Using RETScreen Expert for Natural Gas Heating to Electric ASHP Conversion Analysis – A Toolkit

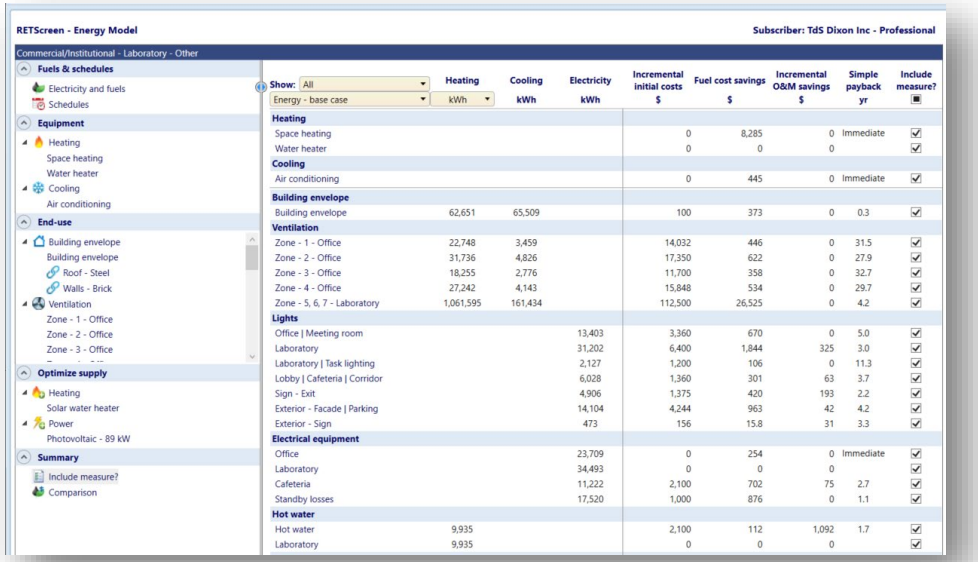
Overview & Guidance

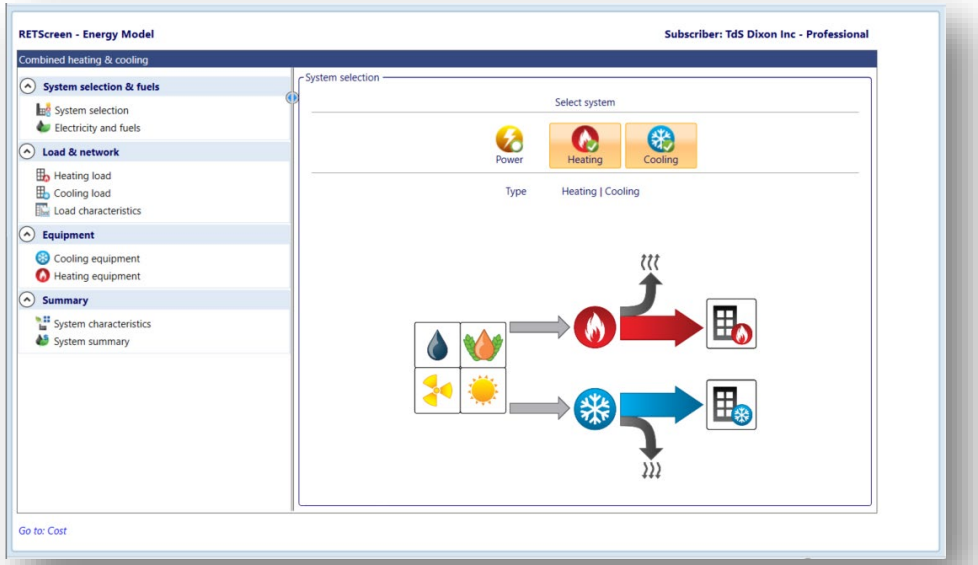
Toolkit Approach

- This toolkit is built upon the feasibility models of the RETScreen Expert analysis software and thereby relies upon the user to possessing RETScreen navigation and feasibility modelling skills.
- Guidance is provided for two situations:
    1. Whole facility where historical data is available for electricity and natural gas with a heating/cooling consumption breakdown by end-use and an estimate of efficiency improvement measures.
    2. For a partial facility or whole facility where historical data is available for electricity and natural gas but there is no breakdown by end-use for heating/cooling or efficiency measures. In this case we present a building (energy) model to represent a base case buildings fuel consumption, a breakdown by end use and efficiency measures to represent a proposed case.
- For both cases, a heating/cooling (load) model to analyze the conversion of the building with efficiency measures heated with gas to a building heated with an ASHP.
    - Building archetypes, from the Virtual Energy Analyzer, for three building types, are used to represent an existing building and as a source of data to populate and calibrate a Power/Heating/Cooling model.
- The Power/Heating/Cooling model is then used to size a heat pump systems and determine energy cost and carbon reductions thereby facilitating an informed decision to convert to air source heat pumps (ASHPs).

What's in the Toolkit?

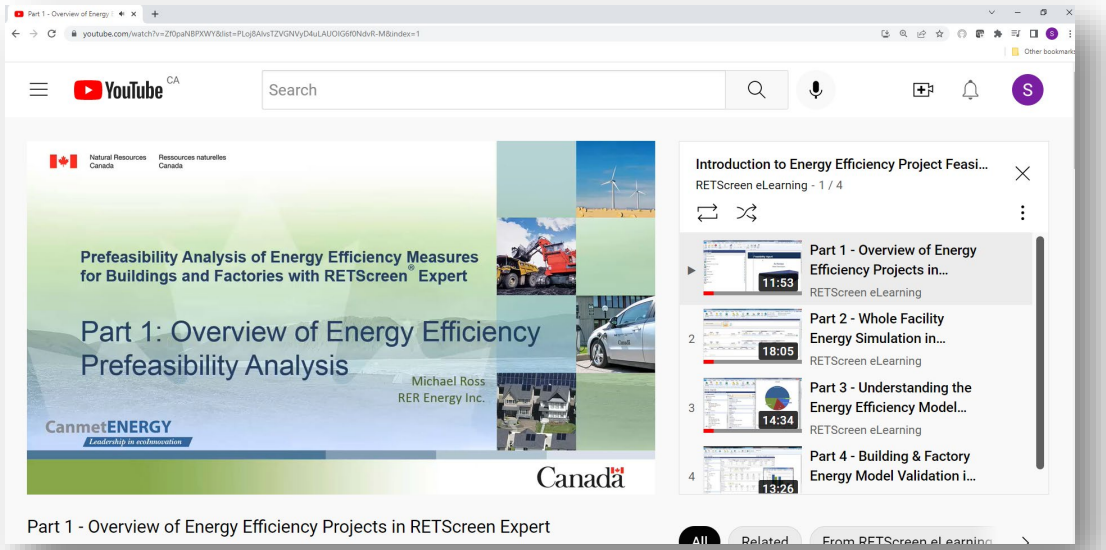
- RETScreen Expert whole building model templates using building archtypes from the RETScreen Expert Virtual Energy Analyzer:
  - Small Office (600m^2) (*.retx file name required*)
  - Laboratory (2250m^2) (*.retx file name required*)
  - Fire Station (600 m^2) (*.retx file name required*)
- RETScreen Expert Heating/Cooling model templates – created based upon the archetypical buildings with conversion from natural gas to ASHPs:
  - Small Office (600m^2) (*.retx file name required*)
  - Laboratory (2250m^2) (*.retx file name required*)
  - Fire Station (600 m^2) (*.retx file name required*)
- Overview & Guidance (this document)
- Toolkit Checklist
- RETScreen Expert Help
  - https://www.youtube.com/channel/UCyFMjG_OXXGtRVnsiTim0IQ





