lighting design lab

Don’t Be Burned by Boiler Decarb Retrofits

Presented by
Stet Sanborn, AIA, FASHRAE
Vice President, Director of Climate IMPACT

April 1, 2025

Seattle City Light

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Webinar Procedures

- All attendees are on mute
- Submit questions at any time
- The webinar is being recorded
- Please take the after-class survey!

Look for the Questions icon in the top menu bar

Chat icon – disabled except for admin

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What Is This “Lighting Design Lab”?

- Seattle City Light's go-to resource for lighting and lighting controls since 1989 – 30+ years
- Formed by BPA and NW utilities to fill education needs for the transforming market
- Now expanded to include resources that support whole buildings
- Being rebranded!

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Where do you do most of your work?

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Have you done a boiler decarb retrofit?

Upcoming Events

Course	Day	Time
2021 Energy Code Update Series — **Service Water Heating**	Thu April 17	10:00-11:30 a.m.
2021 Energy Code Update Series — **Alterations**	Thu May 15	10:00-11:30 a.m.

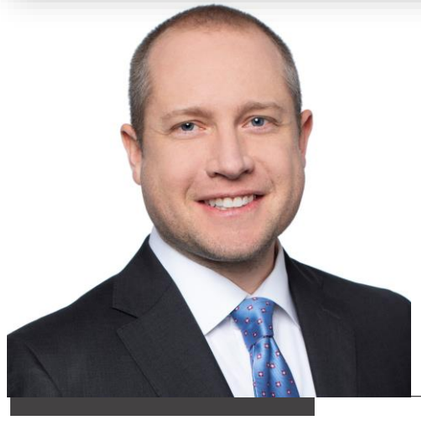
Event	Day	Time
Seattle City Light Trade Ally Office Hours	Fri Apr 18	9:00 a.m.

Stay up-to-date at LightingDesignLab.com and by subscribing to our newsletter.

DON'T GET BURNED BY YOUR BOILER DECARB RETROFIT!

Achieving Real Savings; Right-Sizing & Avoiding Unnecessary Costs.

SMITHGROUP



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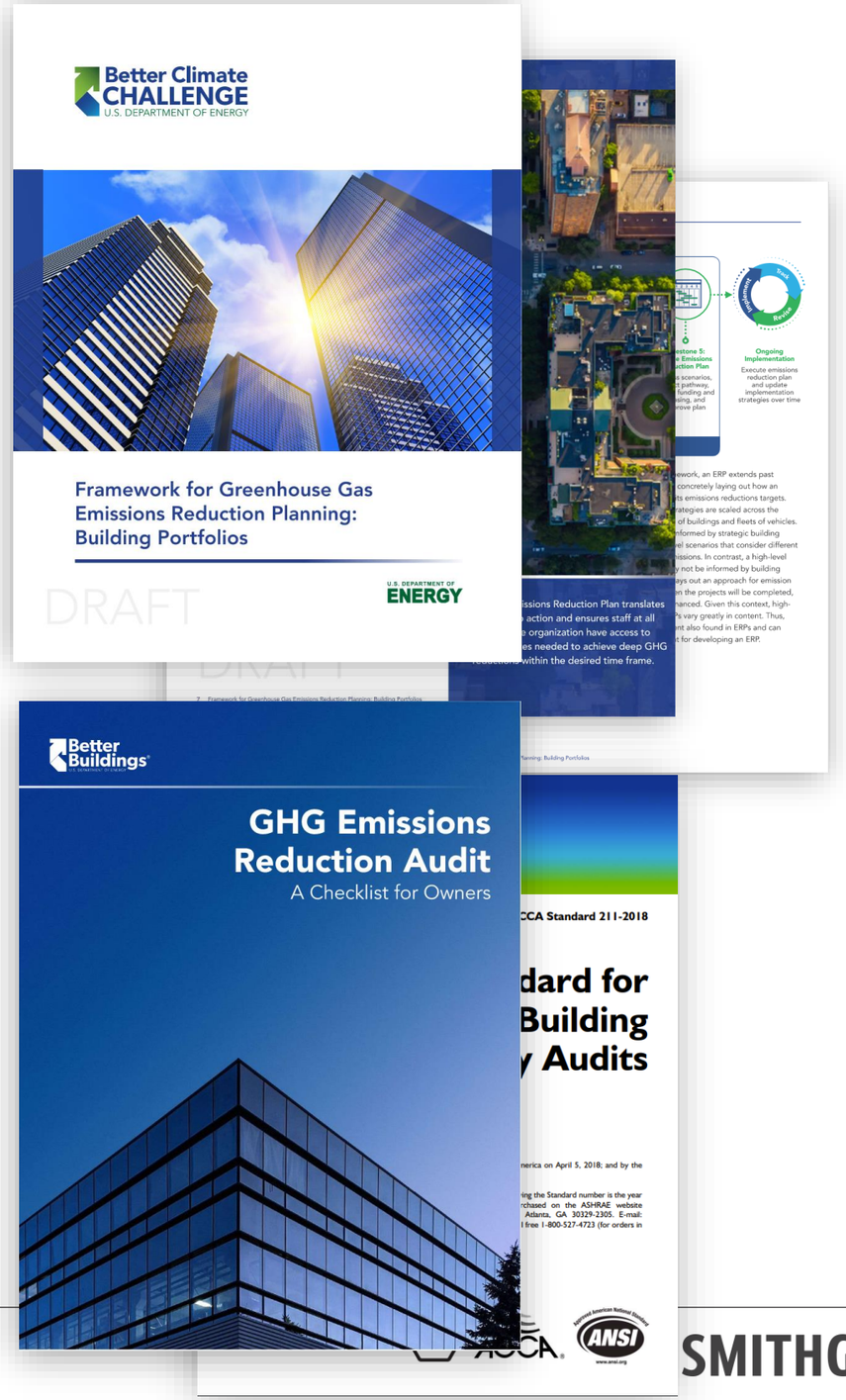
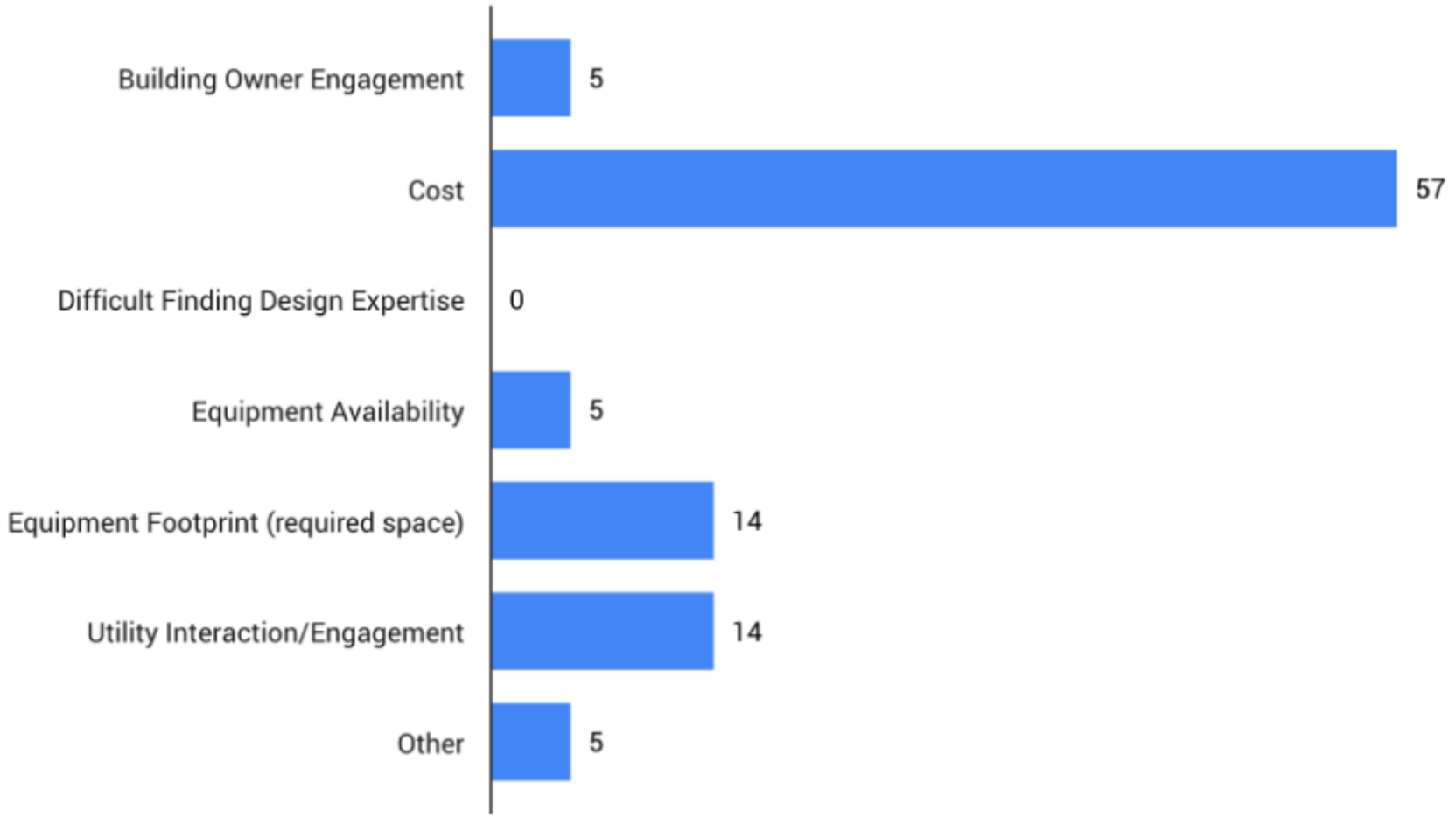


BARRIERS TO ELECTRIFICATION/DECARB RETROFITS

CHOOSE YOUR OWN ADVENTURE



Source: PG&E Building Electrification Seminar

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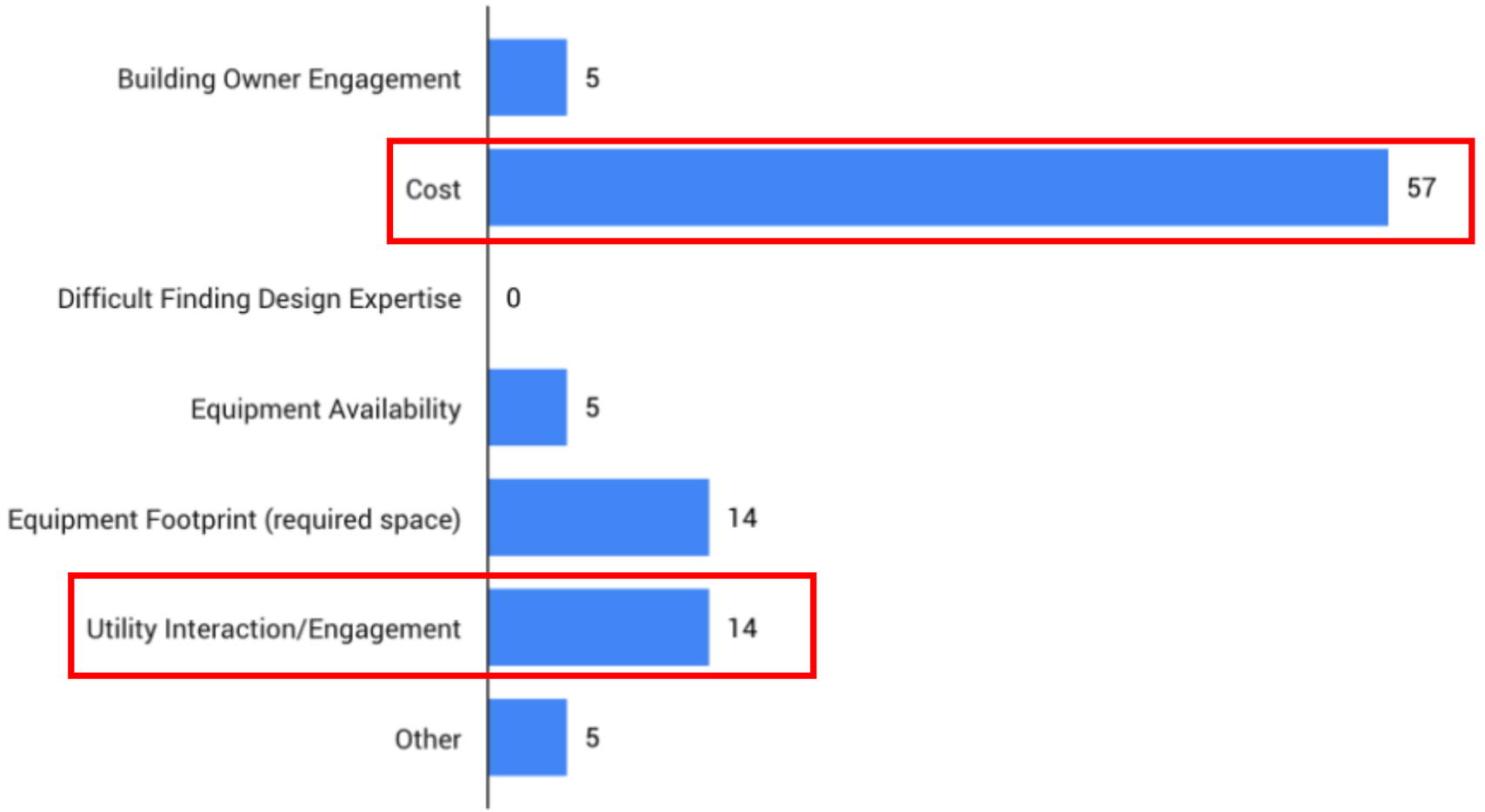


Source: PG&E Building Electrification Seminar

BARRIERS TO ELECTRIFICATION; BEFORE YOU START!

OWNERSHIP & LEASE STRUCTURES

- Who is Responsible for Utilities?
- Who is Responsible for Maintenance?
- Who is Responsible for Improvements?
- Who is Responsible for Taxes?
- Who is Responsible for Operating expenses?

