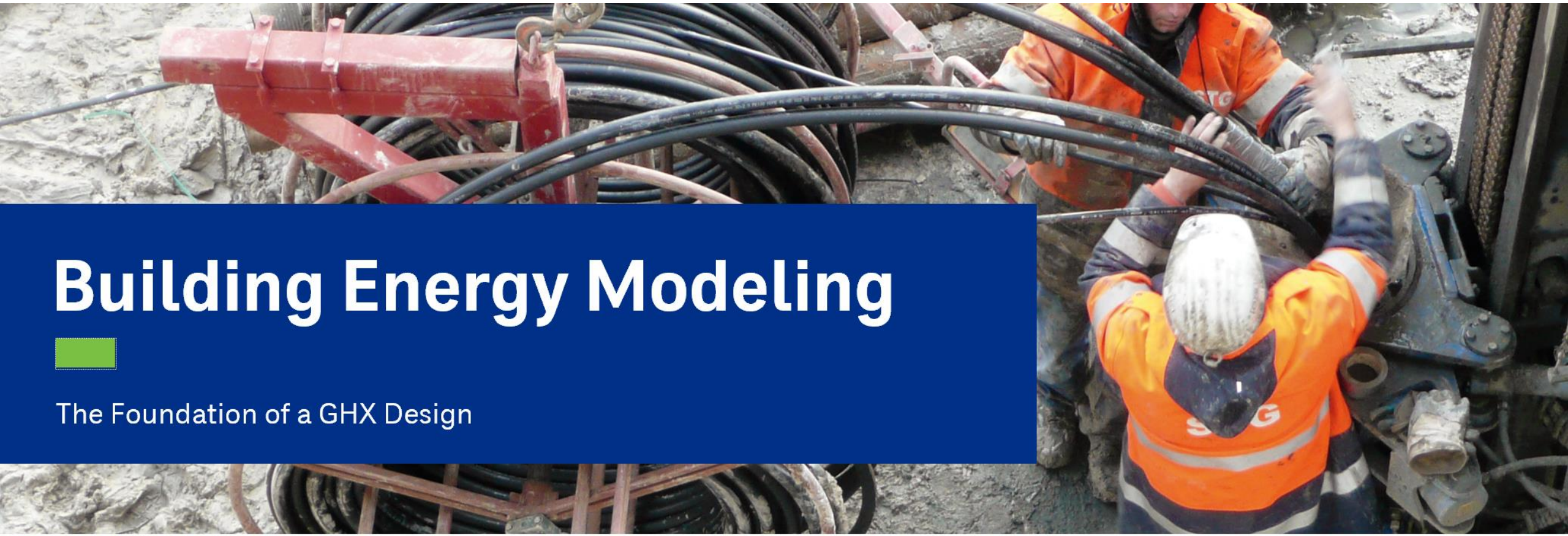
NY-GEO 2024
October 22 -23 | BROOKLYN, NY



Building Energy Modeling

The Foundation of a GHX Design

Jacky Kinson, EIT

October 22, 2024

CDM Smith

Learning Objectives

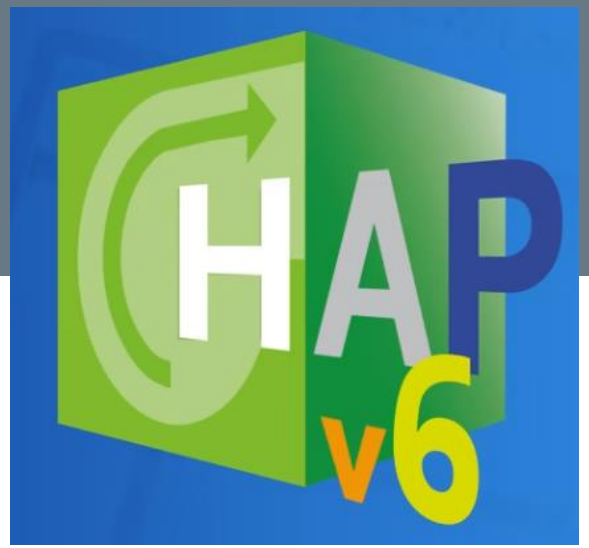
1. Understand the components of building energy modeling
2. Understand the effect of building energy modeling on ground heat exchanger (GHX) design for an individual building
3. Understanding the effect of building energy modeling on GHX design for a district geothermal system

Building Energy Modeling Components

Building Energy Modeling Tools

TRACE 3D

Carrier HAP



eQuest

EnergyPlus

... and more!

Building Energy Modeling Components

- Weather Data (location, TMY3)
- Building Area (sf)
- Building Occupancy
- Space Temperature Setpoints
- Ventilation Loads (ASHRAE 62.1)
- Internal Loads (equipment, lighting, people)
- Building Envelope (ASHRAE 90.1, Passive House)
- Infiltration Loads
- Schedules (occupancy, lighting, equipment)

Building Energy Modeling Applications

Business-as-usual

- Existing buildings
- Poor Insulation

Code Compliance/ ASHRAE 90.1

- Insulation
- BMS Controls
- Energy Recovery

Exceeding Code Compliance

- Passive house design
- Heating dominant loads could become cooling dominant loads

Building Energy Modeling Accuracy

- **GOAL: Capture the actual building energy performance**
- Temperature setpoints (design vs. actual)
- Calibrate with utility bills (natural gas, electricity)
- Schedules
  - Occupancy/Lighting/Equipment
  - Domestic Hot Water Hourly Load Profiles