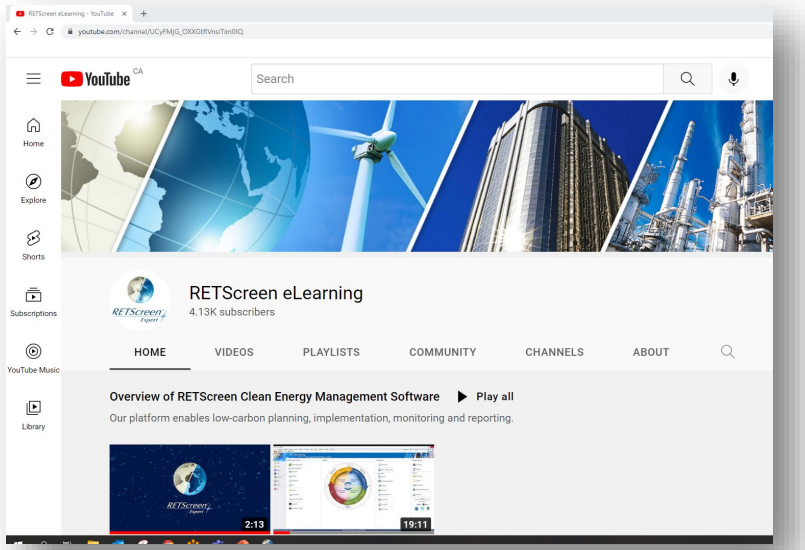
HELP with RETSCreen Use and Navigation

Creating RETScreen Expert Whole Building Modelling



https://www.youtube.com/watch?v=Zf0paNBPXWY&list=PLoj8AlvsTZVGNVyD4uLAUOIG6f0NdvR-M

RETScreen Expert eLearning Channel



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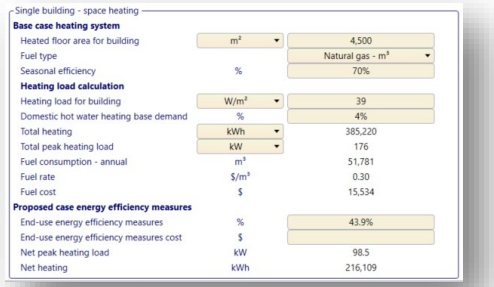
Two Paths

1. Whole Facility (with historical gas & electricity data)

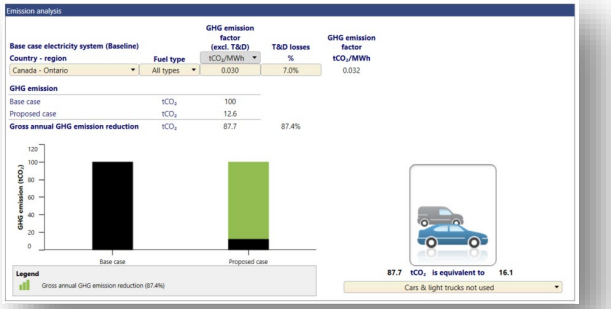
Basic Site Data
(an energy audit could be source)

Historical Data
Floor Area
Heat/Cool Load (W/m^2)
Heat/Cool Efficiency

RETScreen Export Heat/Cool/Power Model

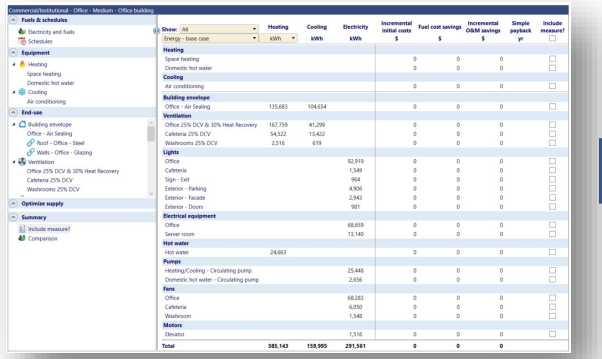


Carbon & Financial Case



2. Partial Facility (or whole facility with no historical data)

RETScreen (Whole/Partial) Building Model



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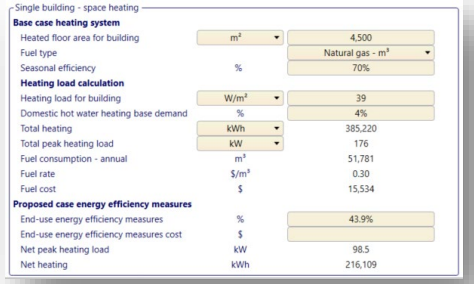
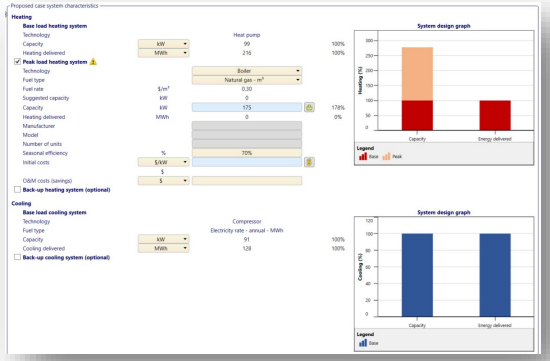
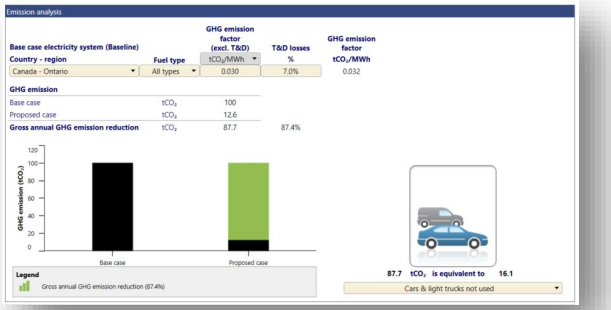




Carbon & Financial Case

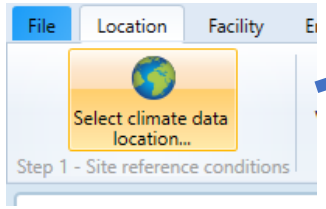


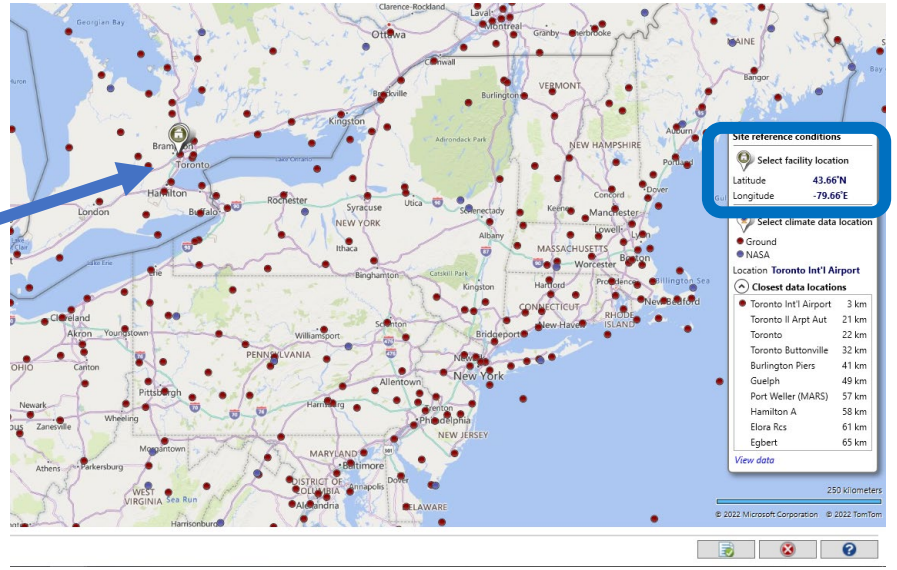
Method 1: Whole Facility

From historical data possibly supported by an energy audit providing an end-use breakdown and efficiency measures.

