Building Energy Modeling:
The Foundation of a GHX Design

Connor Dacquay, P.E.

GEOptimize, Inc.

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Building Energy Modelling

The Foundation of GHX Design

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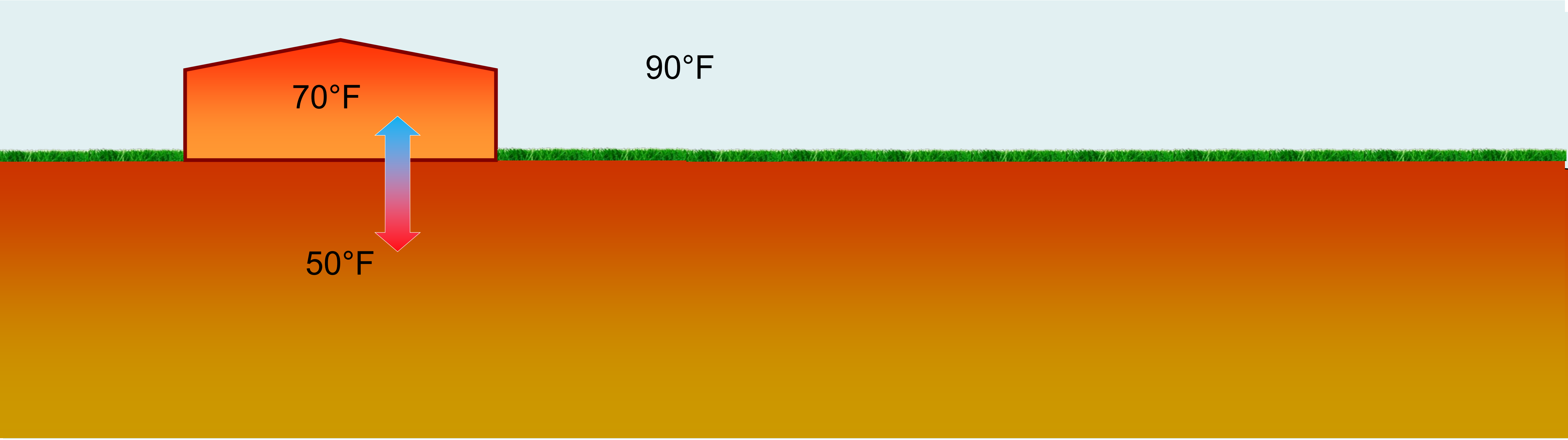
Learning Objectives

- 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

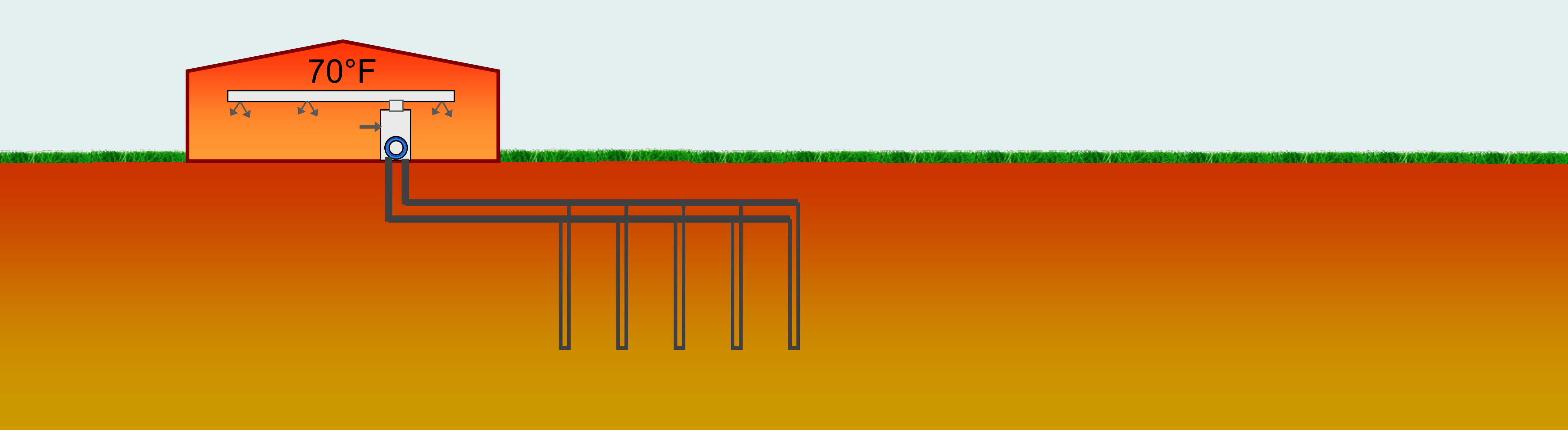
Earth Energy Resource

- Constant earth temperature
- Variable outdoor air temperature



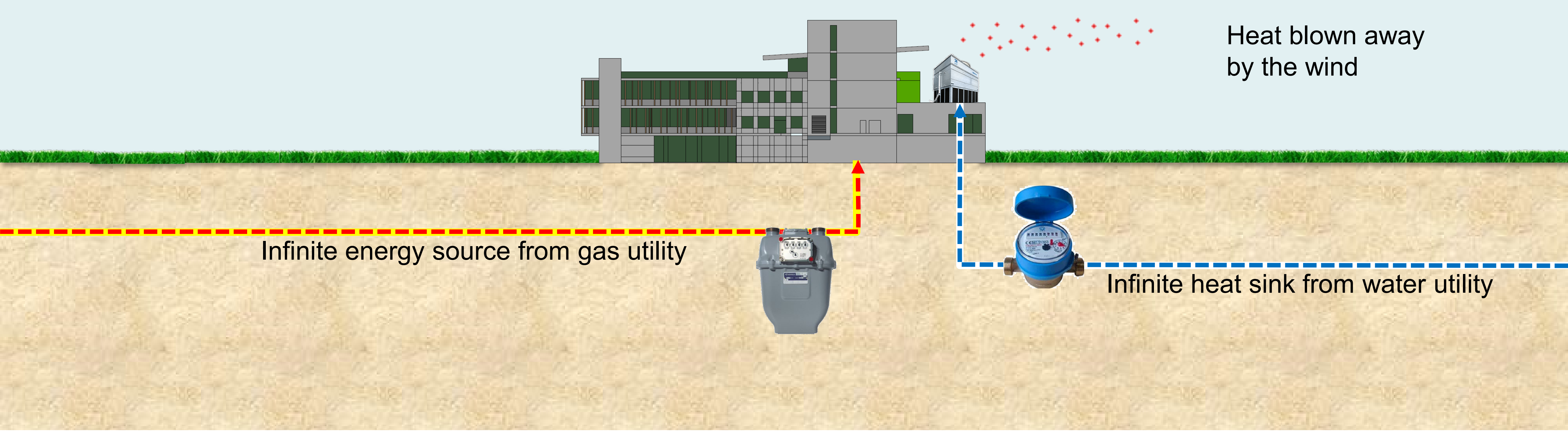
Earth Energy Resource

- 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"		
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

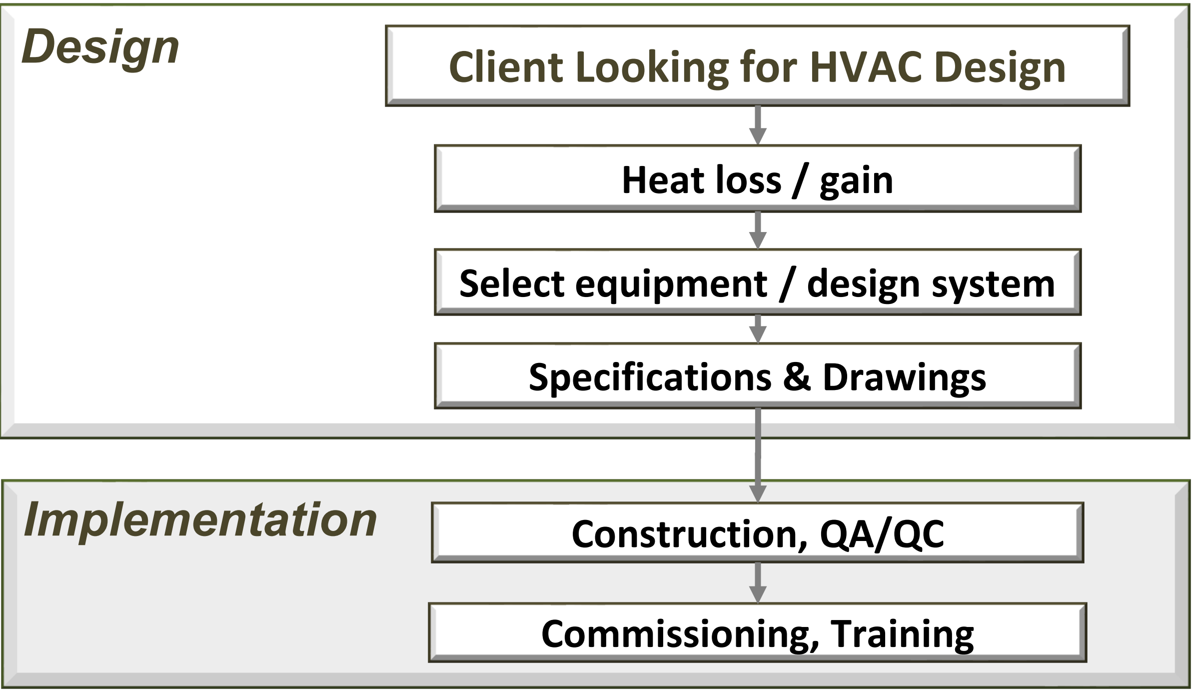
Inlet Pressure:	5 psig
Pressure Drop:	0.5 psig

Length (ft)	Calculated Flow (Natural Gas) (Cubic Feet of Gas Per Hour)								
	CTS		IPS						
Nom OD	1/2	1	3/4	1	1-1/4	1-1/2	2	3	4
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	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	39841
100	139	982	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	37634
125	123	870	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33354
150	111	789	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30221
175	102	726	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	27803
200	95	675	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	25865
250	84	598	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	22924
300	76	542	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	20771
350	70	499	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19109
400	65	464	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	17777
450	61	435	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	16680
500	58	411	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	15756
600	53	373	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	14276
700	48	343	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	13133
800	45	319	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	12218
900	42	299	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11464
1000	40	283	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	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 Loads vs. Total Loads

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

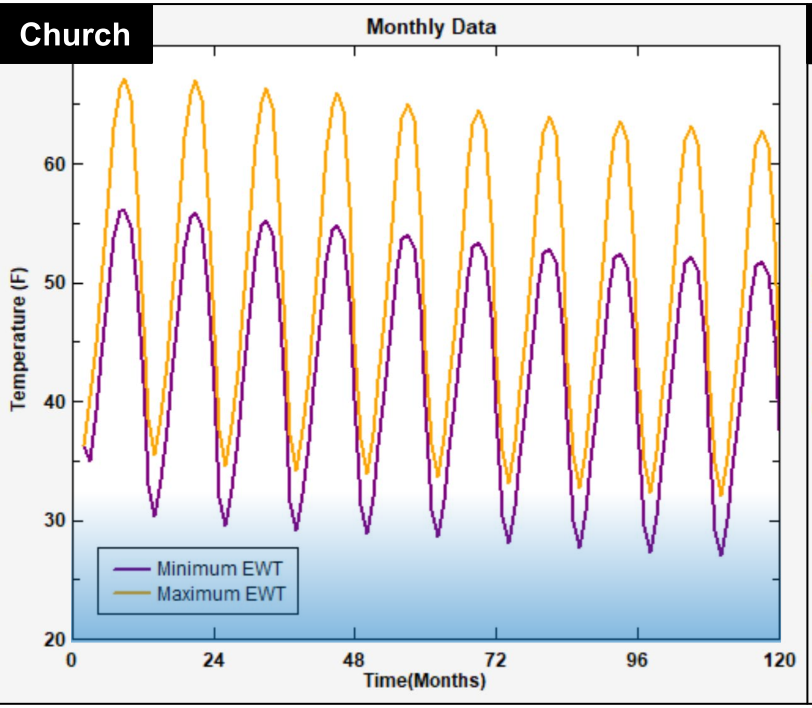
	Church			
	Clg kBtu	Clg kBtu/hr	Htg kBtu	Htg kBtu/hr
Jan	3820	8	189734	**385**
Feb	6202	23	135120	366
Mar	12177	76	81304	312
Apr	16800	216	36614	170
May	24640	367	11152	65
Jun	46285	446	3180	5
Jul	52680	**480**	886	0
Aug	49068	465	1725	0
Sep	38560	314	5479	53
Oct	13821	121	24702	137
Nov	7571	62	98784	298
Dec	4884	10	176775	348
	276508	**480**	**765455**	**385**
	Annual Cooling / Heating Ratio:			**2.8 to 1**

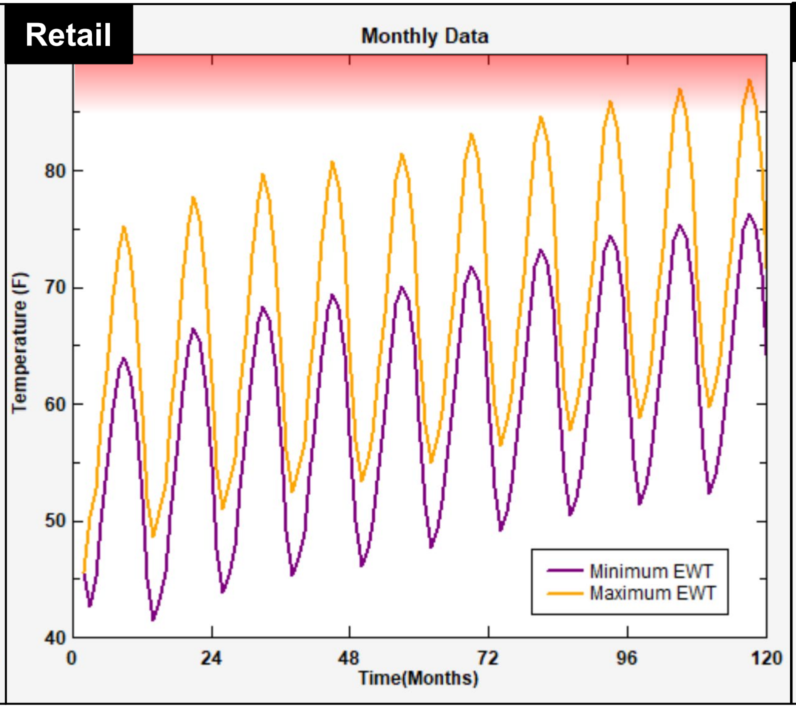
	Retail			
	Clg kBtu	Clg kBtu/hr	Htg kBtu	Htg kBtu/hr
Jan	19906	93	89734	**385**
Feb	28202	110	65120	346
Mar	30177	215	41304	240
Apr	40866	285	16614	110
May	53946	396	3152	35
Jun	82094	446	180	0
Jul	102358	**480**	0	0
Aug	102393	439	125	0
Sep	89245	360	2379	26
Oct	63821	223	9702	128
Nov	41571	135	36784	251
Dec	27884	102	76775	331
	682463	**480**	**341869**	**385**
	Annual Cooling / Heating Ratio:			**2.0 to 1**

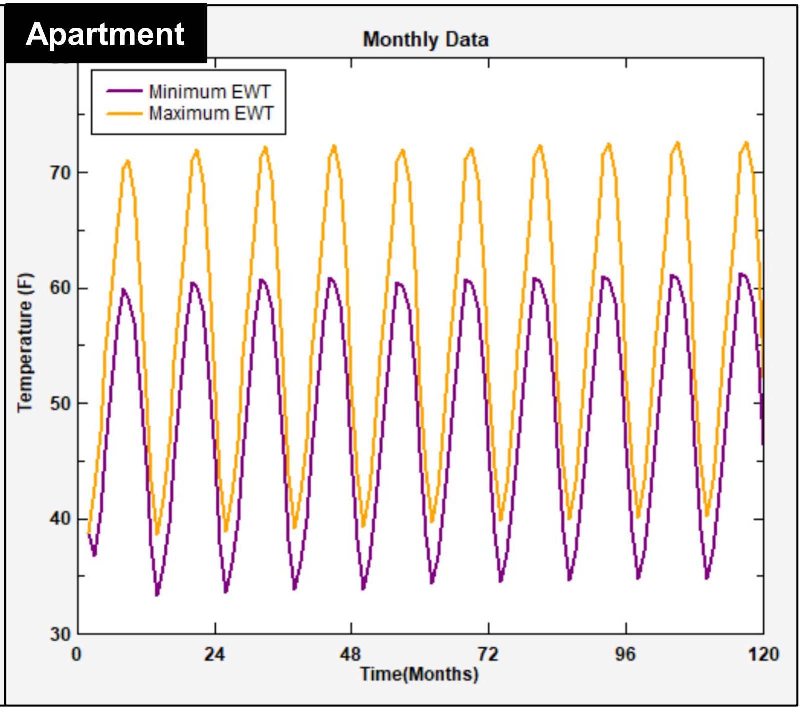
	Apartment			
	Clg kBtu	Clg kBtu/hr	Htg kBtu	Htg kBtu/hr
Jan	5560	25	159734	**385**
Feb	7840	83	112120	360
Mar	14177	185	71304	305
Apr	28866	260	30614	155
May	43946	329	11152	60
Jun	72094	423	8545	45
Jul	92358	**480**	7650	43
Aug	78393	447	7550	45
Sep	59450	360	8479	53
Oct	19821	169	18702	132
Nov	8690	79	66784	269
Dec	6570	22	126775	340
	437765	**480**	**629409**	**385**
	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

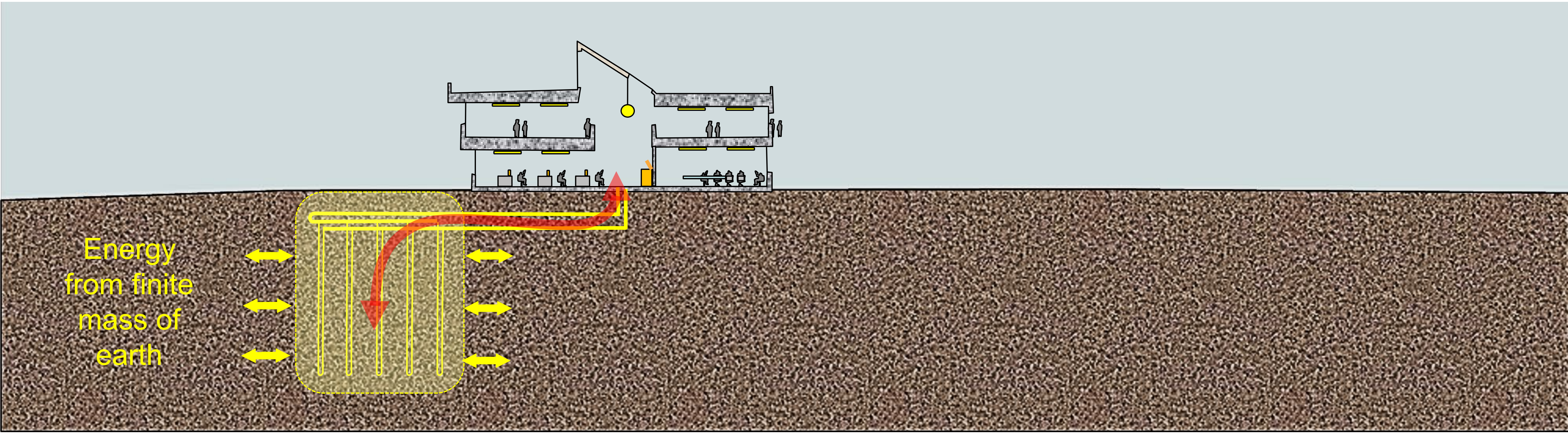




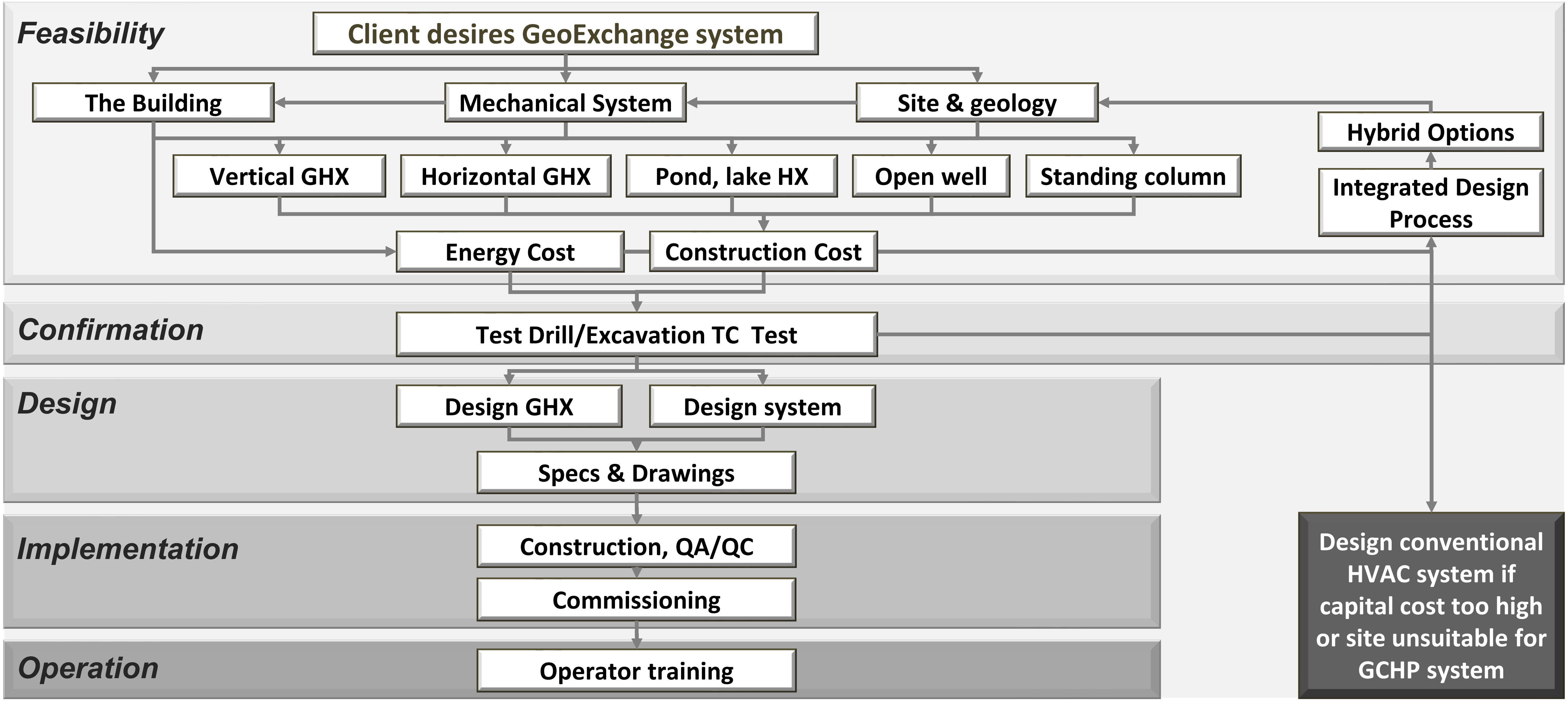


Earth Energy Resource Engineering

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

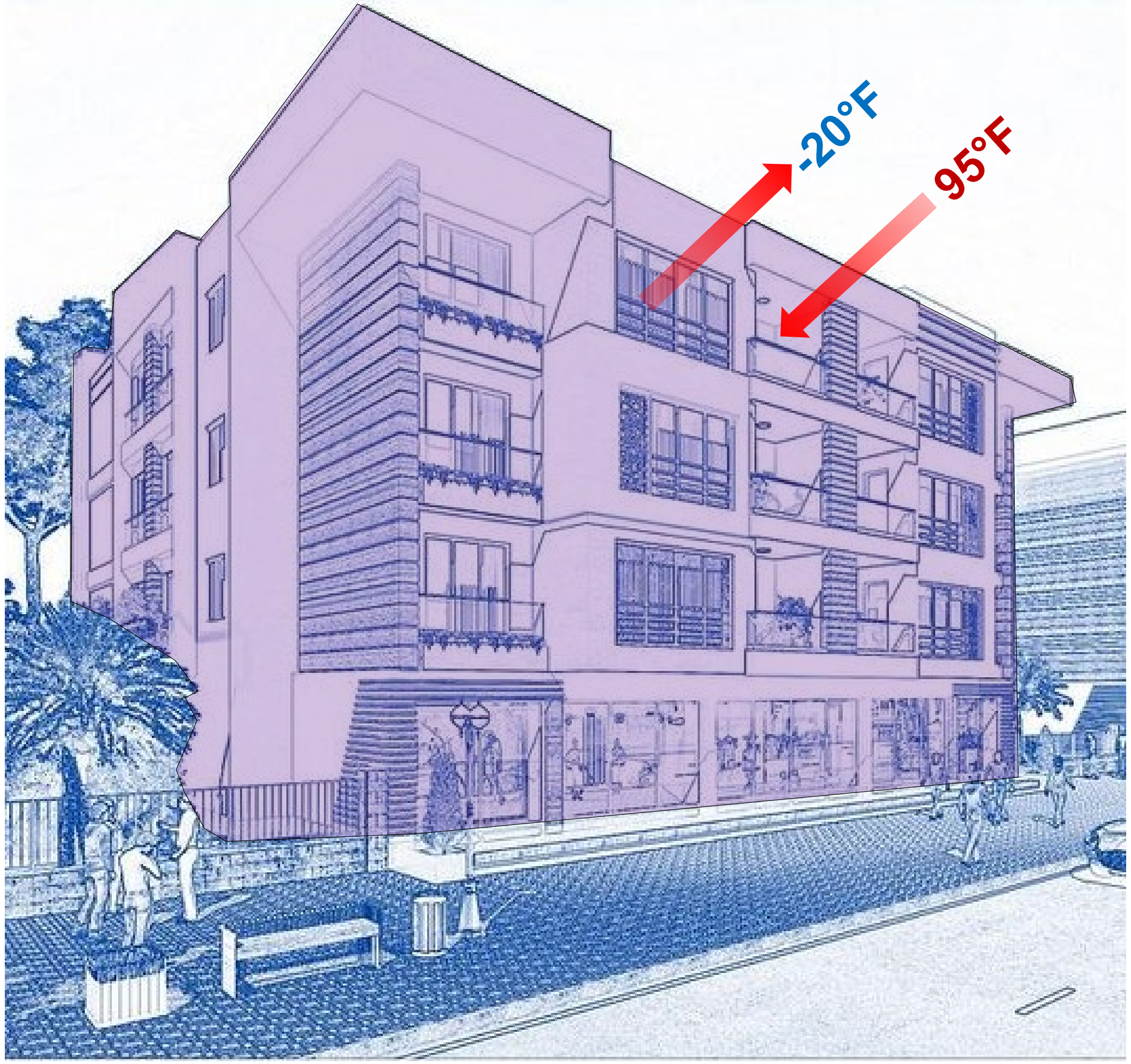


GSHP System Design Process



Q/A

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

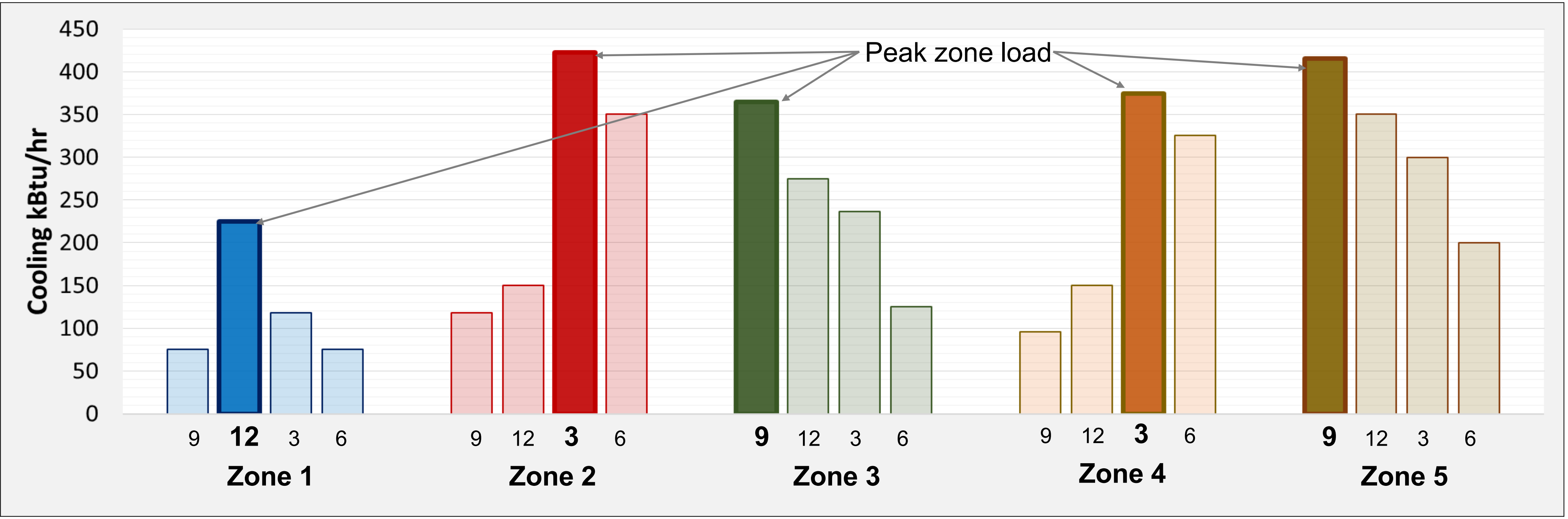
- Solar heat is transferred to the building through windows
- Amount of solar heat is affected by window to wall ratio and solar heat gain coefficient (SHGC) of windows
- Affected by internal and external shading devices

