winter temps, and once with summer temps.



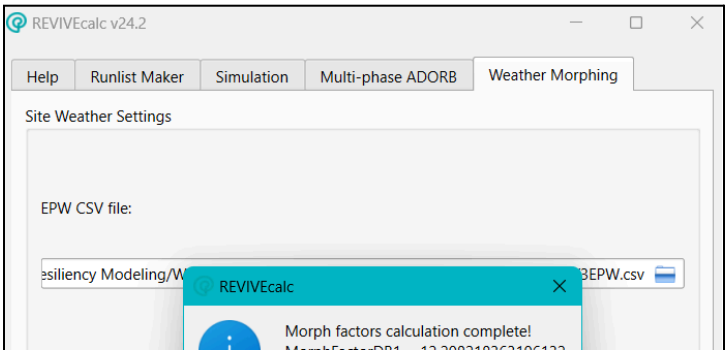
Process Tip: An error will occur if the Wet Bulb temperature is *greater than* the dry bulb temperature. Results will not populate. In this event, set the Wet Bulb temperature to be *equal to* the dry bulb temperature, as shown in the example above.

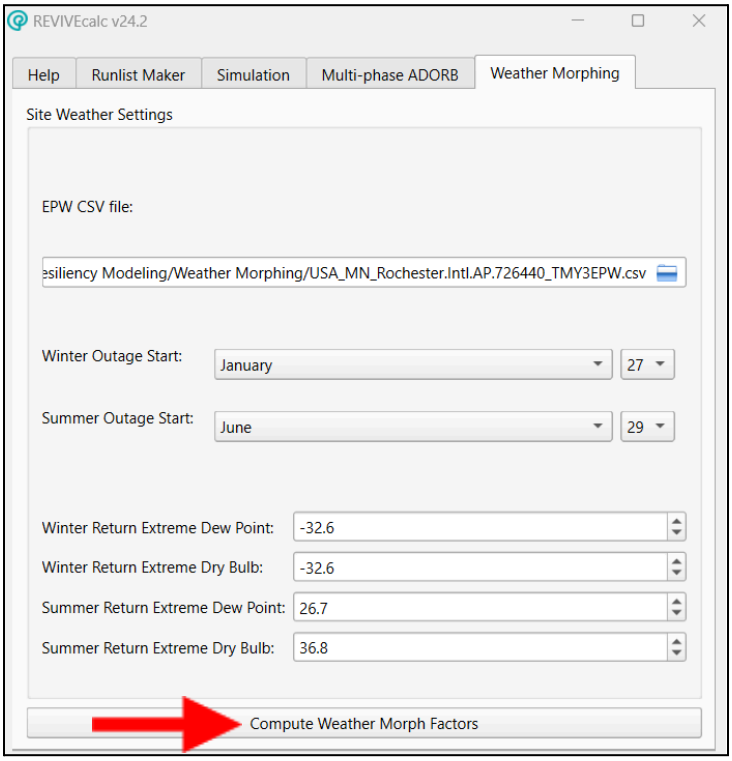
Step 5: Enter the calculated 'Dew Point' temperatures into the corresponding fields in REVIVEcalc.



Save the Morph Factors

Once all of the steps above are complete, hit the button for 'Compute Weather Morph Factors'. A pop-up window will appear with four (4) morph factors. Take a screenshot of the calculated values and save it to a memorable location as they will be needed later when setting up the [Runlist].




REVIVEcalc v24.2
Help
Runlist Maker
Simulation
Multi-phase ADORB
Weather Morphing
Site Weather Settings
EPW CSV file:
esiliency Modeling/Weather Morphing/USA_MN_Rochester.Intl.AP.726440_TMY3EPW.csv
Winter Outage Start:
January
27
Summer Outage Start:
June
29
Winter Return Extreme Dew Point:
-32.6
Winter Return Extreme Dry Bulb:
-32.6
Summer Return Extreme Dew Point:
26.7
Summer Return Extreme Dry Bulb:
36.8
Compute Weather Morph Factors