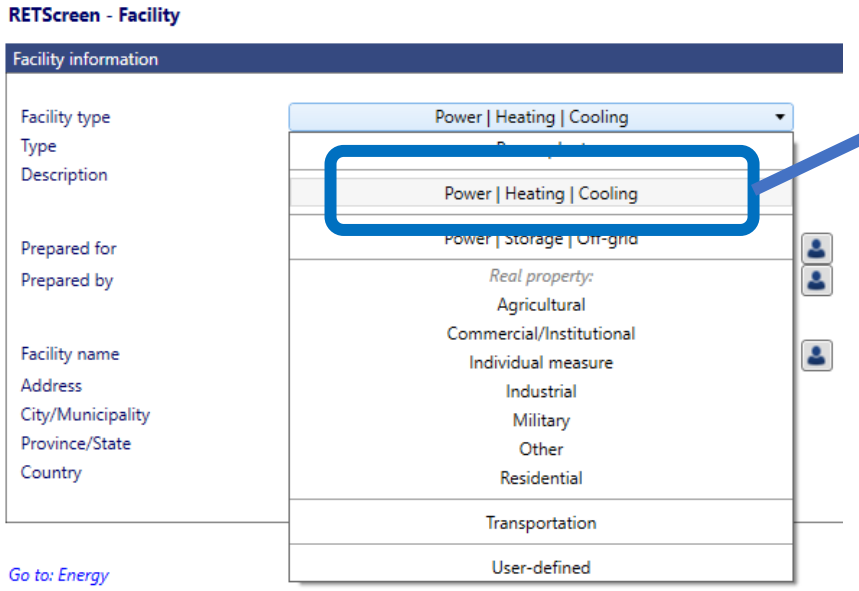
Getting into RETScreen Power/Heating Cooling Model and Setting Location

- Open Retscreen Expert and Navigate to the Location tab across the top bar
- Default location for template files are in Toronto, if a differet location is required click ‘select climate data location…’ button and select building location





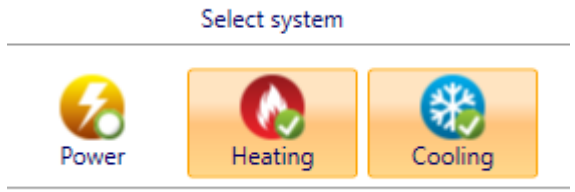
- Note: if location is energy rates and fuels select may need to be changed to match building location
- To setup Retscreen’s power/heating/ cooling model, navigate to the Facility page and under ‘facility type’ select ‘Power/ Heating/ Cooling’ and proceed to Energy tab to begin analysis



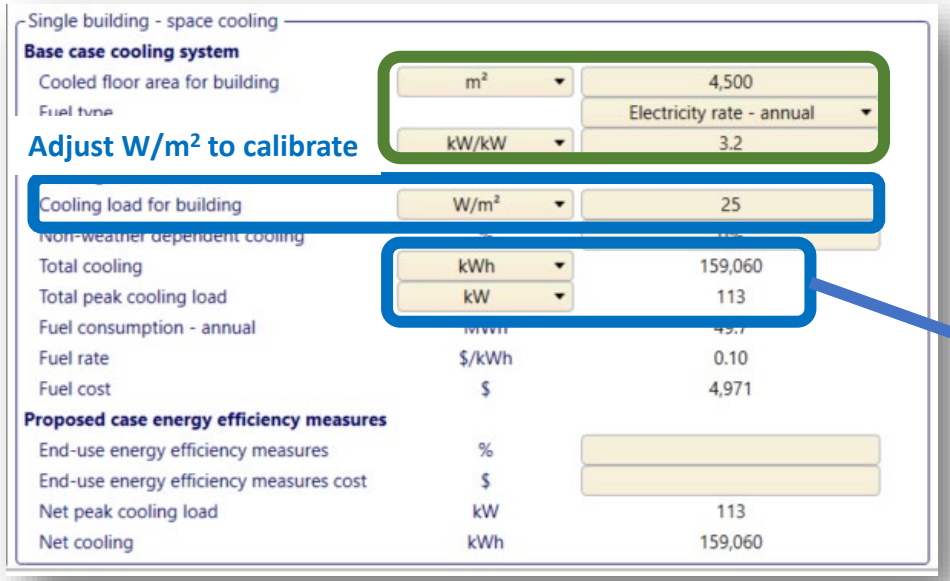
Next step

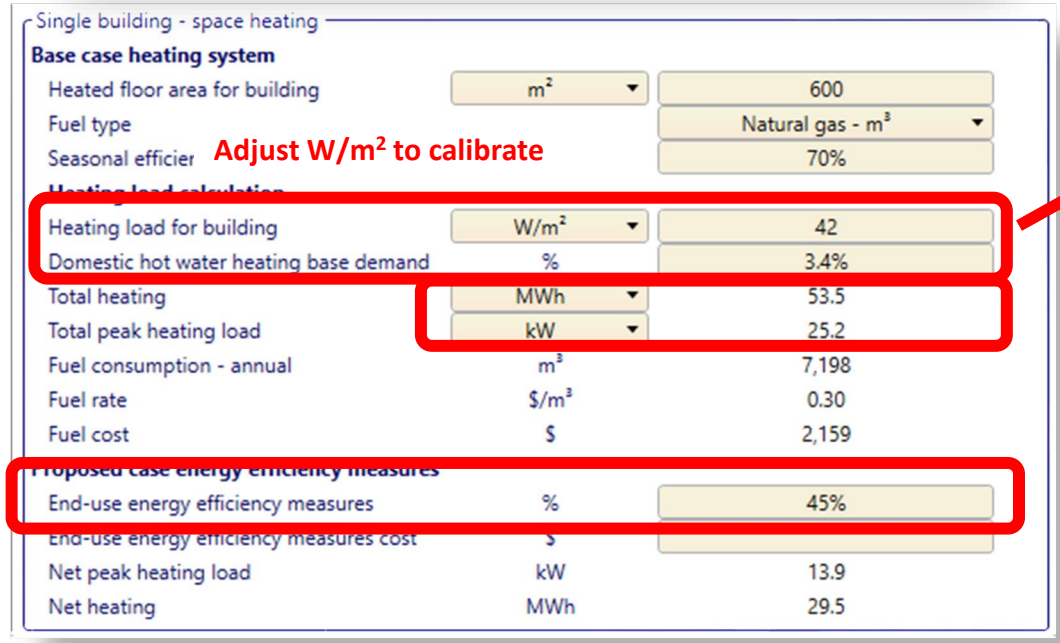
Calibrate Power Model

- Select Heating and Cooling for ‘system selection’ (not power) and set fuel rates
- Navigate to ‘Load & network’ section and proceed to populate building data



- Populate the base case system with correct floor area and equipment efficiency (green box)
- Calibrate the heating and cooling models to the heating and cooling values calculated from historical data – for example from an existing energy audit. (use help section for guidance based on design temperature on location tab)
- Determine % hot water usage for heating and non weather cooling load % based historical consumption and demand data. (see excel template)
- Populate ‘end-use energy efficiency measures’ based on projects in the building if necessary





Next step

Calibration continued…

Proposed case load characteristics

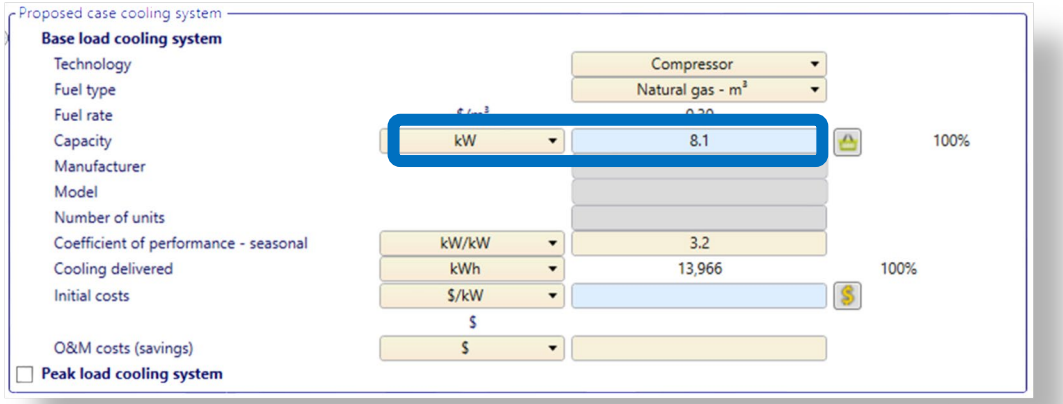
Month	Cooling system load kW	Heating net average load kW	Heat for cooling kW	Heating system load kW
January	0.07	8.6	0	8.6
February	0.07	7.2	0	7.2
March	0.07	5.2	0	5.2
April	0.07	3	0	3
May	1.5	1.3	0	1.3
June	3.7	0.09	0	0.09
July	4.9	0.09	0	0.09
August	4.5	0.09	0	0.09
September	2.7	0.54	0	0.54
October	0.07	2.3	0	2.3
November	0.07	3.9	0	3.9
December	0.07	6.2	0	6.2
Peak load - annual	8.1	13.9	0	13.9

