



Building Energy Modeling: *The Foundation of a GHX Design*

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*GEOptimize, Inc.***

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Building Energy Modelling *The Foundation of GHX Design*

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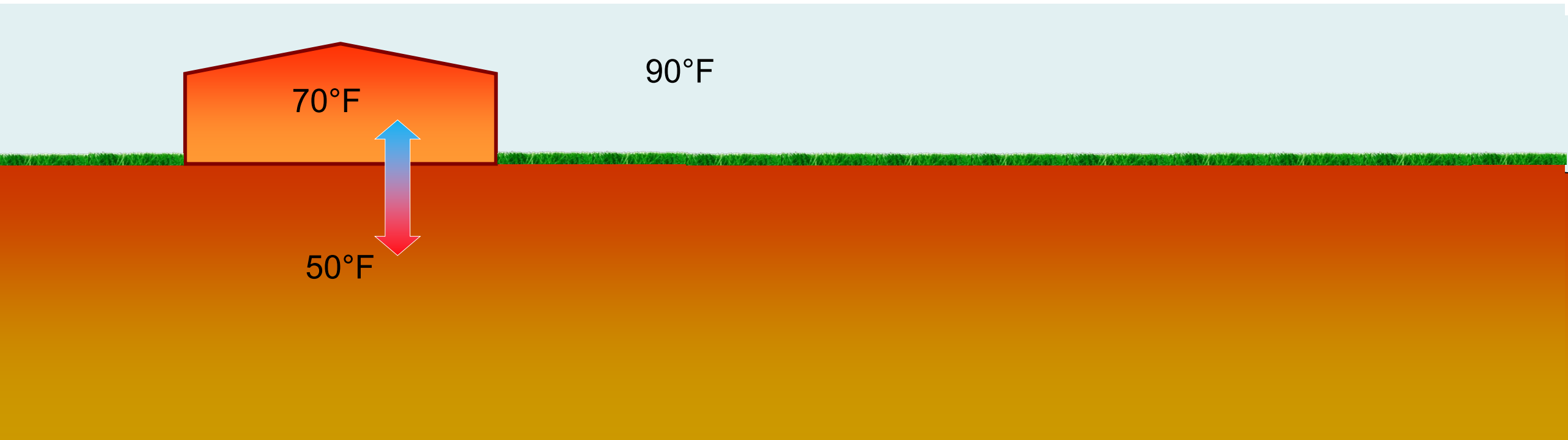


Learning Objectives

- Importance of schedules inside energy models
- Difference between sum of the peak loads vs. block loads
- Difference between reduced weather data vs full weather data

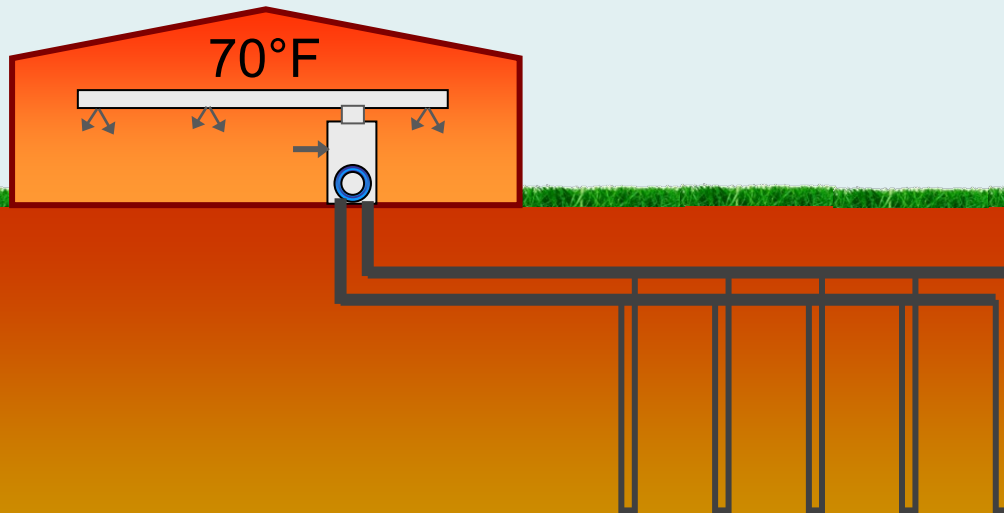
Earth Energy Resource

- Constant earth temperature
- Variable outdoor air temperature



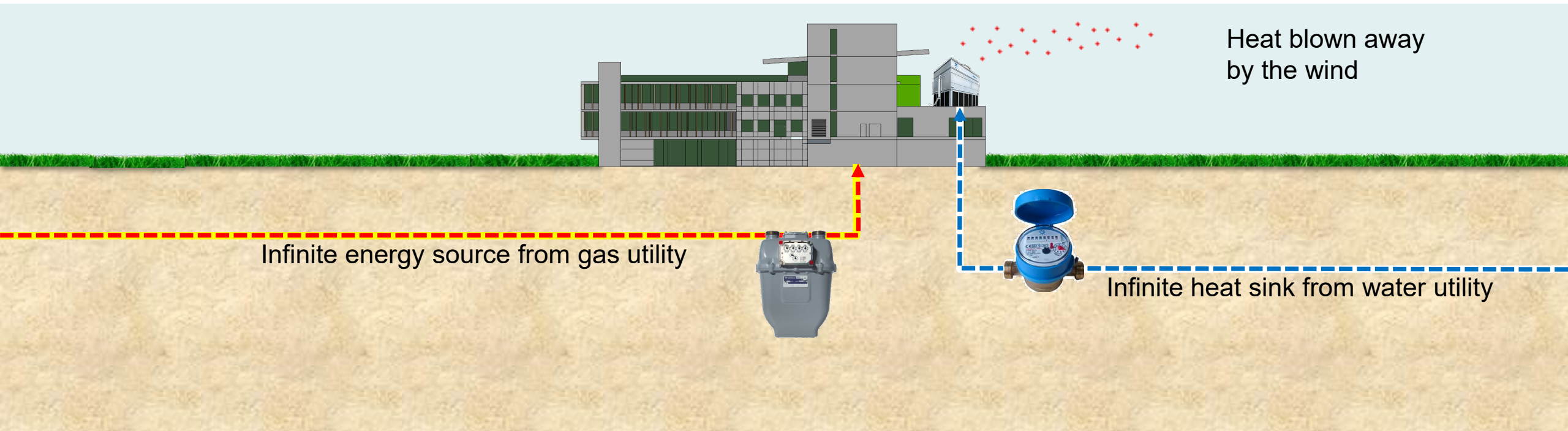
Earth Energy Resource

- Plastic pipe transfers heat to volume of earth
- Heat exchange fluid is pumped through the pipe
- Pipe is connected to a heat pump



Conventional HVAC System Design

- Pipeline large enough to meet peak heating load on the coldest day
- Cooling tower dissipates heat by evaporating water
- Energy available if utility is paid



Conventional HVAC System Design

Design and Operating Conditions		Water Distribution System Construction Materials	
Tower Type:	Counter Flow Induced Draft	Stand Pipe:	PVC
Water Flow Rate (GPM):	88 GPM	Sprinkler Head:	Nylon
Entering Water Temperature	95°F	Sprinkler Pipes:	PVC
Leaving Water Temperature	85°F	Mechanical Equipment	
Wet Bulb Temperature:	75°F	Fan Unit:	One Unit per Tower
Total Fan BHP:	1 HP	Type:	Axial Flow
Total Pump Head:	6.0'	Manufacturer:	CTS
Drift Loss of Water Flow:	0.1%	Diameter:	30.25"
Evaporation Loss of Water Flow:	0.93%	Blade Material:	Nylon
Design Wind Load:	30.7 lbs/sq. ft.	Hub Material:	Nylon
Structural Details		Nominal Air Volume:	8,100 CFM
Overall Diameter:	62.25"	Fan Motor	
Overall Height:	68 3/8"	tower	
Dry Weight:	223 lbs.		
Operating Weight:	1,205 lbs.		
Basic Tower Construction Materials			
Tower Support Frame Assembly	FRP		
Casing:	FRP		
Casing Supporters	Nylon		
Cold Water Basin	FRP		
Filling:	PVC		
Filling Supports:	PVC		
Fan Guard	HDGS		
Mechanical Equipment Supports:	HDGS		
Inlet Louvers:	PVC		
Bolts, Nuts & Washers:	STS		
		Water Flow (GPM):	88 GPM



- Manufacturer designs cooling towers or air-cooled condensers to meet peak loads at peak design conditions
- Designers need the peak cooling load to select a cooling tower from a website or catalog

Conventional HVAC System Design

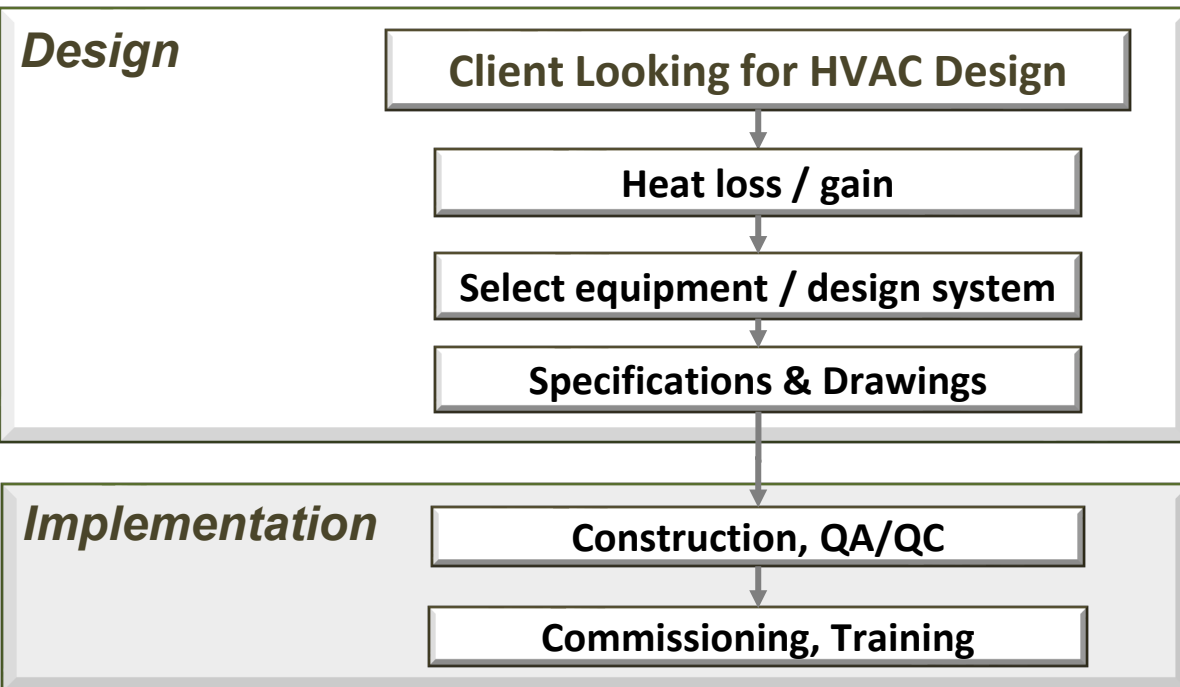
Inlet Pressure: 5 psig Pressure Drop: 0.5 psig		Calculated Flow (Natural Gas) (Cubic Feet of Gas Per Hour)							
Length (ft)	CTS			IPS					
	1/2	1	3/4	1	1-1/4	1-1/2	2	3	4
Nom OD	7	11.5	11	11	10	11	11	11.5	11.5
DR	7	11.5	11	11	10	11	11	11.5	11.5
ID	0.436	0.918	0.848	1.062	1.308	1.534	1.917	2.855	3.670
10	481	3413	2771	5007	8672	13181	23704	67535	130791
20	331	2346	1904	3442	5960	9059	16292	46416	89892
30	266	1884	1529	2764	4786	7275	13083	37274	72186
40	227	1612	1309	2365	4096	6226	11197	31902	61782
50	202	1429	1160	2096	3631	5518	9924	28274	54756
60	183	1295	1051	1899	3290	5000	8992	25618	49613
70	168	1191	967	1747	3026	4600	8272	23568	45643
80	156	1108	899	1626	2815	4279	7696	21926	42462
90	147	1040	844						39841
100	139	982	791						37634
125	123	870	700						33354
150	111	789	640						30221
175	102	726	580						27803
200	95	675	540						25865
250	84	598	480						22924
300	76	542	440						20771
350	70	499	400						19109
400	65	464	370						17777
450	61	435	350						16680
500	58	411	330						15756
600	53	373	300						14276
700	48	343	270						13133
800	45	319	250						12218
900	42	299	240						11464
1000	40	283	220						10829
1500	32	227	184	333	577	876	1576	4490	8696
2000	27	194	158	285	493	750	1349	3843	7443



- Gas utility provides tables to select gas pipe size needed for selected equipment
- Designer need peak heating load to size the pipe line

Conventional HVAC System Design

- Equipment is selected to meet the peak heating & cooling loads
- Oversizing equipment is not cost prohibitive
- The system is designed and installed



Peak Loads vs. Total Loads

- Church, retail store and apartment
- Peak cooling loads are identical – 480 kBtu/hr (40 tons)
- Peak heating loads are identical – 385 kBtu/hr

Peak cooling: 480 kBtu/hr
Peak heating: 385 kBtu/hr



Peak cooling: 480 kBtu/hr
Peak heating: 385 kBtu/hr



Peak cooling: 480 kBtu/hr
Peak heating: 385 kBtu/hr



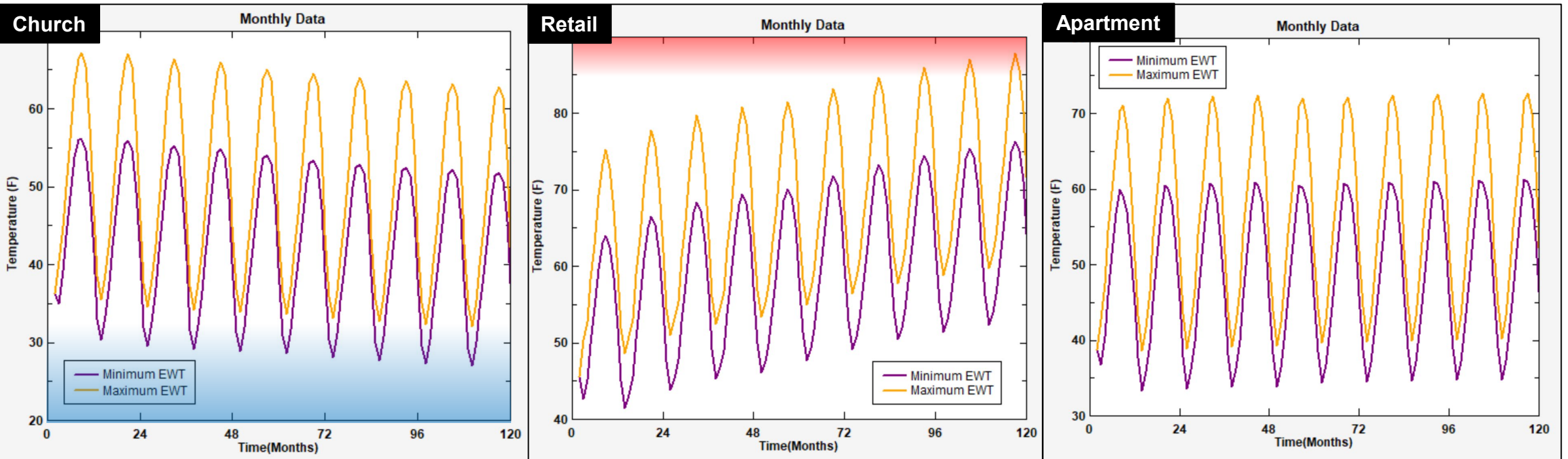
Peak Loads vs. Total Loads

- Different occupancy creates different annual total heating and cooling loads
- Heating / cooling ratio impacts sustainability of GHX

	Church					Retail					Apartment			
	Clg kBtu	Clg kBtu/hr	Htg kBtu	Htg kBtu/hr		Clg kBtu	Clg kBtu/hr	Htg kBtu	Htg kBtu/hr		Clg kBtu	Clg kBtu/hr	Htg kBtu	Htg kBtu/hr
Jan	3820	8	189734	385	Jan	19906	93	89734	385	Jan	5560	25	159734	385
Feb	6202	23	135120	366	Feb	28202	110	65120	346	Feb	7840	83	112120	360
Mar	12177	76	81304	312	Mar	30177	215	41304	240	Mar	14177	185	71304	305
Apr	16800	216	36614	170	Apr	40866	285	16614	110	Apr	28866	260	30614	155
May	24640	367	11152	65	May	53946	396	3152	35	May	43946	329	11152	60
Jun	46285	446	3180	5	Jun	82094	446	180	0	Jun	72094	423	8545	45
Jul	52680	480	886	0	Jul	102358	480	0	0	Jul	92358	480	7650	43
Aug	49068	465	1725	0	Aug	102393	439	125	0	Aug	78393	447	7550	45
Sep	38560	314	5479	53	Sep	89245	360	2379	26	Sep	59450	360	8479	53
Oct	13821	121	24702	137	Oct	63821	223	9702	128	Oct	19821	169	18702	132
Nov	7571	62	98784	298	Nov	41571	135	36784	251	Nov	8690	79	66784	269
Dec	4884	10	176775	348	Dec	27884	102	76775	331	Dec	6570	22	126775	340
	276508	480	765455	385		682463	480	341869	385		437765	480	629409	385
	Annual Cooling / Heating Ratio:			2.8 to 1		Annual Cooling / Heating Ratio:			2.0 to 1		Annual Cooling / Heating Ratio:			0.7 to 1

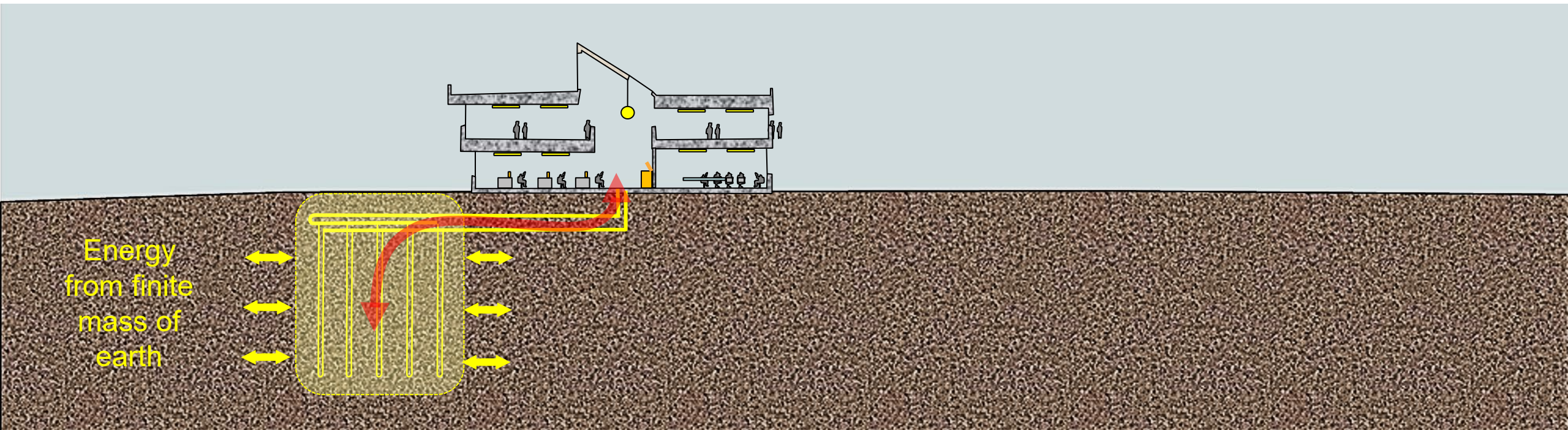
Peak Loads vs. Total Loads

- GHX more similar to a battery compared to a conventional system
- GHX temperature for church and retail store fall outside efficient operating parameters
- Can't design off of peak loads and rules of thumb

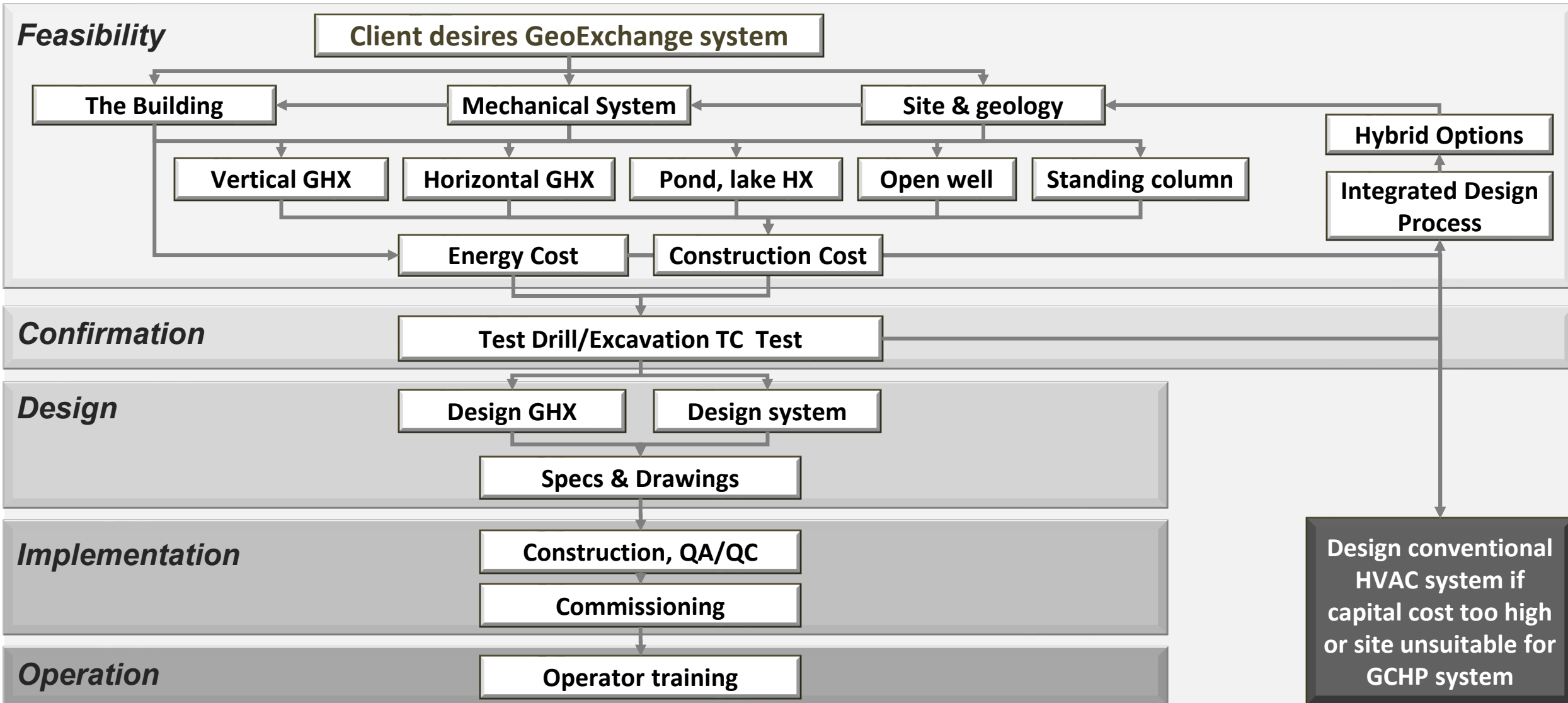


Earth Energy Resource Engineering

- Conventional HVAC system does not consider total annual heating and cooling loads
- The gas line and cooling tower are sized on peak loads.



