Successfully Electrifying Sensible Cooling Systems

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Electrifying a Commercial HVAC System

Electrify…?

Go all-electric & reduce site energy & reduce source operational carbon emissions – CO_2e

What System?

All Hydronic Heat & Cool System for comfort and building conditioning

What Hydronic System?

CoolSense™ System – DOAS with Sensible-Cooling Terminals

This seminar assumes you know what a CoolSense System is. If you do not, it is not required for the concepts discussed on electrification; you can learn the specifics on the DOAS + terminals HVAC system after learning how to electrify it.

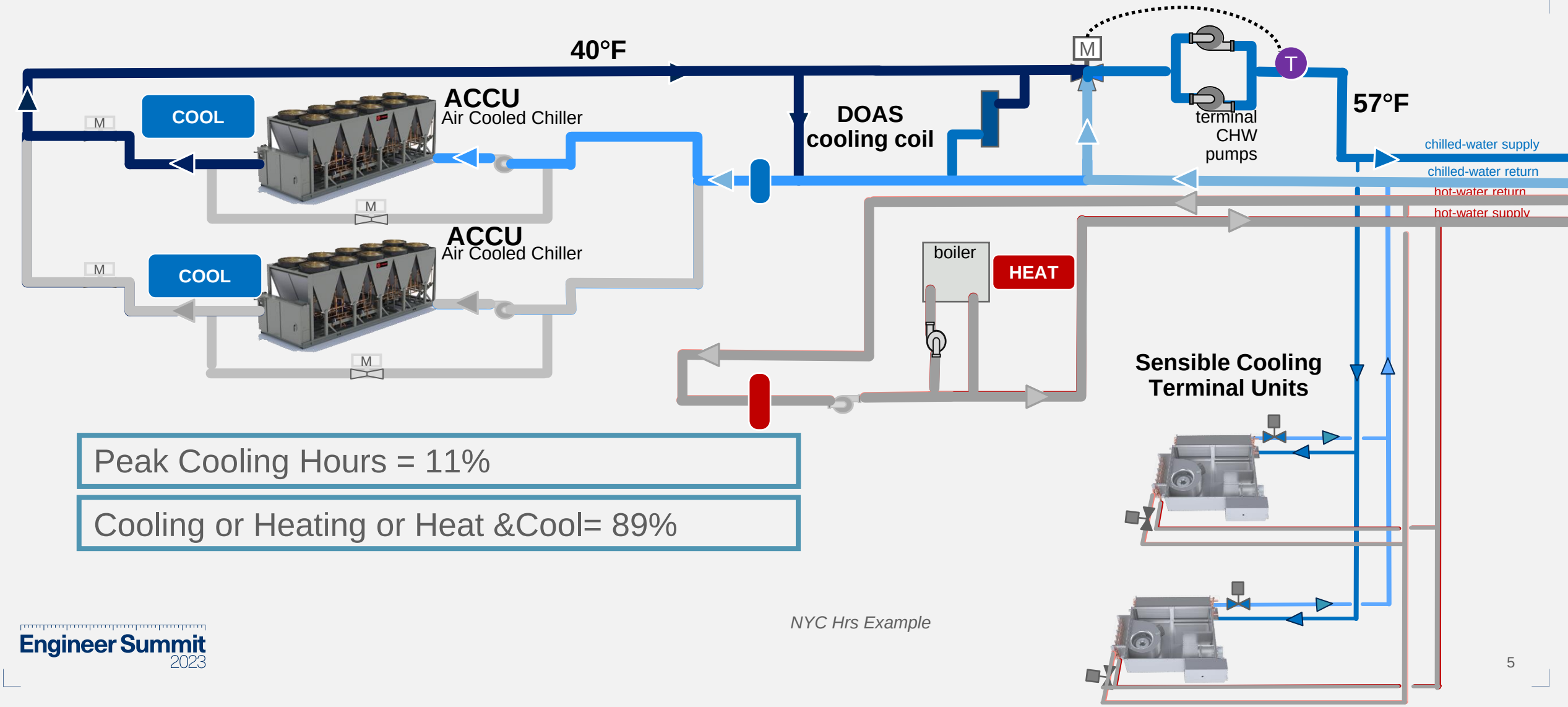
Agenda

- What system are we electrifying?
- Building heating needs and design practices
- Hot water temperature for efficient operation
- Distribution design using switch over terminal units
- Annual CO_2e reduction of three electrified CoolSense Systems
- Using Distribution Area Directors to help with retrofits

What System are we electrifying?

Electrify CoolSense System

Air Cooled Chillers and Boiler(s) Supplying Hot and Cold Water to 4-Pipe Distribution System with Sensible Cooling Terminals



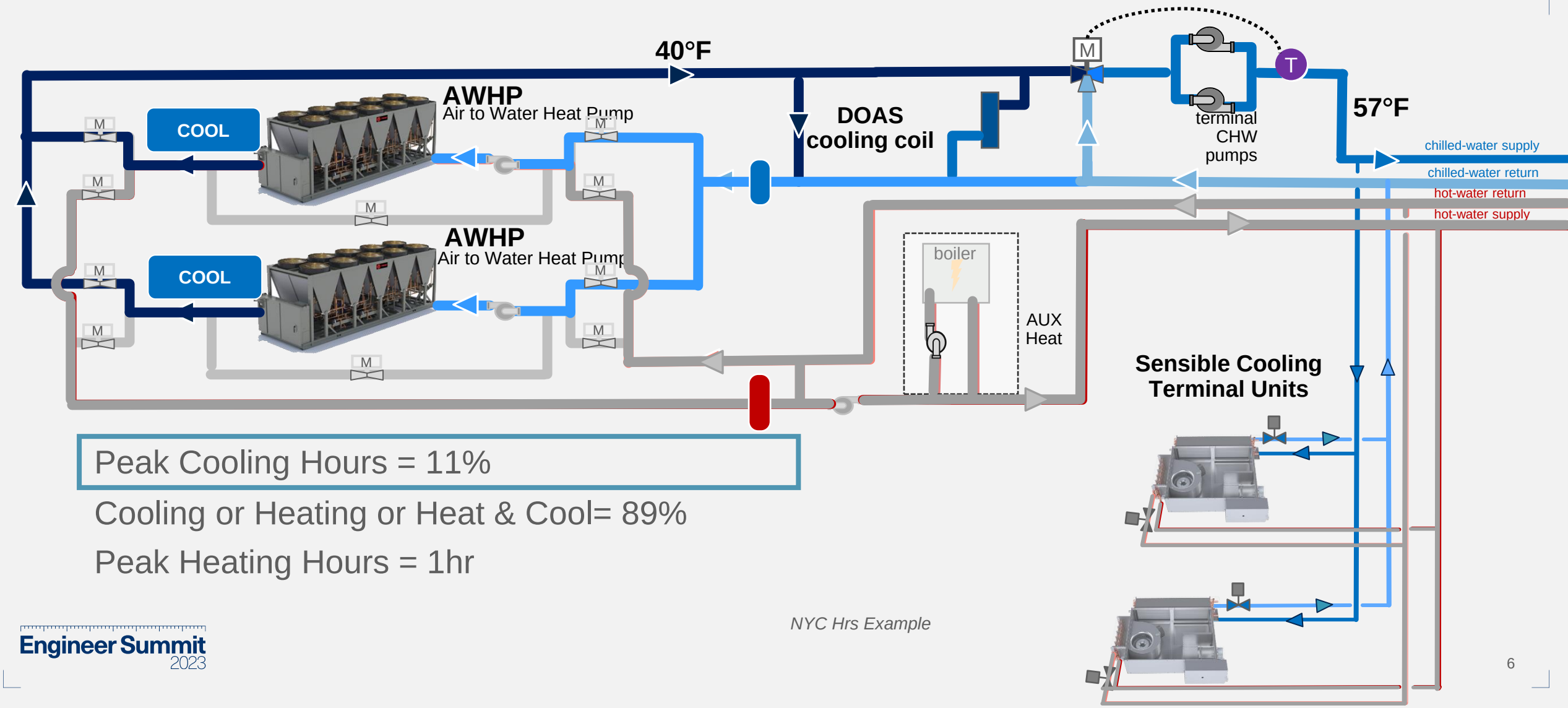
Peak Cooling Hours = 11%

Cooling or Heating or Heat &Cool= 89%

NYC Hrs Example

Electrify CoolSense System

Air to Water Heat Pumps Supplying Hot and Cold Water to 4-Pipe Distribution System with Sensible Cooling Terminals



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Peak Heating Hours = 1hr

NYC Hrs Example

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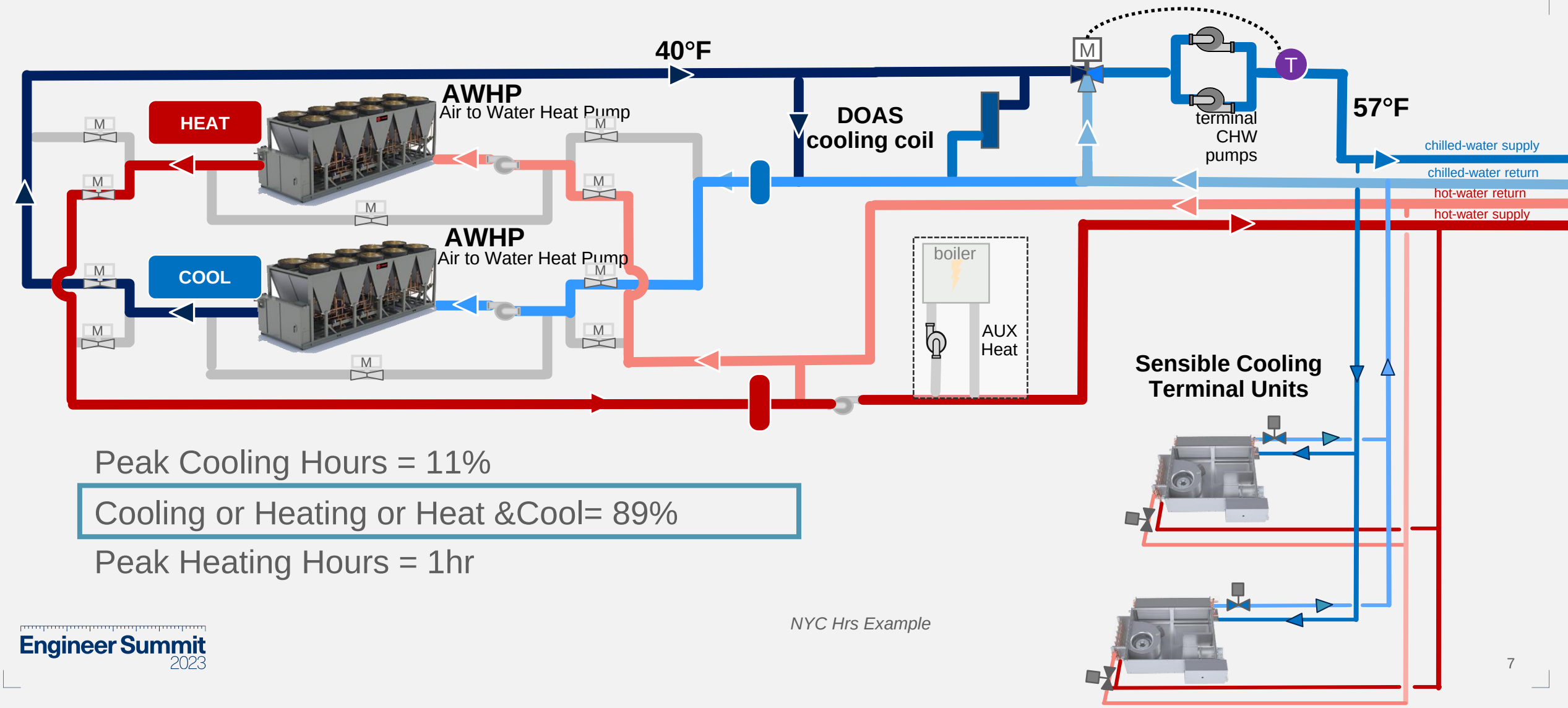

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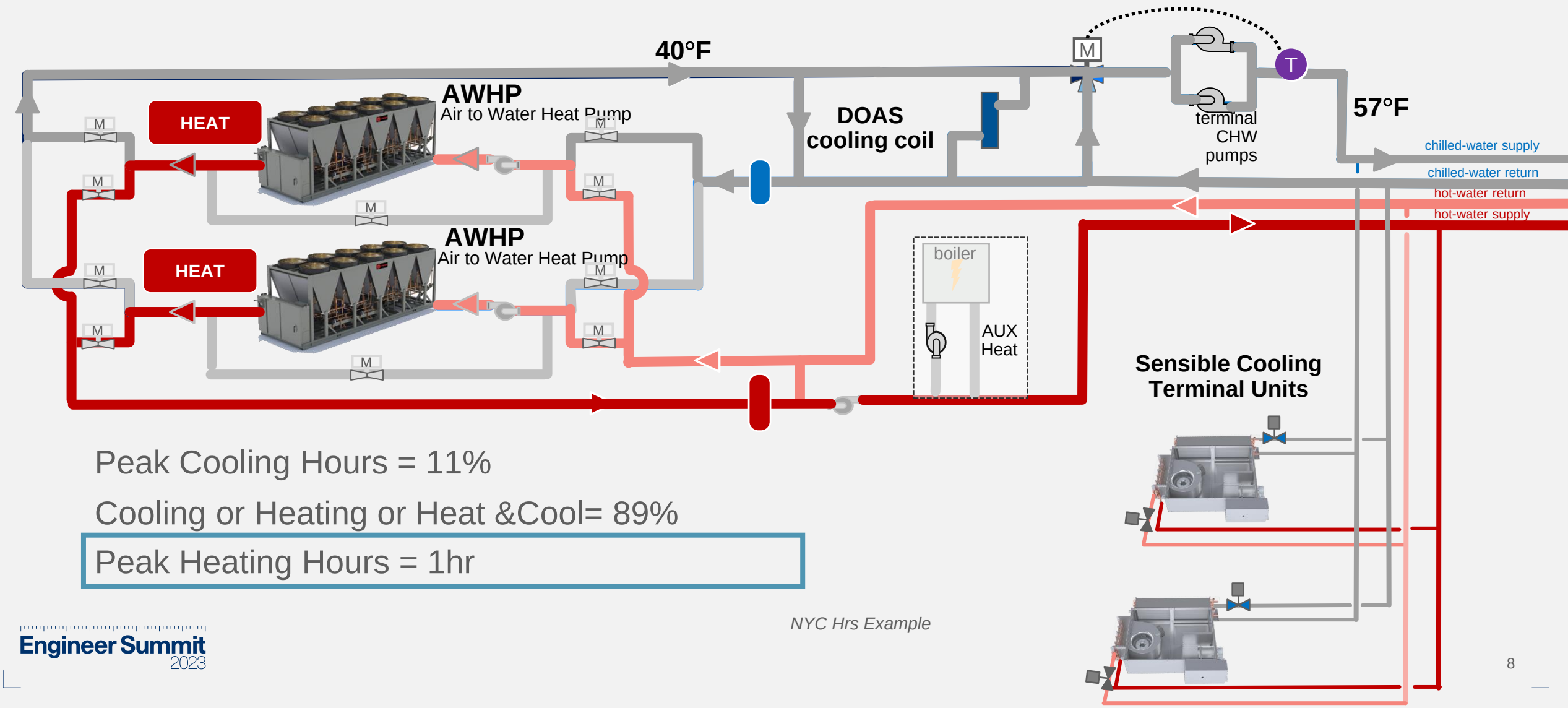

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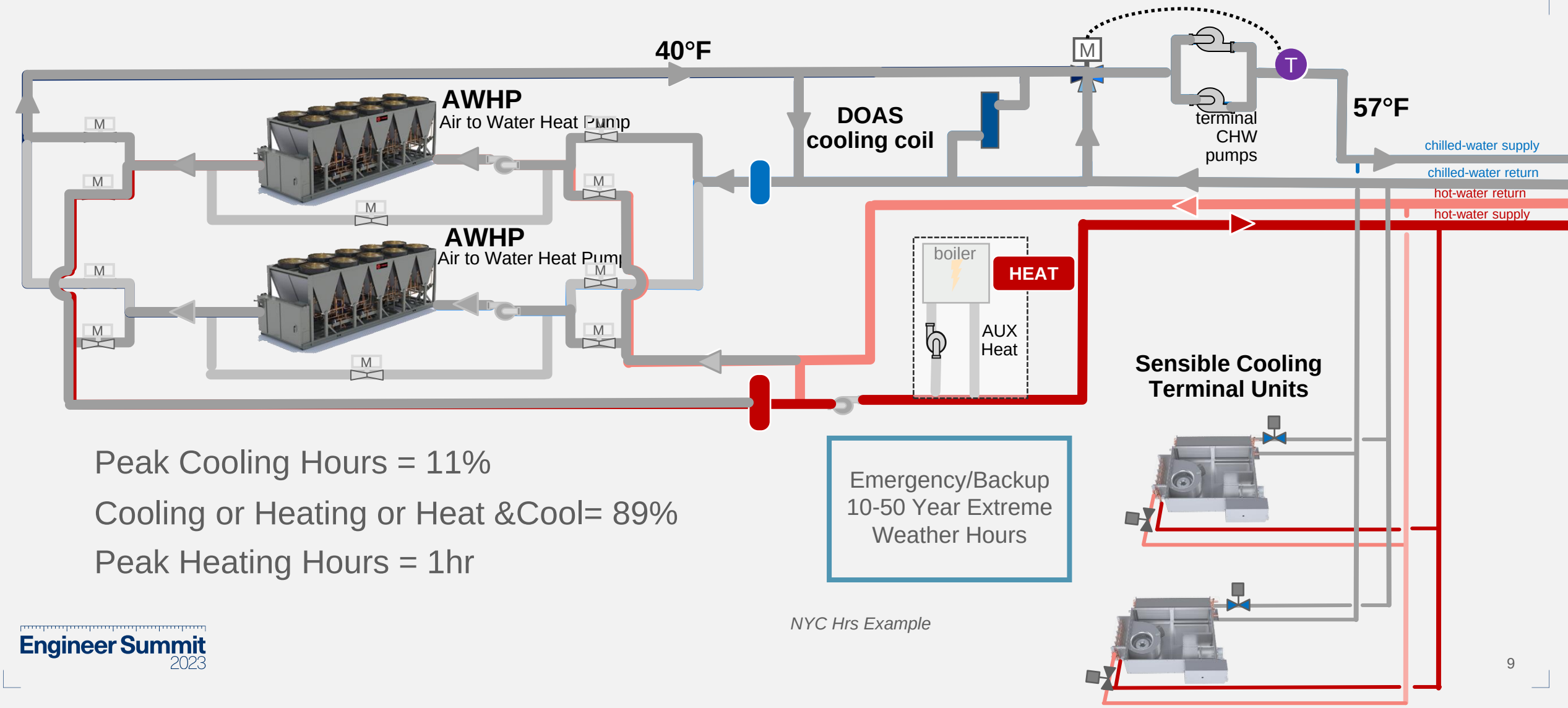


Peak Cooling Hours = 11%

Cooling or Heating or Heat &Cool= 89%

Peak Heating Hours = 1hr

Emergency/Backup
10-50 Year Extreme
Weather Hours

NYC Hrs Example

Electrify Successfully

Peak Building Heating Load < Plant Capacity < Terminal Capacity

Building Design Peak Heating Load vs. Cooling Load

Oversized Terminal Heating Capacity

Design Oversized Plant Heating Capacity

Electrify CoolSense System

Minimize Impact: Understand Terminal Unit Sizing

- Heat Sizing Practices
  - Overwhelming design practice of engineers is to oversize fan terminal unit heating capacity on rules of thumb
  - Scheduled terminal heating capacity on scheduled is rarely zone load

What Fan Terminal Heating Capacity Scheduled?

Heating Coil Flow = ½ Cooling$_{gpm}$

Heating Coil Flow = 1.0gpm

Heating Coil Lvg Air Temp = 95ºF

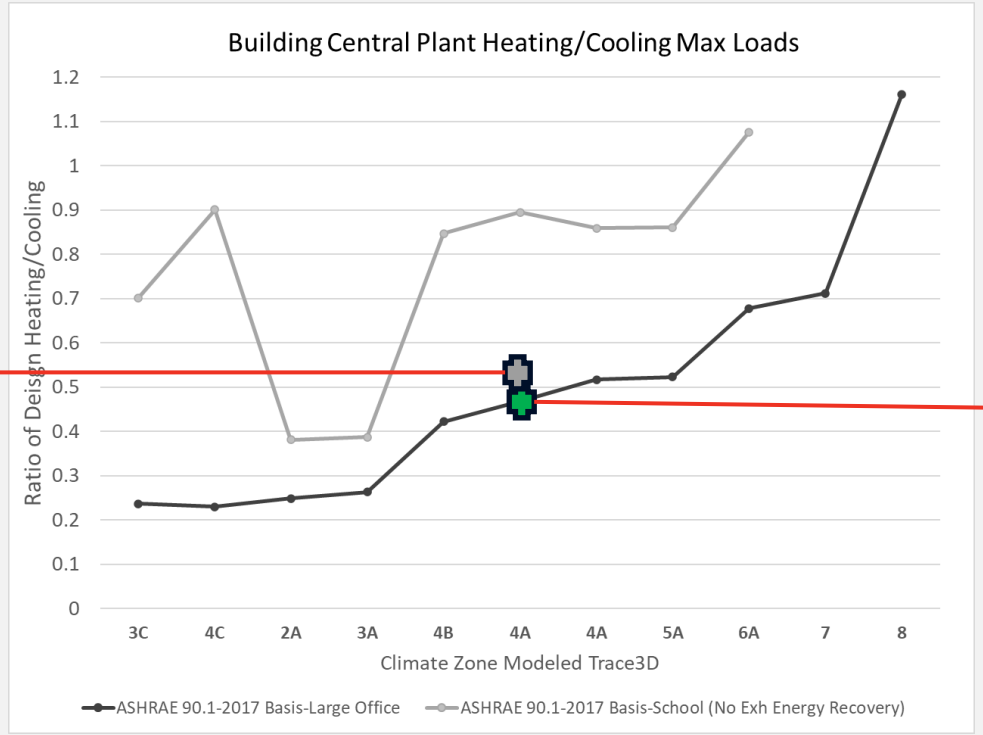
Heating Coil Flow = 0.5gpm, 1.0gpm, 2gpm or…

MAX. PRIMARY AIRFLOW (CFM)	MAX FAN AIRFLOW (CFM)	MIN FAN AIRFLOW (CFM)	EXT. S.P. IN W.C.	PRIMARY ENTERING AIR DB °F	COOLING COIL					HEATING COIL				
					SENSIBLE MBH	GPM	EWT °F	LWT °F	W.P.D. FT. HD	TOTAL MBH	GPM	EWT °F	LWT °F	W.P.D. FT. HD
120	700	120	0.25	54.0	9	1.7	57	67.5	0.93	???	1.0	140		

Electrify CoolSense System

Minimize Impact: Understand Typical Building Heat to Cool Design Loads

- What is typical peak building heating load vs. cooling load?
  - Trane study using ASHRAE 90.1 2017 basis buildings
  - Trace 3D used to model annual performance at different climate zones



1999 Construction Office

$$\frac{\text{Peak Heating}}{\text{Peak Cooling}} < 1$$

Example: NYC Office

What is the oversizing from current practices?