Runlist Maker

The Runlist is a .csv[8] file that contains all unique modeled cases in one-case-per row. To simplify the creation of the runlist, REVIVEcalc v24.2.0 is fitted out with a Runlist Maker that compiles project-specific information into unique cases to be assessed during Simulation. During simulation, the tool will automatically run all of the cases in the runlist, allowing for rapid parametric simulation of different cases. Refer to the following training video for additional guidance:

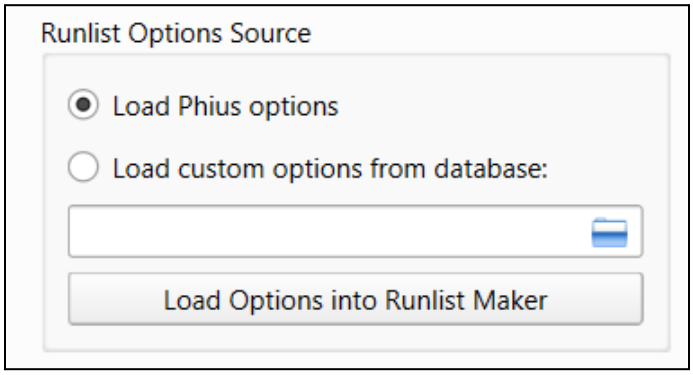
- Runlist Maker

Process Tip: Think of the Runlist Maker similar to the WUFI tree. Work through the 'Navigation' list from top to bottom until all fields are complete. All required fields are described in detail in the sections that follow.

Runlist Options Source

If any of the User Editable Databases were modified, select 'Load custom options from database' and use the folder icon to load in the customized databases. Otherwise, leave the selection set to 'Load Phius options' to use default typical inputs. Once the appropriate source is defined, click 'Load Options into Runlist Maker'.

A popup window will appear if the options were successfully loaded. Click 'Ok' when prompted.



General

Case Name

Use "BASE" in **all caps** at the beginning of the naming convention for the **baseline case** for the project as shown below. This case is required for the comparison of the project baseline to different retrofit upgrade options and should be modeled to reflect the existing conditions of the project.

- BASE-*Baseline Case*

All additional cases should be given a unique naming convention. It is best practice to name the cases in alignment with something that uniquely identifies them.

Example: The following list demonstrates possible case names for assessing the Retrofit Package Tier options according to Informative Appendix P of the Phius REVIVE 2024 Standard. Please note that these tiers are recommended starting-points for the modeling process, and are not limiting options.

- BASE-Baseline Case
- C1-Equipment Swap-outs
- C2-Lite Envelope
- C3-IECC Envelope
- C4-Phius Envelope

[8] A .csv file is a "comma-separated value" file; a common output for spreadsheet programs that contains input data separated by commas. The file can be viewed in a simplified format if opened using any spreadsheet application.

Geometry File

Use the folder icon to load in the .idf file that was created while Saving the Geometry File. In retrofit scenarios where an addition or conversion is planned, at least two geometry files should be created. Make sure to select the baseline geometry to model the baseline case, and the post-retrofit geometry for other cases.

Simulation Duration

Enter 70 years for the duration for certification purposes. This is needed for the life cycle cost analysis

Site

EPW File

Use the folder icon to load in the .epw file provided by Phius for certification. The file must be located in the "Weather Data Database" folder

DDY File

Use the folder icon to load in the .epw file provided by Phius for certification. The file must be located in the "Weather Data Database" folder

Morph Factors

If morph factors were not provided by Phius, refer to Climate Data & Weather Morphing above for guidance on how to acquire them. Round inputs to the nearest tenth of a degree.

Morph Factor 1 - Dry Bulb [°C]:

Enter the dry bulb morph factor for the Winter outage

Morph Factor 1 - Dewpoint [°C]:

Enter the dewpoint morph factor for the Winter outage

Morph Factor 2 - Dry Bulb [°C]:

Enter the dry bulb morph factor for the Summer outage

Morph Factor 2 - Dewpoint [°C]:

Enter the dewpoint morph factor for the Summer outage

Site Country:

Select the country in which the project is going to be built from the dropdown menu

Grid Region:[9]

Define the grid region according to the map below, which is related to the Cambium factors. If working outside the 48 contiguous states, select the option that most closely matches the grid mix of the project site (visit link below for more information on the GEA regions).