Domestic Hot Water Hourly Load Profiles

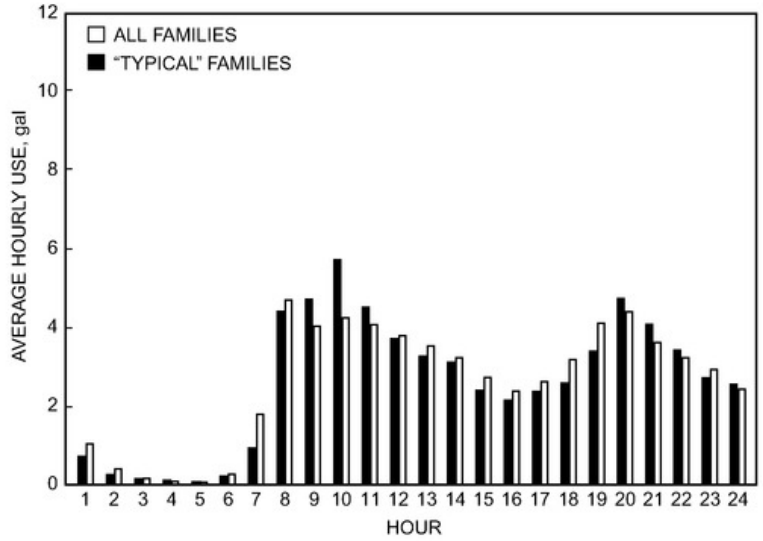


Figure 14. Residential Average Hourly Hot-Water Use

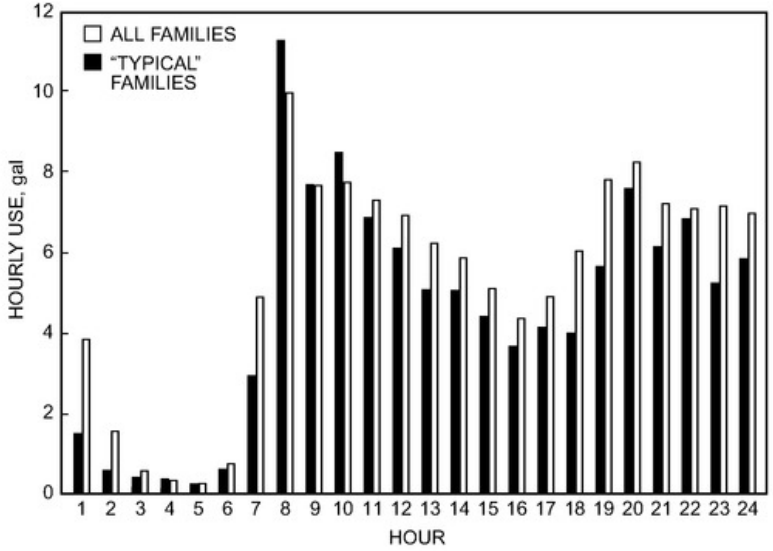


Figure 15. Residential Hourly Hot-Water Use, 95% Confidence Level

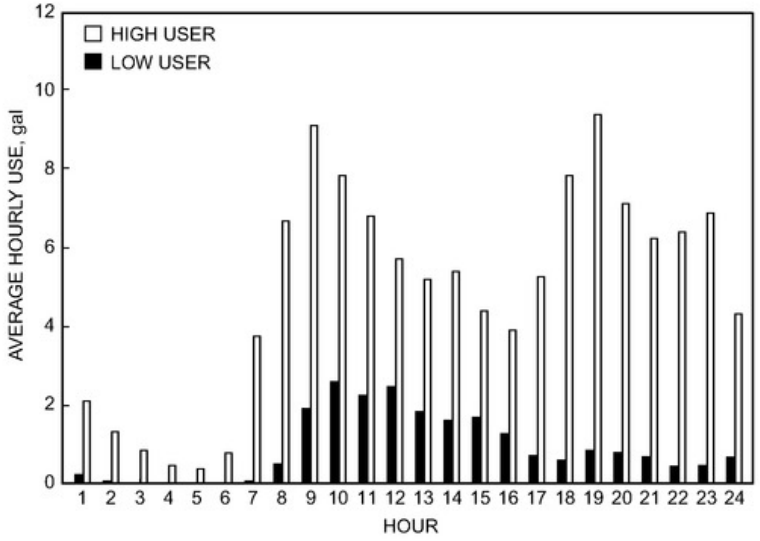


Figure 16. Residential Average Hourly Hot-Water Use Patterns for Low and High Users

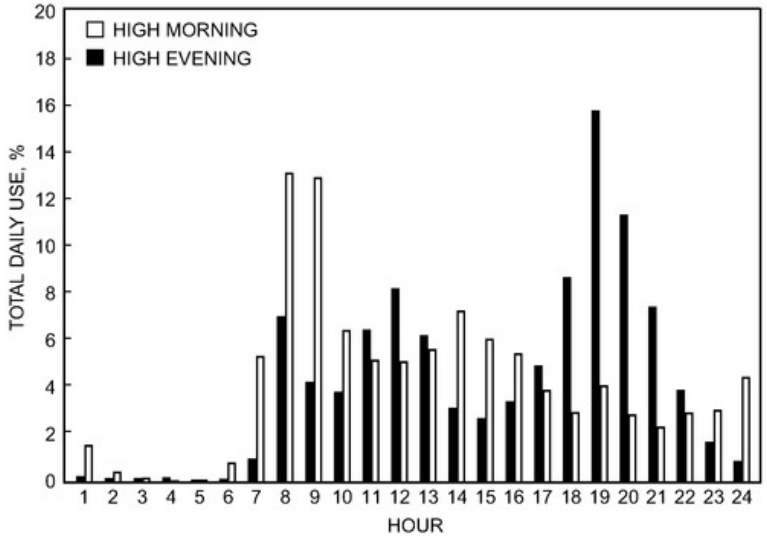


Figure 17. Residential Hourly Hot-Water Use Pattern for Selected High Morning and High Evening Users

Domestic Hot Water Hourly Load Profiles

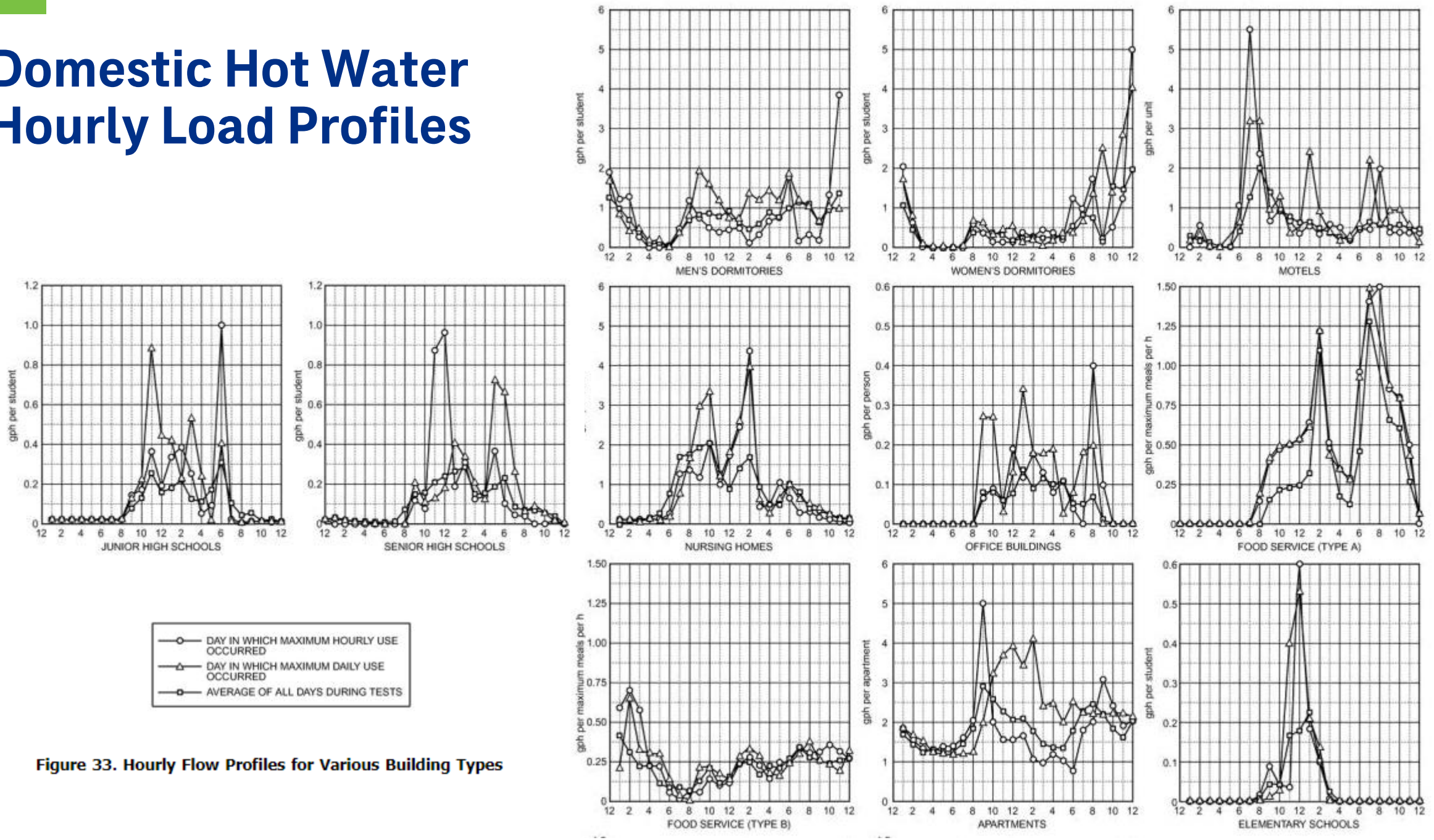


Figure 33. Hourly Flow Profiles for Various Building Types

Knowledge Check #1

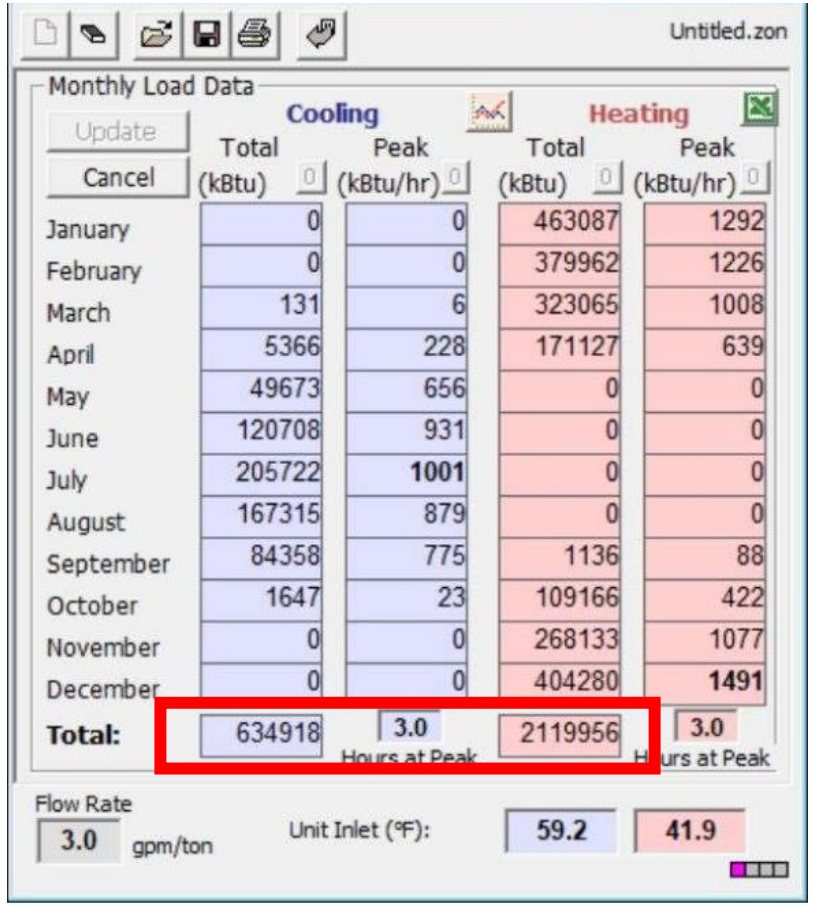
What are some components of building energy modeling?