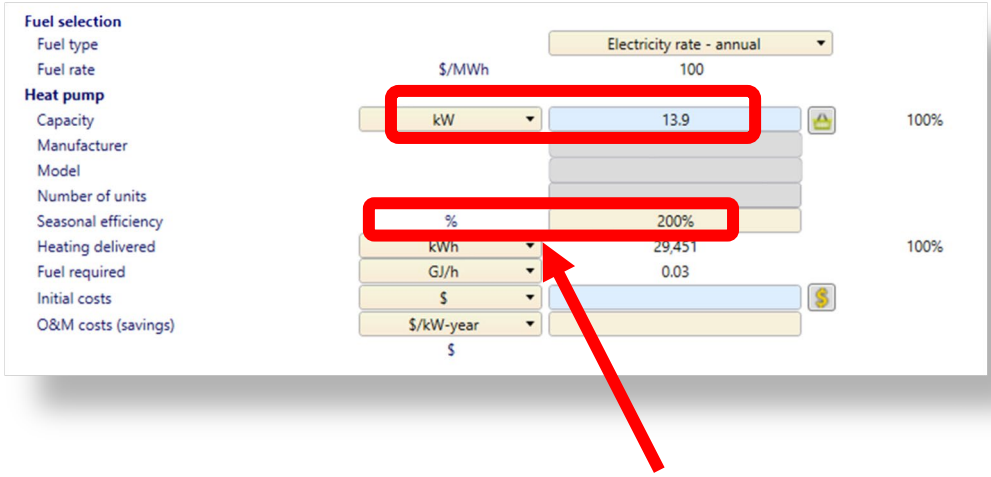
Proposed case load and energy		Heating	Cooling
System peak load	kW	13.9	8.1
System energy	MWh	29.5	14

- Once Base case system have been defined and efficiency measures accounted for, jump to ‘Load characteristics’
- On this page you will see the ‘Proposed Case load characteristics’ that are used to determine the proposed case systems
- Record these numbers for further inputs

Use Proposed Heat/Cool Loads to Model 100% Heat Pump System

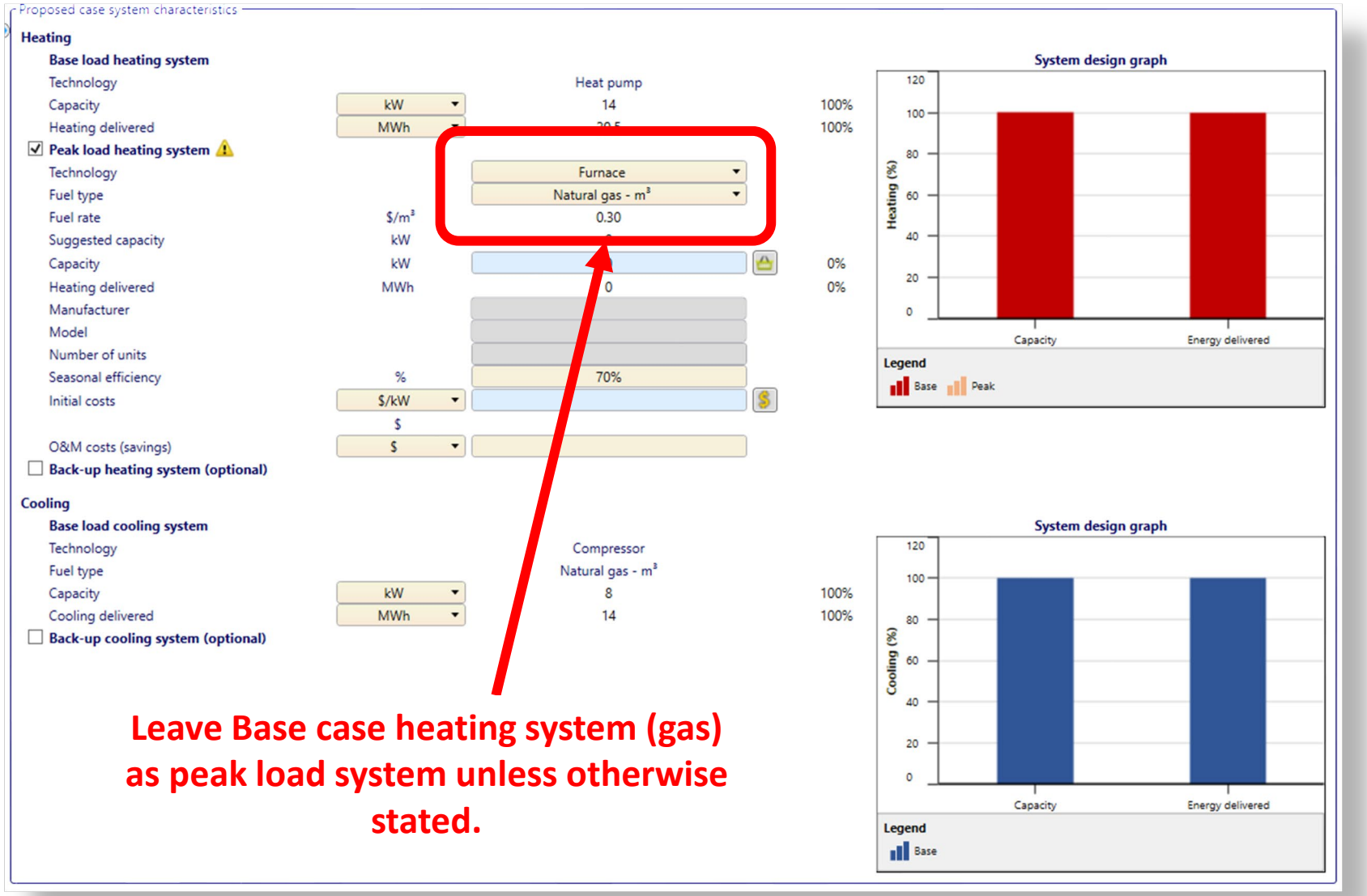
- ‘Size’ the proposed case system appropriately based on previously calculated capacities for both heating and cooling
- Use the RETSCreen Database to find a system, but be careful heating and cooling system are not linked
- In Demo models, capacity in proposed case matches calculated values simply for demo purposes, exact sizing will be based on systems available to meet the building needs
- Costing For new systems will need to be calculated by user





Proposed case electric load (demand) for heat pump system at proposed COP!

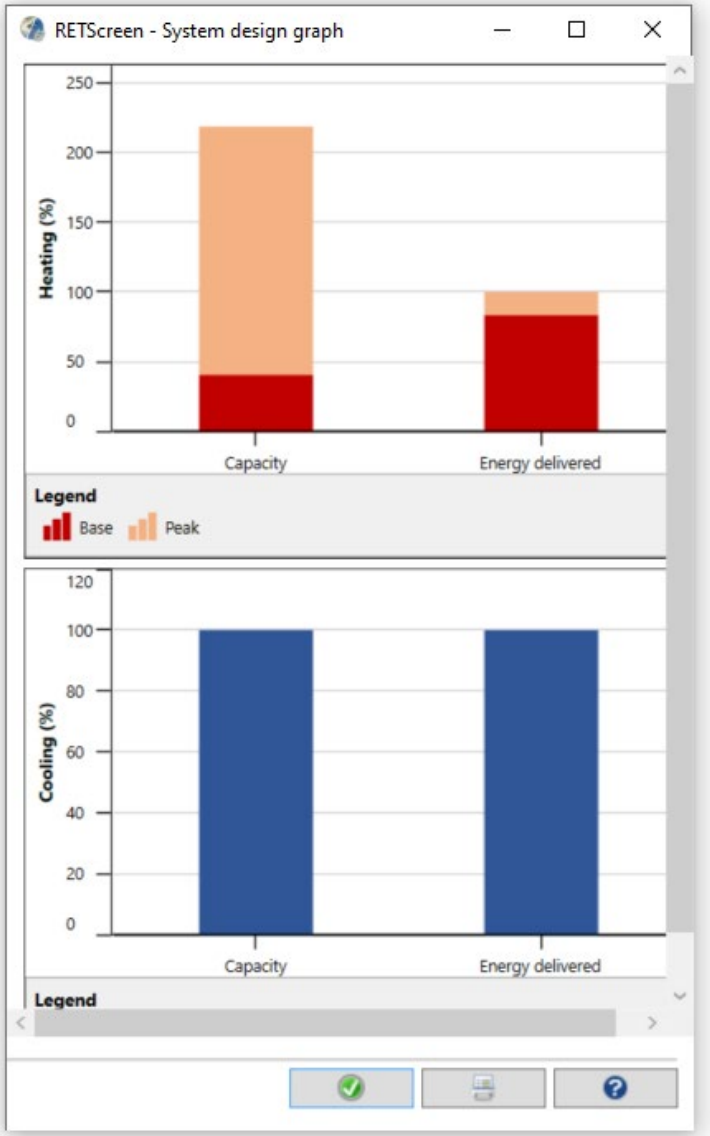
Peak Load System & Fraction (%) of Heat Delivered