[9] NREL Cambium workbook (LRMER) for GEA regions

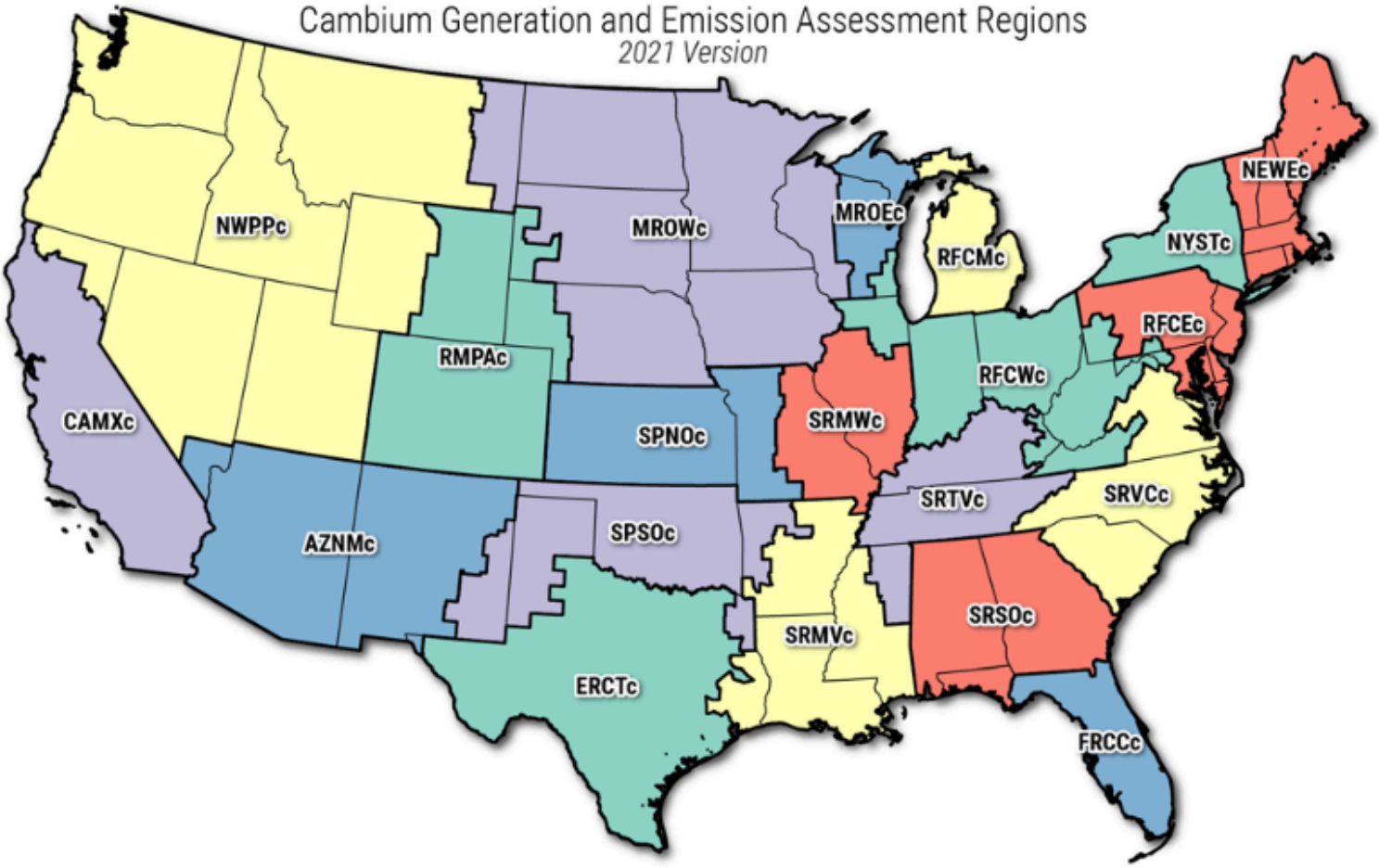


Figure 6. Cambium's generation and emission assessment (GEA) regions

Envelope Labor Fraction

Enter 40% as a default. This is the estimated % of total cost of envelope upgrades that will go towards labor. An actual value can be calculated and defined once envelope upgrades are implemented.