Electrify CoolSense System

Minimize Impact: Understand Installed Total Terminal Heating Capacity vs Peak Load

- Terminal Cooling Capacity vs Heating Capacity Ratio Using Rules of Thumb

What Fan Terminal Heating Capacity Scheduled?

Heating Coil Flow = ½ Cooling$_{gpm}$

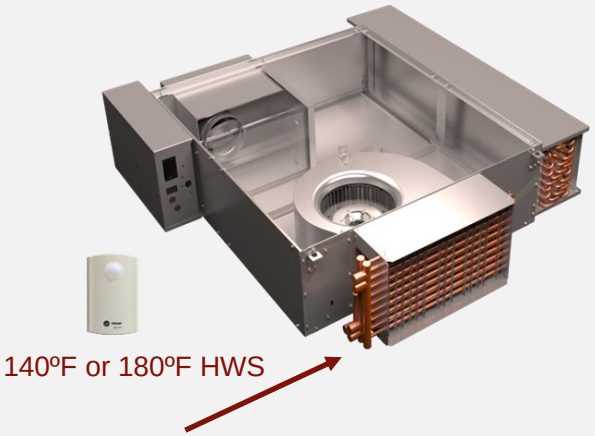
140F ≈1.5 heat/cool
180F ≈ 2.4 heat/cool

Heating Coil Lvg Air Temp = 95ºF

≈1.7 heat/cool

These heat/cool ratios will result in terminal units heating that is

oversized by
≈ 150-500%



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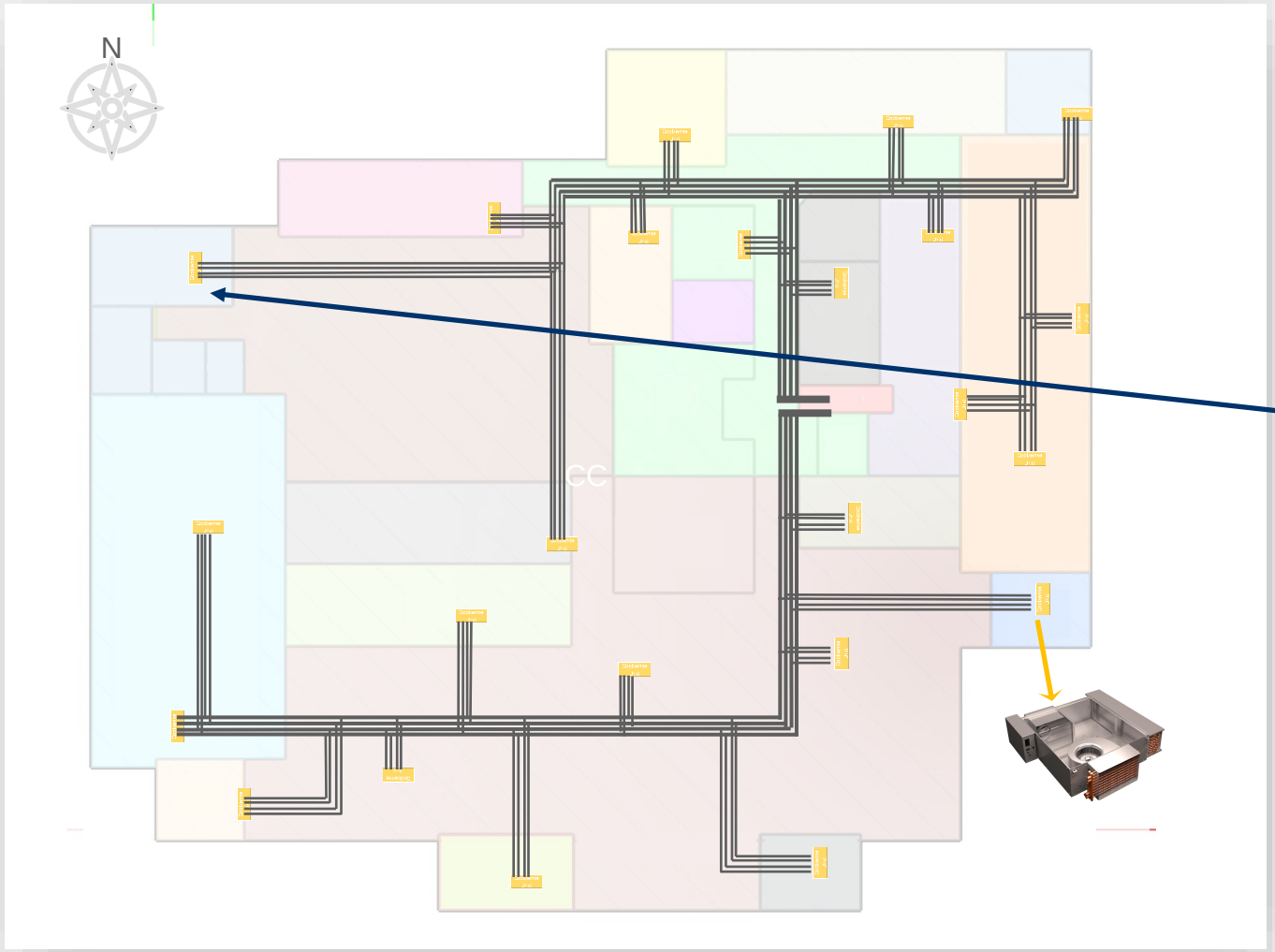
Electrify CoolSense System

Minimize Impact: Understand Installed Total Terminal Heating Capacity vs Peak Load



Example: Office Building

Detailed look at a 15,893 ft² floor

Zones = 20

CoolSense Terminals = 25

Trace 3D Predicted Building Peak Loads

Ratio Heating to Cooling = 0.45

Worst Case NW Corner Office = 0.88

Cooling 6.0MBH

Heating 5.3MBH

Sizing Method Impact on this building in NYC

Heating Coil Flow = 1.5$_{gpm}$ @140ºF

≈ 301% more capacity than peak heating need

Heating Coil Lvg Air Temp = 95ºF

≈ 407% more capacity than peak heating need

Electrify CoolSense System

Minimize Impact: Understand Terminal Oversizing and Plant Oversizing Differences

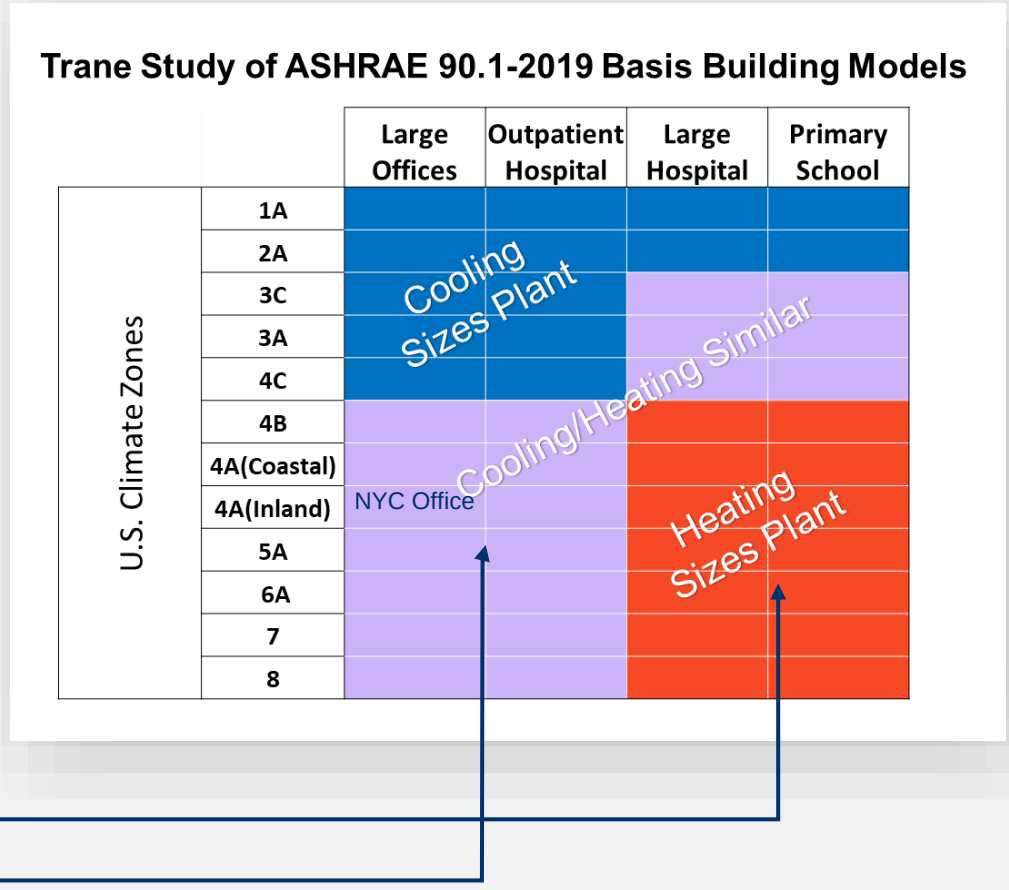
- Oversizing terminals is OK
  - Keeps fans at low speed during heating
  - Each zone has safety factor in case it goes rogue
- Size AWHP on Peak Block Load X SF
  - DO NOT size on sum of terminal capacity, will greatly oversize

What Fan Terminal Heating Capacity Scheduled?

≈ 301% of peak design capacity

What is AWHP Capacity Scheduled?

Cooling sizes unit
Design Cooling Capacity = 120% of peak cooling
Design Heating Capacity = 192% of peak heating @7ºF



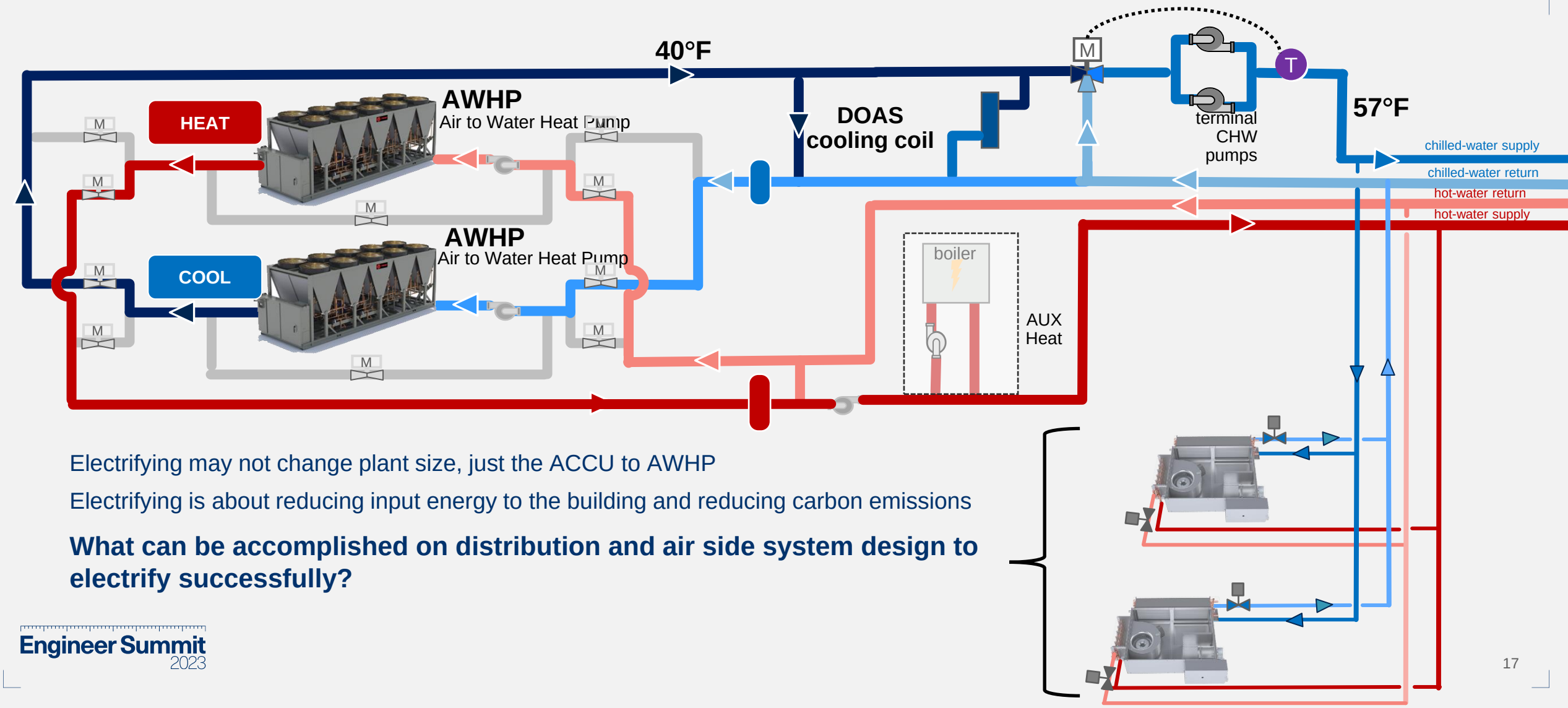
Electrify Successfully

Use Lower Hot Water Temperature

Use the Sensible-Cooling Coil for Heat

Electrify CoolSense System

Air to Water Heat Pumps Supplying Hot and Cold Water to 4-Pipe Distribution System with Sensible Cooling Terminals



Electrifying may not change plant size, just the ACCU to AWHP

Electrifying is about reducing input energy to the building and reducing carbon emissions

What can be accomplished on distribution and air side system design to electrify successfully?

Electrify CoolSense System

Only use the hot water required to heat

- What hot water temperature that is available is restricted by the equipment?
  - Gas fired non-condensing boilers 180ºF HWS to reduce risk of condensing flue gas
  - Gas fired condensing boilers to get efficiency benefit <120ºF HWR
  - Air to water heat pumps are limited by the ambient temperature 95ºF @ 0ºF; HWS = 100ºF @ 10ºF; HWS = 110ºF @ 15ºF

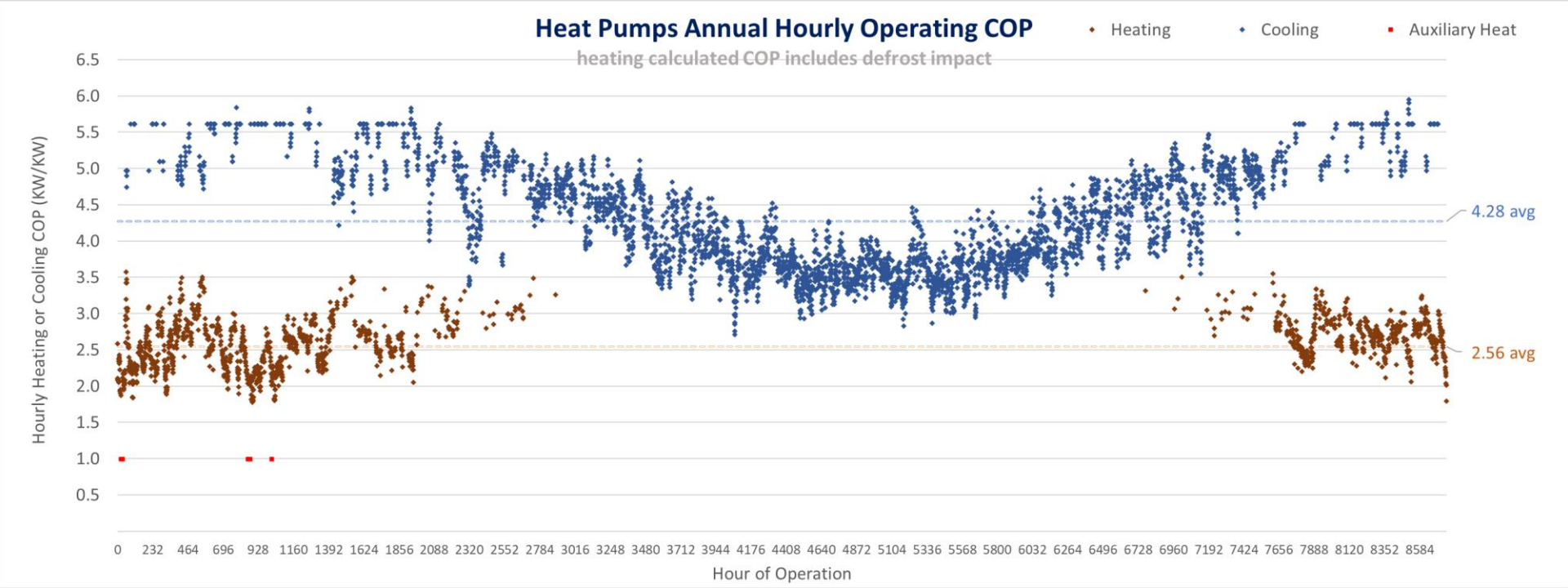
- The lower the temperature of the water, the more efficient the heat pump
  - Less energy
  - Less demand power
  - Lower CO_2e

Electrify CoolSense System

Only use the hot water required to heat

NYC Example Office

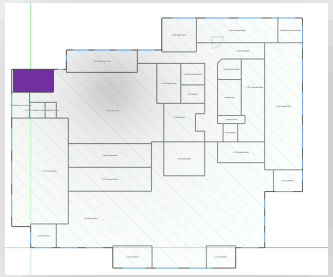
	AWHP Annual Avg COP	Annualized COP
95ºF HWS →	3.33	2.94
110ºF HWS →	2.56	2.35



Electrify CoolSense System

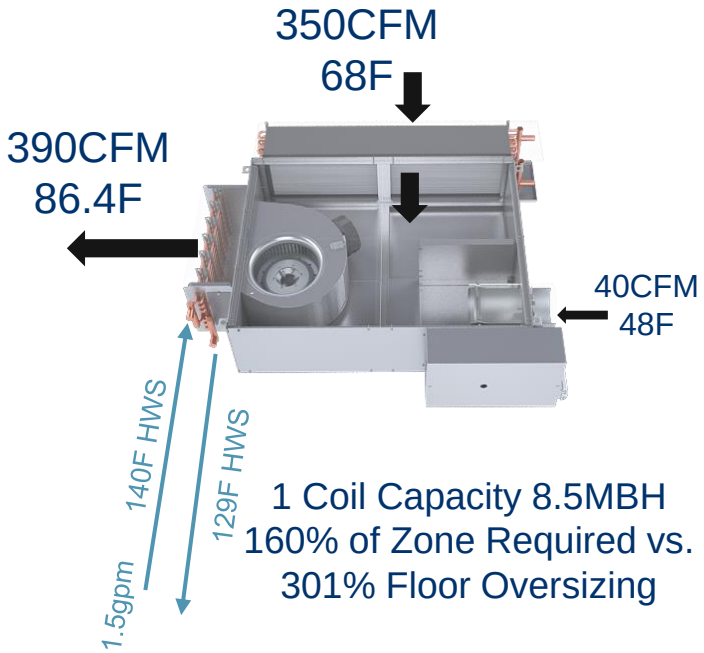
Only use the hot water required to heat

- The lower the face velocity of the coil the lower the hot water temperature needed
- 140ºF or 180ºF use a high air velocity coil to help with control
- CoolSense terminals have a low face velocity coil (Sensible Cooling)
  - Sensible Coil can be used for heating with AWHP hot water to reduce required hot water temperature

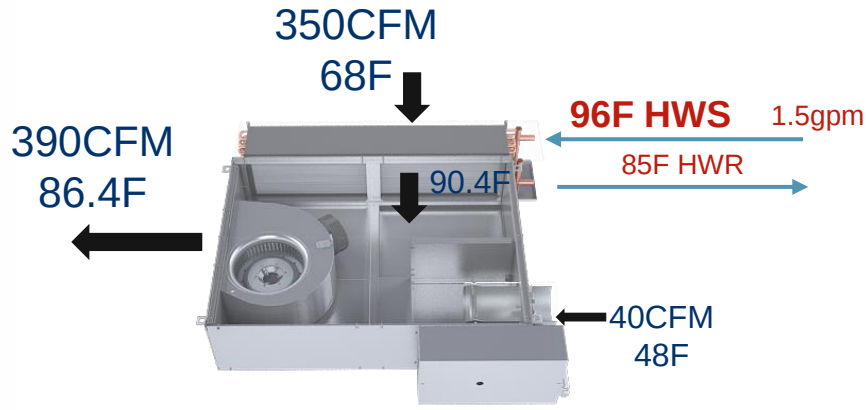


NW Office
Cool 6.0MBH
Heat 5.3MBH

Worst Case Ratio



1 Coil Capacity 8.5MBH
160% of Zone Required vs.
301% Floor Oversizing



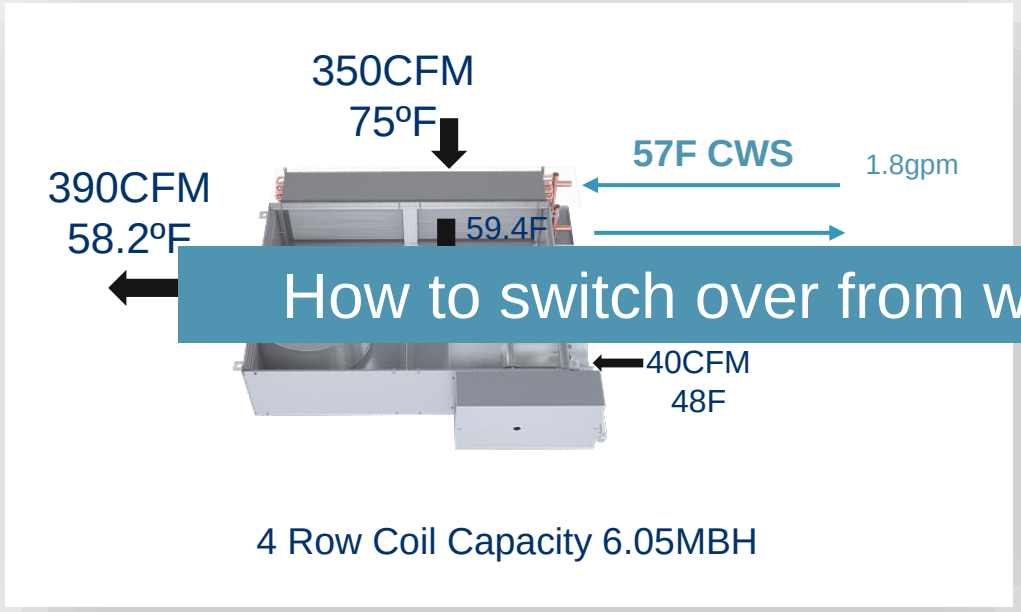
4 Row Coil Capacity 8.5MBH
160% of Zone Required vs.
380% Floor Oversizing