GSHP System Design Process



Building Heat Transfer – Envelope Conduction



- Heat is conducted through all surfaces and exposed to the outdoor air temperature
- The amount of heat transferred is directly proportional to the ΔT between the indoor & outdoor air temperatures

Building Heat Transfer - Internal Gains



- Occupants, lights and electrical equipment emits heat into the space
- Building use affects the amount of heat contributed by internal gains

Building Heat Transfer - Solar Gains



- Solar heat is transferred to the building through windows
- Amount of solar heat is affected by window to wall ratio and solar heat gain coefficient (SHGC) of windows
- Affected by internal and external shading devices

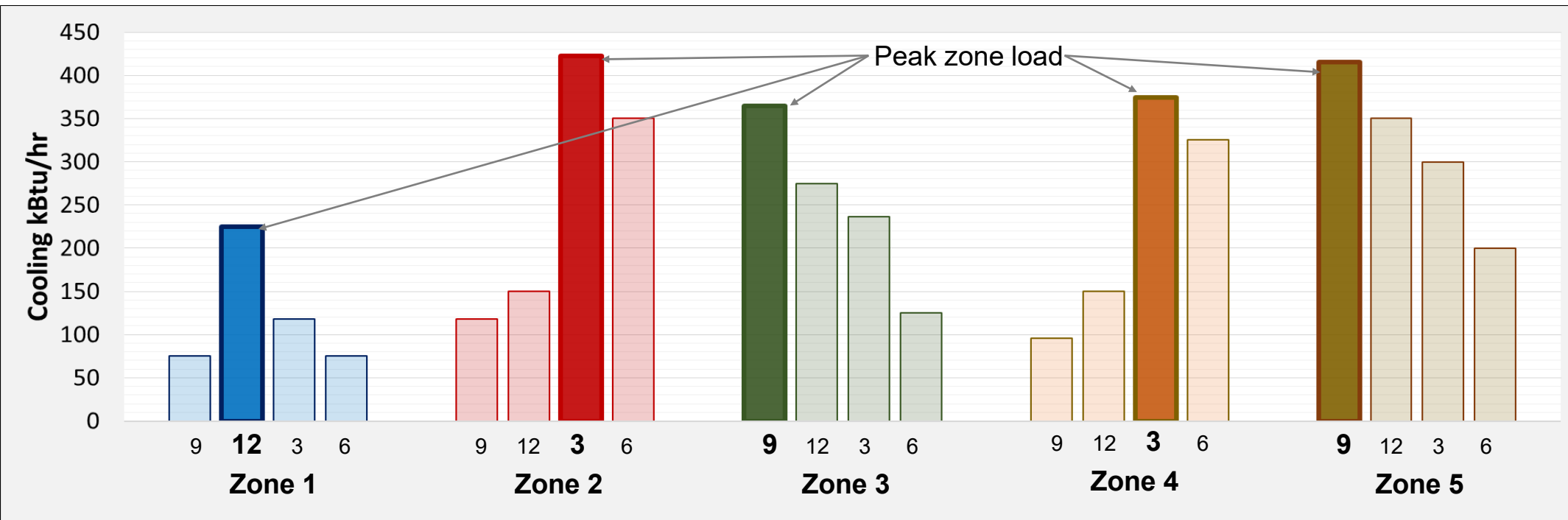
Building Heat Transfer - Ventilation



- Heating or cooling is required to condition fresh outdoor air
- Ventilation rate is variable based on building type
- Ventilation heating or cooling is highly dependent on climate
- HRV's affect ventilation load

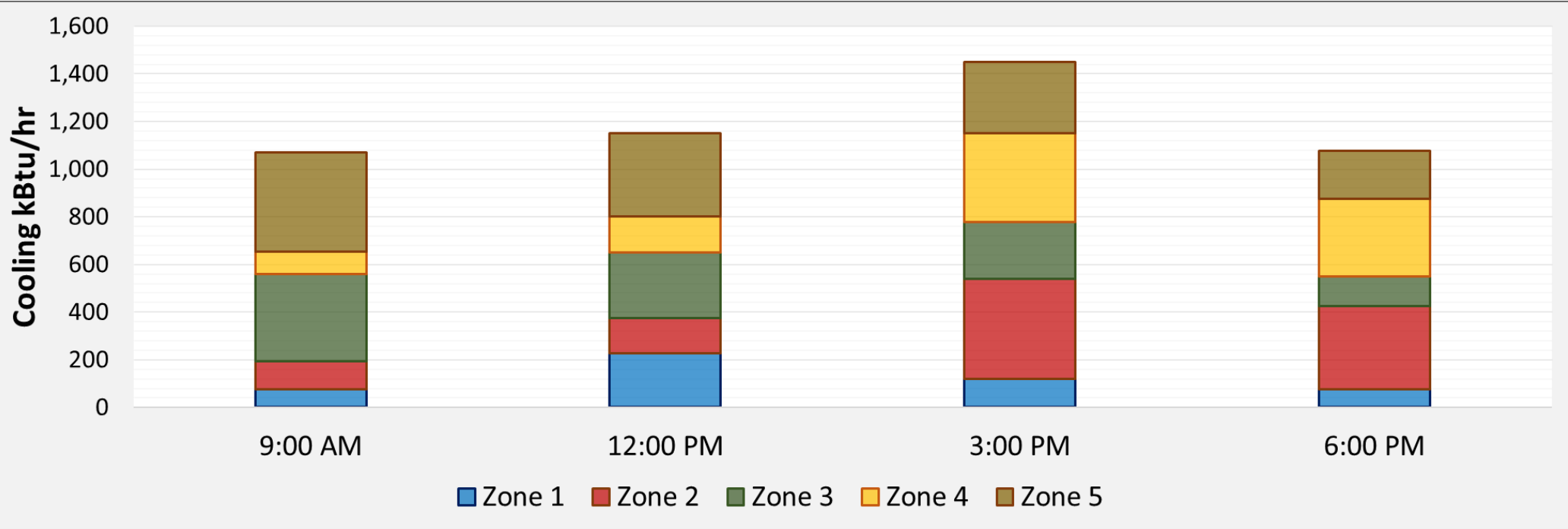
Zone Loads

- Peak loads in different building zones are not coincidental
- Use of the space and exposure to environment impact peak zone load times



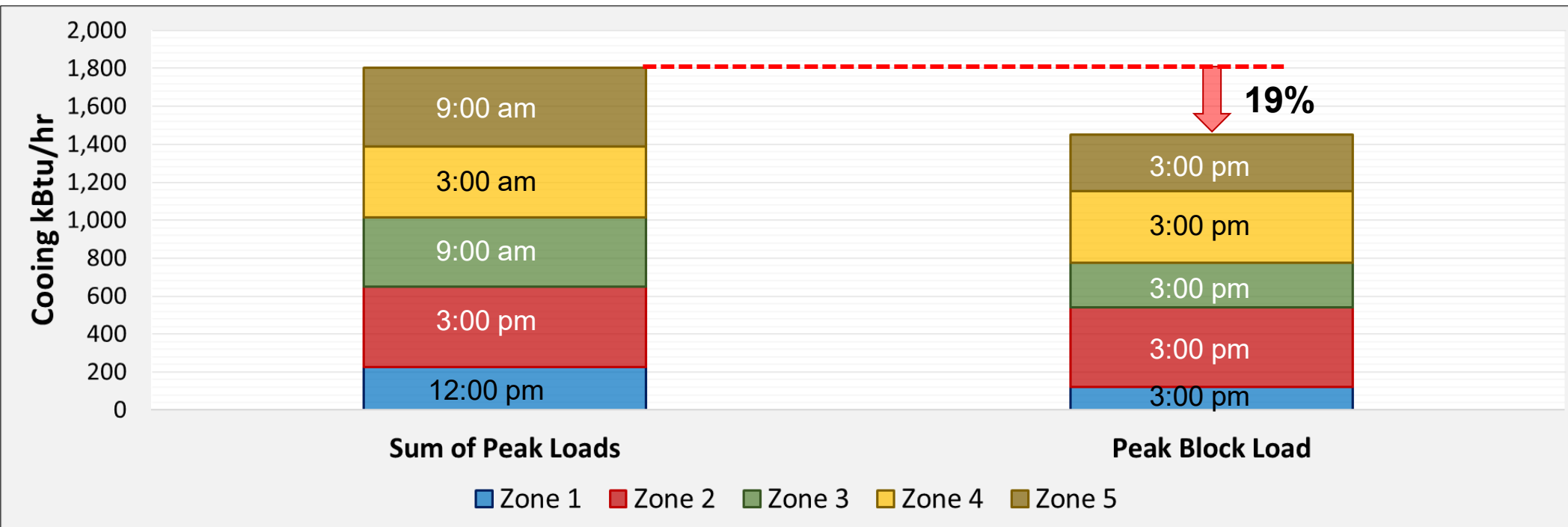
Block Loads

- Hourly loads for each hour are aggregated to determine peak block loads of building
- Peak block loads in this example occur at 3:00 pm



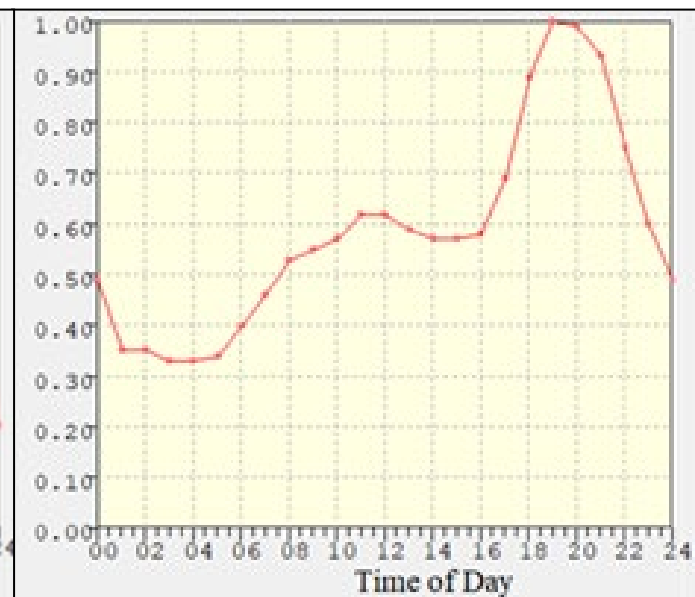
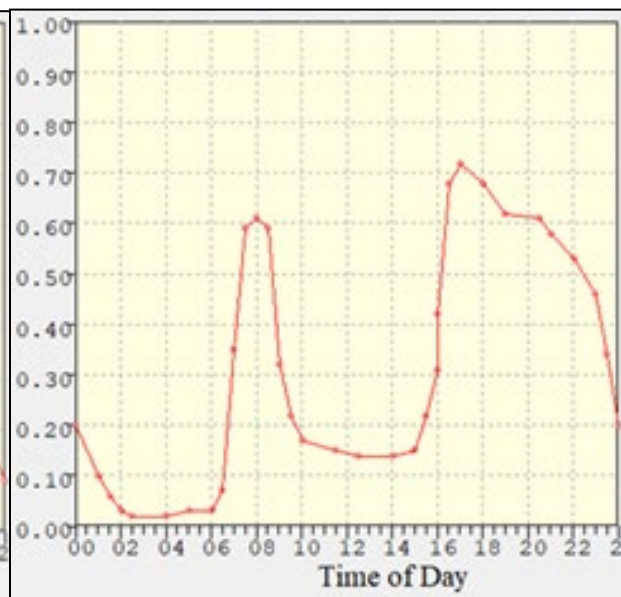
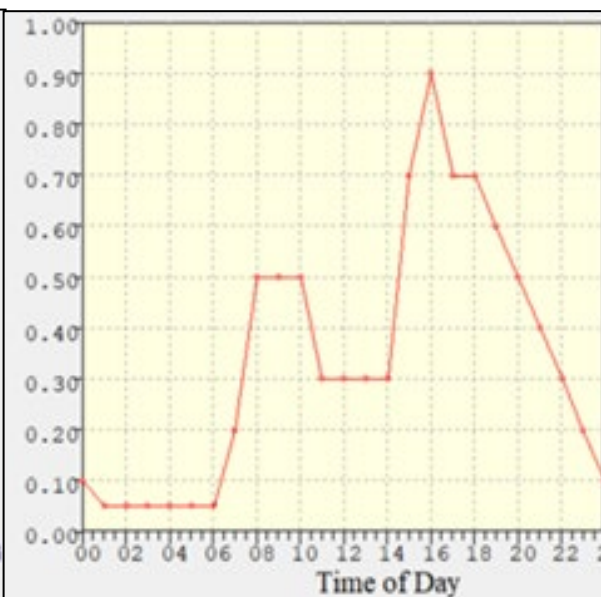
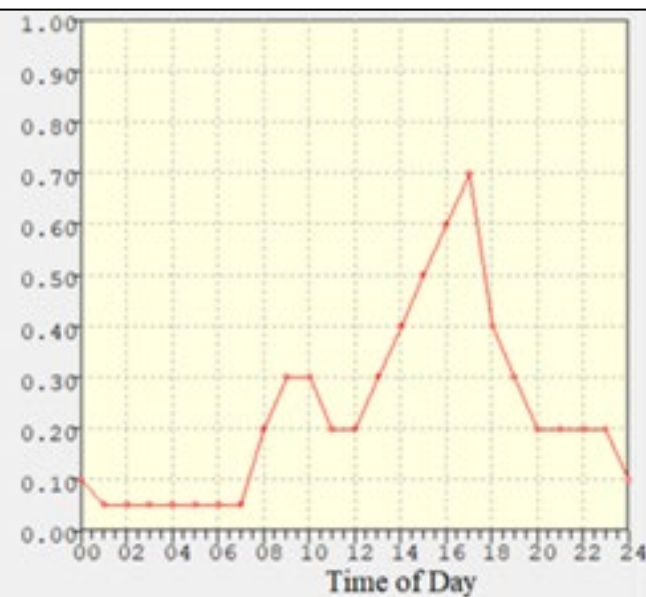
Peak Loads vs. Block Loads

- Peak loads in each zone are not coincidental and occur at different times
- Peak block loads are the loads transferred to or from the GHX
- Stacking safety factors can have unintended consequences



Energy Modelling – Schedules

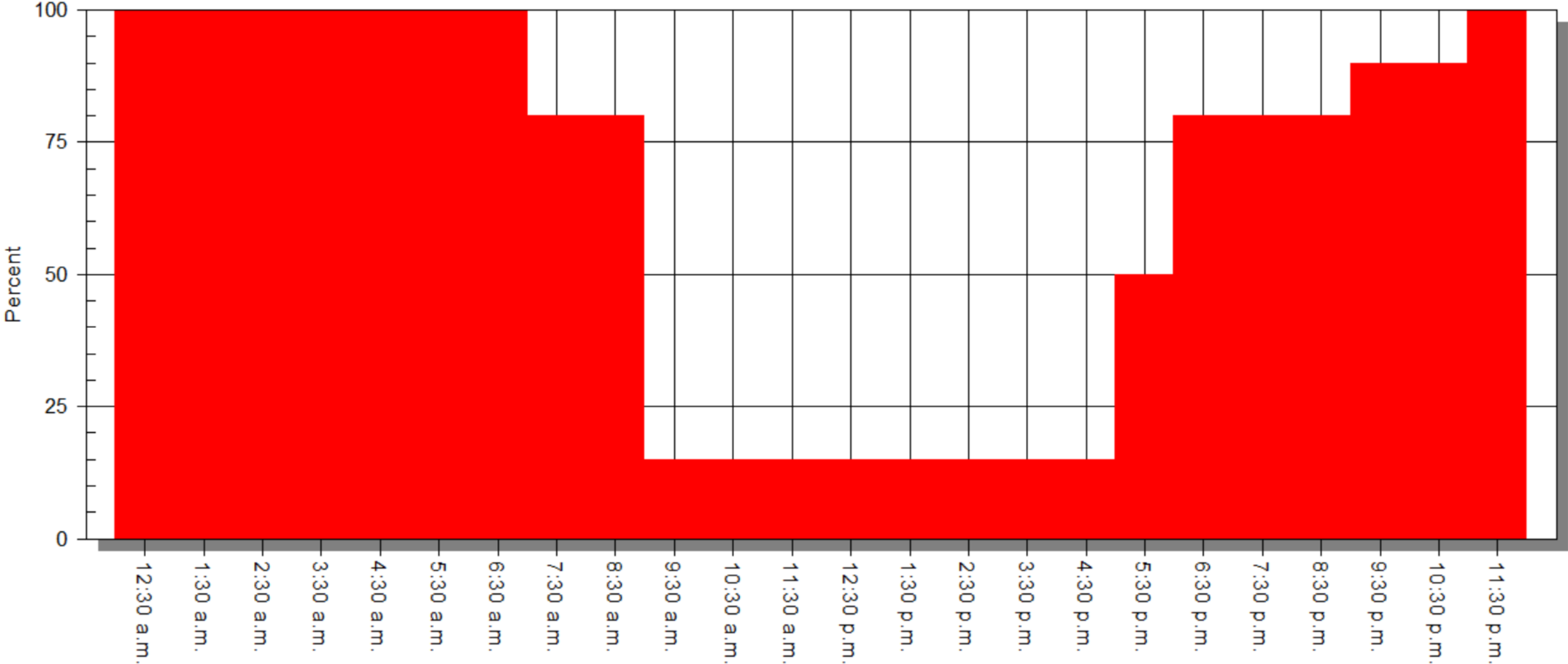
- ASHRAE 90.1 for envelope U-values and internal load density
- ASHRAE 62.1 for ventilation
- Scheduling internal heat gains is sometimes challenging