Performance Carbon Correction Measure

Select 'Add Performance Carbon Correction' and define the carbon correction to be applied (if applicable). See Carbon Correction Database above for detailed information on these inputs.

Non-Performance Carbon Correction Measure

Select 'Add Non-Performance Carbon Correction' and define the carbon correction to be applied (if applicable). See Carbon Correction Database above for detailed information on these inputs.

Energy Economics

The following inputs for energy economics are used in the ADORB cost as a basis to estimate lifetime operational cost.

Electricity Price [$/kWh]:

Enter the marginal electric rate for the location. Do not include fixed charges (static utility fees)

Electricity Sell-back Price [$/kWh]:

Enter the price which the utility purchases electricity that is sold back from the grid (if applicable)

☐ Natural Gas Present:

Check this box if there is natural gas used in this case of the project.

Natural Gas Price [$/Therm]:

If the box above is checked, enter the marginal natural gas price for the location. Do not include fixed charges (static utility fees).

Annual Electricity Fixed Charge [$]:

Enter the annual fixed electrical charge for the location.

Annual Natural Gas Fixed Charge [$]:

Enter the annual fixed natural gas charge for location (if applicable).

Mechanicals

The mechanical inputs are to approximate the systems that exist in the building or are installed. Similar to WUFI Passive, the equipment types are predefined, and can be selected from the menu. System efficiencies need to be input as outlined in the sections that follow.

Ventilation system:

Select the ventilation system type from the options in the dropdown menu listed below:

Balanced

This setting will assume the installation of either an ERV or HRV

Exhaust:

This setting will assume 50 cfm exhaust from the bathrooms with an estimated run time of 30 minutes (per bathroom) at 6:00 AM and 6:00 PM.

Water Heater Fuel Type:

Select the water heater fuel type from the available dropdown options:

- DHW_Electricity
- DHW_NaturalGas

Mechanical System Type:

Select the mechanical system type from the available dropdown options:

- Packaged Terminal Heat Pump (PTHP)
- Gas furnace with DX cooling
- Mini-split heat pump

Coefficient of Performance (COP):

Input the annual coefficient of performance (COP) for the heating and cooling systems applied to the project.

Furnaces

Enter the efficiency as a decimal according to the AFUE of the system. (70% baseline if unknown)

Example: A furnace with an 80% AFUE would have a COP of 0.80.

Sensible and Latent Recovery Efficiencies:

If modeling a balanced ventilation system with an E/HRV, enter the sensible and latent recovery efficiencies.

- The upper limit is 1.0.
- Enter 0.0 for the latent efficiency to model an HRV

If an exhaust-only system is modeled, leave both inputs at 0.

Photovoltaics:

REVIVEcalc v24.2.0 runs PVWatts 5.0 internally to calculate the hourly PV generation that is used in the model.

Process Tip: All projects must enter values regardless of whether a PV array is installed. See guidance below on default values to use if no PV system is installed.

Photovoltaics Size [W]:

Enter the size of the PV array on the project. Use 0.1 W for the sizing for a model with no PV installed

Photovoltaics tilt [deg]:

Enter the angle of the PV array

- 0° for a system that is flat on the roof
- 90° for a vertical system.

Photovoltaics Azimuth [deg]:

Enter the azimuth angle of the PV array,

- 180° for a system that faces South
- 0° for a system that faces North

Appliances

Select the appliances in the project from the available dropdown options that reference the Construction Database for efficiency ratings. These inputs are used to calculate the annual energy consumption per ANSI / RESNET 301-2014.

Envelope

The specific envelope components in the runlist are designed to reference the different assemblies in the database. The names entered in each of the different cells must match those in the construction database.

Operable Window Area [ft^2]:

Enter the glazing area per facade.

