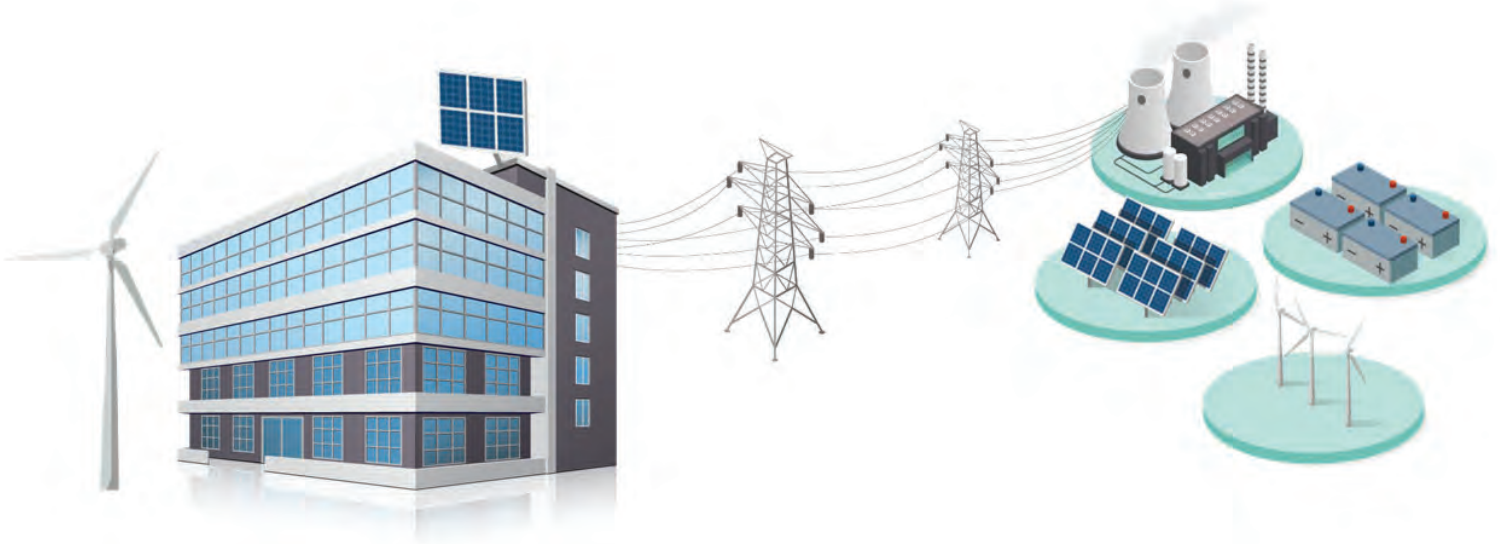




Trane Engineers Newsletter Live

Decarbonization/Electrification of HVAC Systems

with Trane Application Engineer, Charlie Jelen, and Centrifugal Chiller Product Support Engineer, Dan Gentry



Trane program number: APP-CMC074-EN

November 2020

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Agenda

Trane Engineers Newsletter Live Series

Decarbonization/Electrification of HVAC Systems

Abstract

Many municipalities throughout the United States are taking action to reduce their carbon emissions. One of the tactics they are using that effects the HVAC industry is the reduction, or removal, of natural gas for heating. This means our Industry will face the challenge of heating our buildings with electric heat. This ENL will cover the motivation to electrify, areas currently affected by this trend, and potential systems to meet electrification needs.

Presenters: Trane engineers Dan Gentry and Charlie Jelen

After viewing attendees will be able to:

1. Explain the concept and goals of electrification of HVAC systems
2. Understand the impact of policy to drive toward electrification
3. Identify areas in the U.S. that are moving toward electrification
4. Identify various systems and solutions that can be applied in an electrified HVAC system

Agenda

- Introduction
- What is electrification/decarb
- Why is it happening
- Where is it happening
- Product Solutions
 - Unitary
 - Distributed
 - Applied
 - Potable Hot Water



Presenter biographies

Decarbonization/Electrification of HVAC Systems

DAN GENTRY | CENTRIFUGAL PRODUCT SUPPORT ENGINEER | TRANE

Dan Gentry is a Marketing Engineer in the Centrifugal Product Support group starting in the summer of 2018 where he provides pre-sale support to the field. Dan first interned at Trane in the Technology Lab while attending school through 2008.

Dan graduated from Ferris State University in 2011 with a Bachelor's Degree in HVAC Engineering Technology. He has worked several years in chiller sales prior to coming back to Trane. Dan enjoys spending time with his family on the river, at the family cabin up north and relaxing.