Energy Modelling – Schedules – People Example

Steamboat - People - Apartment

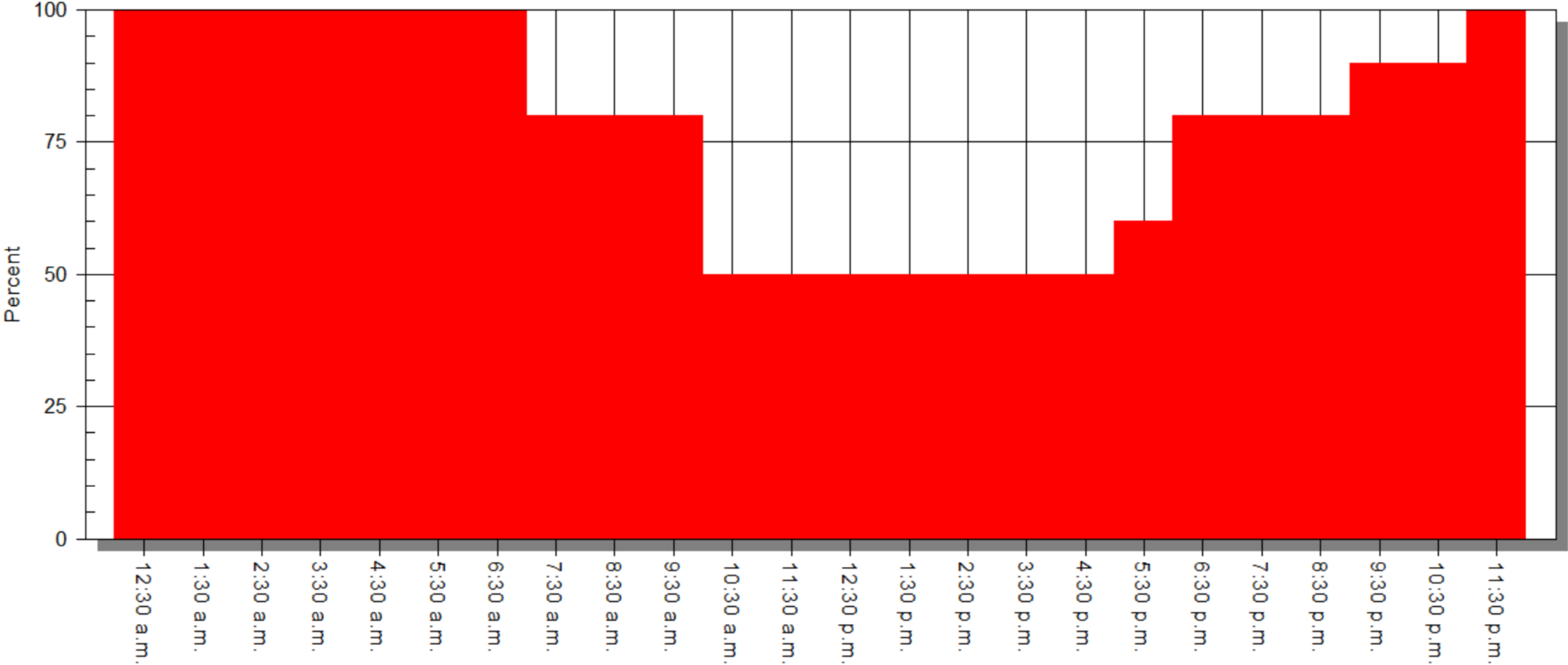
Day type: Weekday Month: January



Energy Modelling – Schedules – People Example

Steamboat - People - Apartment

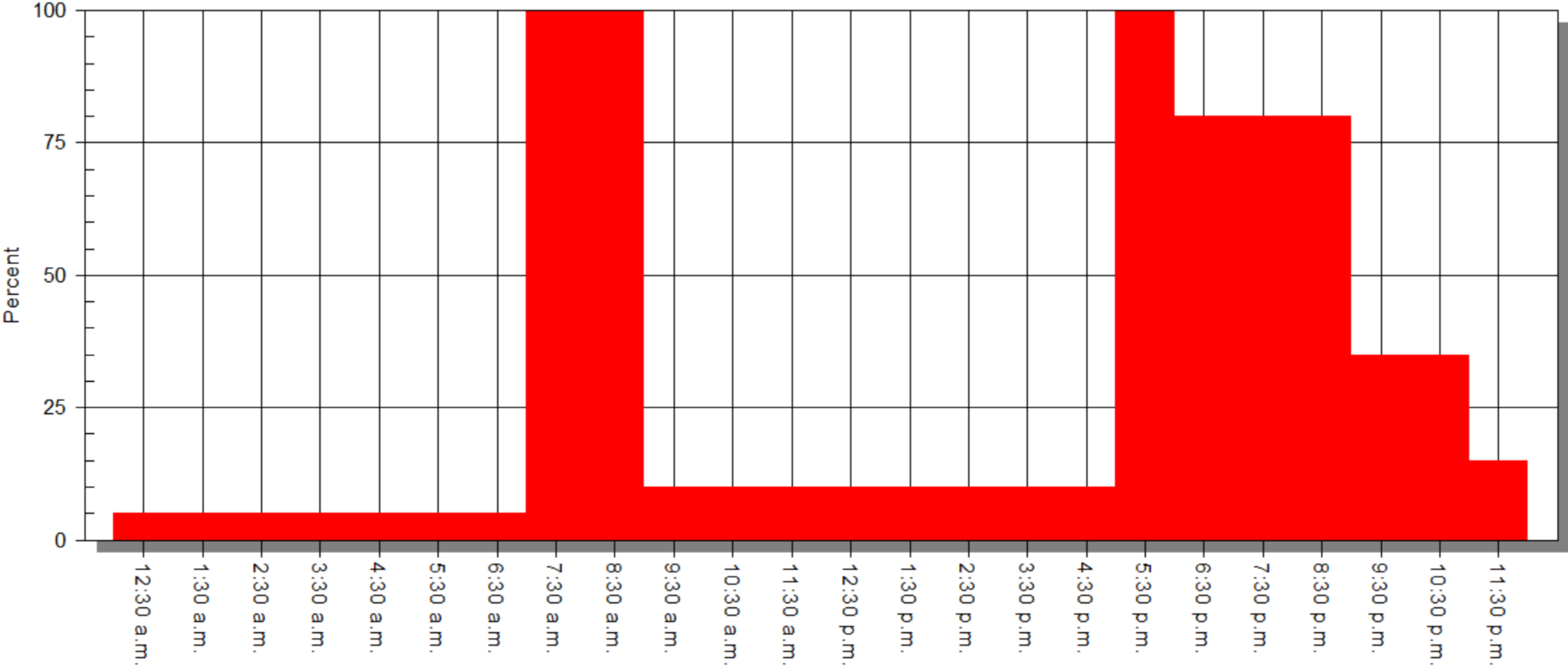
Day type: Saturday Month: August



Energy Modelling – Schedules – Lights Example

Steamboat - Lights - Apartment

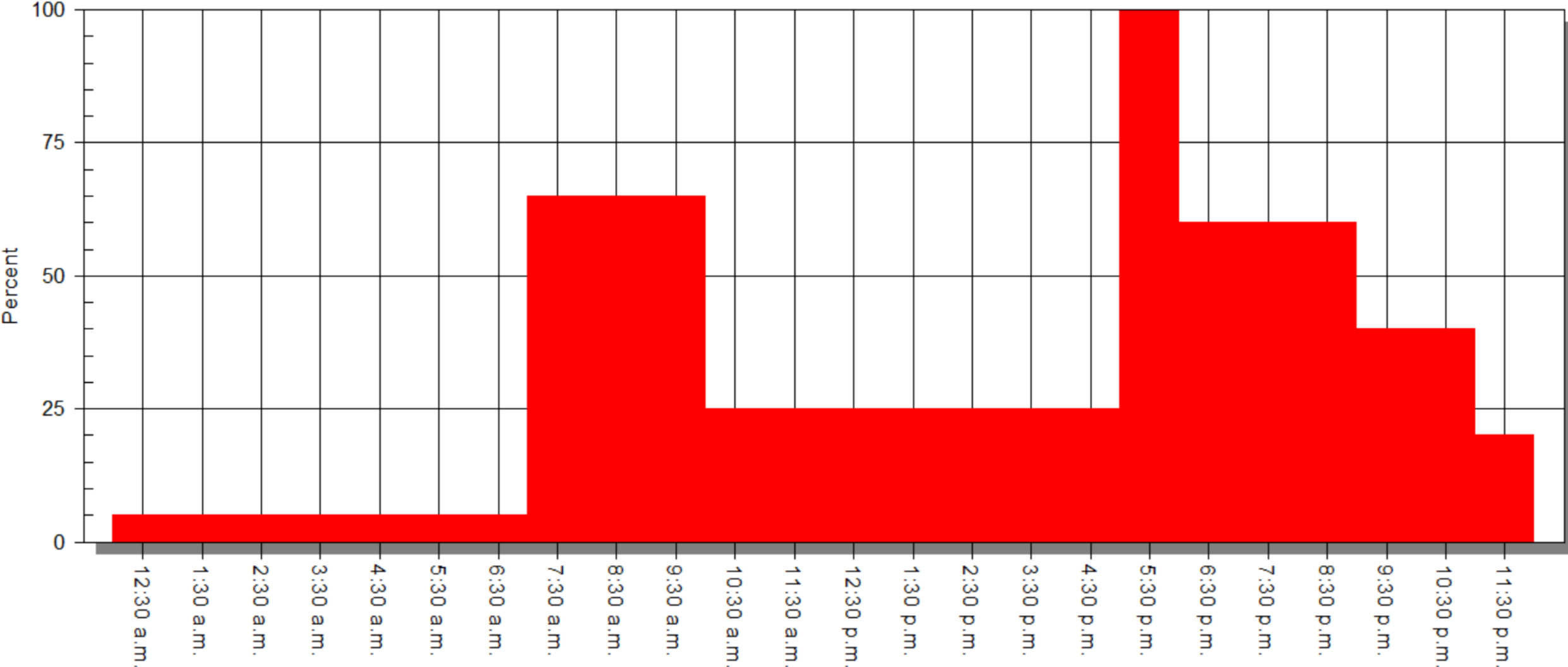
Day type: Weekday Month: January



Energy Modelling – Schedules – Lights Example

Steamboat - Lights - Apartment

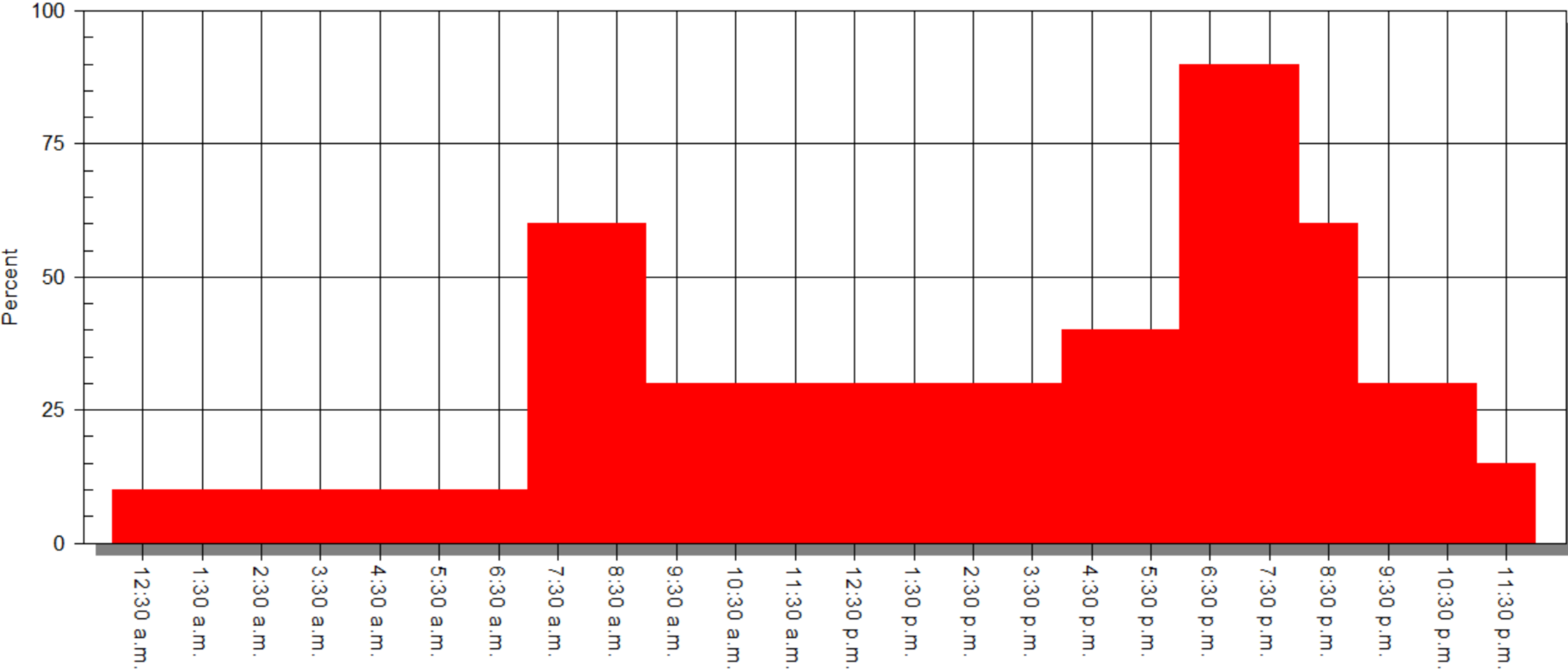
Day type: Saturday Month: January



Energy Modelling – Schedules – Misc Example

Steamboat - Misc - Apartment

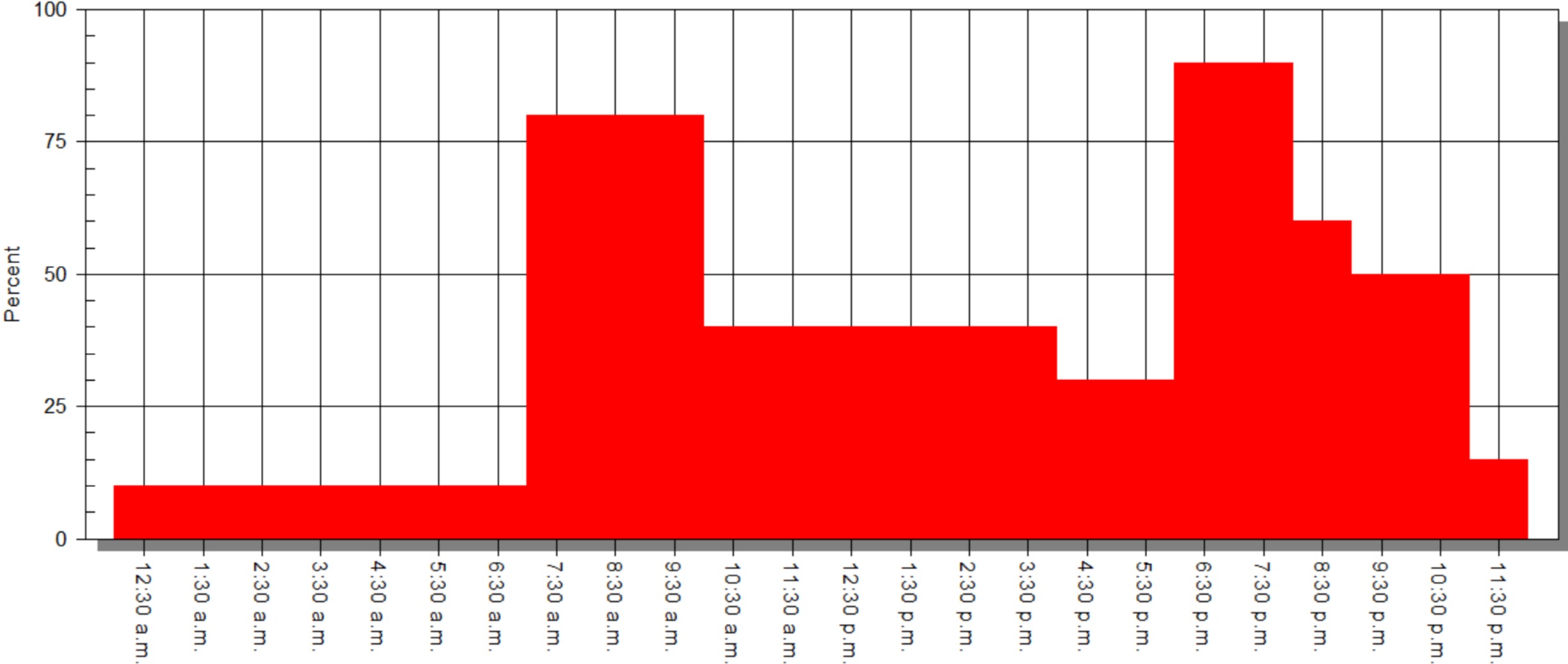
Day type: Weekday Month: January



Energy Modelling – Schedules – Misc Example

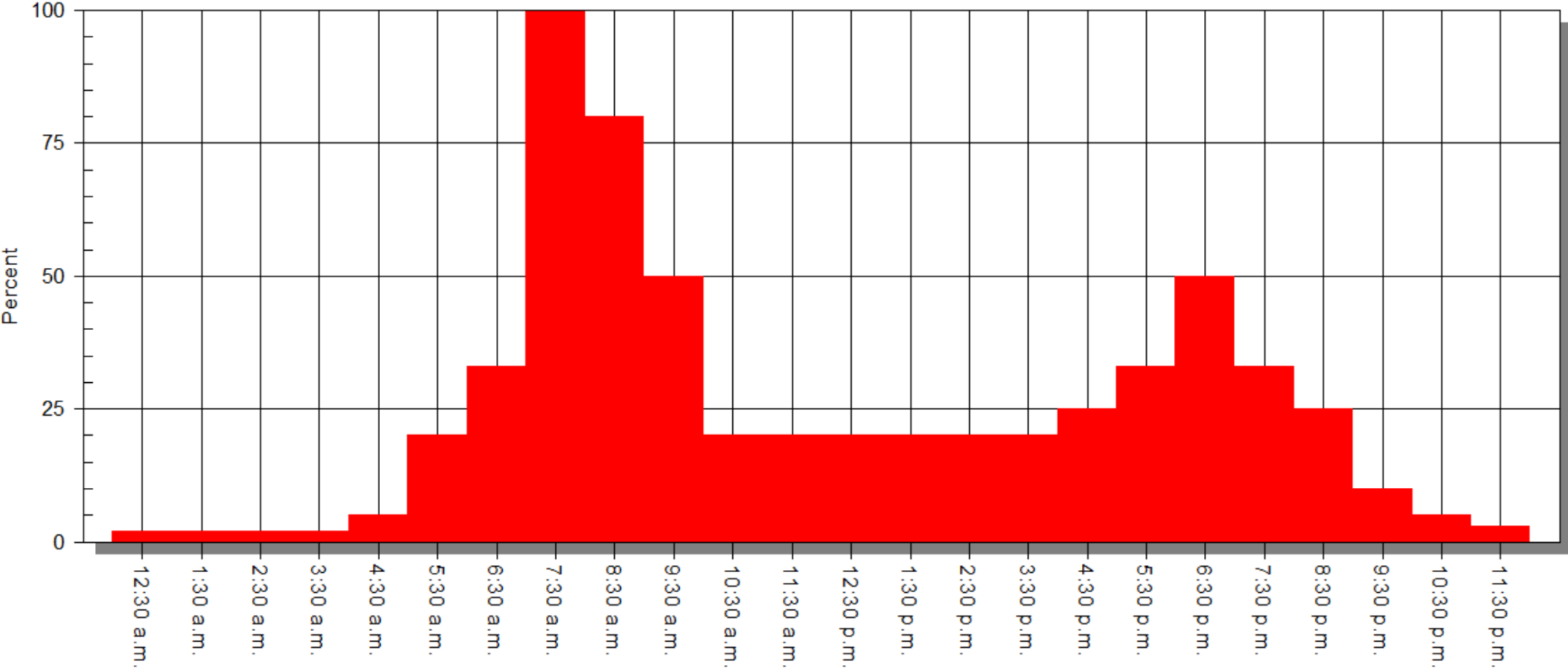
Steamboat - Misc - Apartment

Day type: Saturday Month: January



Energy Modelling – Schedules – DHW Example

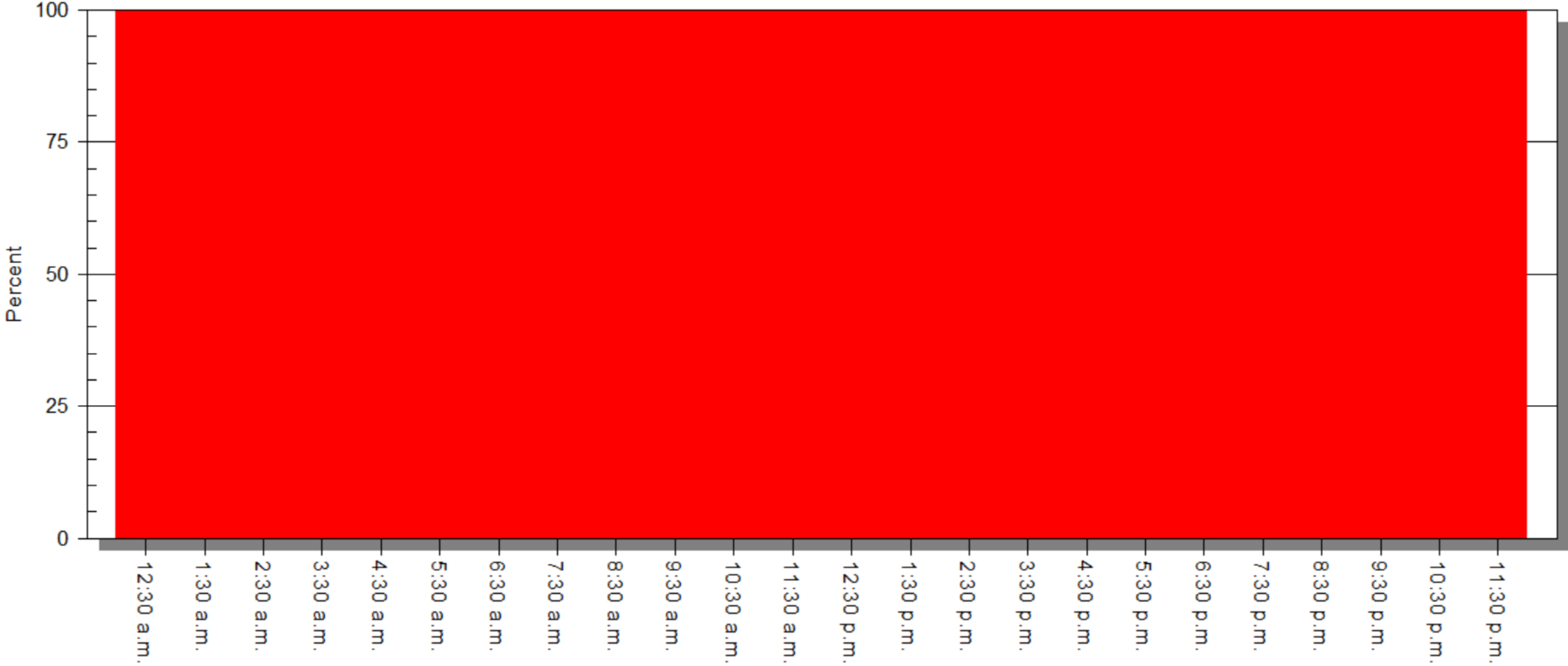
Hot Water - Apartment
Day type: Weekday Month: January