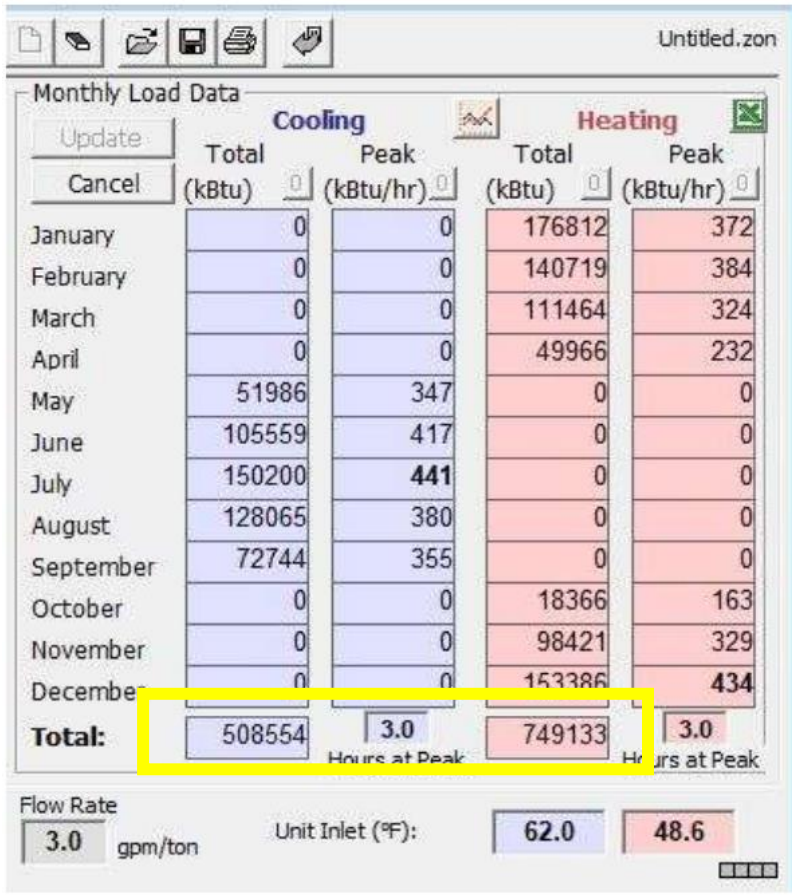
Building Energy Modeling

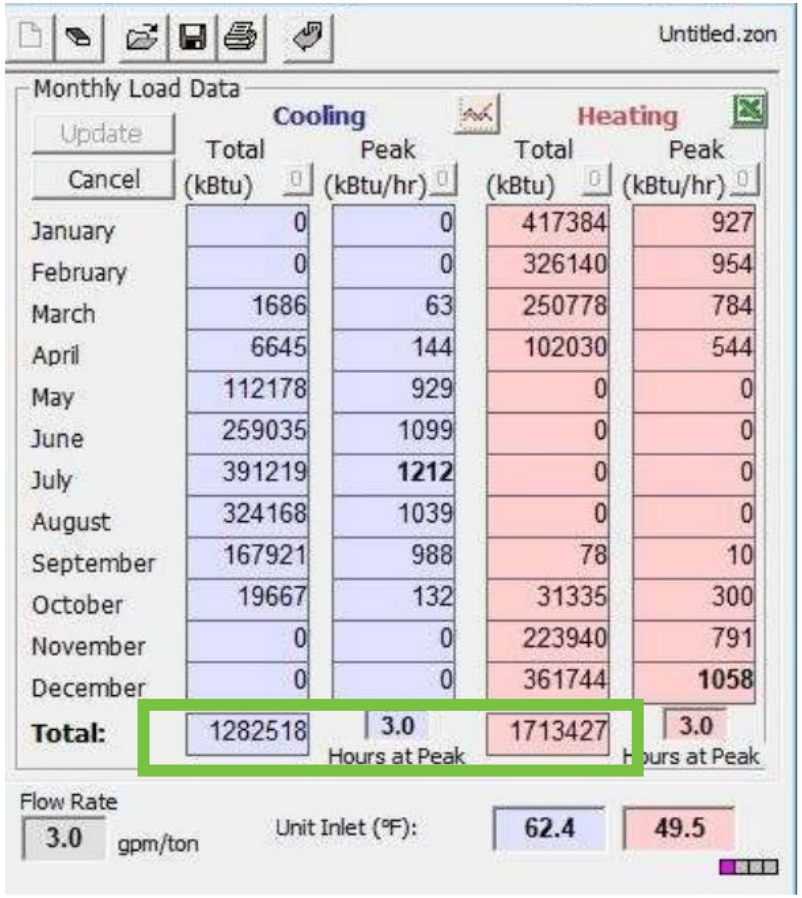
- Weather Data (location, TMY3)
- Building Occupancy
- Building Area (sf)
- Ventilation Loads (ASHRAE 62.1)
- Internal Loads (equipment, lighting, people)
- Building Envelope (ASHRAE 90.1, Passive House)
- Infiltration Loads
- Schedules (occupancy, lighting, equipment)
- Space Temperature Setpoints