Process Tip: In future versions of the tool, this input will be entered as a percentage (in decimal form) of total glazing area in each direction

Chi-Value:

This value represents all of the thermal bridges in the project or zone being modeled. It is a SUMPRODUCT of all of the thermal bridge psi-values multiplied their length.

Example: A project has identified and calculated the following three thermal bridges:

- Perimeter TB = 0.1 Btu/hr.ft2.F; 120ft length
- Existing canopy TB = 0.05 Btu/hr.ft2.F; 20ft length
- Rim joist TBs = 0.01 Btu/hr.ft2.F; 360ft length

To calculate the Chi-value, multiply the TB psi-values by their length, and then add them all together:

- Perimeter = (0.1*120=**12**); Canopy = (0.05*20=**1**); Rim Joist = (0.01*360=**3.6**)
- **Total Chi-value:** 12 + 1 + 3.6 = **16.6**

Infiltration Rate:

Enter the infiltration rate for the project in terms of cfm/ft^2_{env} at 50Pa (same input as WUFI Passive)

Foundation Interface

Add all of the foundation conditions found in the project. Multiple may be defined if needed. The required fields for each foundation type are outlined in the sections that follow.

Interface

Select the foundation type from the available dropdown options

- Basement
- Crawlspace
- Slab (on grade)

Insulation

If applicable, define the type and thickness of any horizontal or vertical perimeter / stem-wall insulation from the available options (similar input as in WUFI Passive)

Perimeter [ft]:

Enter the perimeter length of each foundation type in feet based on the modeled geometry

Depth [ft]:

If applicable, enter the width or depth of perimeter insulation in feet

Fenestration

Windows

Define the window types in the project by selecting from the available options in the dropdown menu. This section should be used for all windows and doors with greater than 25% glazing area.

The list of available options will correspond to the assemblies within the Construction Database. The 'Window Type #' for each modeled window type must correspond with the construction tags assigned to the window components in the Geometry file.

Process Tip: The quantity of window types to be modeled is dependent on the quantity of unique window types in the project. All of the fenestration types modeled in REVIVEcalc must correspond with at least one geometry

component, otherwise it will not be accounted for. Have the SketchUp geometry file open while completing the assemblies sections to stay organized.

Example: All components with the construction tag 'Ext_Window1' in the geometry file (.idf) will be assigned the properties defined for 'Window Type 1' in REVIVEcalc. A project with the same operable windows, fixed windows, and glazed doors used throughout the project would model the following:

- SketchUp (.idf) Construction tags
  - **Fixed** windows: Ext_Window**1**
  - **Operable** windows: Ext_Window**2**
  - **Glazed doors**: Ext_Window**3**
- REVIVEcalc (add two additional window types)
  - Window Type **1**: assign the assembly for **fixed** windows using the dropdown options
  - Window Type **2**: assign the assembly for **operable** windows using the dropdown options
  - Window Type **3**: assign the assembly for **glazed doors** using the dropdown options
- If none of the available default options are desired, a custom assembly must be manually added to the construction database and loaded in to the project

Doors

Use this section to model all opaque doors in the project by selecting from the available options in the dropdown menu. Just like windows, each option should correspond with an assembly defined in the construction database and assigned in the geometry file. If no opaque doors exist in the project, no inputs are needed here.

Opaque Assemblies

Define all unique opaque assemblies in the project by selecting from the available options in the dropdown menu, which come from the Construction Database. Only one component 'Type' is required per unique assembly. Just like fenestration, each assembly type should correspond with the construction tags defined in the geometry file as demonstrated in the example above for windows.

Process Tip: Just like in WUFI Passive, simplicity is key when modeling assemblies and geometry to stay organized. Large quantities of assembly types can get overwhelming, confusing, and sometimes redundant. Project teams should do their best to consolidate similar assemblies wherever it is appropriate to do so.

Outages

In order to test the resilience of the building during an outage as required by sections 6.3-6.4 of the Phius REVIVE 2024 Standard, information about the outage start and end dates need to be input into the model. The program automatically runs two simulations during the outage periods:

1. Thermal resilience during the outage
2. Ability to maintain normal operation during the outage

Each location within the Weather Data Database will have a .STAT file, and at the bottom of the file, the extreme weather periods can be found. Refer to Winter & Summer Outage Start Dates above for guidance on where to find these values within the .STAT file.