Electrify CoolSense System

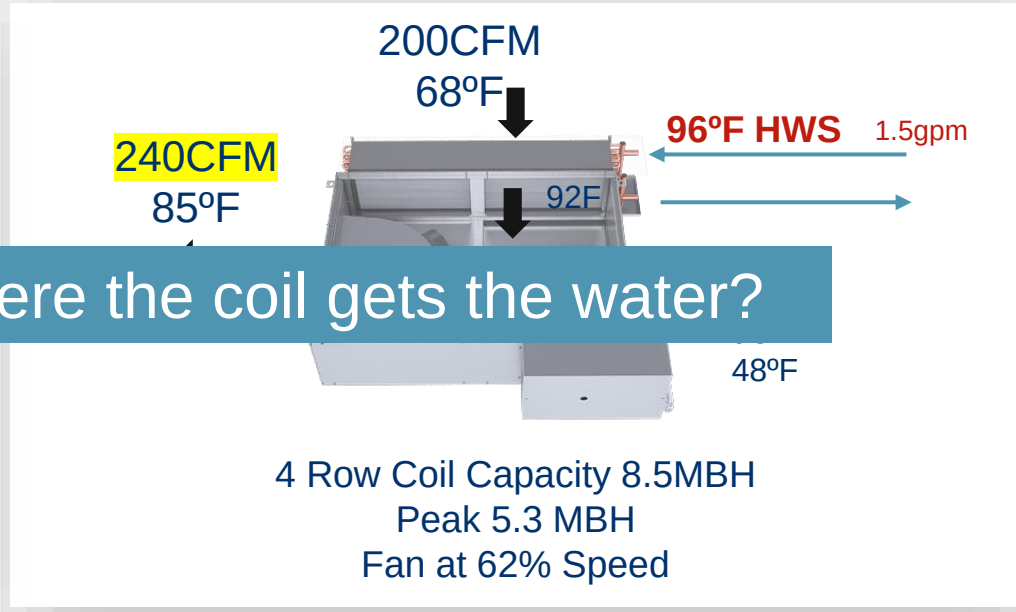
Only use the hot water required to heat

- AWHP system is a 4-pipe system
- Building is 4-pipe system
- Hot water or chilled water is available for each terminal

Predicted Performance on Peak Load Days



4 Row Coil Capacity 6.05MBH



4 Row Coil Capacity 8.5MBH
Peak 5.3 MBH
Fan at 62% Speed

How to switch over from where the coil gets the water?

Electrify Successfully

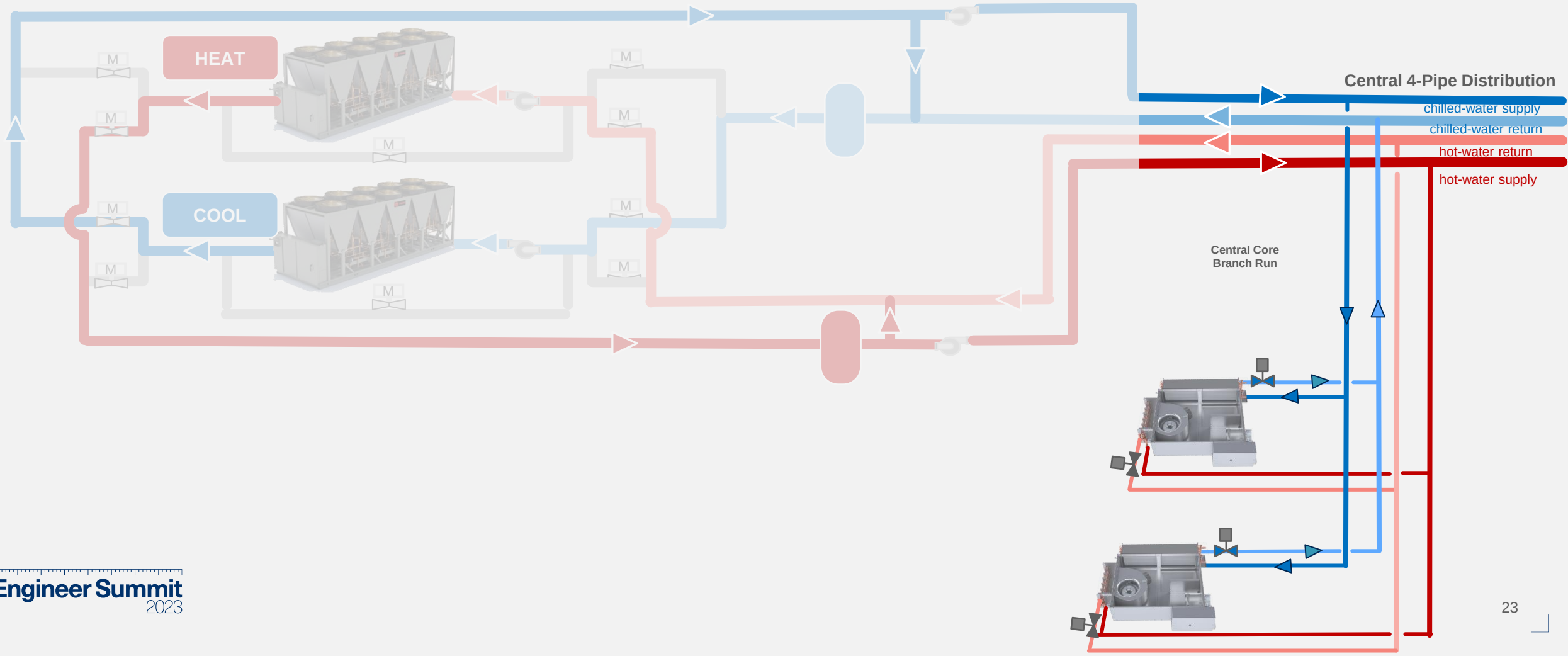
4-Pipe
Distribution Design

Switch Over
Terminal Units

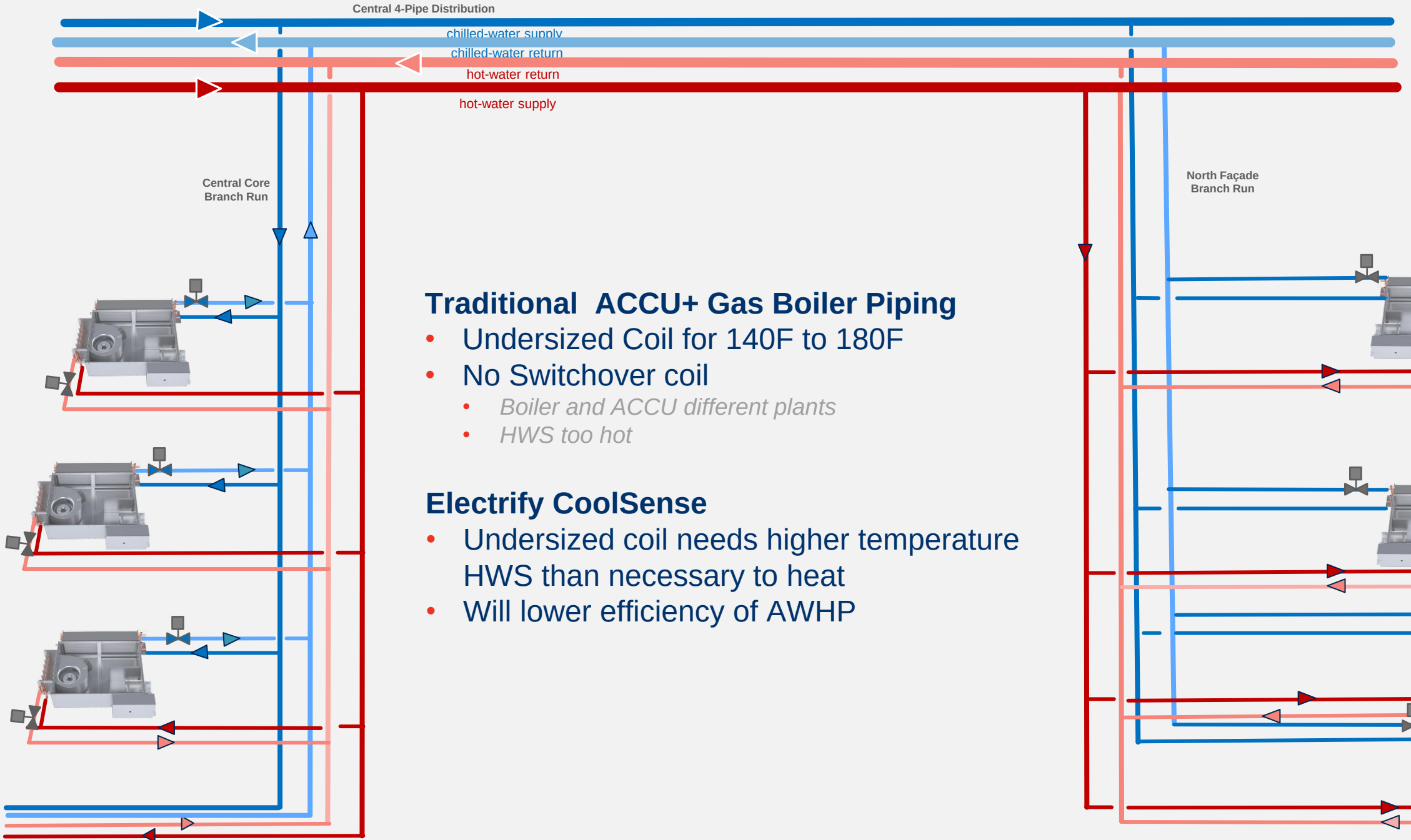
Distribution Area
Director

Electrify CoolSense System

4-Pipe Distribution for Switch Over CoolSense Terminals



4-PIPE DISTRIBUTION PIPING FOR CoolSense TERMINALS



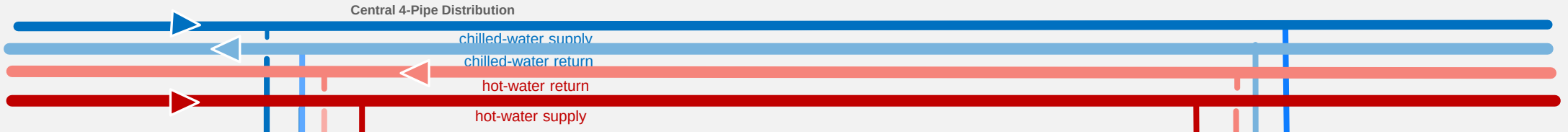
Traditional ACCU+ Gas Boiler Piping

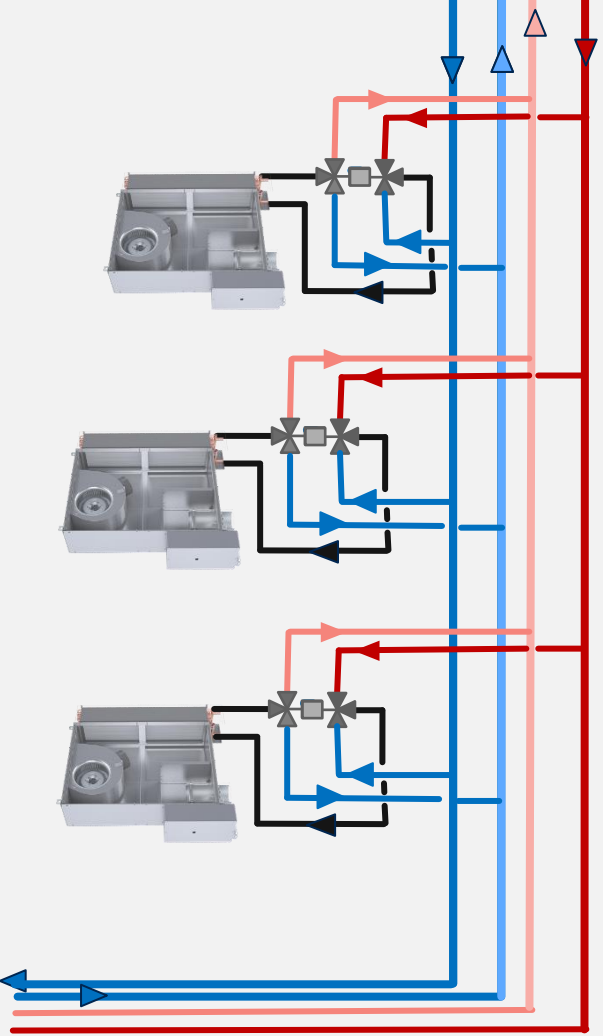
- Undersized Coil for 140F to 180F
- No Switchover coil
  - *Boiler and ACCU different plants*
  - *HWS too hot*

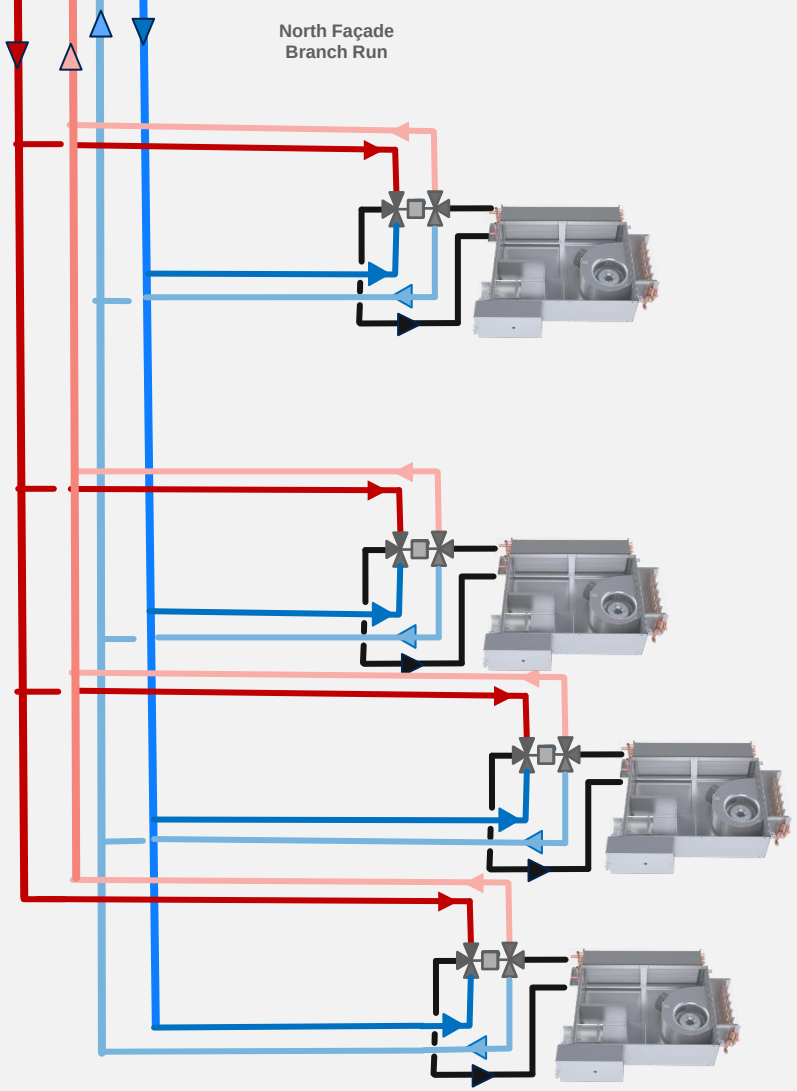
Electrify CoolSense

- Undersized coil needs higher temperature HWS than necessary to heat
- Will lower efficiency of AWHP

4-PIPE DISTRIBUTION PIPING FOR CoolSense TERMINALS







Electrify CoolSense 6-way Valve at each zone

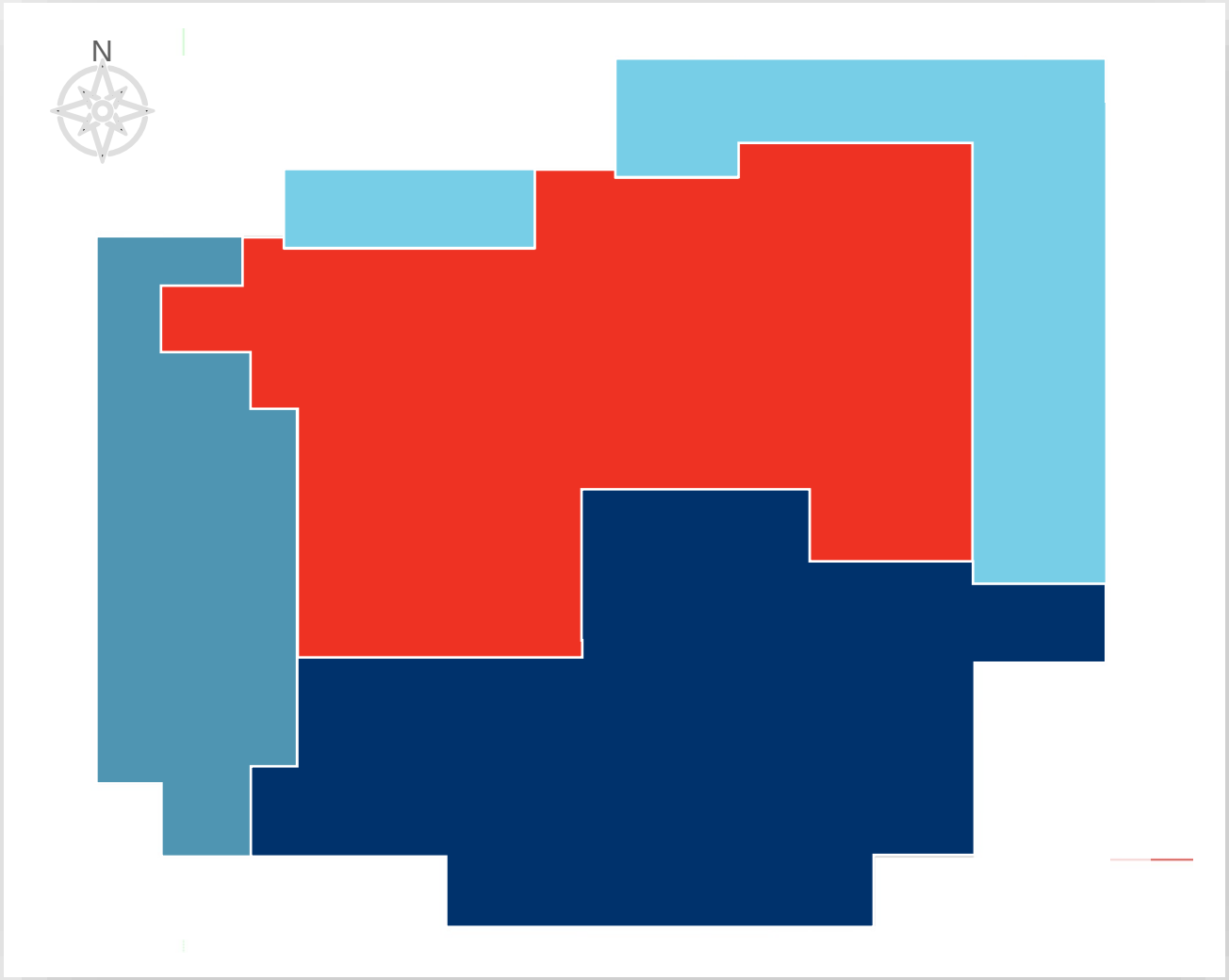
- Removes high velocity coil and lowers fan SP
- Allows for lower temperature water (96ºF)

- Requires in the zone space for valve
- Adds costs (One 6-way $ > Two 2-way $)
- Zone controls more complex not out of the box

Primary benefit is each zone has independent heat/cool mode

Electrify CoolSense System

4-Pipe Distribution for Switch Over CoolSense Terminals



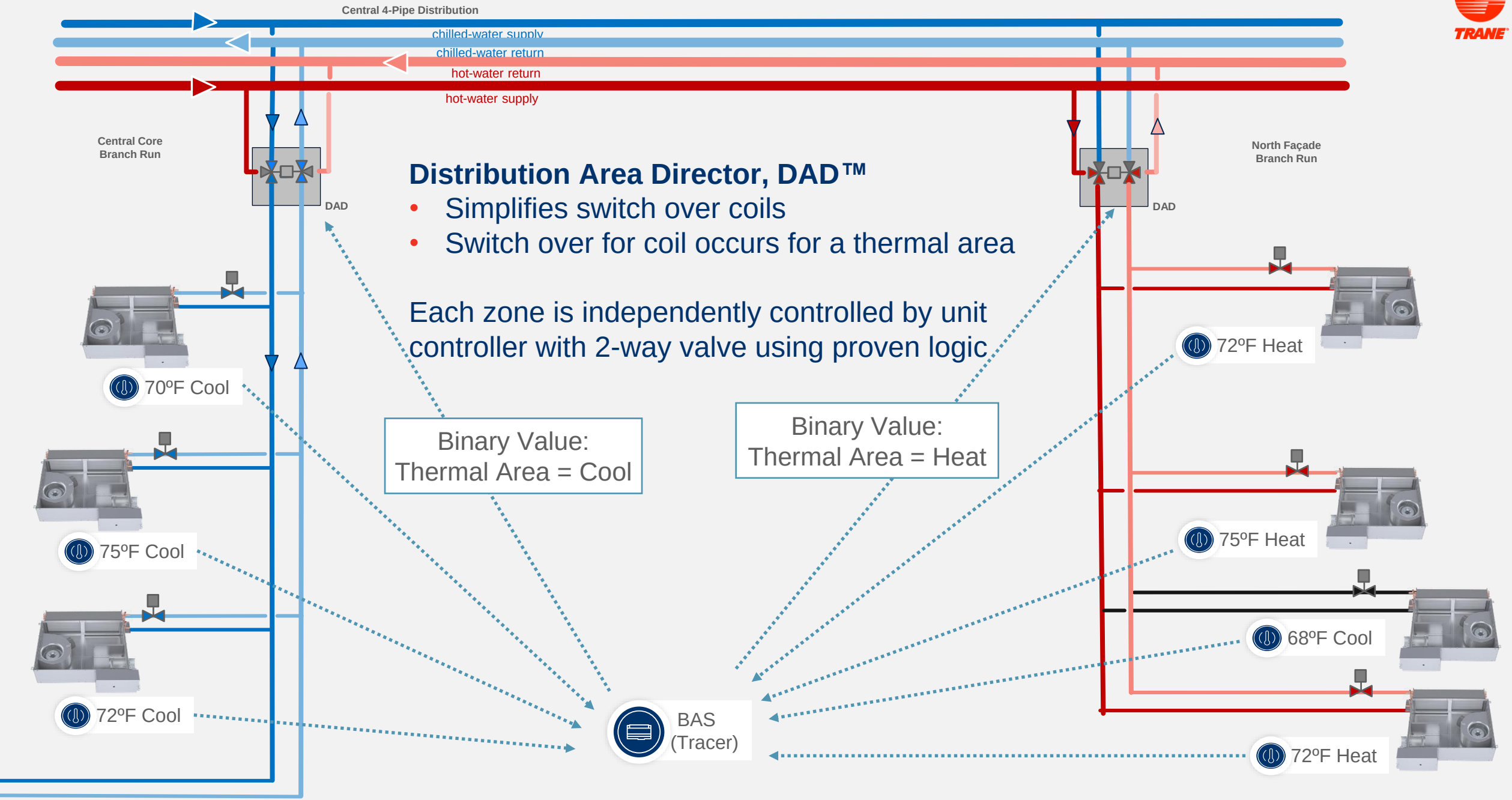
25 Zones for Floor
Independent zone control is important, each zone should have ability for different set points!