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

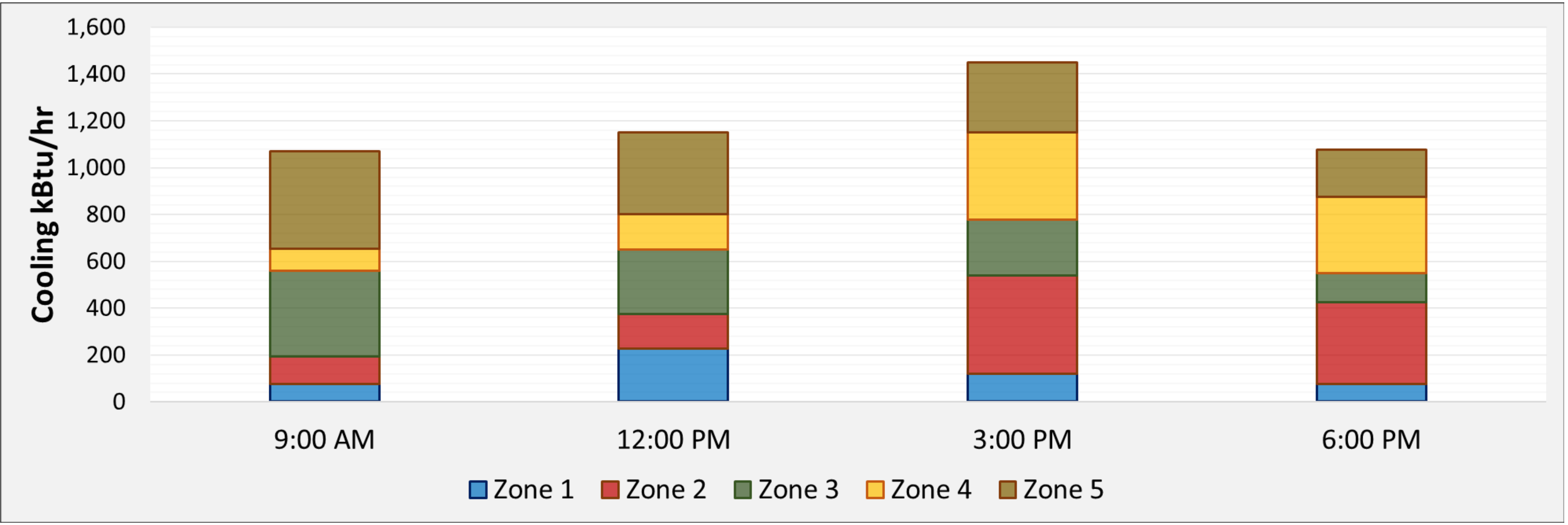
Zone Loads

- 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



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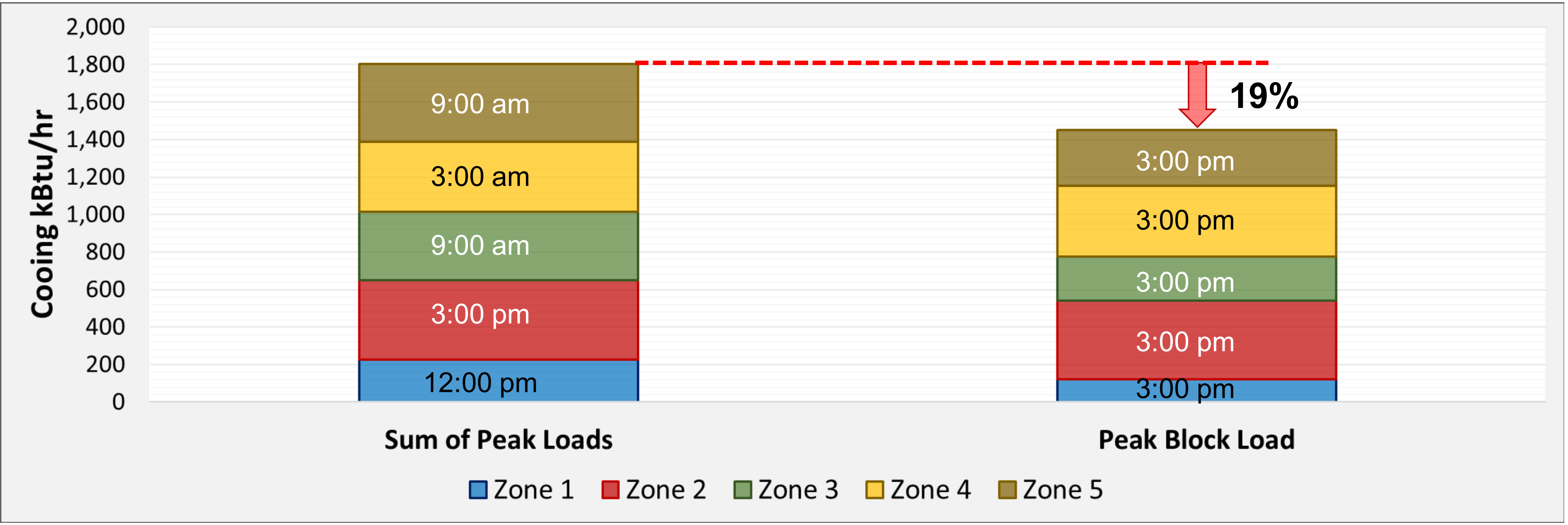
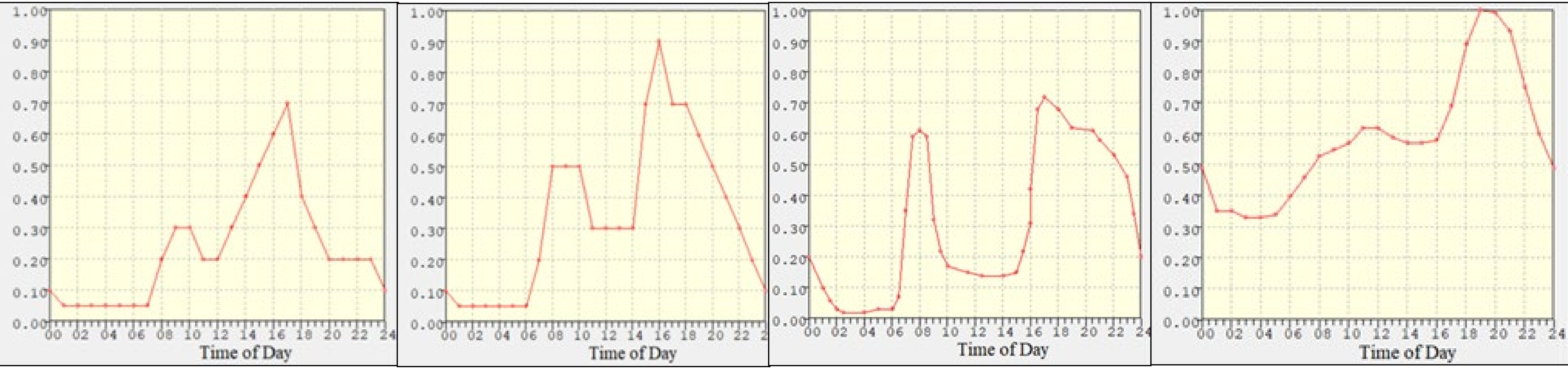
Peak Loads vs. Block Loads

- 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

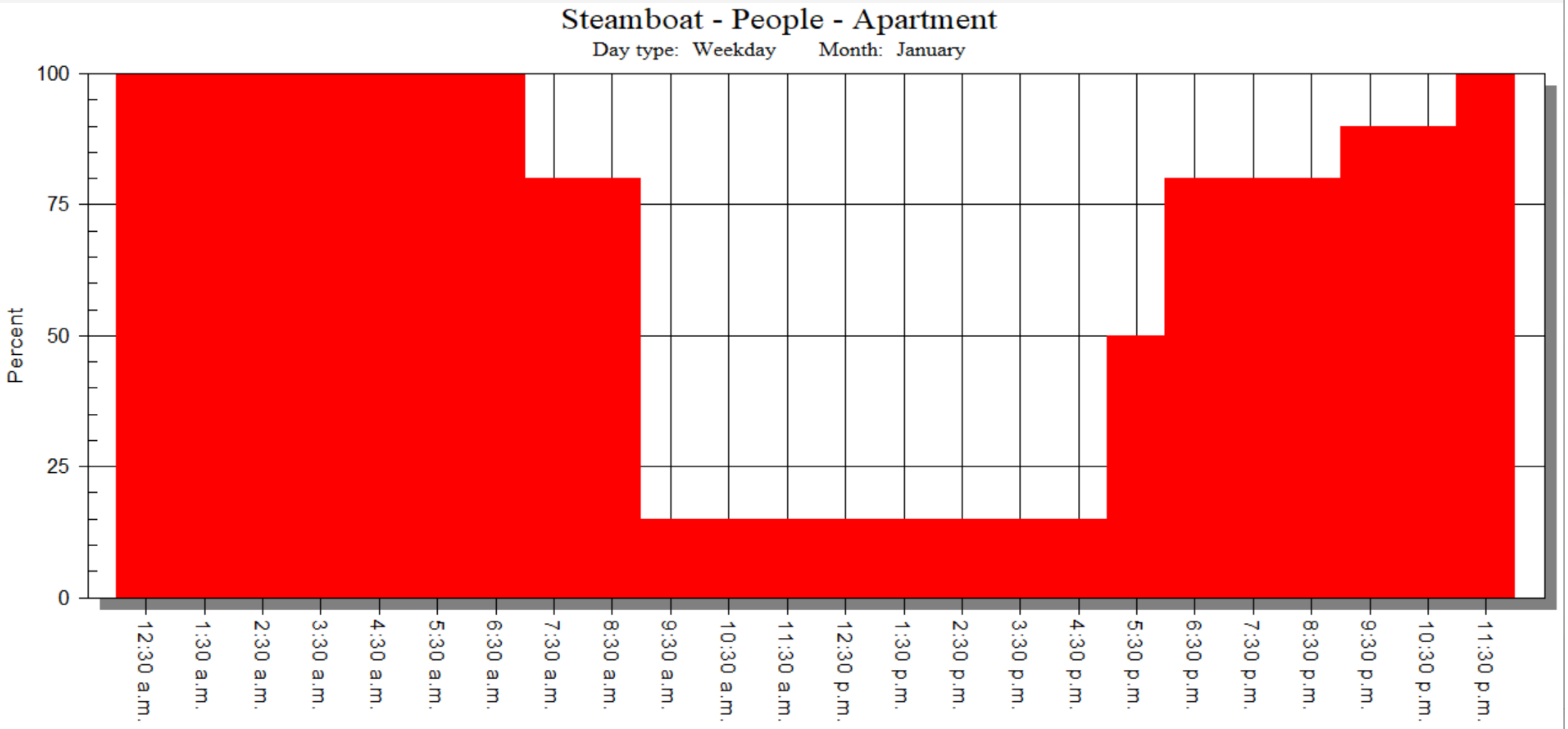


Energy Modelling – Schedules

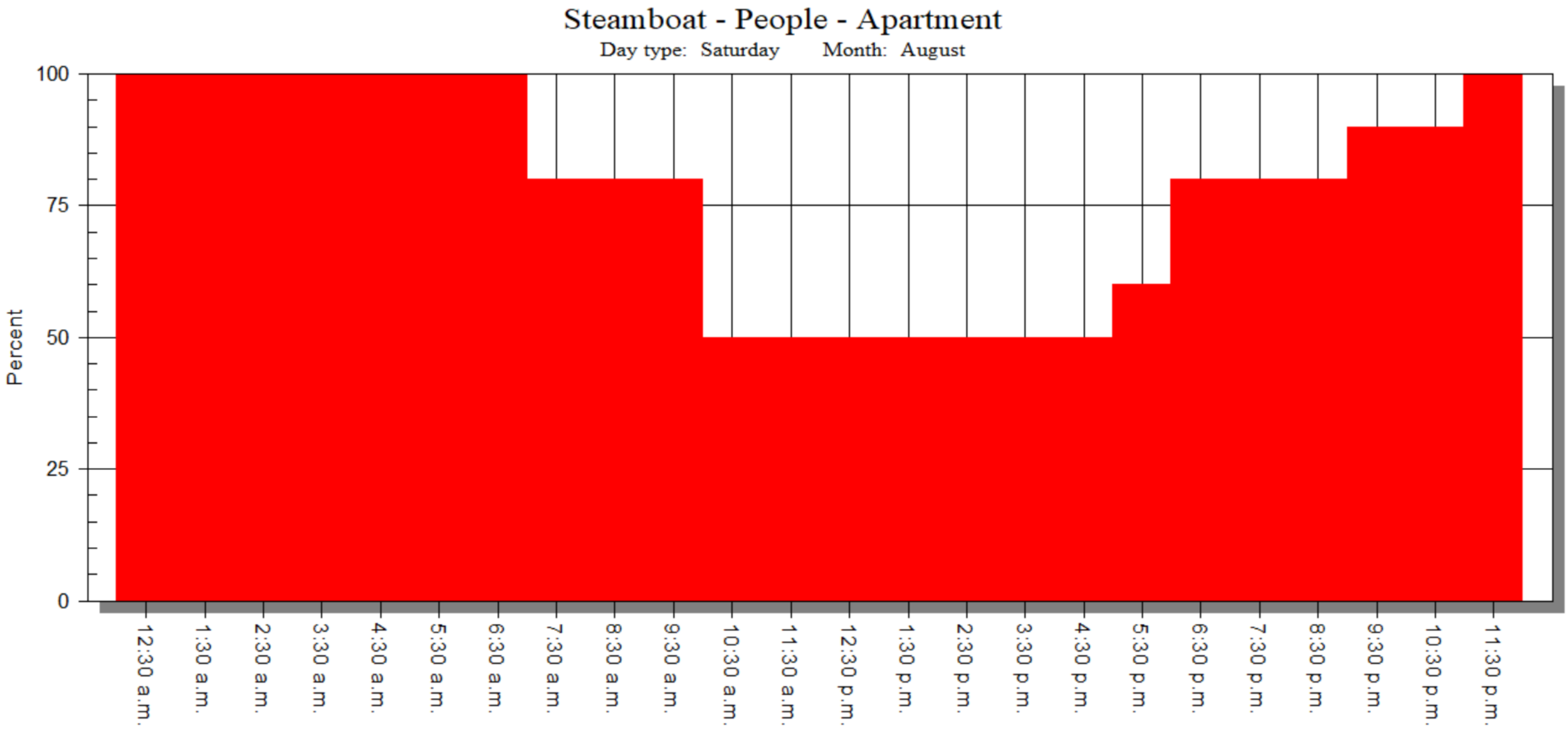
- ASHRAE 90.1 for envelope U-values and internal load density
- ASHRAE 62.1 for ventilation
- Scheduling internal heat gains is sometimes challenging



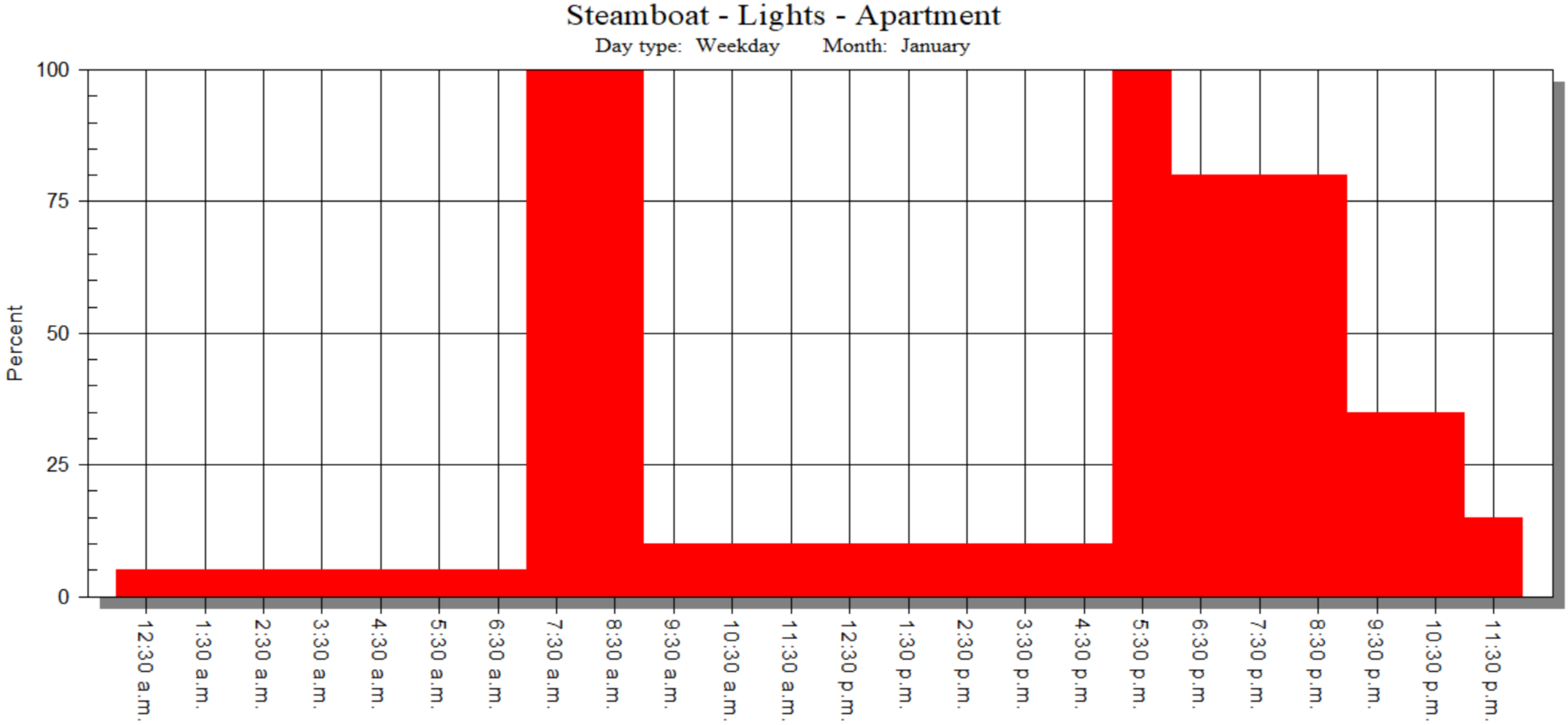
Energy Modelling – Schedules – People Example



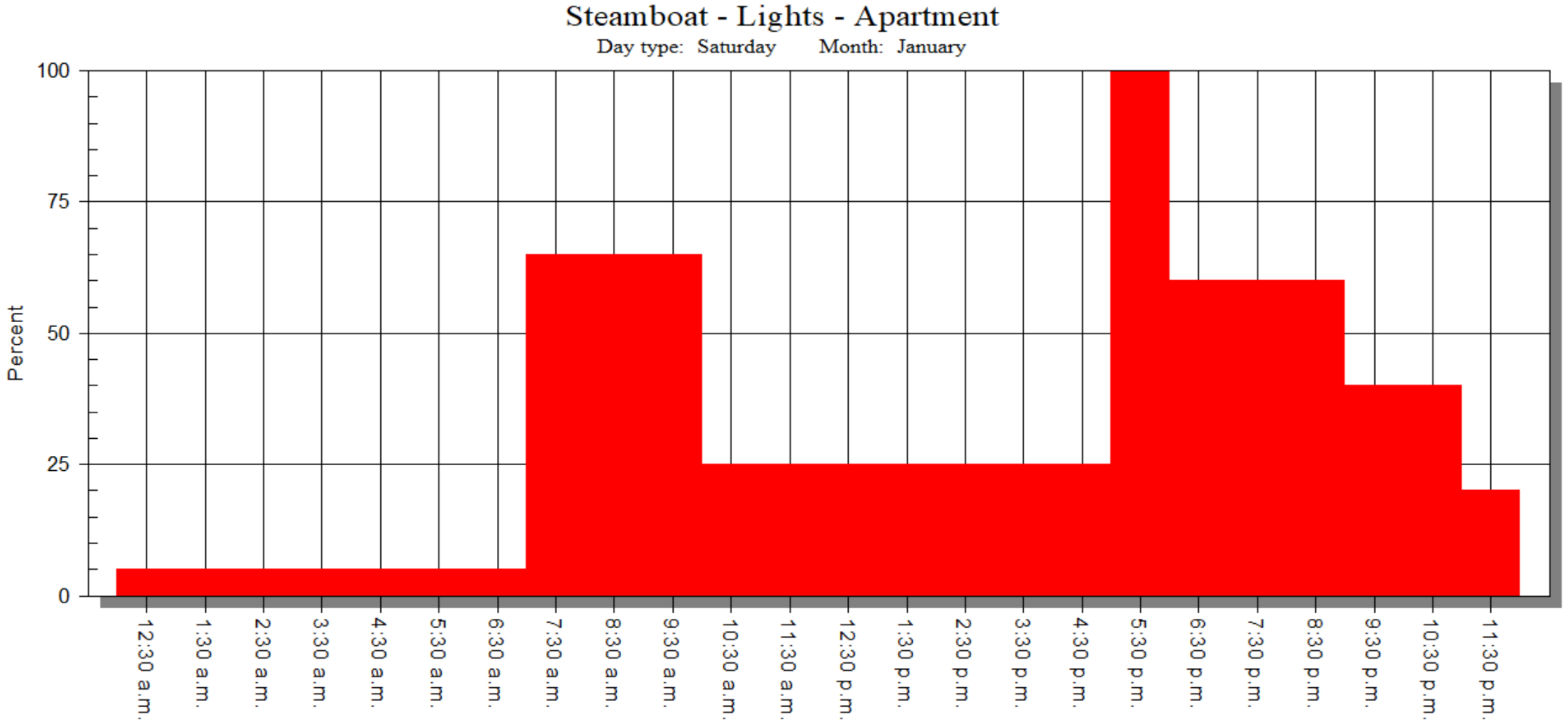
Energy Modelling – Schedules – People Example



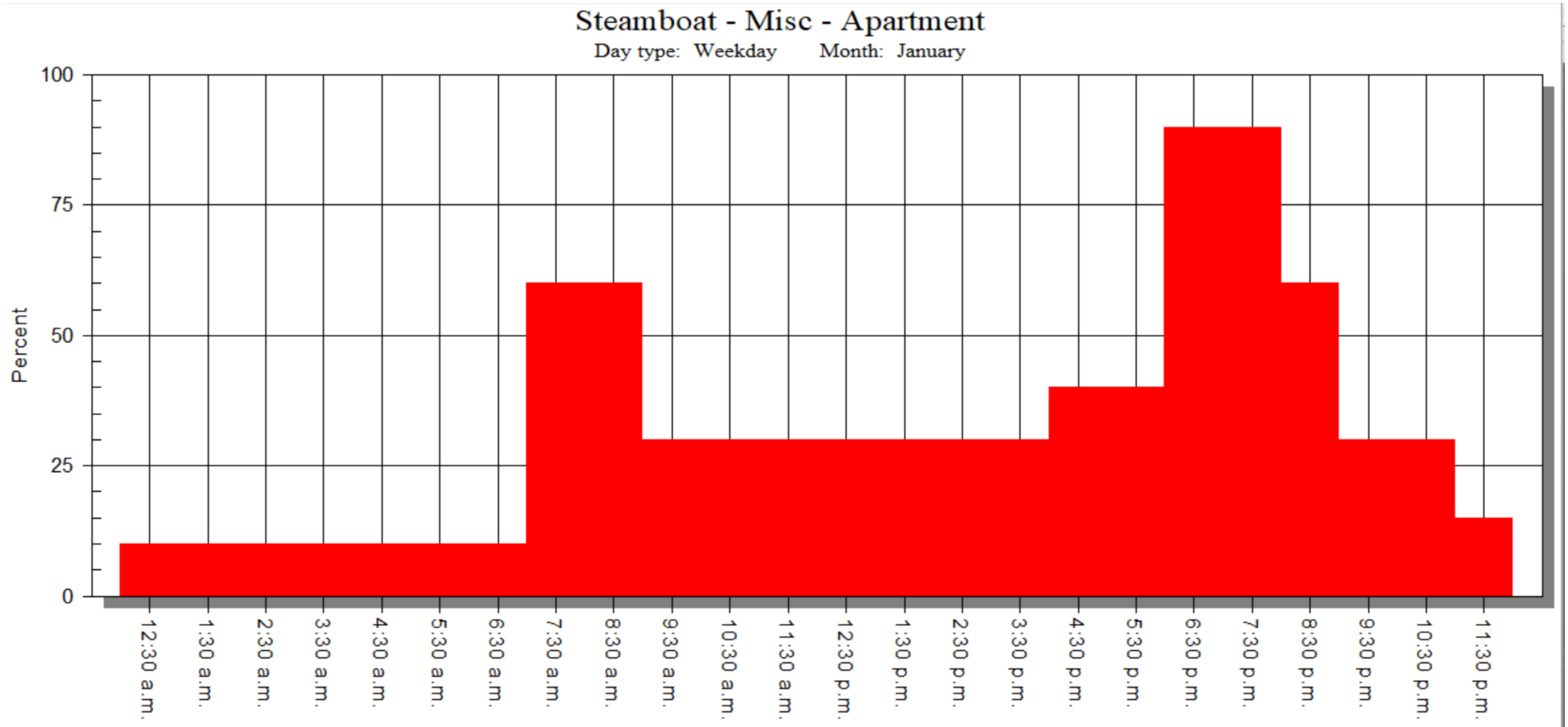
Energy Modelling – Schedules – Lights Example