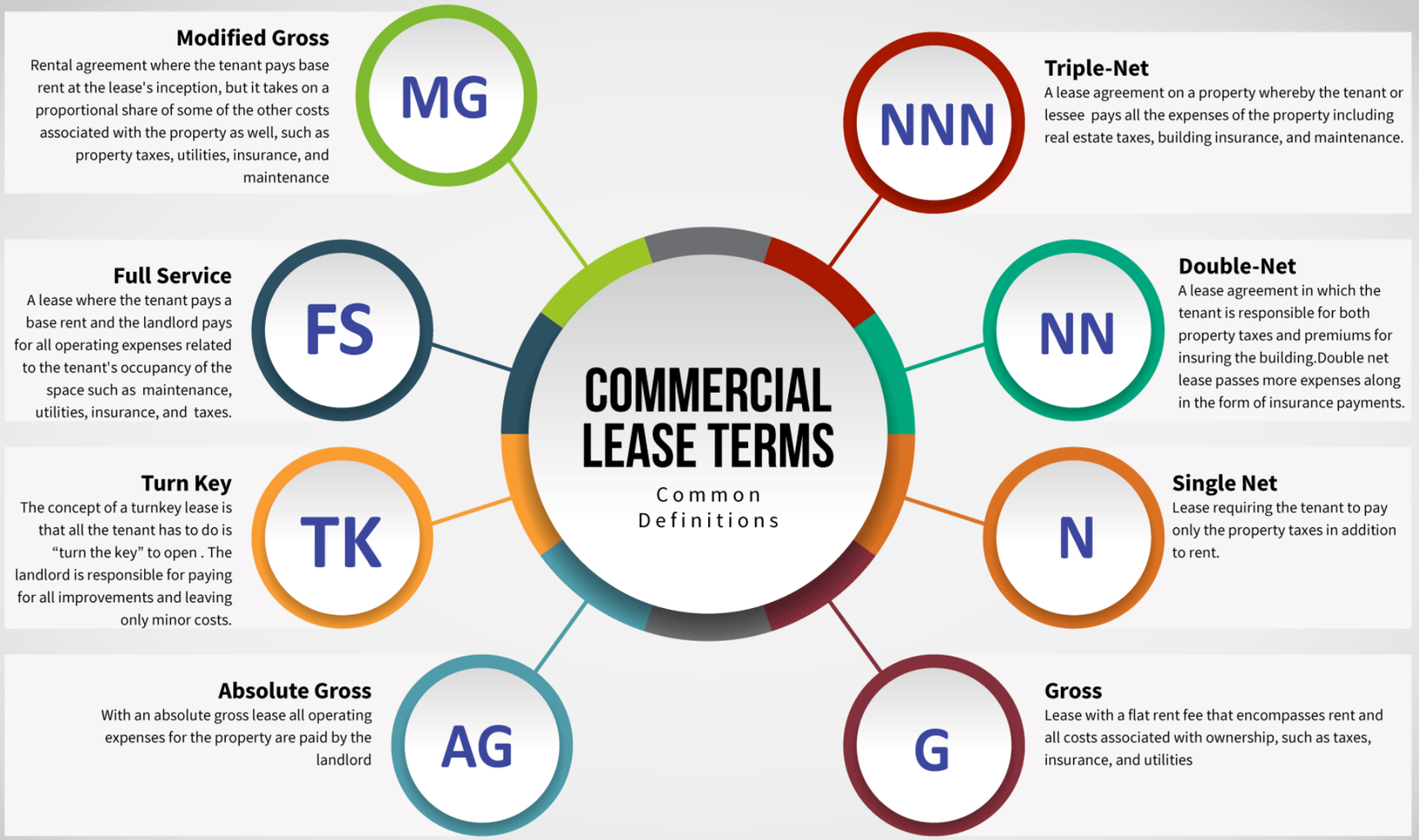
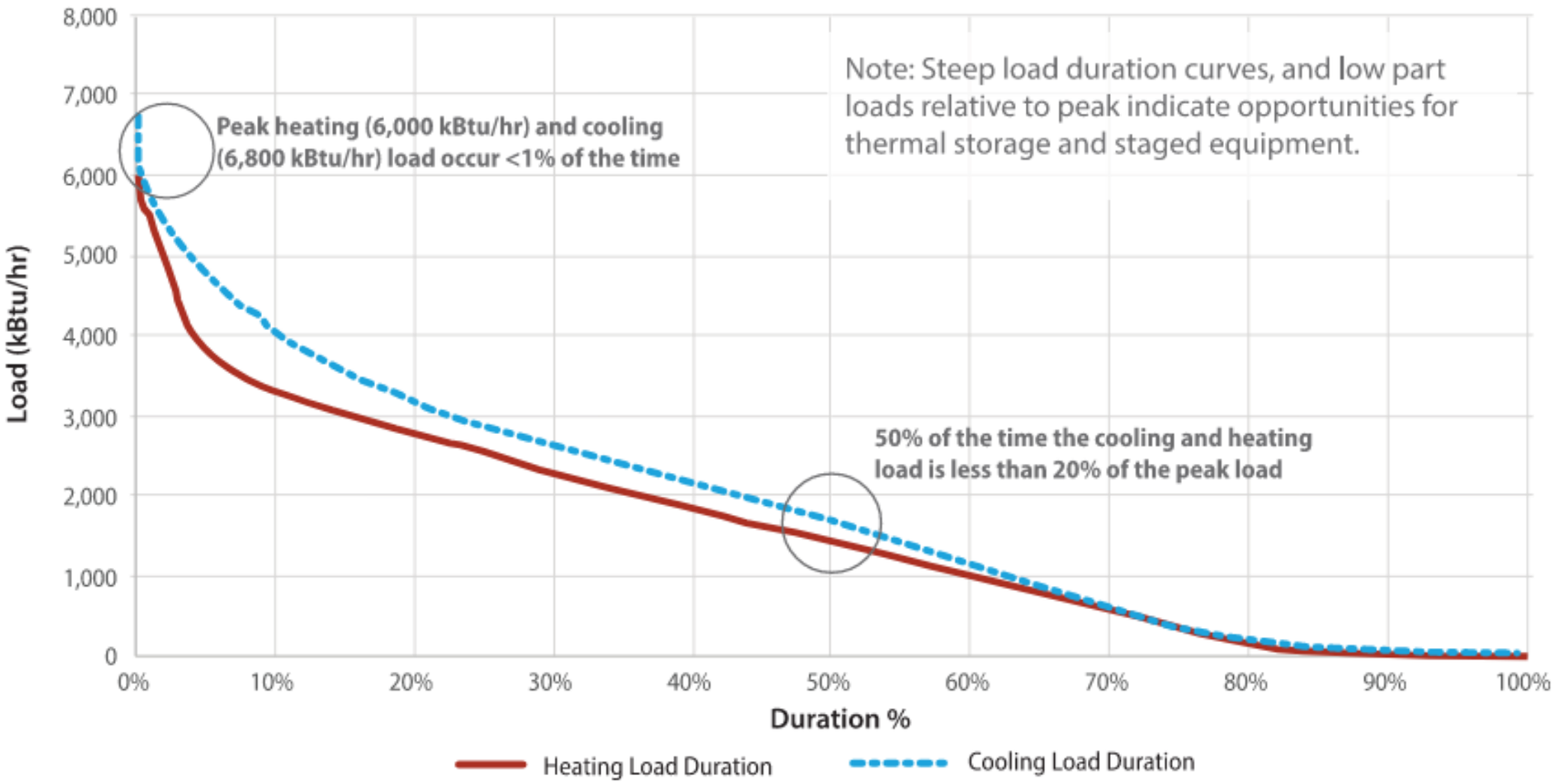


Image Courtesy EV Bishoff Company

AGENDA

A PROCESS FOR COST-EFFECTIVE DECARB RETROFITS

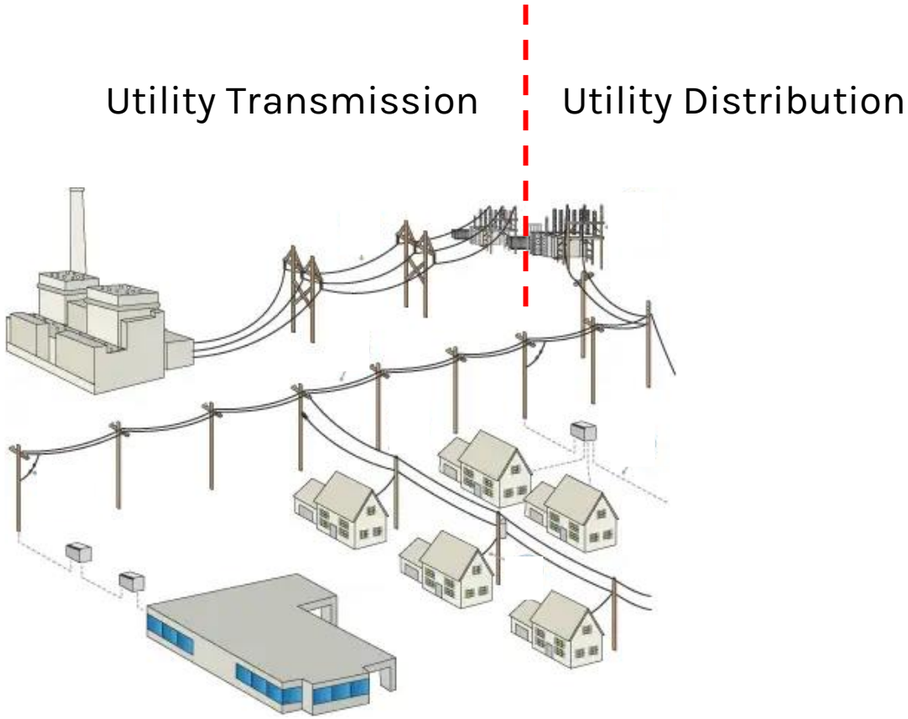
- **The Scale of Barriers**
  - Building Level
  - Beyond Your Site
- **Where to Start**
  - Knowing your Loads and Limits
    - Panel Limits
    - Stress Tests
- **Design Strategies**
  - Selection Strategies
  - Hybrid Options



BARRIERS: CAPACITY

CAPACITY CONSTRAINTS

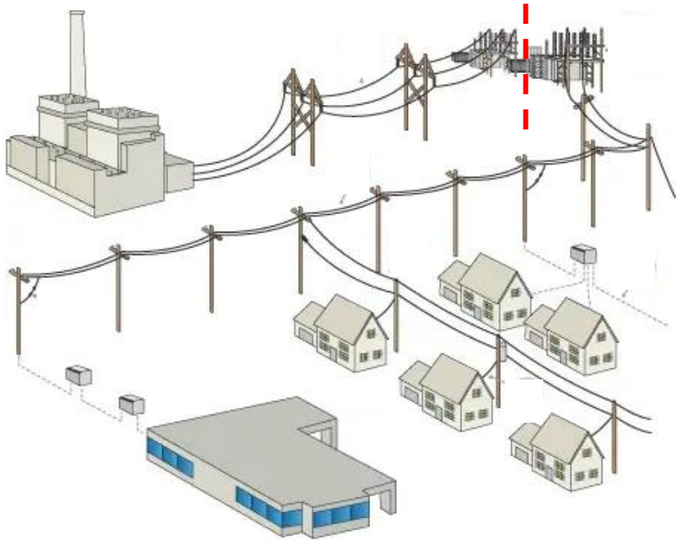
ALL OF THE WAYS YOUR PROJECT COULD DIE ON THE VINE

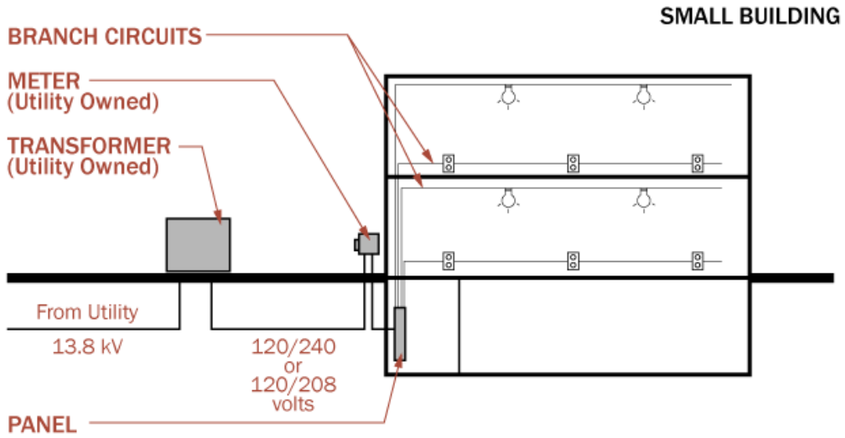


CAPACITY CONSTRAINTS

ALL OF THE WAYS YOUR PROJECT COULD DIE ON THE VINE

Utility Transmission | Utility Distribution





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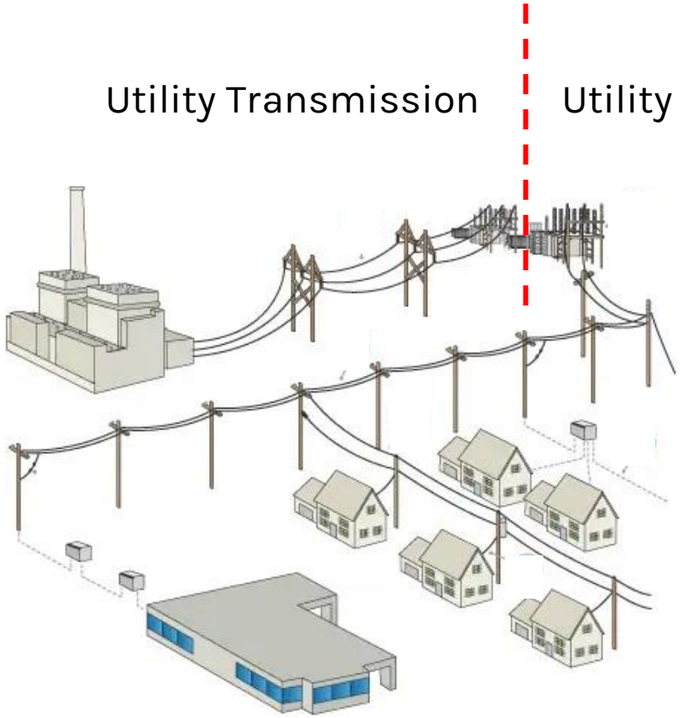
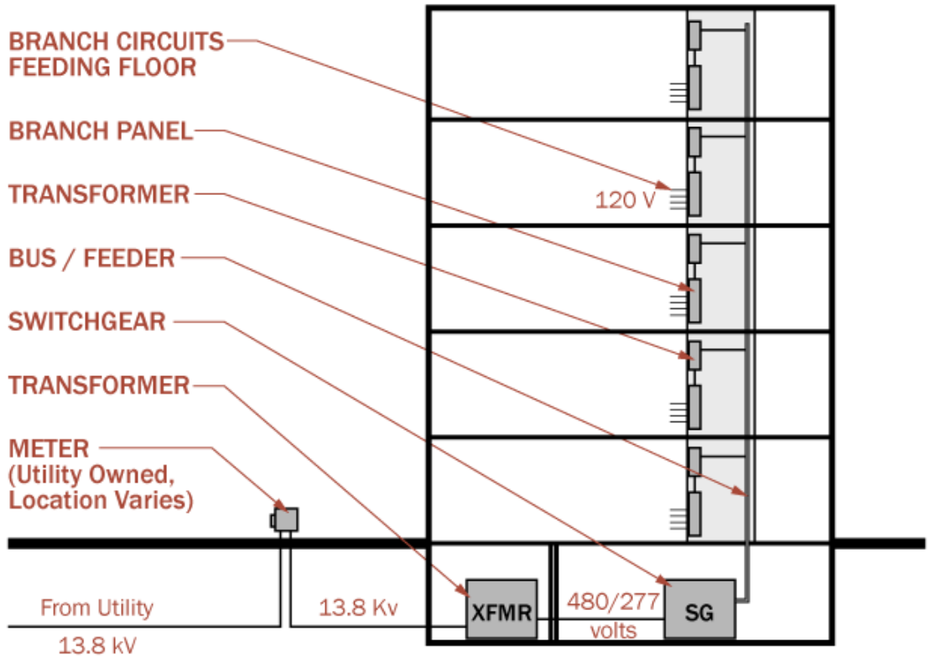
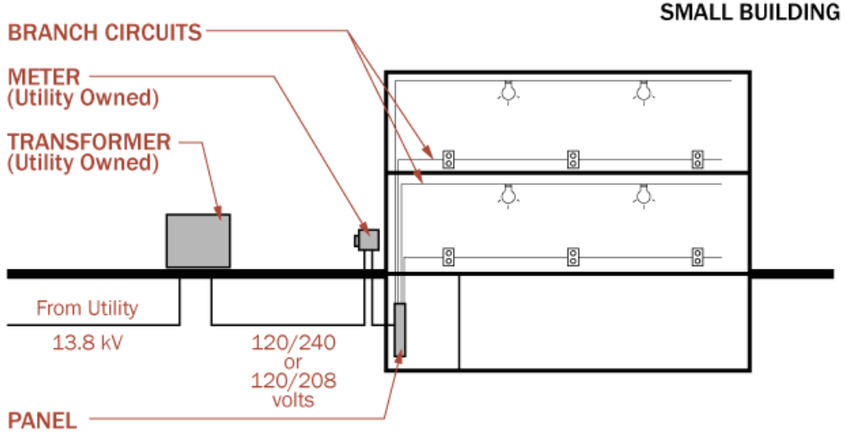