Don’t forget the primary purpose: COMFORT

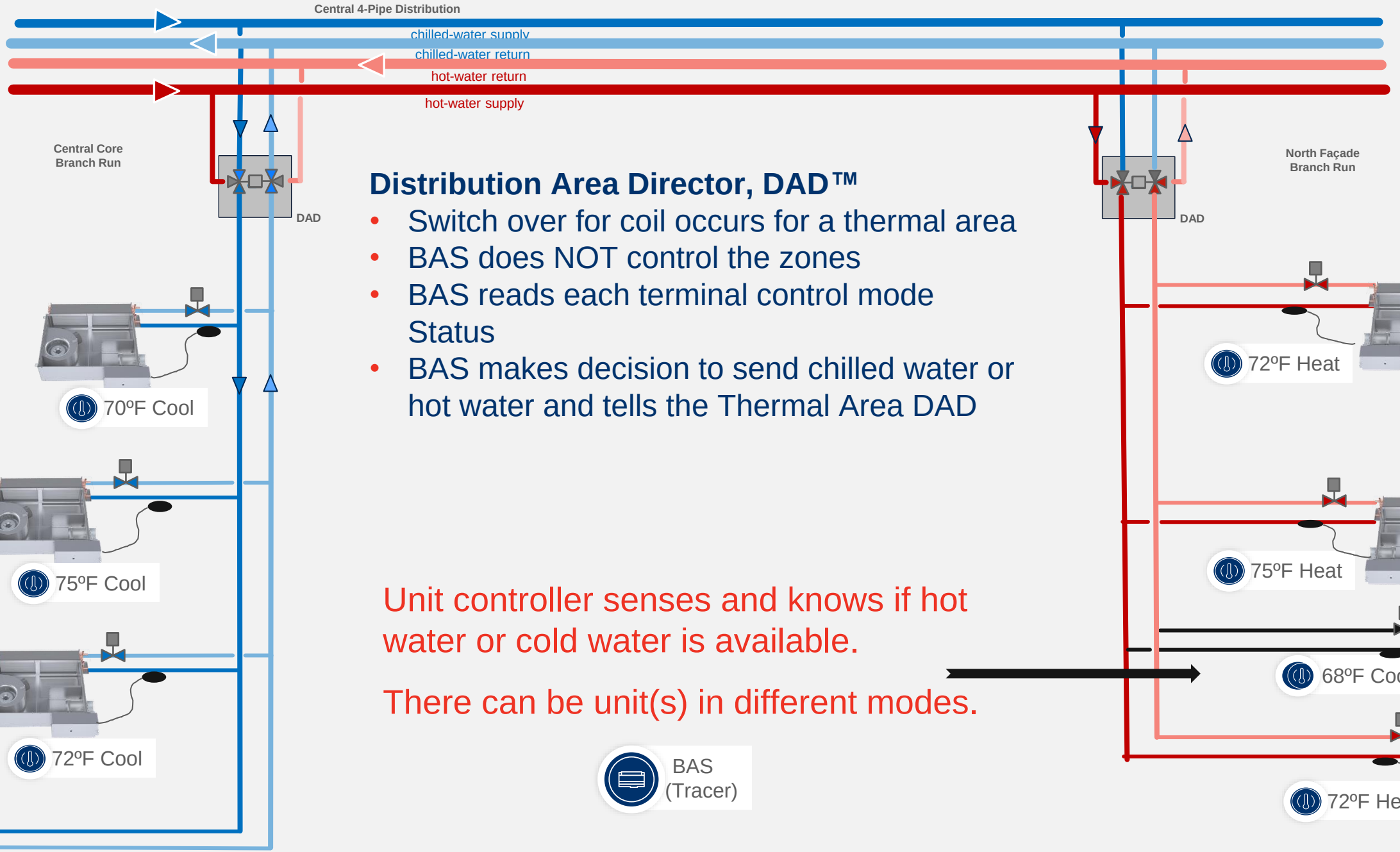
Every zone does not need independent heat/cool switchover
Boston Model 3.3% hours simultaneous heat/cool

South Area 4 Independent Zones, 7 Units
North/East 5 Independent Zones, 6 Units
Central Area 8 Independent Zones, 8 Units
West 3 Independent Zones, 4 units

4 PIPE DISTRIBUTION PIPING FOR CoolSense TERMINALS



4-PIPE DISTRIBUTION PIPING FOR CoolSense TERMINALS



Distribution Area Director, DAD™

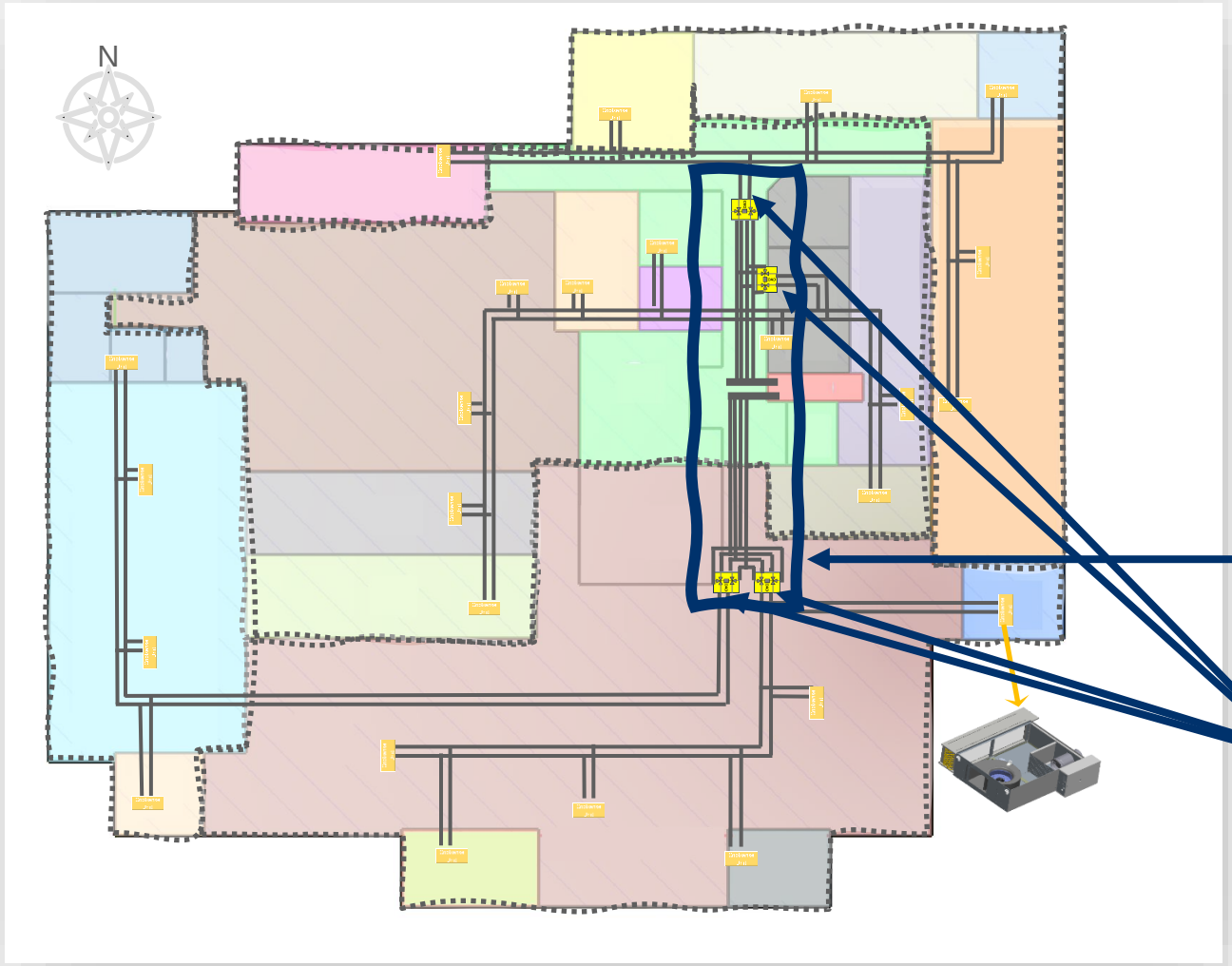
- Switch over for coil occurs for a thermal area
- BAS does NOT control the zones
- BAS reads each terminal control mode Status
- BAS makes decision to send chilled water or hot water and tells the Thermal Area DAD

Unit controller senses and knows if hot water or cold water is available.

There can be unit(s) in different modes.

Electrify CoolSense System

4 pipe Distribution Piping for Switch Over CoolSense Terminals using DAD



Distribution Area Director, DAD™

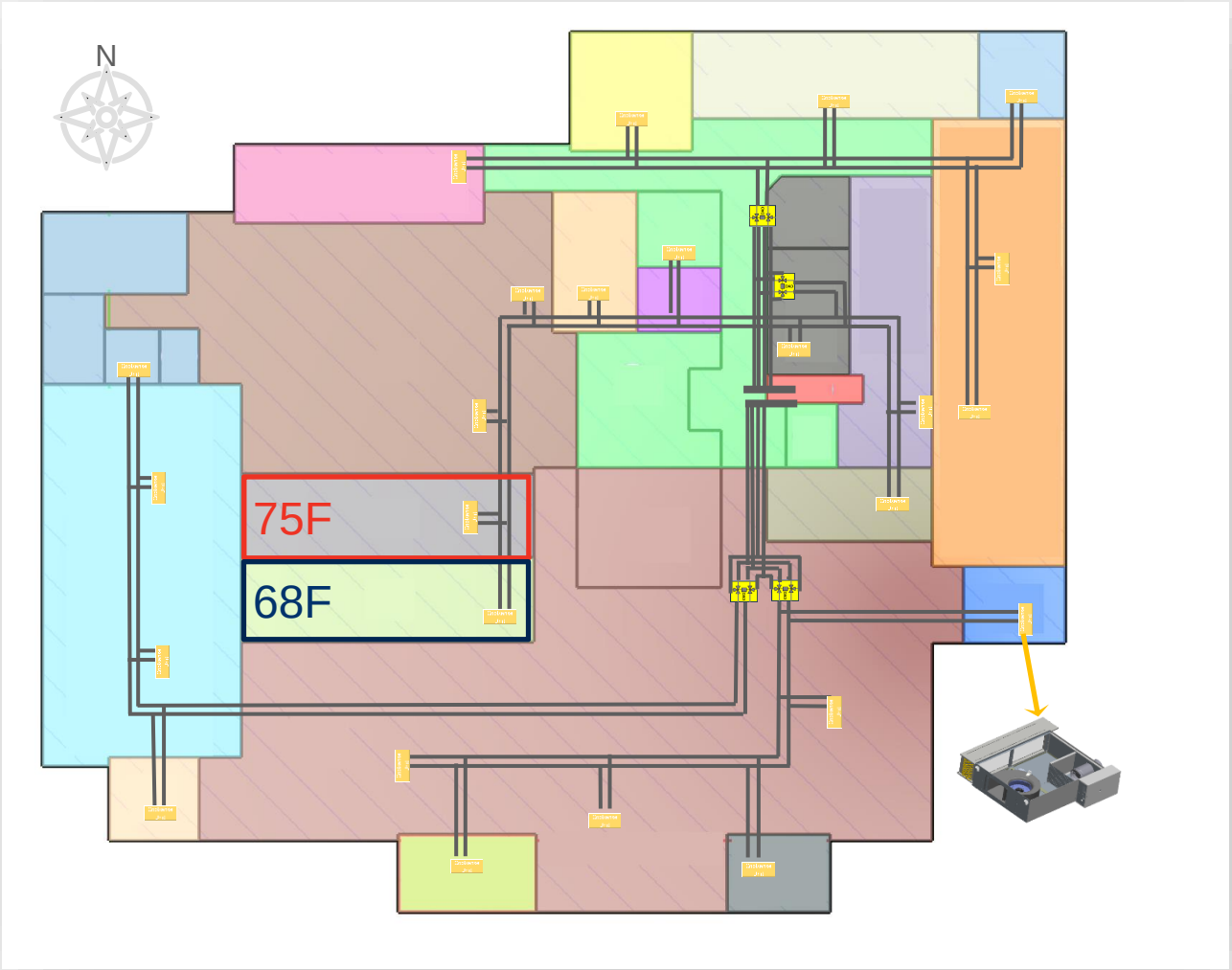
- Greatly reduces the piping for building
- All branch area piping is 2-pipe

Center Floor 4-Pipe Run from Central 4-Pipe Chase

All Thermal Area Branch Pipe Run are 2-pipe leaving the Distribution Area Director

Electrify CoolSense System

4-pipe Distribution Piping for Switch Over CoolSense Terminals using DAD



Distribution Area Director, DAD™

- Stops the zone fighting!
- Allows independent set points
- Improved comfort
- Reduced energy impact

Example: Adjacent Zones
75ºF vs 68ºF all year

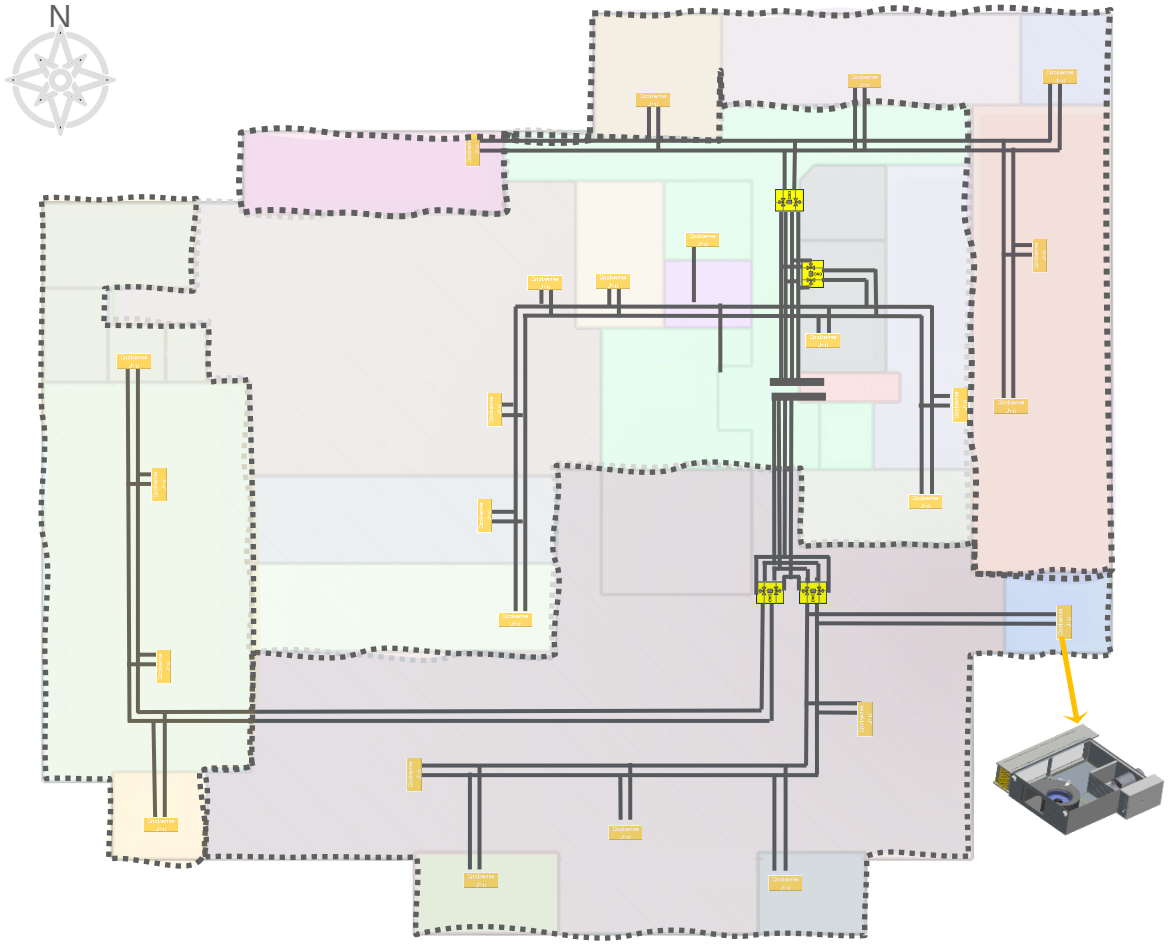
Modeling example the adjacent zones meets set point 8759 out of 8760hrs both in same Heat/Cool mode

Adds 5,376,000 BTU Annual Cool
Reduces 832,000 BTU Annual Heat

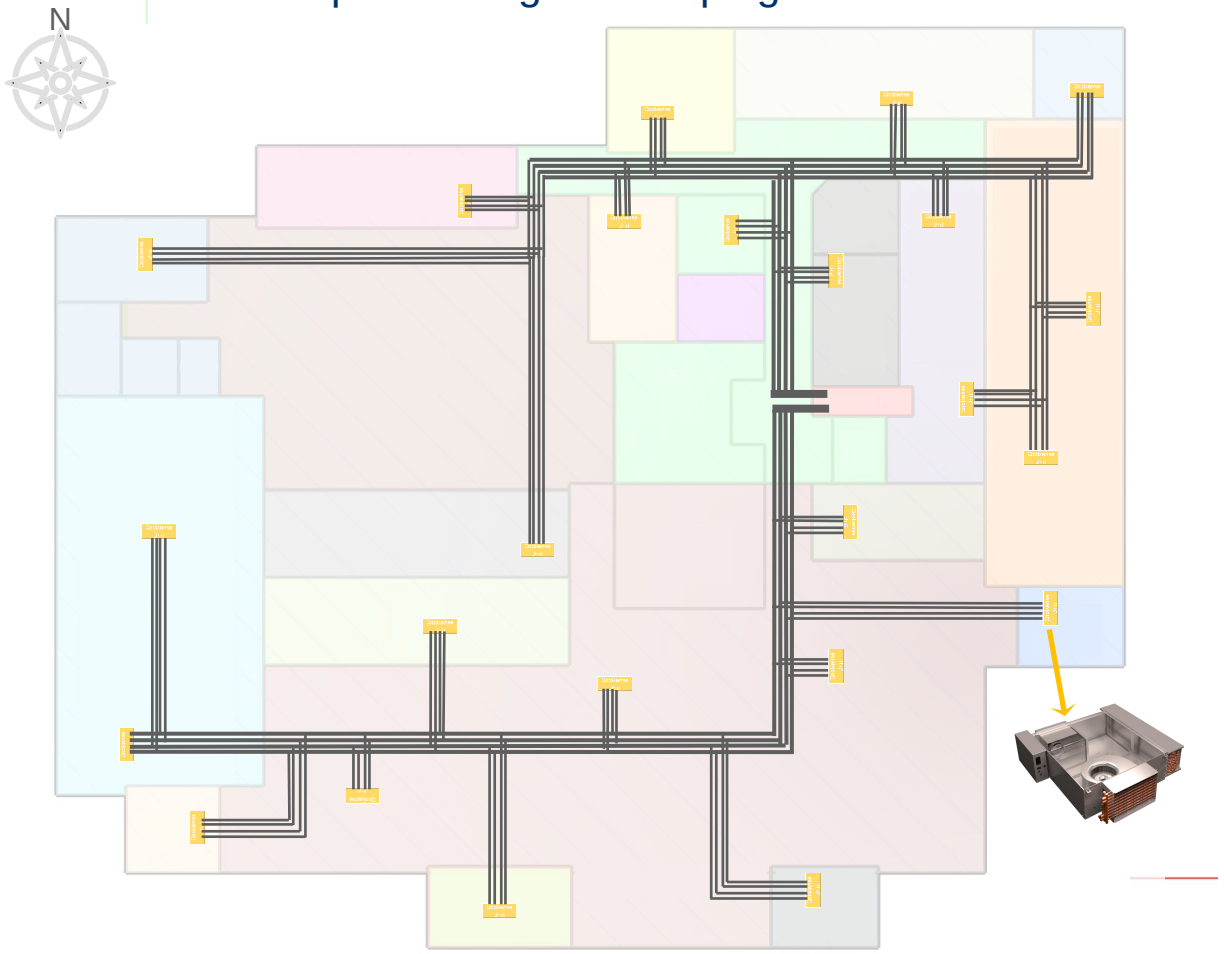
Electrify CoolSense System

Distribution Area Director and switch over coils will significantly reduce building costs