Building Energy Modeling Effect on GHX Design

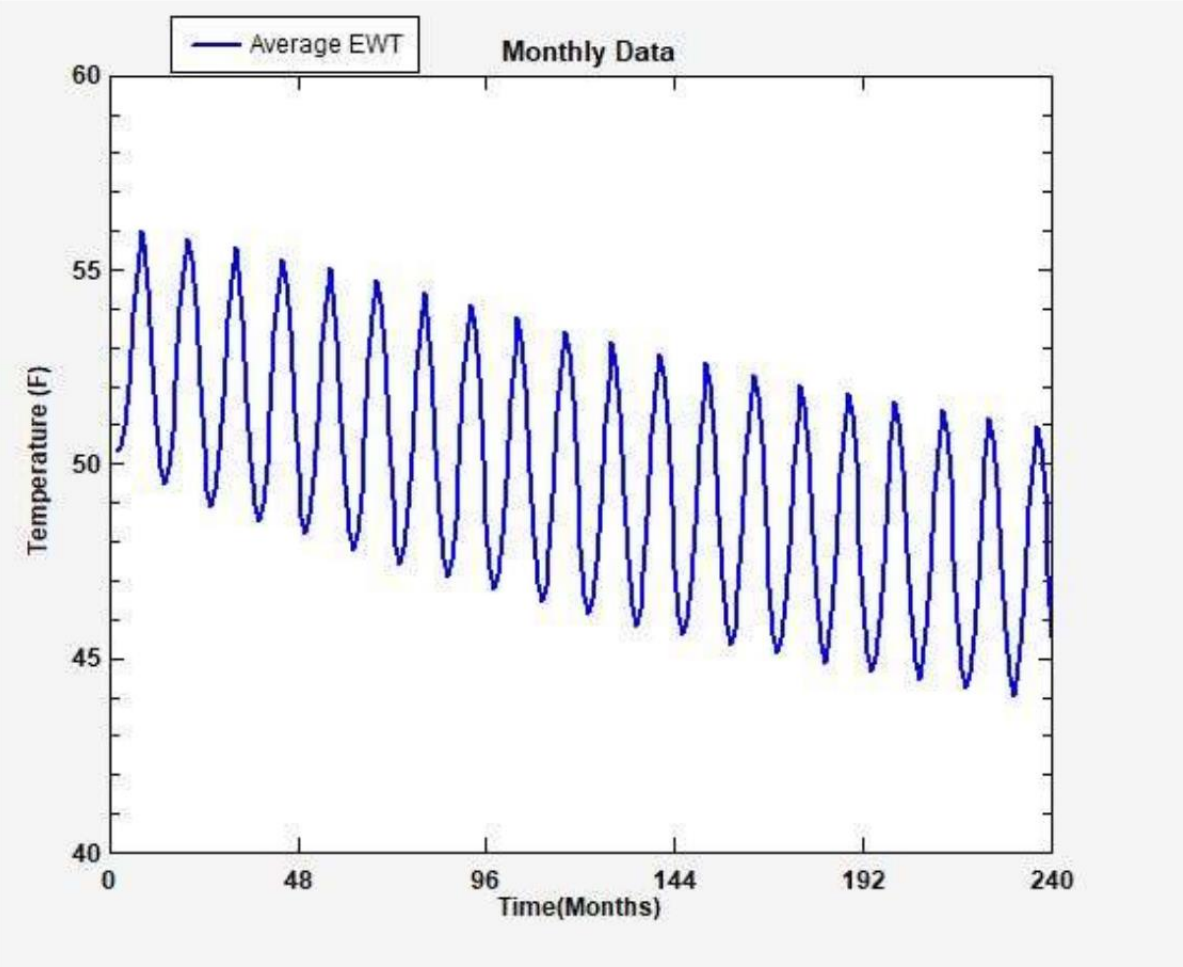
Peak vs. Annual Energy Loads



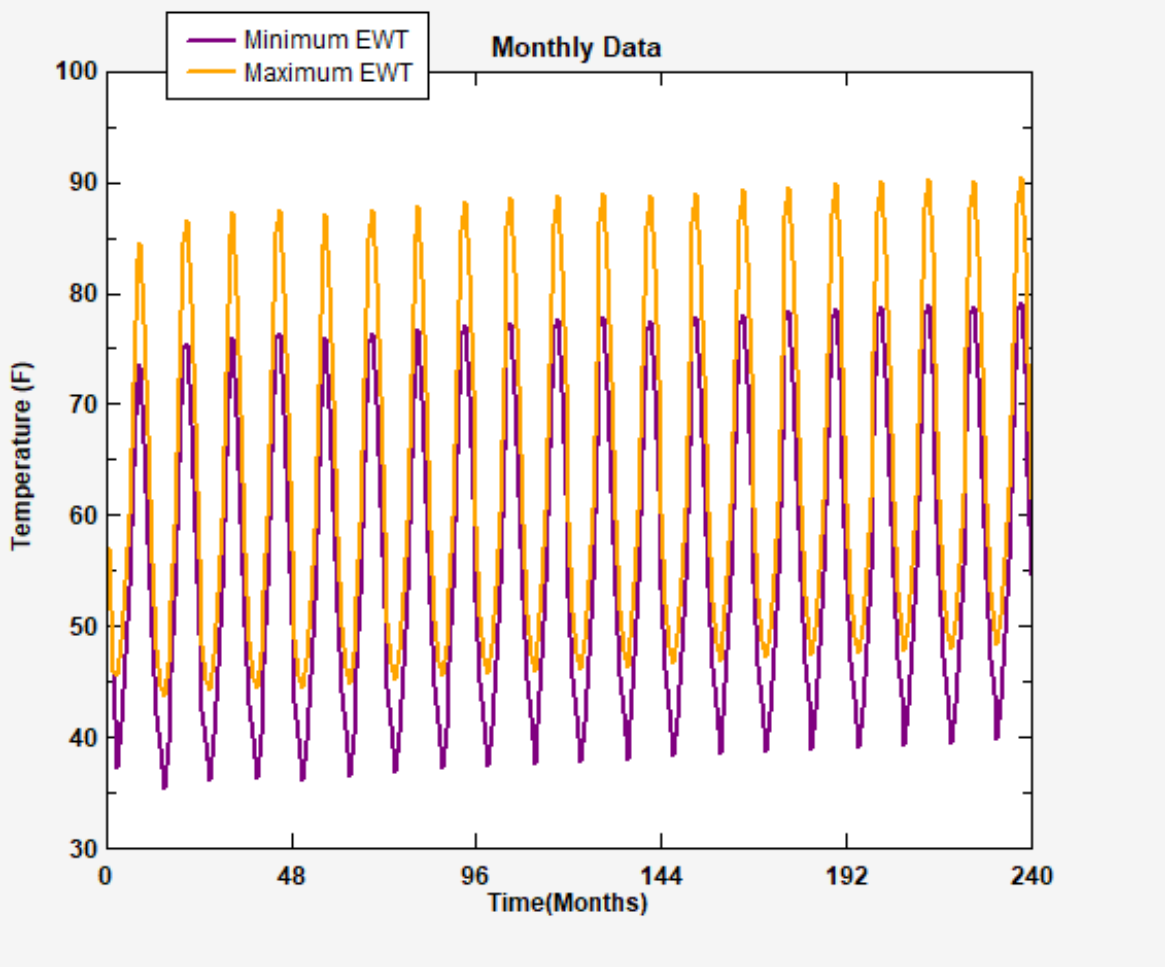




Thermal Drift



HEATING DOMINANT



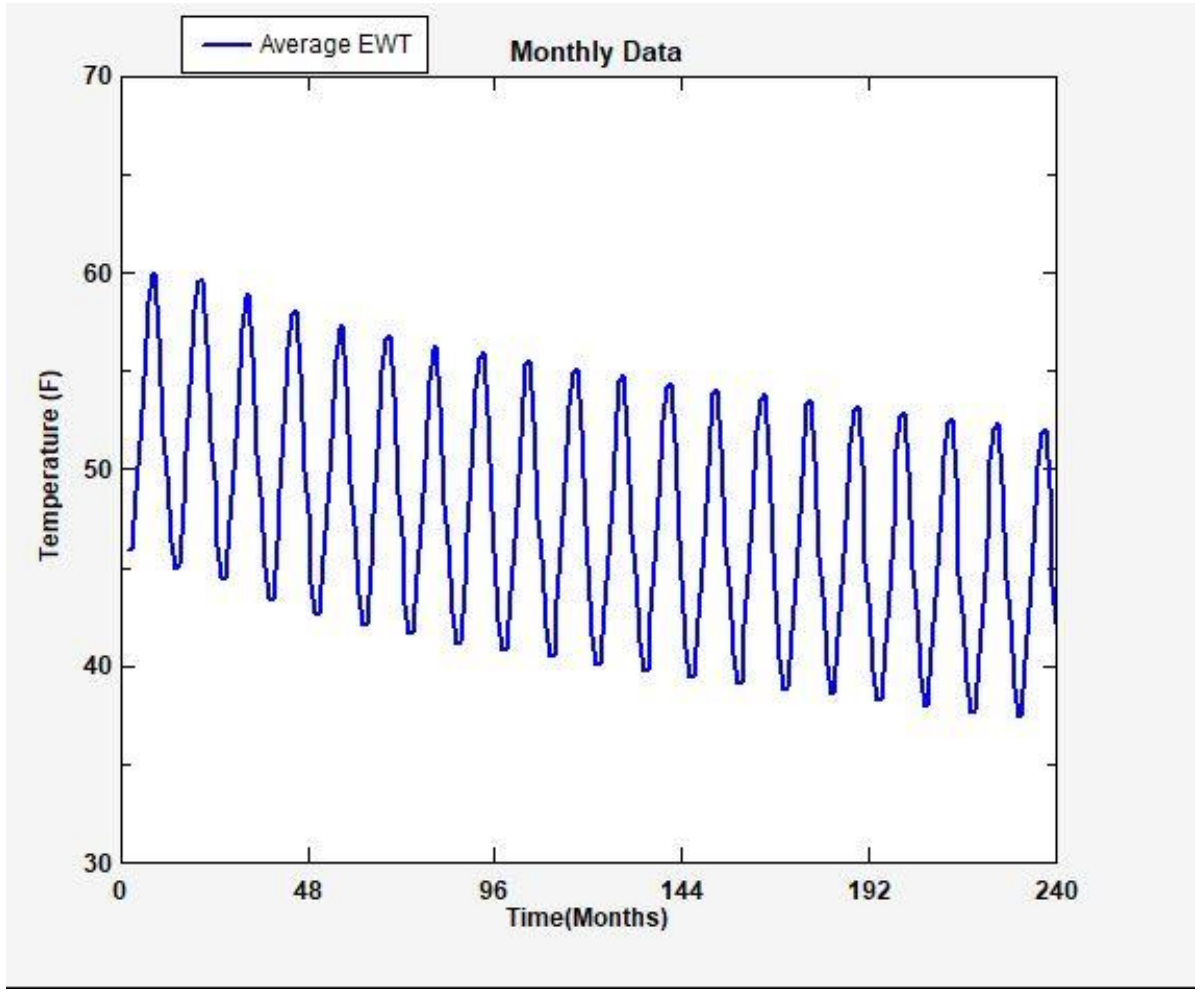
COOLING DOMINANT

Optimizing GHX Design

Monthly Load Data

Update | Cancel

	Cooling Total (kBtu)	Cooling Peak (kBtu/hr)	Heating Total (kBtu)	Heating Peak (kBtu/hr)
January	164	12	276281	**531**
February	285	13	237738	510
March	7242	93	184659	406
April	26645	261	139124	371