LARGE BUILDING

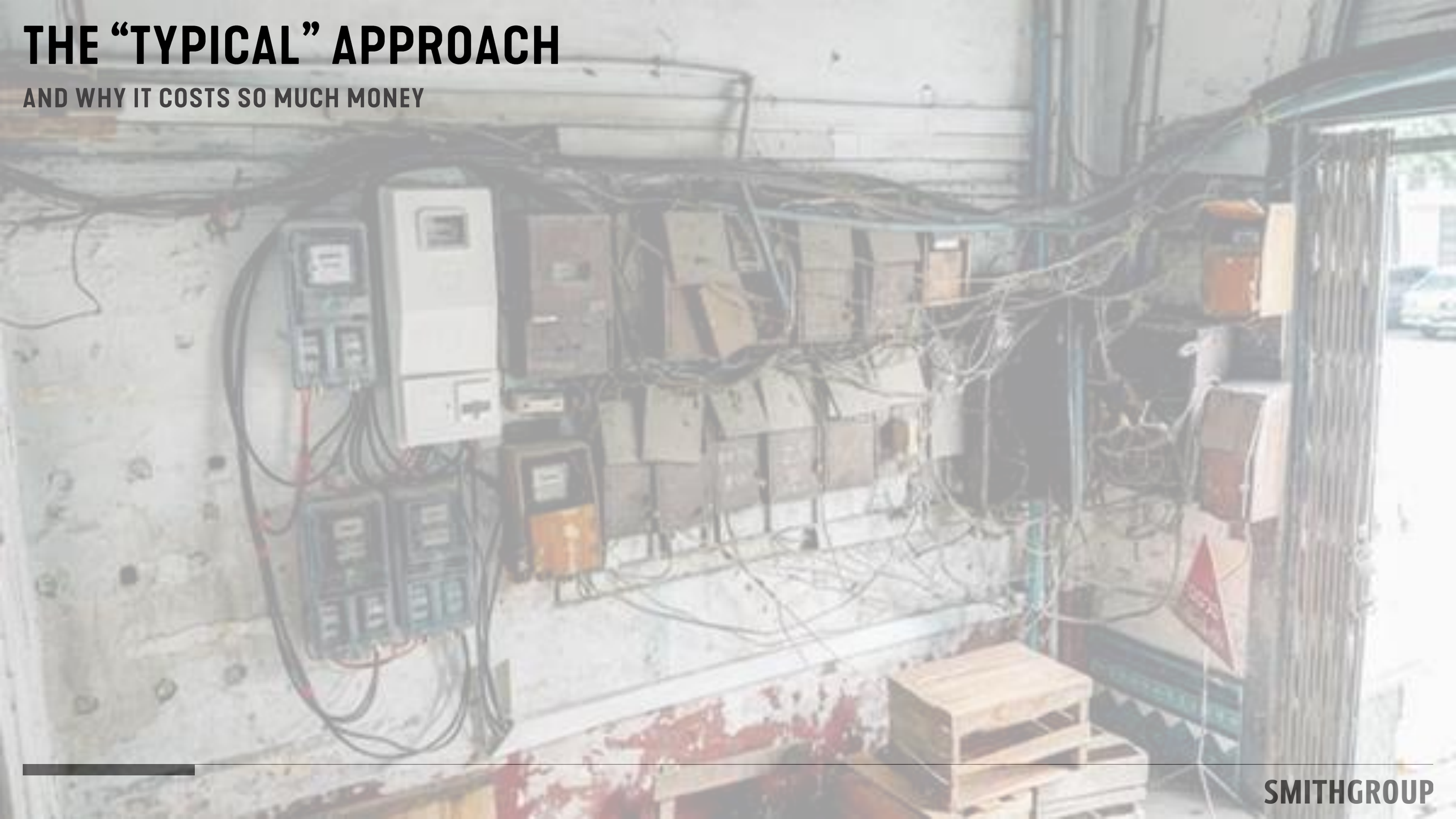


SMALL BUILDING



THE “TYPICAL” APPROACH

AND WHY IT COSTS SO MUCH MONEY



AVOIDING UPGRADES

WORKING WITHIN THE LIMITS

17 Stories, ~400 Units

Hey, just electrify me; that’s easy right?

AVOIDING UPGRADES

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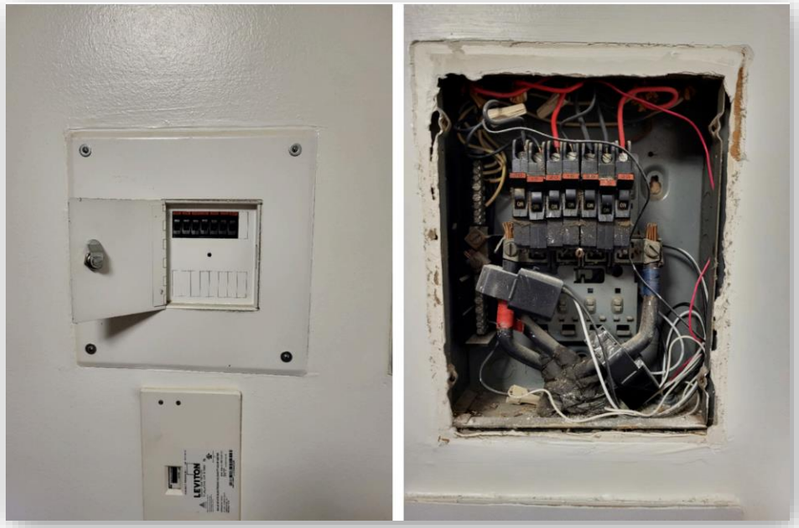


Existing 60 Amps Panels

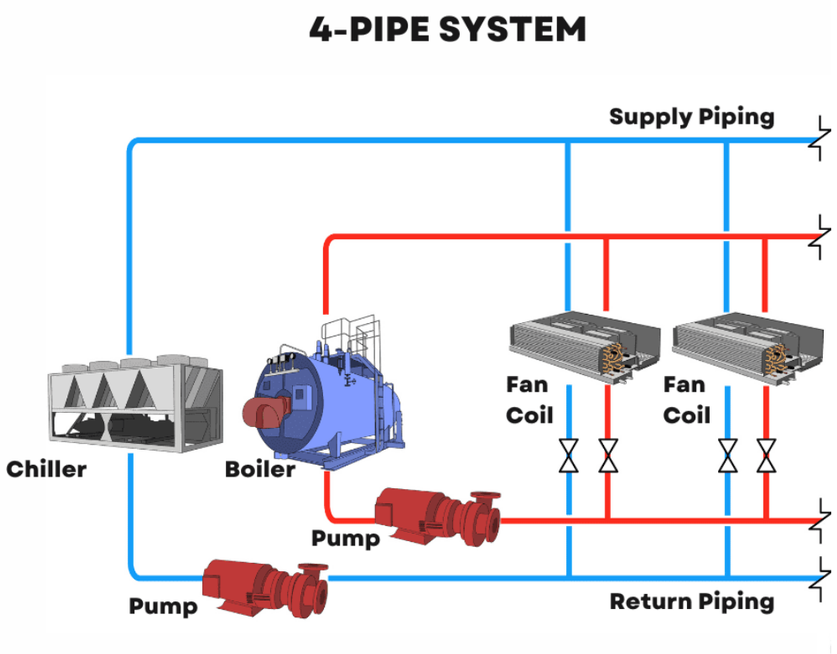
RESIDENTIAL APARTMENT LOAD CALCULATION - 1 BR

	SF	VA
GENERAL LIGHTING (3VA/SF)	952	2856
SMALL APPLIANCE		3000
DISHWASHER		1500
DISPOSAL		1350
RANGE		8000
LAUNDRY		1500
DRYER		4500
MICROWAVE		1500
REFRIGERATOR		800
TOTAL CONNECTED LOAD		25006
DEMAND		
FIRST 10,000 VA @ 100%		10000
REMAINDER @ 40%		6002
FURNACE (FAN MOTOR)		1500
CONDENSING UNIT		0
TOTAL LOAD		17502
TOTAL COMPUTED LOAD (TOTAL LOAD/208V)		84.1 -AMPS

Proposed Solution

HAVE YOU RUN INTO COST CONSTRAINTS

17 Stories, ~400 Units



Very Traditional 4-Pipe System

Equipment requiring replacement is as follows:

There are a total of three natural gas boilers with a cumulative output capacity of 9,000 MBTUH.

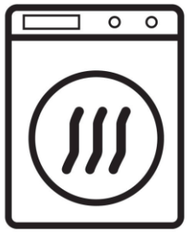
The proposed electric boilers serving the hydronic loop will need to have a cumulative capacity of 2,637 KW. This would require three (3) electric boilers with an approximate capacity of 880-KW each. This equates to approximately 1060-amps of power (277/480-volt, 3-phase) for each boiler.

There are a total of two natural gas boilers associated with the domestic hot water system with a cumulative output capacity of 6,000 MBTUH. This is equivalent to 1757 KW, or two electric boilers with an approximate capacity of 880 KW each. This equates to approximately 1060-amps of power (277/480-volt, 3-phase) for each boiler.

Proposed Solution

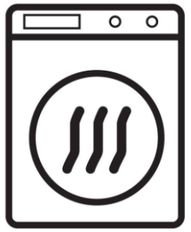
HAVE YOU RUN INTO COST CONSTRAINTS

17 Stories, ~400 Units



ITEM	EACH	COST EACH	TOTAL COST
RANGES	394	700	$ 275,800.00
APARTMENT ELECTRICAL RISERS	46	20000	$ 920,000.00
APARTMENT LOAD CENTERS	384	1500	$ 576,000.00
RISER SWITCHGEAR - 6000-AMP	1	25000	$ 25,000.00
SERVICE SWITCHGEAR - 6000-AMP	1	25000	$ 25,000.00
SERVICE - 6000-AMP	1	50000	$ 50,000.00
480/208 TRANSFORMERS	4	30000	$ 120,000.00
CARPENTRY	394	500	$ 197,000.00
BOILERS	5	80000	$ 400,000.00
BOILER INSTALL	5	20000	$ 100,000.00
TOTAL			$ 2,688,800.00
CONTINGENCY (15%)			**$ 3,092,120.00**

HAVE YOU RUN INTO COST CONSTRAINTS



All in One
Ventless HP Dryer
+ Washer Combo
120v 15 Amp

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HAVE YOU RUN INTO COST CONSTRAINTS

All in One
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120v 15 Amp

Battery Integrated
Induction Range
120v 15 Amp
(5kWh Storage)

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WHERE TO START

KNOWING YOUR LOADS AND YOUR LIMITS

THE REAL ‘HOW’ OF SMART ELECTRIFICATION

WHATEVER YOU DO, DON’T JUST REPLACE YOUR GAS BOILER WITH A SAME SIZED HEAT PUMP OR ELECTRIC BOILER

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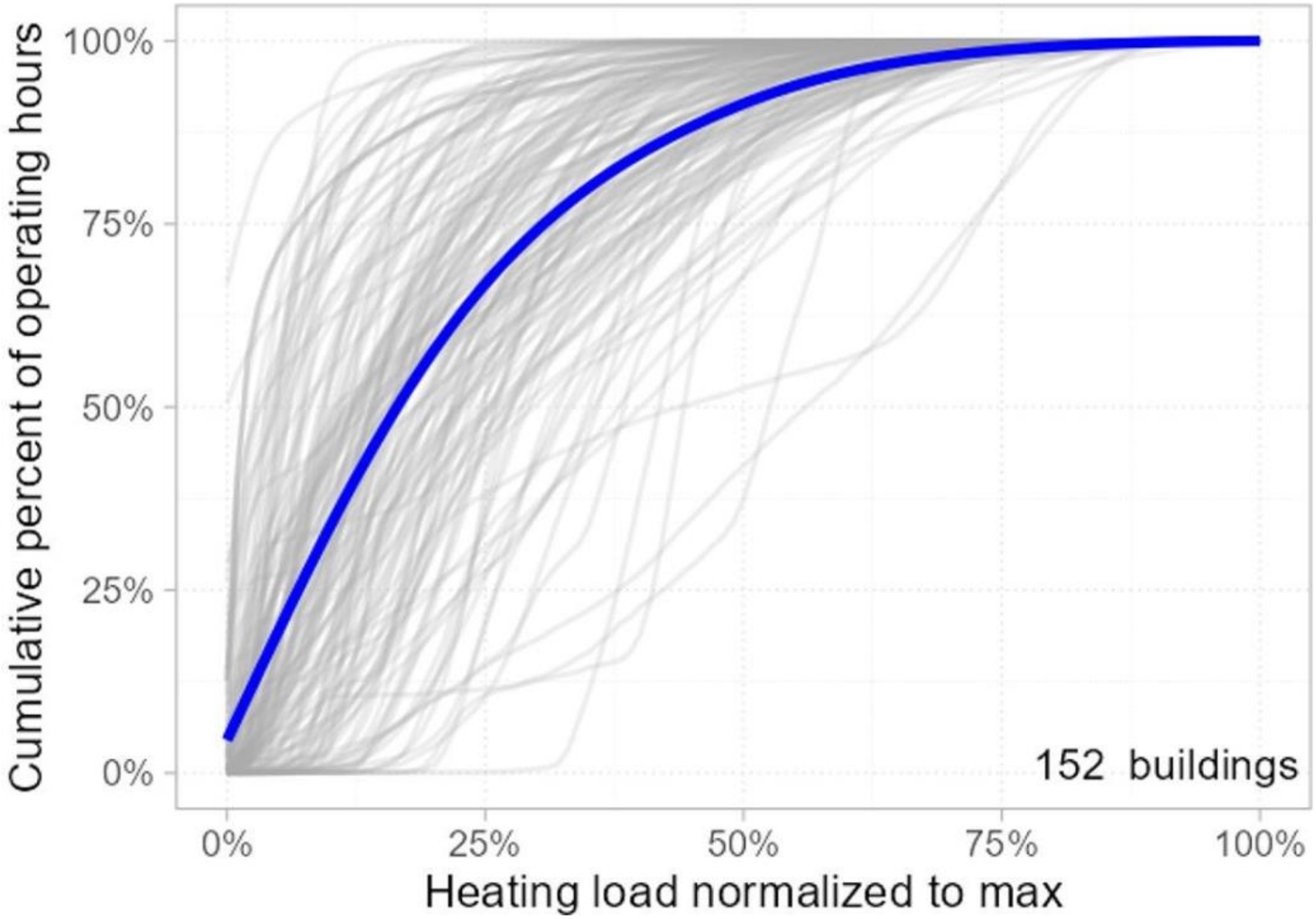

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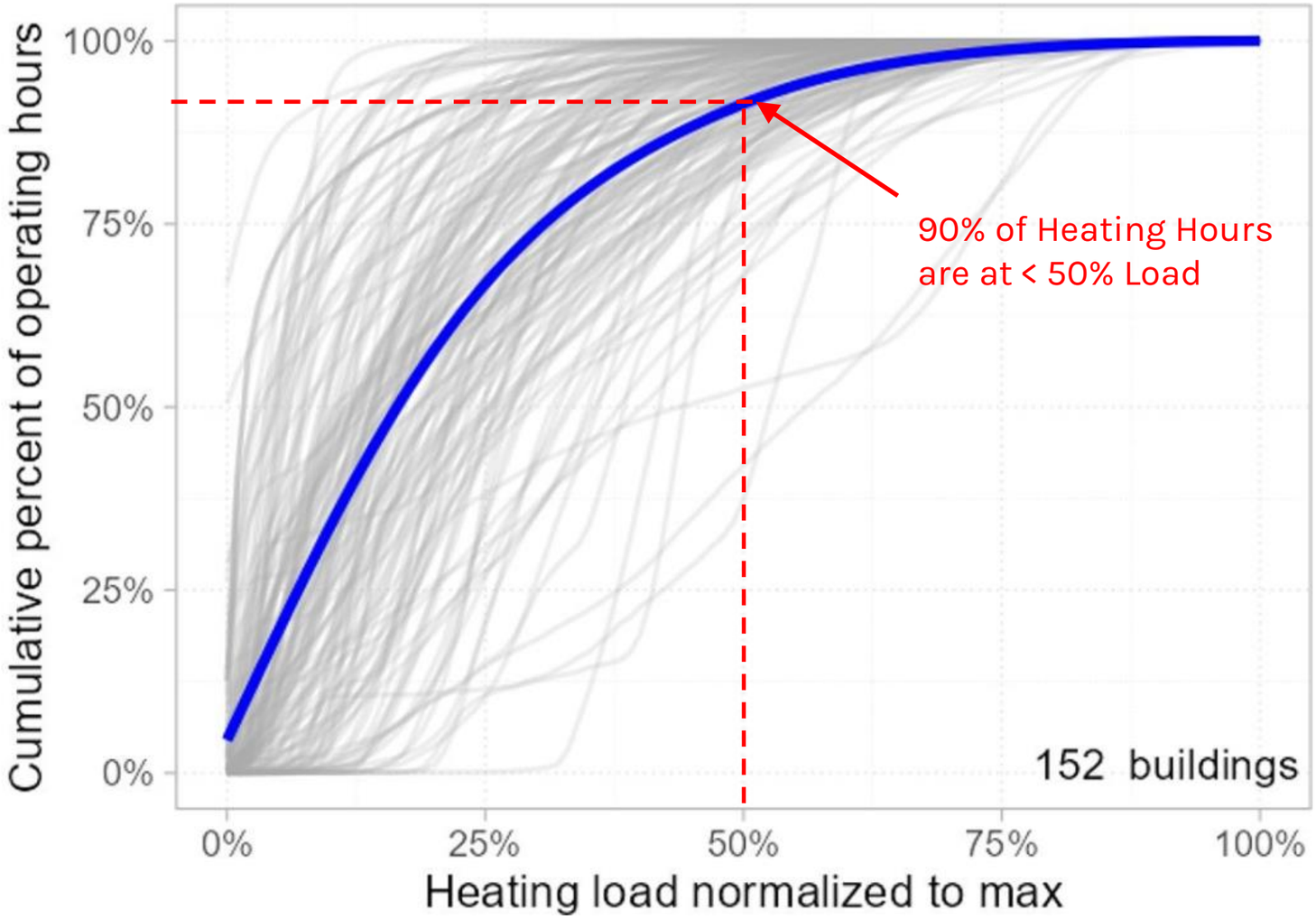