Energy Modelling – Schedules – Ventilation Example

Vent - Apartment Complex

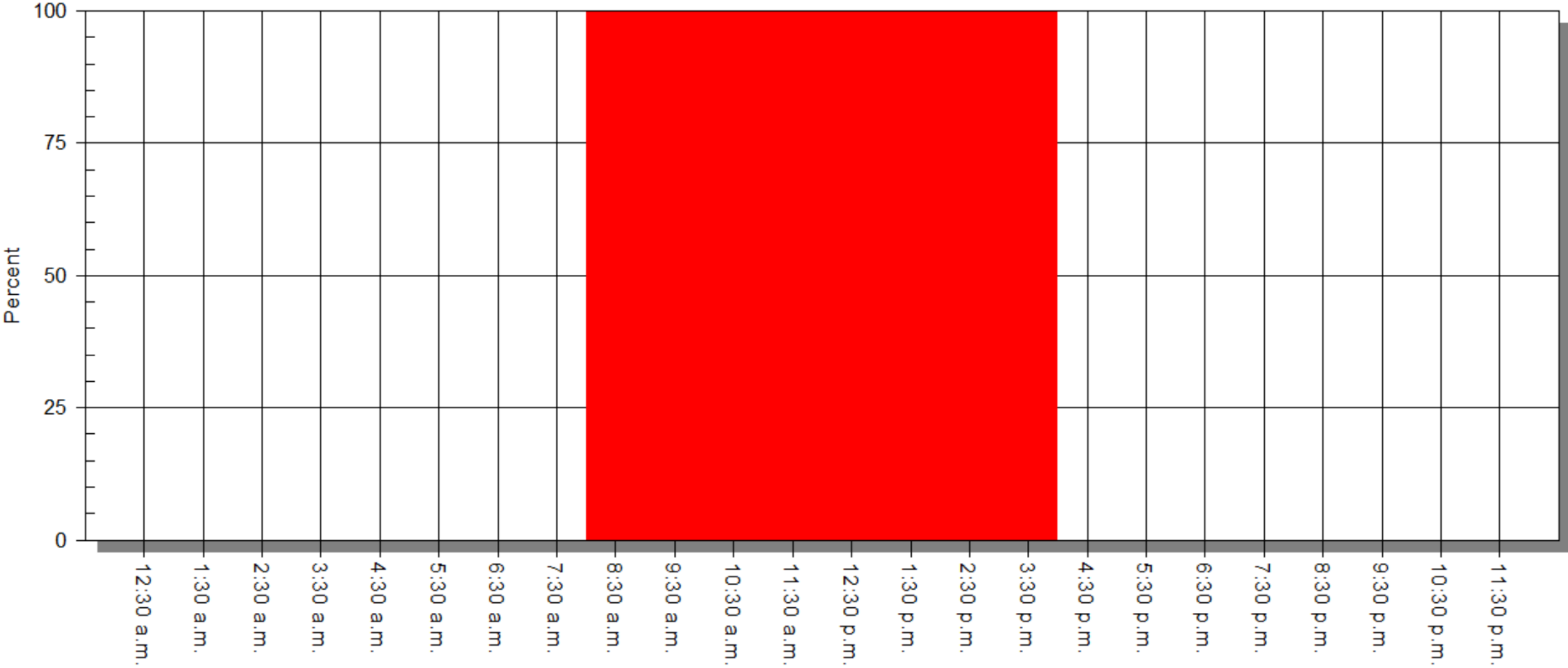
Day type: Weekday Month: January



Energy Modelling – Schedules – Ventilation Example

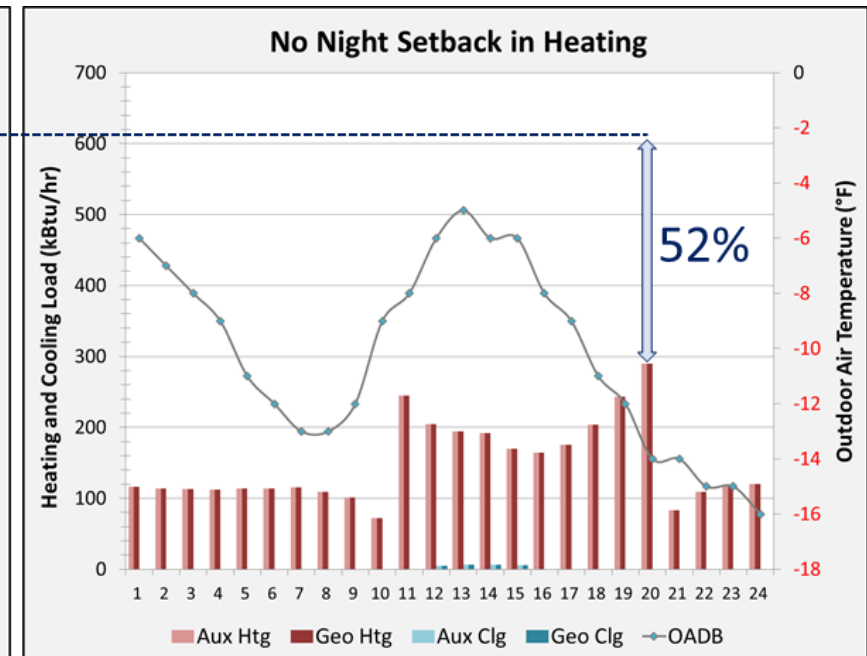
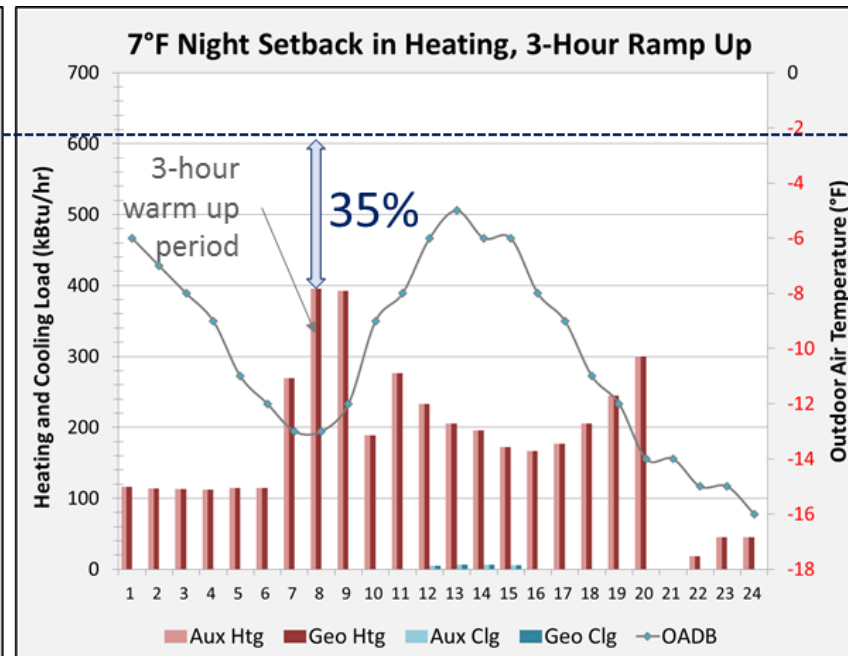
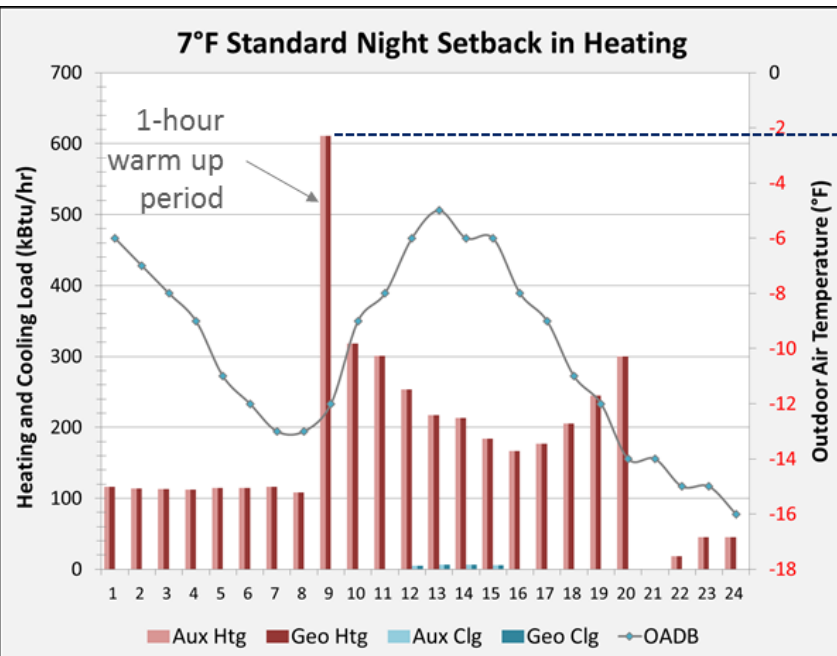
Vent - School

Day type: Weekday Month: January

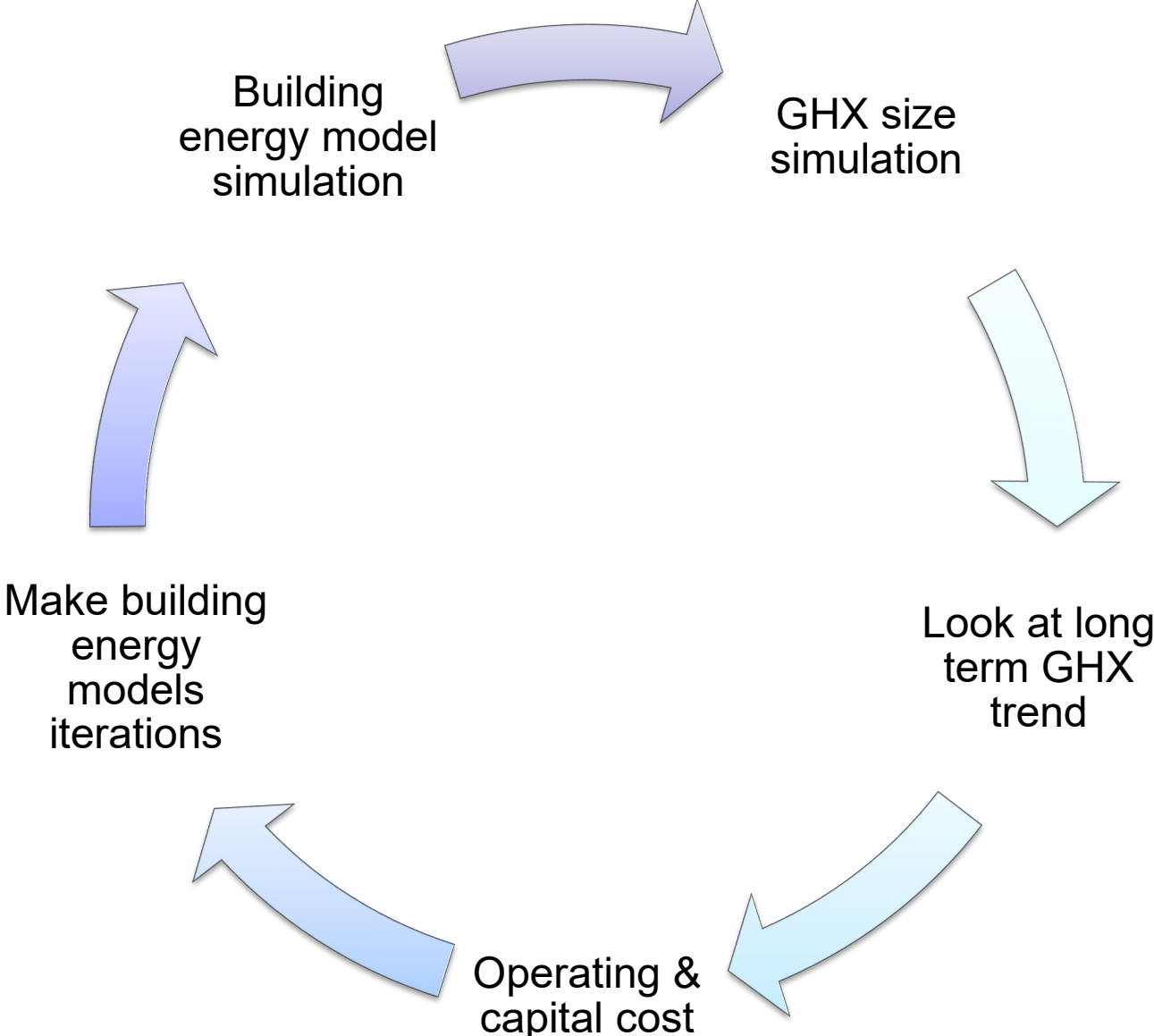


Energy Modelling – Schedules – Night-time Setback

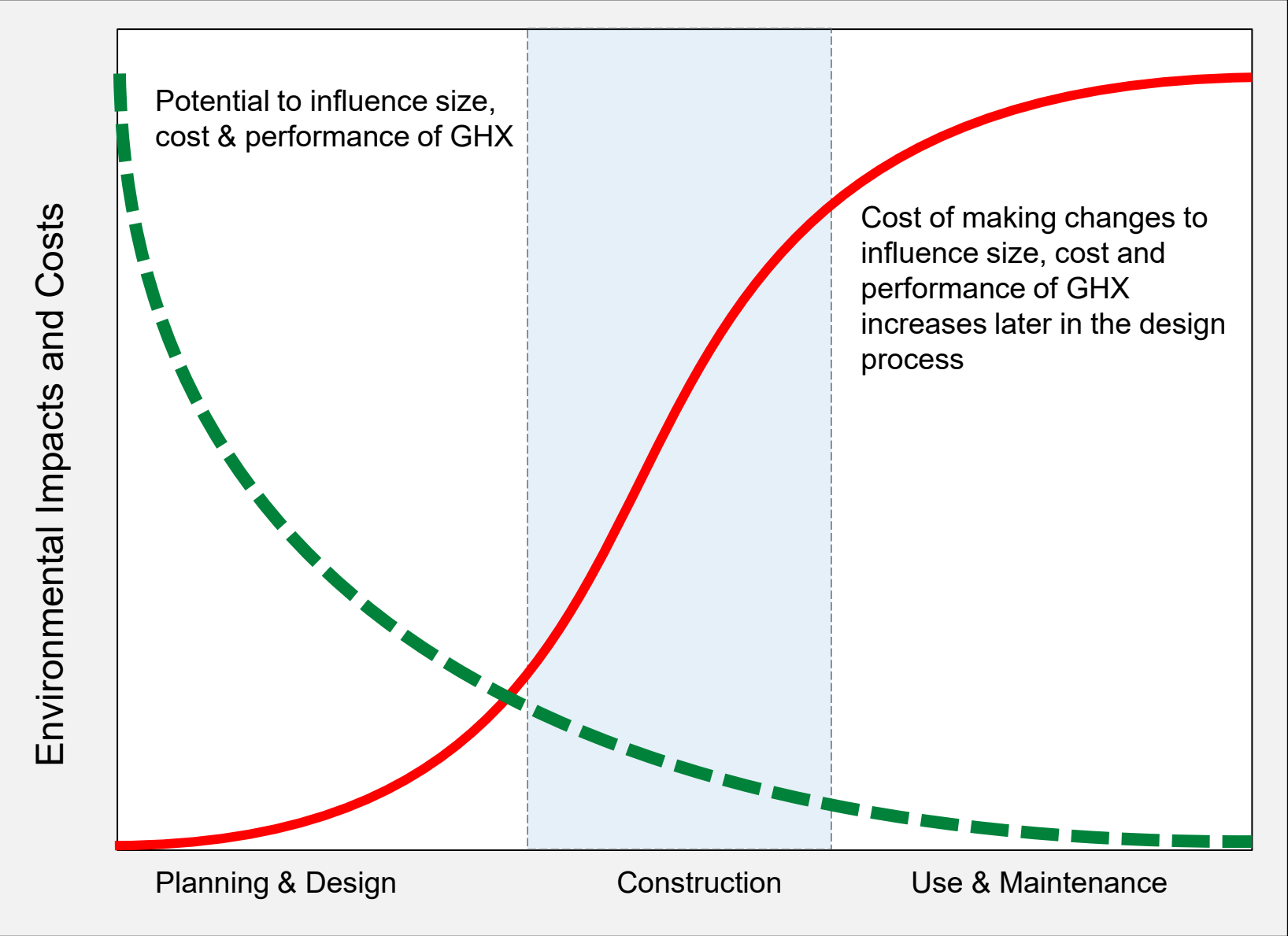
- Small difference in energy savings for GSHP system
- Increase peak heating loads
- Increase in GHX size



Energy Modelling – Mental Model



Energy Modelling as a Design Tool

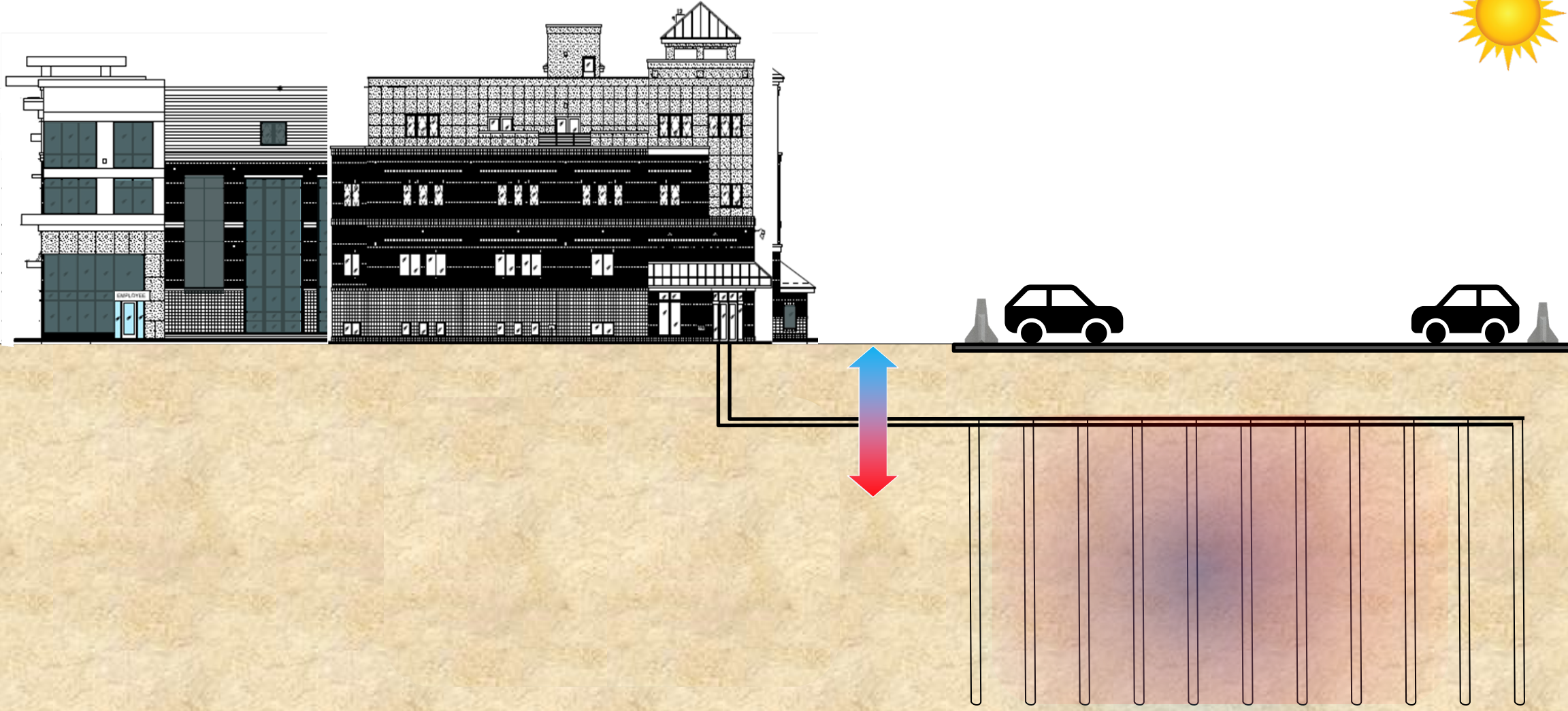


Case Study 1 – Office Expansion

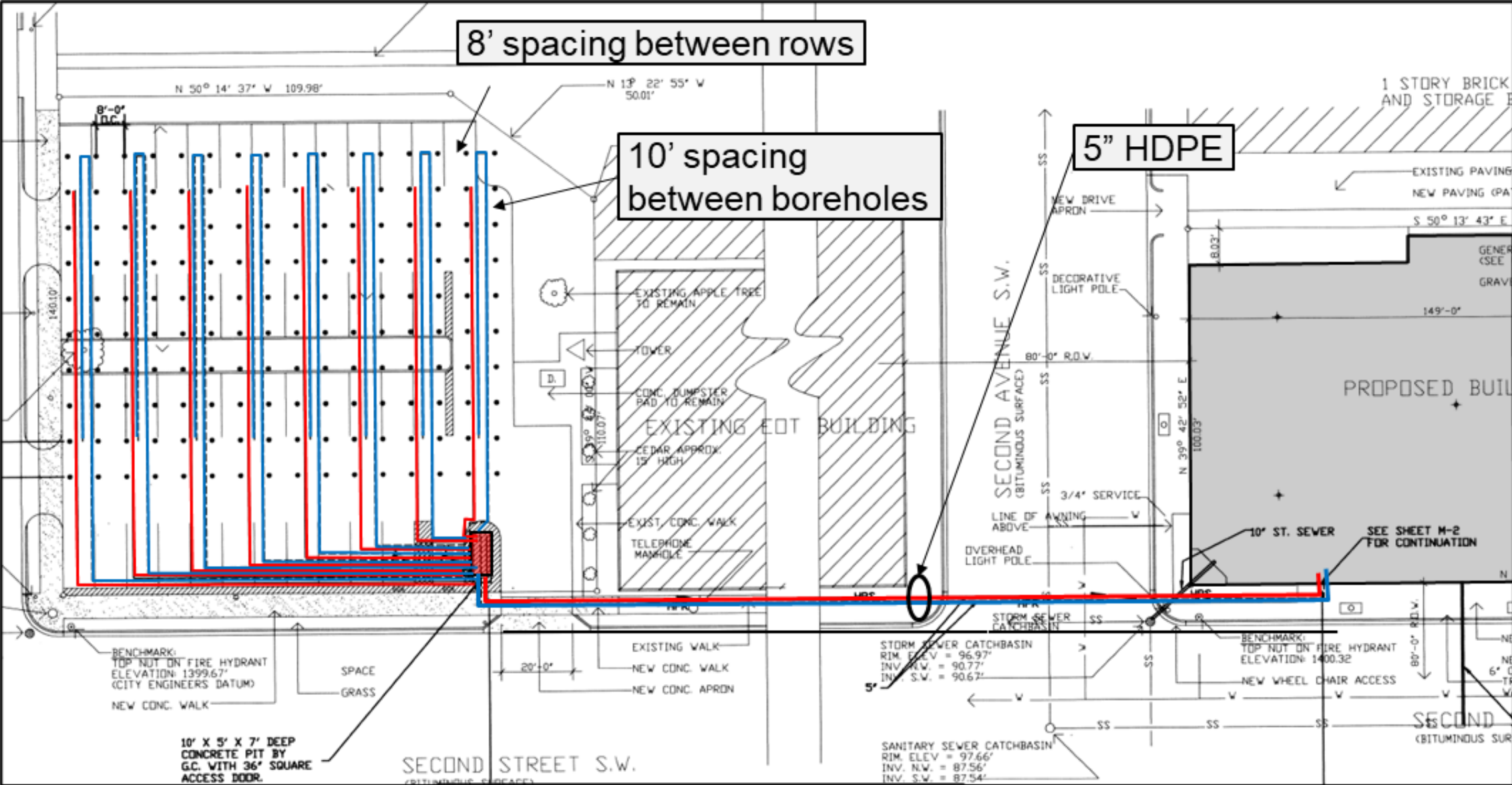
- Increased floor area by 28%
- Increased window to wall ratio to 30%
- Existing GSHP system