May	61813	387	111848	279
June	103572	**399**	83513	228
July	118106	341	76349	180
August	113720	378	77641	197
September	66238	322	95590	229
October	20357	265	154153	359
November	4505	89	168428	398
December	41	5	248962	487
Total:	522688	3.0 Hours at Peak	1854286	3.0 Hours at Peak



22 500' Boreholes @ 30' OC

Optimizing GHX Design

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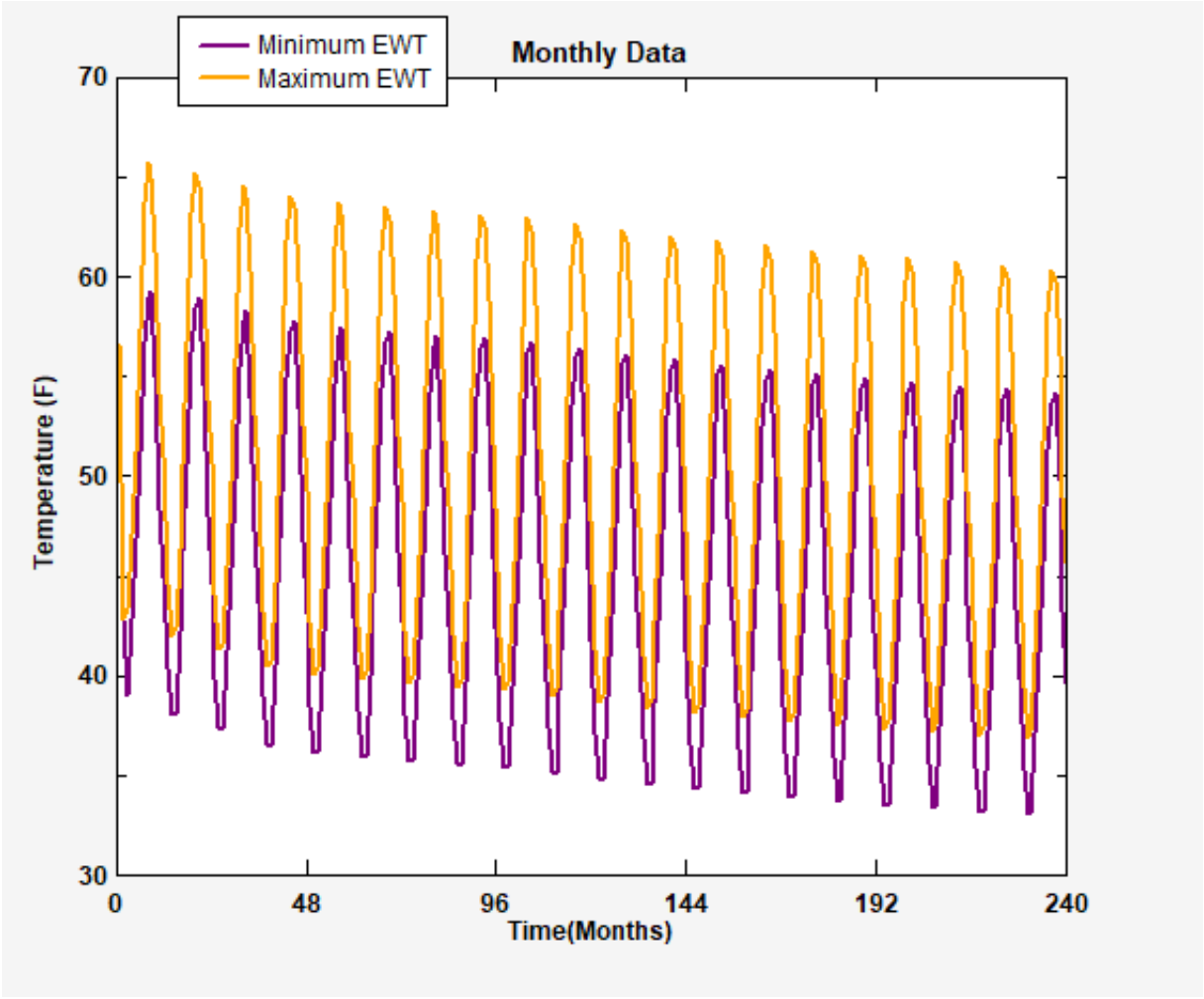
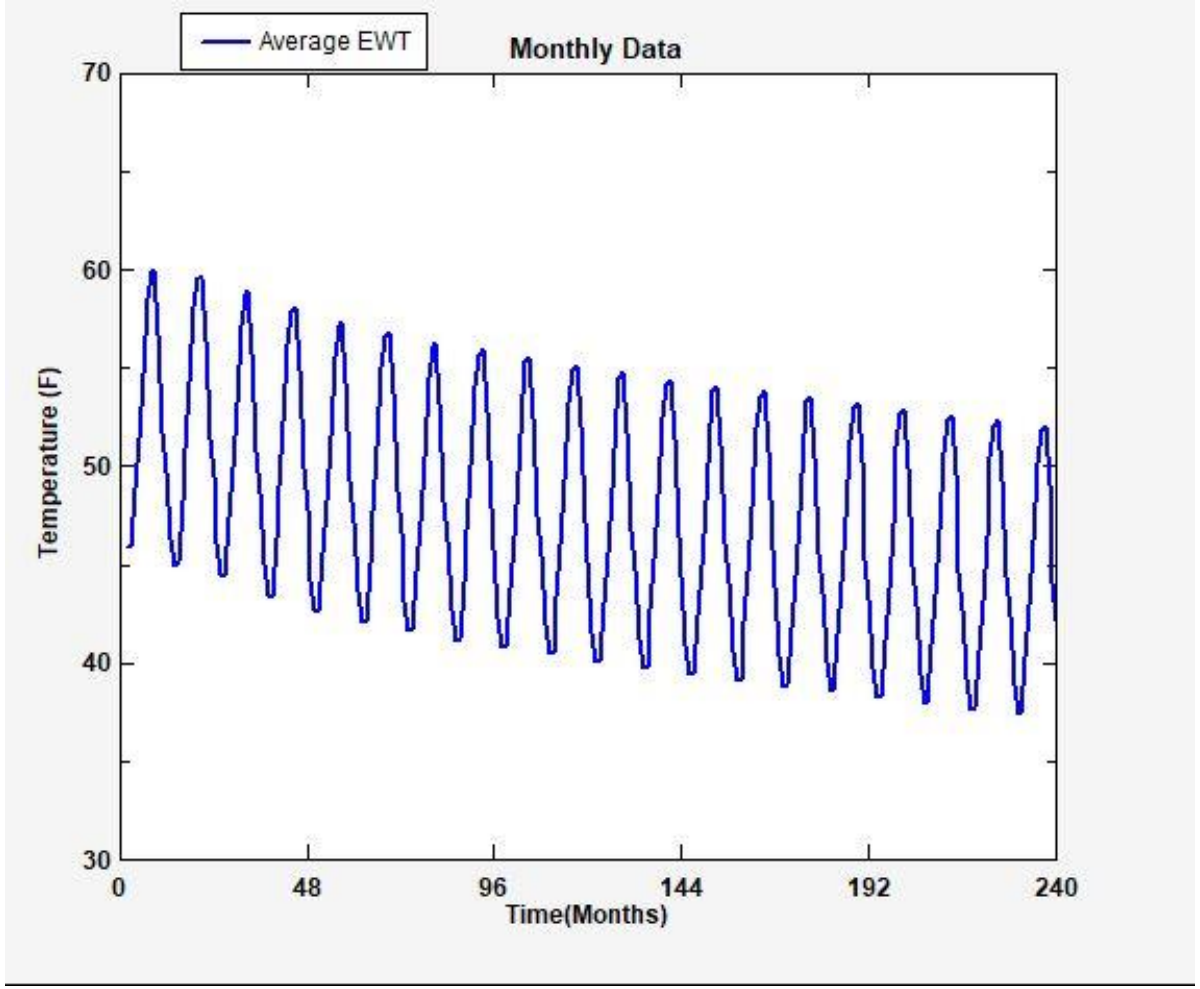
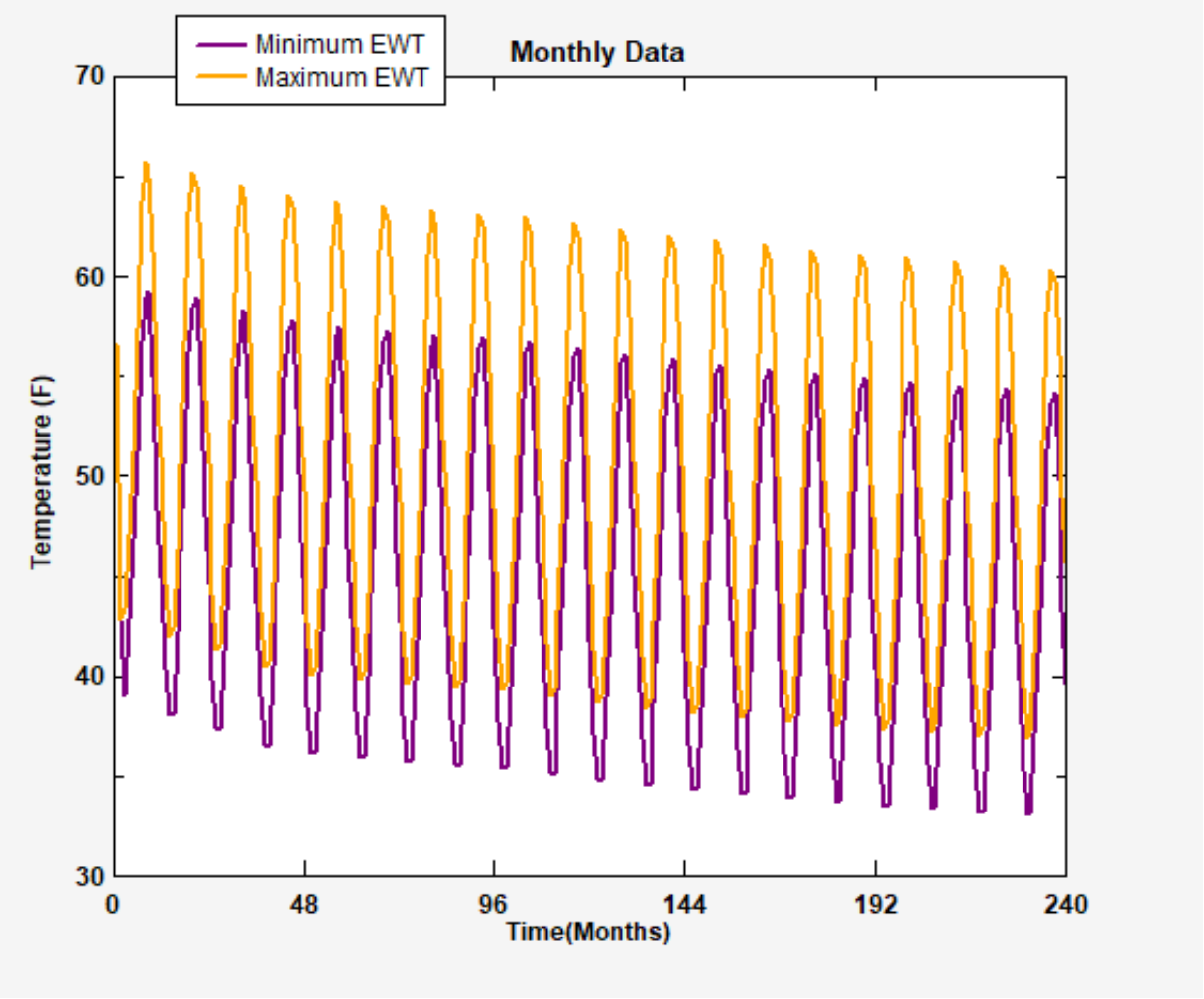