4-Pipe Building Floor Piping – DAD



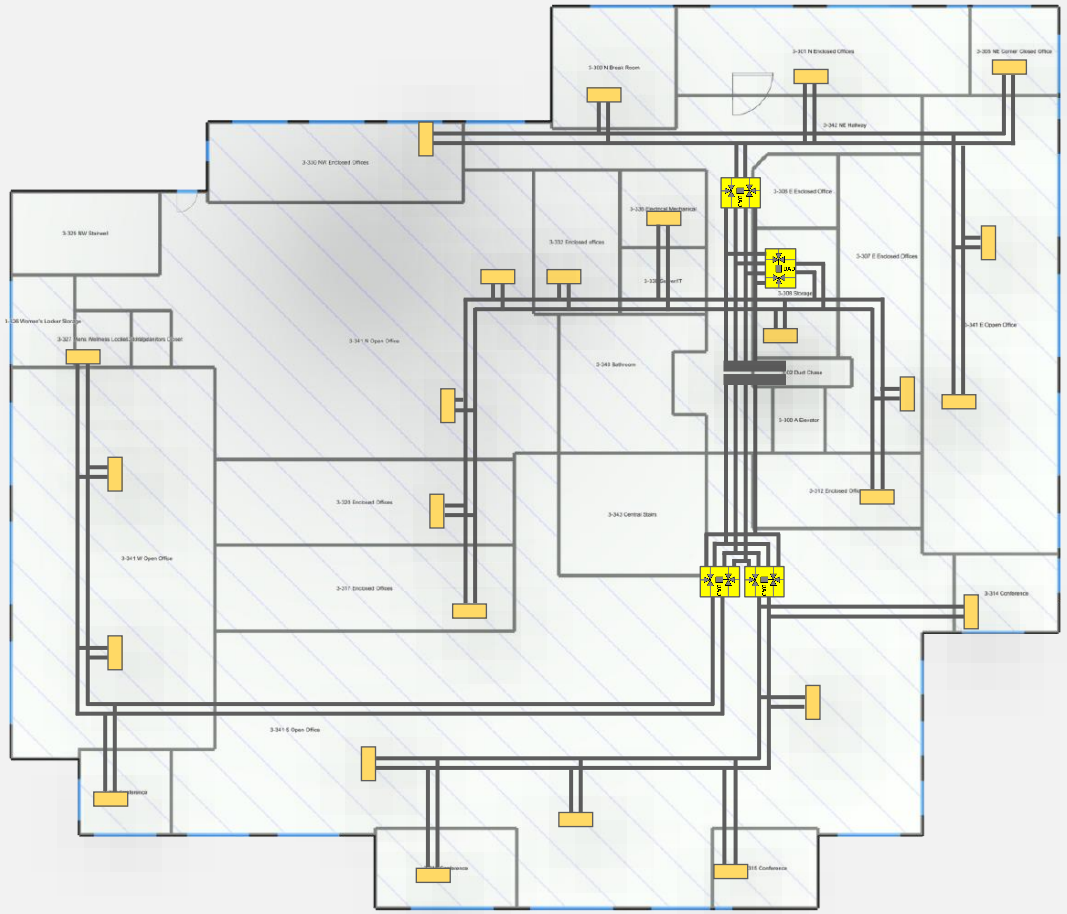
4-Pipe Building Floor Piping – Traditional

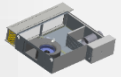


Electrify CoolSense System

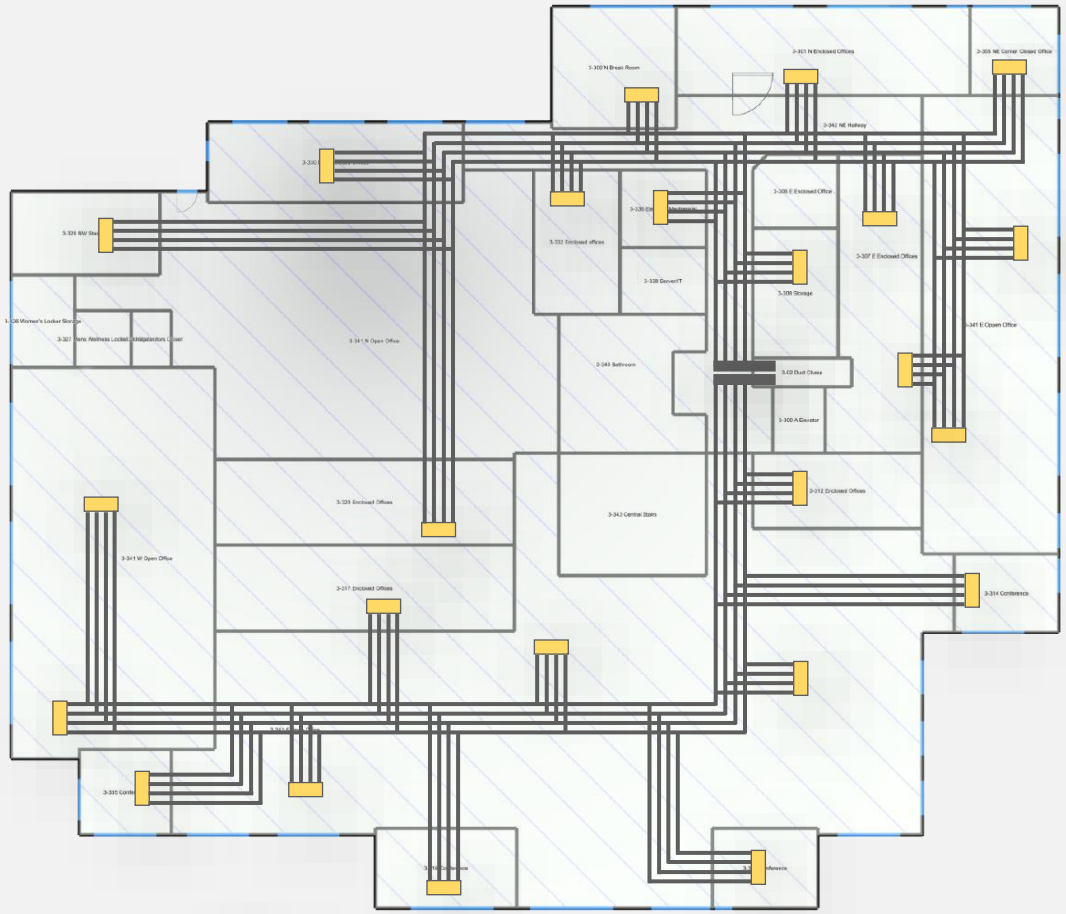
Distribution Area Director and switch over coils will significantly reduce building costs

4-Pipe Building Floor Piping – DAD



=  25 CoolSense Terminals with 1 Coil

4-Pipe Building Floor Piping – Traditional

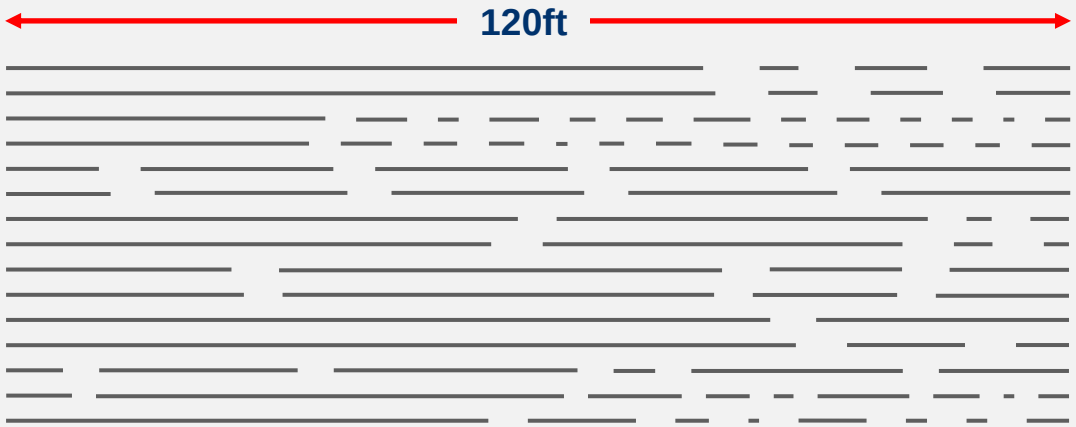


=  25 CoolSense Terminals with 2 Coils

Electrify CoolSense System

Distribution Area Director and switch over coils will significantly reduce building costs

4-Pipe Building Floor Piping – DAD

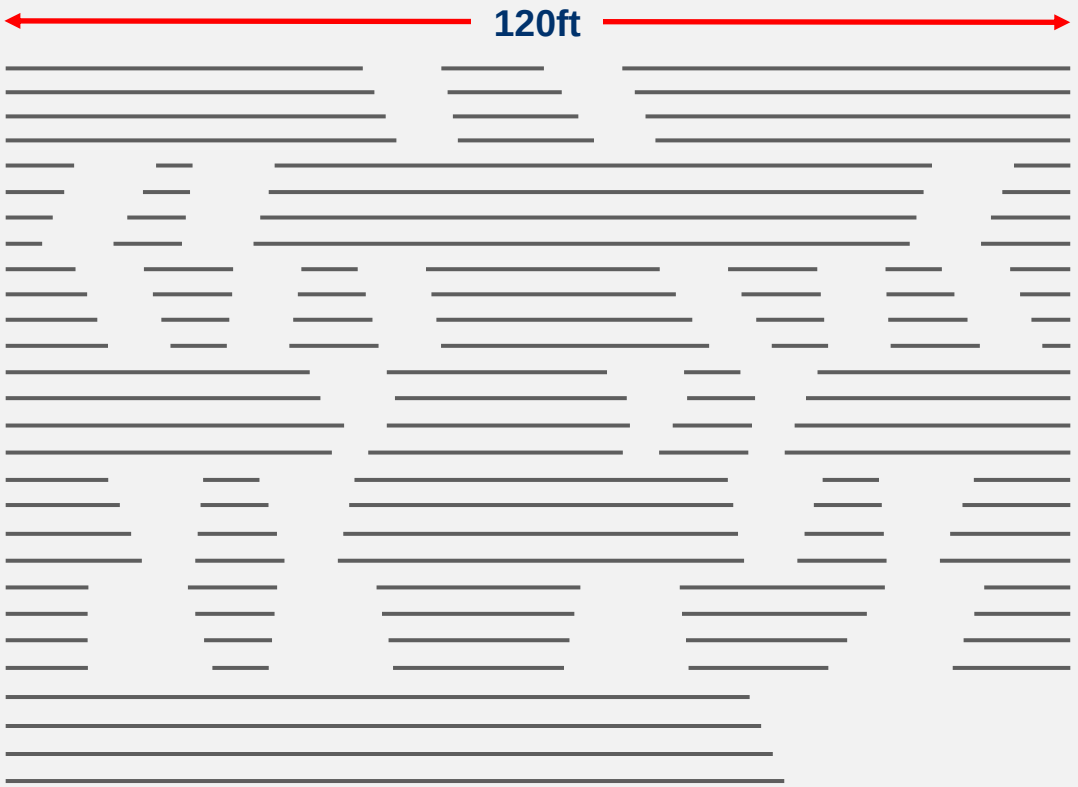


1660 ft Steel Pipe

Majority 1 ½” DIA; Some 2” DIA

- Minimum Est Fittings (Ts, Elbows, Etc) >176

4-Pipe Building Floor Piping – Traditional



2780 ft Steel Pipe

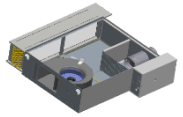
Majority 2” DIA; Some1 ½” DIA

- Minimum Est Fittings (Ts, Elbows, Etc) > 254

Electrify CoolSense System

Distribution Area Director and switch over coils will significantly reduce building costs

4-Pipe Building Floor Piping – DAD



25 CoolSense Terminals with 1 Coil

1660 ft Steel Pipe

Majority 1 ½” DIA; Some 2” DIA

- Minimum Est Fittings (Ts, Elbows, Etc) >174

Control Valves Qty = **25** 2-Way

Distribution Area Director Qty = 4

Savings Est: $1.30/sqft

4-Pipe Building Floor Piping – Traditional

25 CoolSense Terminals with 2 Coils

2780 ft Steel Pipe

Majority 2” DIA; Some1 ½” DIA

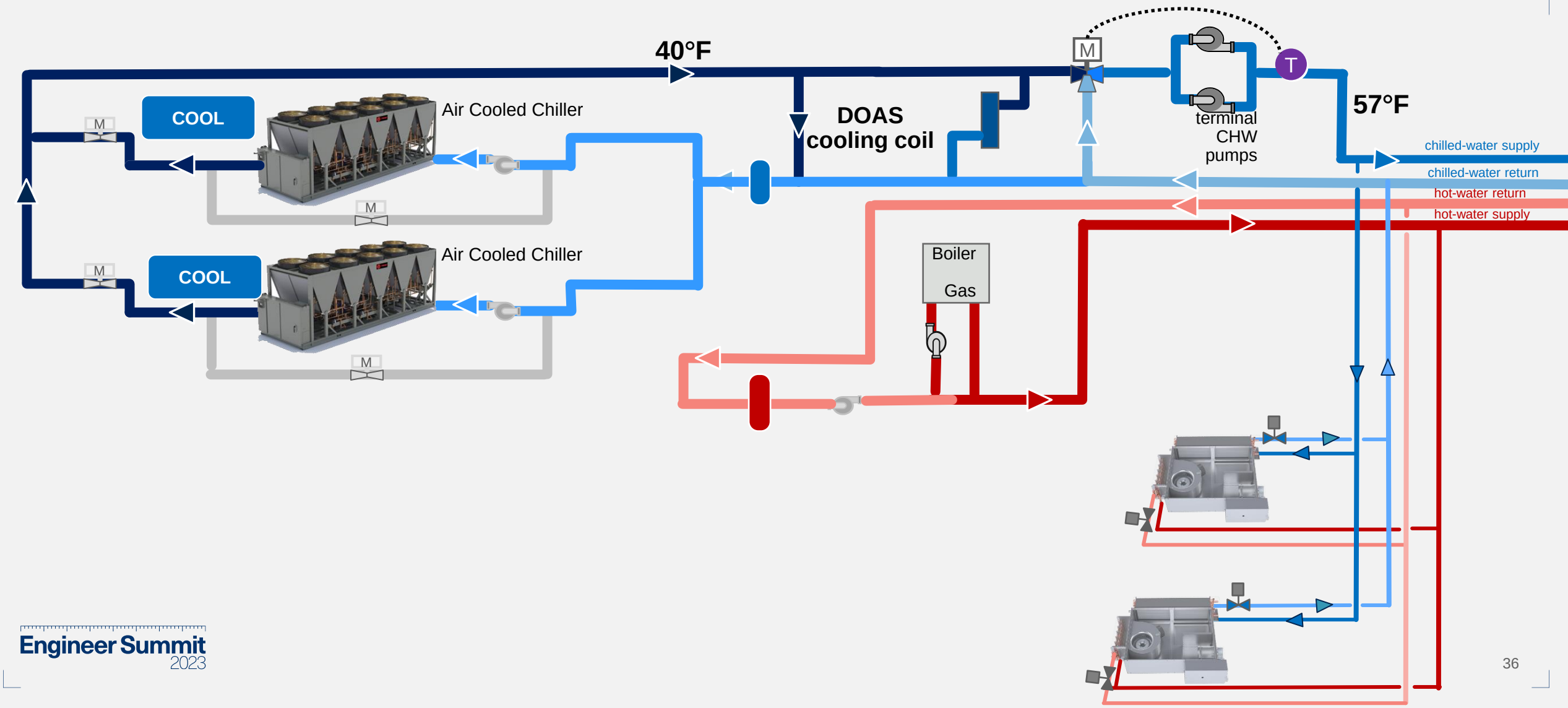
- Minimum Est Fittings (Ts, Elbows, Etc) >254