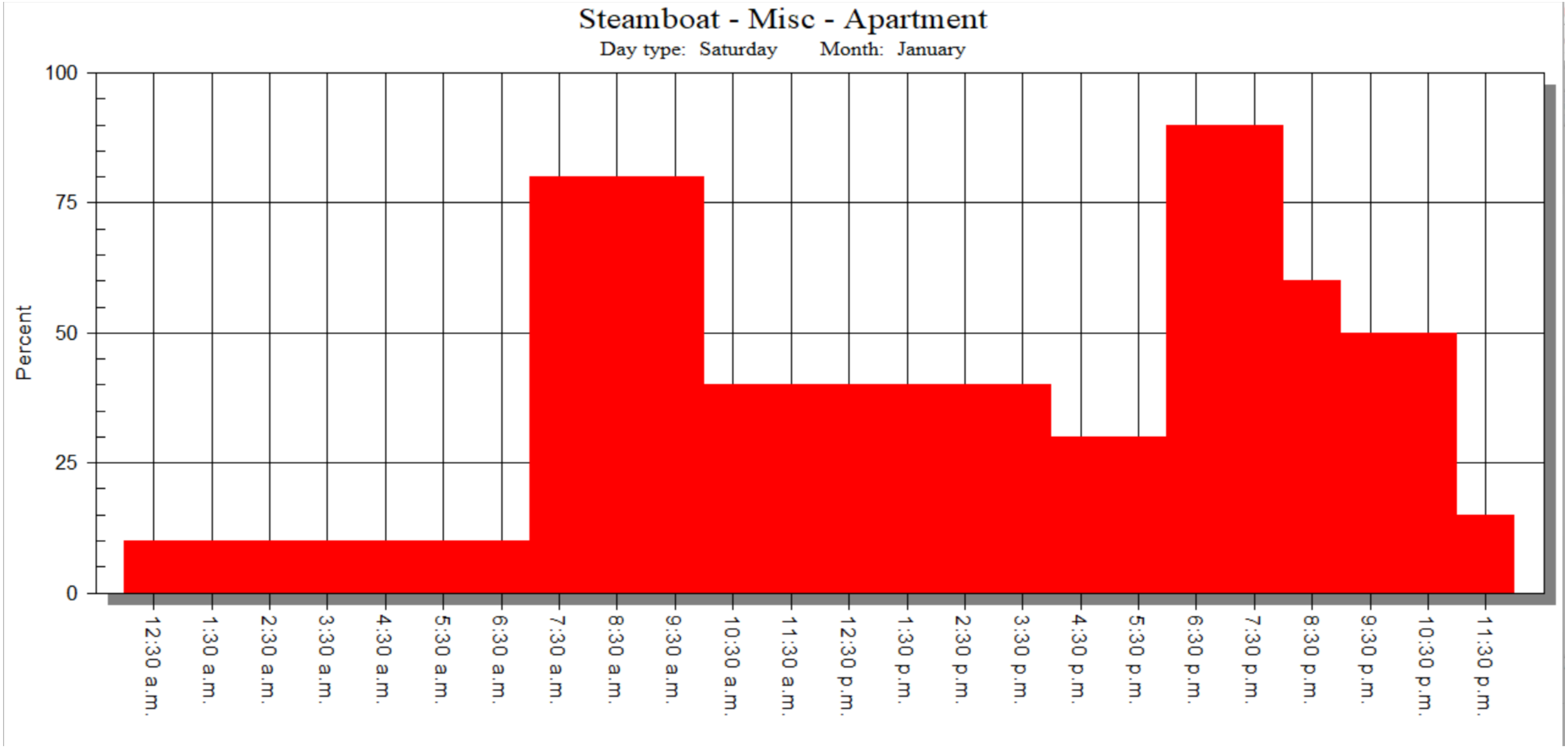
Energy Modelling – Schedules – Lights Example



Energy Modelling – Schedules – Misc Example



Energy Modelling – Schedules – Misc Example



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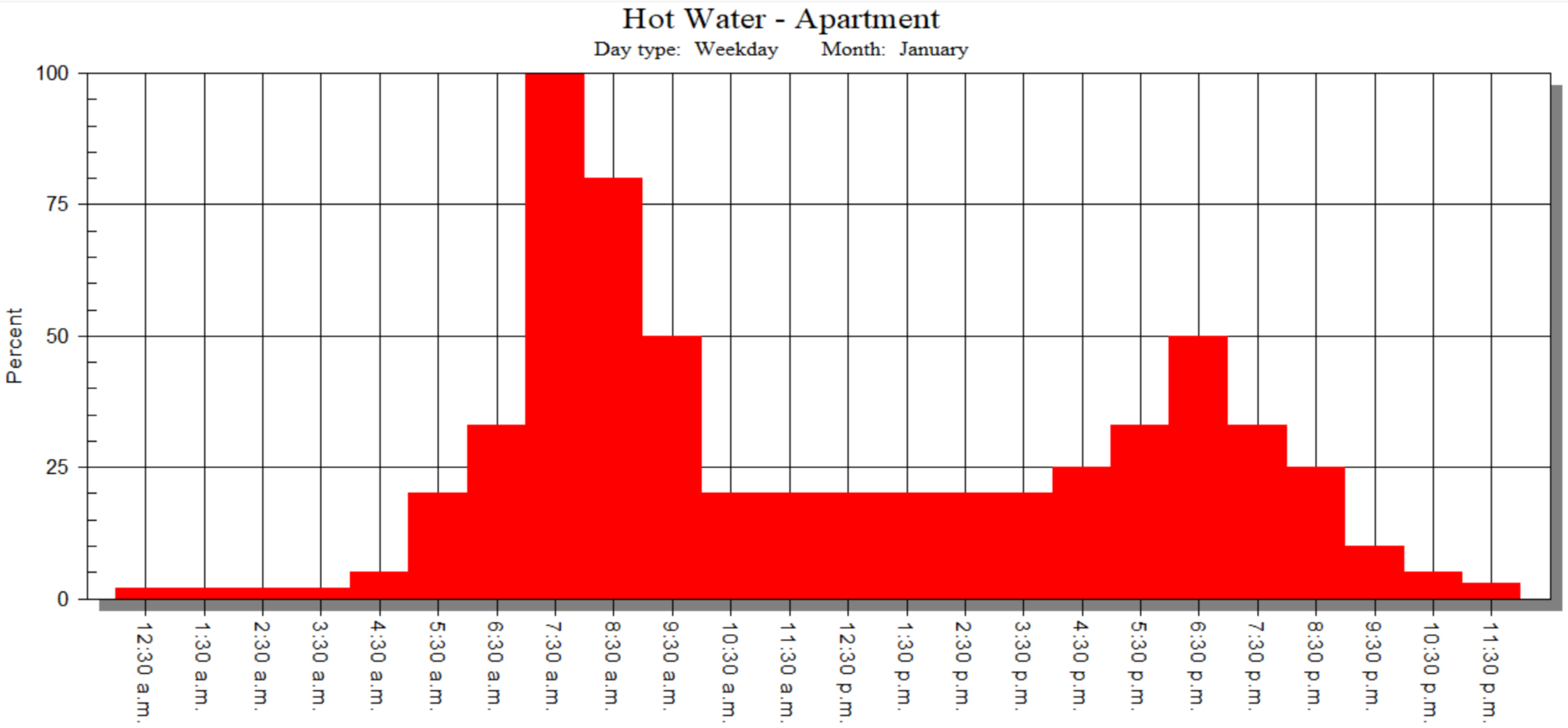
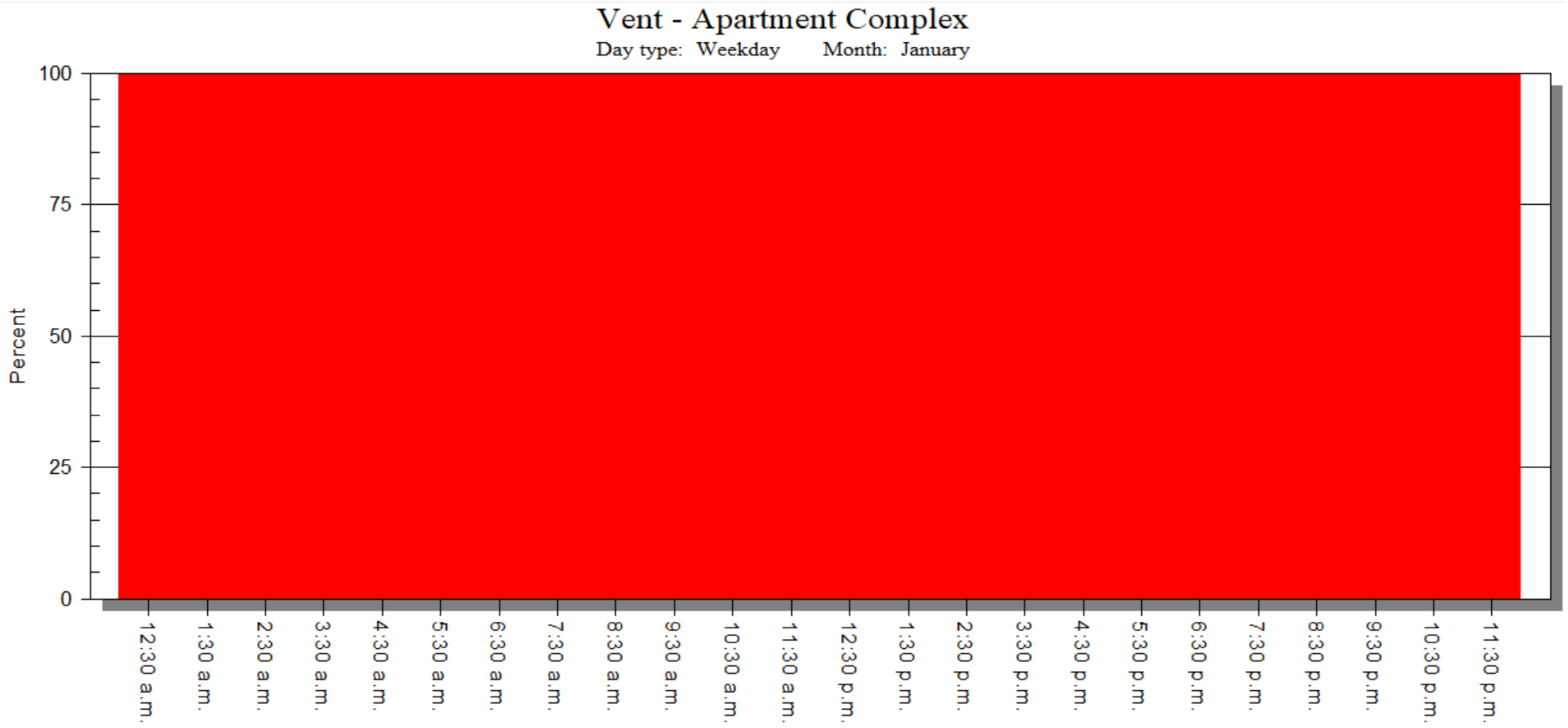
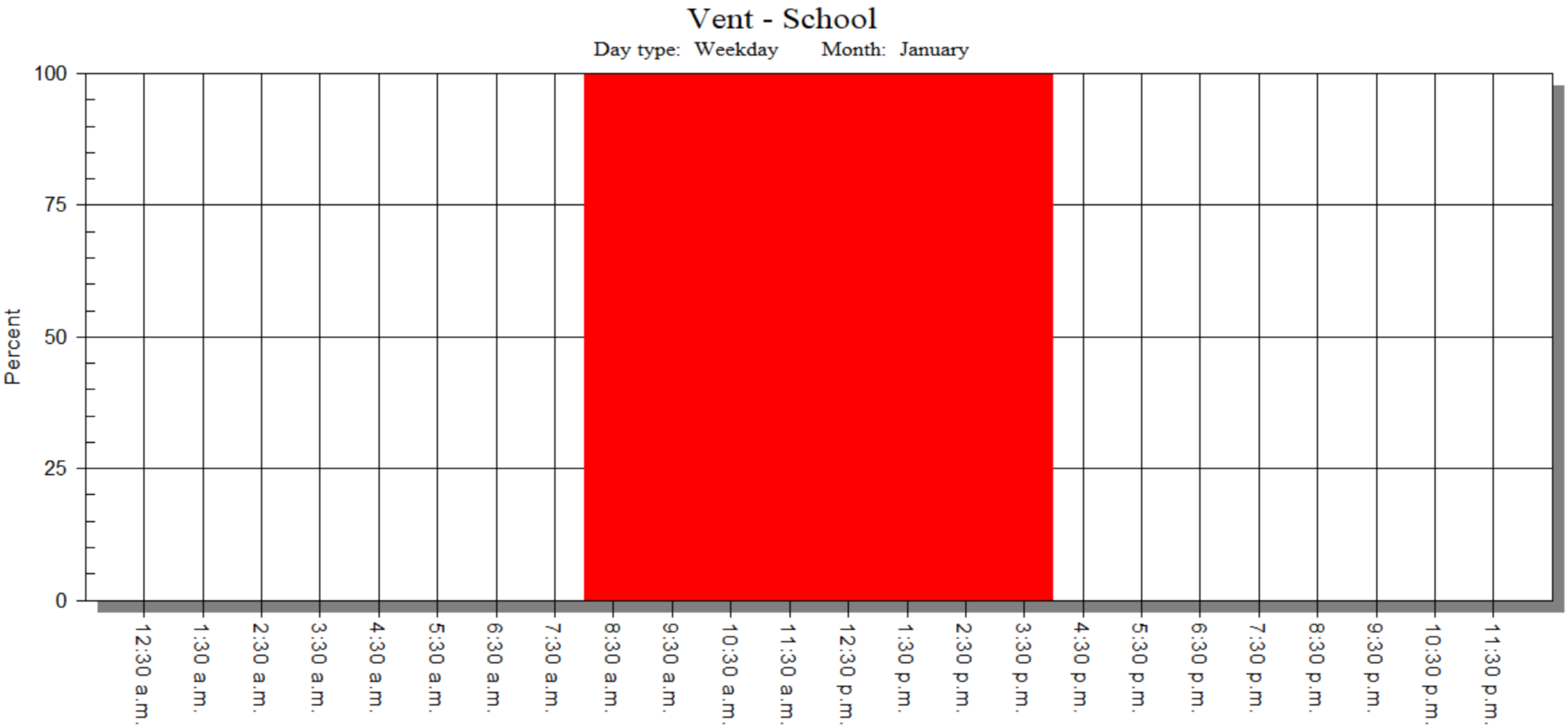
Energy Modelling – Schedules – DHW Example



Energy Modelling – Schedules – Ventilation Example

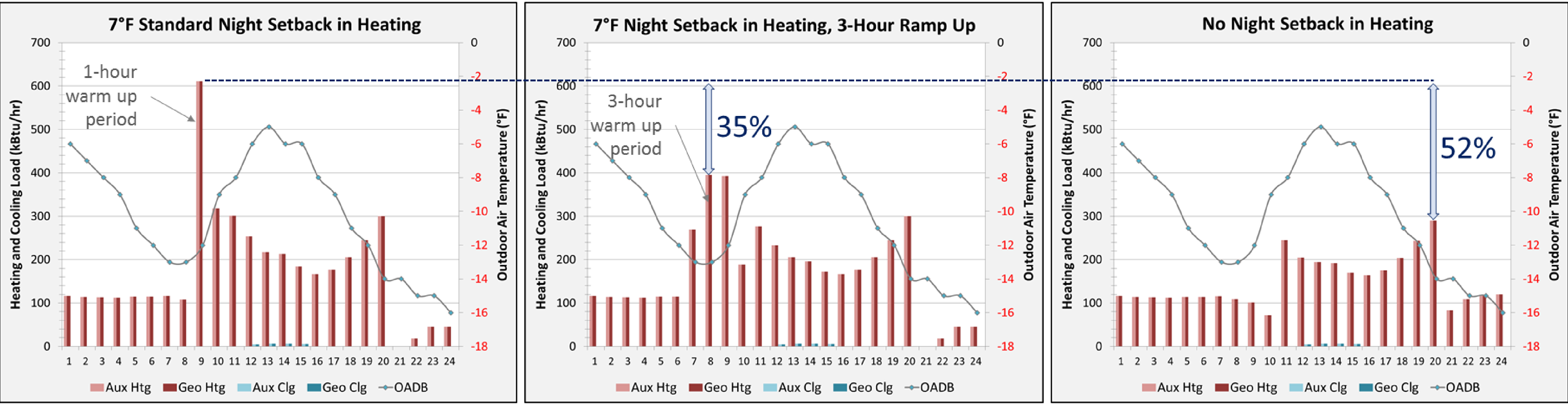


Energy Modelling – Schedules – Ventilation Example



Energy Modelling – Schedules – Night-time Setback

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



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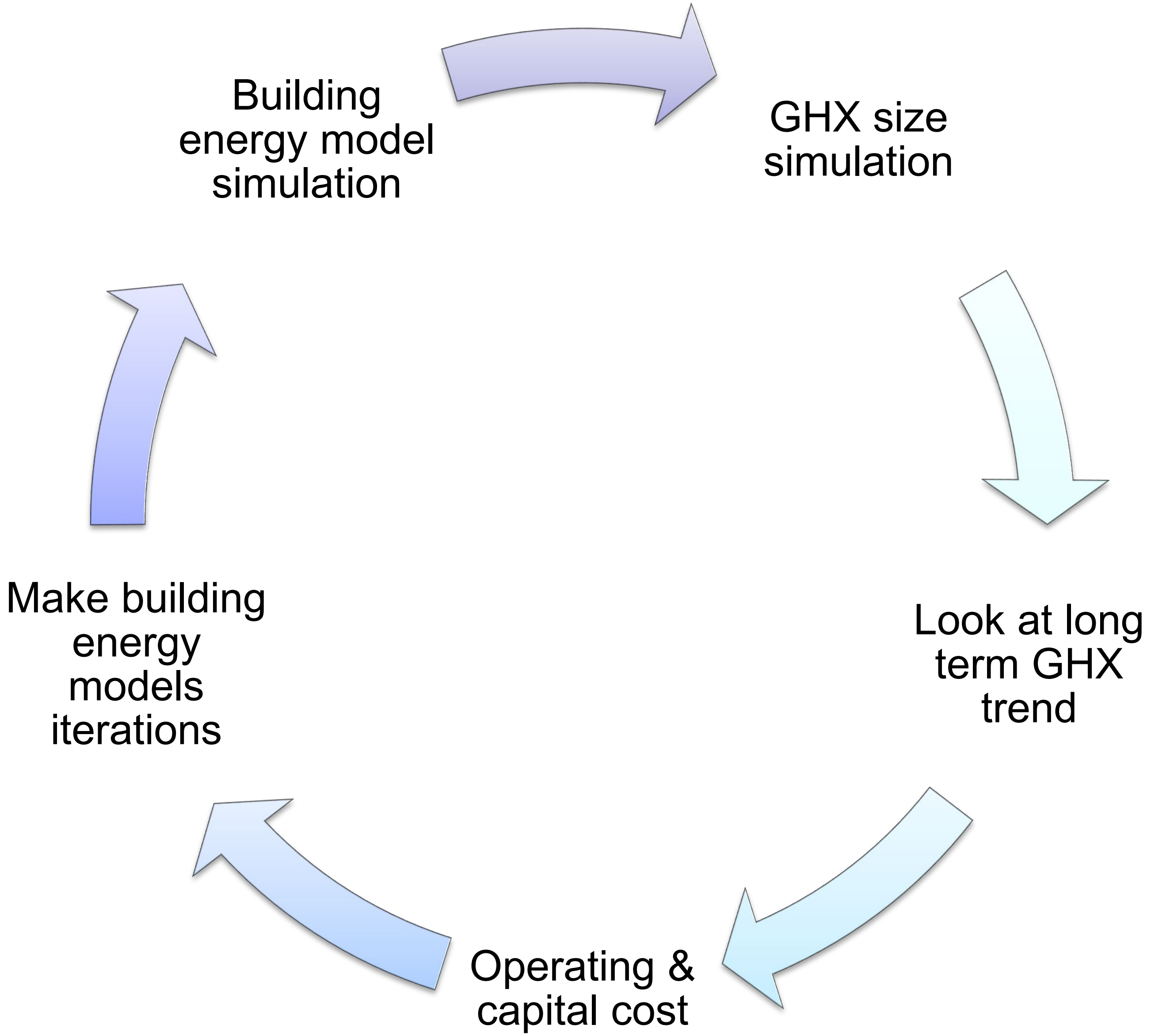
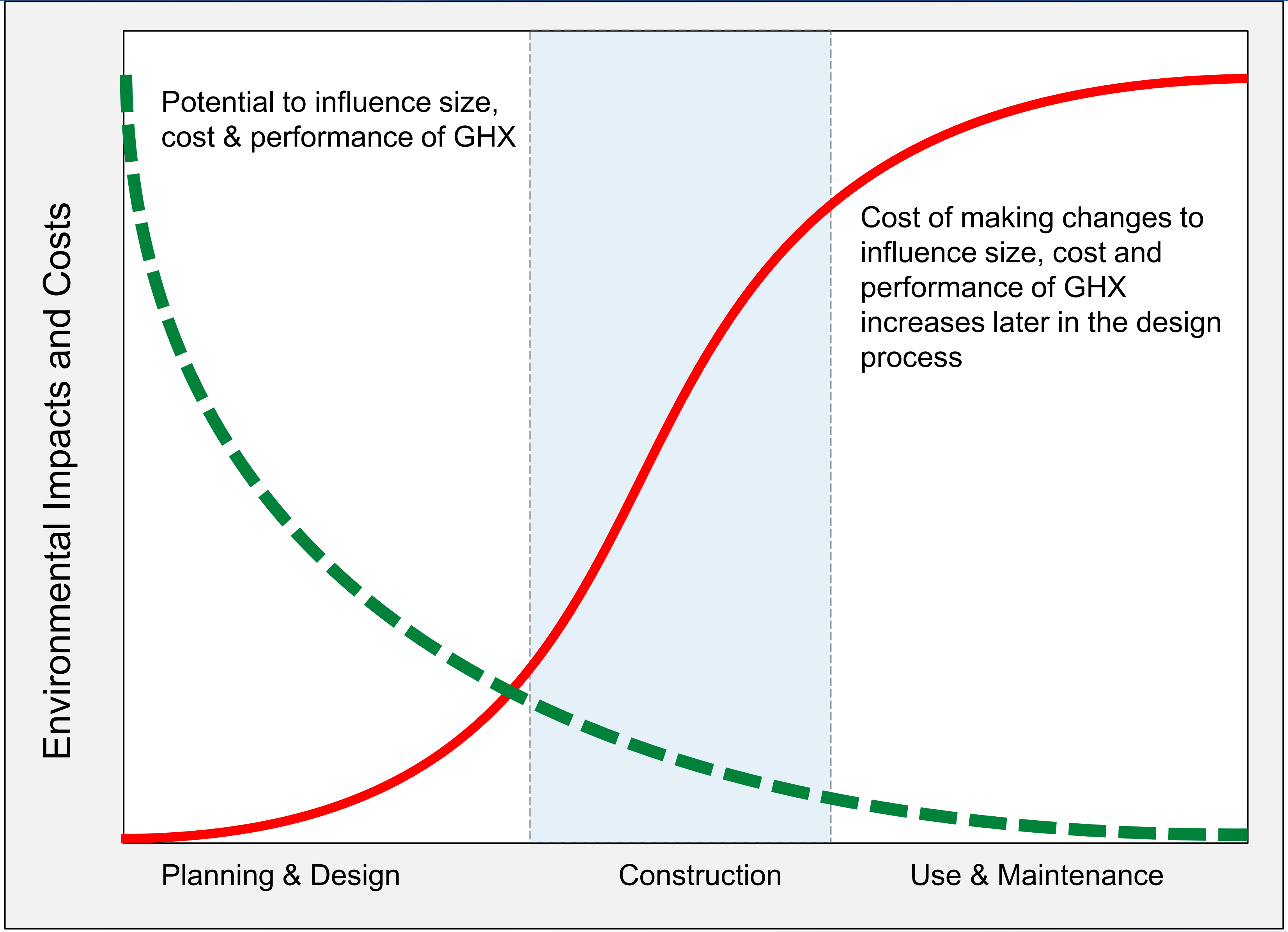
Q/A