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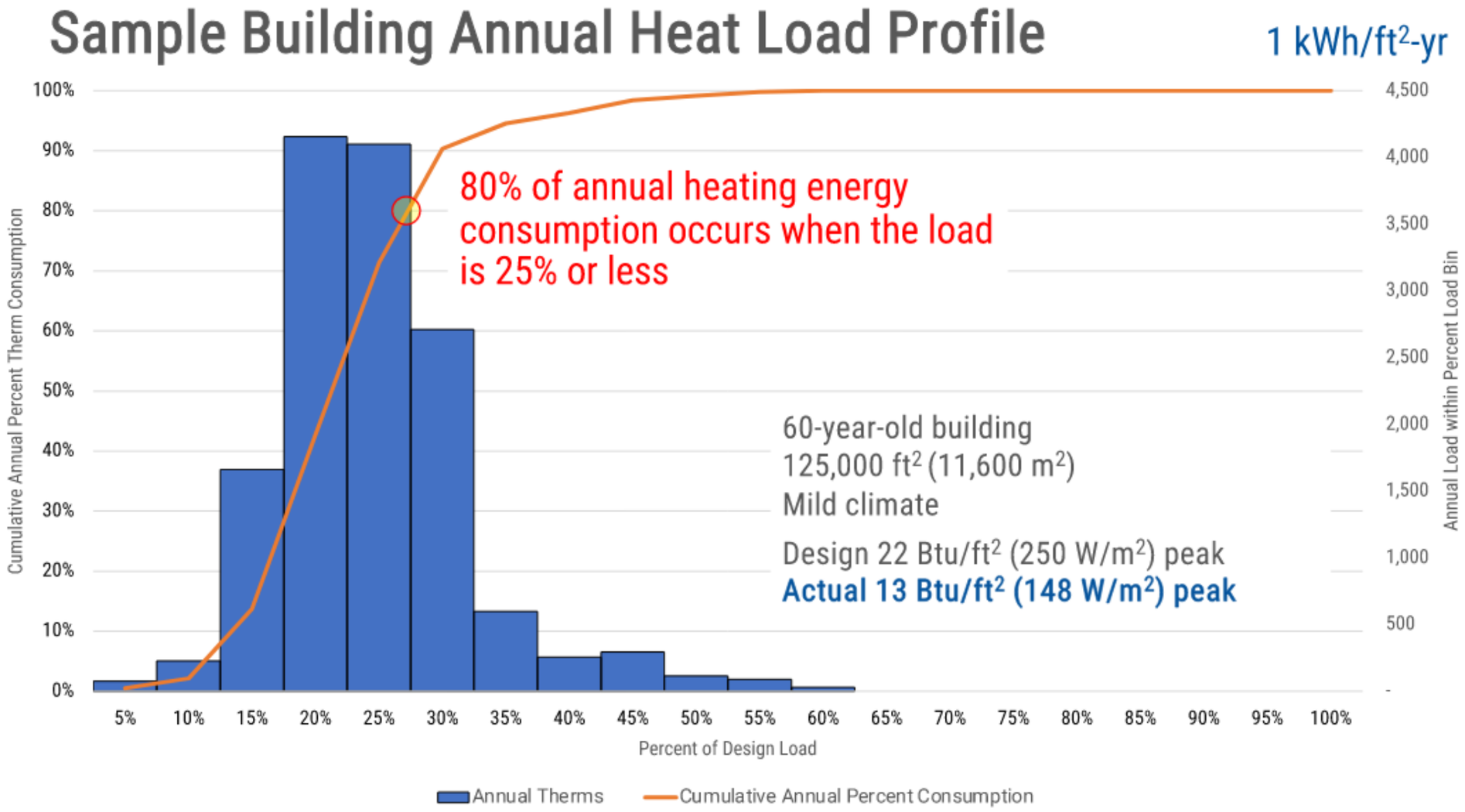

Graphic Courtesy of Kent Peterson, P2S Inc

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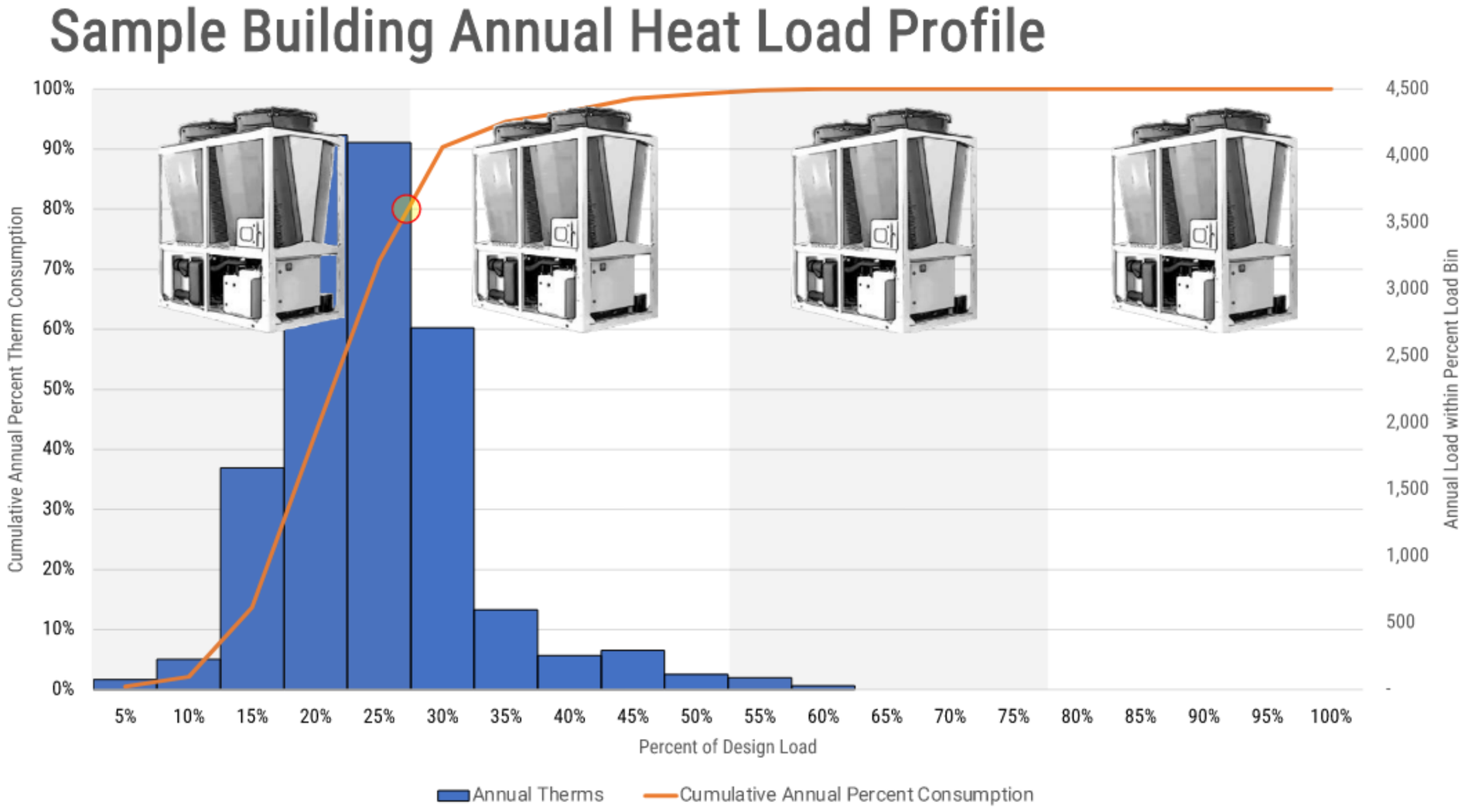

Graphic Courtesy of Kent Peterson, P2S Inc

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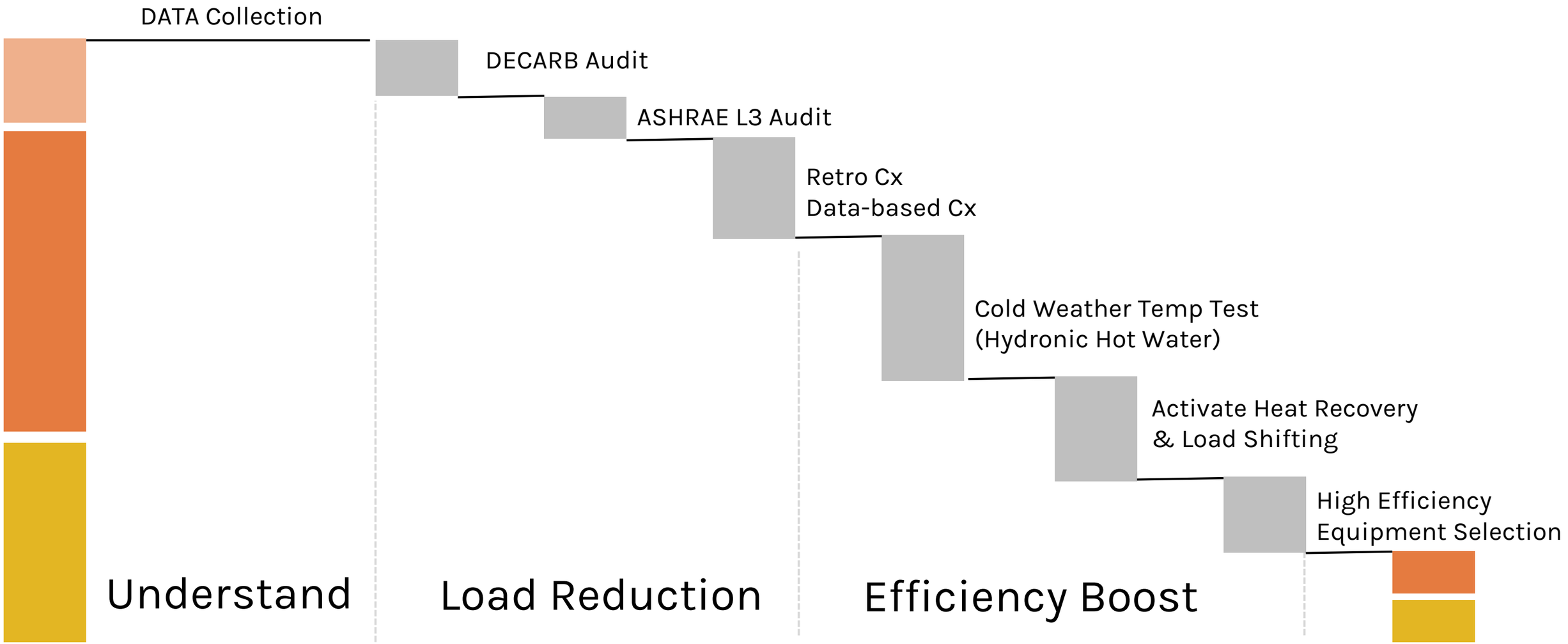
ELECTRIFICATION RETROFIT PROCESS

STACKING ORDER FOR A COST-EFFECTIVE DESIGN



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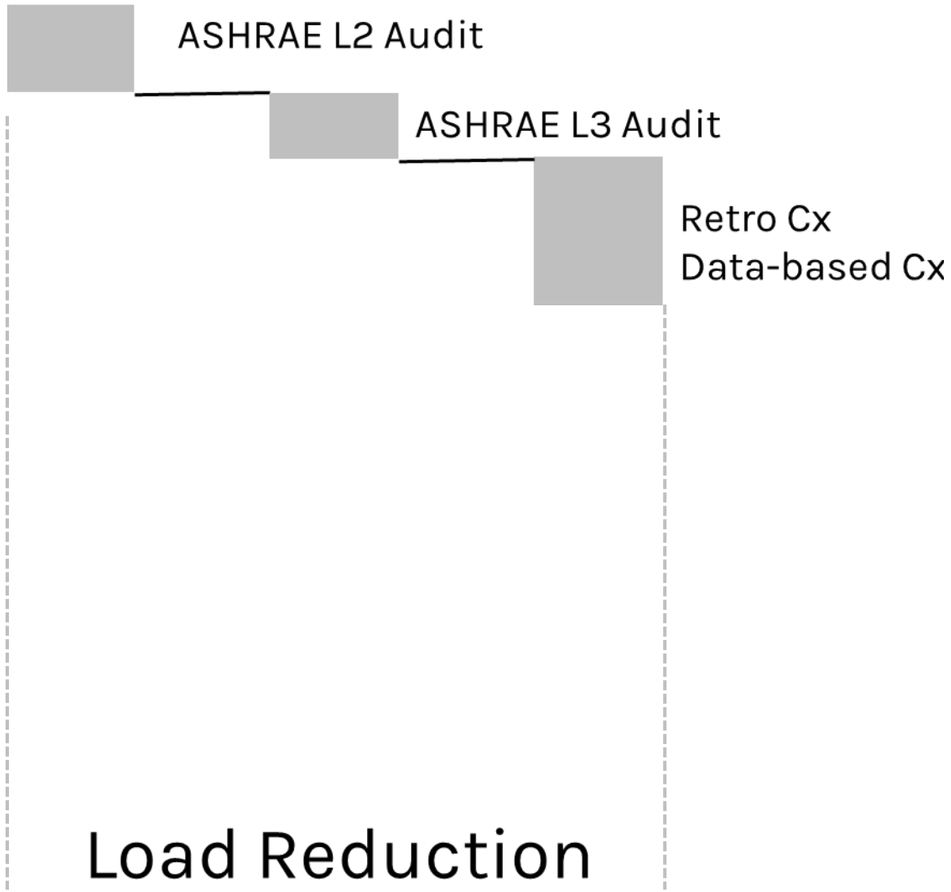