Control Valves Qty = **50** 2-Way

Annual Modeling of Three CoolSense Systems

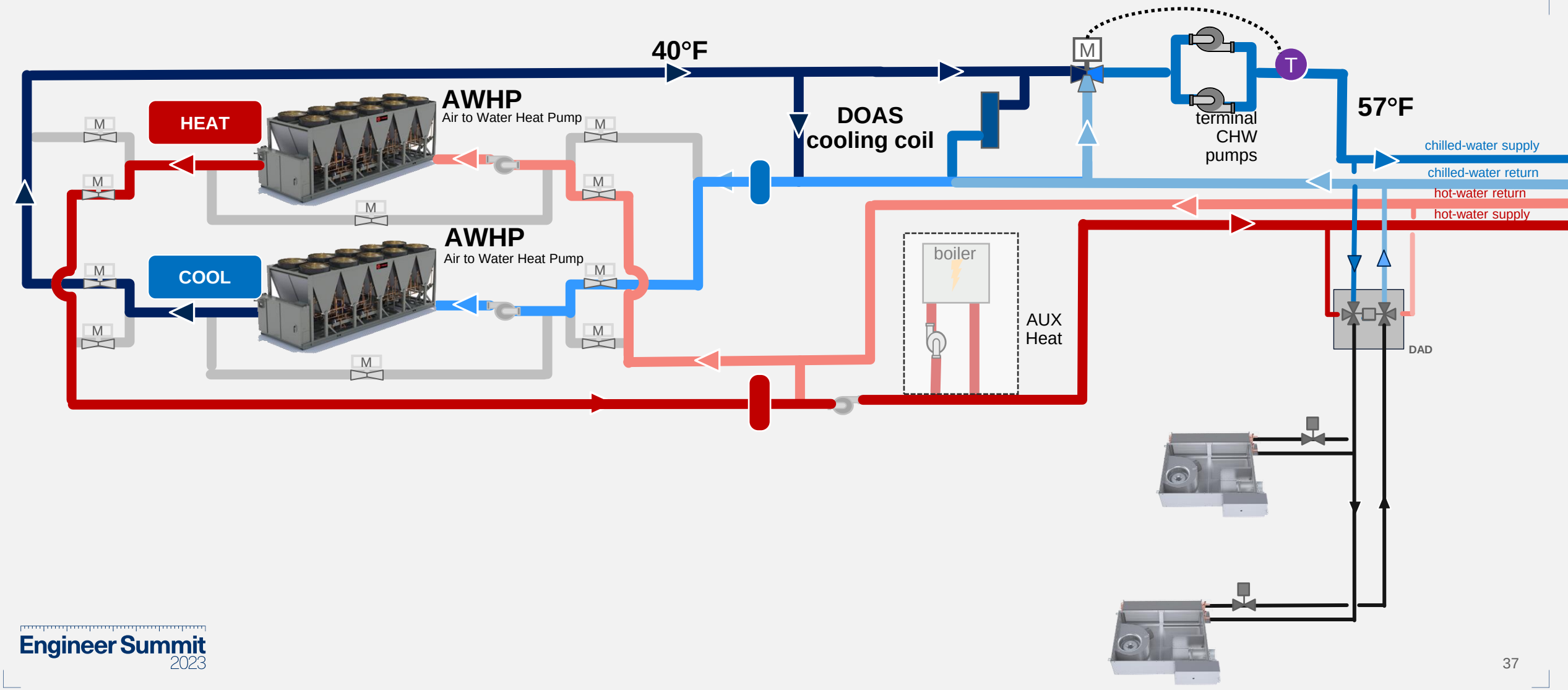
Electrify CoolSense System

Baseline Fossil Fuel: CoolSense System Natural Gas Heating



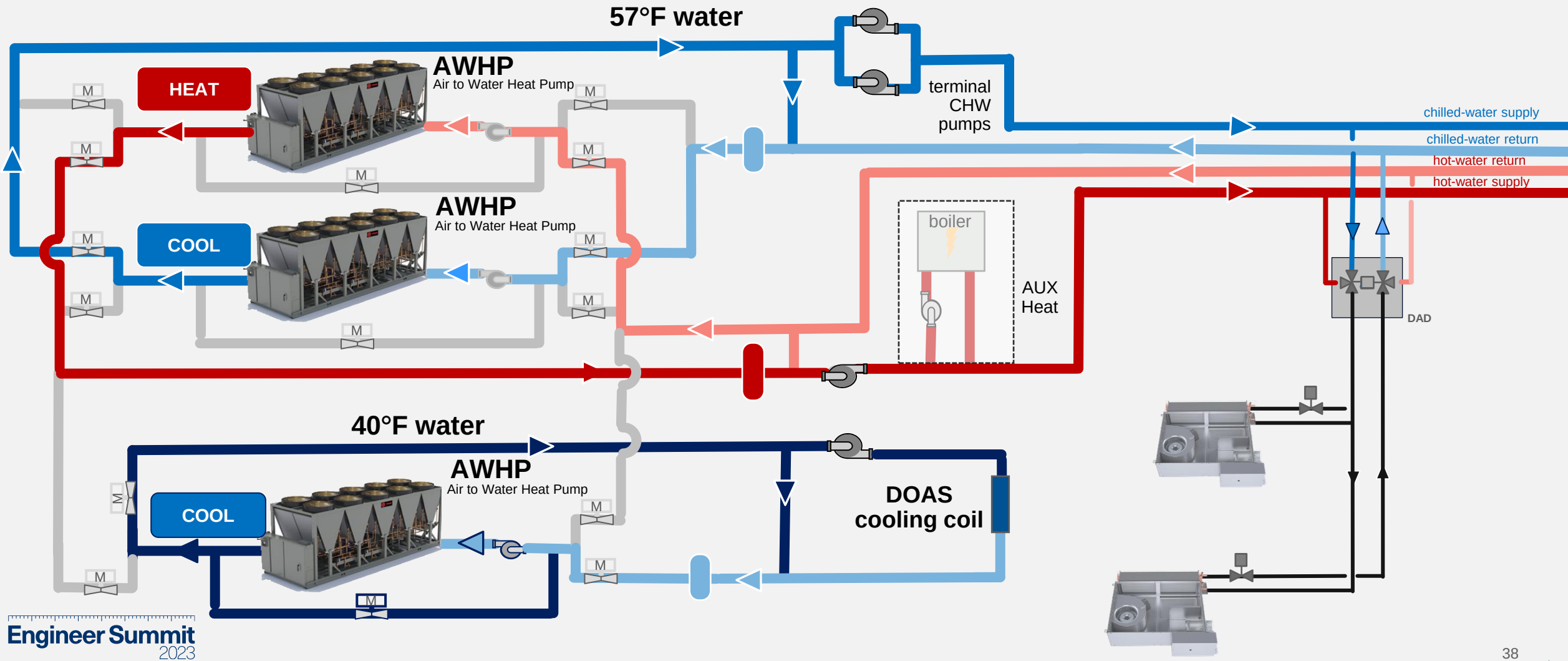
Electrify CoolSense System

All-electric CoolSense System AWHP Heating



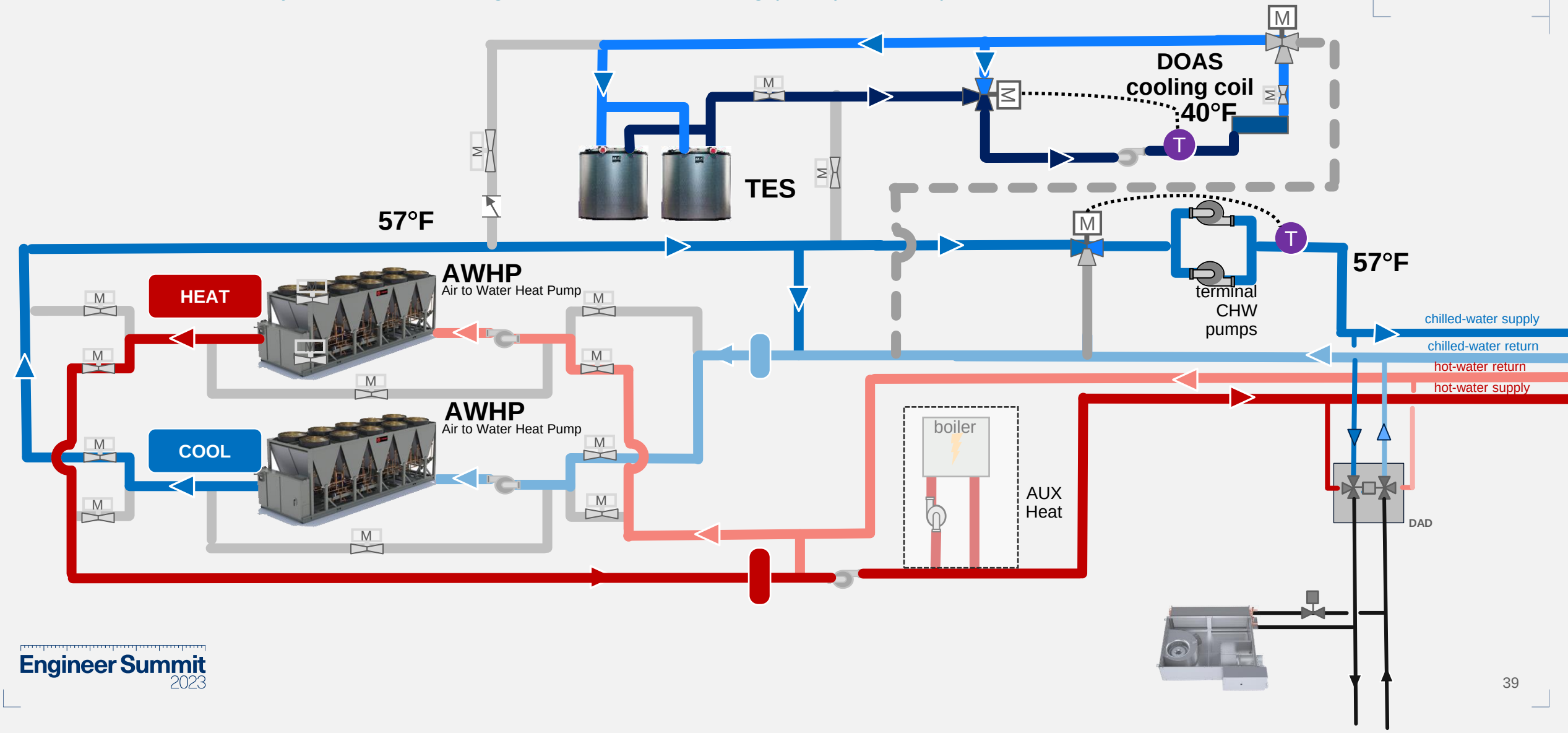
Electrify CoolSense System

All-electric CoolSense System AWHP Heating – Dual Temperature Chilled Water Plant



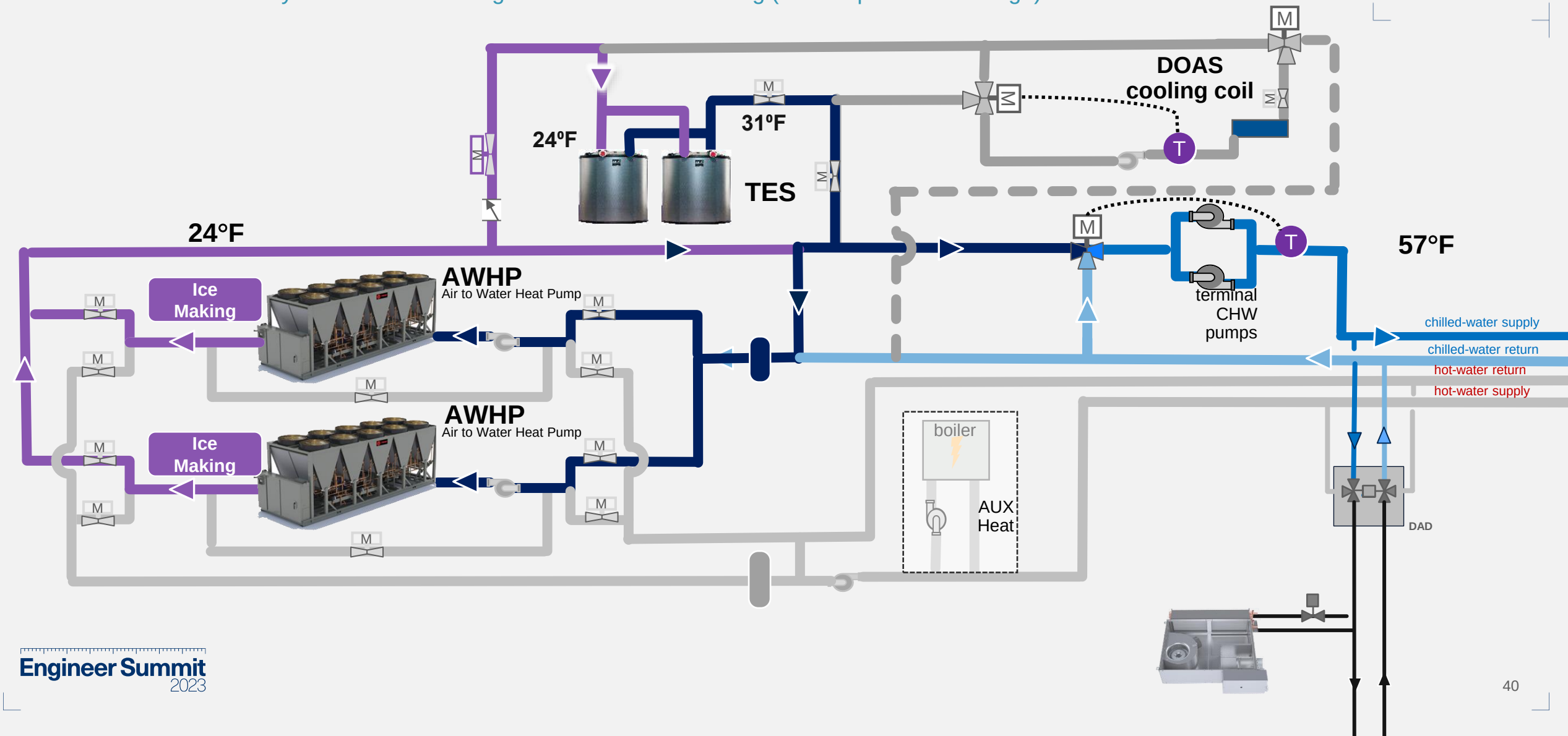
Electrify CoolSense System

All-electric CoolSense System AWHP Heating – TES for DOAS Cooling (Occupied Mode)



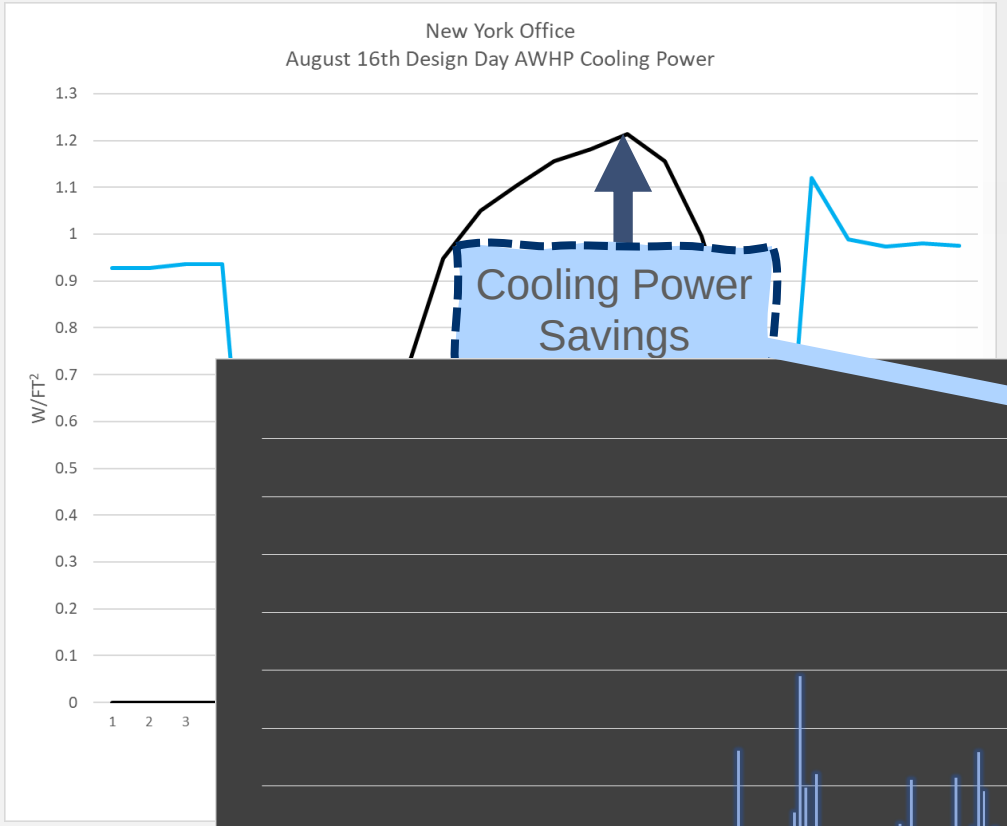
Electrify CoolSense System

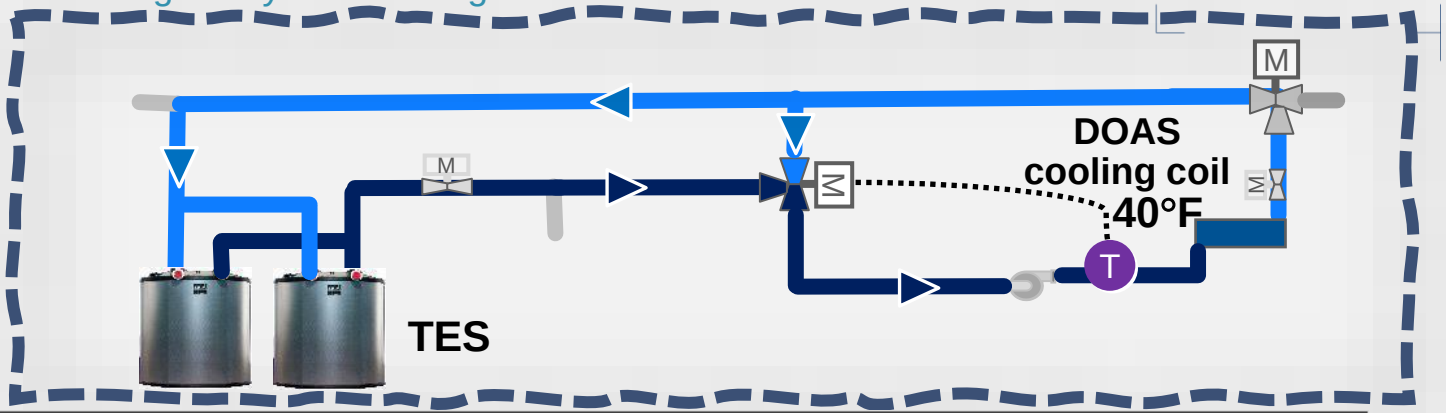
All-electric CoolSense System AWHP Heating – TES for DOAS Cooling (Unoccupied TES Charge)



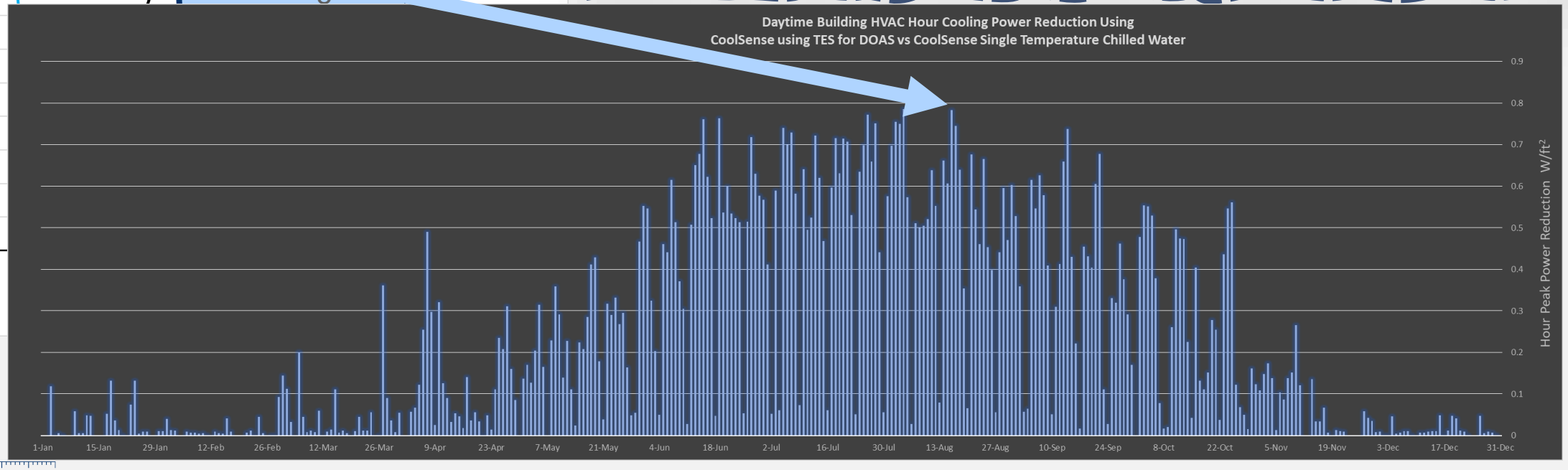
Electrify CoolSense System

All-electric CoolSense System AWHP Heating – TES for DOAS Cooling – Daytime Cooling Power Reduction



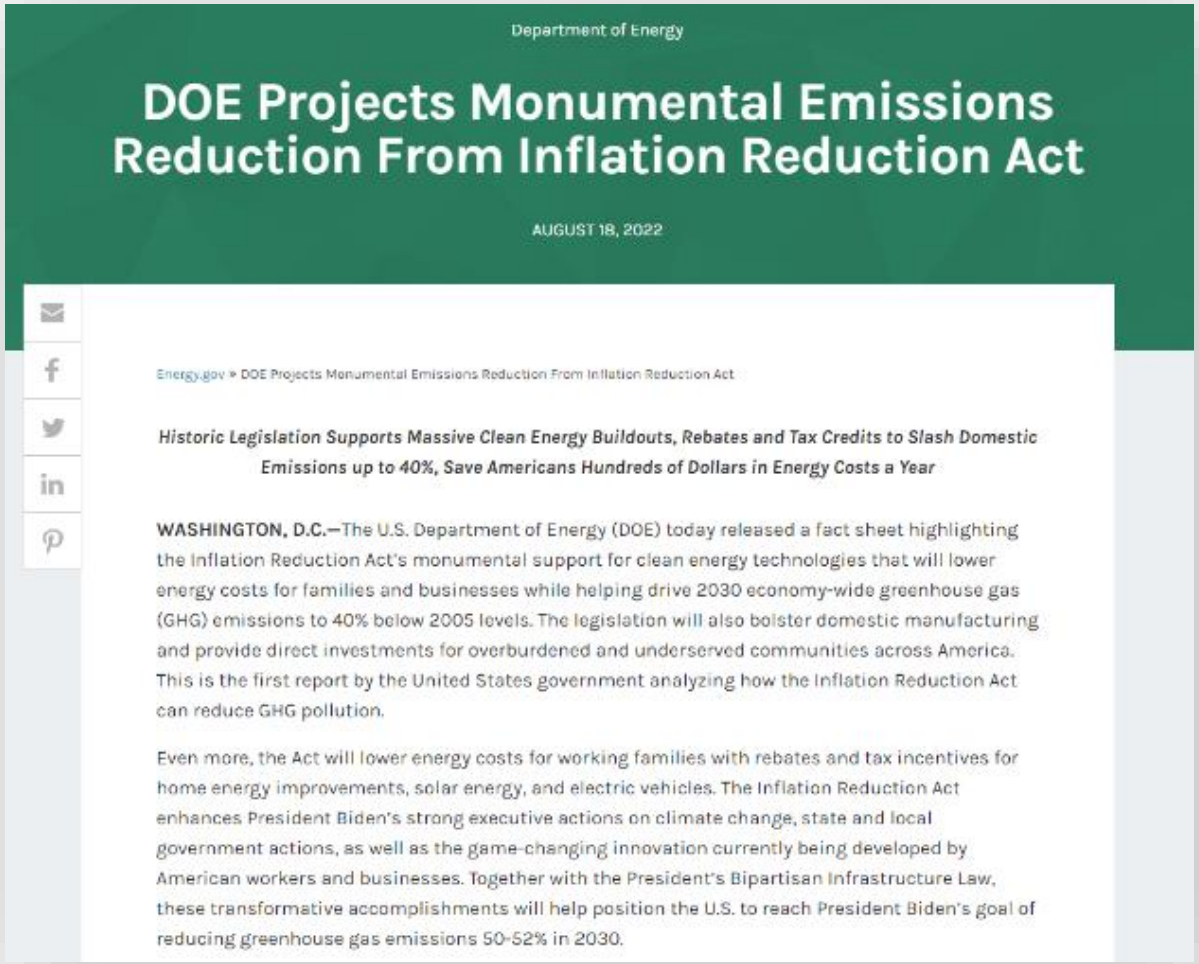


Cooling Power Savings



Electrify CoolSense System

All-electric CoolSense System AWHP Heating – TES Inflation Reduction Act Impact



Department of Energy

DOE Projects Monumental Emissions Reduction From Inflation Reduction Act

AUGUST 18, 2022

Energy.gov » DOE Projects Monumental Emissions Reduction From Inflation Reduction Act

Historic Legislation Supports Massive Clean Energy Buildouts, Rebates and Tax Credits to Slash Domestic Emissions up to 40%, Save Americans Hundreds of Dollars in Energy Costs a Year

WASHINGTON, D.C.—The U.S. Department of Energy (DOE) today released a fact sheet highlighting the Inflation Reduction Act's monumental support for clean energy technologies that will lower energy costs for families and businesses while helping drive 2030 economy-wide greenhouse gas (GHG) emissions to 40% below 2005 levels. The legislation will also bolster domestic manufacturing and provide direct investments for overburdened and underserved communities across America. This is the first report by the United States government analyzing how the Inflation Reduction Act can reduce GHG pollution.

Even more, the Act will lower energy costs for working families with rebates and tax incentives for home energy improvements, solar energy, and electric vehicles. The Inflation Reduction Act enhances President Biden's strong executive actions on climate change, state and local government actions, as well as the game-changing innovation currently being developed by American workers and businesses. Together with the President's Bipartisan Infrastructure Law, these transformative accomplishments will help position the U.S. to reach President Biden's goal of reducing greenhouse gas emissions 50-52% in 2030.

Source: US Dept of Energy

The White House
@WhiteHouse

The Inflation Reduction Act will reduce greenhouse gas emissions by about a gigaton. That puts America on track to cut climate pollution by 40% and positions us to meet @POTUS' goal to cut that pollution in half by 2030.

4:30 PM · Aug 21, 2022 · The White House

Source: The White House

IRA Incentives & Investments

Impacts on the Commercial Market

~$216B*

In est. corporate **tax incentives** designed to catalyze private investment in **clean energy**, transport and manufacturing

$30.5B+

To **boost U.S. production to support building electrification**
(incl. energy storage & heat pumps)

$30B

To transition states & electric utilities to clean electricity

$3.42B

To decarbonize federal buildings through construction or retrofit

$1B+

In grants for **local governments to modernize commercial** & residential buildings to meet energy codes

$50M+

To reduce air pollutants in schools

*Source: McKinsey & Company

Updates to Tax Deduction

179D: Energy Efficient Commercial Buildings Tax Deduction

- Long-standing **tax deduction** for building owners
- **Expanded** for both **private & tax-exempt** entities
  *Added inclusion allows specified "**tax-exempt entities**" that own buildings to "**allocate**" 179D deduction amounts to "the person primarily responsible for **designing the property** in lieu of the owner of such property."
- Incentivizes commercial owners who **retrofit** or **newly construct** facilities to be energy efficient
- Increased deduction **up to $5/sq.ft.**
- **Reduced** improved efficiency threshold to **25%**
- **Alternative deduction** for energy efficient retrofit property allows comparison to **baseline energy use intensity**
- **3-year cap** (vs. previous lifetime), allowing for **multiple projects over time**

Notable Criteria to Reach Maximum

- ✓ Qualifying property must:
  - ✓ Be within scope of ASHRAE 90.1
  - ✓ Be in service after 12/31/2022
- ✓ Qualifying improvements include: **HVAC & hot water systems,** building envelope, **interior lighting** and more
- ✓ Bonus deduction – must meet prevailing wages and apprenticeship requirements*
- ✓ Retrofit buildings must be in service 5+ years to qualify for alt. deduction path

Efficiency Gain Over Baseline	**Base Deduction Rate**	**Bonus Deduction Rate***
25% (min)	$0.50 / sq.ft.	$2.50 / sq.ft.
30%	$0.60 / sq.ft.	$3.00 / sq.ft.
35%	$0.70 / sq.ft.	$3.50 / sq.ft.
40%	$0.80 / sq.ft.	$4.00 / sq.ft.
50% (max)	**$1.00 / sq.ft.**	**$5.00 / sq.ft.**

Source: full text of the legislation (Link) | Disclaimer: Trane does not provide tax, legal, or accounting advice. This material is for informational purposes only and it should not be relied on for tax, legal, or accounting advice. Tax law is subject to continual change. All decisions are your responsibility, and you should consult your own tax, legal, and accounting advisors. Trane disclaims any responsibility for actions taken on the material presented.