Energy Modelling – Mental Model



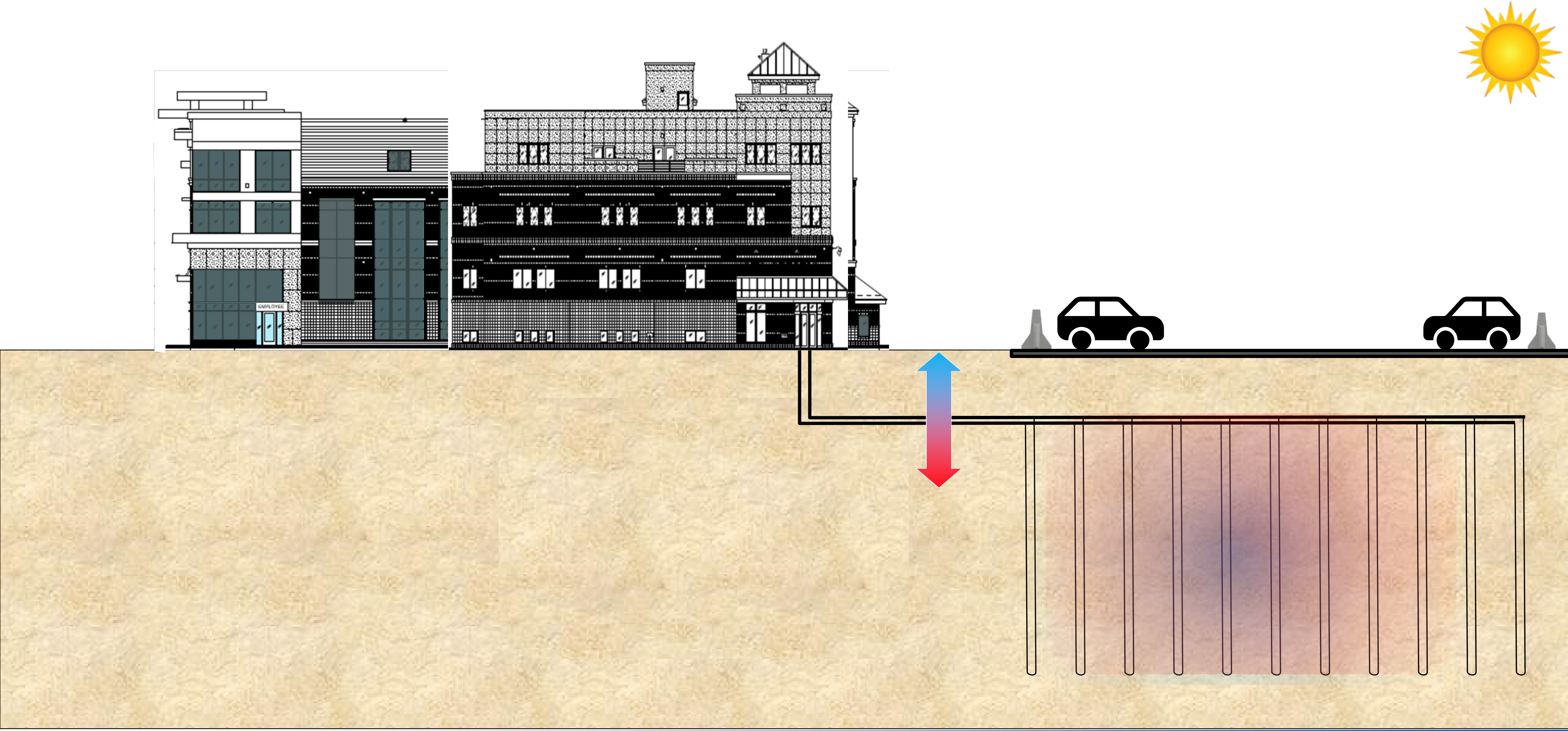
Energy Modelling as a Design Tool



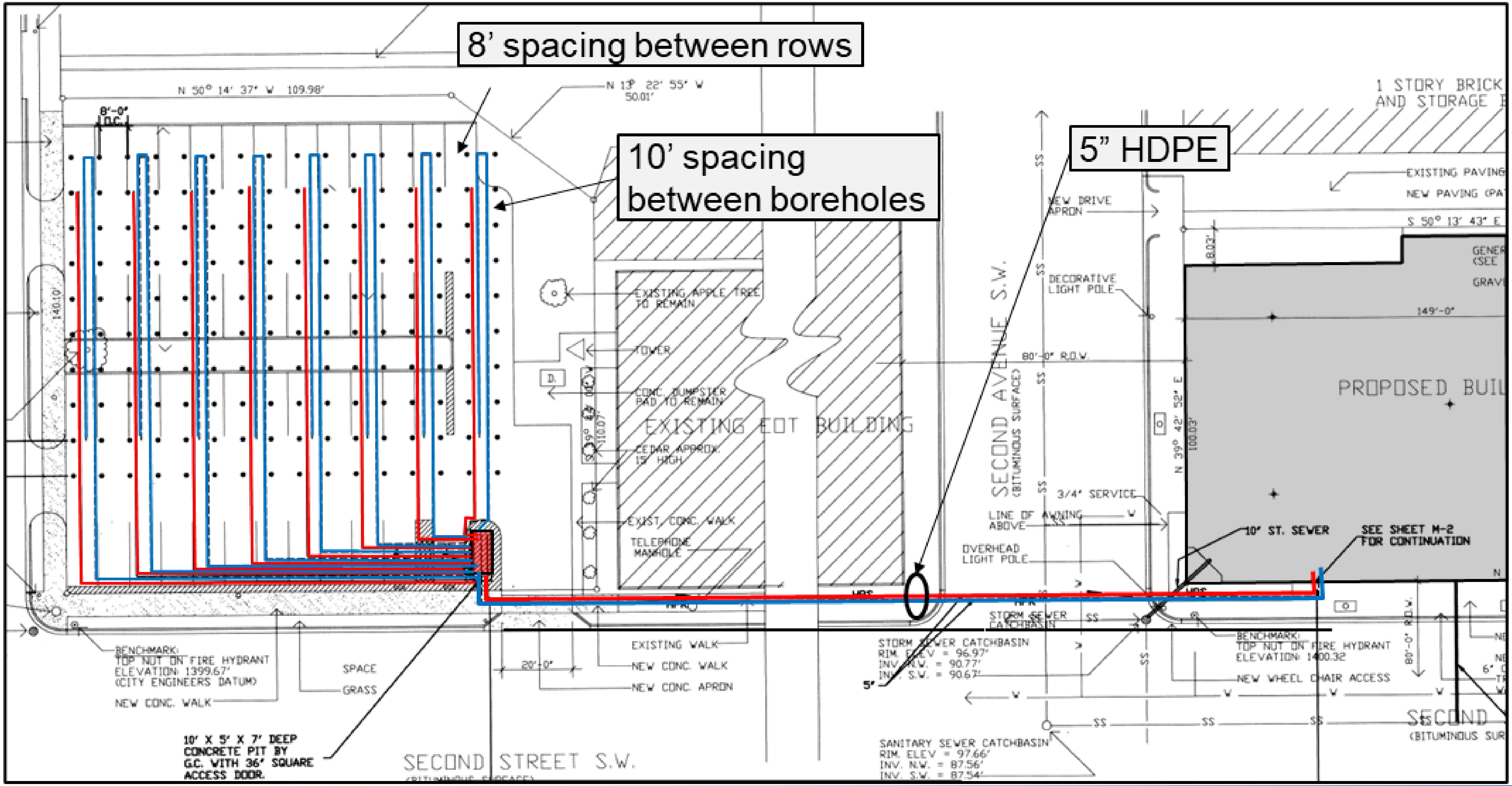
Case Study 1 – Office Expansion

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

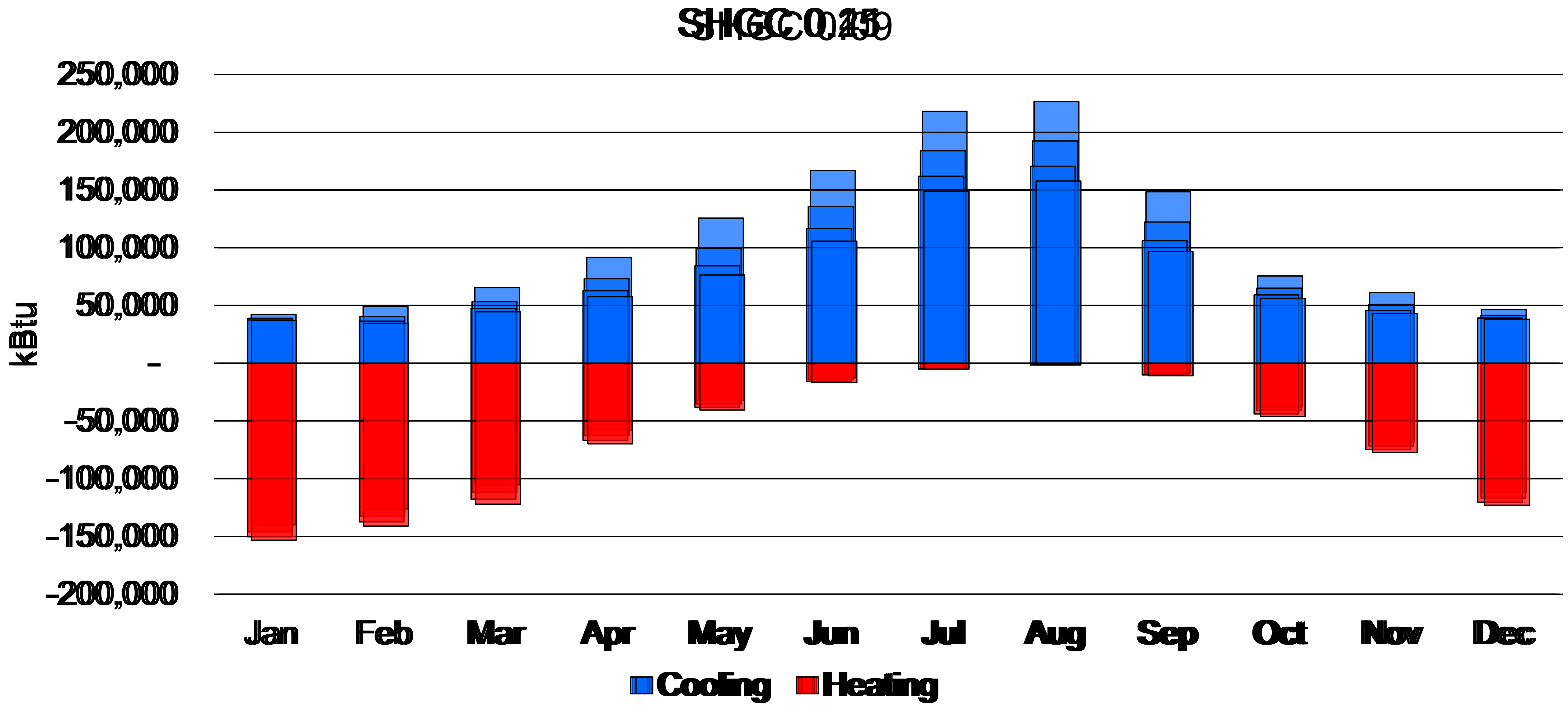
Case Study 1 - Project Description



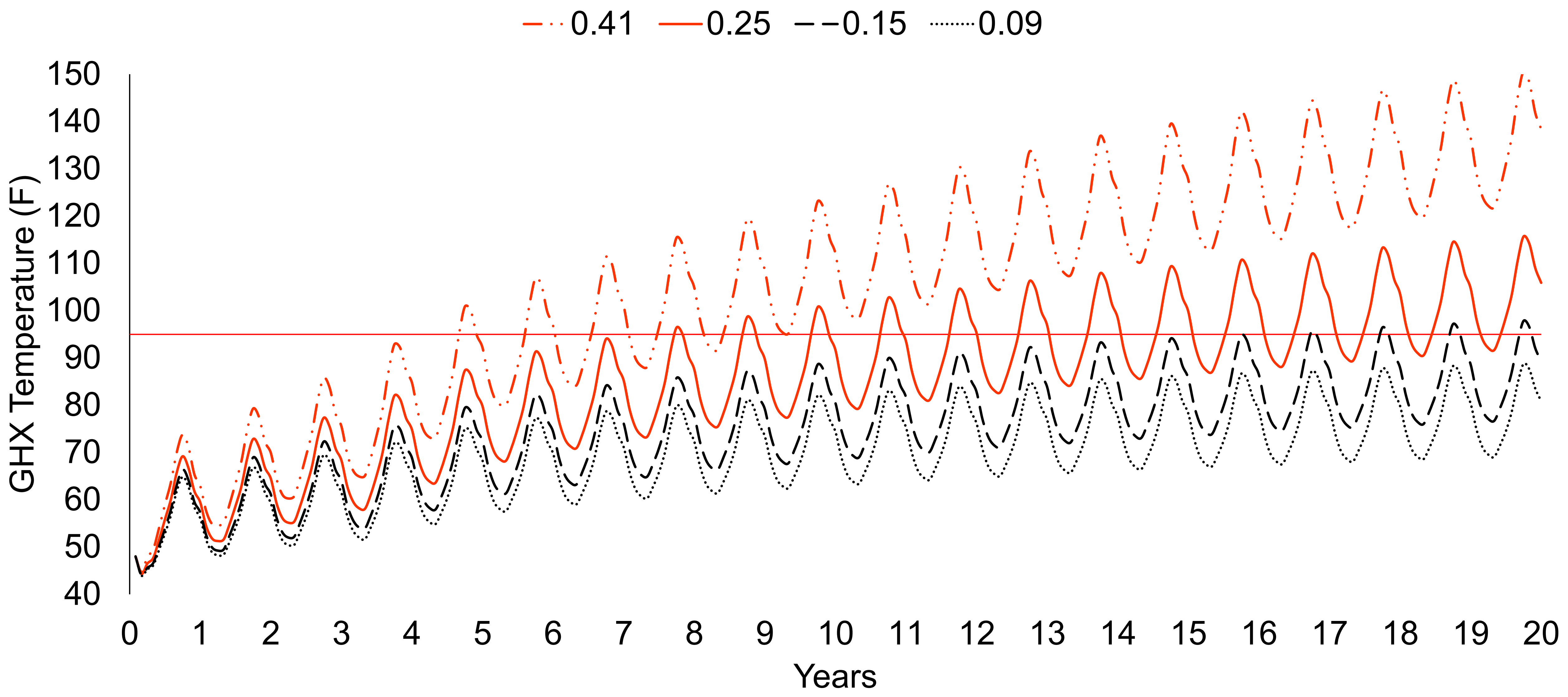
Case Study 1 - GHX Description



Case Study 1 - Annual Energy Load Variability



Case Study 1 - Long-Term GSHP Temperature



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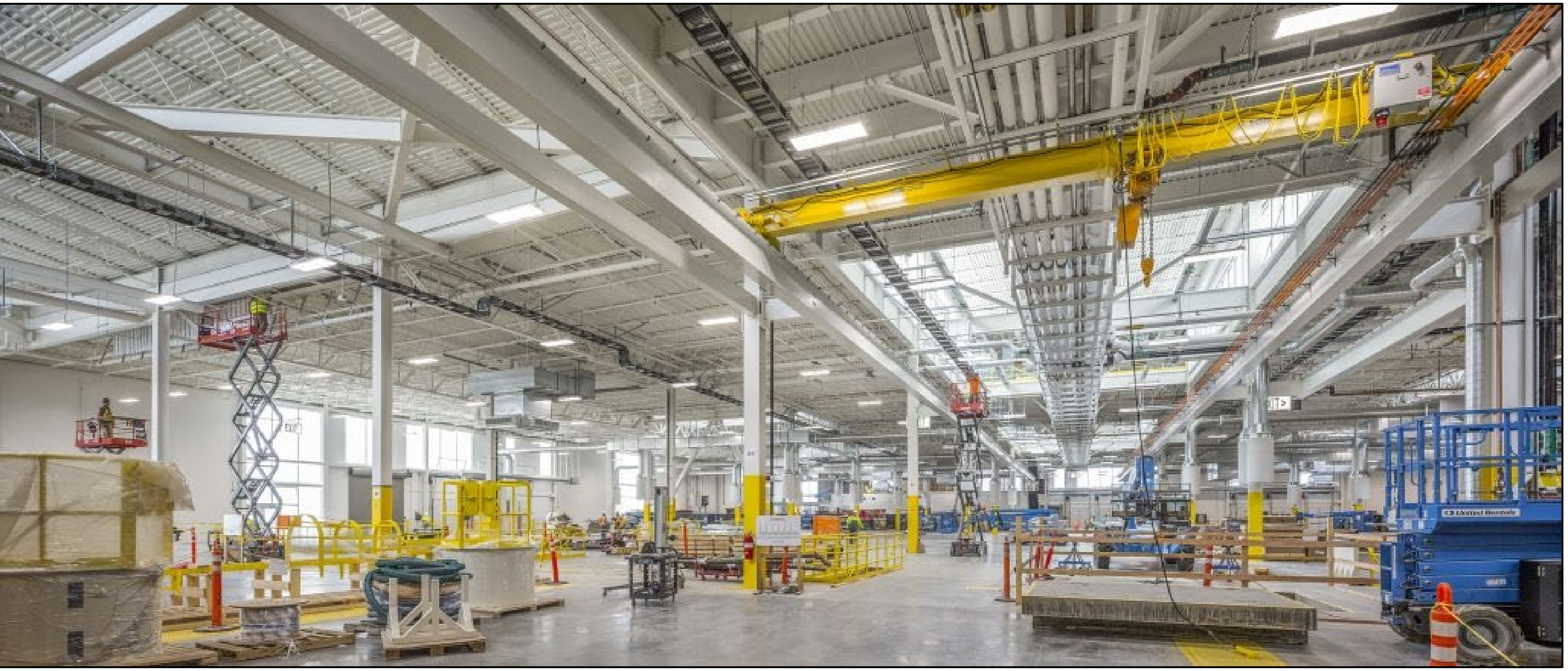
Case Study 2 – Warehouse Retrofit

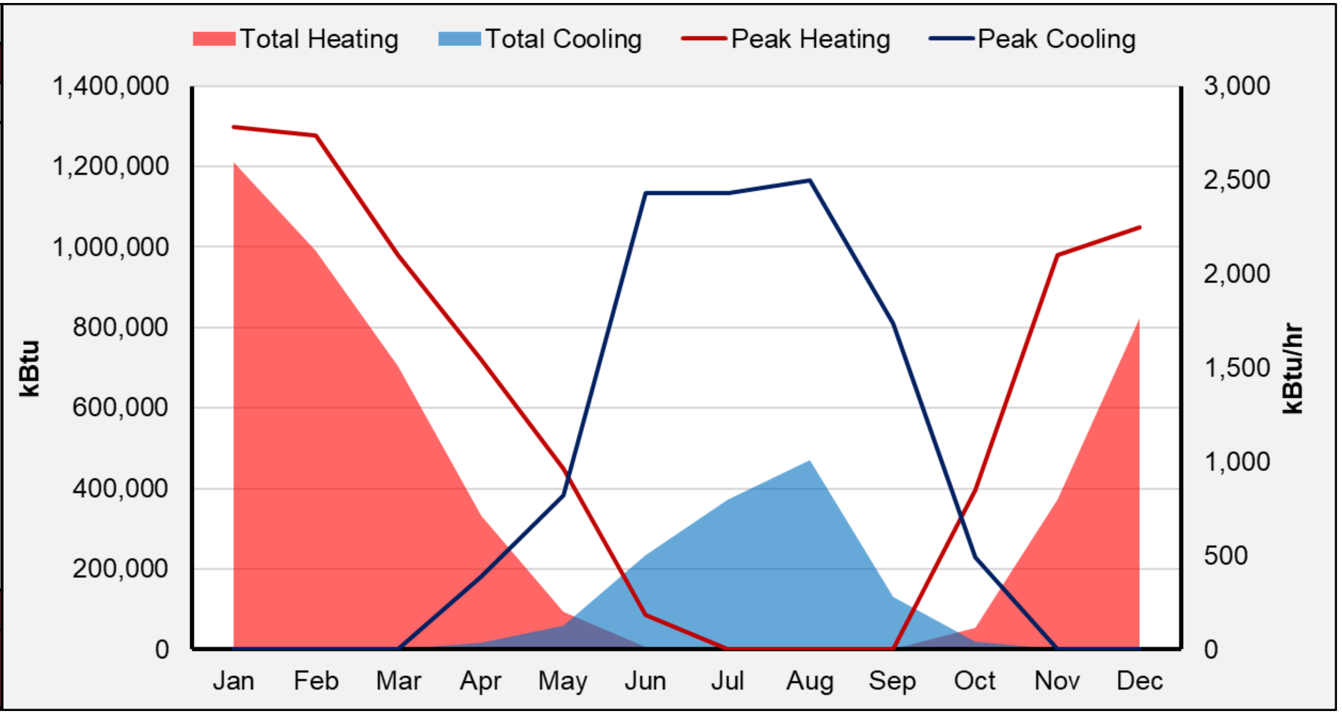
- 250,000 ft^2 manufacturing facility
- Existing natural gas heating system
- Interested in GSHP system



Case Study 2 – Energy Model V1

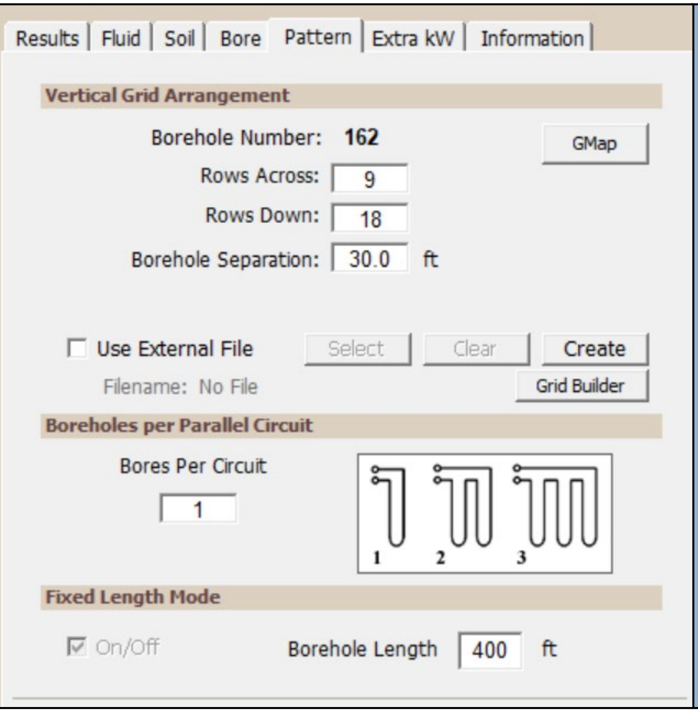
- Trace Trace 700 used to model building
- Floor plans and interviews with the building owners used to develop energy model

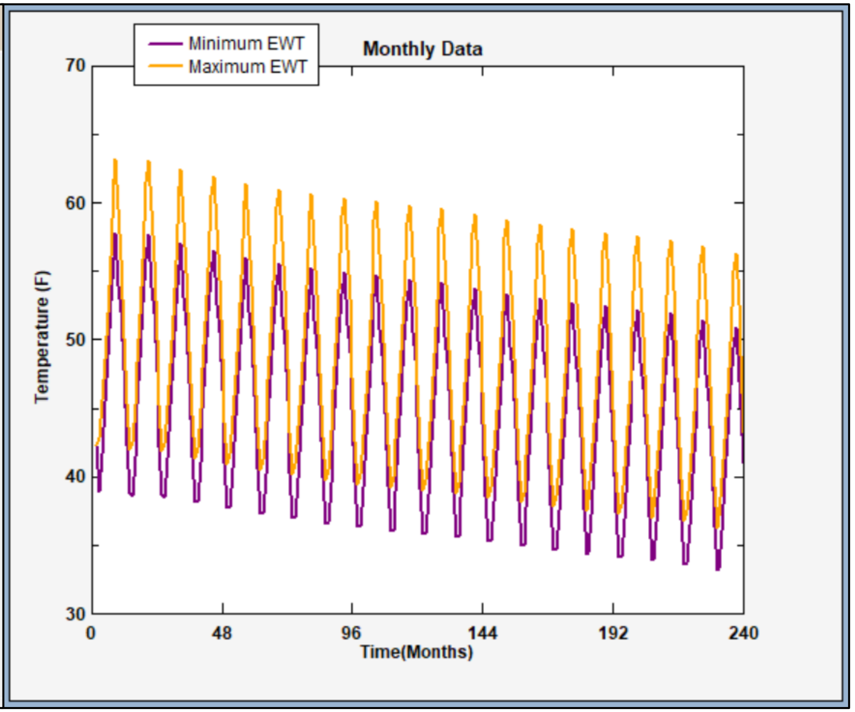
	Geo Cooling		Geo Heating	
	kBtu	kBtu/hr	kBtu	kBtu/hr
Jan	-	-	1,210,098	2,781
Feb	-	-	989,513	2,736
Mar	-	-	703,856	2,099
Apr	17,421	390	331,263	1,543
May	59,832	822	92,418	964
Jun	232,996	2,429	7,009	186
Jul	372,543	2,430	-	-
Aug	469,345	2,498	-	-
Sep	130,447	1,738	-	-
Oct	18,027	488	52,722	849
Nov	-	-	373,289	2,101
Dec	-	-	822,038	2,250
	1,300,612	**2,498**	**4,582,206**	**2,781**
	Tons	208	Tons	232
	EFLH	521	EFLH	1,648



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

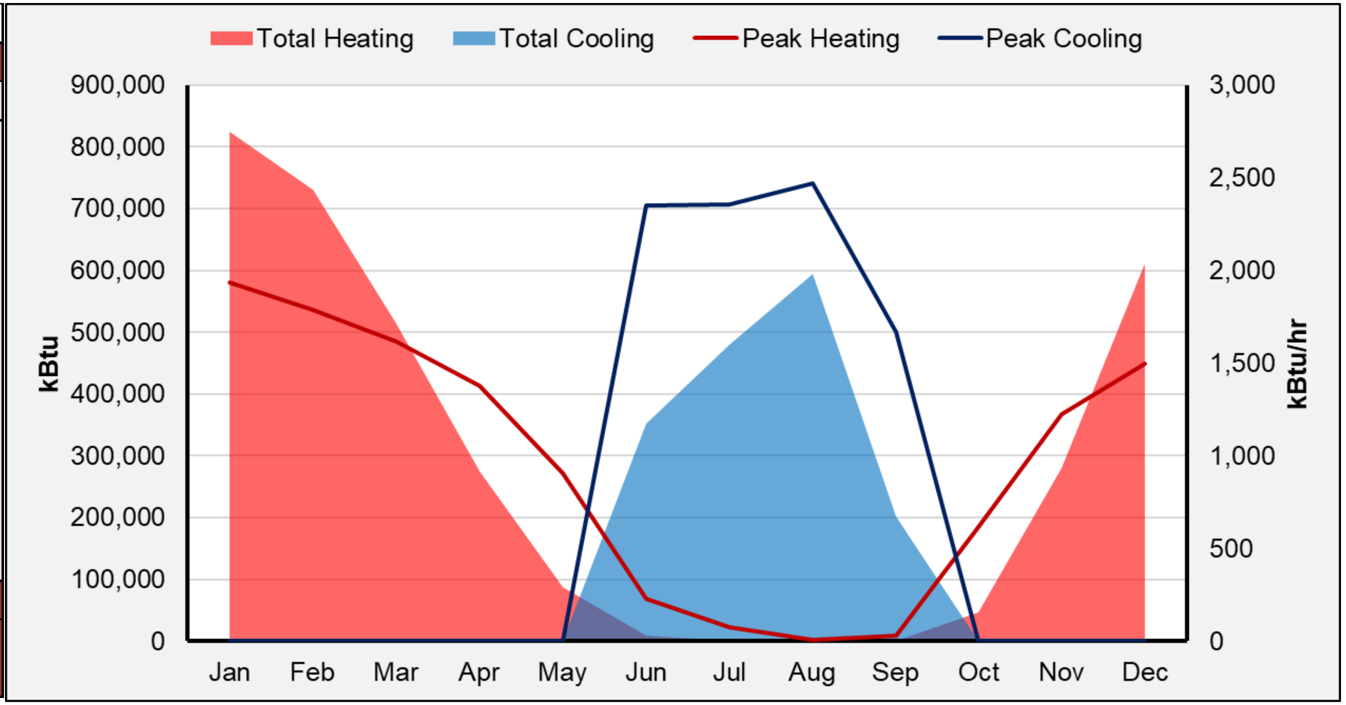




Case Study 2 – Energy Model V2

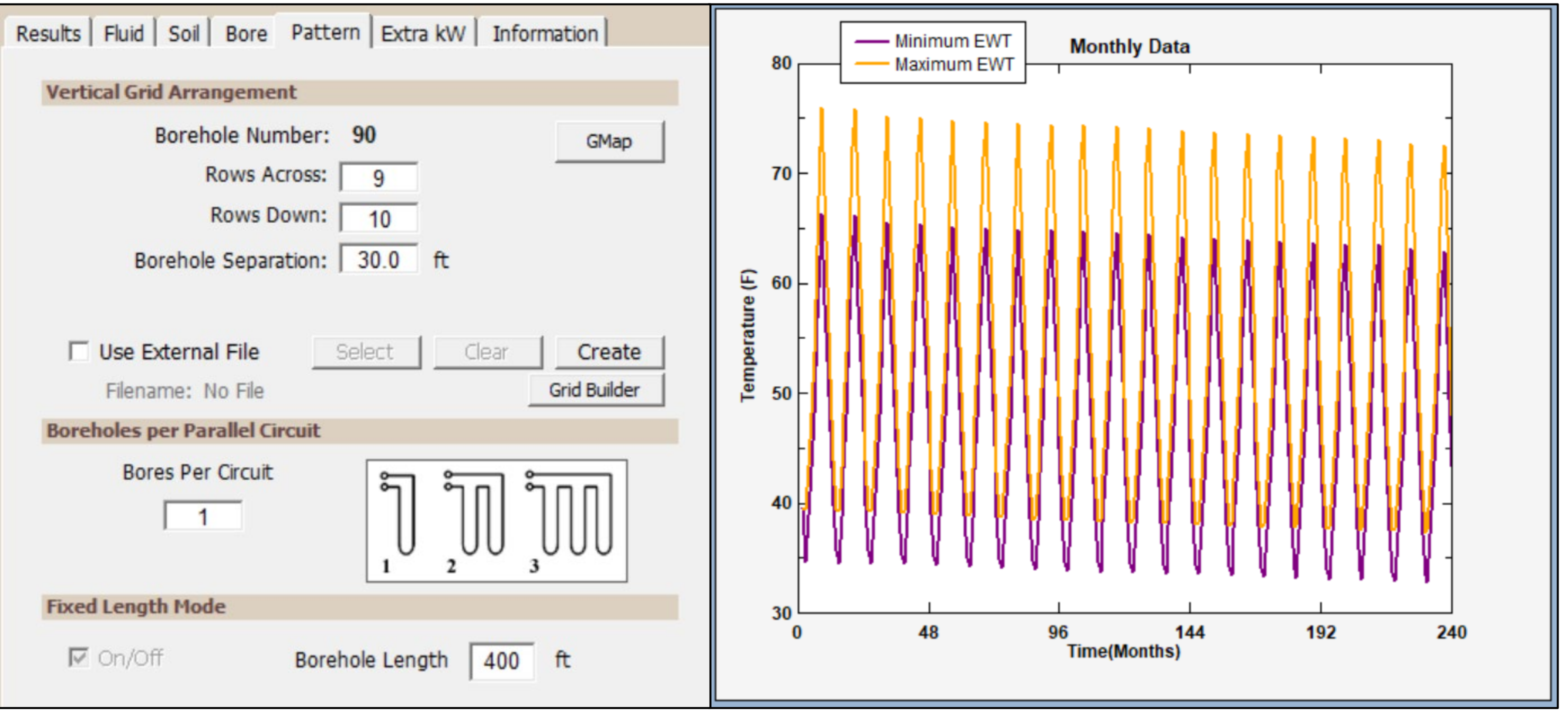
- Sensible wheel energy recovery ventilation added
- Reduces total amount of heating needed and increases the energy balance