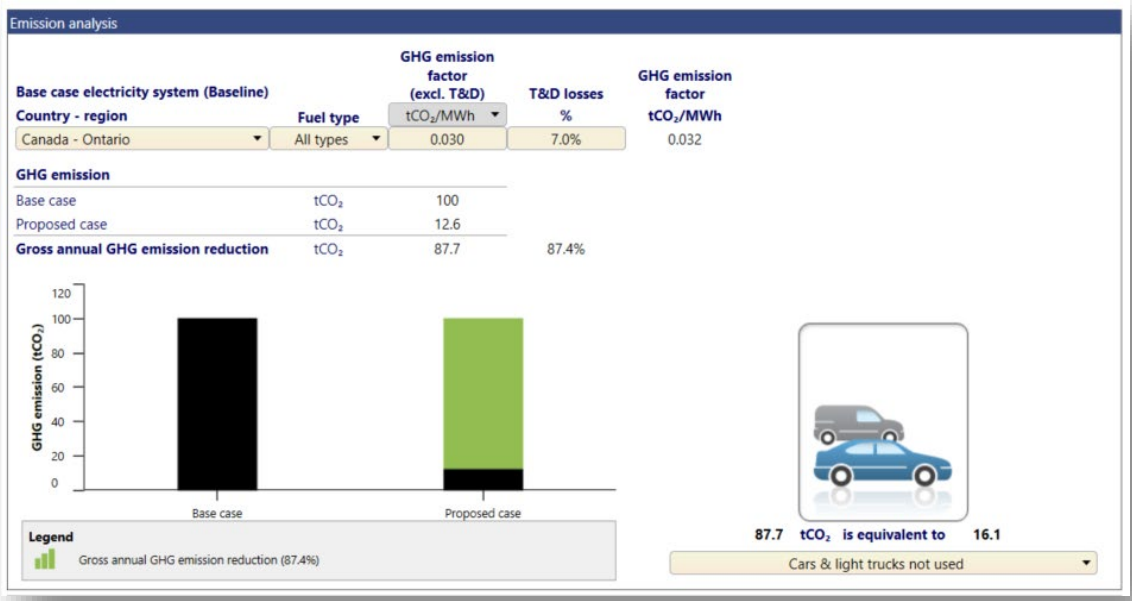


Leave Base case heating system (gas) as peak load system unless otherwise stated.

- 'Size' the proposed case system appropriately based on previously calculated capacities for both heating and cooling
- Use the RETSCreen Database to find a system, but be careful heating and cooling system are not linked
- In Demo models, capacity in proposed case matches calculated values simply for demo purposes, exact sizing will be based on systems available to meet the building needs

Fraction (%) of Heat Delivered versus Carbon Reduction



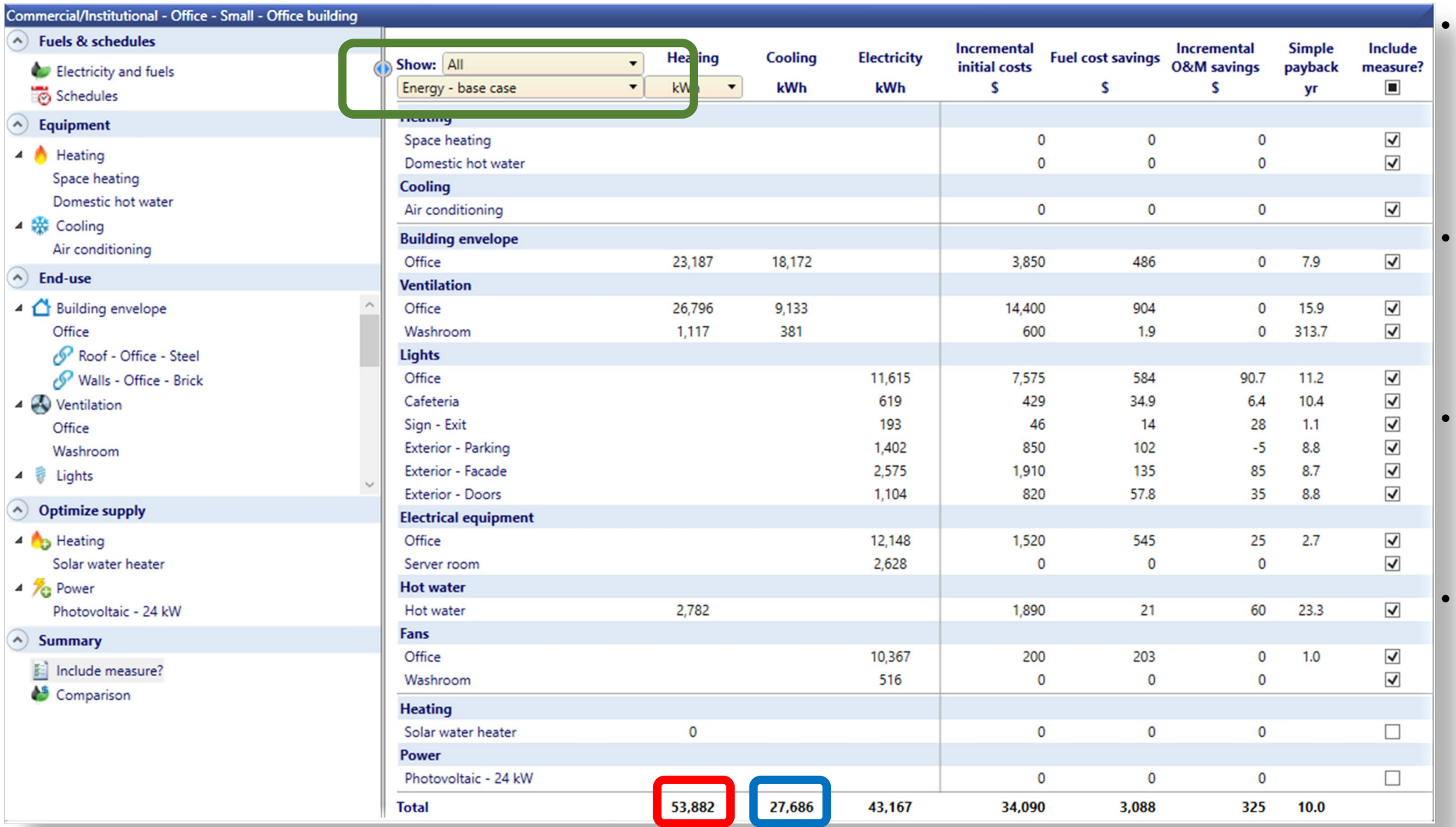


- In some cases the energy delivered may not meet the needs of the building, therefore a gas backup system may be required for peak load heating, rather that installing a larger system…
- We can see carbon reduction is still likely to be very high vs the cost of putting the larger peaking system, which could be costly