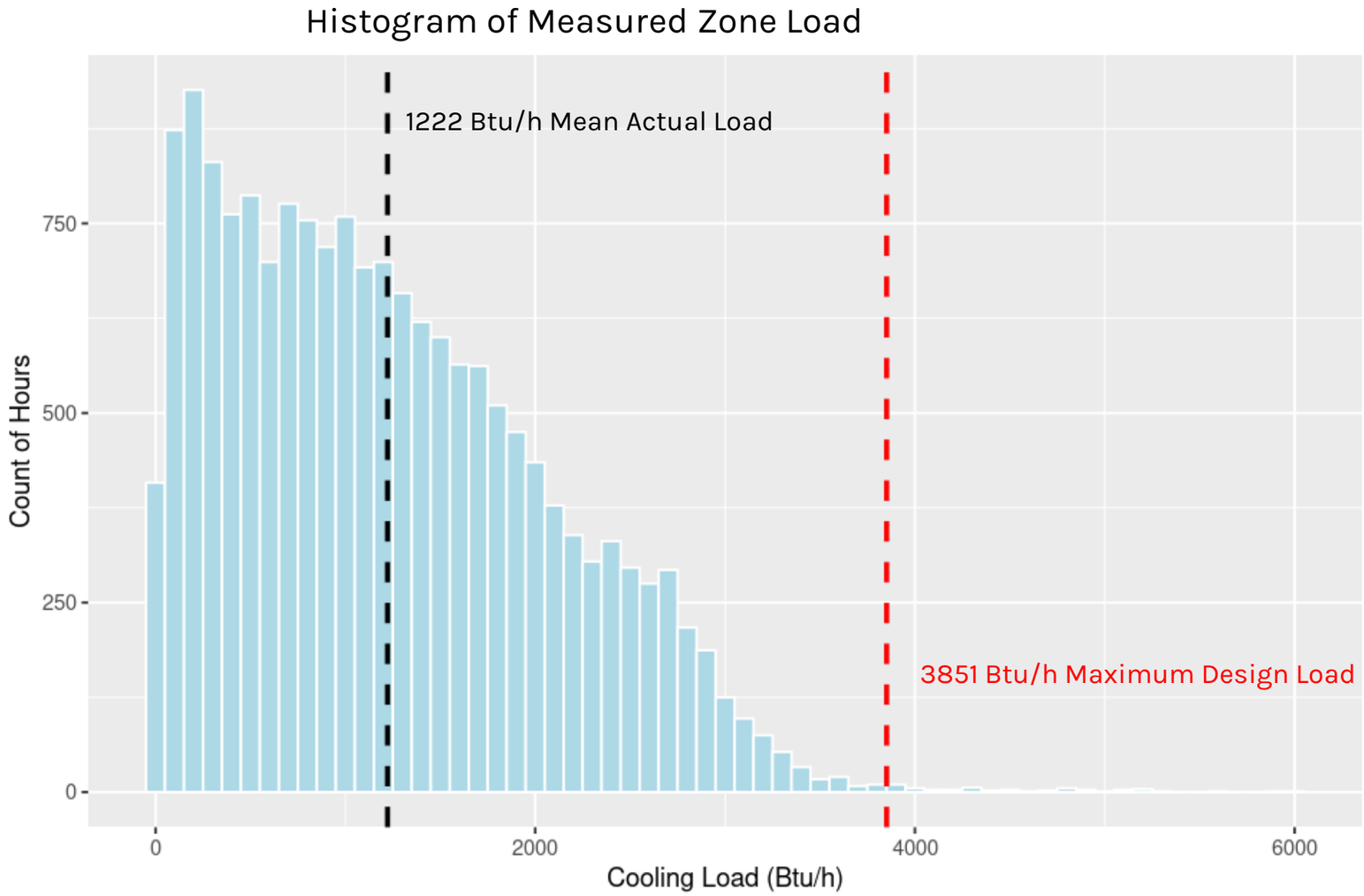

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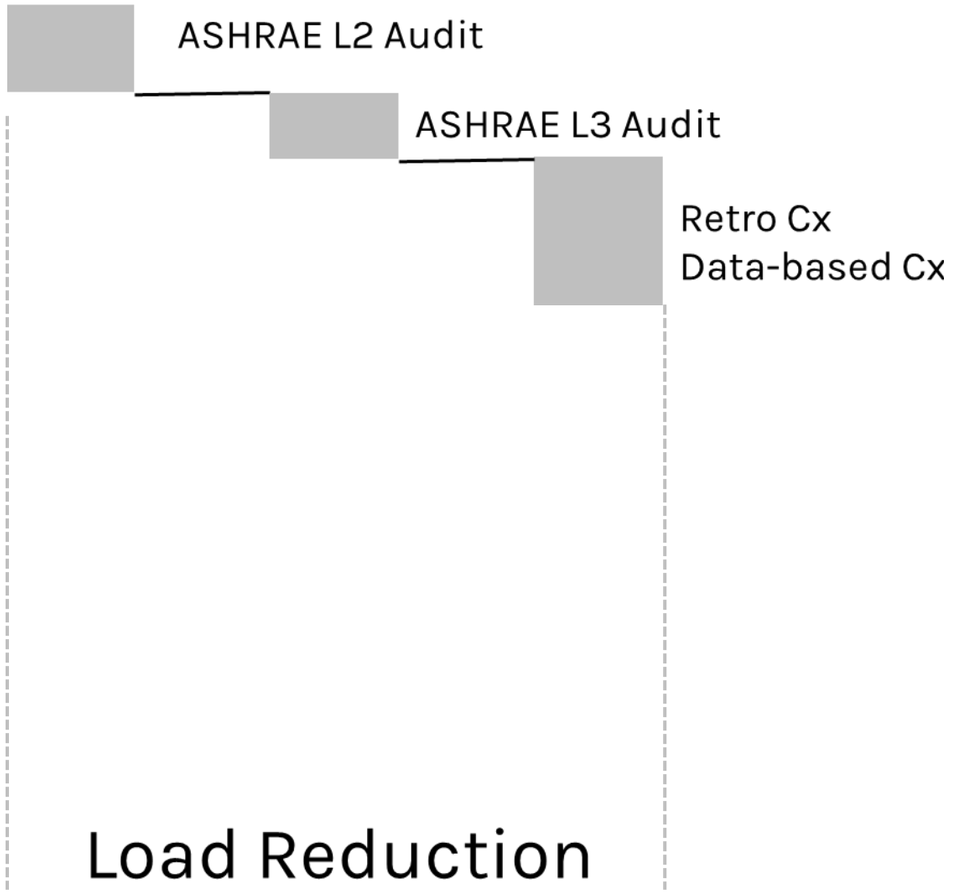
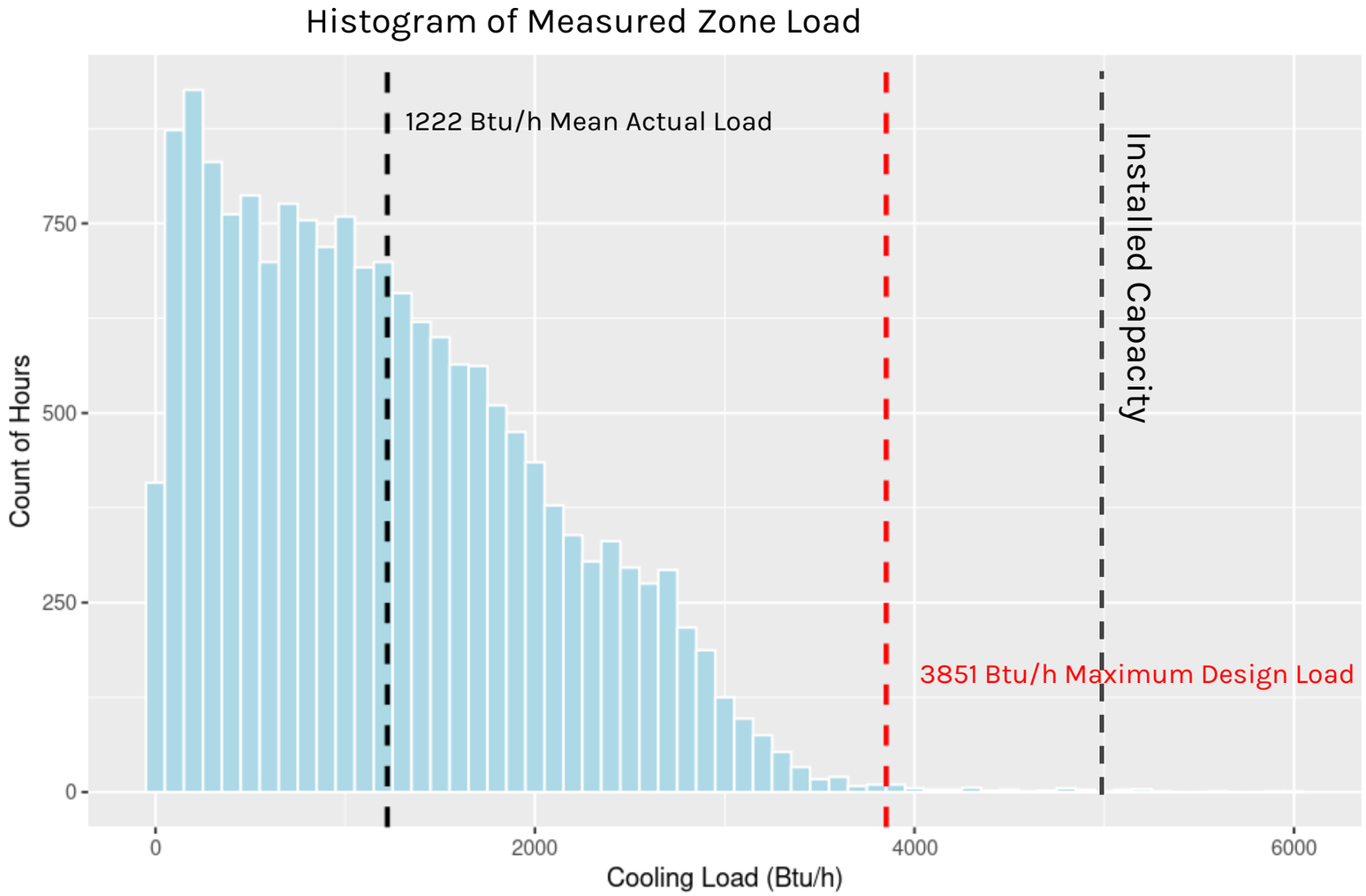
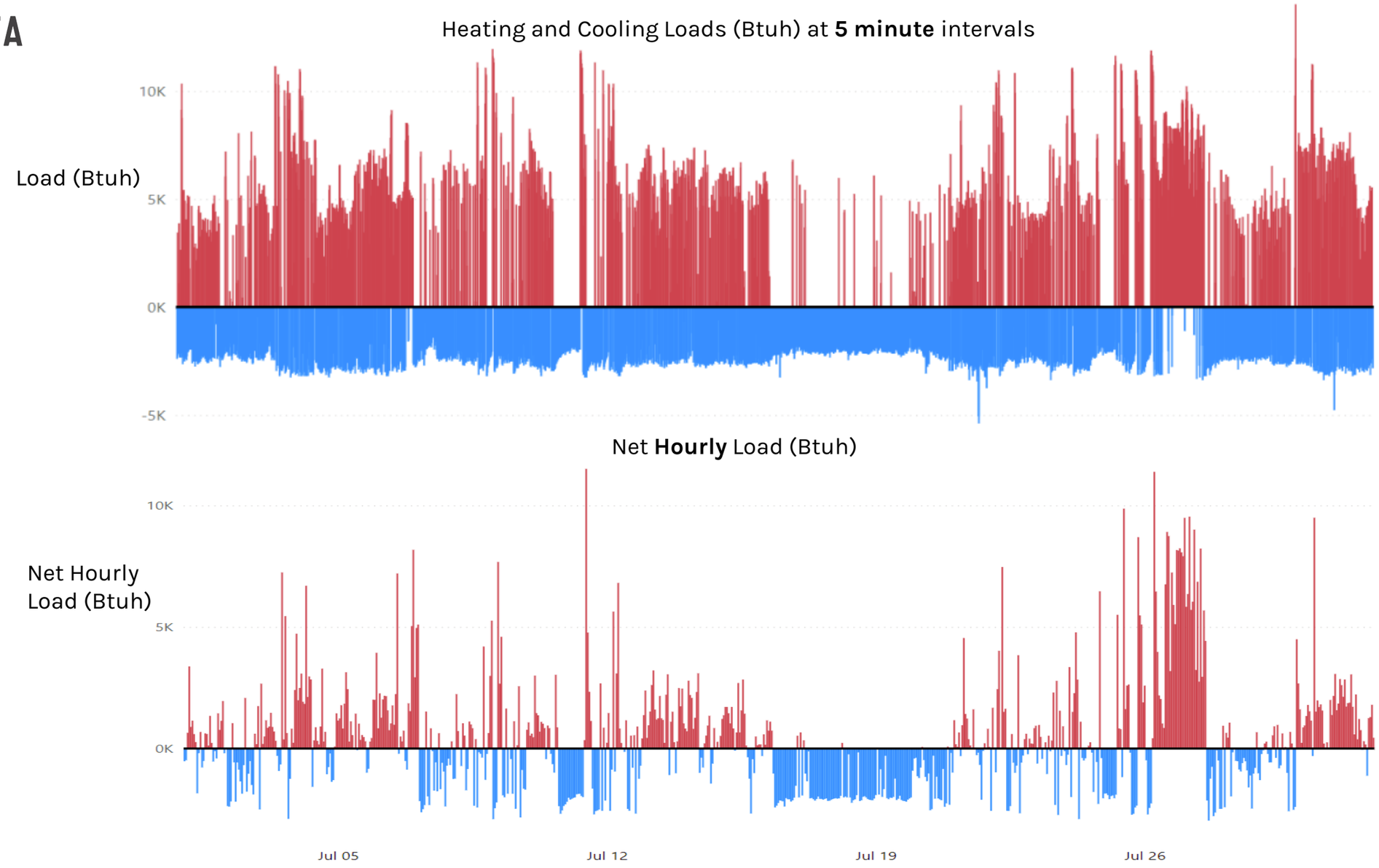




ELECTRIFICATION RETROFIT PROCESS

AGGREGATE SENSOR DATA

- Comparison of a single Zone in July 2020
- Aggregating data from 5 minute intervals to hourly smooths Load



ELECTRIFICATION RETROFIT PROCESS

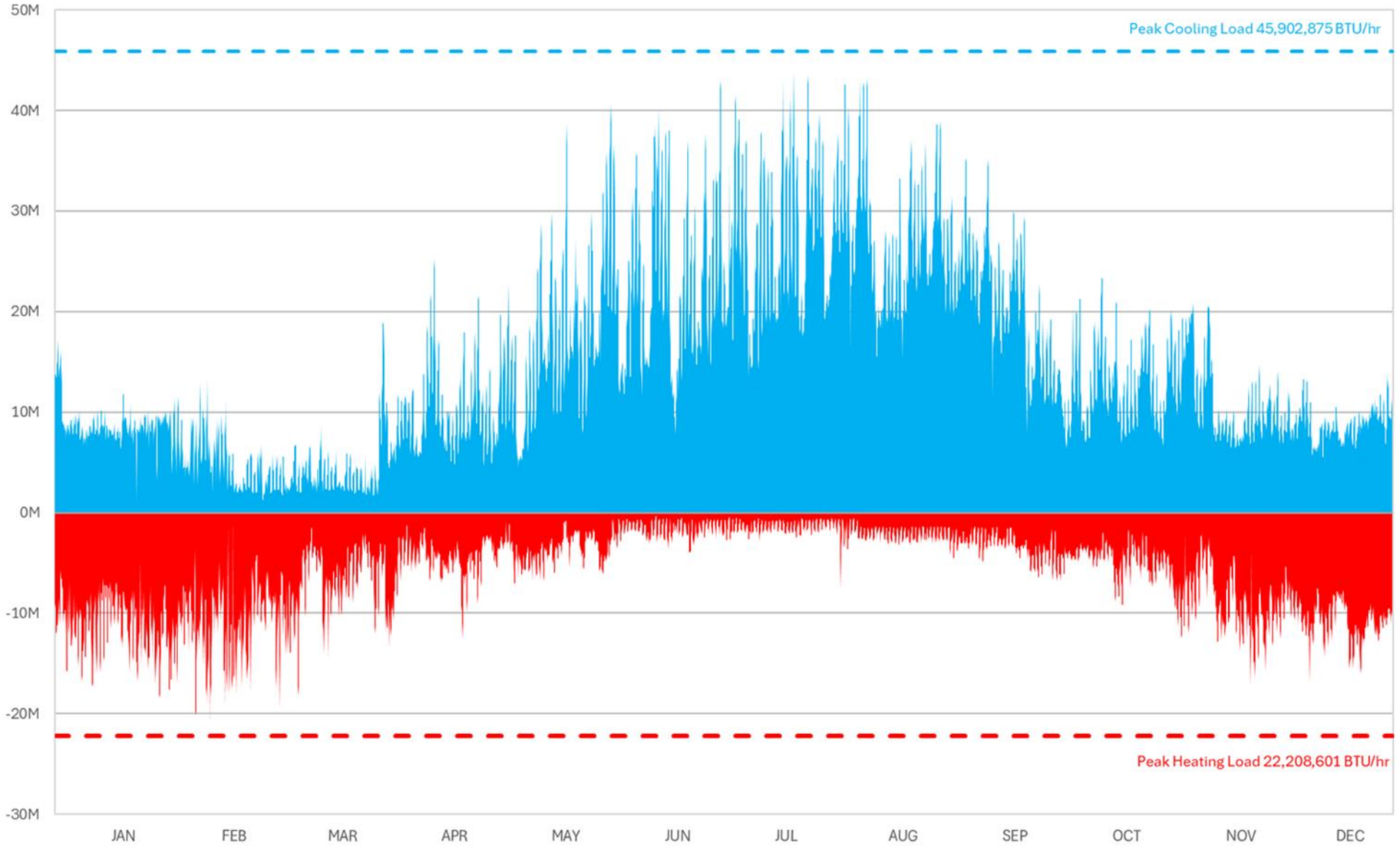
STACKING ORDER FOR A COST-EFFECTIVE DESIGN

DATA Collection

Trend Data

- Hourly Heating Loads
- Hourly Cooling Loads
- Hourly Steam Loads (if applicable)
- Building Level Electrical Demand
- Panel Level Electrical Demand

Understand



KNOW YOUR LIMITS

A PANEL STUDY MAY SAVE YOU AN UPGRADE

DATA Collection

Trend Data

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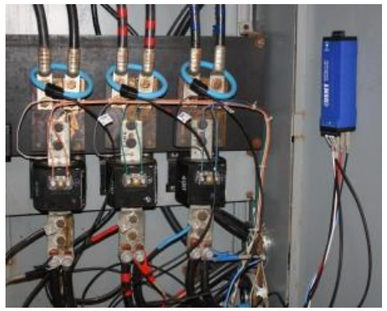


The **NEC Code 220.87 Determining Existing Loads** specifies that the calculation of a feeder or service load for existing installations shall be permitted to use actual maximum demand to determine the existing load under all of the following conditions:

- The maximum demand data is available for a 1-year period.
- The maximum demand at 125% plus the new load does not exceed the ampacity of the feeder or rating of the service.
- The feeder has overcurrent protection in accordance with 240.4, and the service has overload protection in accordance with 230.90.