	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

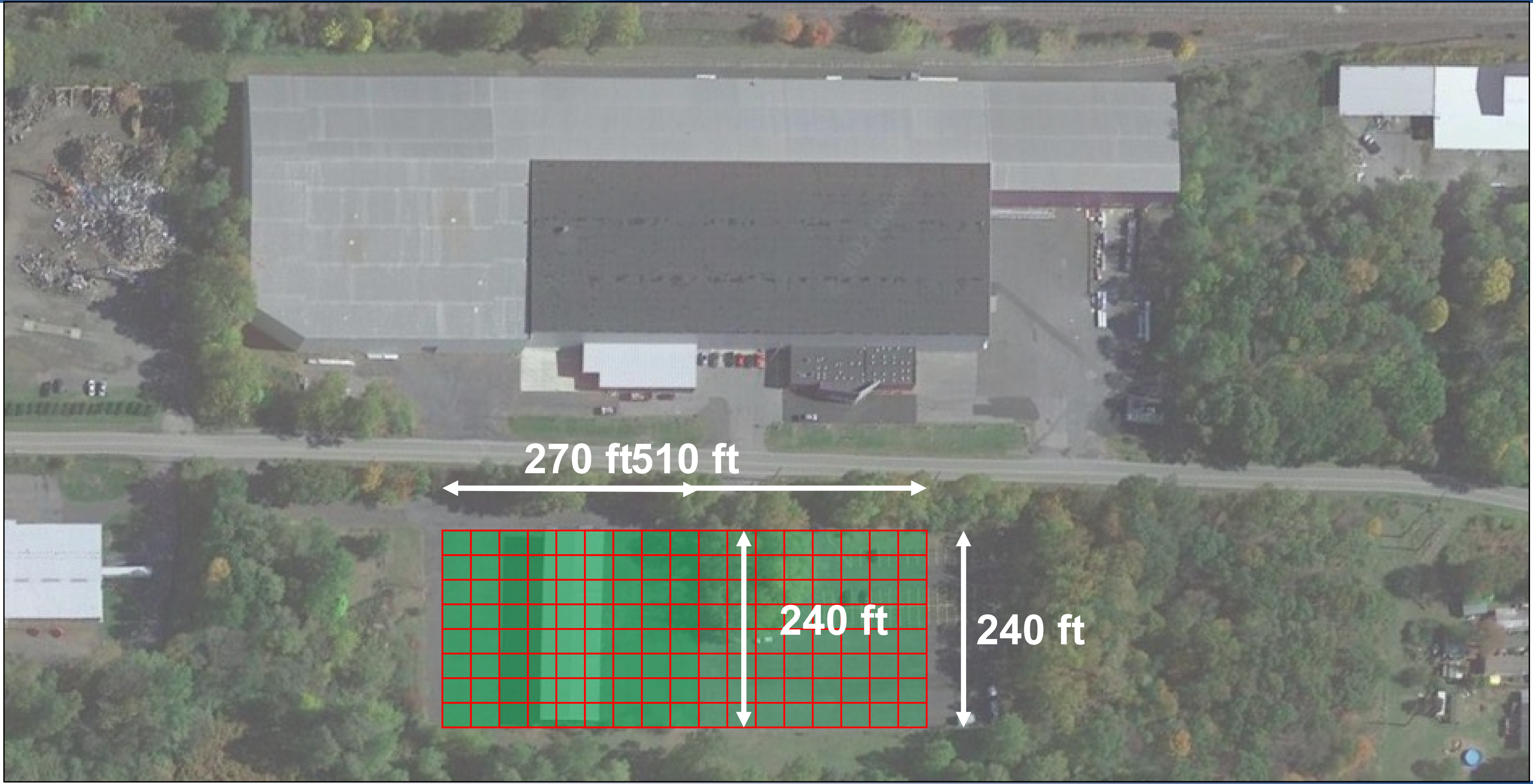


Case Study 2 – GHX Size V2

- 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

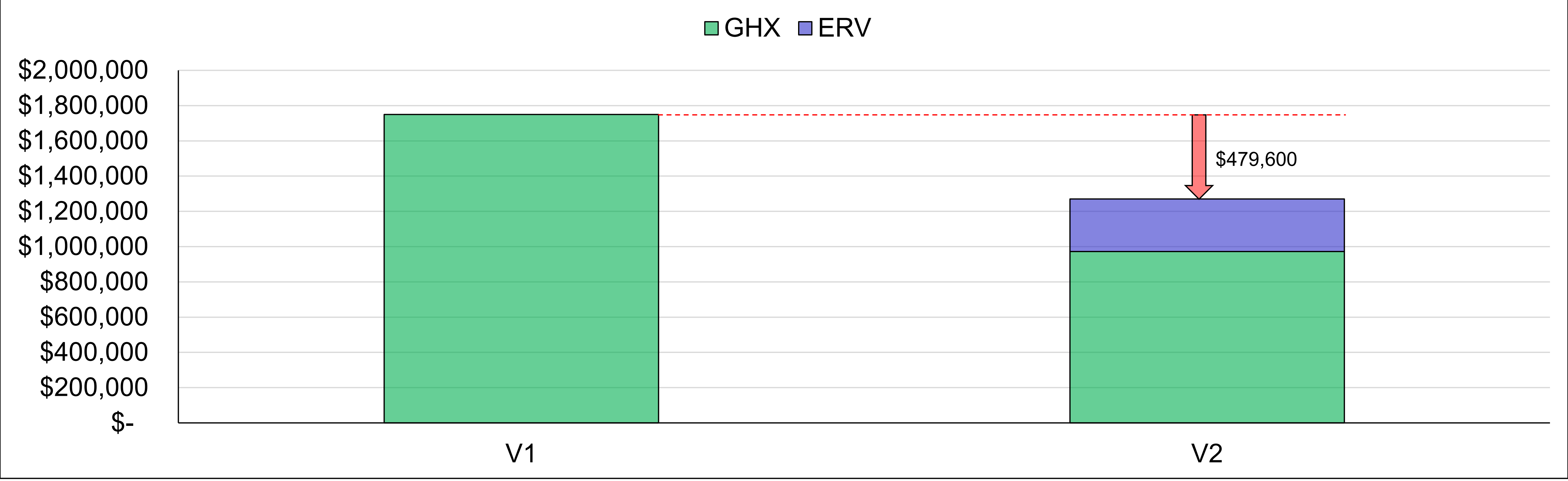


Case Study 2 – GHX Reduction

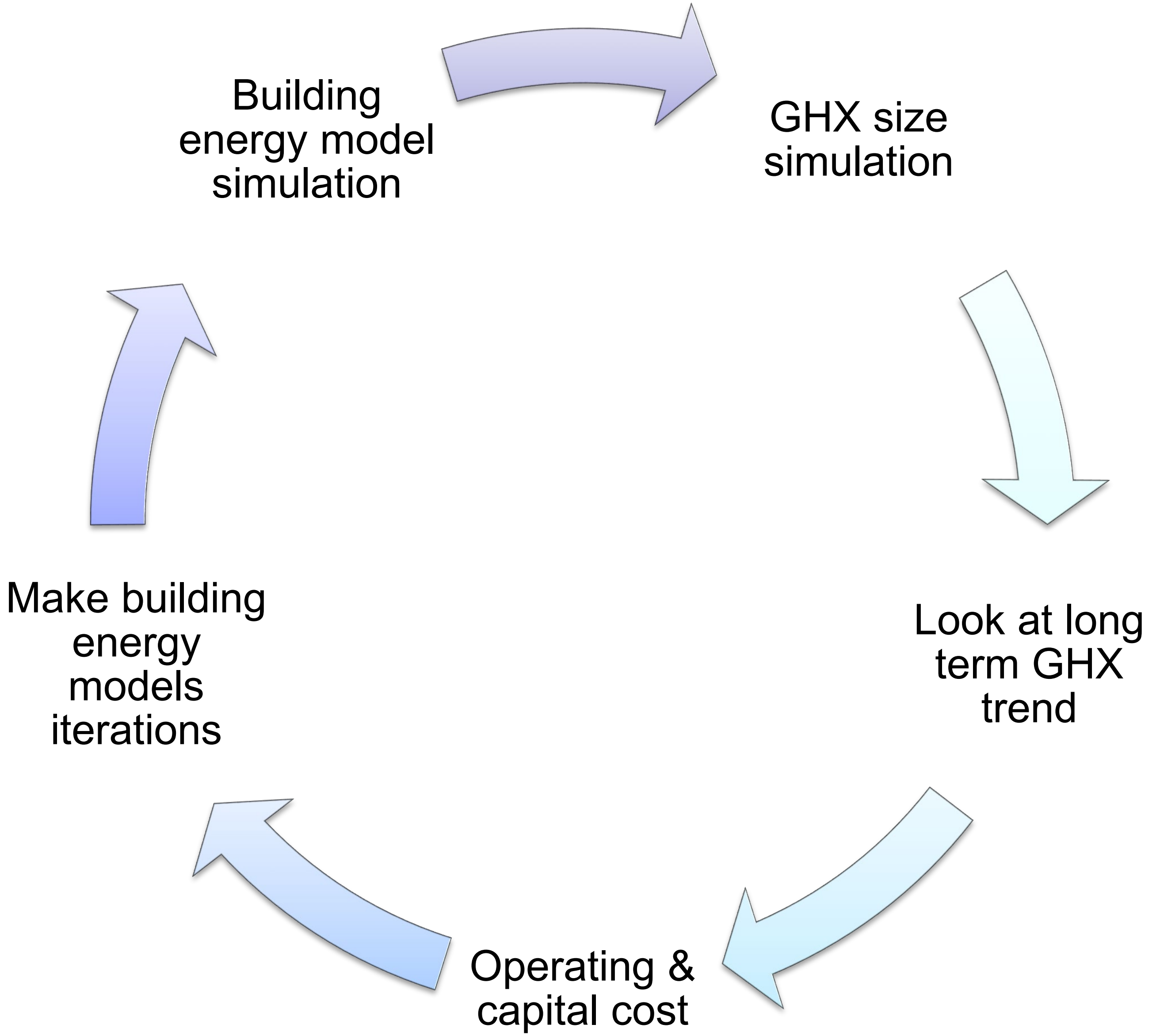


Case Study 2 – Economics

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

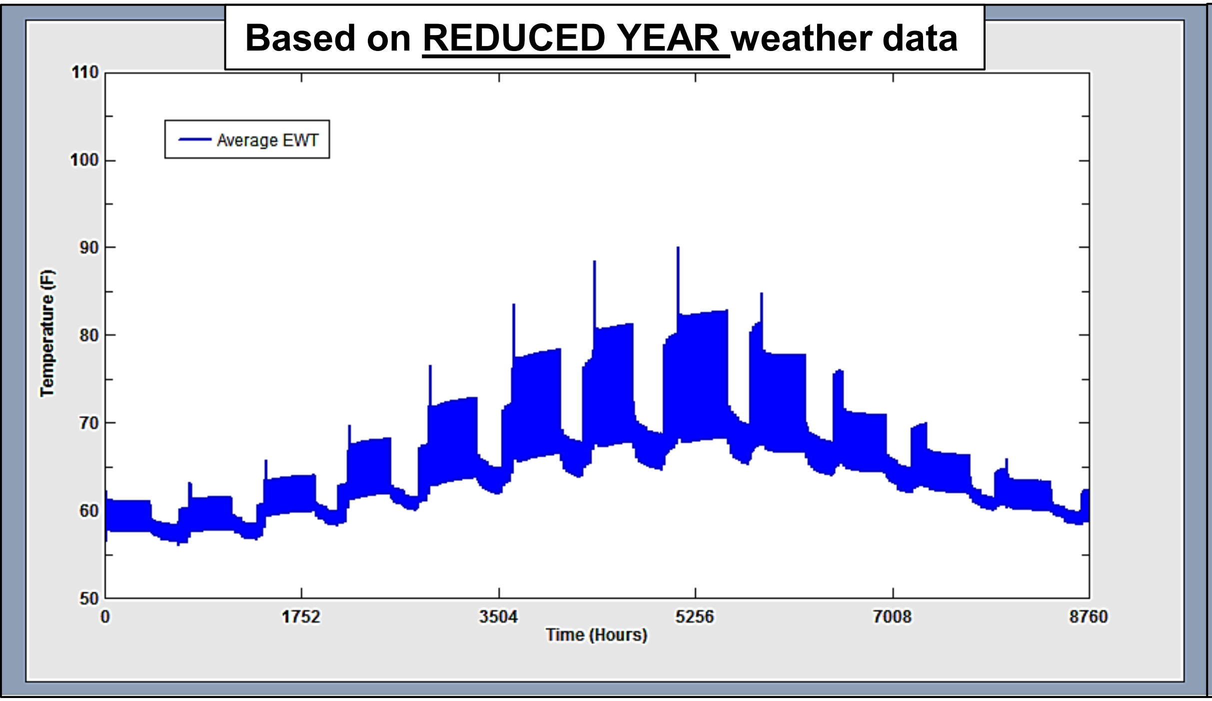


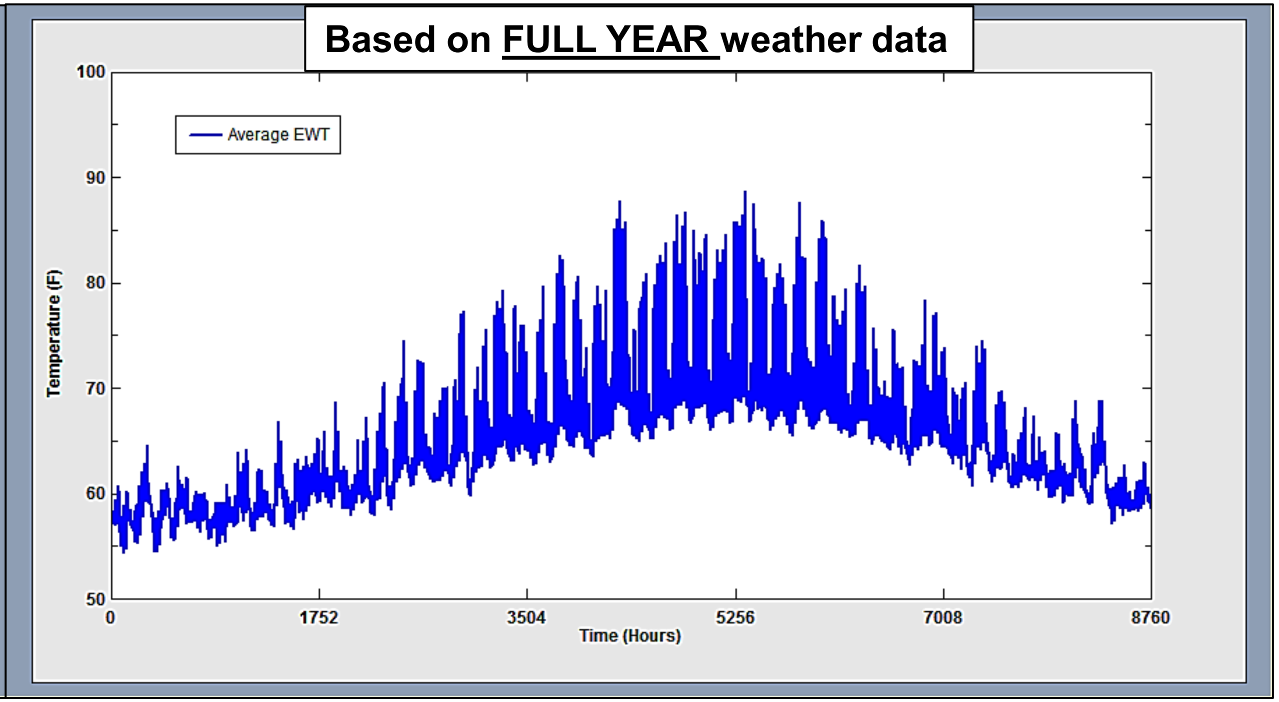
Energy Modelling – Mental Model



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

Energy Modelling Software

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

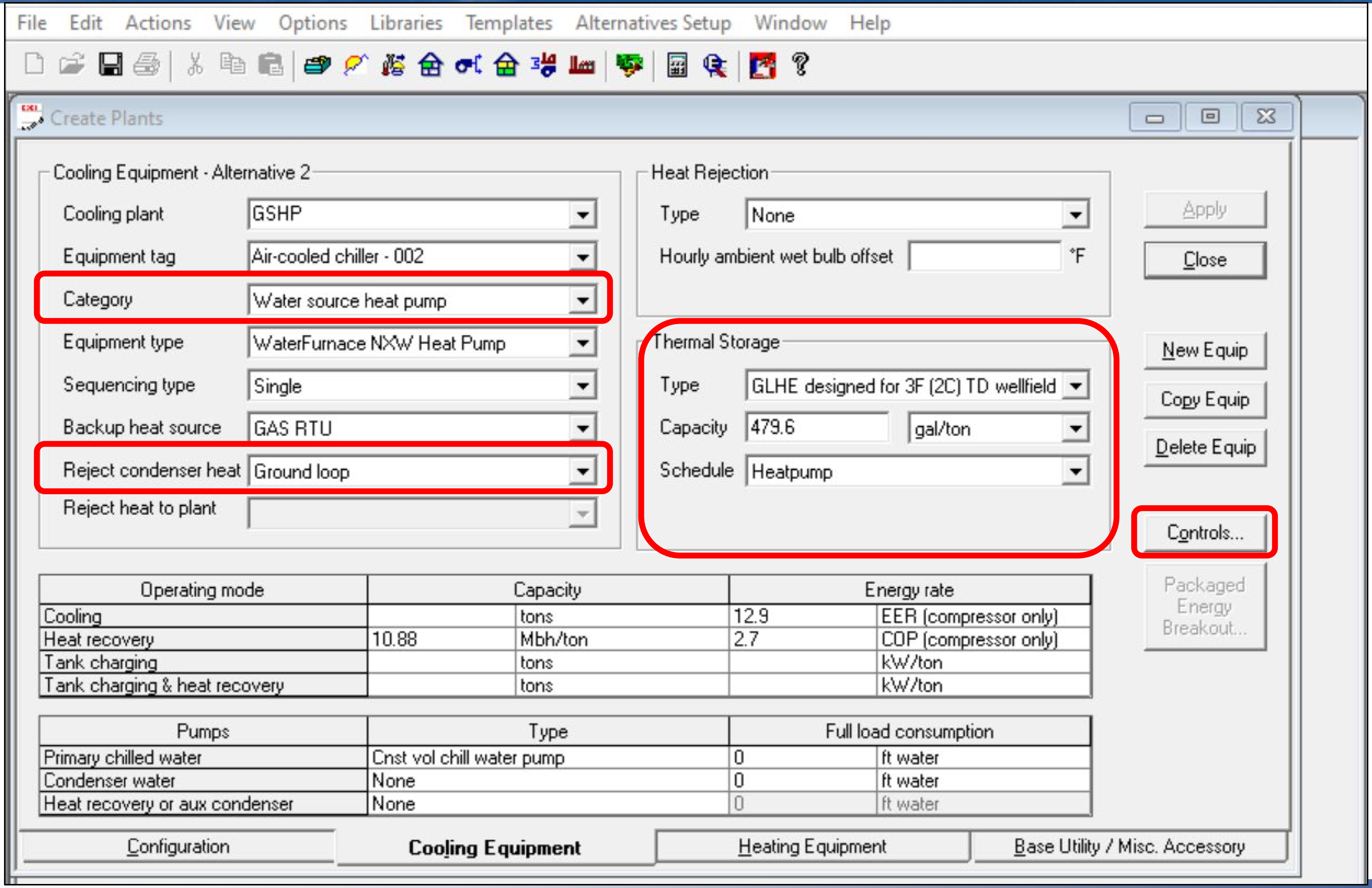
Trane Trace Export Demo

File Edit Actions View Options Libraries Templates Alternatives Setup Window Help