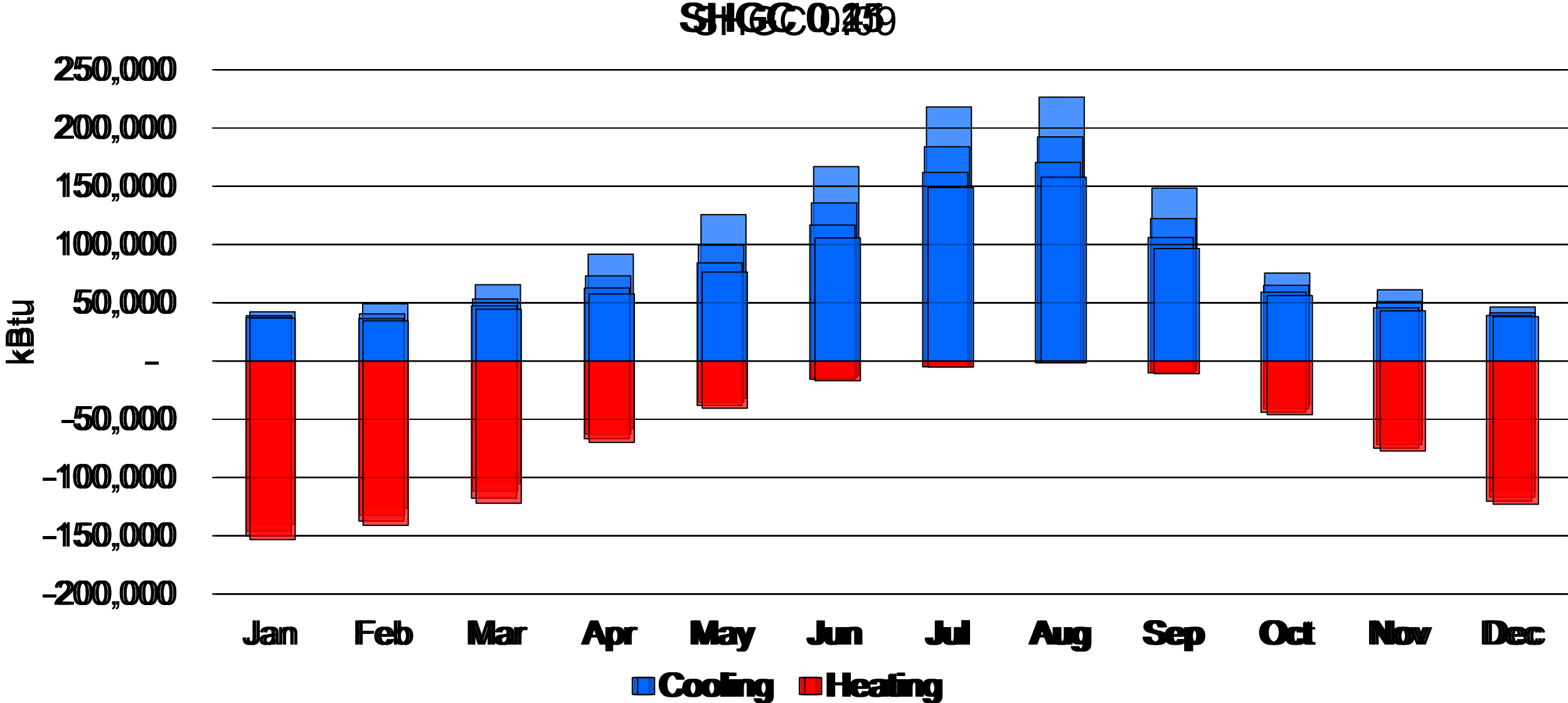
Case Study 1 - Project Description



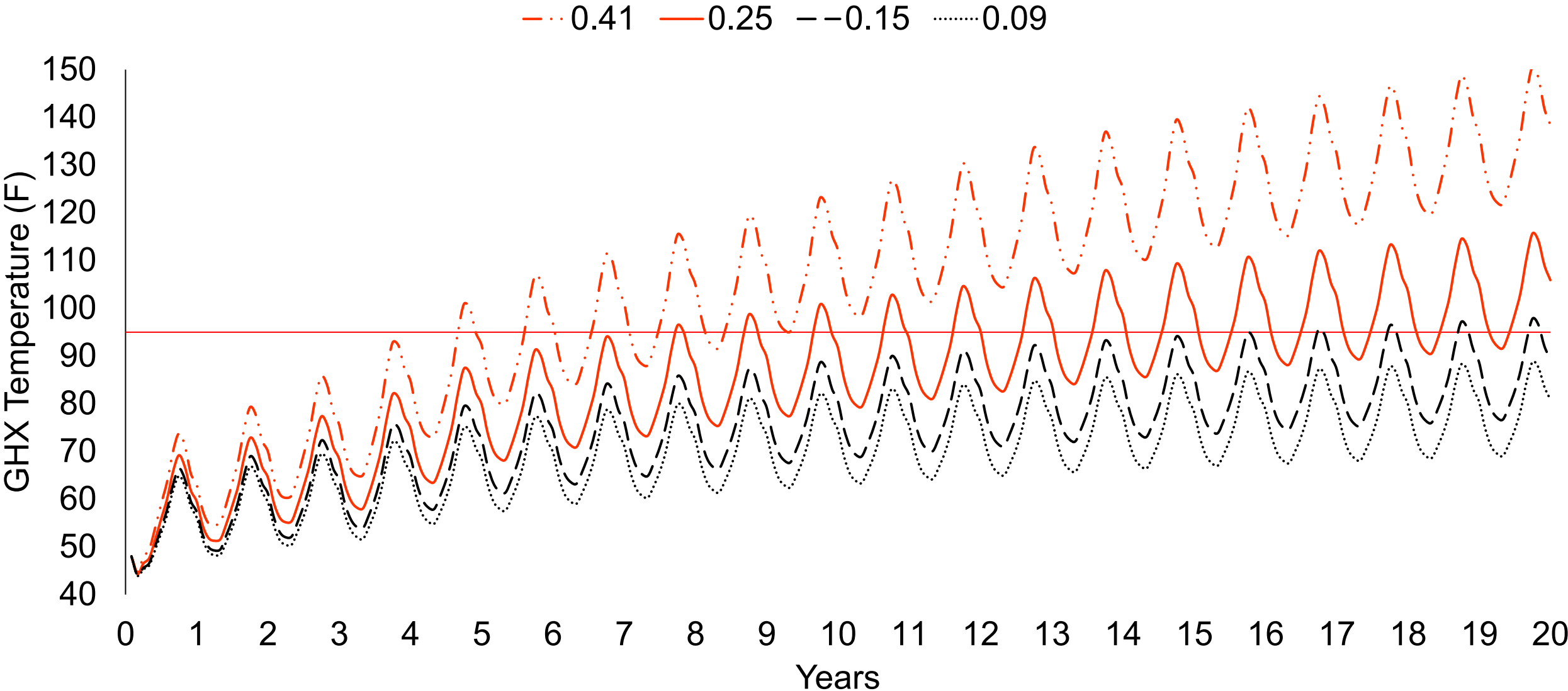
Case Study 1 - GHX Description



Case Study 1 - Annual Energy Load Variability

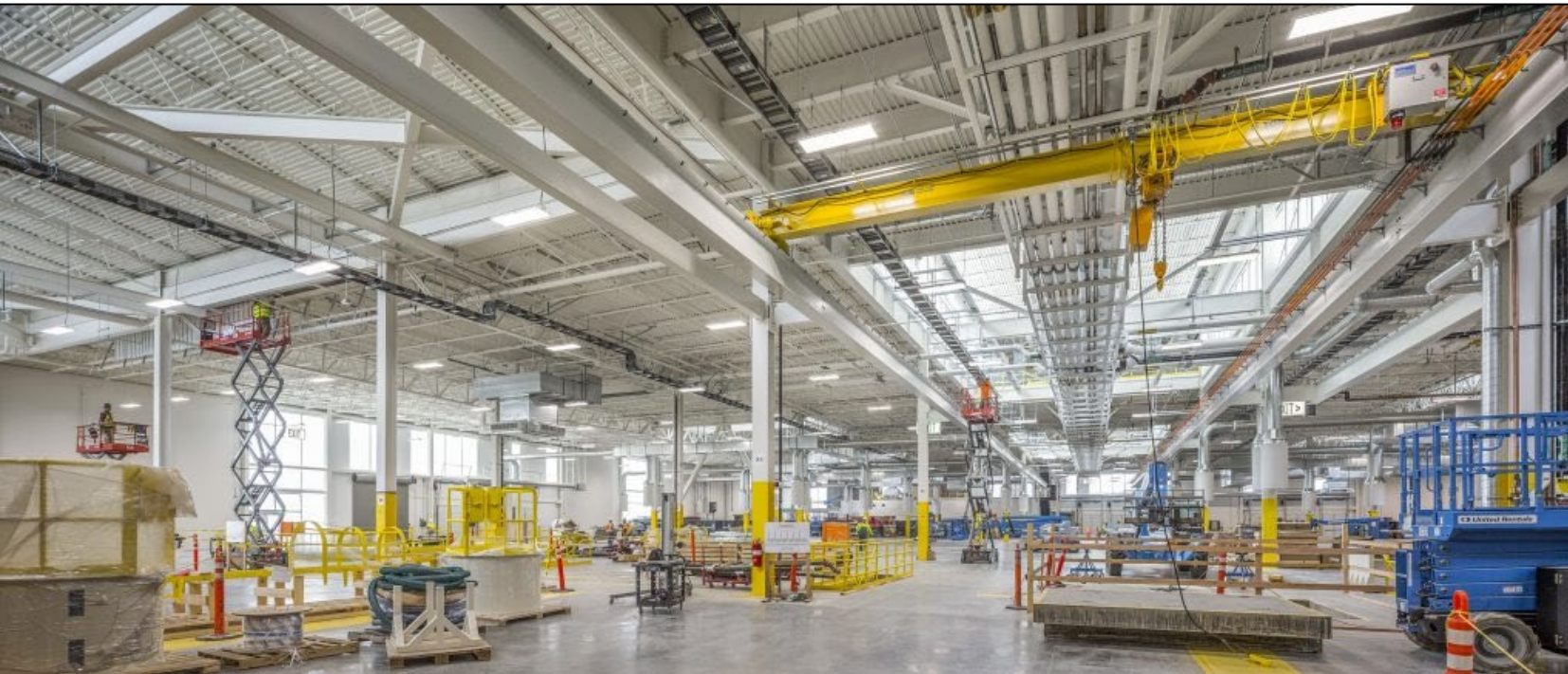


Case Study 1 - Long-Term GSHP Temperature



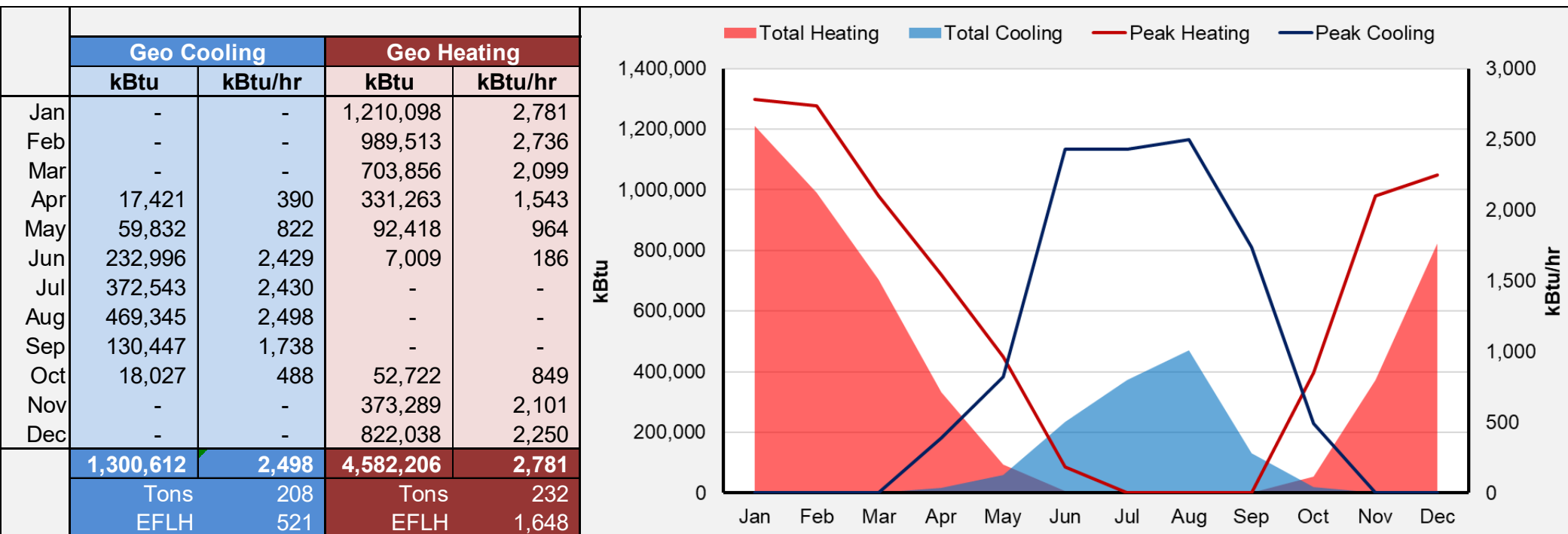
Case Study 2 – Warehouse Retrofit

- 250,000 ft² manufacturing facility
- Existing natural gas heating system
- Interested in GSHP system



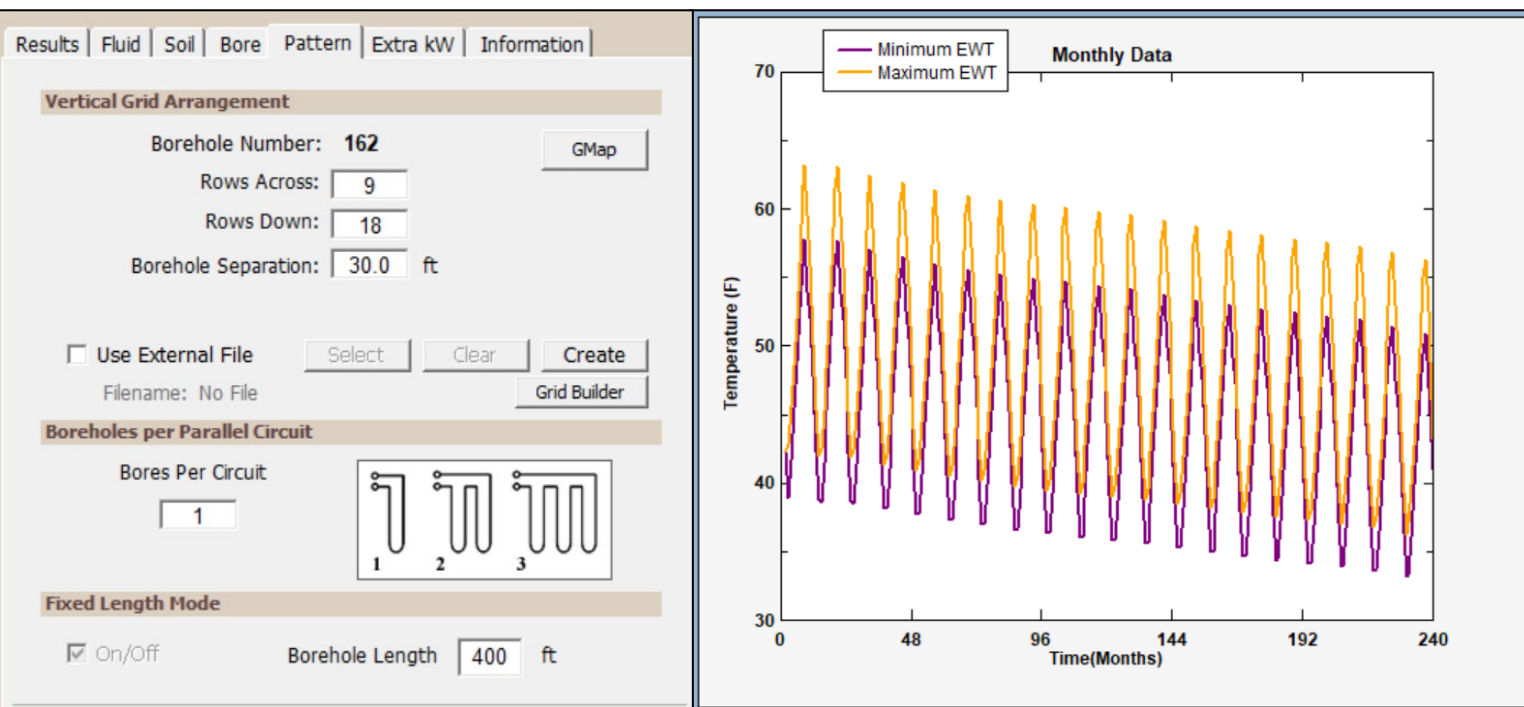
Case Study 2 – Energy Model V1

- Trace Trace 700 used to model building
- Floor plans and interviews with the building owners used to develop energy model



Case Study 2 – GHX Size V1

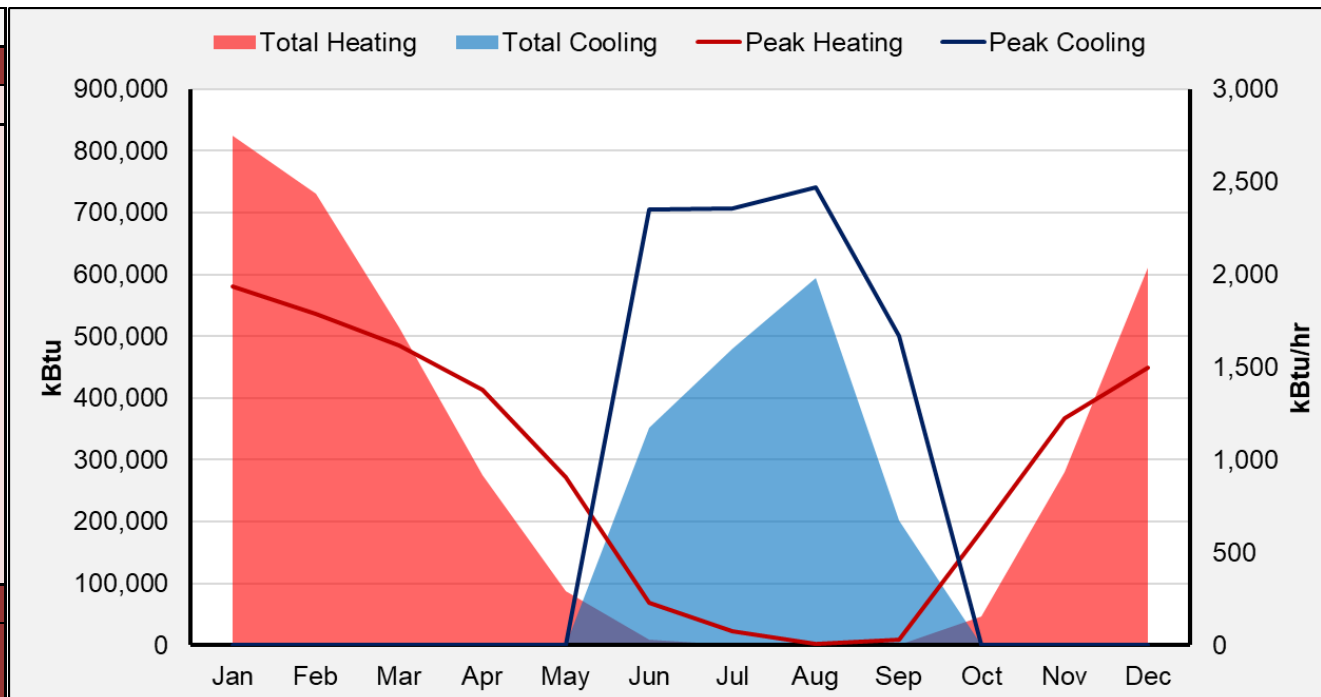
- 162 boreholes to a depth of 400 ft with 30 ft spacing
- Maintains a minimum EWT of 32°F and maximum of 90°F over 20 years