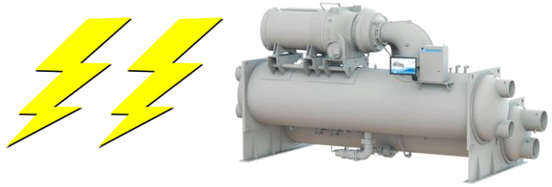
If the maximum demand data for a 1-year period is not available, the calculated load shall be permitted to be based on the maximum demand (measure of average power demand over a 15-minute period) continuously recorded over a minimum 30-day period. This 30-day period is to be measured using a recording ammeter or power meter connected to the highest loaded phase of the feeder or service, based on the initial loading at the start of the recording.

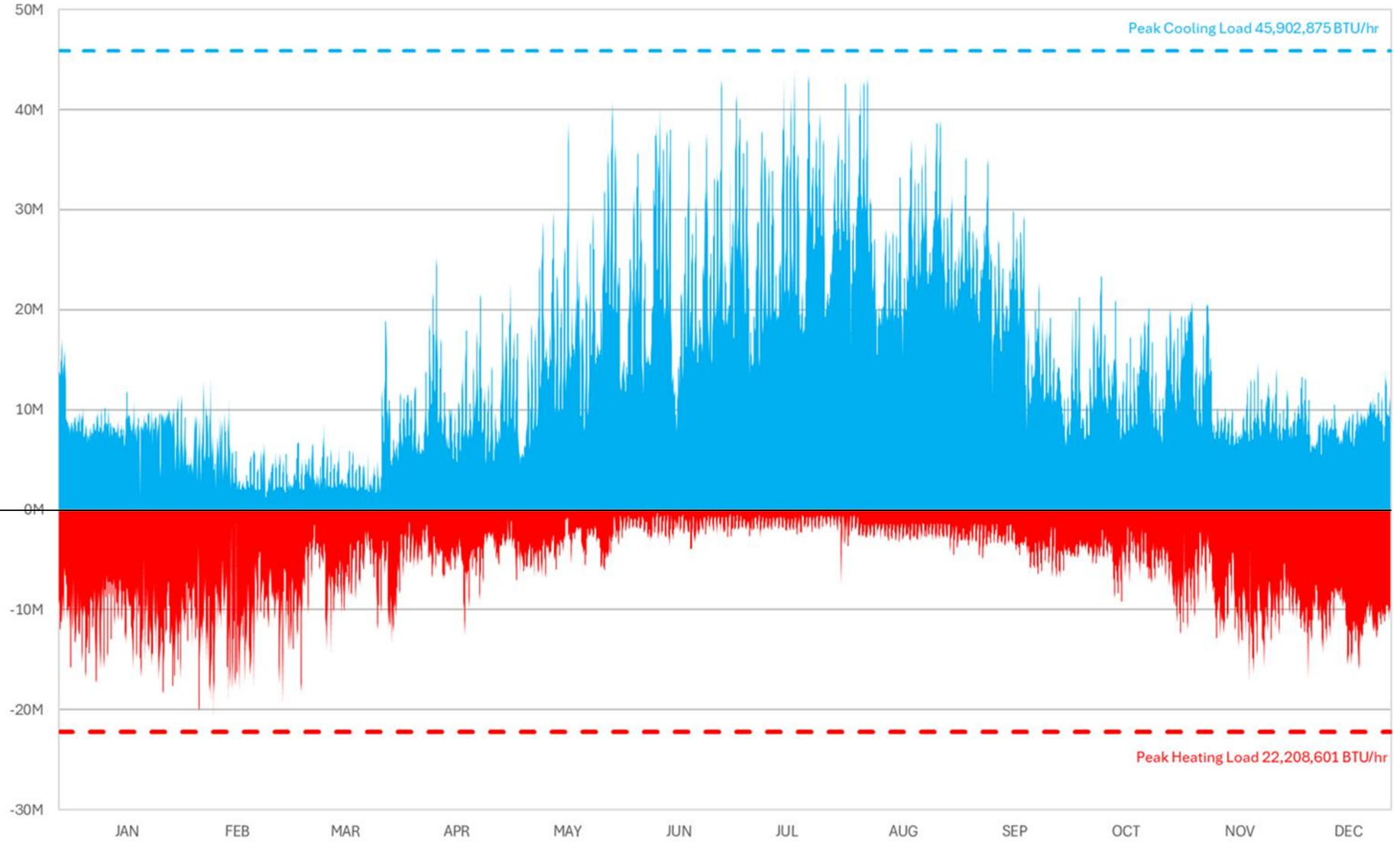
The recording shall reflect the maximum demand of the feeder or service by being taken when the building or space is occupied and shall include by measurement or calculation the larger of the heating or cooling equipment load, and other loads that may be periodic in nature due to seasonal or similar conditions.

DESIGN STRATEGIES

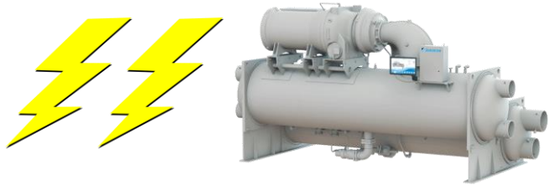
DESIGN TOWARDS REDUCING YOUR CONNECTED ELECTRICAL LOAD

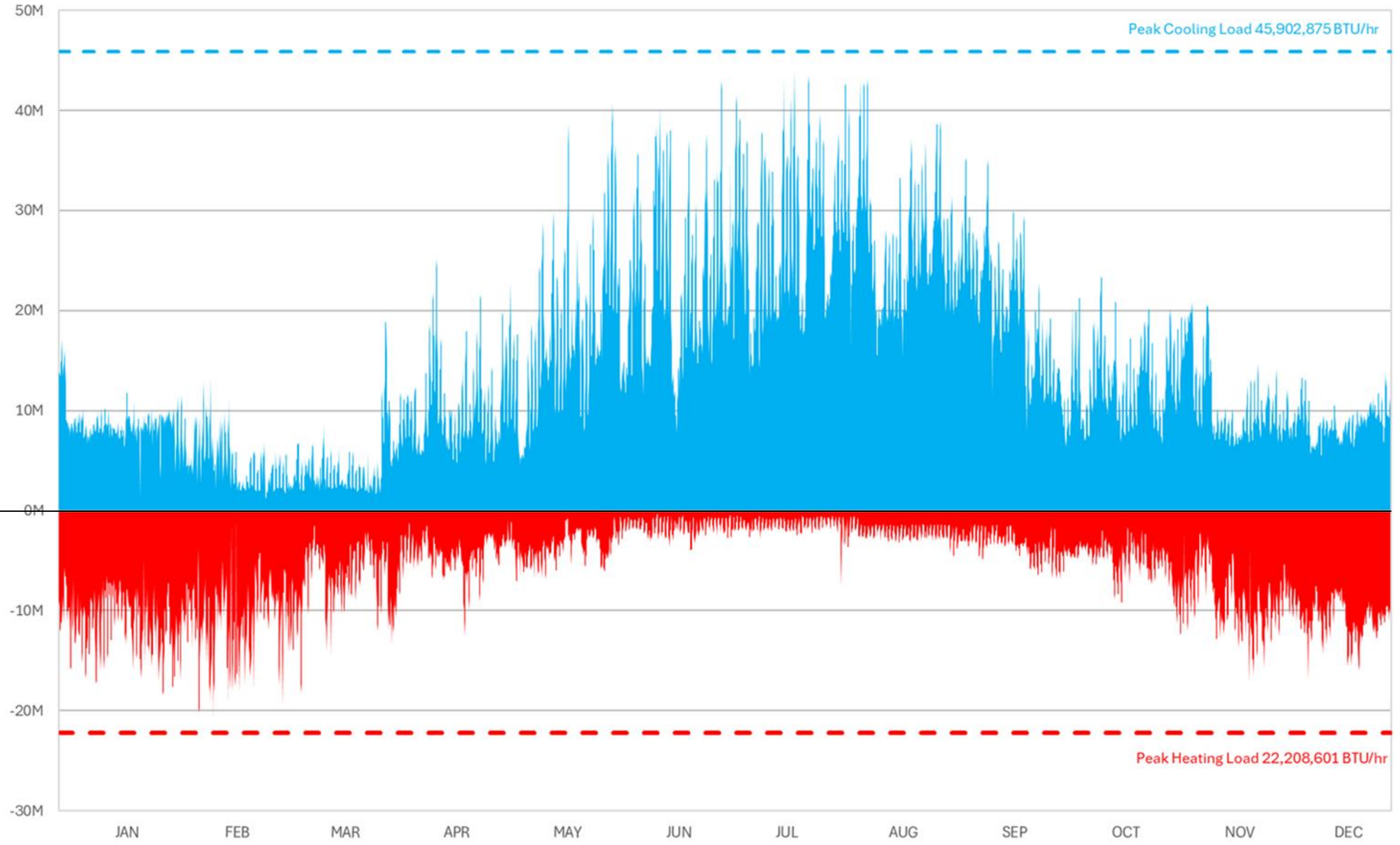
Designing to a Capacity Limit





Question: How Much of My Heating Need Could be Provided by Heat Recovery?





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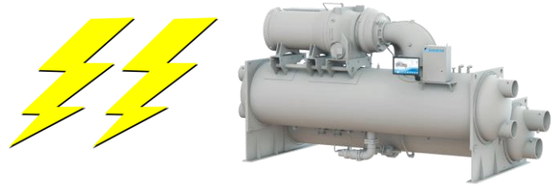