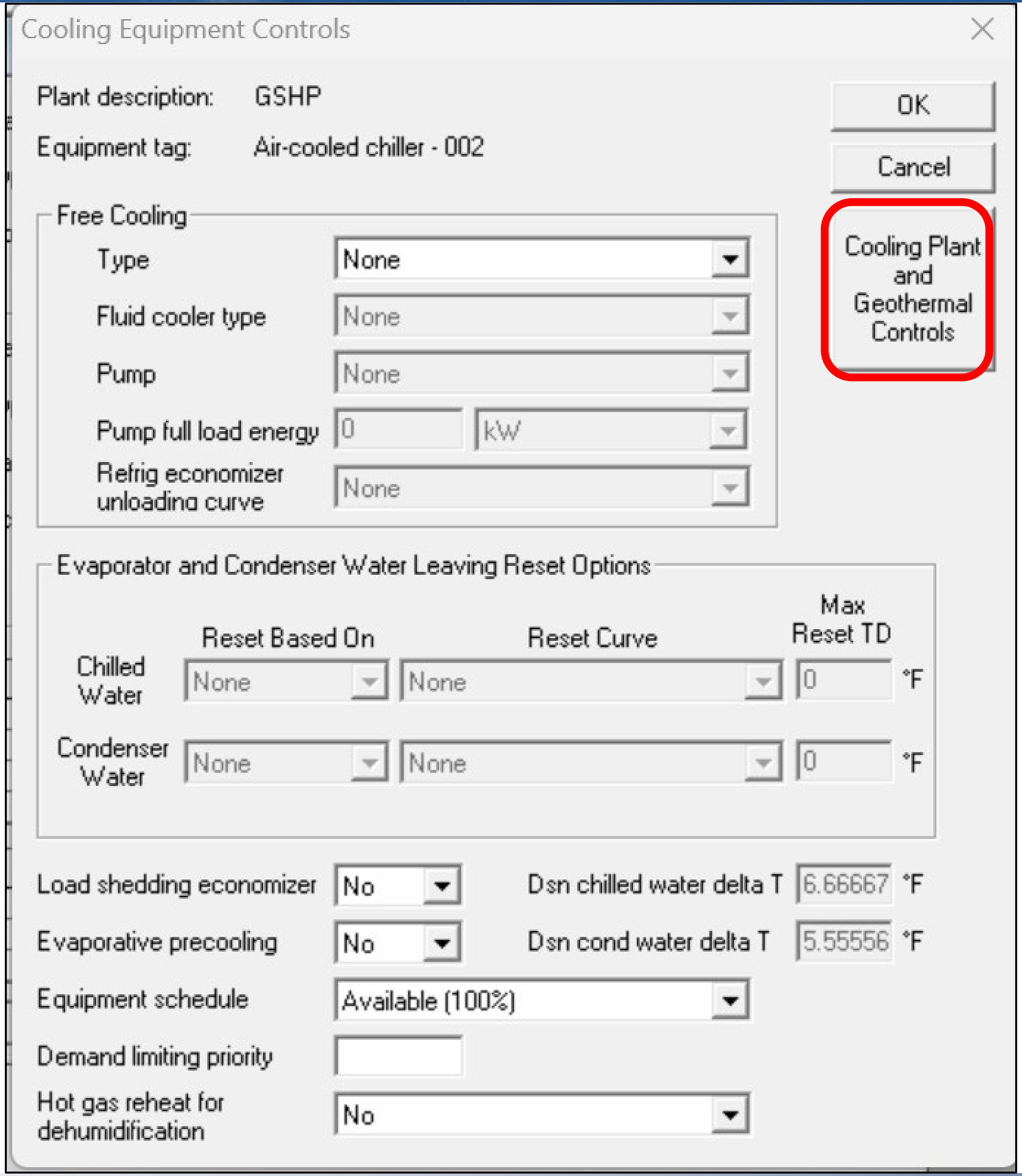
Project Navigator

	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

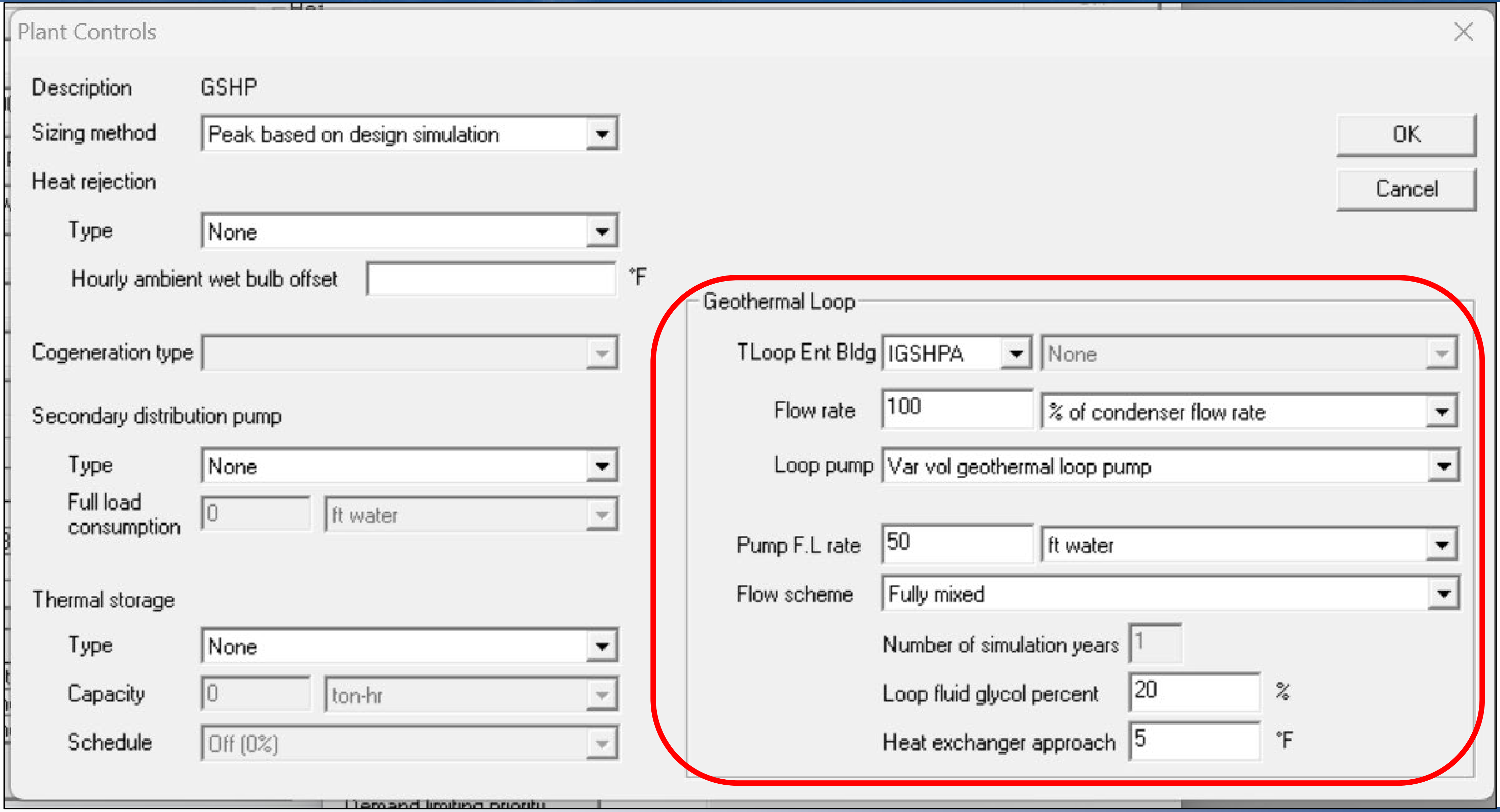
Trane Trace Export Demo



Trane Trace Export Demo



Trane Trace Export Demo



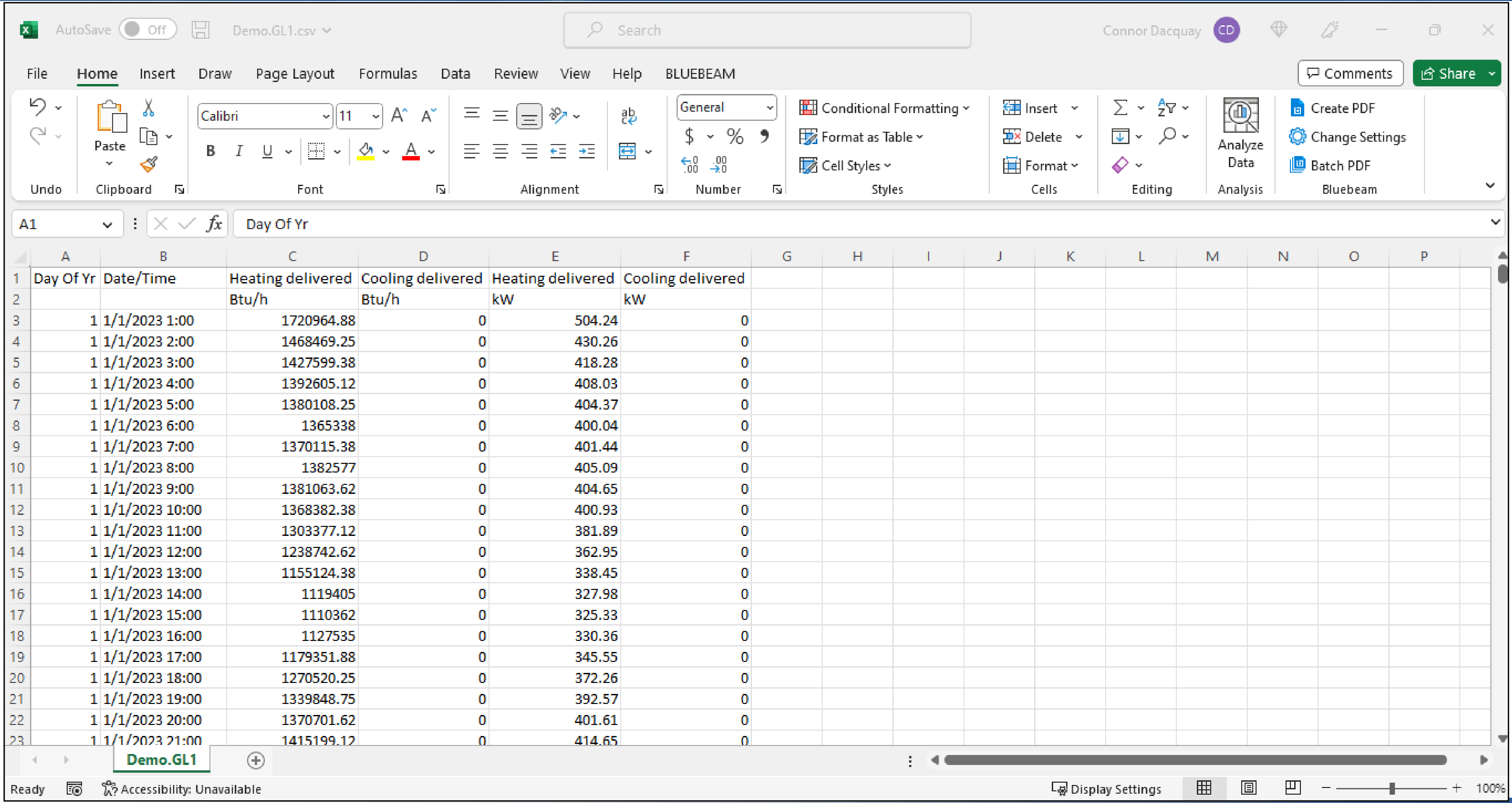
Trane Trace Export Demo

Documents > Demo

Search Demo

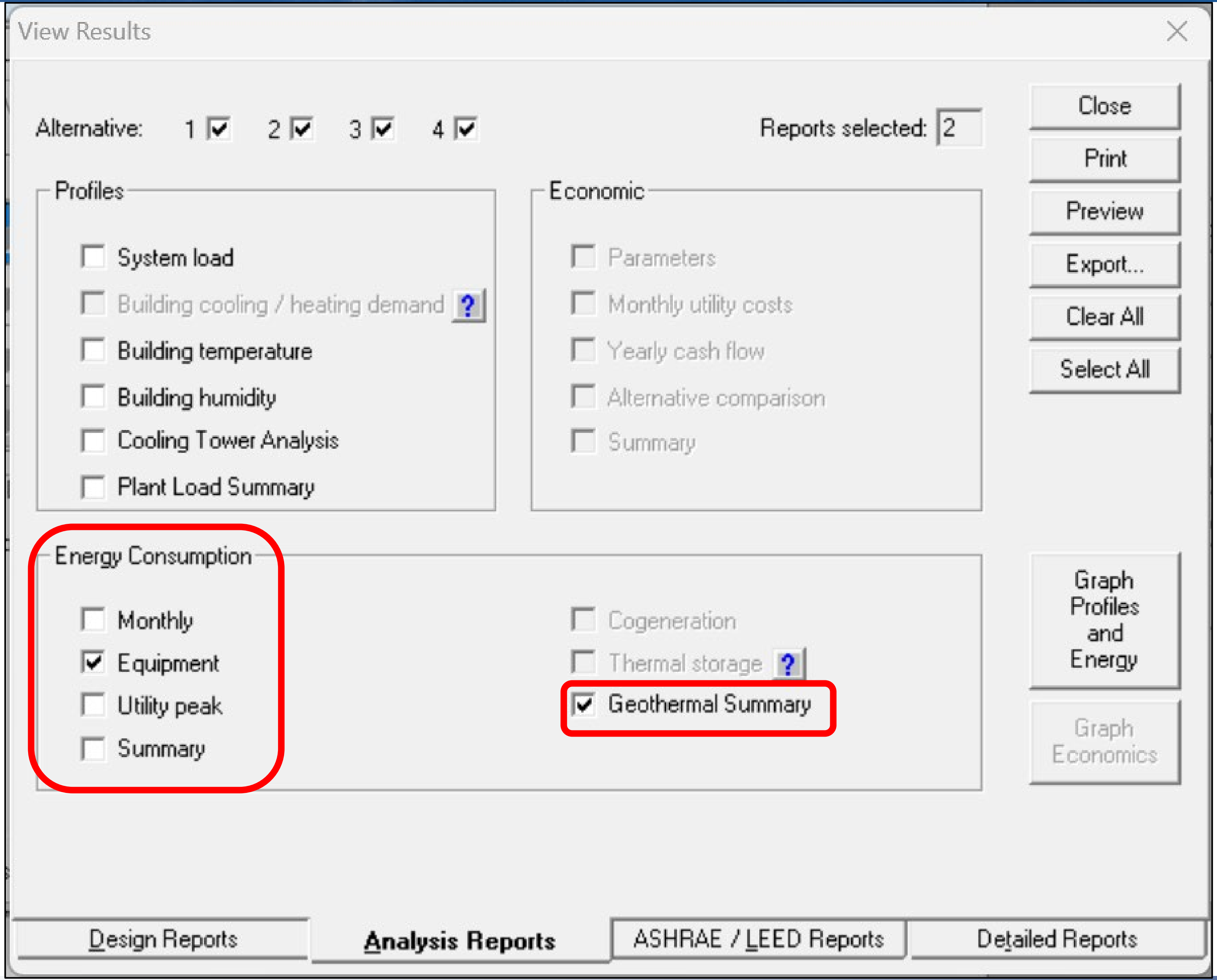
Name	Date modified	Type	Size
Demo.GL1.csv	2023-01-19 11:11 AM	Microsoft Excel Comma Separat...	925 KB
Demo.GL2.csv	2023-01-19 11:11 AM	Microsoft Excel Comma Separat...	925 KB
Demo.GL3.csv	2023-01-19 11:11 AM	Microsoft Excel Comma Separat...	925 KB
Demo.GL4.csv	2023-01-19 11:11 AM	Microsoft Excel Comma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

Trane Trace Export Demo

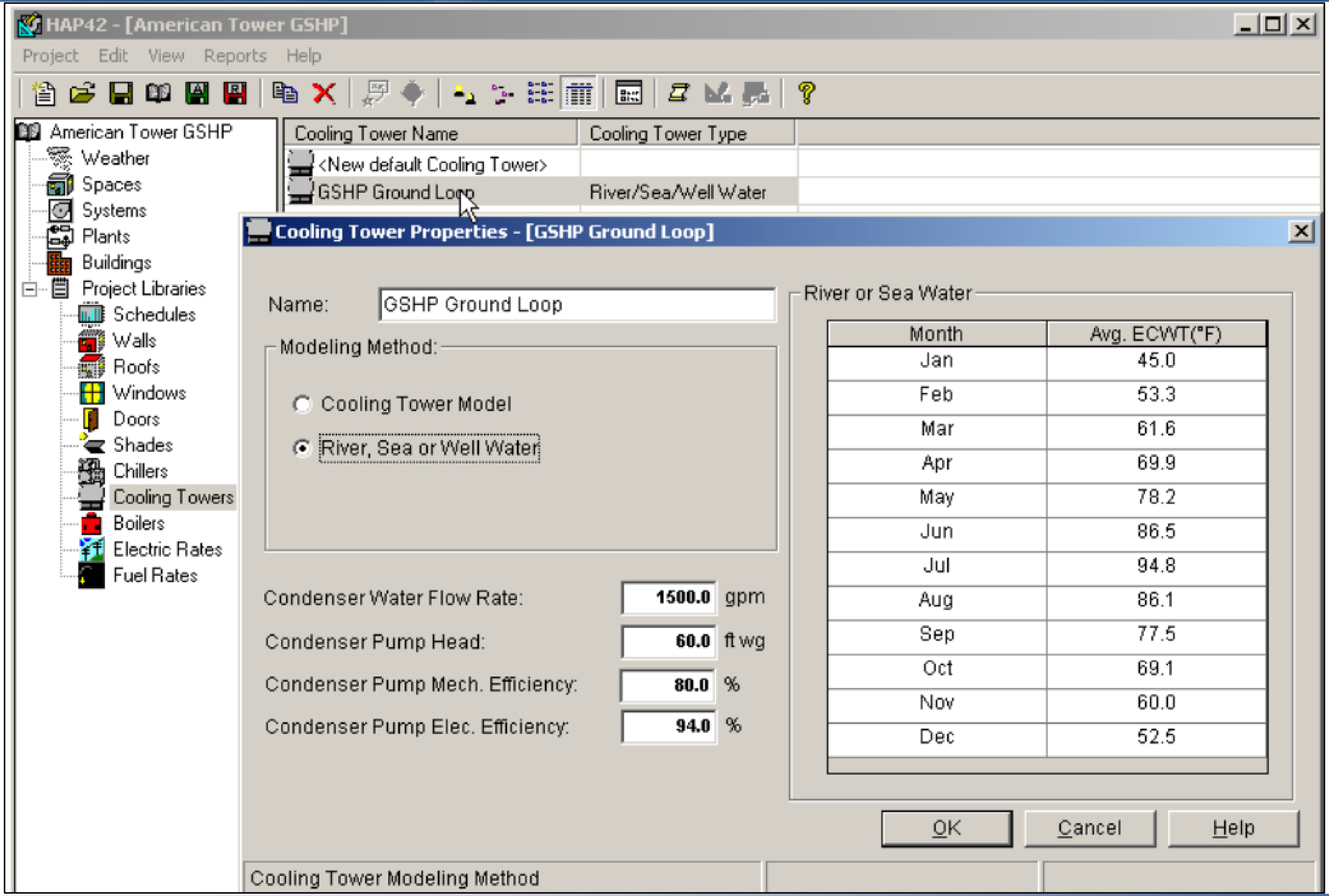


	A	B	C	D	E	F
1	Day Of Yr	Date/Time	Heating delivered	Cooling delivered	Heating delivered	Cooling delivered
2			Btu/h	Btu/h	kW	kW
3	1	1/1/2023 1:00	1720964.88	0	504.24	0
4	1	1/1/2023 2:00	1468469.25	0	430.26	0
5	1	1/1/2023 3:00	1427599.38	0	418.28	0
6	1	1/1/2023 4:00	1392605.12	0	408.03	0
7	1	1/1/2023 5:00	1380108.25	0	404.37	0
8	1	1/1/2023 6:00	1365338	0	400.04	0
9	1	1/1/2023 7:00	1370115.38	0	401.44	0
10	1	1/1/2023 8:00	1382577	0	405.09	0
11	1	1/1/2023 9:00	1381063.62	0	404.65	0
12	1	1/1/2023 10:00	1368382.38	0	400.93	0
13	1	1/1/2023 11:00	1303377.12	0	381.89	0
14	1	1/1/2023 12:00	1238742.62	0	362.95	0
15	1	1/1/2023 13:00	1155124.38	0	338.45	0
16	1	1/1/2023 14:00	1119405	0	327.98	0
17	1	1/1/2023 15:00	1110362	0	325.33	0
18	1	1/1/2023 16:00	1127535	0	330.36	0
19	1	1/1/2023 17:00	1179351.88	0	345.55	0
20	1	1/1/2023 18:00	1270520.25	0	372.26	0
21	1	1/1/2023 19:00	1339848.75	0	392.57	0
22	1	1/1/2023 20:00	1370701.62	0	401.61	0
23	1	1/1/2023 21:00	1415199.12	0	414.65	0