The additional data at the bottom of the 'Outages' section deals with the passive cooling strategy assumptions during the summer outage period. These inputs are expanded upon in the sections that follow.

Outage Start Dates:

Input the start dates of the winter and summer outage periods based on the .STAT file as noted above. Input the *last day of power*, and the outage will start at midnight of the following date.

Example: The day entered in REVIVEcalc must be one day BEFORE the outage start date identified in the .STAT file.

- .STAT File outage start dates
  - Winter: Jan **27**
  - Summer: Jun **29**
- REVIVEcalc outage start dates
  - Winter: Jan **26**
  - Summer: Jun **28**

Outage End Dates:

Input the end dates of the winter and summer outage periods based on the .STAT file as noted above. Input the *last day of the outage*. At midnight of the following date, power will be restored to the model.

Process Tip: Unlike the outage start date entry, the outage end dates should align exactly with the dates noted in the .STAT file.

Passive Cooling & Natural Ventilation:

☐ Shading Available:

Check this box is using exterior retractable shading only. The shading will be activated by the solar gain on the surface of the window.

☐ Demand cooling available:

Check this box if demand limited cooling is available for the project. The model will maintain a setback temperature of 82°F. When cooling is called for, but no onsite PV is provided, the model will draw from the battery, and the unmet demand is calculated in the battery sizing outputs. When extra PV production is available, the control sequence will overcool the building below the setback temperature, using the building itself as a thermal battery.

☐ Natural ventilation available:

Check this box if natural ventilation (operable windows) should be assessed as a passive cooling strategy to be employed during the summer outage period. If this box is checked, the Natural Ventilation Type must be defined as indicated below

Natural Ventilation Type:

Select the type of natural ventilation used during the summer outage from the dropdown menu according to the following two options:

1. NatVent (cooling during the day)
   - This setting assumes that whenever the outdoor air temperature is ≥1.8°F cooler than the indoor air, the windows will be opened.
   - This control sequence uses a delta dry bulb temperature control.
2. SchNatVent (night flush cooling)
   - This setting assumes that whenever the outdoor air temperature is ≥1.8°F cooler than the indoor air **and** the sun is not up, the windows will be opened.

- This control sequence uses a delta dry bulb temperature control **and** an astronomical clock to determine if the sun is up.

Creating & Exporting the Runlist

Once all inputs in the Case Builder are complete, the case is ready to be added to the Runlist. If the case being modeled is the very first case in the project (typically this would be the baseline case), the Runlist must be created first. Subsequent cases for comparison against the baseline should be added to the same Runlist that was created when setting up the baseline.

☐ Create New Runlist

Use this option for the very first case in the project. Click the folder icon to choose the location to save the Runlist to. Enter a unique name (i.e. ProjectName_Runlist) and hit 'Ok'

☐ Add to Existing Runlist

Use this option to add all comparison cases to be run during Simulation. Click the folder icon to identify the existing Runlist that each case should be added to and hit 'Ok'

Export Case to Runlist

This will either create a new runlist or add a case to an existing runlist depending on the option selected above. If the export is successful, a popup window will appear to confirm, hit 'Ok'.

If adding a case to an existing Runlist, make sure that the Runlist file is **closed** before exporting.

Process Tip: The Runlist (.csv) file can be opened in Excel or other spreadsheet editor. Once all cases have been exported to the Runlist, it is best practice to open the Runlist to visually confirm all of the desired cases have been added. ***This is the 'Save' function -. Inputs cannot be re-loaded into the 'Case Builder'***

Editing the Runlist

If an input was mis-entered, or if a previously exported case needs to be edited, the Runlist (.csv) file can be edited in Excel or other spreadsheet editor. Note that this is recommended only on an as-needed basis unless the user is proficient in their understanding of the inner workings of the tool and the text language required for successful simulation.

First, find the case to be edited by looking for the Case Name in Column A of the file. All of the REVIVEcalc inputs for that specific **case** are contained in the same **row**. Each **column** represents each **input field** in REVIVEcalc, in the same order. The Runlist inputs for the case-to-be-modified can be overridden by simply typing in the cell that corresponds with the input to change.