Updates to Investment Tax Credit

48 ITC: Energy Investment Tax Credit

- Long-standing **tax credit** for private and non-taxable entities
- **Historically for qualified "energy property"**
  - Includes: solar, fuel cells, microturbines, geothermal heat pumps and combined heat and power
- **Expanded to include thermal energy storage property** – defined as: Property comprising a **system** which:
  - i. is directly connected to a heating, ventilation, or air conditioning system,
  - ii. removes heat from, or adds heat to, a storage medium for subsequent use, and
  - iii. provides energy for the heating/cooling of the interior of a residential or commercial building
- Increased credit value of **up to 50% of the cost** for energy property projects
- Timeframe base credit rates apply:
  - **Thermal energy storage:** 12/31/2022-12/31/2024
  - Geothermal heat pumps: phase out from 6%-4.4% from 12/31/2021 – 1/1/2035

Updated Investment Tax Credit	
Base Rate	**6%**
Increased Credit Amount*	**Up to 30%**
Meets Domestic Content Requirements**	**2% or 10%**
Meets Energy Communities Requirements***	**2% or 10%**
Total Potential Credit Value	**Up to 6% Base + Up to 50% Bonus**

*Increase Credit Amount: must meet prevailing wage and apprenticeship requirements **Domestic Content: i.e., materials are made in the USA ***Energy Communities: a brownfield site (as defined by the EPA); a community with above-average unemployment rate and 1) $0.17 direct employment or 2) 25%+ local tax revenue from coal, oil or nat gas processes; census tracts containing mines and/or coal-fired generating units that have retired after 12/31/1999 or 12/31/2009 respectively | Source: full text of the legislation (Link) | Disclaimer: Trane does not provide tax, legal, or accounting advice. This material is for informational purposes only and it should not be relied on for tax, legal, or accounting advice. Tax law is subject to continual change. All decisions are your responsibility, and you should consult your own tax, legal, and accounting advisors. Trane disclaims any responsibility for actions taken on the material presented.

IRS Form 3468

2022

Instructions for Form 3468

Department of the Treasury
Internal Revenue Service

Investment Credit

Section references are to the Internal Revenue Code unless otherwise noted.

Future Developments

For the latest information about developments related to Form 3468 and its instructions, such as legislation enacted after they were published, go to *IRS.gov/Form3468*.

What's New

New advanced manufacturing investment credit. The Creating Helpful Incentives To Produce Semiconductors (CHIPS) Act of 2022, P.L. 117-167, Div. A, sec. 107, added a new investment credit equal to 25% of the qualified investment in any advanced manufacturing facility for the primary purpose of manufacturing of semiconductors or semiconductor manufacturing equipment. This credit applies to property placed in service after 2022, and, for any property the construction of which begins prior to 2023, only to the extent of the basis thereof attributable to the construction, reconstruction, or erection after August 9, 2022. See *Advanced Manufacturing Investment Credit*, later.

If properly elected, an eligible taxpayer, can treat the amount of the credit attributable to any advanced manufacturing facility for the tax year as a payment against the tax. A partnership or S

General Instructions

Purpose of Form

Use Form 3468 to claim the investment credit. The investment credit consists of the following credits.

- Rehabilitation.
- Energy.
- Qualifying advanced coal project.
- Qualifying gasification project.
- Qualifying advanced energy project.
- Advanced manufacturing investment.

If you file electronically, you must send in a paper Form 8453, U.S. Individual Income Tax Transmittal for an IRS *e-file* Return, if attachments are required for Form 3468.

Investment Credit Property

Investment credit property is any depreciable or amortizable property that qualifies for the rehabilitation credit, energy credit, qualifying advanced coal project credit, qualifying gasification project credit, qualifying advanced energy project credit, or advanced manufacturing investment credit.

You can't claim a credit for property that is:

- Used mainly outside the United States (except for property

IRS Form 3468

Thermal energy storage property. Thermal energy storage property is property comprising a system that:

- Is directly connected to a heating, ventilation, or air conditioning system;
- Removes heat from, or adds heat to, a storage medium for subsequent use; and
- Provides energy for the heating or cooling of the interior of a residential or commercial building.

Thermal energy storage property doesn't include:

- A swimming pool,
- Combined heat and power system property, or
- A building or its structural components.

Enter the basis on Line 12hh Worksheet, line 1, attributable to periods after 2022, of any energy storage technology property placed in service during the tax year, to the extent of basis attributable to construction, reconstruction, or erection by the taxpayer after August 16, 2022. Attach to your return a statement with the description of how you calculated the credit. See *Additional information*, later, for more information.

Additional information. You must attach a statement to Form 3468 that includes the following information.

1. Your name, address, taxpayer identification number, and telephone number.
2. For each qualified investment credit facility property, include the following.
   a. A detailed technical description of the facility, including generating capacity.
   b. A detailed technical description of the energy property placed in service during the tax year as an integral part of the facility, including a statement that the property is an integral part of such facility.
   c. The date that the energy property was placed in service.
   d. An accounting of your basis in the energy property.
   e. A depreciation schedule reflecting your remaining basis in the energy property after the energy credit is claimed.
3. A statement that you haven't and won't claim a Section 1603 grant for new investment in the property for which you are claiming the energy credit.
4. A declaration, applicable to the statement and any accompanying documents, signed by you, or signed by a person currently authorized to bind you in such matters that state the following: "Under penalties of perjury, I declare that I have examined this statement, including accompanying documents, and to the best of my knowledge and belief, the facts presented in support of this statement are true, correct, and complete."

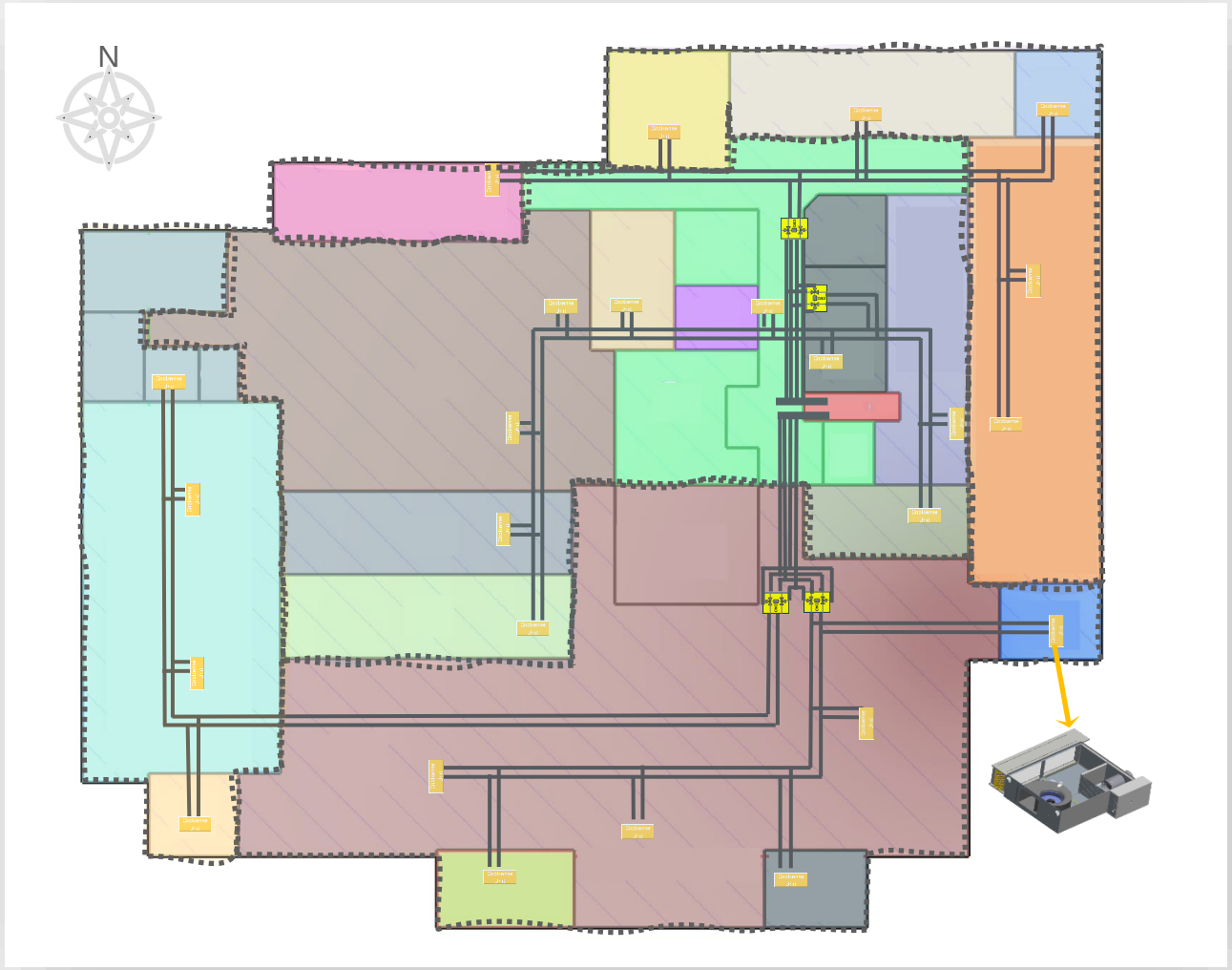
2022 Instructions for Form 3468 (irs.gov)

Thermal Energy Storage

- Provides demand flexibility and can reduce reliance on grid (thus reducing costs)
- Enables renewable energy and decarbonization
- Offers reliable power redundancy and assurance
- Incentivized by utility programs, federal tax incentives and local funding programs

Electrify CoolSense System

All-electric CoolSense System AWHP Heating – CoolSense System Options Compared



DOAS with Terminals System Modeled

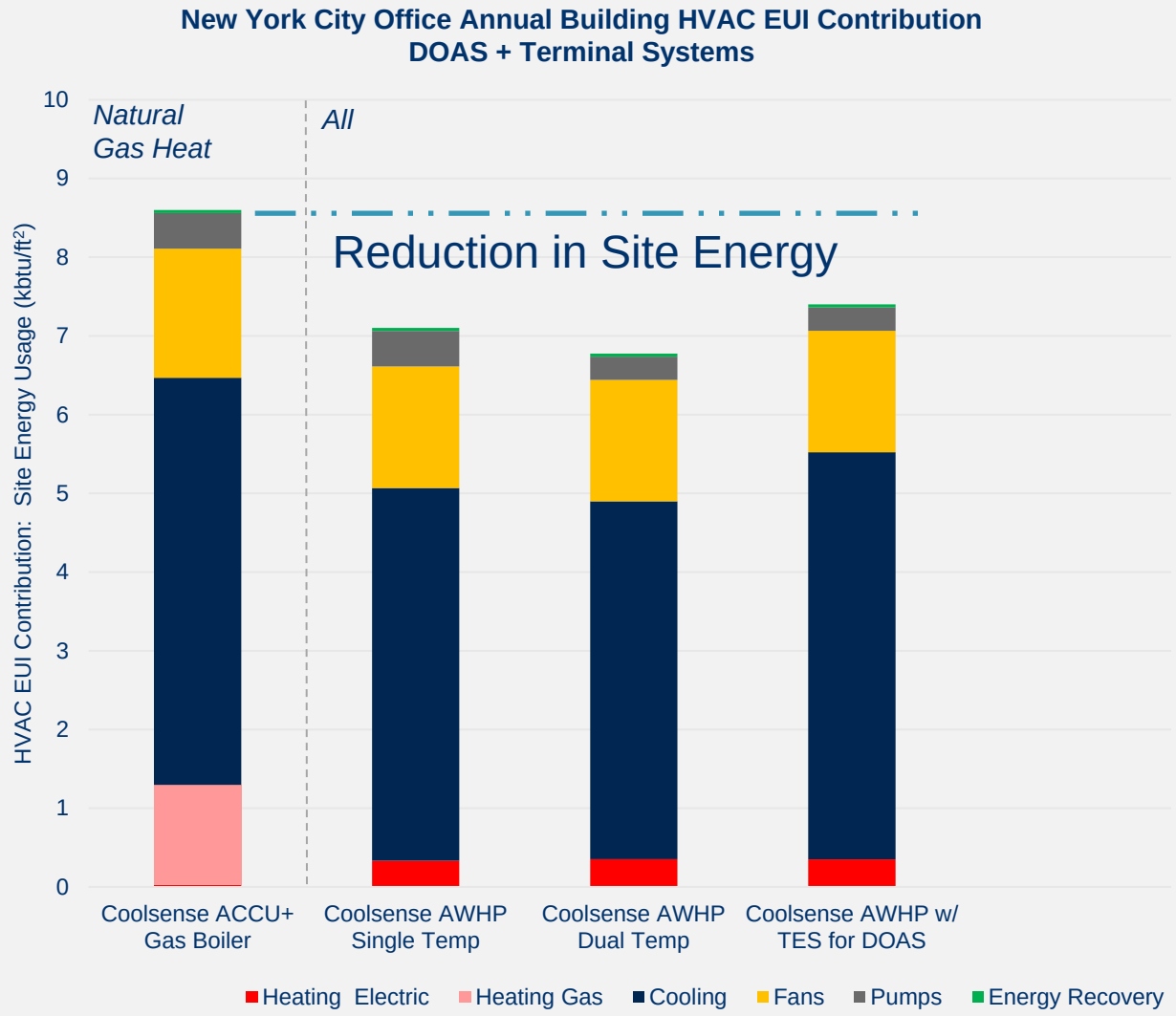
- Detailed Annual Model of Office Building
- Baseline: CoolSense System with Natural Gas
- Electrify Benefits of three CoolSense Systems
  - Site Source Energy Improvement
  - Source CO_2e Reduction
- All Electric Alternate System
  - DX DOAS and VRF Terminals

Models for 6 cities

- Different climate zones
- Different power grids (source emissions)

Electrify CoolSense System

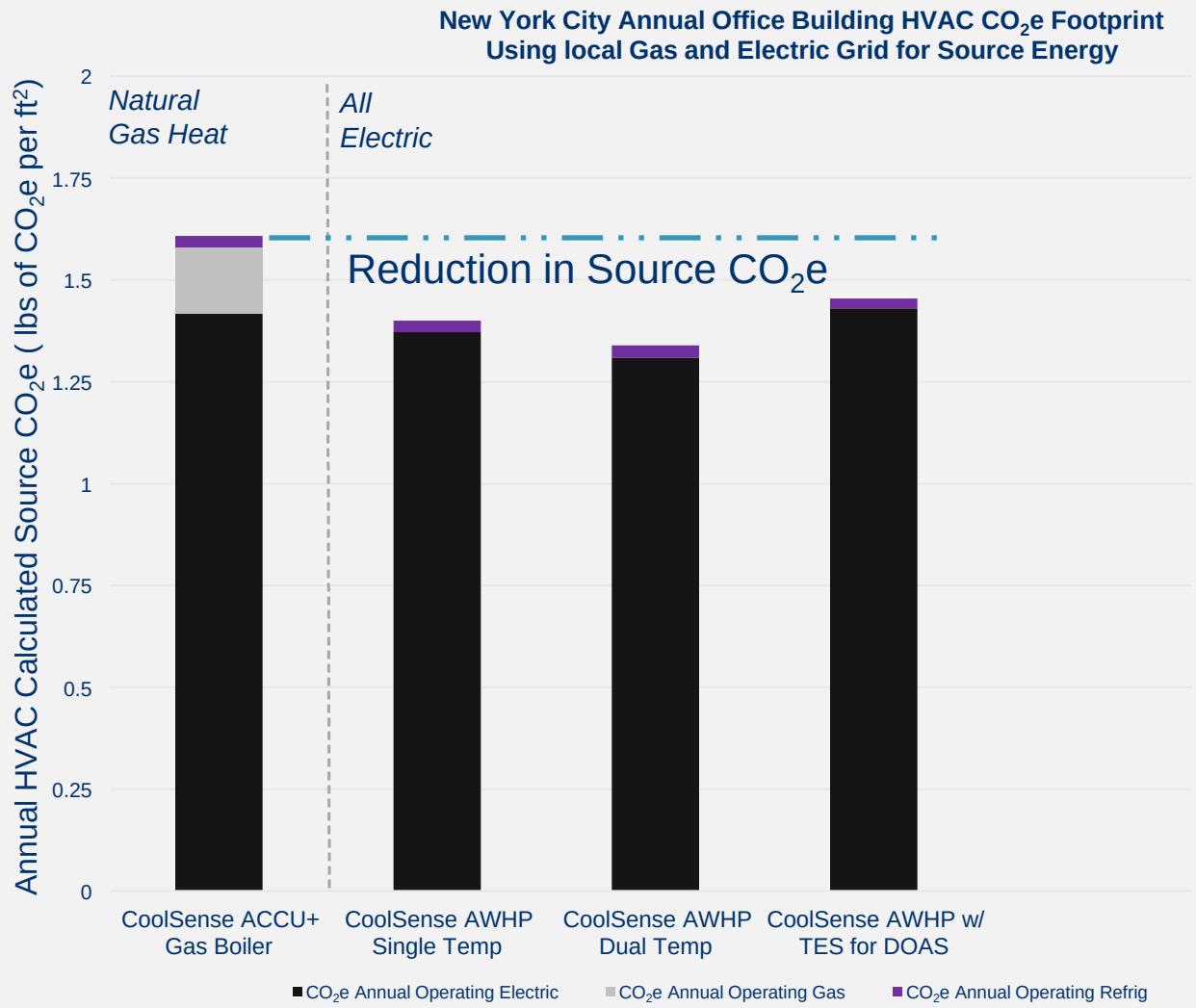
All-electric CoolSense System Input Energy Reduction – NYC