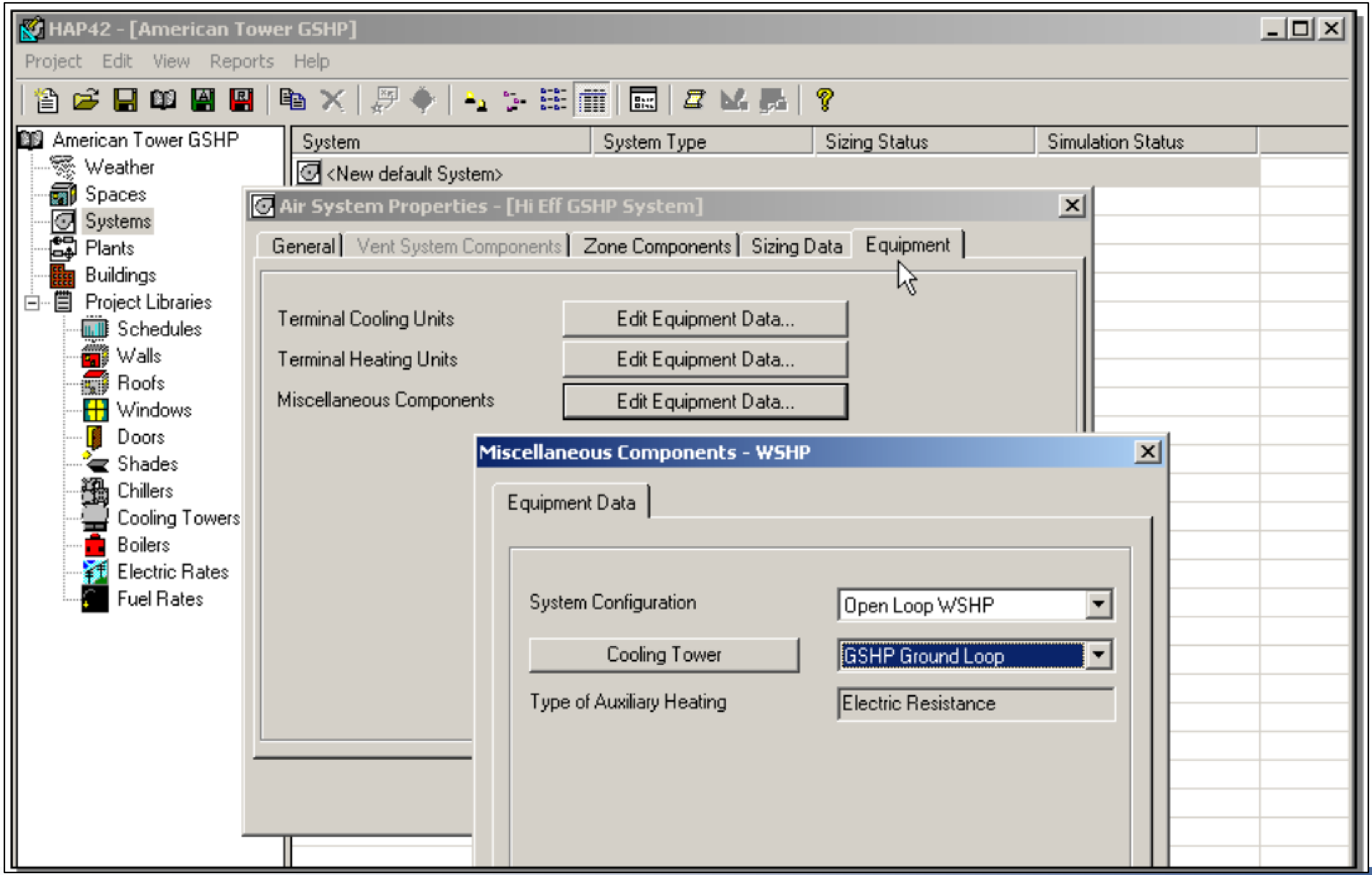
Trane Trace Export Demo



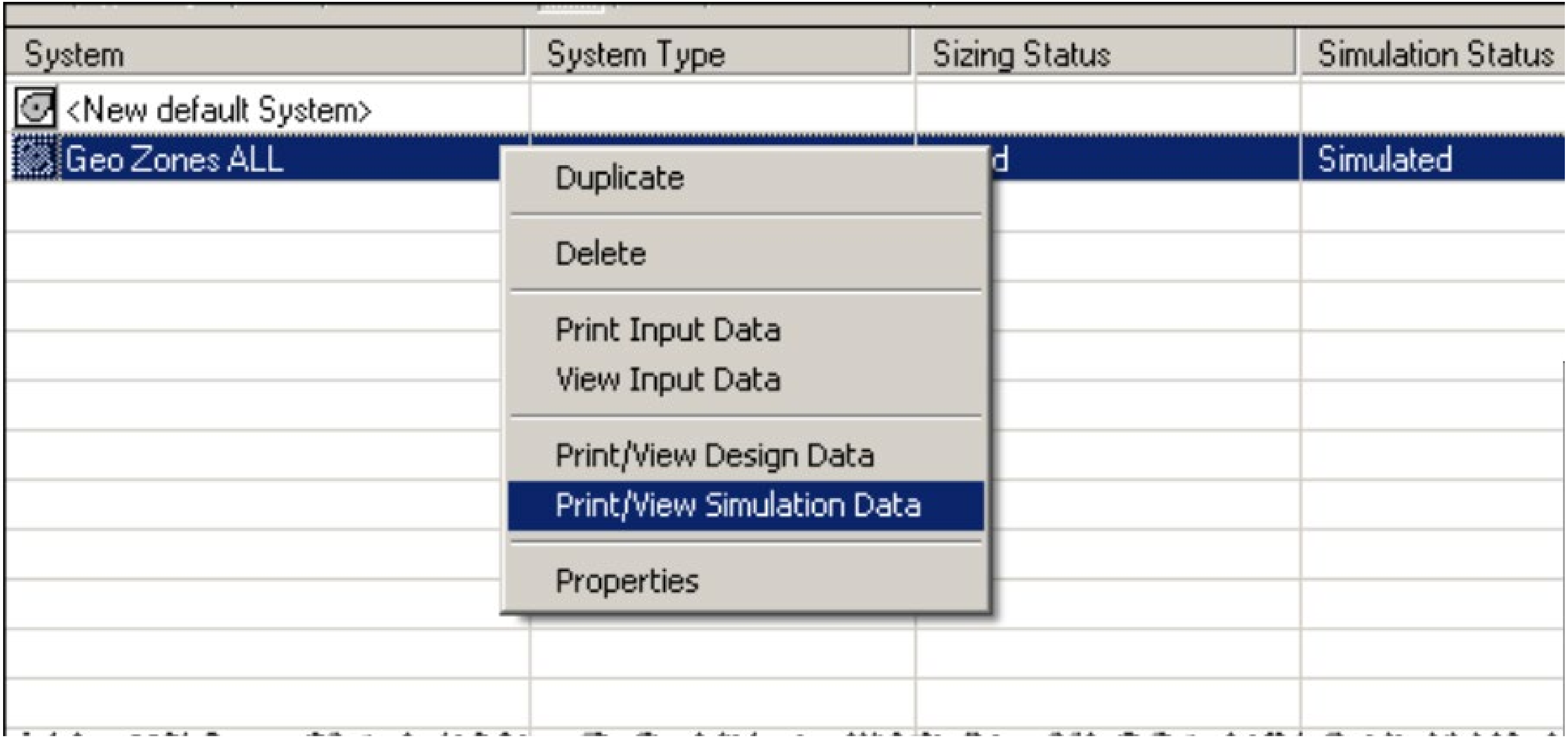
Carrier HAP Export Demo



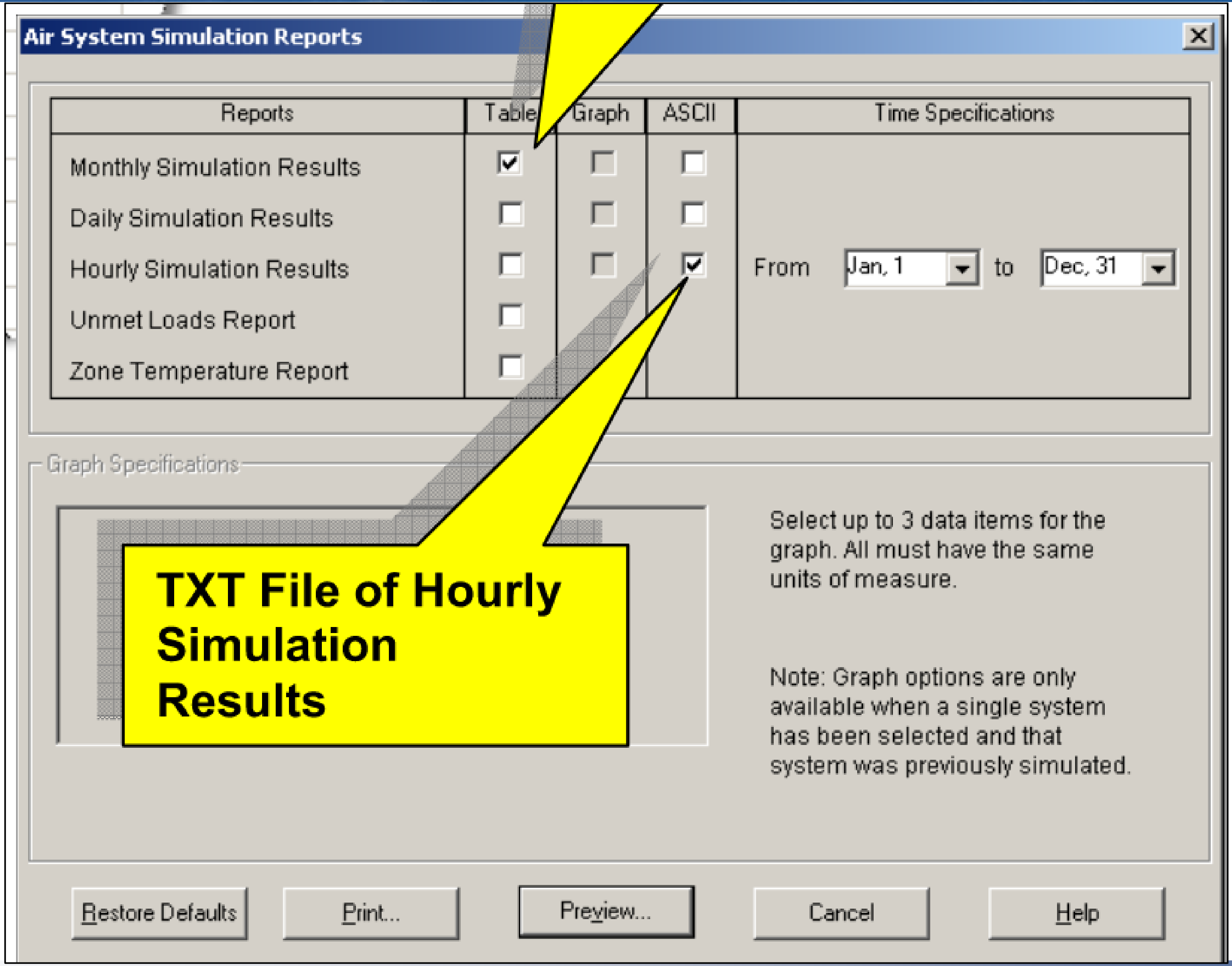
Carrier HAP Export Demo



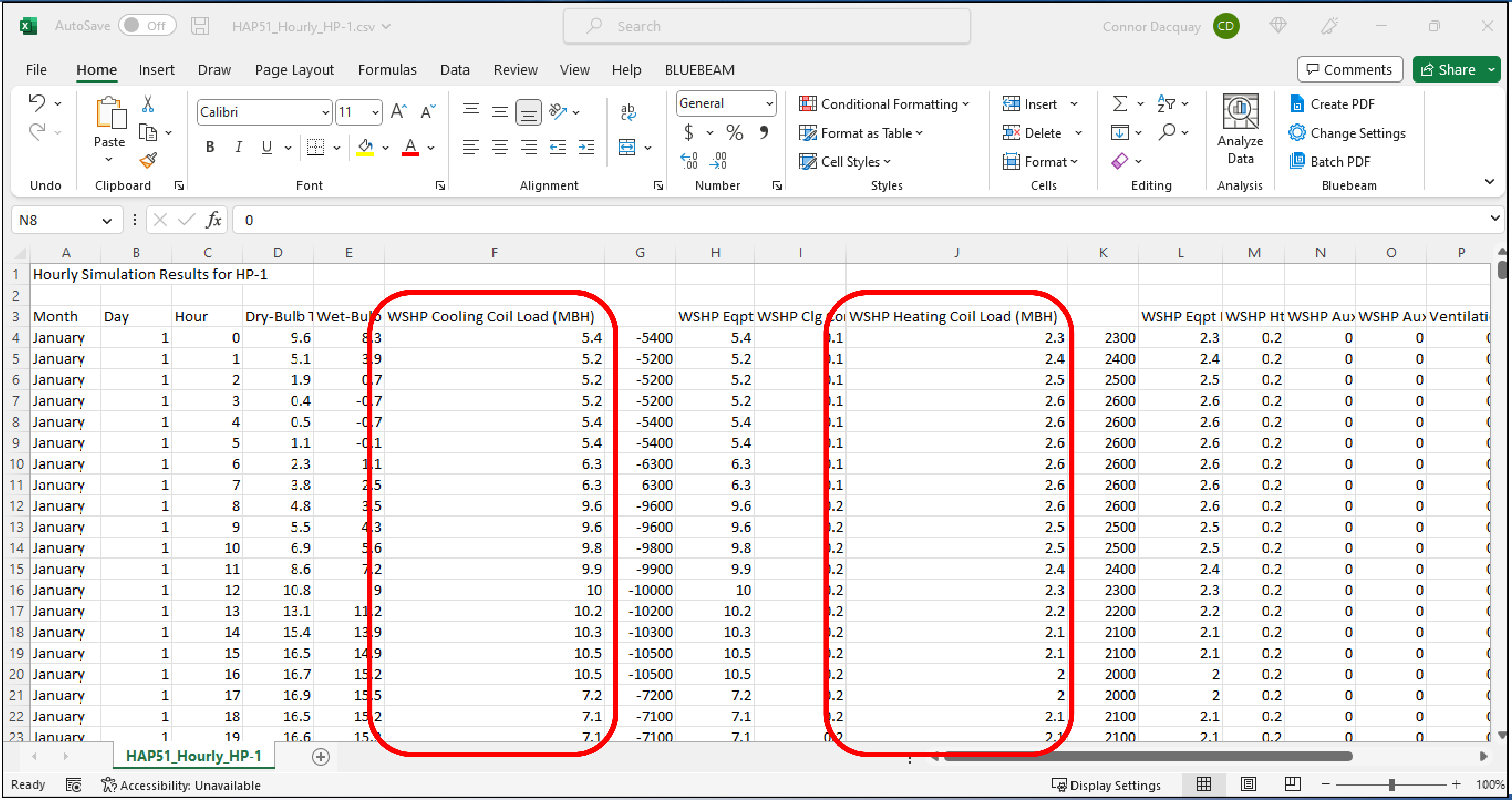
Carrier HAP Export Demo



Carrier HAP Export Demo

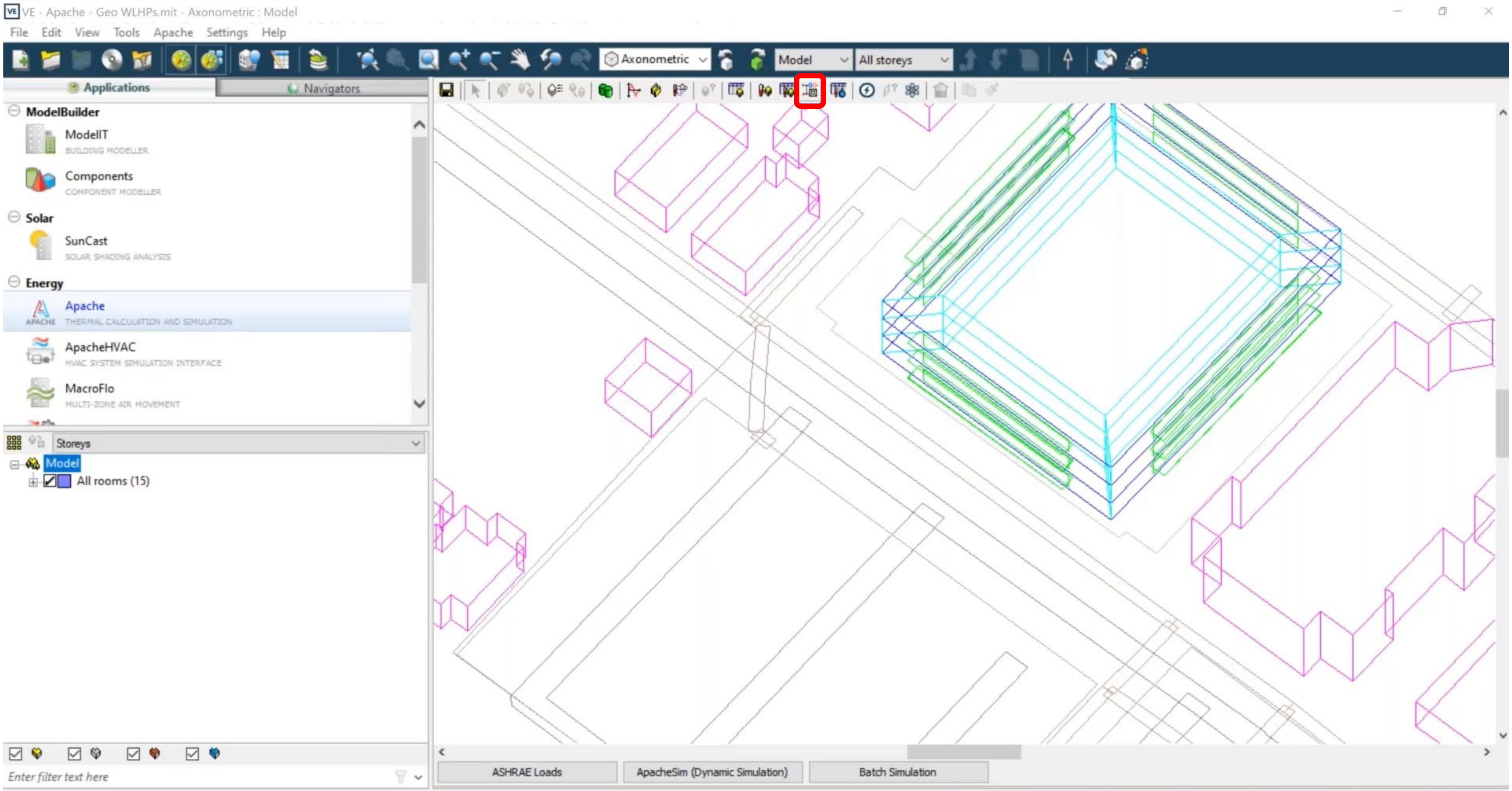


Carrier HAP Export Demo



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	Hourly Simulation Results for HP-1															
2																
3	Month	Day	Hour	Dry-Bulb T	Wet-Bulb	WSHP Cooling Coil Load (MBH)		WSHP Eqpt	WSHP Clg Coi	WSHP Heating Coil Load (MBH)		WSHP Eqpt I	WSHP Ht	WSHP Aux	WSHP Aux	Ventilati
4	January	1	0	9.6	8.3	5.4	-5400	5.4	.1	2.3	2300	2.3	0.2	0	0	
5	January	1	1	5.1	3.9	5.2	-5200	5.2	.1	2.4	2400	2.4	0.2	0	0	
6	January	1	2	1.9	0.7	5.2	-5200	5.2	.1	2.5	2500	2.5	0.2	0	0	
7	January	1	3	0.4	-0.7	5.2	-5200	5.2	.1	2.6	2600	2.6	0.2	0	0	
8	January	1	4	0.5	-0.7	5.4	-5400	5.4	.1	2.6	2600	2.6	0.2	0	0	
9	January	1	5	1.1	-0.1	5.4	-5400	5.4	.1	2.6	2600	2.6	0.2	0	0	
10	January	1	6	2.3	1.1	6.3	-6300	6.3	.1	2.6	2600	2.6	0.2	0	0	
11	January	1	7	3.8	2.5	6.3	-6300	6.3	.1	2.6	2600	2.6	0.2	0	0	
12	January	1	8	4.8	3.5	9.6	-9600	9.6	.2	2.6	2600	2.6	0.2	0	0	
13	January	1	9	5.5	4.3	9.6	-9600	9.6	.2	2.5	2500	2.5	0.2	0	0	
14	January	1	10	6.9	5.6	9.8	-9800	9.8	.2	2.5	2500	2.5	0.2	0	0	
15	January	1	11	8.6	7.2	9.9	-9900	9.9	.2	2.4	2400	2.4	0.2	0	0	
16	January	1	12	10.8	9	10	-10000	10	.2	2.3	2300	2.3	0.2	0	0	
17	January	1	13	13.1	11.2	10.2	-10200	10.2	.2	2.2	2200	2.2	0.2	0	0	
18	January	1	14	15.4	13.9	10.3	-10300	10.3	.2	2.1	2100	2.1	0.2	0	0	
19	January	1	15	16.5	14.9	10.5	-10500	10.5	.2	2.1	2100	2.1	0.2	0	0	
20	January	1	16	16.7	15.2	10.5	-10500	10.5	.2	2	2000	2	0.2	0	0	
21	January	1	17	16.9	15.5	7.2	-7200	7.2	.2	2	2000	2	0.2	0	0	
22	January	1	18	16.5	15.2	7.1	-7100	7.1	.2	2.1	2100	2.1	0.2	0	0	
23	January	1	19	16.6	15.	7.1	-7100	7.1	0.2	2.1	2100	2.1	0.2	0	0	

IES Export demo



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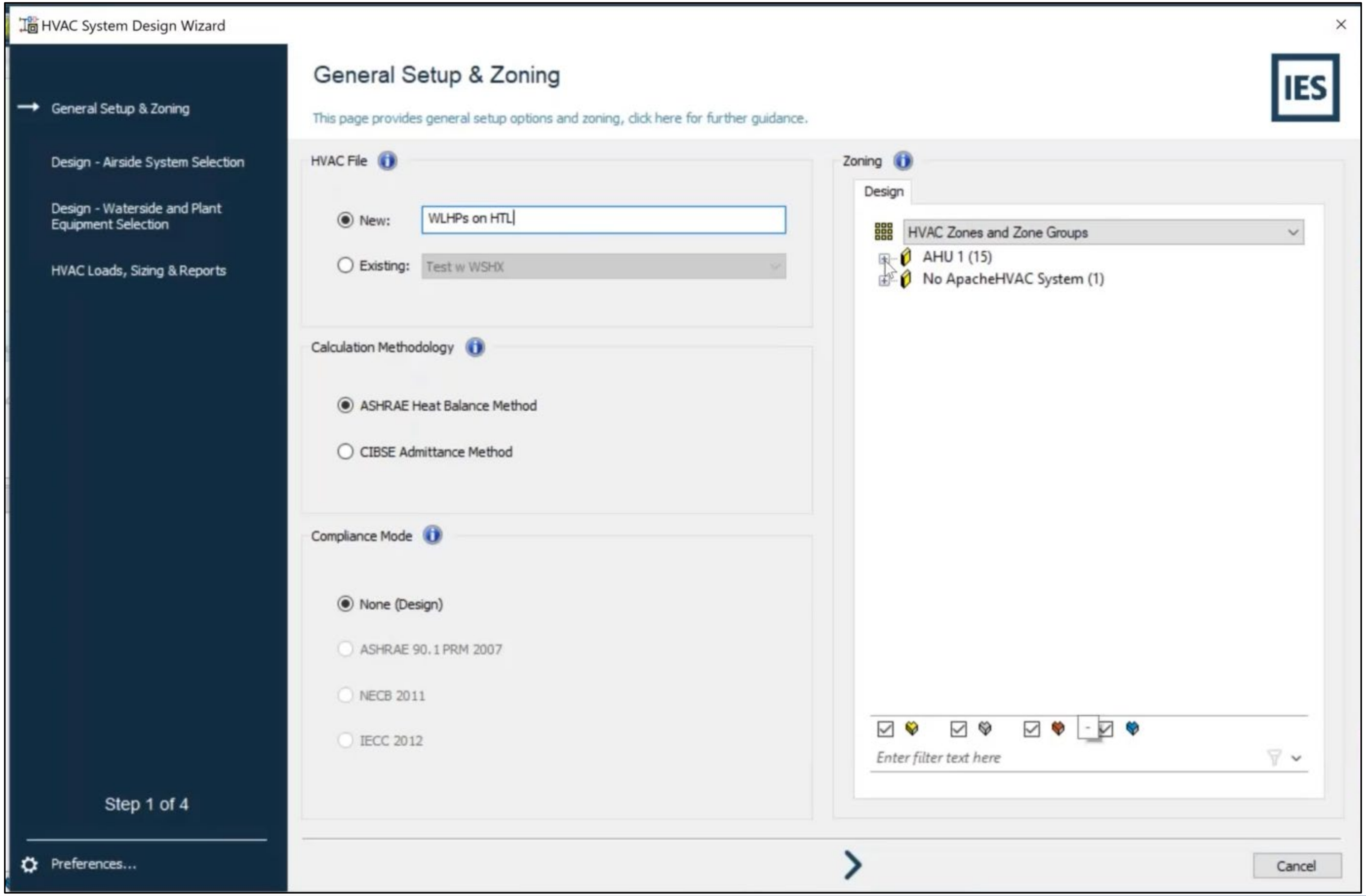

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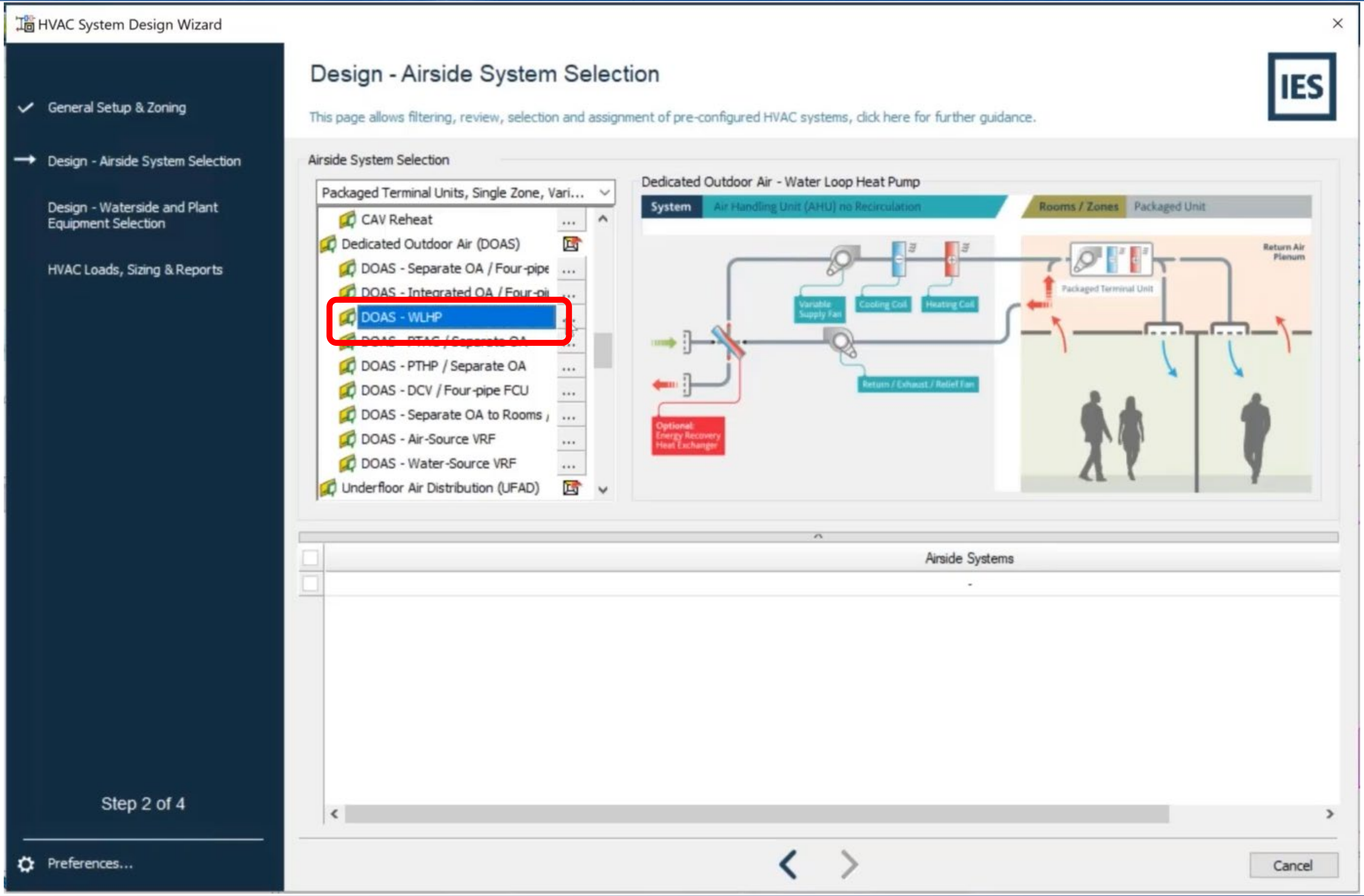

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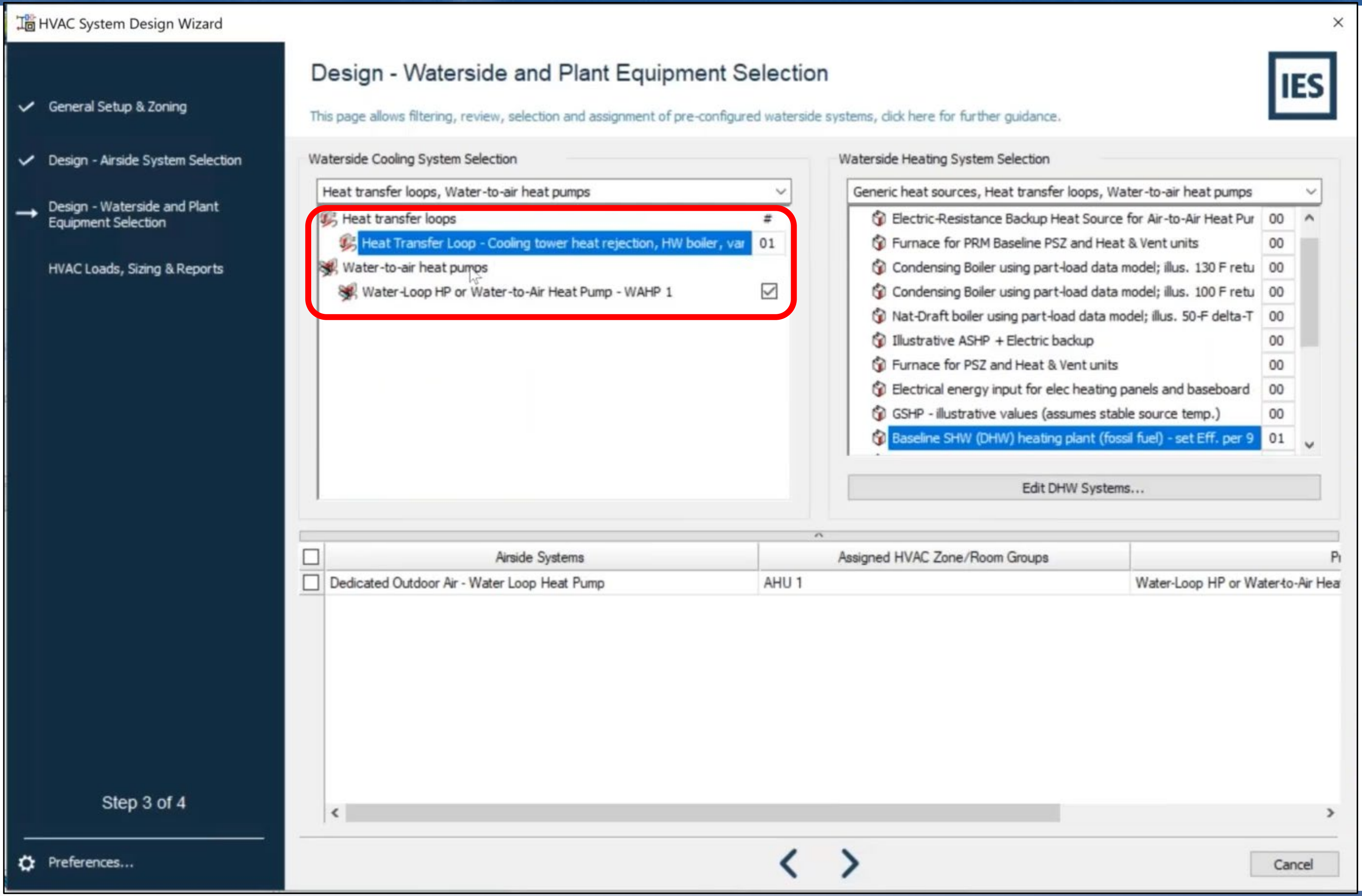

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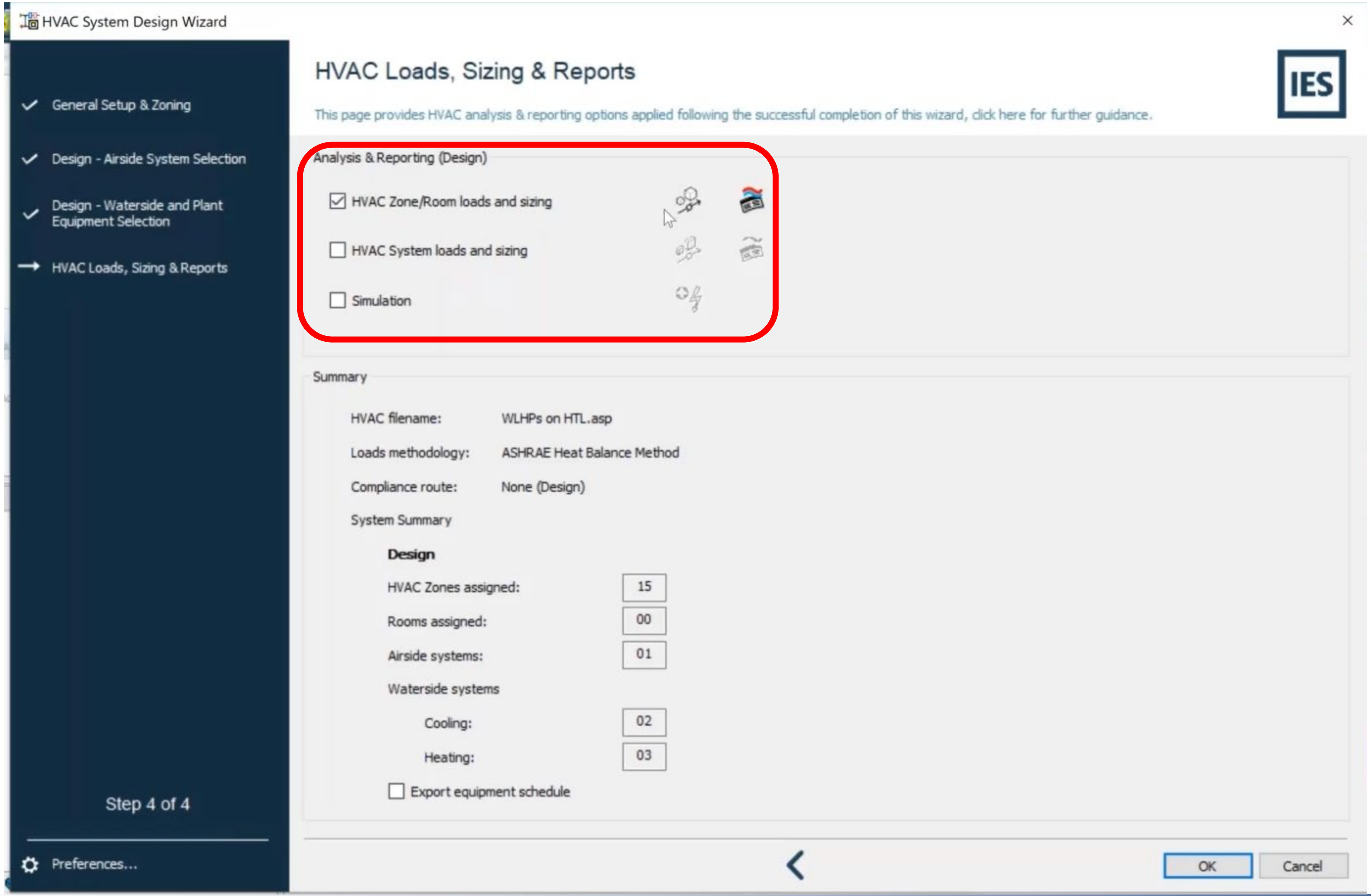
IES Export demo