Case Study 2 – Energy Model V2

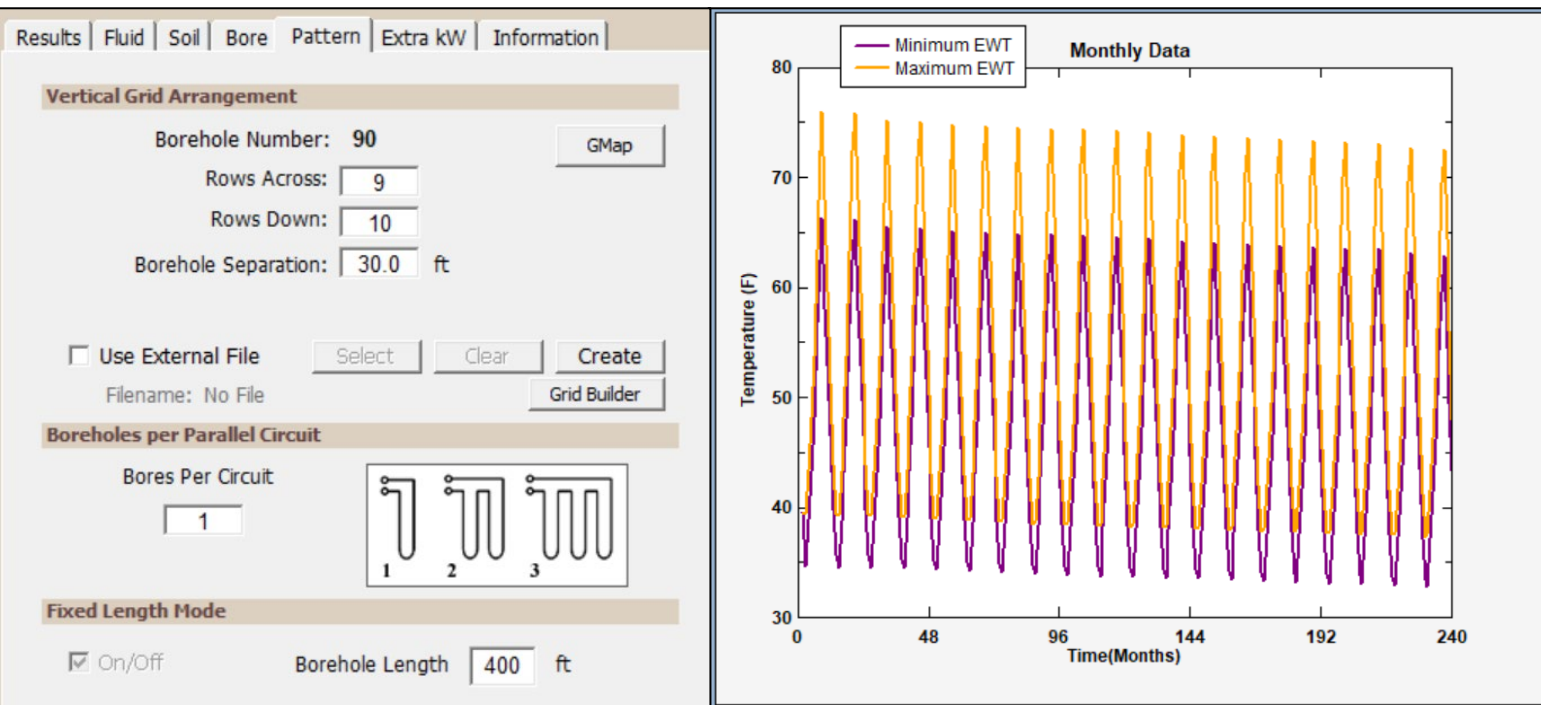
- Sensible wheel energy recovery ventilation added
- Reduces total amount of heating needed and increases the energy balance

	Geo Cooling		Geo Heating	
	kBtu	kBtu/hr	kBtu	kBtu/hr
Jan	-	-	824,585	1,935
Feb	-	-	730,205	1,787
Mar	-	-	514,002	1,617
Apr	-	-	274,914	1,378
May	-	-	87,081	906
Jun	351,188	2,351	8,199	230
Jul	479,326	2,354	1,154	77
Aug	594,135	2,472	30	7
Sep	202,286	1,668	348	28
Oct	-	-	46,179	614
Nov	-	-	280,254	1,227
Dec	-	-	611,906	1,499
	1,626,935	2,472	3,378,857	1,935
	Tons	206	Tons	161
	EFLH	658	EFLH	1,746

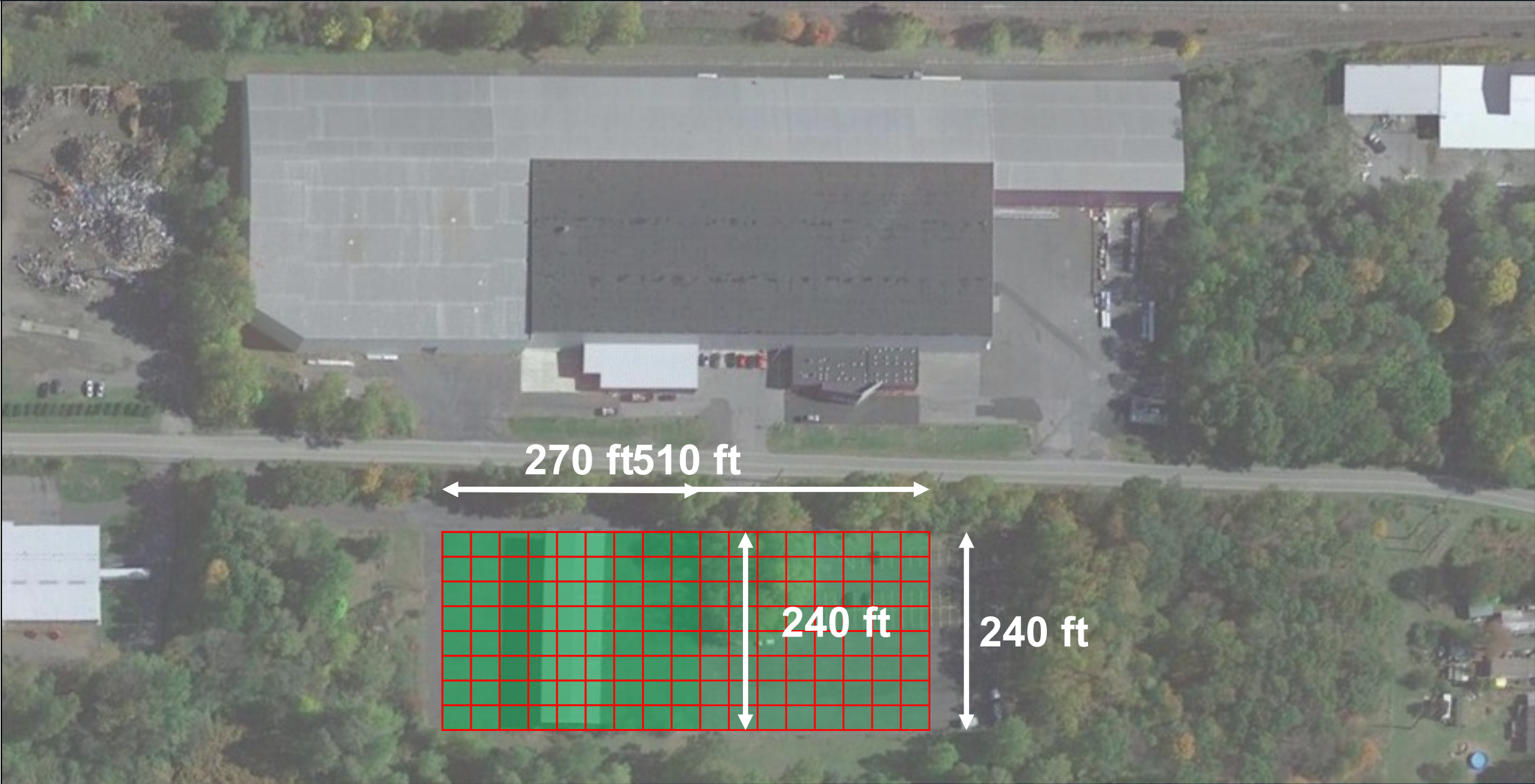


Case Study 2 – GHX Size V2

- 90 boreholes to a depth of 400 ft with 30 ft spacing
- Maintains a minimum EWT of 32°F and maximum of 90°F over 20 years

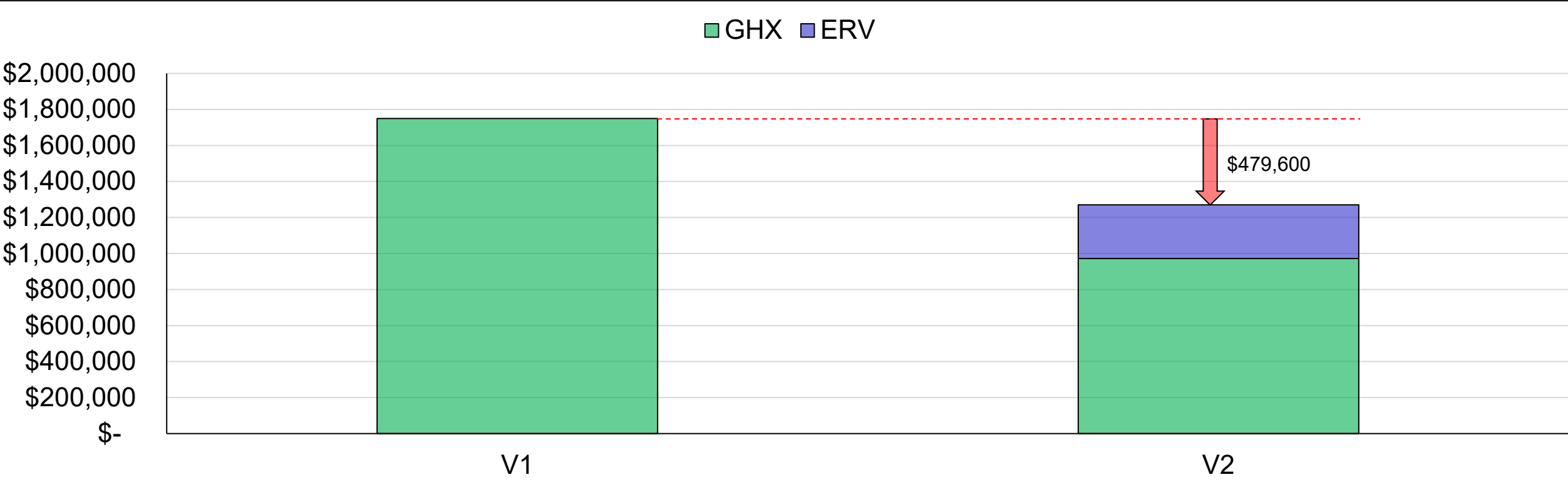


Case Study 2 – GHX Reduction

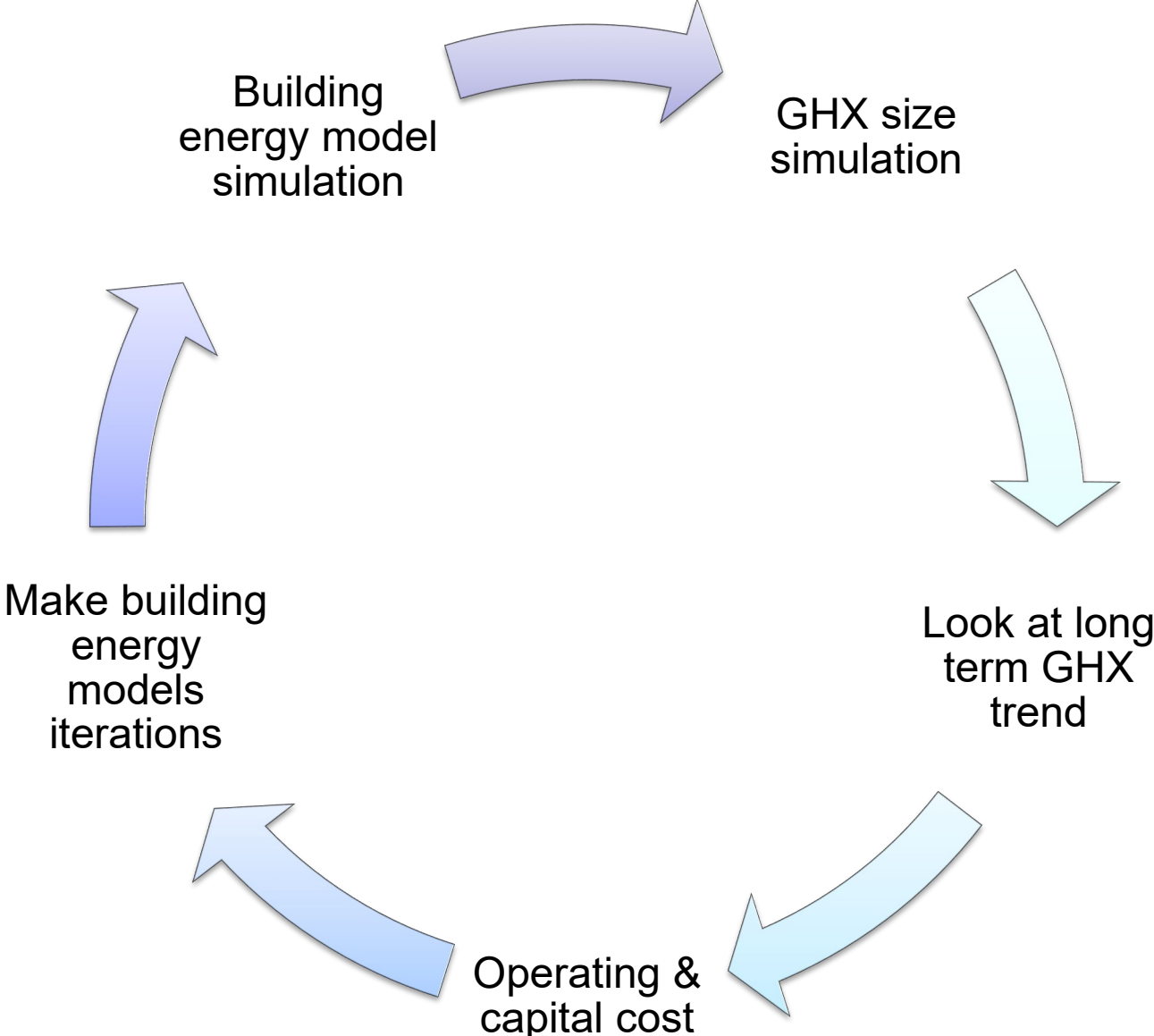


Case Study 2 – Economics

- Vertical drilling in region was \$27/ft supplied and installed
- V2 reduces total capital cost and increase long term sustainability of GHX

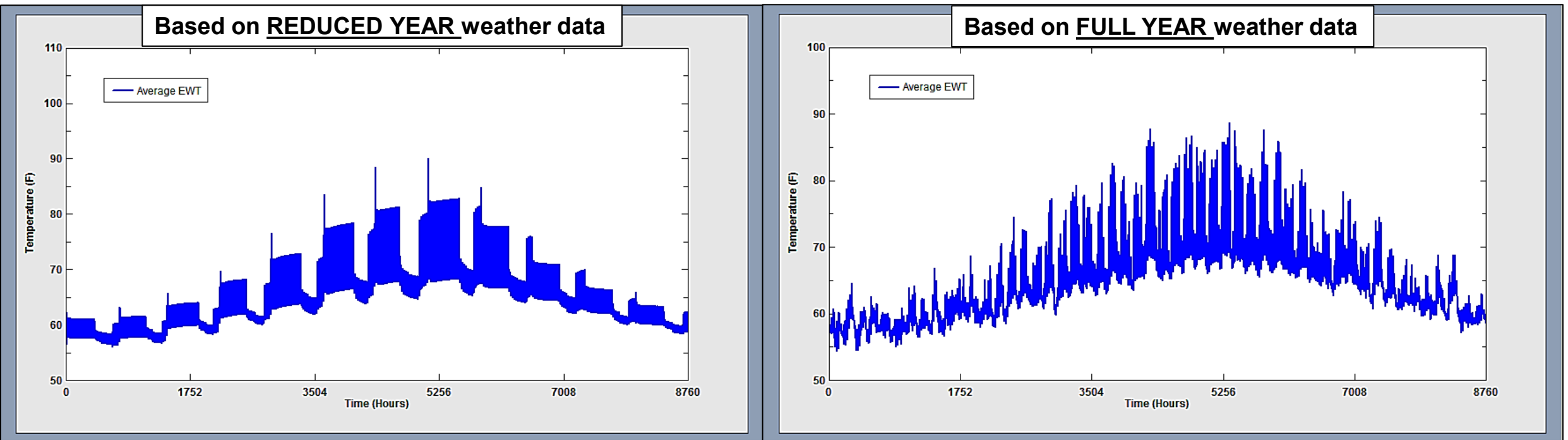


Energy Modelling – Mental Model



Weather Data

- Some modelling software defaults to reduced year weather data
- Reduced weather data only includes weekday, Monday, Saturday, and Sunday
- Important to use full-year weather data (TMY, CWEC, EPW etc.)



Learning Objectives

- Importance of schedules inside energy models

Schedules allow for modelling hourly block loads of the building which creates a more accurate energy model.

- Difference between peak loads vs. block loads











Hourly loads for each hour are aggregated to determine peak block loads of building. Peak loads in each zone occur at different times but are summated.

- Difference between reduced weather data vs full weather data

Reduced weather data only includes weekday, Monday, Saturday, and Sunday

- How many people energy model?
- What software do you use?
 - IES
 - Trane Trace
 - eQuest
 - Carrier Hap

Trane Trace Export Demo

		Alternative 1	Alternative 2	Alternative 3	Alternative 4
	Enter Project Information	Demo - Alt 1	Demo - Alt 2	Demo - Alt 3	Demo - Alt 4
	Select Weather Information	8760 Stroudsberg	8760 Stroudsberg	8760 Stroudsberg	8760 Stroudsberg
	Create Templates	28 Templates	28 Templates Based on Alternative 1	Use Alternative 2 Based on Alternative 1	28 Templates
	Create Rooms	36 Rooms	Use Alternative 1	Use Alternative 1	36 Rooms
	Create Systems	2 Systems	Use Alternative 1	Use Alternative 1	2 Systems
	Assign Rooms to Systems	36 Assigned Rooms	36 Assigned Rooms	36 Assigned Rooms	36 Assigned Rooms
	Create Plants	4 Plants	4 Plants Based on Alternative 1	4 Plants Based on Alternative 2	2 Plants
	Assign Systems to Plants	System Assignments	System Assignments	System Assignments	System Assignments
	Define Economics	No utility rates defined 0(\$)	No utility rates defined 0(\$)	No utility rates defined 0(\$)	No utility rates defined 0(\$)
	Calculate and View Results	01/19/2023 - 12:16 PM	01/19/2023 - 12:16 PM	01/19/2023 - 12:16 PM	01/19/2023 - 12:16 PM

Trane Trace Export Demo

File Edit Actions View Options Libraries Templates Alternatives Setup Window Help

Create Plants

Cooling Equipment - Alternative 2

Cooling plant: GSHP

Equipment tag: Air-cooled chiller - 002

Category: Water source heat pump

Equipment type: WaterFurnace NXW Heat Pump

Sequencing type: Single

Backup heat source: GAS RTU

Reject condenser heat: Ground loop

Reject heat to plant:

Heat Rejection

Type: None

Hourly ambient wet bulb offset: °F

Thermal Storage

Type: GLHE designed for 3F (2C) TD wellfield

Capacity: 479.6 gal/ton

Schedule: Heatpump

Controls...

Apply

Close

New Equip

Copy Equip

Delete Equip

Packaged Energy Breakout...