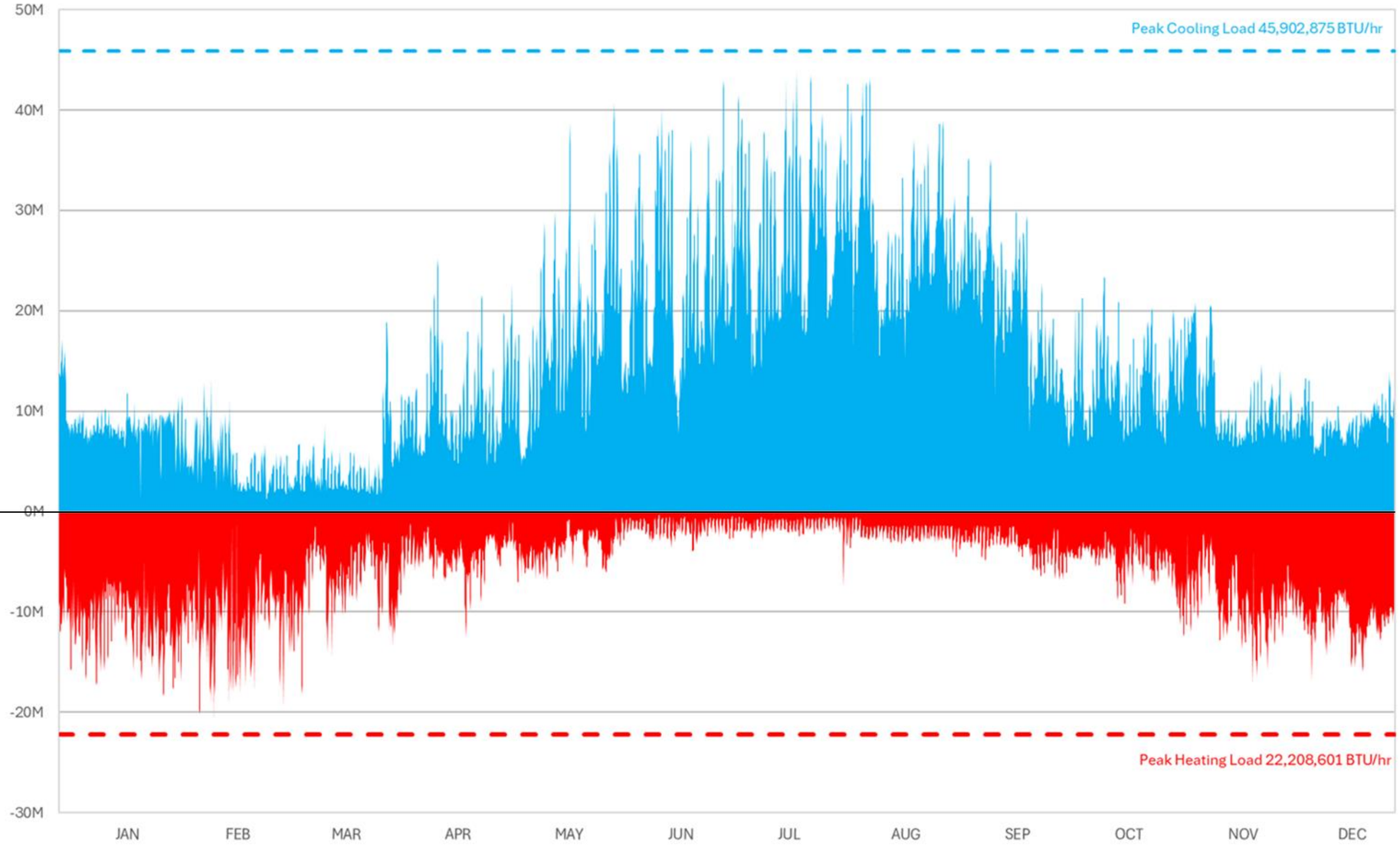

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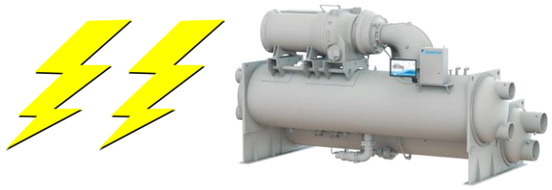
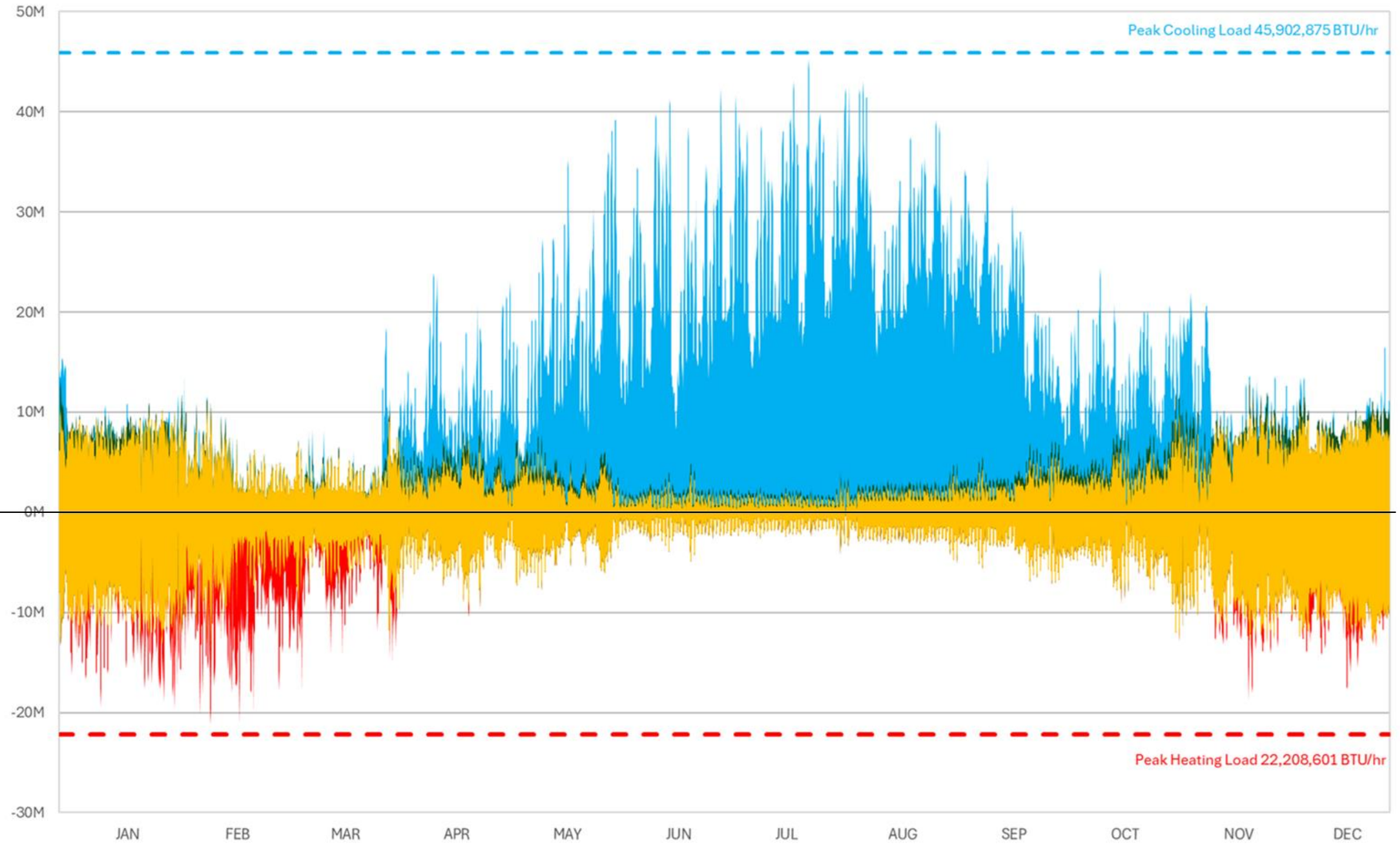
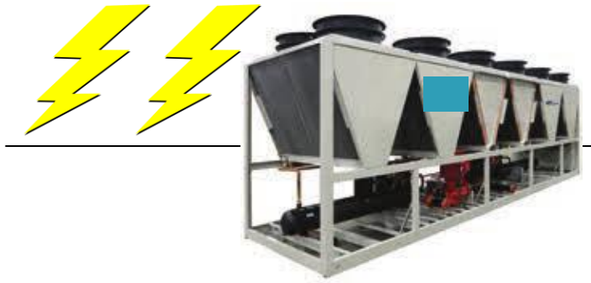
Heat Recovery Chiller

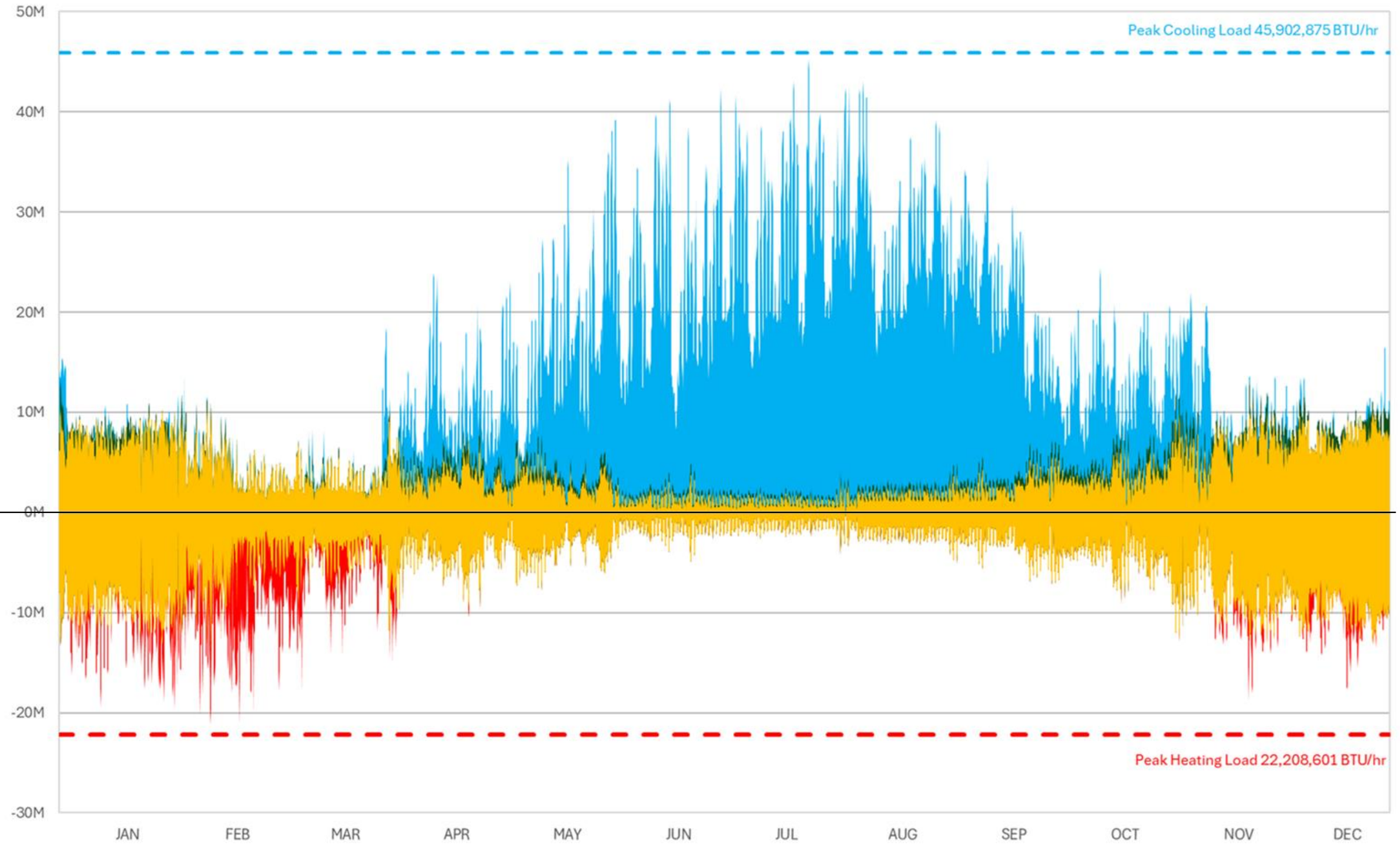




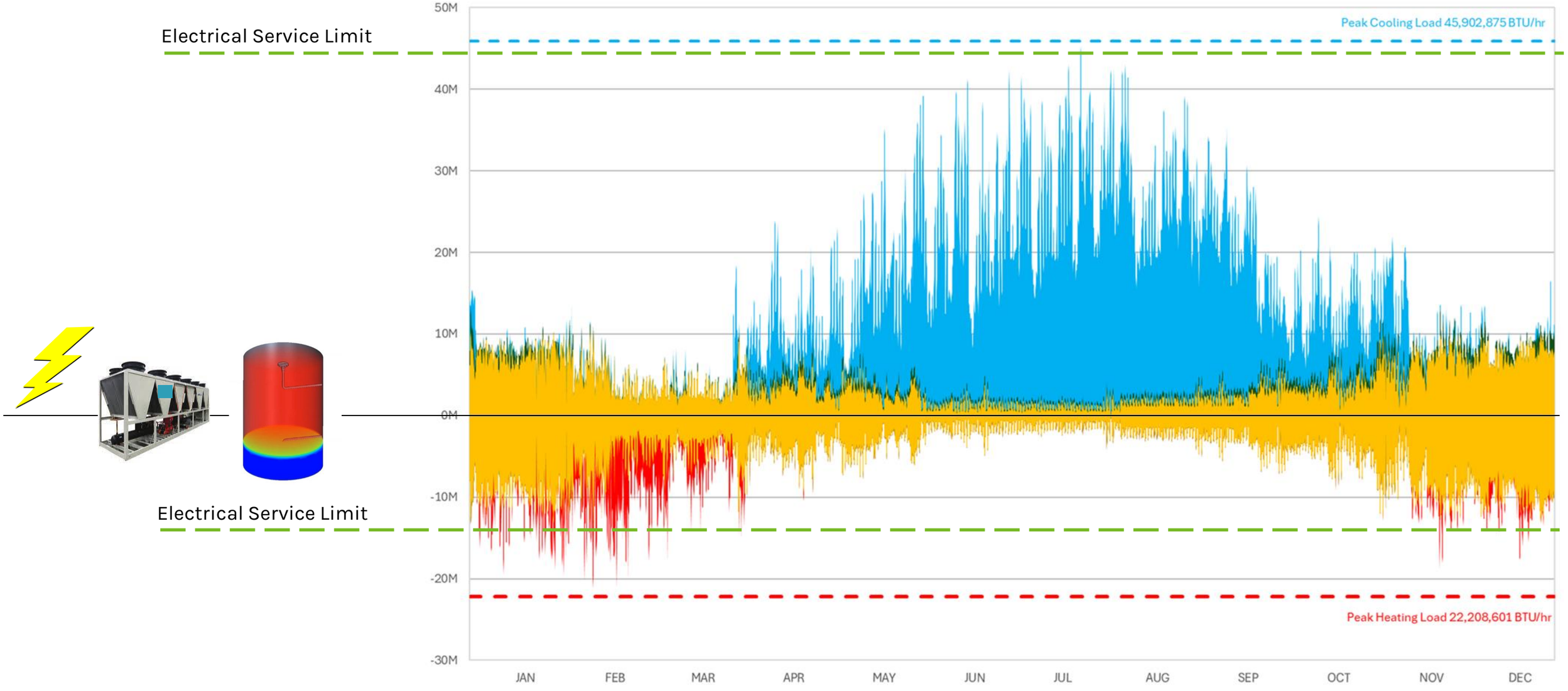
Question: How Much of My Heating Need Could be Provided by Heat Recovery?

4-Pipe Heat Recovery
Heat pump



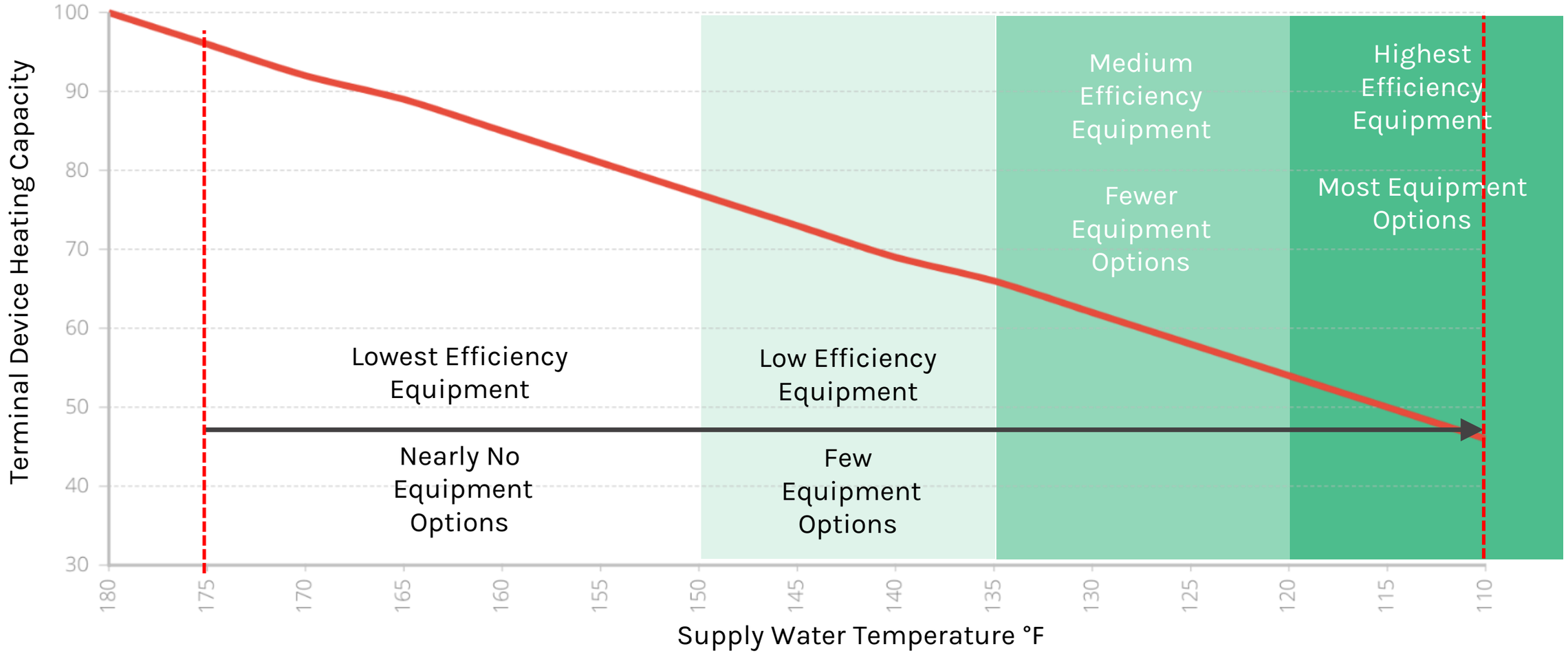


Still have capacity issues?? Add Storage!