Some additional things to keep in mind about manually editing the Runlist include:

- Cells that are blank are not applicable to that case which is okay (they should be left blank unless an edit is needed for that case for that specific input)
- Any check-boxes or option selections within REVIVEcalc are *boolean inputs,* where:
  - 1 = TRUE
  - 0 = FALSE
- Assembly names manually entered must be IDENTICAL to the assembly name in the Construction Database

Process Checkpoint: There is no limit on the quantity of cases that can be run in the tool at the same time - any combination of options can be used. All of the inputs will remain the same after exporting the runlist, allowing the user to change one input at a time between exporting cases, if they wish, to assess the impact of different options without having to restart each case from scratch. All of the cases in the runlist will be run simultaneously for rapid comparison, so it is best practice to create a wide variety of different cases that reflect different levels of upgrade options before committing to running the simulation. Make sure to **at least change the Case Name** for each unique modeled case.

Simulation

When the Runlist is complete and has been populated with all of the desired cases to be assessed, simulation of the cases can begin. Navigate to the 'Simulation' tab in REVIVEcalc. Refer to the following training video for additional guidance:

- Simulation

Batch Name

Assign a unique name to the batch of cases that are being run. Some possible unique identifiers that could be used to name the batches include but are not limited to:

- The date the simulation is being run
- "Theme" or goal of the batch
    - Project Name_Appliance Upgrades
    - Project Name_Envelope Upgrades
    - etc.

IDD File Name

Use the folder icon to select the .idd file for Energy Plus v9.5.0 (shown in red below). Typically this file will live at the following file path:

- C:\EnergyPlus\V9-5-0/Energy+.idd

Study/Output Folder

Use the folder icon to select where to save the folder that contains the Simulation output files. Give the folder a unique name that is easily identifiable. A recommended approach is to align this folder name with the Batch Name defined above.

Run List File

Use the folder icon to navigate to and select the Runlist (.csv) file created in the previous section.

Database Directory

Use the folder icon to navigate to and select the Databases folder that must contain all of the required databases as previously discussed in this handbook.

Parallel Processes

Define the number parallel processes based on the **lower value** of the two following conditions:

- Number of cases to be run **OR**
- The maximum number of parallel processes that your device is able to run
    - This is generally dependent on the quantity of cores within the device
        - A 32-core machine can run up to 32 cases in parallel
    - Typical laptops that can run CAD / REVIT should choose 4-8