11 800' Boreholes @ 30' OC

Optimizing GHX Design



22 500' Boreholes @ 30' OC



11 800' Boreholes @ 30' OC

Individual Building Geothermal

CASE STUDY
1 Java – Brooklyn, NY

- Mixed-use new construction
  - 800 Residential Units
  - 13,000+ sf Retail
  - Below Grade Parking
- Cooling Dominant
- 320 boreholes (500’ @ 15’ OC)
- Ground Source Heat Pumps (apartments and common spaces) & Electric Heat (mechanical rooms & storage rooms)
- Dry Cooler required for long term system thermal balance and performance

	Cooling		Heating	
	Total (kBtu)	Peak (kBtu/hr)	Total (kBtu)	Peak (kBtu/hr)
January	122711	1526	1452573	6344
February	129416	1228	1292623	6864
March	249972	2739	844480	3895
April	467103	4300	596770	3098
May	983975	5889	502752	2938
June	2148772	8030	474741	2634
July	3254485	9010	489796	2633
August	2931221	8826	489523	2632
September	1570104	7241	476548	2681
October	875190	5584	567930	3423
November	220855	2197	815202	4333
December	152348	1809	1200563	4874
Total	**13106151**		**9203501**	
Hours at Peak		**9.0**		**5.0**

Knowledge Check #2

How does building energy modeling effect GHX design for an individual building?

District Geothermal Systems

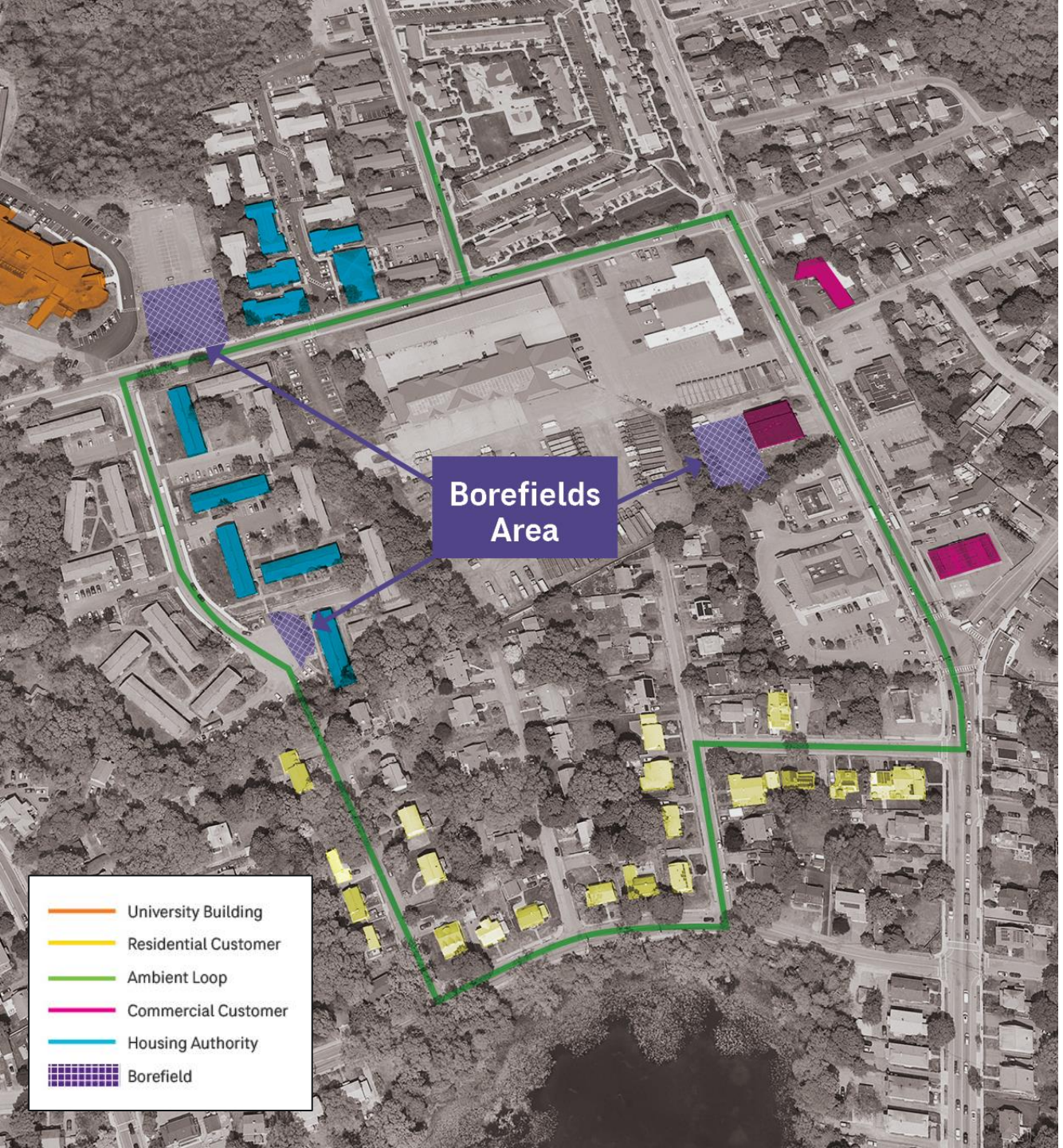
District Geothermal Building Energy Modeling