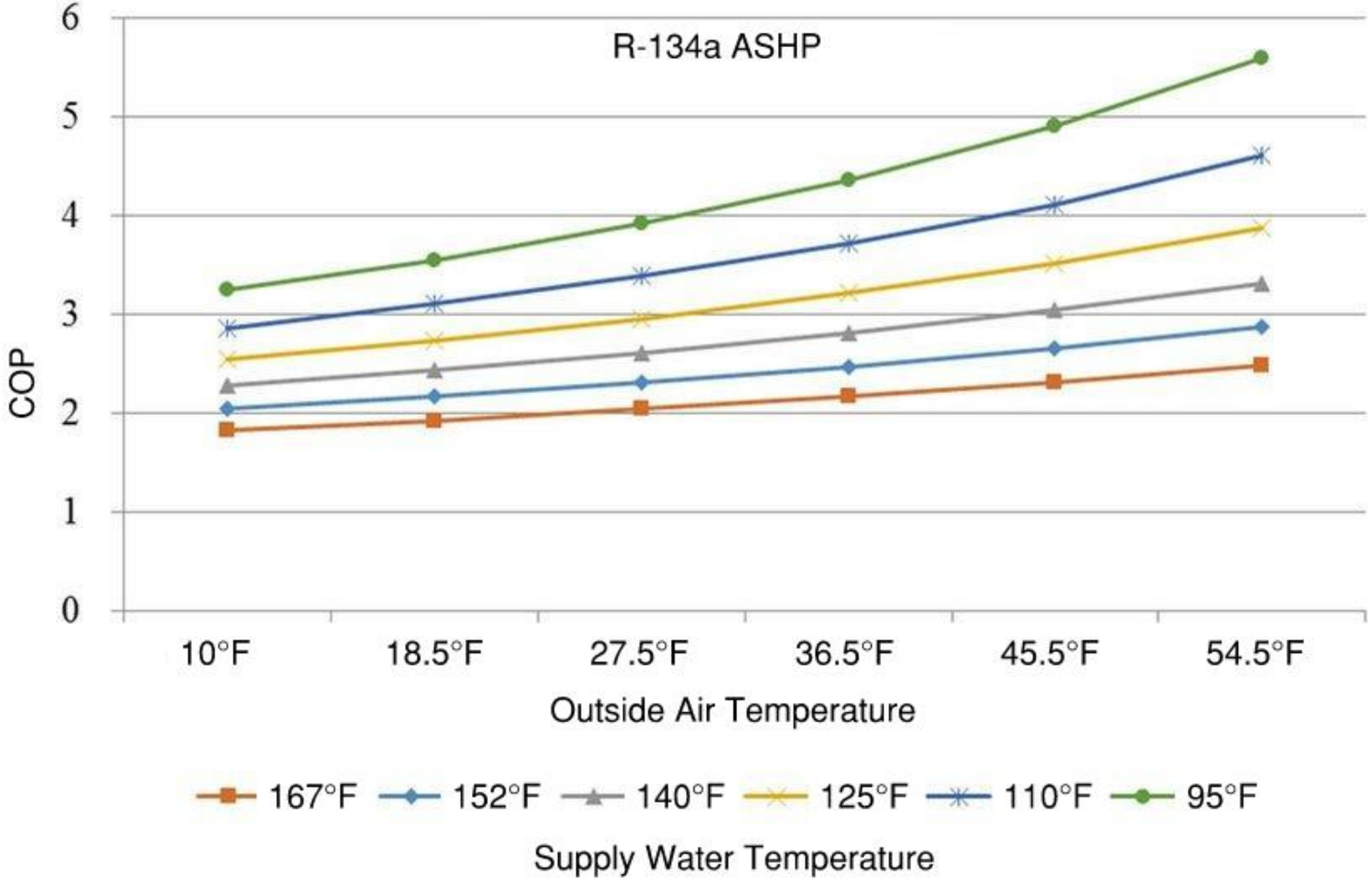
STRESS TEST YOUR SYSTEM

REIMAGING HHWS TEMPERATURE REGIMES



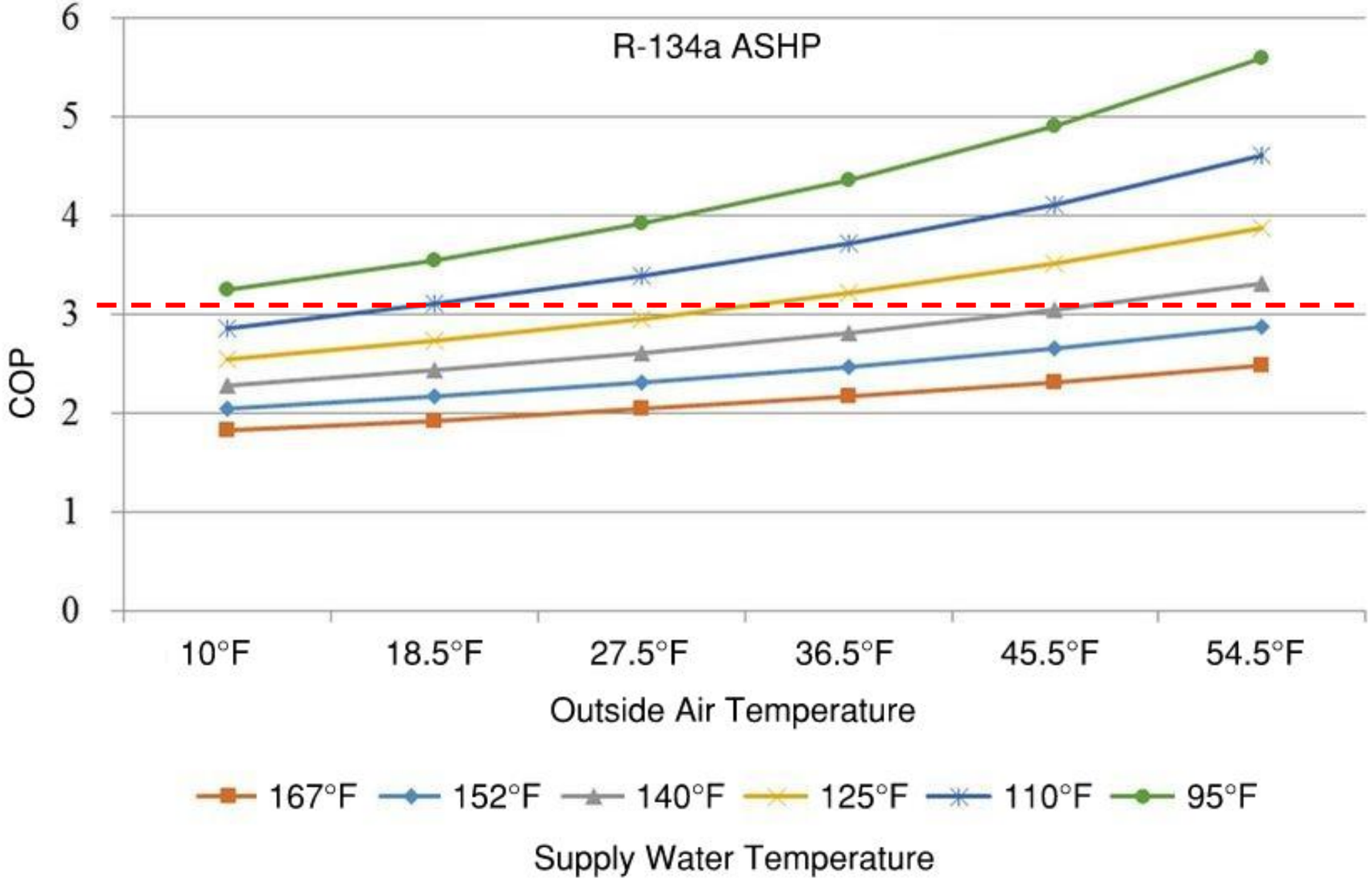
DISTRIBUTION TEMPS→ COP → CONNECTED LOAD

WHERE DO YOU START AND HOW TO ACHIEVE REDUCTIONS



DISTRIBUTION TEMPS→ COP → CONNECTED LOAD

WHERE DO YOU START AND HOW TO ACHIEVE REDUCTIONS



NOT ALL HEAT PUMPS ARE CREATED EQUAL

DESIGN TOWARDS REDUCING YOUR CONNECTED ELECTRICAL LOAD

SERVICE HOT WATER RETROFITS

WHY CO2 HEAT PUMPS AND POOP MAY BE YOUR BEST FRIEND

- Mixed Use – Ground Floor Commercial
- 100x 1-Bedroom
- 100x 2-Bedroom

- ASPE
  - Peak: 1,433 gph for 3 hours
  - Off-peak: 158 gph for 8 hours

SERVICE HOT WATER RETROFITS

WHY CO2 HEAT PUMPS AND POOP MAY BE YOUR BEST FRIEND

- Mixed Use – Ground Floor Commercial
- 100x 1-Bedroom
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- ASPE
  - Peak: 1,433 gph for 3 hours
  - Off-peak: 158 gph for 8 hours

4 Air-Source R-134a Heat Pumps
4 x 70 A CB @ 480v
176 KVA
COP ~<2 @ 5F OAT
COP: 4.1 @ 40F OAT

2,750 Gallons of Storage
(@ 140F)

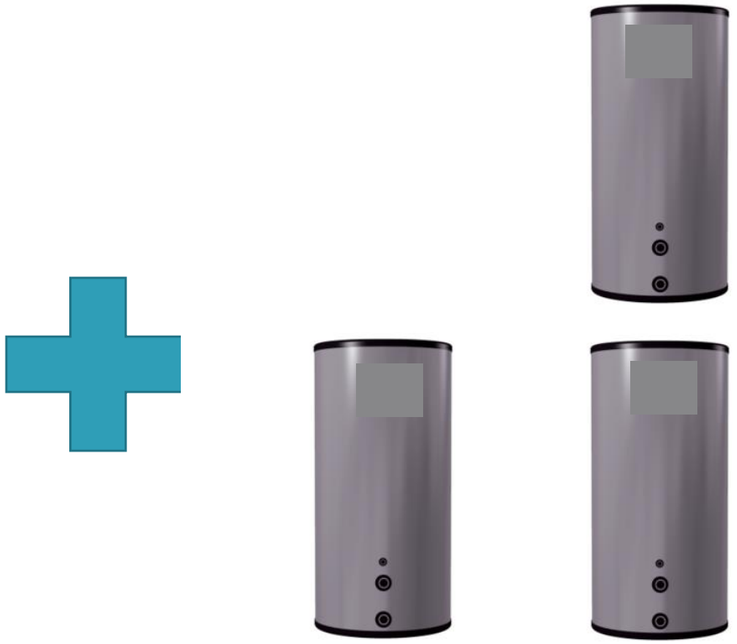
SERVICE HOT WATER RETROFITS

WHY CO2 HEAT PUMPS AND POOP MAY BE YOUR BEST FRIEND

- Mixed Use – Ground Floor Commercial
- 100x 1-Bedroom
- 100x 2-Bedroom

- ASPE
  - Peak: 1,433 gph for 3 hours
  - Off-peak: 158 gph for 8 hours

2 x C02 Heat (R744)
2x 125A CB at 480v
138KVA
COP 2.2 at 5F OAT
COP 3 at 40 F OAT



1,500 Gallons of Storage
(@ 180F)

SERVICE HOT WATER RETROFITS

WHY CO2 HEAT PUMPS AND POOP MAY BE YOUR BEST FRIEND

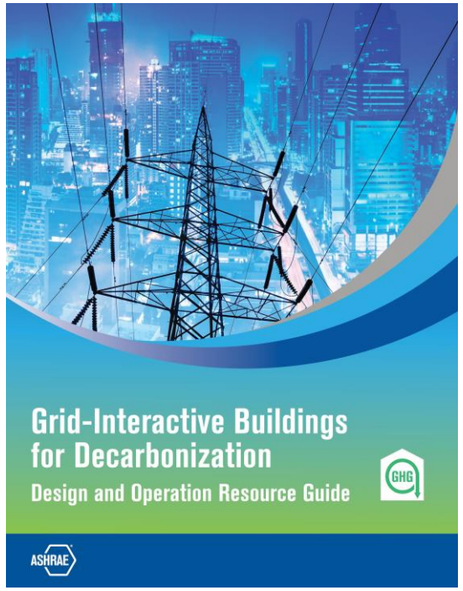
- Mixed Use – Ground Floor Commercial
- 100x 1-Bedroom
- 100x 2-Bedroom

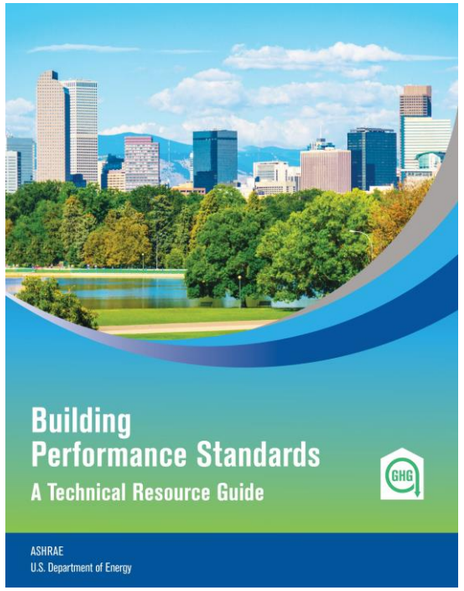
- ASPE
  - Peak: 1,433 gph for 3 hours
  - Off-peak: 158 gph for 8 hours

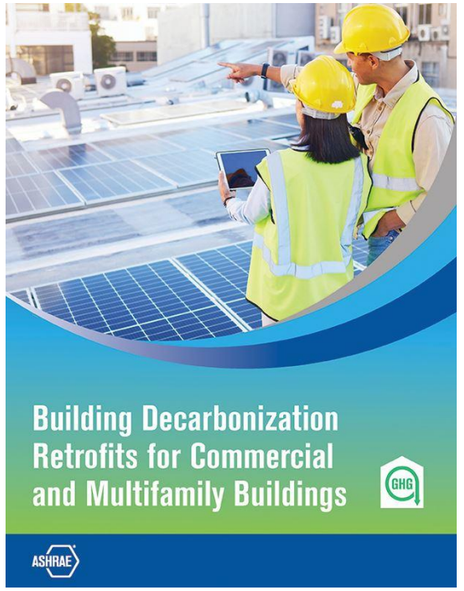
2 x Waste Heat Recovery Heat Pump (R-513a)
2x 110A CB @ 480v
88 kVA
COP 4.1

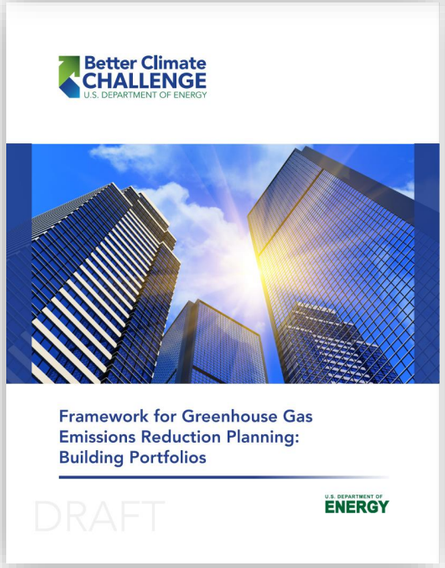
2,750 Gallons of Storage (@ 140F) + ~2,250 Gal Waste Storage Below Grade

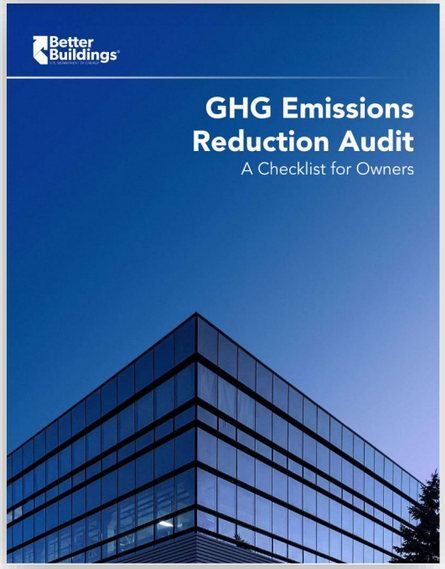
RESOURCES: YOU'RE NOT ALONE!!

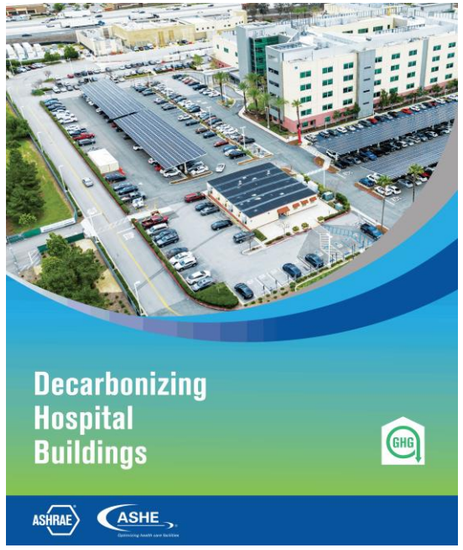












www.ashrae.org/about/cebd-technical-resources

Q & A and closing

- **Questions?**
  - Stet Sanborn Stet.Sanborn@smithgroup.com
  - City Light Energy Advisors SCLEnergyAdvisor@seattle.gov, 206-684-3800
  - Lighting Design Lab lightingdesignlab@seattle.gov
- **Take the survey!**

THANK YOU

lighting® design lab

Seattle City Light

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