Similar energy as baseline, however, no fossil fuel use

Electrify CoolSense System

All-electric CoolSense System Input Energy Reduction – NYC

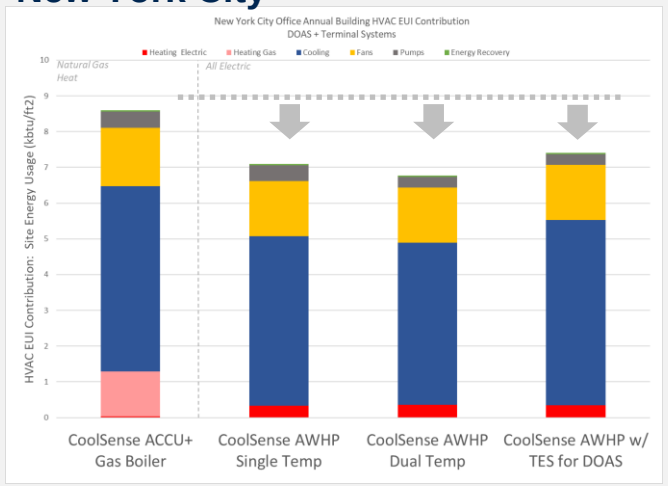


Significant Refrigerant Impact

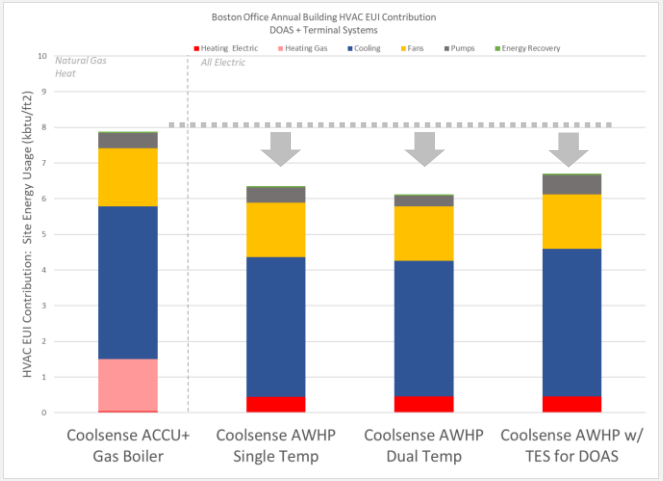
Electrify CoolSense System

All Electric CoolSense System Input Energy Reduction –All Cities Modeled

New York City

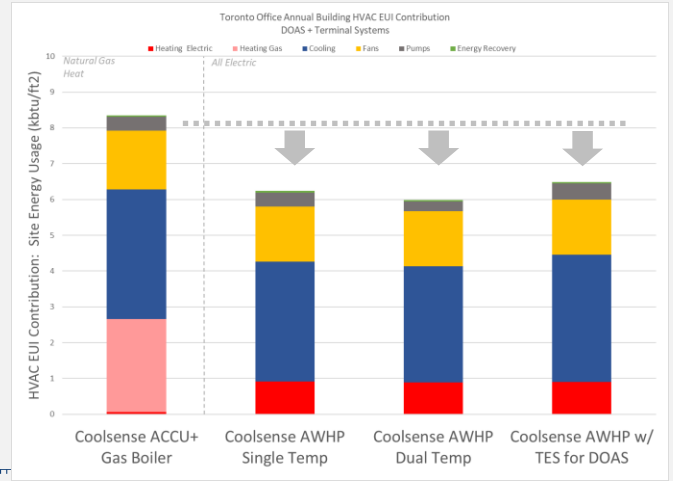


Boston

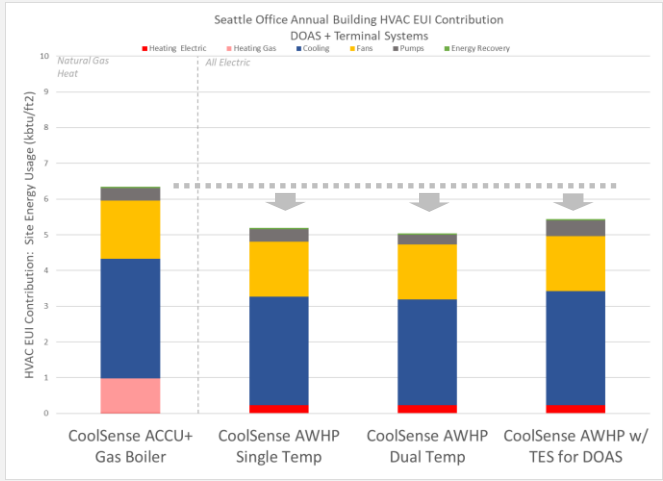


Houston

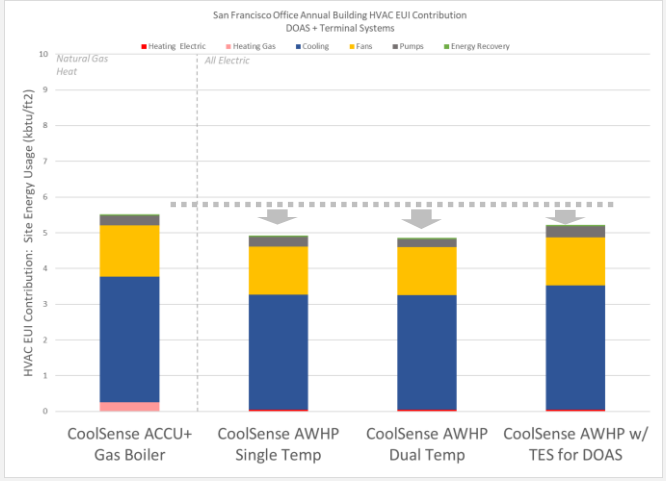
Toronto



Seattle



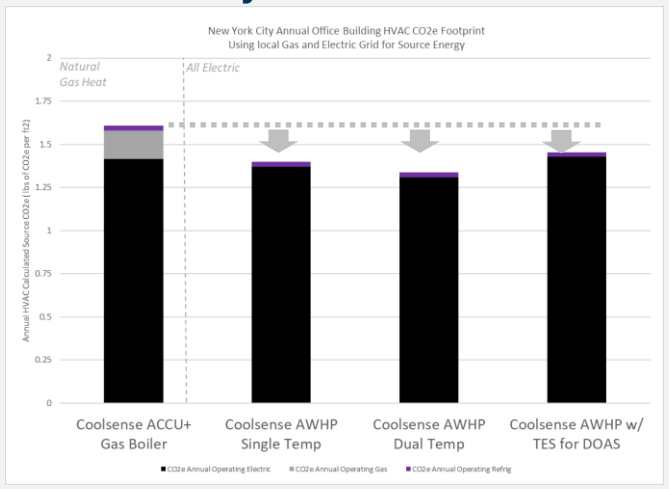
San Francisco



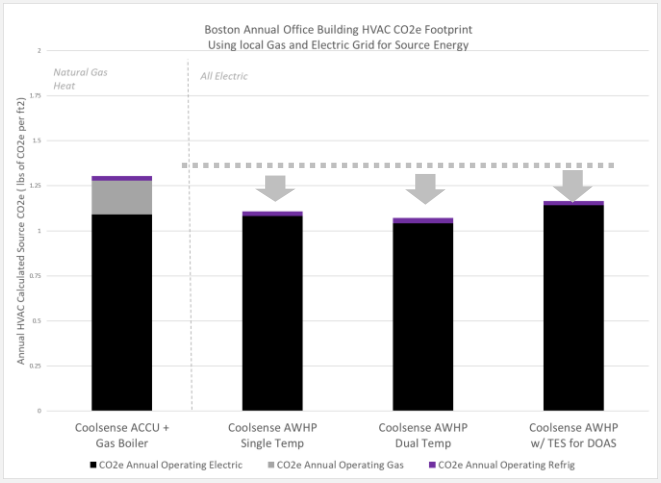
Electrify CoolSense System

All-electric CoolSense System Source CO_2e – All Cities Modeled

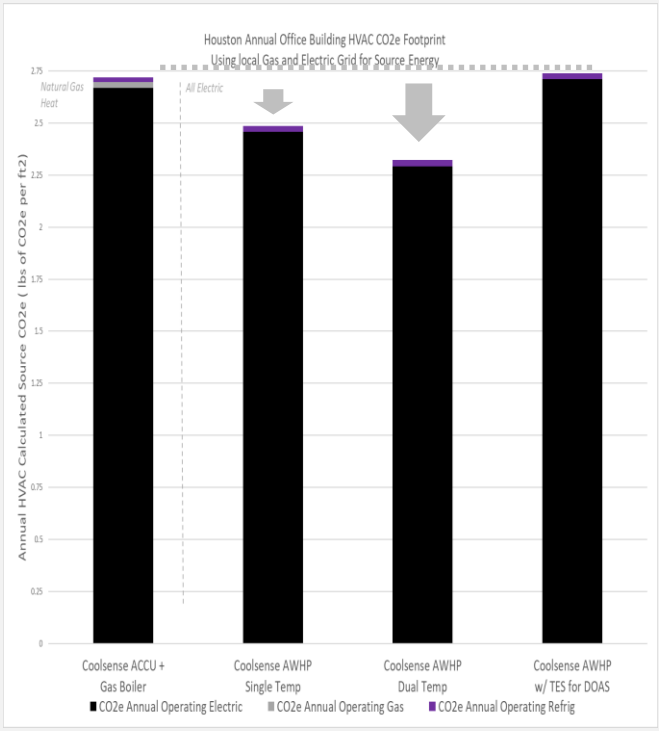
New York City



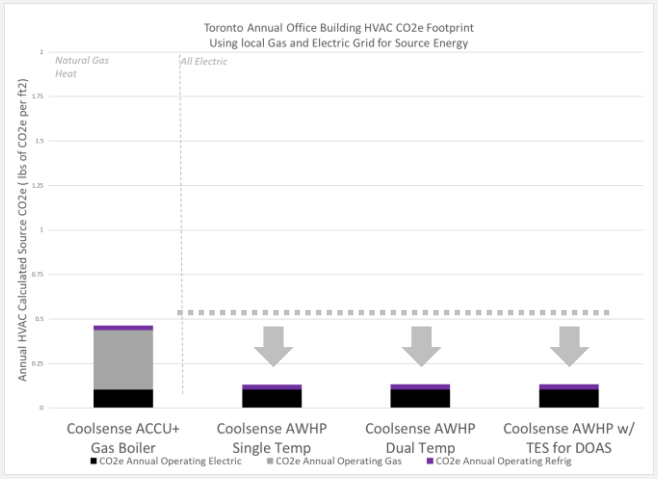
Boston



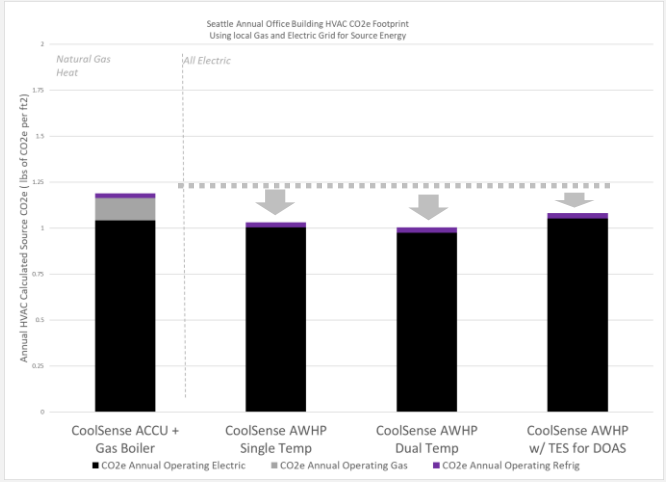
Houston



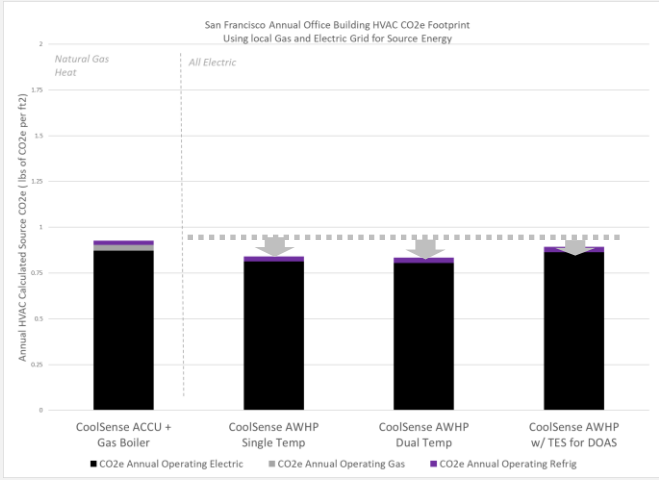
Toronto



Seattle

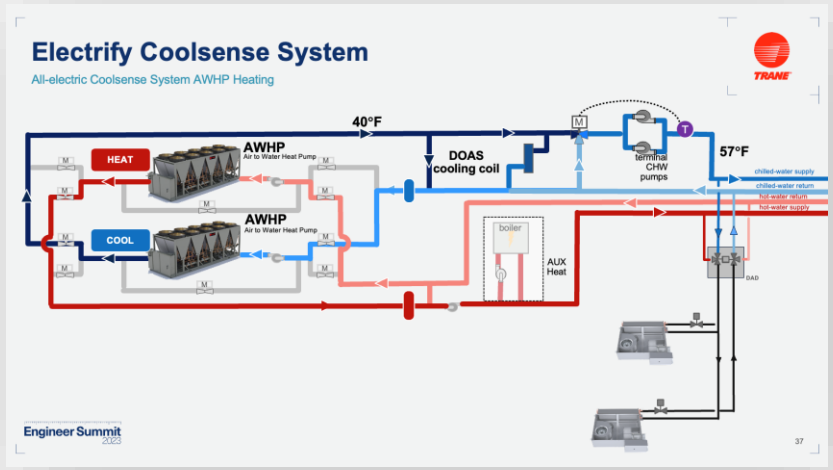


San Francisco

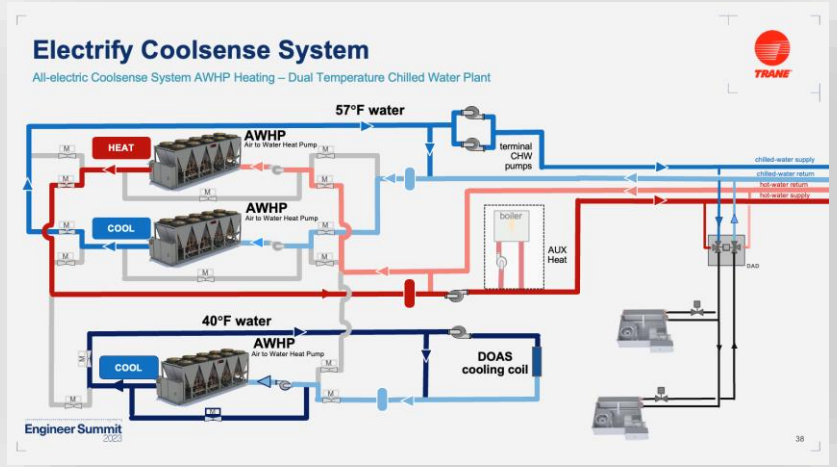


Electrify CoolSense System

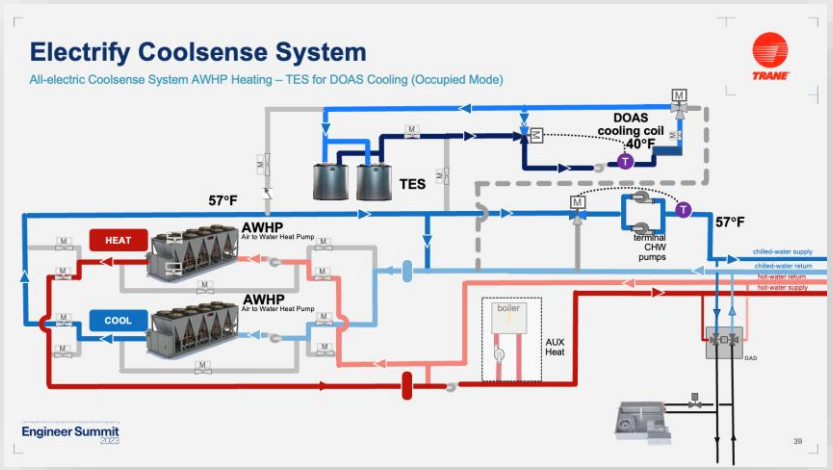
All-electric CoolSense System AWHP Heating Systems



Reduce CO_2e
Lowest Cost
Smaller Systems



Reduce CO_2e
Lowest Energy
Large Systems

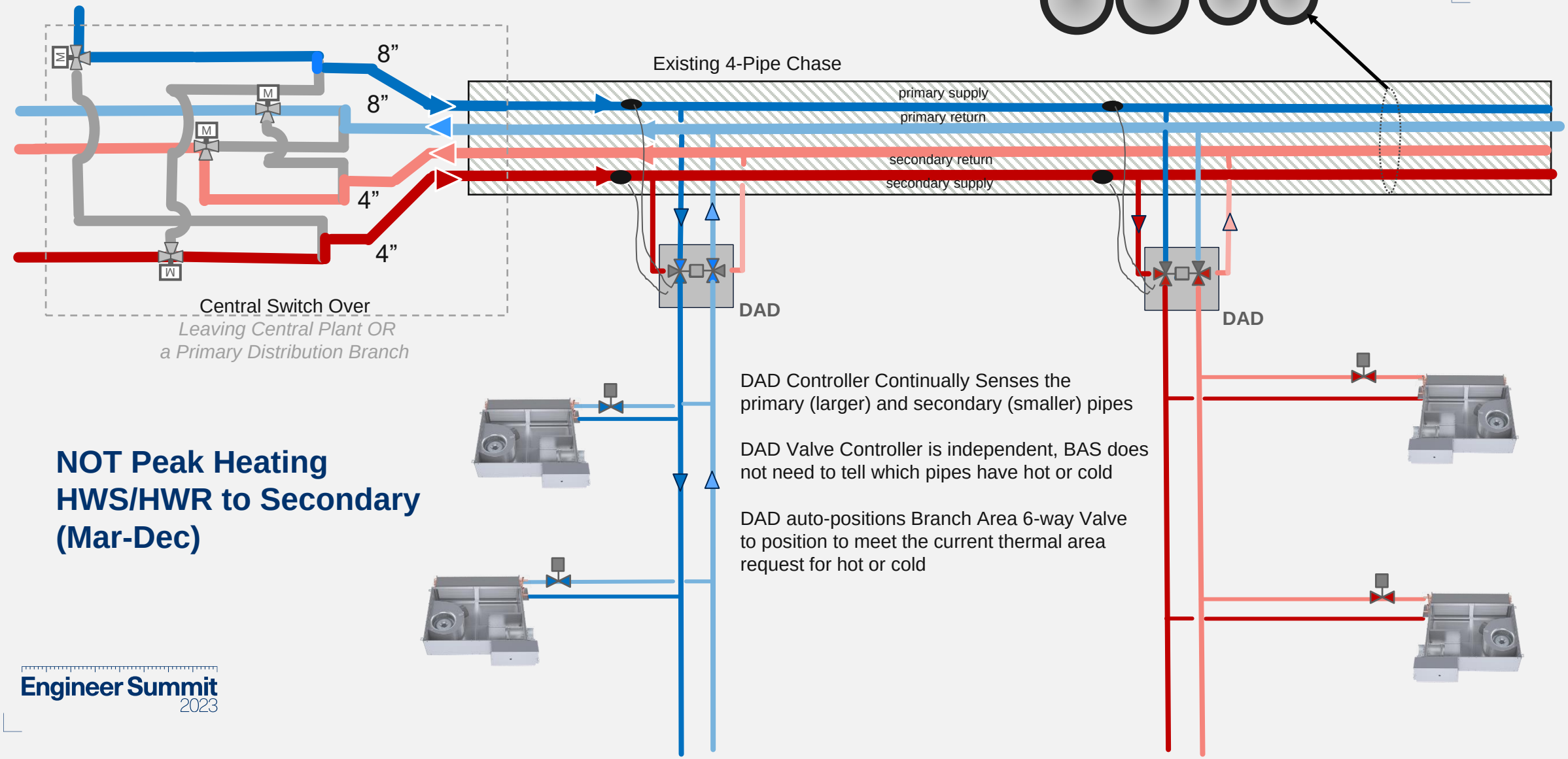


Reduce CO_2e
Reduce Daytime Power Demand
Reduce Installed Capacity
I.R.A. incentives

Using Distribution Area Directors to help with retrofits

Electrify CoolSense System

Reusing Undersized Central Pipe Chase: Distribution Area Director Auto-Switch



NOT Peak Heating
HWS/HWR to Secondary
(Mar-Dec)

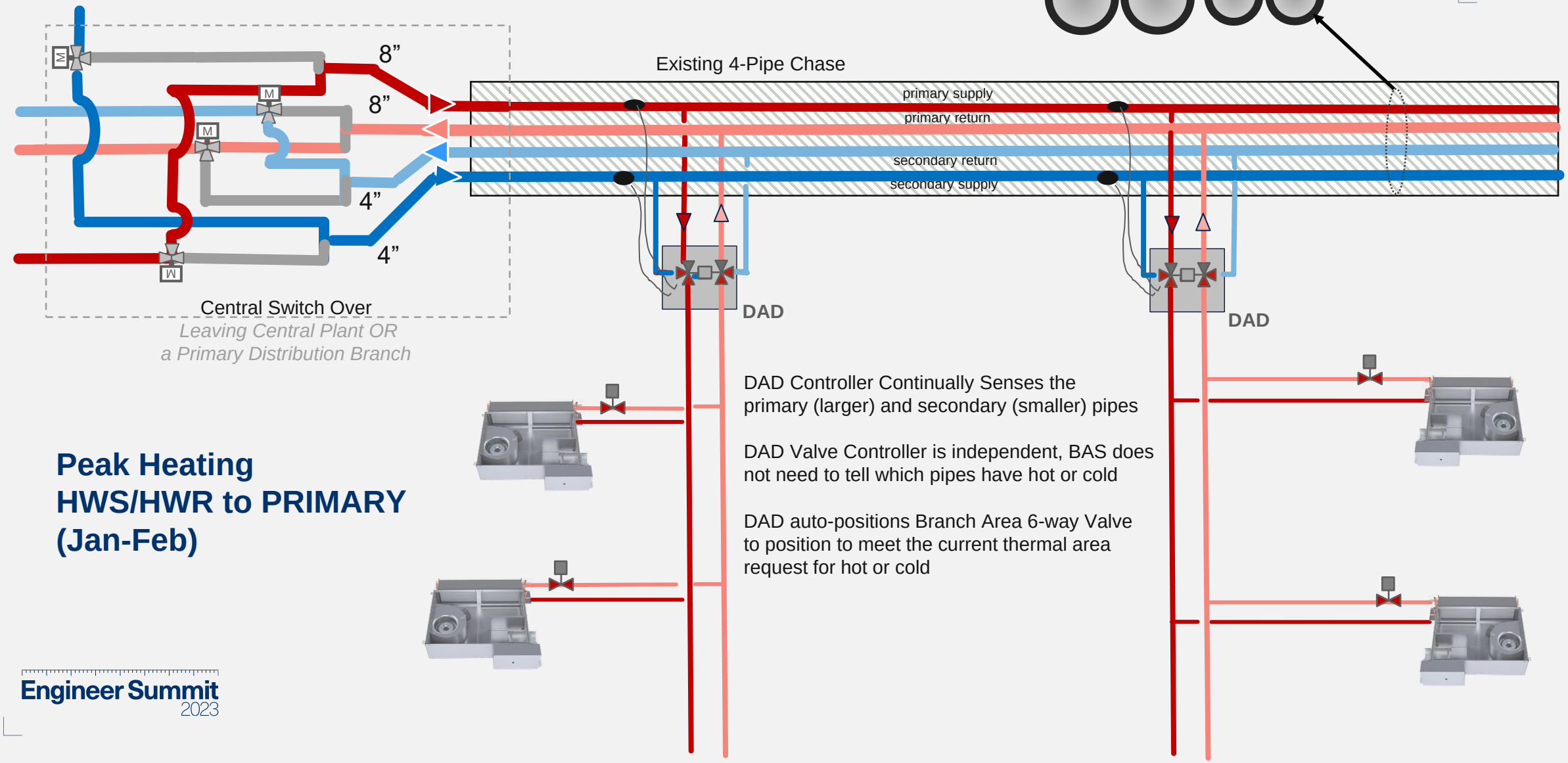
DAD Controller Continually Senses the primary (larger) and secondary (smaller) pipes

DAD Valve Controller is independent, BAS does not need to tell which pipes have hot or cold

DAD auto-positions Branch Area 6-way Valve to position to meet the current thermal area request for hot or cold

Electrify CoolSense System

Reusing Undersized Central Pipe Chase: Distribution Area Director Auto-Switch



Peak Heating
HWS/HWR to PRIMARY
(Jan-Feb)

DAD Controller Continually Senses the primary (larger) and secondary (smaller) pipes

DAD Valve Controller is independent, BAS does not need to tell which pipes have hot or cold

DAD auto-positions Branch Area 6-way Valve to position to meet the current thermal area request for hot or cold

Conclusions

- Building heating peak heat sizing and design practices need a closer look than the past when electrifying
- Designing for lower hot water temperature is the biggest impact for efficient operation when electrifying
- Distribution design using switch over terminal units with Distribution Area Directors can help in many ways
- All three electrified CoolSense Systems can reduce Annual CO_2e, what one to use depends on job goals

- **These concepts using Air To Water Heat pumps to electrify can be applied to other systems beyond CoolSense**

Thank you!

Any questions?

Engineer Summit 2023

Engineer Summit 2023