Method 2: Partial Facility or No Historical Data/End-Use Breakdown

Using RETScreen Expert Building Model Data

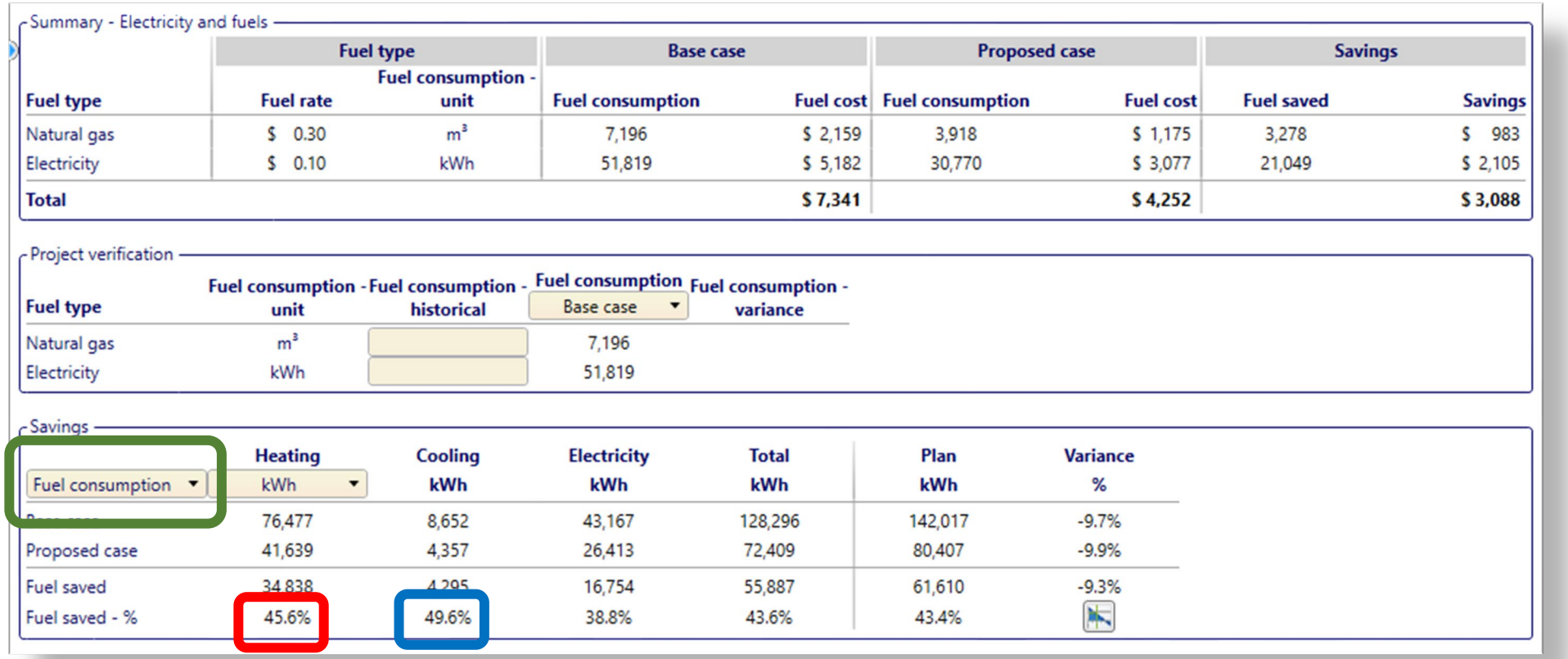
Use Energy Model: Heating, Cooling & Electricity & Interactions



- Start with RETScreen ArcheType Building (virtual Energy Analyzer) similar to your building supplied with tool
- OR Build an Energy Model of your building based on current building characteristics
- Use data From include measure screen to determine Heating and cooling consumption
- Ensure you are viewing ‘Energy – base case’

Use Energy Model: Determine Efficiency reduction %

- In “Comparison” section determine Fuel saved %



Summary - Electricity and fuels

	Fuel type		Base case		Proposed case		Savings	
Fuel type	Fuel rate	Fuel consumption - unit	Fuel consumption	Fuel cost	Fuel consumption	Fuel cost	Fuel saved	Savings
Natural gas	$ 0.30	m^3	7,196	$ 2,159	3,918	$ 1,175	3,278	$ 983
Electricity	$ 0.10	kWh	51,819	$ 5,182	30,770	$ 3,077	21,049	$ 2,105
Total				**$ 7,341**		**$ 4,252**		**$ 3,088**

Project verification

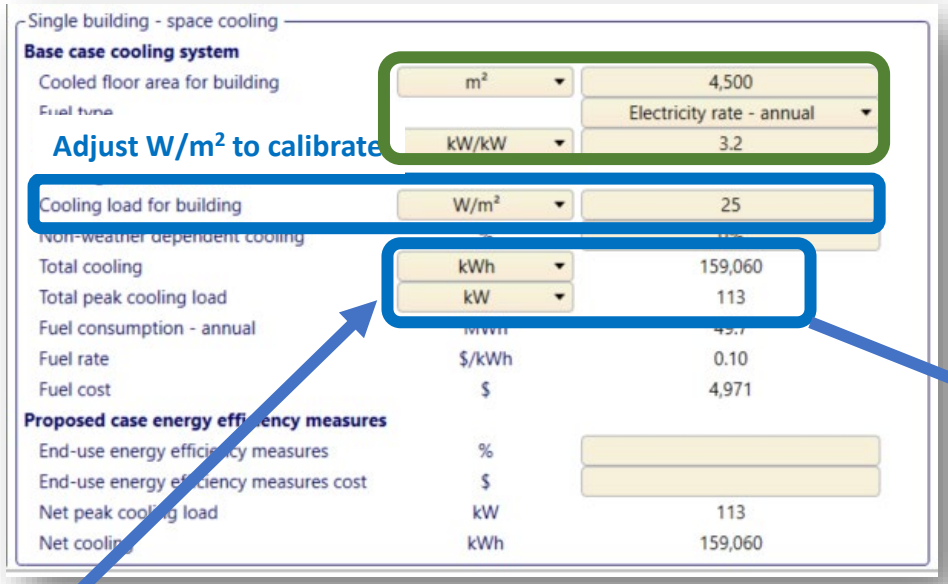
Fuel type	Fuel consumption - unit	Fuel consumption - historical	Fuel consumption (Base case)	Fuel consumption - variance
Natural gas	m^3		7,196	
Electricity	kWh		51,819	

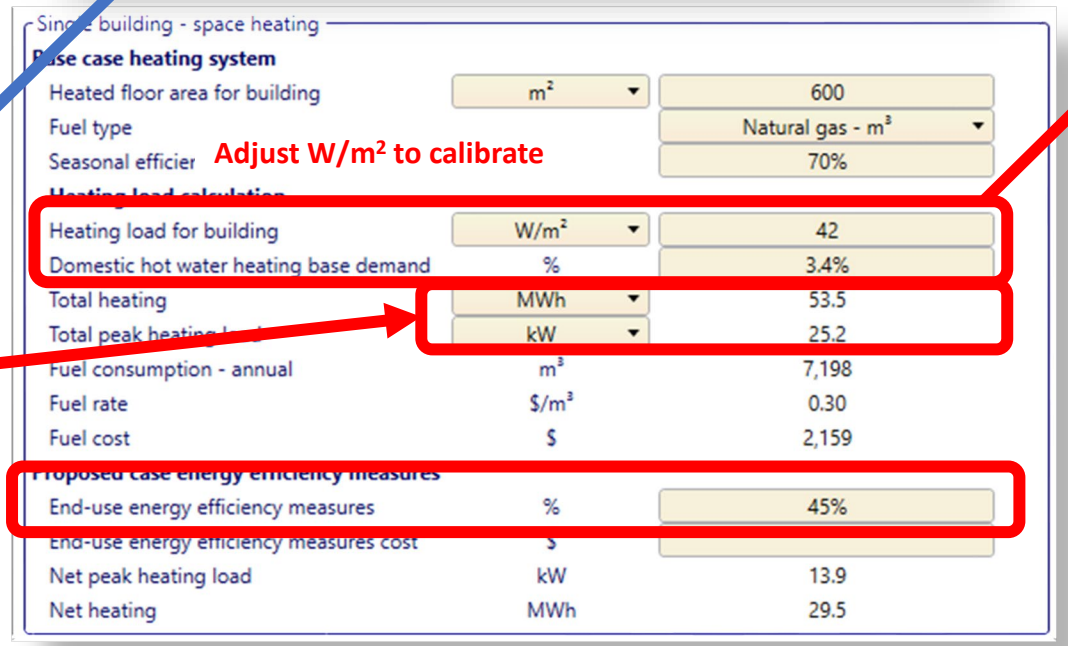
Savings

Fuel consumption	Heating kWh	Cooling kWh	Electricity kWh	Total kWh	Plan kWh	Variance %
	76,477	8,652	43,167	128,296	142,017	-9.7%
Proposed case	41,639	4,357	26,413	72,409	80,407	-9.9%
Fuel saved	34,838	4,295	16,754	55,887	61,610	-9.3%
Fuel saved - %	45.6%	49.6%	38.8%	43.6%	43.4%	

Calibrate Energy Model to Power Model (ignore non weather usage)

- Open New RETScreen Model, Select Power, Heating and Cooling on Facility Page
- Select Heating and Cooling for system selection (not power) and set fuel rates
- Populate the base case system with correct floor area and equipment efficiency (green box)
- Calibrate the heating and cooling models to the heating and cooling values in efficiency model, adjust w/m2 as needed within reasonable values
- Determine % hot water usage for heating and non weather cooling load % based on the 'include measure' screen data in the building model
- Populate 'end-use energy efficiency measures' input based on values from comparison