Feasibility Study

- UTEN: Evaluating 20+ sites to get down to one
- Where do you begin? How much effort do you put into accurate building energy modeling?
  - Public assessors information
  - EUI factors based on occupancy and square footage

Detailed Design

- Manual J calculations
- Existing plans & site visits to build detailed energy models
- Important Characteristics for District System
  - Diversity of Loads (Commercial vs. Residential; Heating dominant vs. cooling dominant)
  - Annual balance of loads

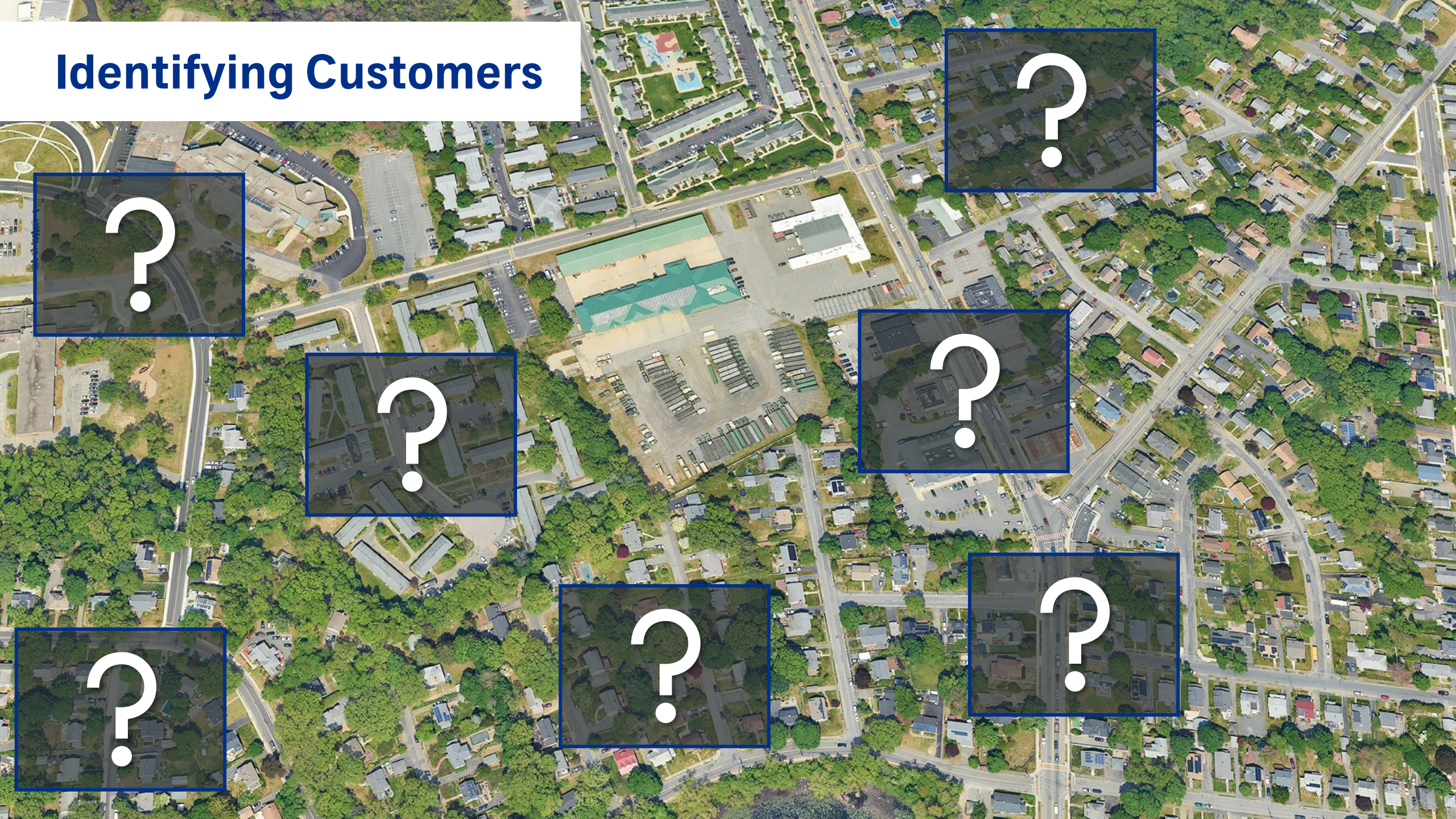


CASE STUDY

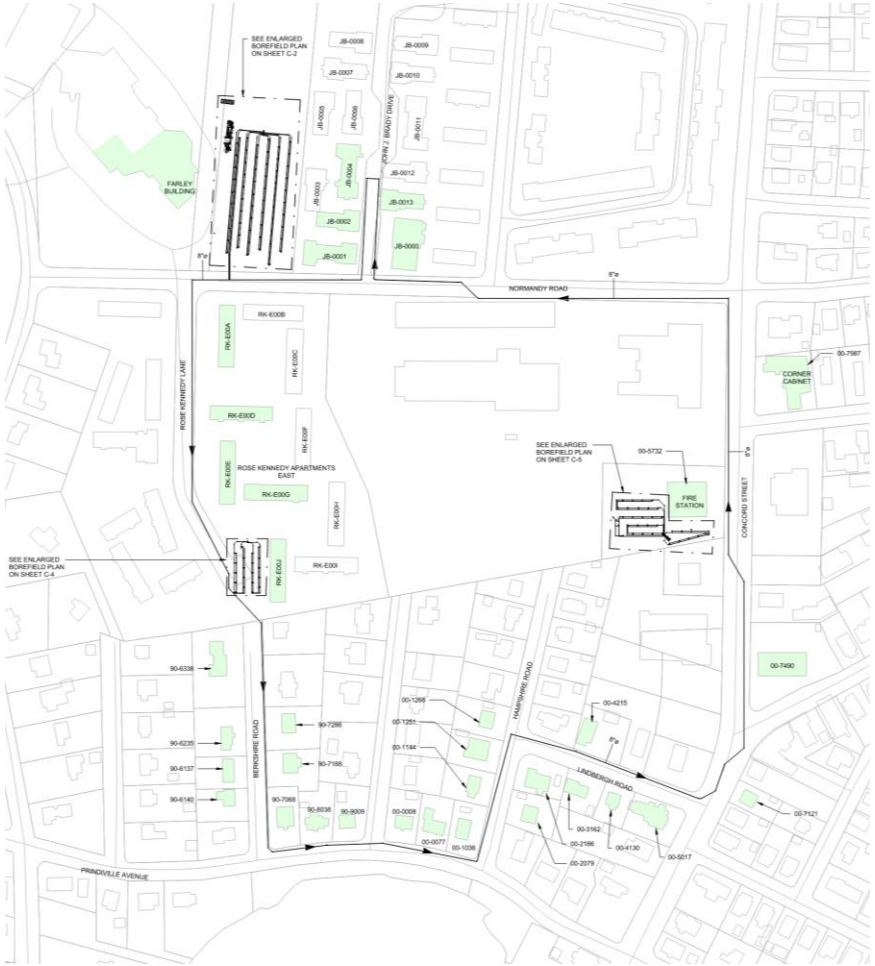
Eversource Geothermal Pilot Project (Framingham, MA)