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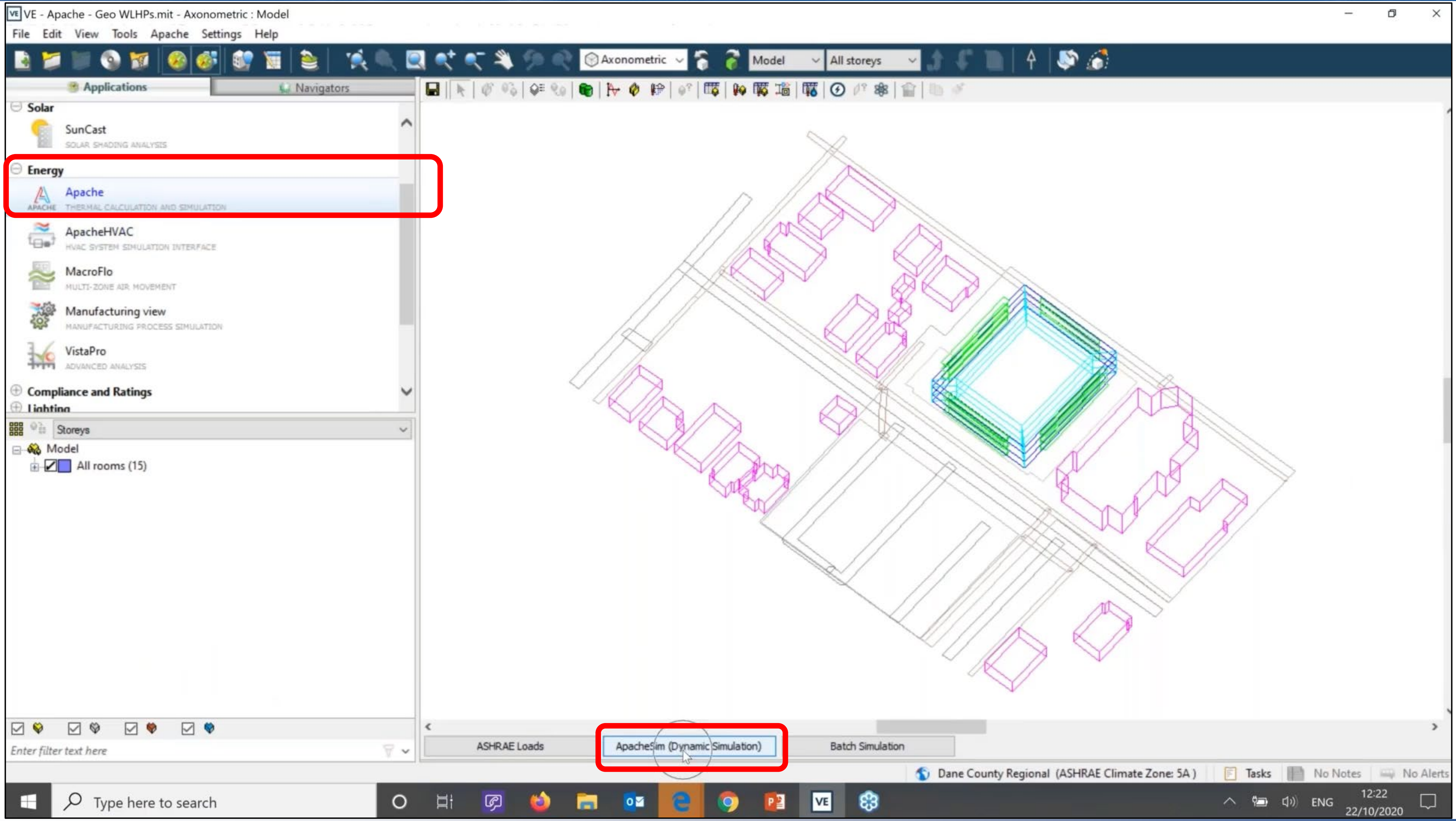

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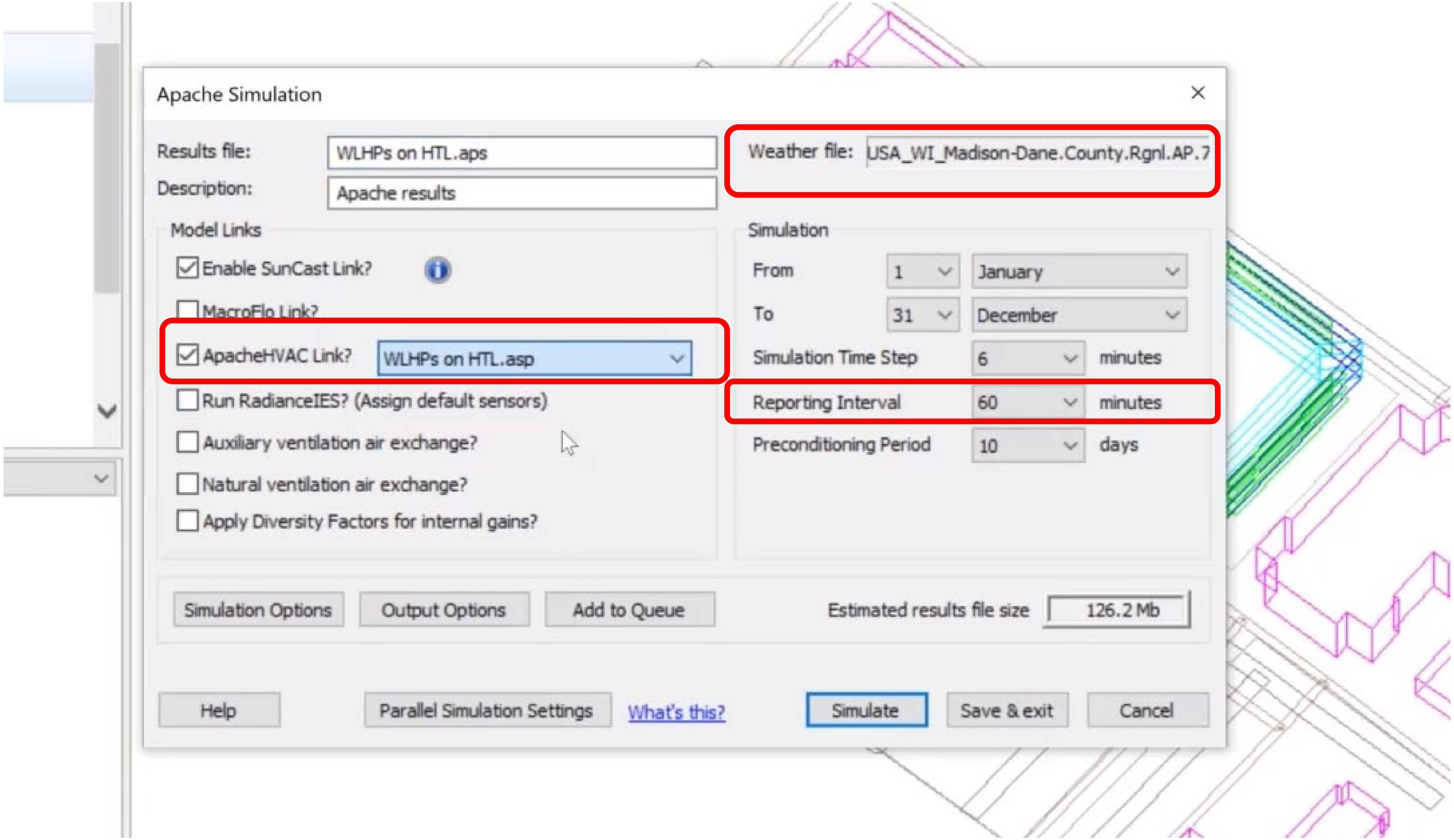
IES Export demo



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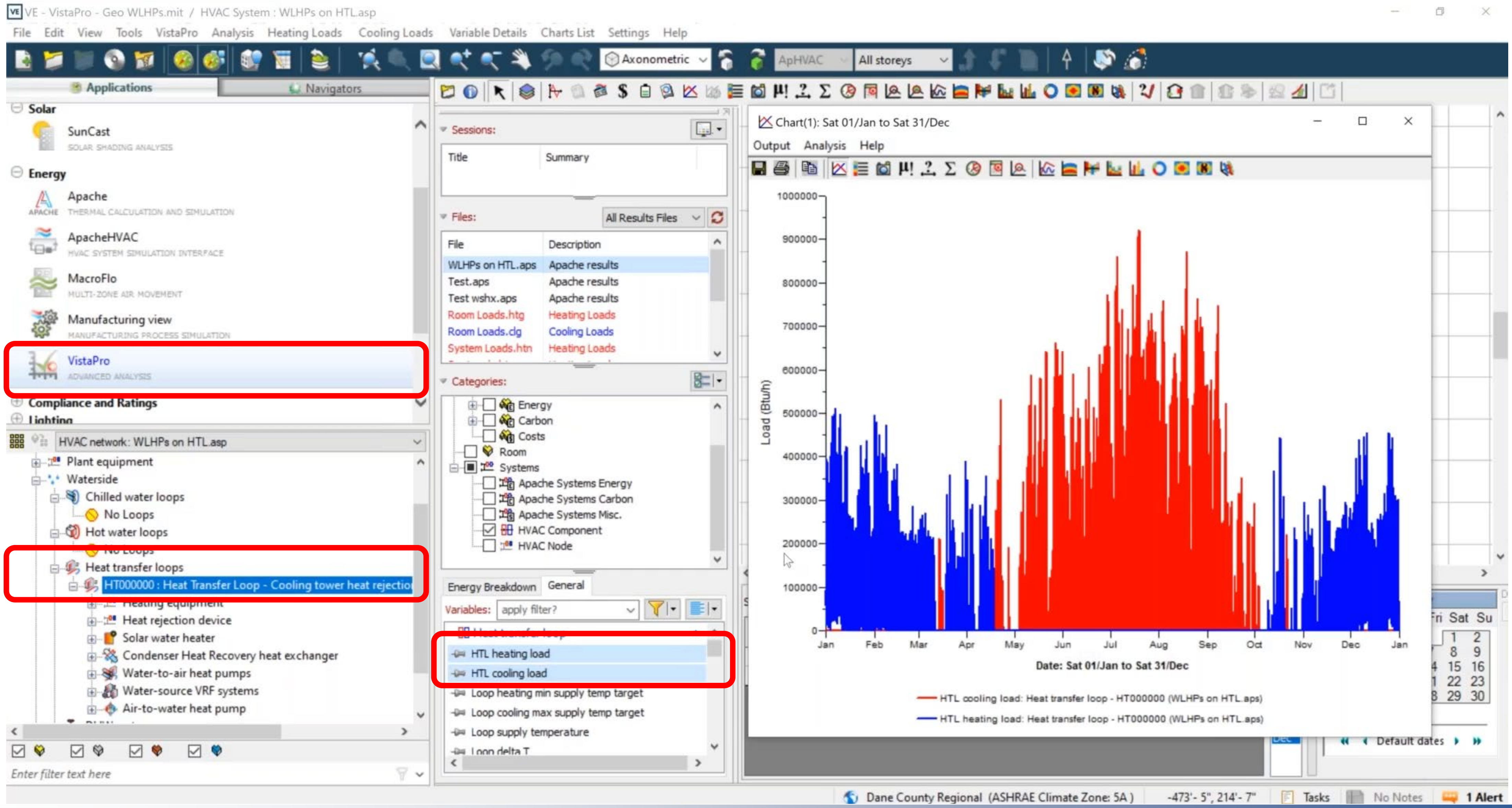
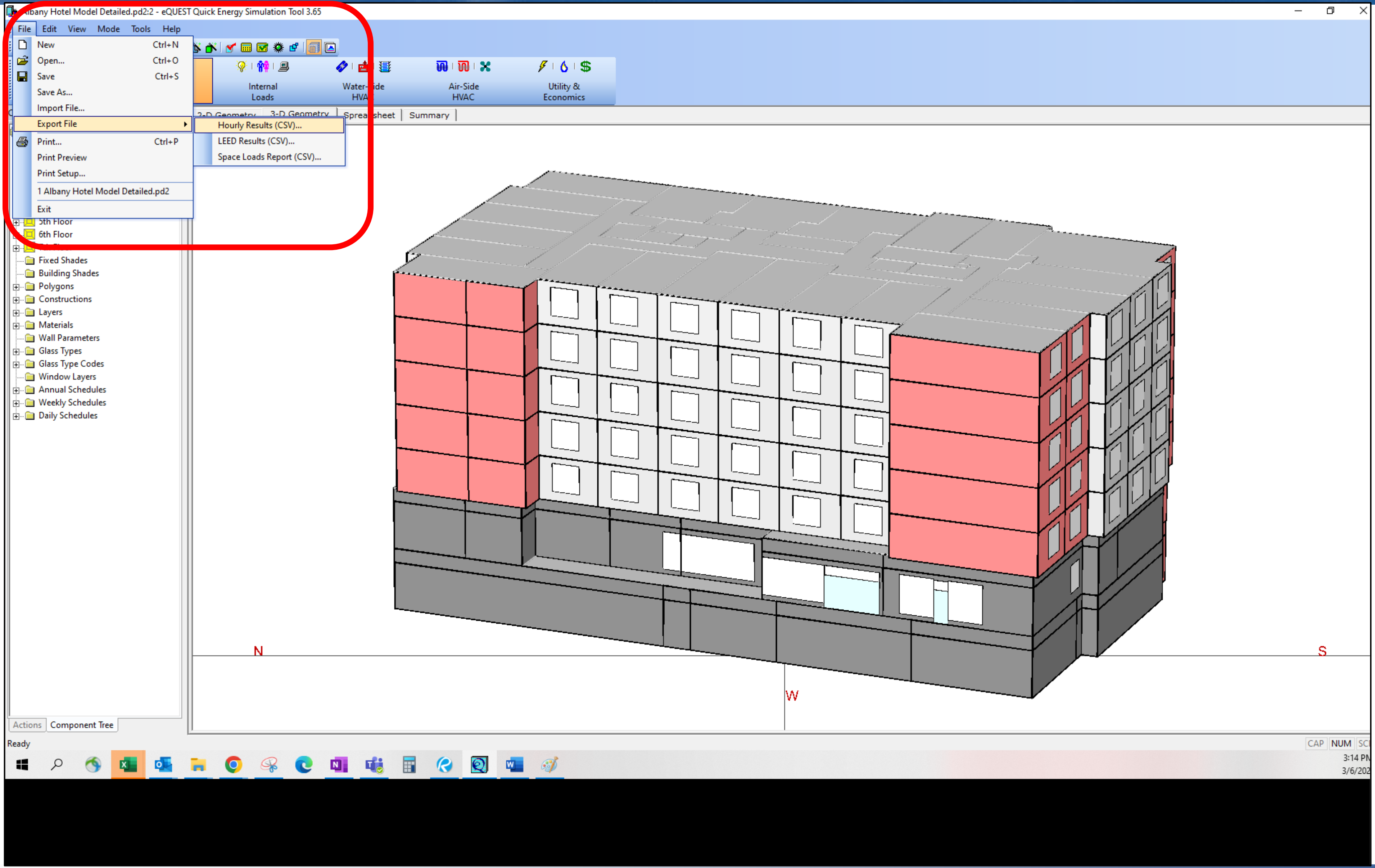


E-quest Export demo



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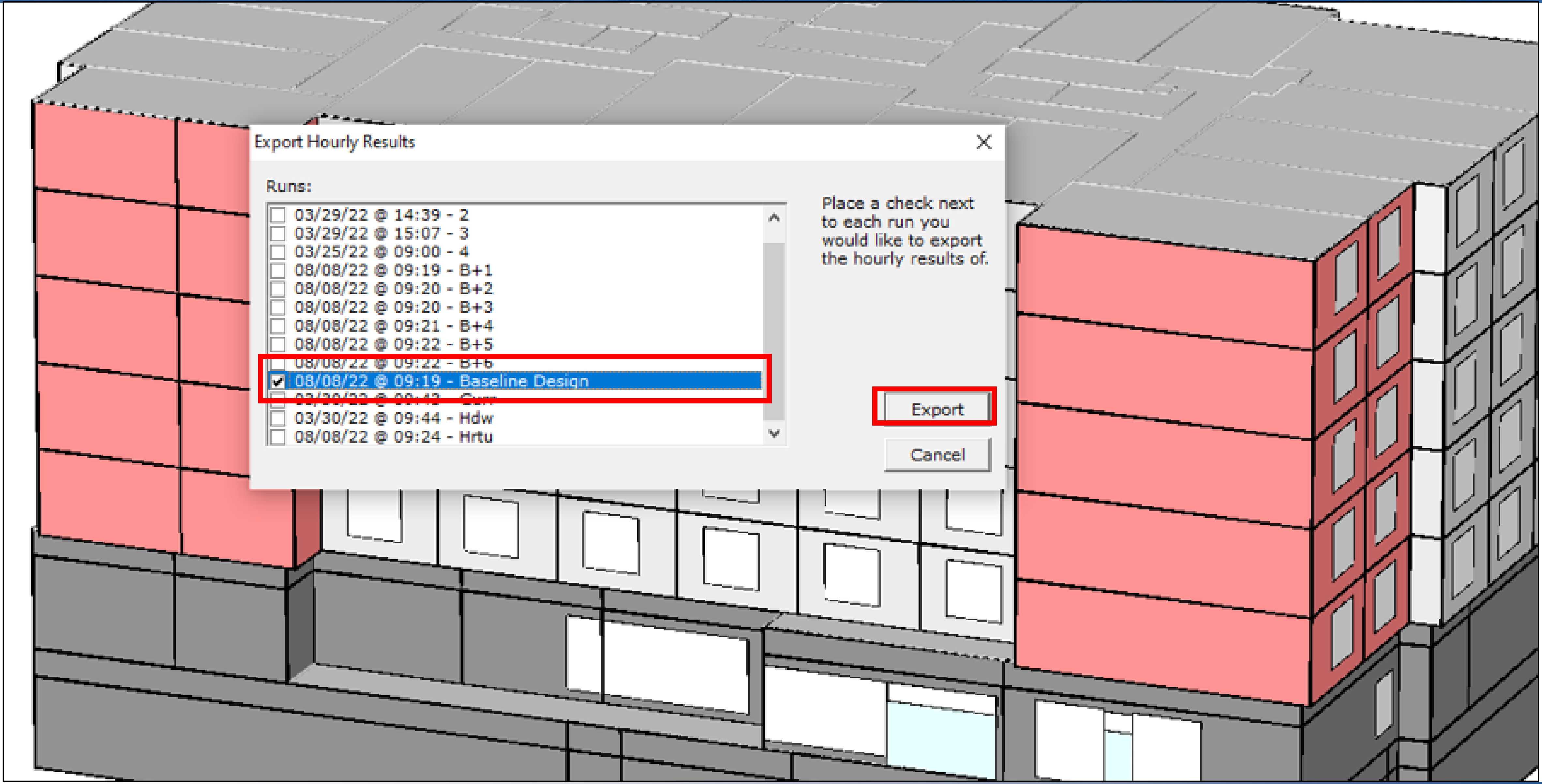
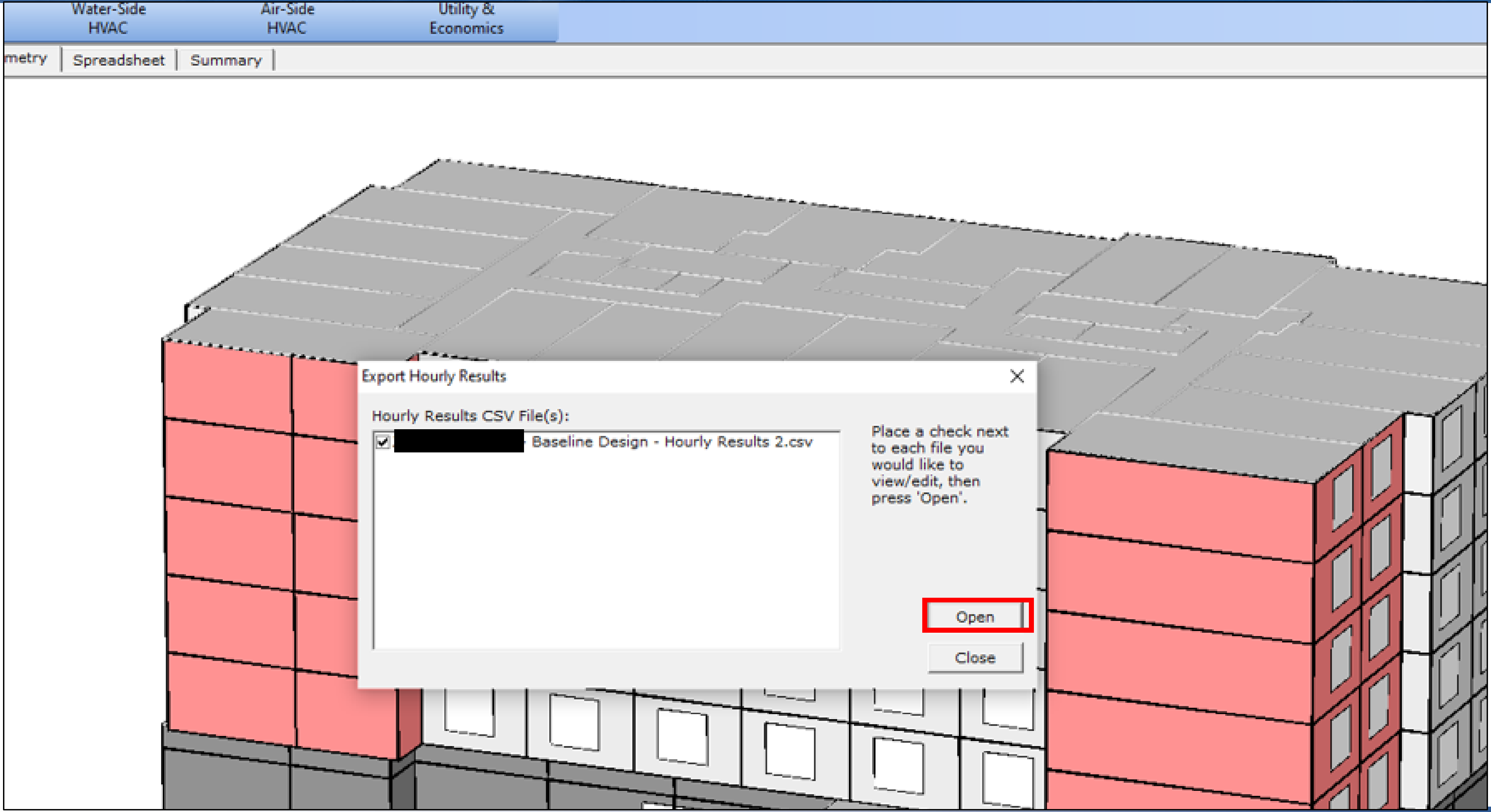
E-quest Export demo

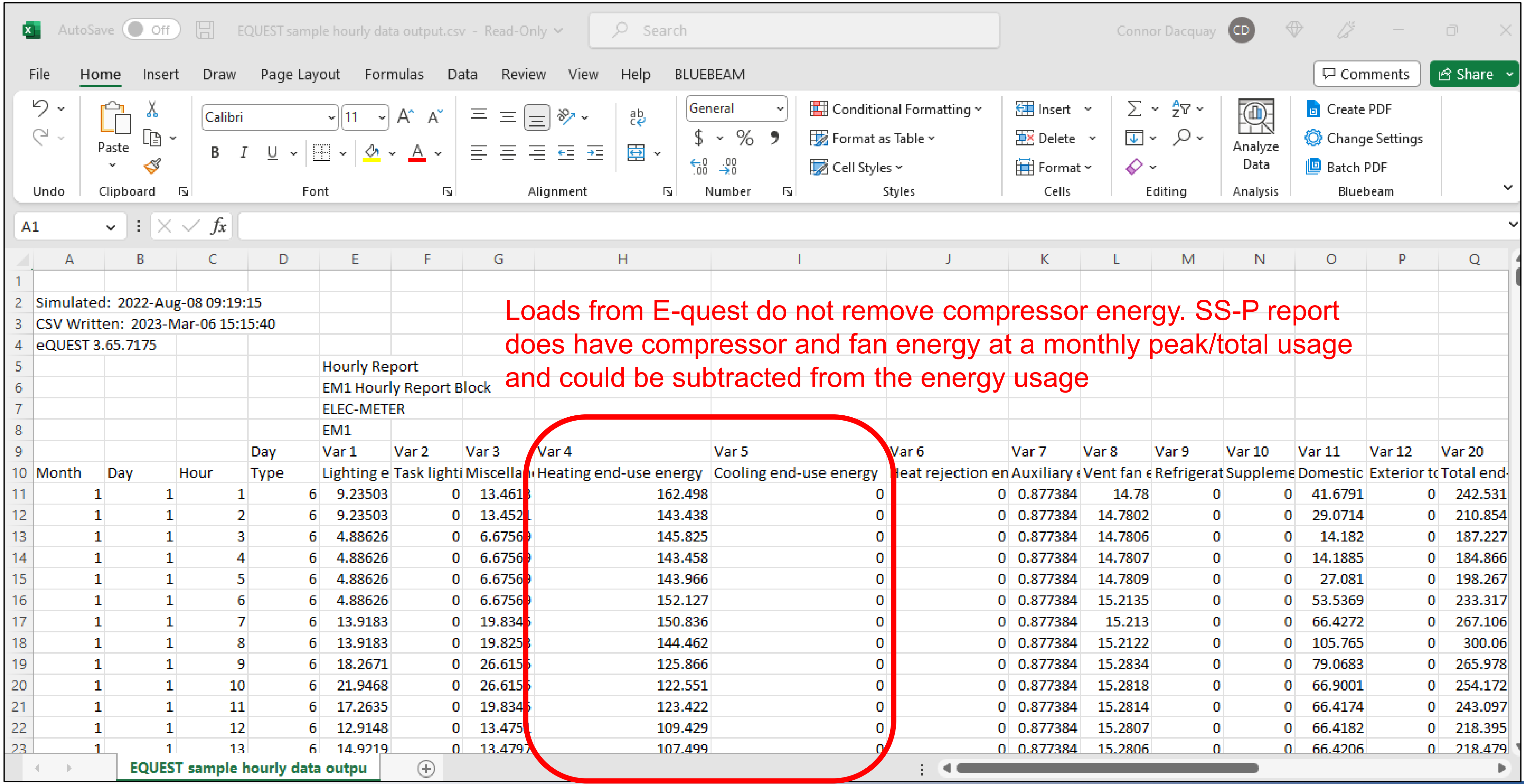


E-quest Export demo



E-quest Export demo

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



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1																	
2	Simulated: 2022-Aug-08 09:19:15																
3	CSV Written: 2023-Mar-06 15:15:40																
4	eQUEST 3.65.7175																
5					Hourly Report												
6					EM1 Hourly Report Block												
7					ELEC-METER												
8					EM1												
9				Day	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
10	Month	Day	Hour	Type	Lighting e	Task lighti	Miscella	Heating end-use energy	Cooling end-use energy	Heat rejection en	Auxiliary	Vent fan e	Refrigerat	Suppleme	Domestic	Exterior t	Total end-
11	1	1	1	6	9.23503	0	13.4618	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	19.8258	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

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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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