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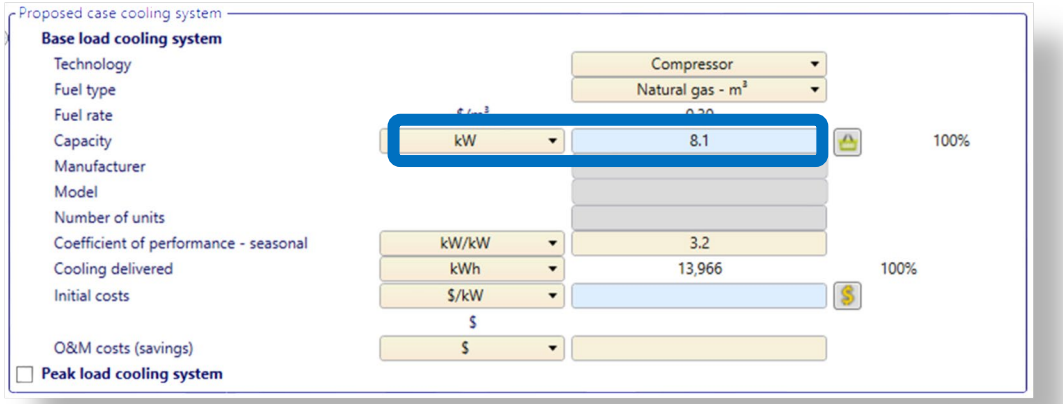

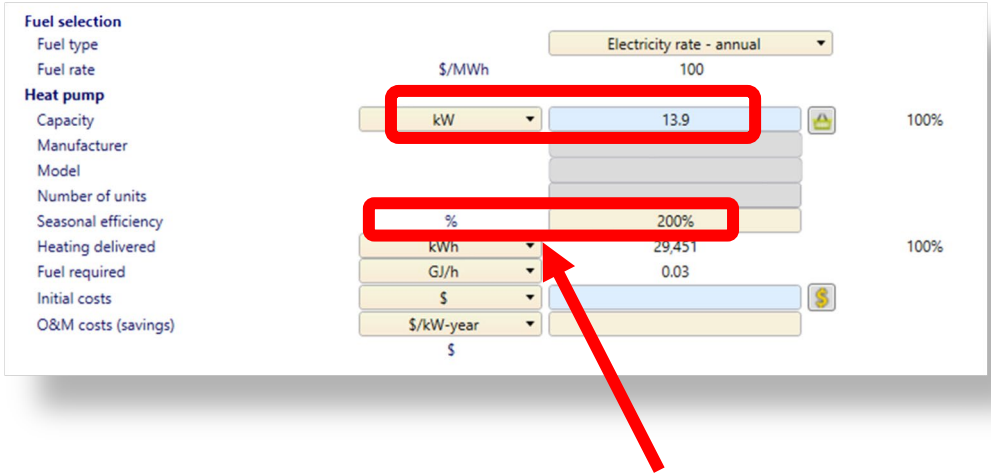

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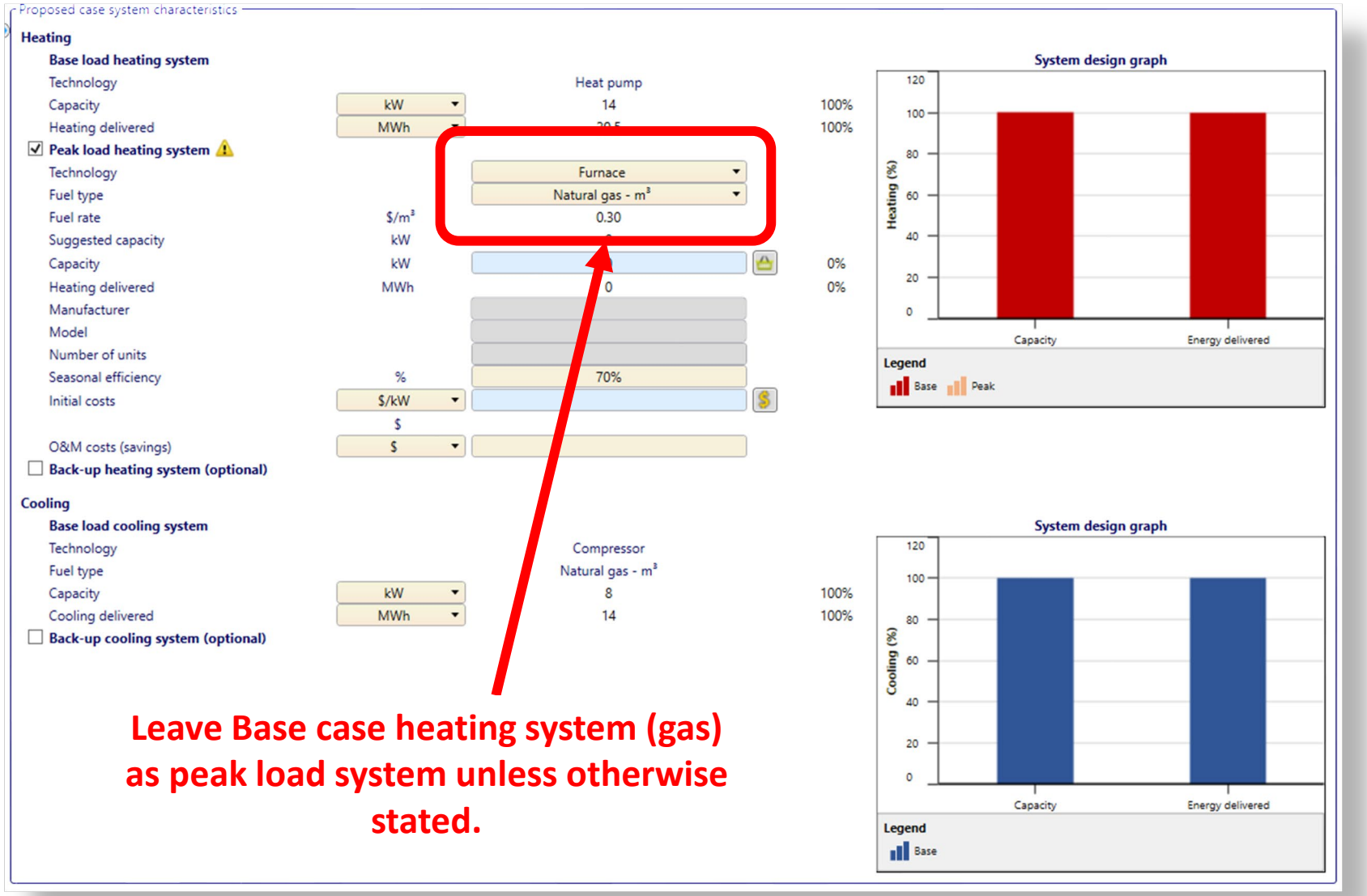

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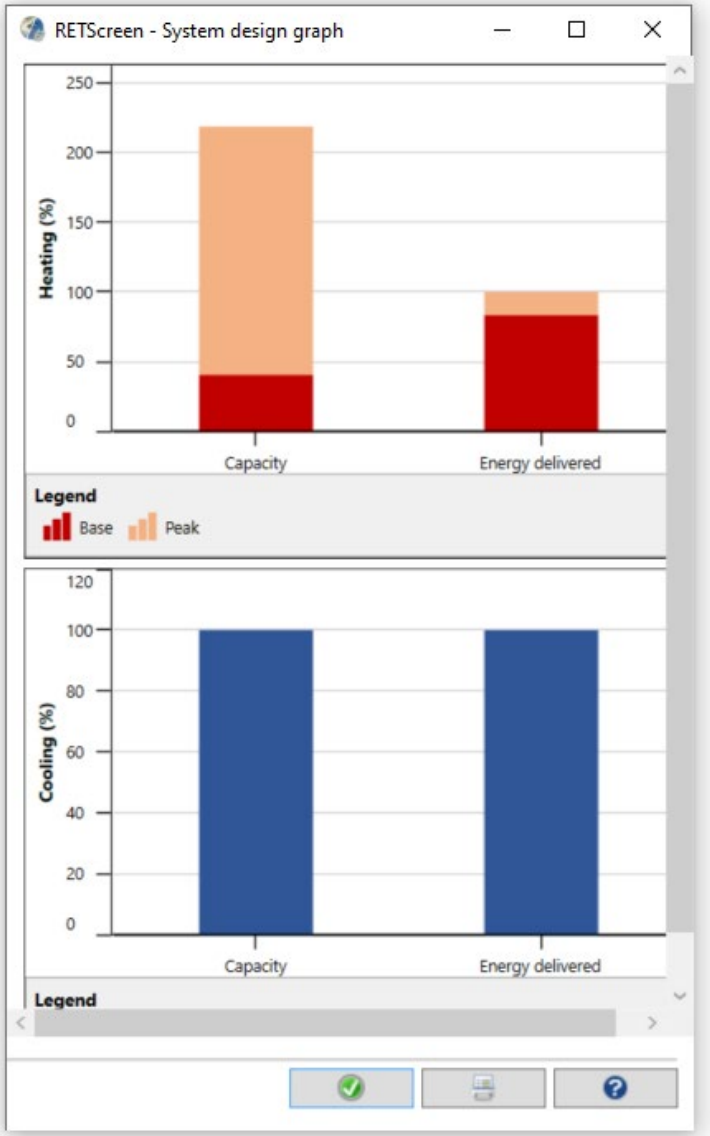