- One main and two recharge borefields
- Primarily Environmental Justice Community
- Mix of loads for system balancing
- 1+ mile of ambient loop piping
- Six outside stakeholders to integrate

Identifying Customers

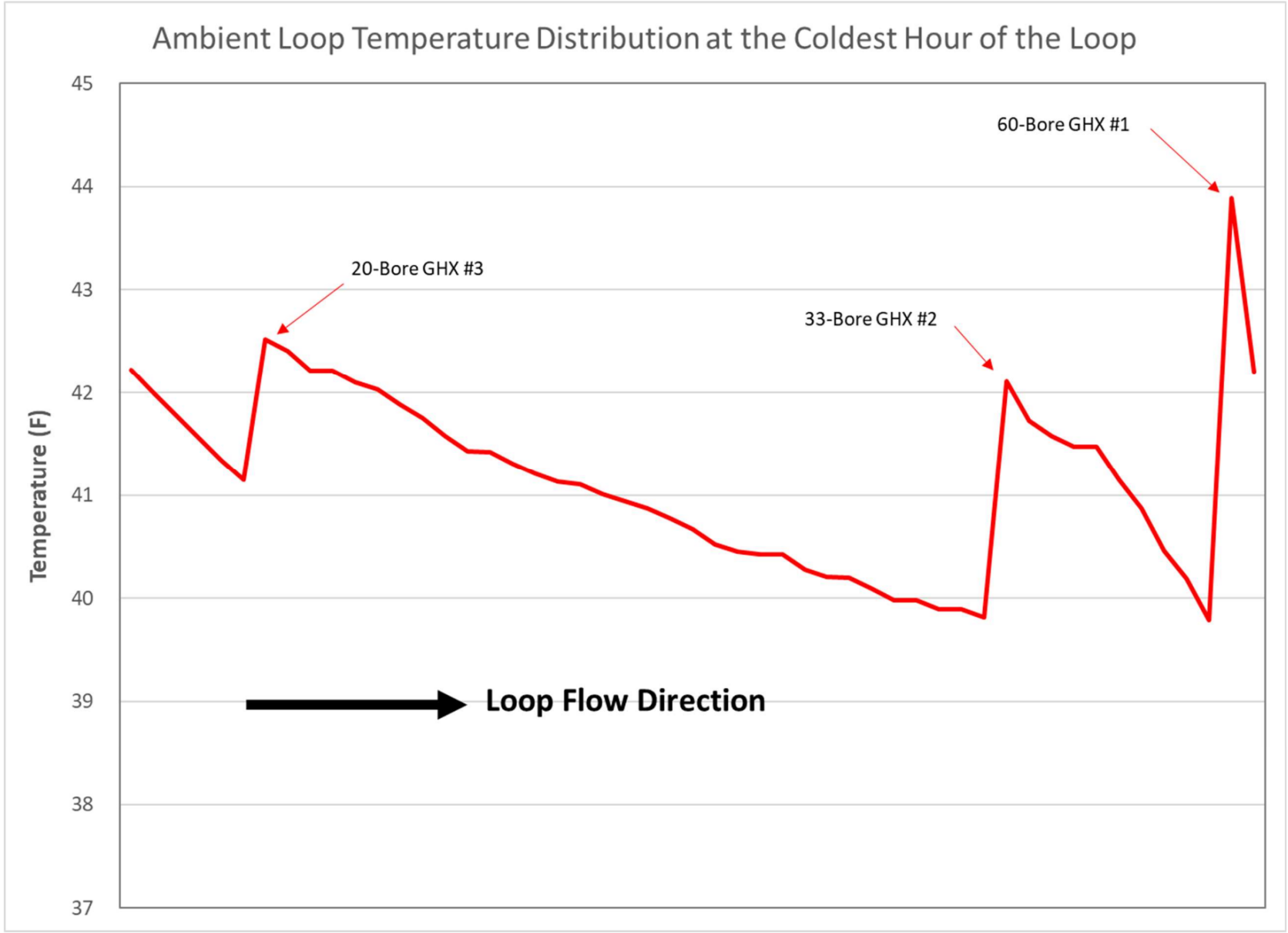


Building the District & Getting the Loads



TRNSYS Modeling

- Transient modeling to assess the performance of the thermal system
- Ensure customers get similar entering water temperatures along the loop
- Recharge Borefields boost temperature



Knowledge Check #3

How does building energy modeling effect GHX design for a district of buildings?

Learning Objectives

1. Understand the components of building energy modeling
2. Understand the effect of building energy modeling on ground heat exchanger (GHX) design for an individual building
3. Understanding the effect of building energy modeling on GHX design for a district geothermal system

Questions?

Thank you

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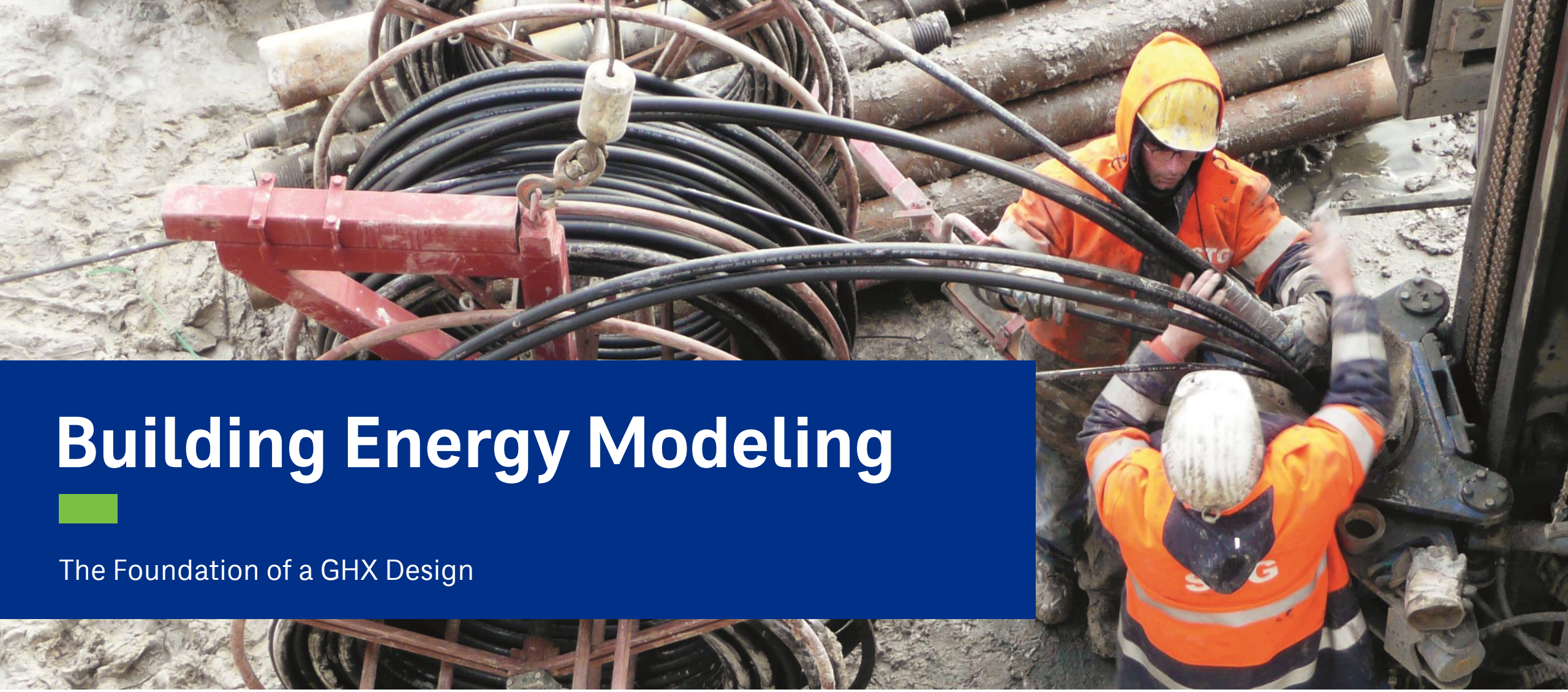

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