Operating mode	Capacity	Energy rate
Cooling	tons	12.9 EER (compressor only)
Heat recovery	10.88 Mbh/ton	2.7 COP (compressor only)
Tank charging	tons	kW/ton
Tank charging & heat recovery	tons	kW/ton

Pumps	Type	Full load consumption
Primary chilled water	Cnst vol chill water pump	0 ft water
Condenser water	None	0 ft water
Heat recovery or aux condenser	None	0 ft water

Configuration Cooling Equipment Heating Equipment Base Utility / Misc. Accessory

Trane Trace Export Demo

Cooling Equipment Controls

Plant description: GSHP
Equipment tag: Air-cooled chiller - 002

OK
Cancel

Free Cooling

Type: None
Fluid cooler type: None
Pump: None
Pump full load energy: 0 kW
Refrig economizer unloading curve: None

Cooling Plant and Geothermal Controls

Evaporator and Condenser Water Leaving Reset Options

	Reset Based On	Reset Curve	Max Reset TD
Chilled Water	None	None	0 °F
Condenser Water	None	None	0 °F

Load shedding economizer: No
Evaporative precooling: No
Equipment schedule: Available (100%)
Demand limiting priority:
Hot gas reheat for dehumidification: No
Dsn chilled water delta T: 6.66667 °F
Dsn cond water delta T: 5.55556 °F

Trane Trace Export Demo

Plant Controls

Description GSHP

Sizing method Peak based on design simulation

Heat rejection

Type None

Hourly ambient wet bulb offset °F

Cogeneration type

Secondary distribution pump

Type None

Full load consumption ft water

Thermal storage

Type None

Capacity ton-hr

Schedule Off (0%)

Geothermal Loop

TLoop Ent Bldg IGSHPA None

Flow rate % of condenser flow rate

Loop pump Var vol geothermal loop pump

Pump F.L rate ft water

Flow scheme Fully mixed

Number of simulation years

Loop fluid glycol percent %

Heat exchanger approach °F






OK

Cancel

Trane Trace Export Demo

Documents > Demo

Search Demo

Name	Date modified	Type	Size
 Demo.GL1.csv	2023-01-19 11:11 AM	Microsoft Excel Comma Separat...	925 KB
 Demo.GL2.csv	2023-01-19 11:11 AM	Microsoft Excel Comma Separat...	925 KB
 Demo.GL3.csv	2023-01-19 11:11 AM	Microsoft Excel Comma Separat...	925 KB
 Demo.GL4.csv	2023-01-19 11:11 AM	Microsoft Excel Comma Separat...	925 KB
 Demo.trc	2023-03-06 10:46 AM	TRC File	466 KB

Trane Trace Export Demo

The screenshot shows the Microsoft Excel interface with the following data in the spreadsheet:

Day Of Yr	Date/Time	Heating delivered Btu/h	Cooling delivered Btu/h	Heating delivered kW	Cooling delivered kW
1	1/1/2023 1:00	1720964.88	0	504.24	0
1	1/1/2023 2:00	1468469.25	0	430.26	0
1	1/1/2023 3:00	1427599.38	0	418.28	0
1	1/1/2023 4:00	1392605.12	0	408.03	0
1	1/1/2023 5:00	1380108.25	0	404.37	0
1	1/1/2023 6:00	1365338	0	400.04	0
1	1/1/2023 7:00	1370115.38	0	401.44	0
1	1/1/2023 8:00	1382577	0	405.09	0
1	1/1/2023 9:00	1381063.62	0	404.65	0
1	1/1/2023 10:00	1368382.38	0	400.93	0
1	1/1/2023 11:00	1303377.12	0	381.89	0
1	1/1/2023 12:00	1238742.62	0	362.95	0
1	1/1/2023 13:00	1155124.38	0	338.45	0
1	1/1/2023 14:00	1119405	0	327.98	0
1	1/1/2023 15:00	1110362	0	325.33	0
1	1/1/2023 16:00	1127535	0	330.36	0
1	1/1/2023 17:00	1179351.88	0	345.55	0
1	1/1/2023 18:00	1270520.25	0	372.26	0
1	1/1/2023 19:00	1339848.75	0	392.57	0
1	1/1/2023 20:00	1370701.62	0	401.61	0
1	1/1/2023 21:00	1415199.12	0	414.65	0

Trane Trace Export Demo

View Results ✕

Alternative: 1 2 3 4 Reports selected: 2

Profiles

- System load
- Building cooling / heating demand [?](#)
- Building temperature
- Building humidity
- Cooling Tower Analysis
- Plant Load Summary

Economic

- Parameters
- Monthly utility costs
- Yearly cash flow
- Alternative comparison
- Summary

Energy Consumption

- Monthly
- Equipment
- Utility peak
- Summary

- Cogeneration
- Thermal storage [?](#)
- Geothermal Summary

Buttons: Close, Print, Preview, Export..., Clear All, Select All, Graph Profiles and Energy, Graph Economics

Report Categories: Design Reports, **Analysis Reports**, ASHRAE / LEED Reports, Detailed Reports

Carrier HAP Export Demo

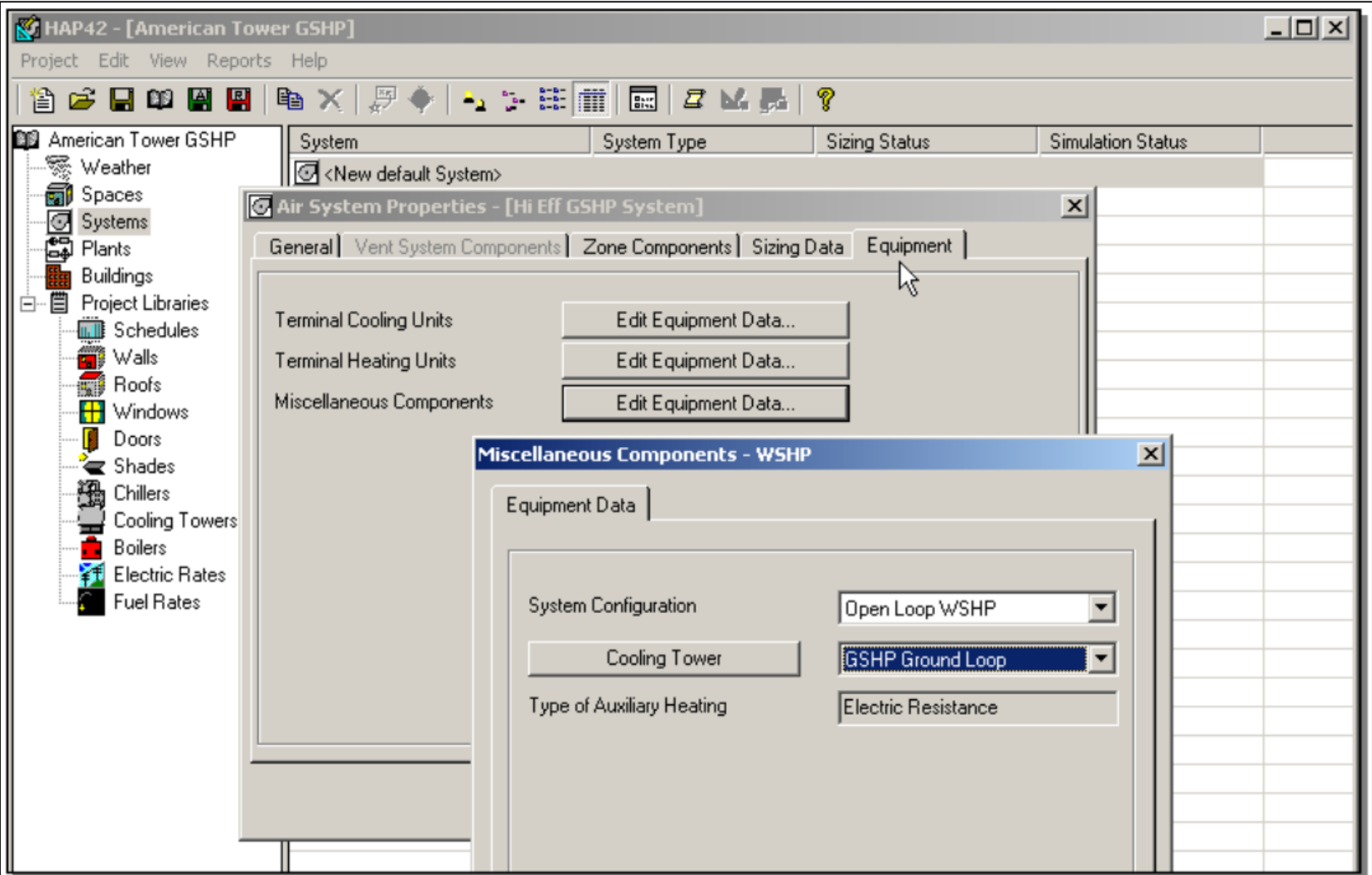
The screenshot shows the Carrier HAP software interface. The main window is titled "HAP42 - [American Tower GSHP]". A tree view on the left shows the project structure, with "Cooling Towers" selected. The "Cooling Tower Properties - [GSHP Ground Loop]" dialog is open, showing the following details:

- Name: GSHP Ground Loop
- Modeling Method: River, Sea or Well Water
- Condenser Water Flow Rate: 1500.0 gpm
- Condenser Pump Head: 60.0 ft wg
- Condenser Pump Mech. Efficiency: 80.0 %
- Condenser Pump Elec. Efficiency: 94.0 %

The "River or Sea Water" section contains a table with the following data:

Month	Avg. ECWT(°F)
Jan	45.0
Feb	53.3
Mar	61.6
Apr	69.9
May	78.2
Jun	86.5
Jul	94.8
Aug	86.1
Sep	77.5
Oct	69.1
Nov	60.0
Dec	52.5

Carrier HAP Export Demo



Carrier HAP Export Demo

Air System Simulation Reports

Reports	Table	Graph	ASCII	Time Specifications
Monthly Simulation Results	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	From <input type="text" value="Jan, 1"/> to <input type="text" value="Dec, 31"/>
Daily Simulation Results	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Hourly Simulation Results	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	
Unmet Loads Report	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Zone Temperature Report	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Graph Specifications

Select up to 3 data items for the graph. All must have the same units of measure.

Note: Graph options are only available when a single system has been selected and that system was previously simulated.

TXT File of Hourly Simulation Results

Restore Defaults Print... Preview... Cancel Help

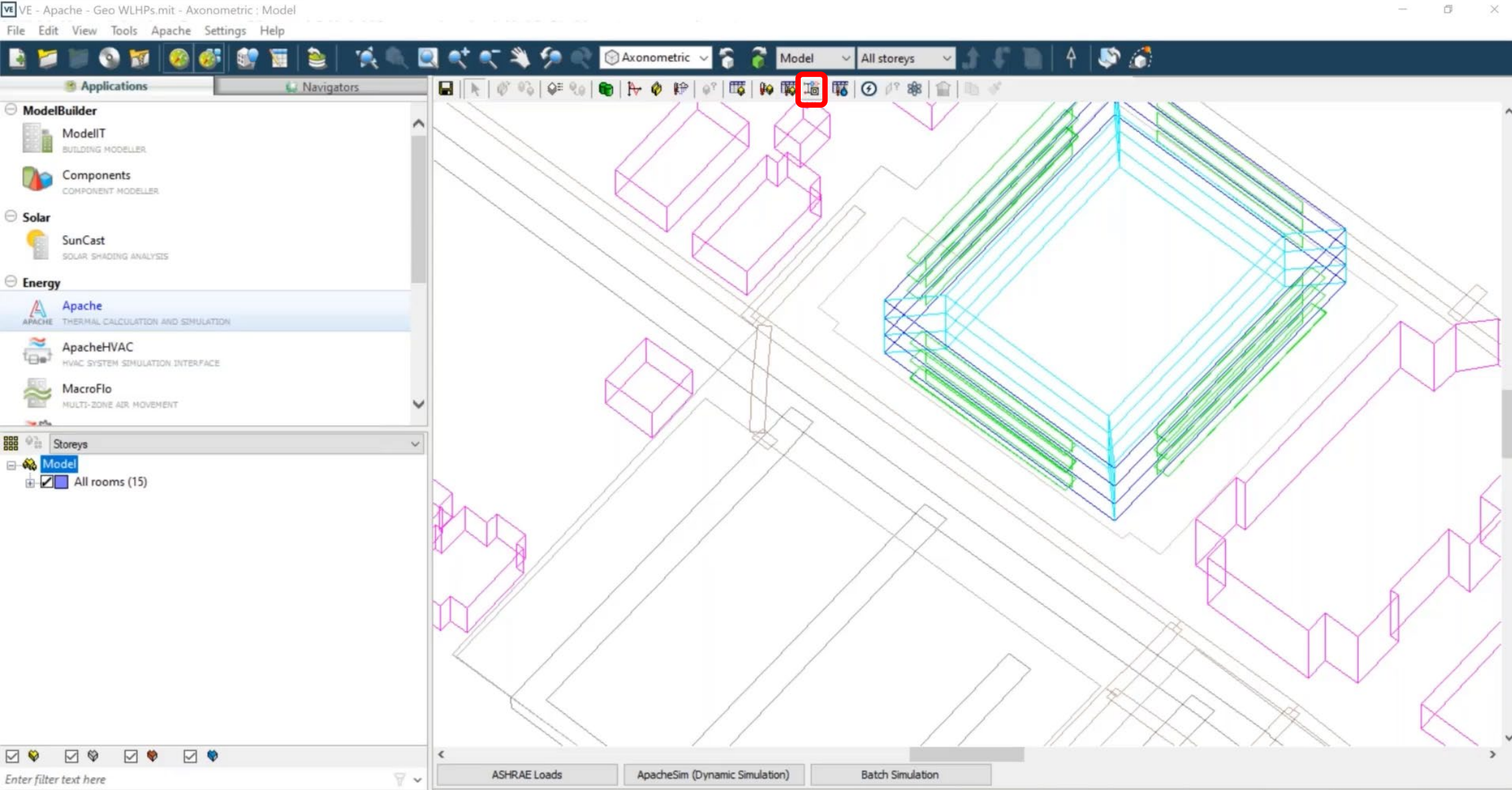
Carrier HAP Export Demo

The screenshot shows the Microsoft Excel interface with the following details:

- File Name:** HAP51_Hourly_HP-1.csv
- Worksheet:** HAP51_Hourly_HP-1
- Table Headers (Row 3):**
 - Month
 - Day
 - Hour
 - Dry-Bulb
 - Wet-Bulb
 - WSHP Cooling Coil Load (MBH)
 - WSHP Eqpt
 - WSHP Clg Co
 - WSHP Heating Coil Load (MBH)
 - WSHP Eqpt
 - WSHP Ht
 - WSHP Au
 - WSHP Au
 - Ventilati
- Highlighted Columns (Red Boxes):**
 - WSHP Cooling Coil Load (MBH)
 - WSHP Heating Coil Load (MBH)
- Sample Data (Rows 4-23):**

Month	Day	Hour	Dry-Bulb	Wet-Bulb	WSHP Cooling Coil Load (MBH)	WSHP Eqpt	WSHP Clg Co	WSHP Heating Coil Load (MBH)	WSHP Eqpt	WSHP Ht	WSHP Au	WSHP Au	Ventilati
January	1	0	9.6	8.3	5.4	-5400	5.4	2.3	2300	2.3	0.2	0	0
January	1	1	5.1	3.9	5.2	-5200	5.2	2.4	2400	2.4	0.2	0	0
January	1	2	1.9	0.7	5.2	-5200	5.2	2.5	2500	2.5	0.2	0	0
January	1	3	0.4	-0.7	5.2	-5200	5.2	2.6	2600	2.6	0.2	0	0
January	1	4	0.5	-0.7	5.4	-5400	5.4	2.6	2600	2.6	0.2	0	0
January	1	5	1.1	-0.1	5.4	-5400	5.4	2.6	2600	2.6	0.2	0	0
January	1	6	2.3	1.1	6.3	-6300	6.3	2.6	2600	2.6	0.2	0	0
January	1	7	3.8	2.5	6.3	-6300	6.3	2.6	2600	2.6	0.2	0	0
January	1	8	4.8	3.5	9.6	-9600	9.6	2.6	2600	2.6	0.2	0	0
January	1	9	5.5	4.3	9.6	-9600	9.6	2.5	2500	2.5	0.2	0	0
January	1	10	6.9	5.6	9.8	-9800	9.8	2.5	2500	2.5	0.2	0	0
January	1	11	8.6	7.2	9.9	-9900	9.9	2.4	2400	2.4	0.2	0	0
January	1	12	10.8	9	10	-10000	10	2.3	2300	2.3	0.2	0	0
January	1	13	13.1	11.2	10.2	-10200	10.2	2.2	2200	2.2	0.2	0	0
January	1	14	15.4	13.9	10.3	-10300	10.3	2.1	2100	2.1	0.2	0	0
January	1	15	16.5	14.9	10.5	-10500	10.5	2.1	2100	2.1	0.2	0	0
January	1	16	16.7	15.2	10.5	-10500	10.5	2	2000	2	0.2	0	0
January	1	17	16.9	15.5	7.2	-7200	7.2	2	2000	2	0.2	0	0
January	1	18	16.5	15.2	7.1	-7100	7.1	2.1	2100	2.1	0.2	0	0
January	1	19	16.6	15	7.1	-7100	7.1	2.1	2100	2.1	0.2	0	0

IES Export demo



IES Export demo

The screenshot shows the 'HVAC System Design Wizard' application window. The title bar reads 'HVAC System Design Wizard' and the IES logo is in the top right corner. The main window is titled 'General Setup & Zoning' and includes a sub-header: 'This page provides general setup options and zoning, click here for further guidance.'

The interface is divided into several sections:

- HVAC File:** Contains two radio buttons. The 'New:' option is selected with the text 'WLHPs on HTL' in the adjacent input field. The 'Existing:' option is unselected with a dropdown menu showing 'Test w WSHX'.
- Calculation Methodology:** Contains two radio buttons. 'ASHRAE Heat Balance Method' is selected, and 'CIBSE Admittance Method' is unselected.
- Compliance Mode:** Contains four radio buttons. 'None (Design)' is selected, while 'ASHRAE 90.1 PRM 2007', 'NECB 2011', and 'IECC 2012' are unselected.
- Zoning:** A panel on the right with a 'Design' tab. It features a dropdown menu labeled 'HVAC Zones and Zone Groups'. Below it, a tree view shows 'AHU 1 (15)' and 'No ApacheHVAC System (1)'. At the bottom of this panel, there is a toolbar with icons for selection, deletion, and other actions, along with a search bar containing the text 'Enter filter text here'.

On the left side of the window, a dark sidebar contains a navigation menu with the following items: 'General Setup & Zoning' (highlighted with a right-pointing arrow), 'Design - Airside System Selection', 'Design - Waterside and Plant Equipment Selection', and 'HVAC Loads, Sizing & Reports'. At the bottom of the sidebar, it says 'Step 1 of 4' and 'Preferences...'. A large blue arrow at the bottom center of the main window indicates the next step, and a 'Cancel' button is located at the bottom right.

IES Export demo

HVAC System Design Wizard

Design - Airside System Selection

This page allows filtering, review, selection and assignment of pre-configured HVAC systems, click here for further guidance.

Airside System Selection

- Packaged Terminal Units, Single Zone, Vari...
- CAV Reheat
- Dedicated Outdoor Air (DOAS)
- DOAS - Separate OA / Four-pipe
- DOAS - Integrated OA / Four-pi
- DOAS - WLHP**
- DOAS - PTAC / Separate OA
- DOAS - PTHP / Separate OA
- DOAS - DCV / Four-pipe FCU
- DOAS - Separate OA to Rooms
- DOAS - Air-Source VRF
- DOAS - Water-Source VRF
- Underfloor Air Distribution (UFAD)

Dedicated Outdoor Air - Water Loop Heat Pump

System	Rooms / Zones	Packaged Unit
Air Handling Unit (AHU) no Recirculation		

Airside Systems

Step 2 of 4

Preferences...

Cancel

IES Export demo

HVAC System Design Wizard

Design - Waterside and Plant Equipment Selection

This page allows filtering, review, selection and assignment of pre-configured waterside systems, click here for further guidance.

Waterside Cooling System Selection

Heat transfer loops, Water-to-air heat pumps

- Heat transfer loops #
- Heat Transfer Loop - Cooling tower heat rejection, HW boiler, var 01**
- Water-to-air heat pumps
- Water-Loop HP or Water-to-Air Heat Pump - WAHP 1

Waterside Heating System Selection

Generic heat sources, Heat transfer loops, Water-to-air heat pumps

- Electric-Resistance Backup Heat Source for Air-to-Air Heat Pur 00
- Furnace for PRM Baseline PSZ and Heat & Vent units 00
- Condensing Boiler using part-load data model; illus. 130 F retu 00
- Condensing Boiler using part-load data model; illus. 100 F retu 00
- Nat-Draft boiler using part-load data model; illus. 50-F delta-T 00
- Illustrative ASHP + Electric backup 00
- Furnace for PSZ and Heat & Vent units 00
- Electrical energy input for elec heating panels and baseboard 00
- GSHP - illustrative values (assumes stable source temp.) 00
- Baseline SHW (DHW) heating plant (fossil fuel) - set Eff. per 9 01**

Edit DHW Systems...

Airside Systems	Assigned HVAC Zone/Room Groups	Pi
<input type="checkbox"/> Dedicated Outdoor Air - Water Loop Heat Pump	AHU 1	Water-Loop HP or Water-to-Air Hea

Step 3 of 4

Preferences... < > Cancel

IES Export demo

HVAC System Design Wizard

HVAC Loads, Sizing & Reports

This page provides HVAC analysis & reporting options applied following the successful completion of this wizard, click here for further guidance.