☐ Generate Graphs

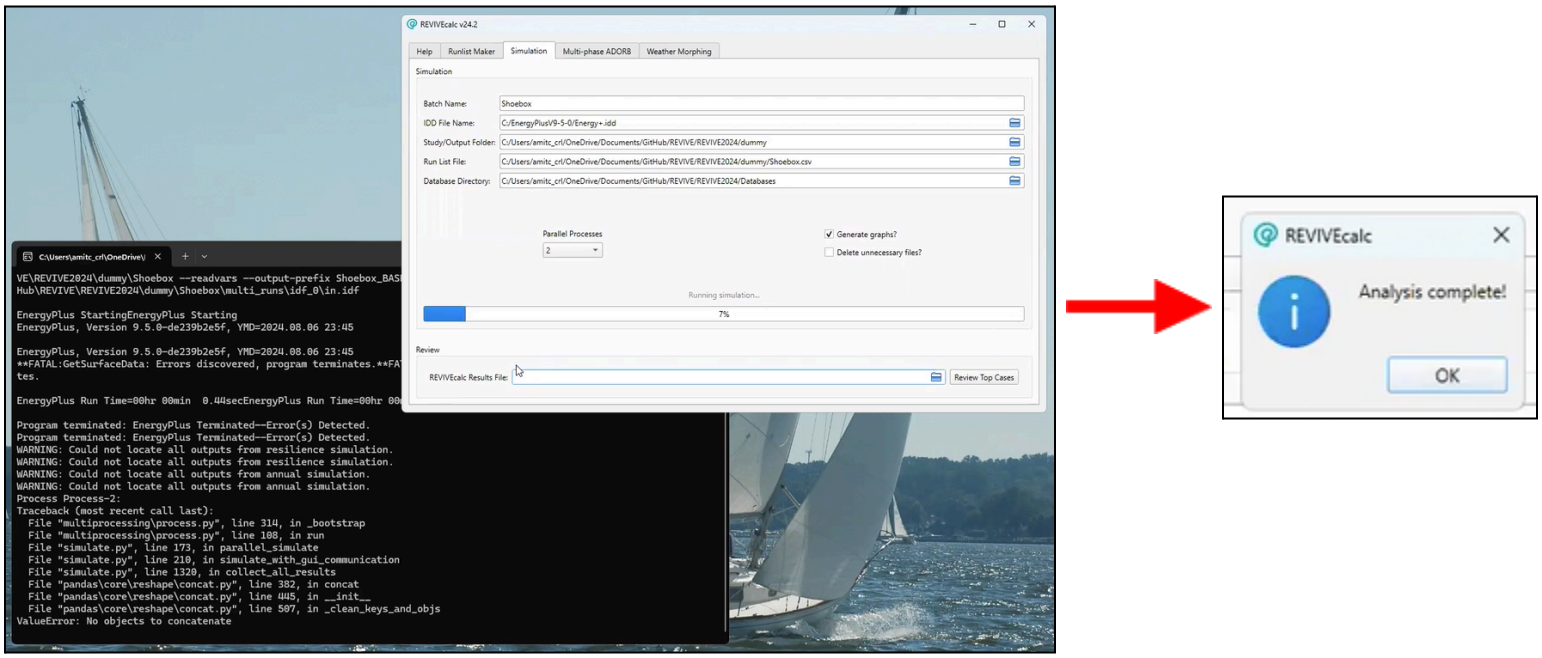
If checked, graphical outputs of the results will be saved to the Study/Output folder. This setting is not recommended when running 20 cases or more.

☐ Delete Unnecessary Files

It is recommended to leave this box unchecked unless your device is low on storage space.

Simulate Results

Use the 'Simulate' button to run the simulation. If successful, the progress bar will show the % progress. The terminal window that runs in the background will begin to compute the Runlist (see Launcher Introduction). A popup window will appear when the analysis is complete.



Error Messages / Failed Simulation

If the simulation fails to run, an error message will appear directing the user to the specific input that is causing the error as shown in the example below. Read this message closely, correct the issue (Edit the Runlist if needed), and attempt to re-run the simulation.

Results Table (.csv)

After successful simulation, use the 'Review' section towards the bottom of the Simulation tab to view the top cases. Use the folder icon to navigate to and select the Results Table (.csv) file. This file will live within the Study/Output Folder created in the steps above:

- C:\...\StudyOutput Folder Name\results\BatchName_ResultsTable.csv

Once the .csv file has been loaded in, hit 'Review Top Cases'. A popup window will appear with the top 5 cases organized by ADORB cost (least to greatest). In general, this table is meant to show the 5 cases within a large batch that have the lowest ADORB cost and that also meet the resiliency criteria for certification.

Projects that **do not** meet the resilience criteria will be highlighted in red. The remaining results metrics are described in the sections below.

SET Hours

A thermal comfort metric for hypothermic conditions. The certification limit is 216 SET Hours.

Deadly Days

The summer outage metric for thermal comfort. The certification limit is 0 Deadly Days.

EUI (Energy Use Intensity)

The source energy of the project, expressed in kBtu/sf.yr.

First Cost

The total estimated cost of upgrades, including labor and maintenance.

ADORB[10] Cost

The total estimated life cycle cost of owning and operating the project for the duration of the simulation period (70 years).

Additional Results & Generated Graphs

If the 'Generate Graphs' option is selected prior to simulation, multiple will be produced and saved within the Study/Output Folder in the subfolder titled 'graphs'. In addition, the simulation creates dozens of additional results files. Refer to the following training video for additional guidance on navigating and interpreting the REVIVEcalc results:

- Essential Results

[10] ADORB = Annualized Decarbonization of Retrofitted Buildings