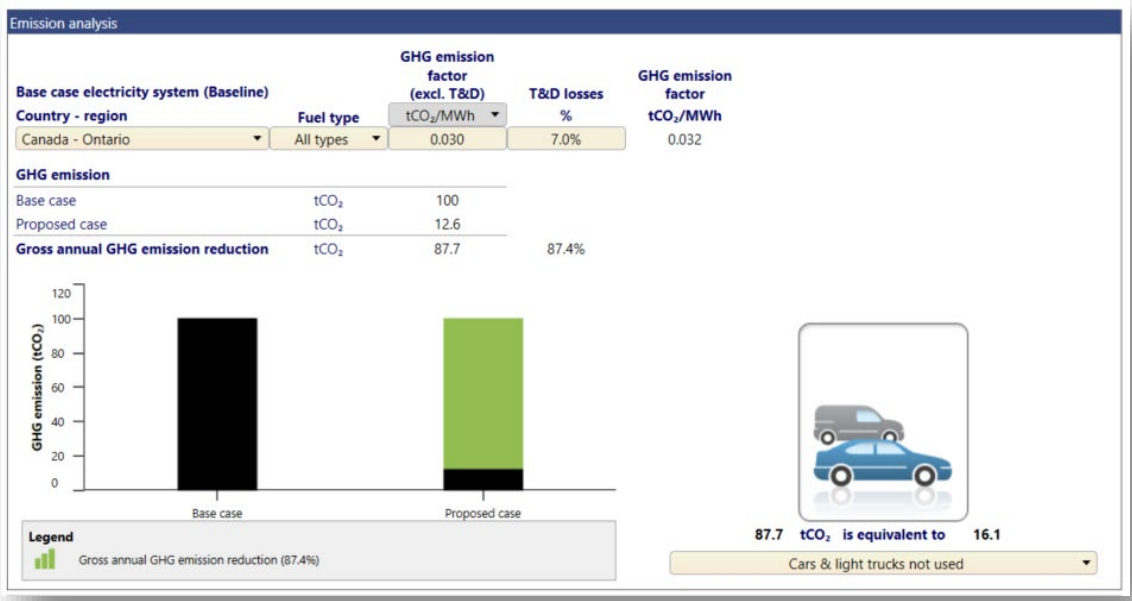

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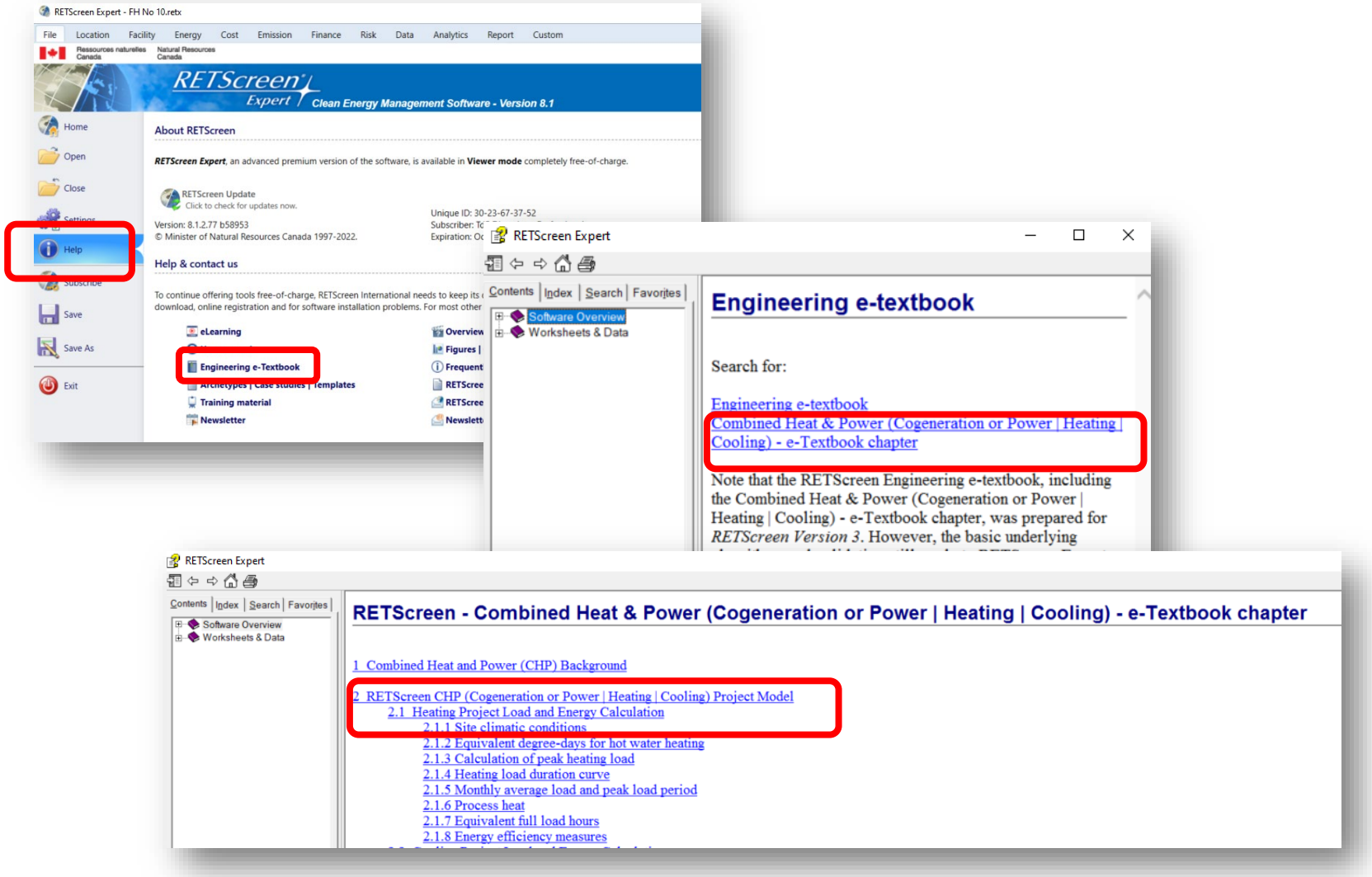
Reference for the Heating Cooling Load Model

- Click HELP and select Engineering e-Textbook
- Select Combined Heat & Power… …chapter
- Model is detailed in Section 2.1 (heating) & 2.2 (cooling)



Efficient Electrification RETScreen Expert Checklist

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○ Location
○ Facility Size</td></tr>
<tr><td>Feasibility Model:
○ Fuel Price
○ Electricity
○ Gas
○ Other
○ Equipment Base case efficiency
○ Heating
○ Cooling
○ Include measure -Energy – base case
○ Heating energy
○ Cooling Energy
○ Hot water Energy
○ Comparison
○ Heating Fuel Saved
○ Cooling Fuel Saved</td><td>Heating and Cooling Model:
○ System Selection
○ Fuel Price
○ Electricity
○ Gas
○ Other
○ Equipment Base case efficiency
○ Heating
○ Cooling
○ Equipment Proposed case efficiency
○ Heating
○ Cooling
○ Heating Load (W/m2)
○ Cooling Load (W/m2)
○ Domestic Hot Water percentage
○ Heating Fuel Saved
○ Cooling Fuel Saved
○ Proposed Case Heating Capacity
○ Proposed Case Cooling Capacity
○ Equipment Proposed case efficiency
○ Heating
○ Cooling
○ Peak Load System
○ Costing</td></tr>
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