Analysis & Reporting (Design)

- HVAC Zone/Room loads and sizing
- HVAC System loads and sizing
- Simulation

Summary

HVAC filename: WLHPs on HTL.asp
Loads methodology: ASHRAE Heat Balance Method
Compliance route: None (Design)

System Summary

Design

HVAC Zones assigned: 15
Rooms assigned: 00
Airside systems: 01
Waterside systems
Cooling: 02
Heating: 03

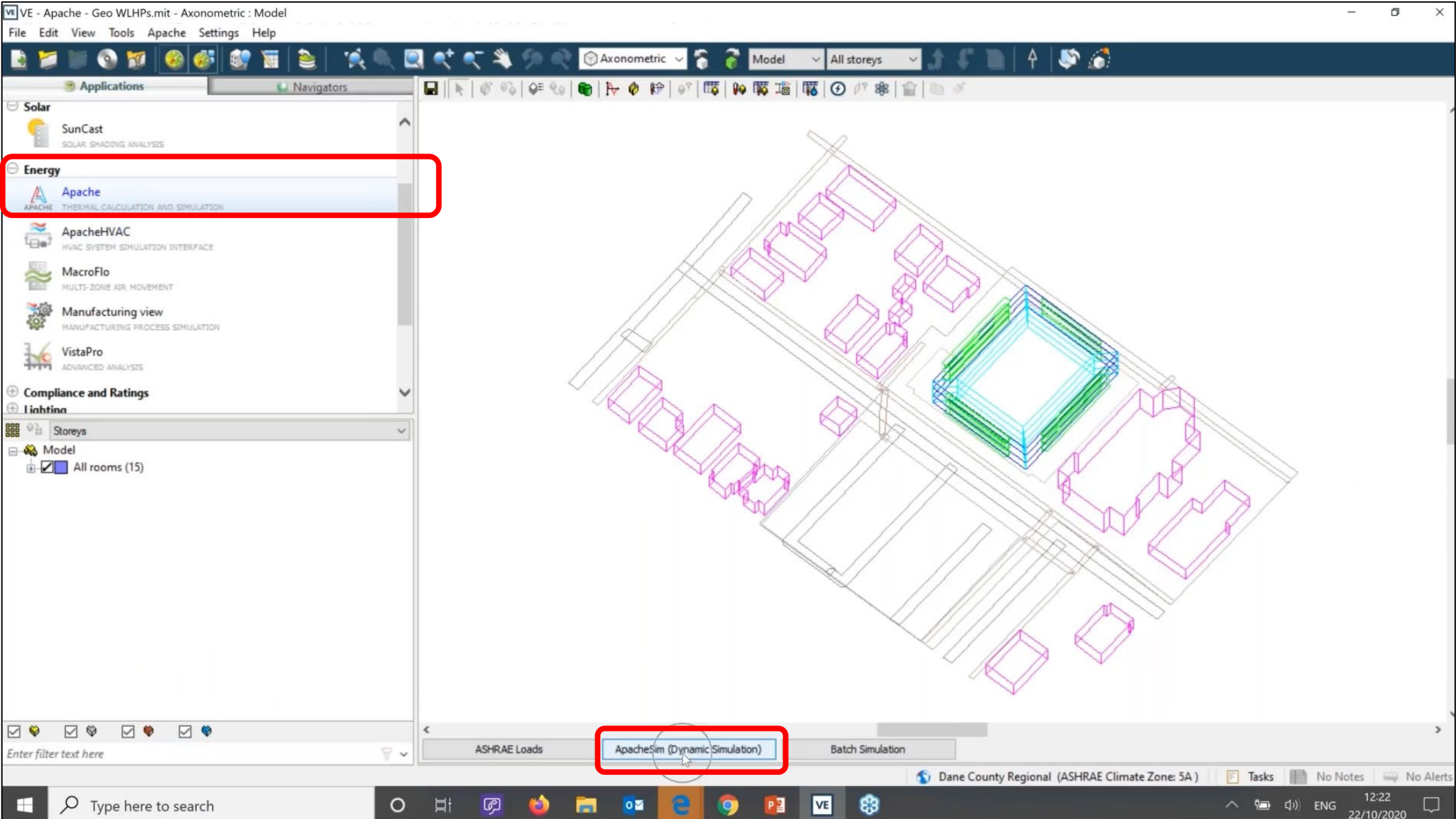
Export equipment schedule

Step 4 of 4

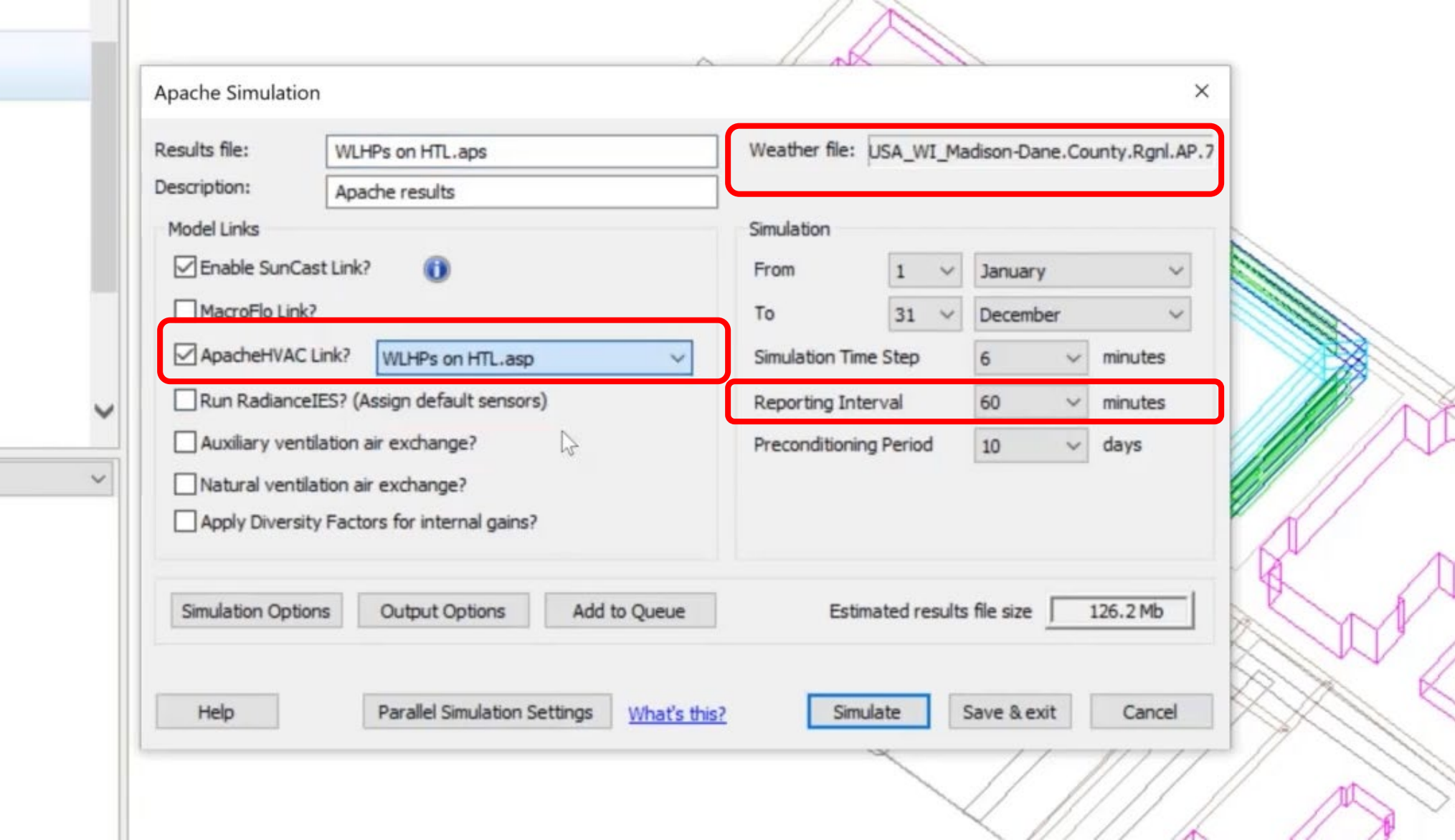
Preferences...

OK Cancel

IES Export demo



IES Export demo

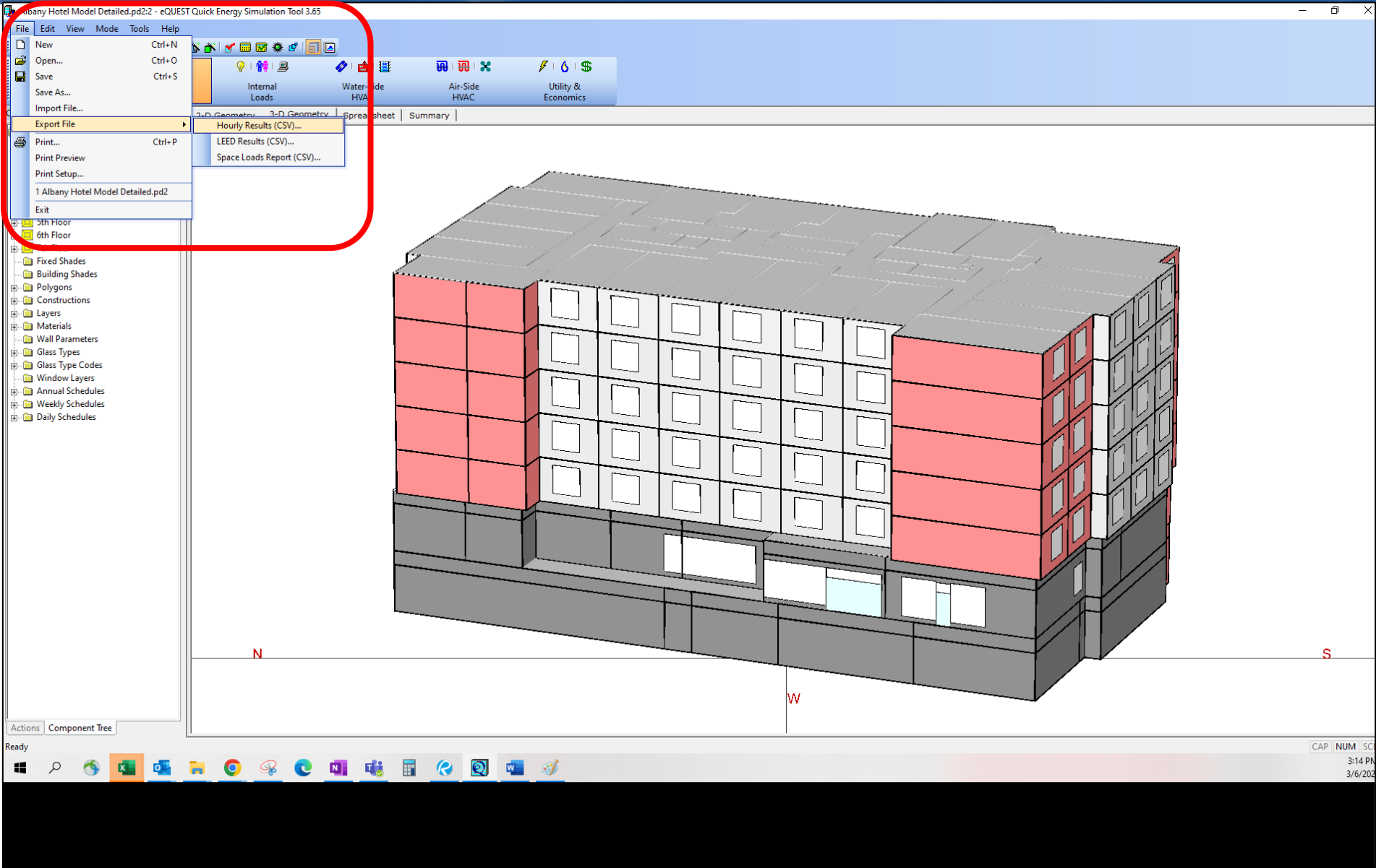


IES Export demo

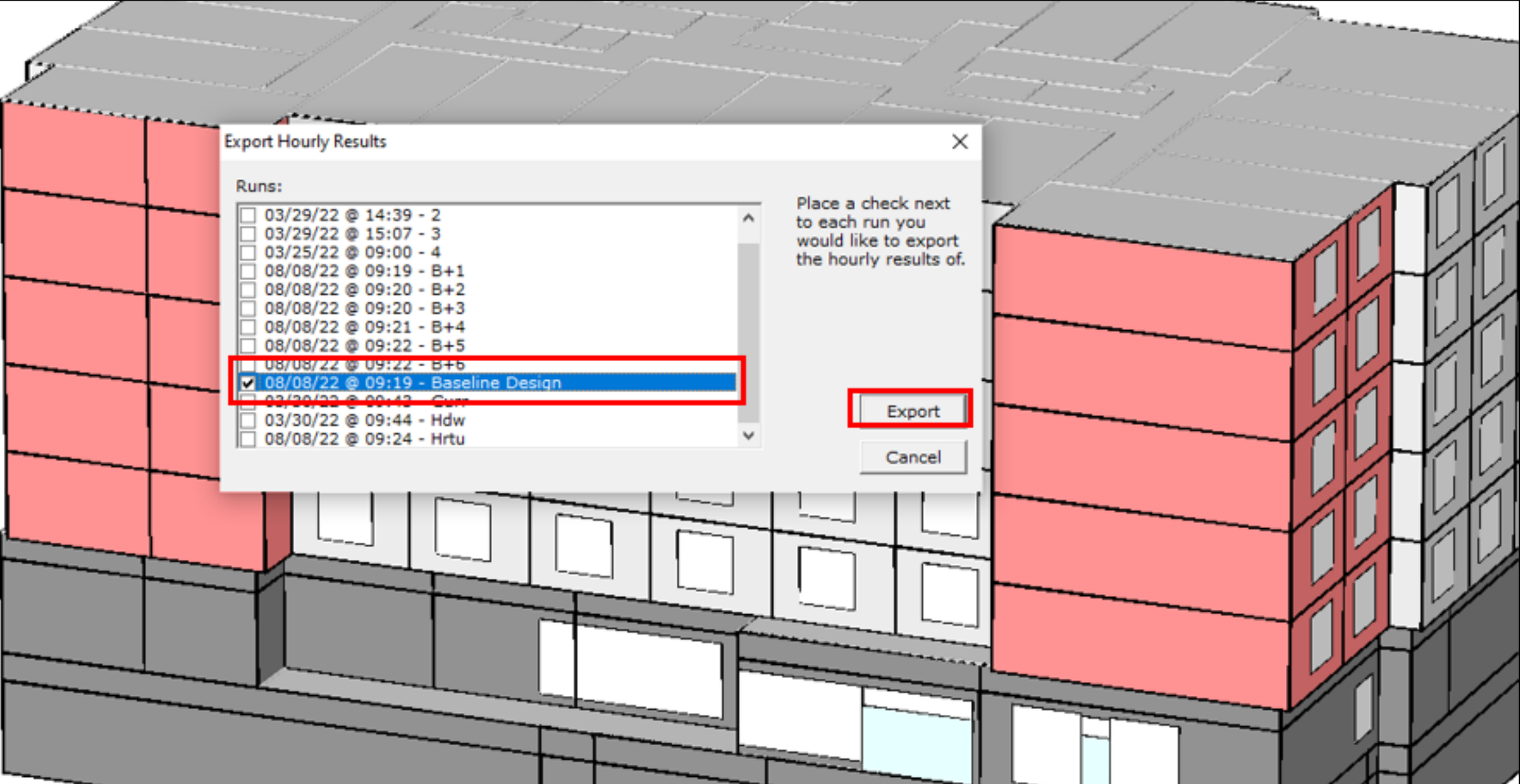
The screenshot displays the IES software interface for a project named "VistaPro - Geo WLHPs.mit / HVAC System : WLHPs on HTL.asp". The interface is divided into several panes:

- Left Pane (Applications):** Lists various simulation tools. "VistaPro" is highlighted with a red box. Other tools include SunCast, Apache, ApacheHVAC, MacroFlo, Manufacturing view, and Compliance and Ratings.
- Tree View (HVAC network):** Shows a hierarchical structure of the HVAC system. "Heat transfer loops" is expanded, and "HT000000 : Heat Transfer Loop - Cooling tower heat rejection" is highlighted with a red box.
- Files List:** A table listing simulation files and their descriptions. "WLHPs on HTL.aps" is highlighted with a red box.
- Energy Breakdown:** A list of variables for energy analysis. "HTL heating load" and "HTL cooling load" are highlighted with a red box.
- Chart (1):** A line graph showing "Load (Btu/h)" over time from January to December. The y-axis ranges from 0 to 1,000,000. The chart shows two data series: "HTL cooling load" (red line) and "HTL heating load" (blue line). The cooling load peaks in the summer months (June-August), while the heating load peaks in the winter months (January-March).

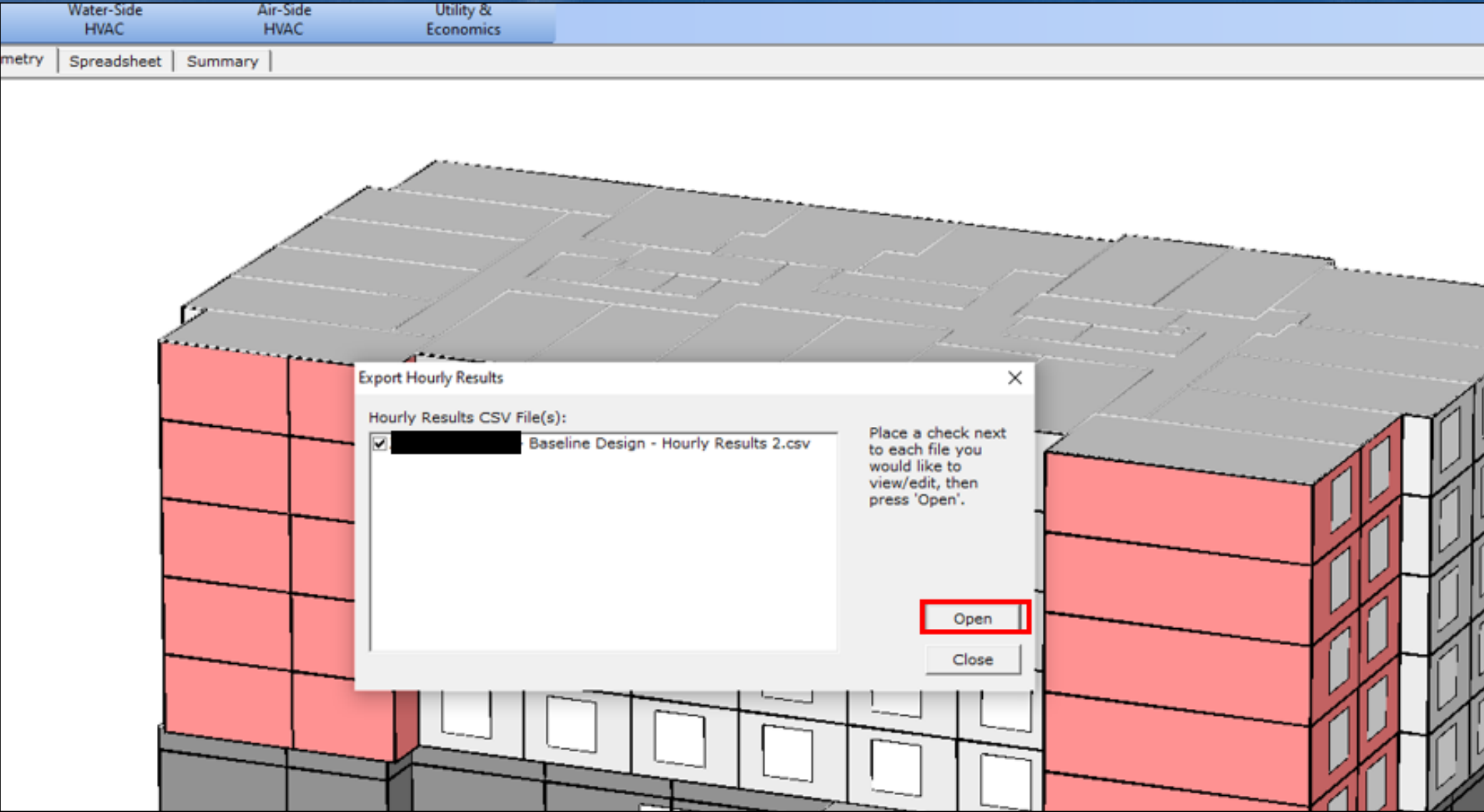
E-quest Export demo



E-request Export demo



E-quest Export demo



E-quest Export demo

AutoSave Off EQEST sample hourly data output.csv - Read-Only Search Connor Dacquay CD

File Home Insert Draw Page Layout Formulas Data Review View Help BLUEBEAM

Undo Paste Font Alignment Number Styles Cells Editing Analysis Bluebeam

A1

Simulated: 2022-Aug-08 09:19:15
CSV Written: 2023-Mar-06 15:15:40
eQUEST 3.65.7175

Hourly Report
EM1 Hourly Report Block
ELEC-METER
EM1

Month	Day	Hour	Day Type	Var 1	Var 2	Var 3	Var 4	Var 5	Var 6	Var 7	Var 8	Var 9	Var 10	Var 11	Var 12	Var 20	
1	1	1	1	6	9.23503	0	13.4613	162.498	0	0	0.877384	14.78	0	0	41.6791	0	242.531
12	1	1	2	6	9.23503	0	13.4521	143.438	0	0	0.877384	14.7802	0	0	29.0714	0	210.854
13	1	1	3	6	4.88626	0	6.67569	145.825	0	0	0.877384	14.7806	0	0	14.182	0	187.227
14	1	1	4	6	4.88626	0	6.67569	143.458	0	0	0.877384	14.7807	0	0	14.1885	0	184.866
15	1	1	5	6	4.88626	0	6.67569	143.966	0	0	0.877384	14.7809	0	0	27.081	0	198.267
16	1	1	6	6	4.88626	0	6.67569	152.127	0	0	0.877384	15.2135	0	0	53.5369	0	233.317
17	1	1	7	6	13.9183	0	19.8345	150.836	0	0	0.877384	15.213	0	0	66.4272	0	267.106
18	1	1	8	6	13.9183	0	19.8253	144.462	0	0	0.877384	15.2122	0	0	105.765	0	300.06
19	1	1	9	6	18.2671	0	26.6155	125.866	0	0	0.877384	15.2834	0	0	79.0683	0	265.978
20	1	1	10	6	21.9468	0	26.6155	122.551	0	0	0.877384	15.2818	0	0	66.9001	0	254.172
21	1	1	11	6	17.2635	0	19.8345	123.422	0	0	0.877384	15.2814	0	0	66.4174	0	243.097
22	1	1	12	6	12.9148	0	13.4751	109.429	0	0	0.877384	15.2807	0	0	66.4182	0	218.395
23	1	1	13	6	14.9219	0	13.4797	107.499	0	0	0.877384	15.2806	0	0	66.4206	0	218.479

EQEST sample hourly data output

Loads from E-quest do not remove compressor energy. SS-P report does have compressor and fan energy at a monthly peak/total usage and could be subtracted from the energy usage

Final Remarks

- Human inconsistency avoidance tendency
- Confirmation bias
- Positive vs. zero sum mindset





NY-GEO Conference
2023-04-26

Building Energy Modelling

*The Foundation of
GHX Design*

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