CHARLES JELEN | APPLICATIONS ENGINEER | TRANE

Charles Jelen is an Application Engineer based out of La Crosse, WI. He is primarily responsible for pre-sale support of Trane systems and system design concepts. His areas of expertise are in chilled-water systems, refrigerants, electrification, and system modeling. Charles has been with Trane for 9 years and has held roles as TRACE 700 Product Manager, Centrifugal and Water-Cooled Product Support Engineer, and C.D.S.(Customer Direct Service) Support Engineer.

Prior to joining Trane Charles worked as an application and sales engineer for a process automation company out of Minneapolis, MN. Charles earned his bachelor's degree in Mechanical Engineering from the University of Minnesota and is a member of ASHRAE.



Decarb / Electrification of HVAC Systems: Part 1

Trane Engineers Newsletter Live Series

1

The logo for the American Institute of Architects (AIA) Continuing Education System, featuring the text 'CONTINUING EDUCATION' in a circular arrangement around the AIA logo.

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Credit for viewing today's program can be applied toward LEED® credential maintenance requirements.

www.USGBC.org

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www.RCEP.net

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Learning Objectives

- Understand why electrification is happening.
- Understand the type of policy that might be impacting your city and state.
- Learn which products are currently available to help electrify HVAC systems

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Agenda

- Introduction
 - What is electrification/decarb
 - Why is it happening
 - Where is it happening
- Product Solutions
 - Unitary
 - Distributed
 - Applied
 - Potable Hot Water

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Today's Presenters



Charles Jelen
Applications Engineer



Dan Gentry
Marketing Engineer –
Centrifugal Chillers

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Sections

- What is Decarb / Electrification
- Heat Pump Considerations
- Product Solutions


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What is Decarb / Electrification ?


DECARBONIZE

Reduce carbon emissions

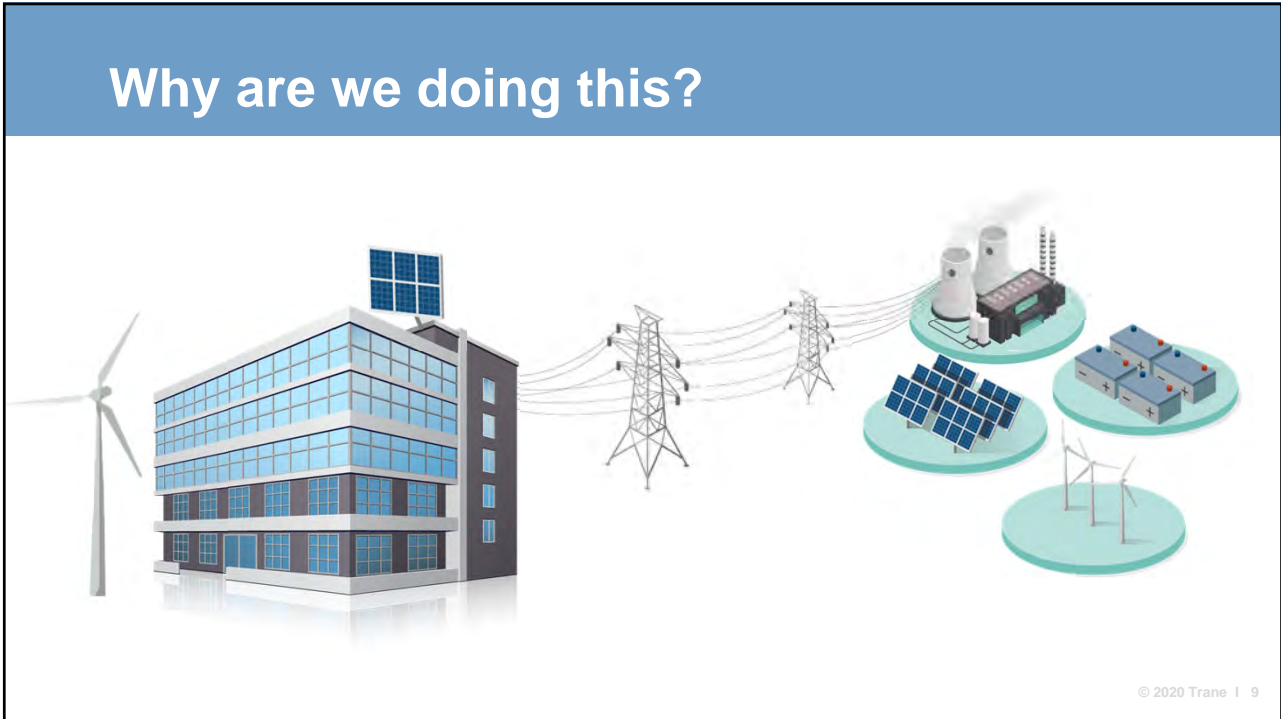


ELECTRIFICATION

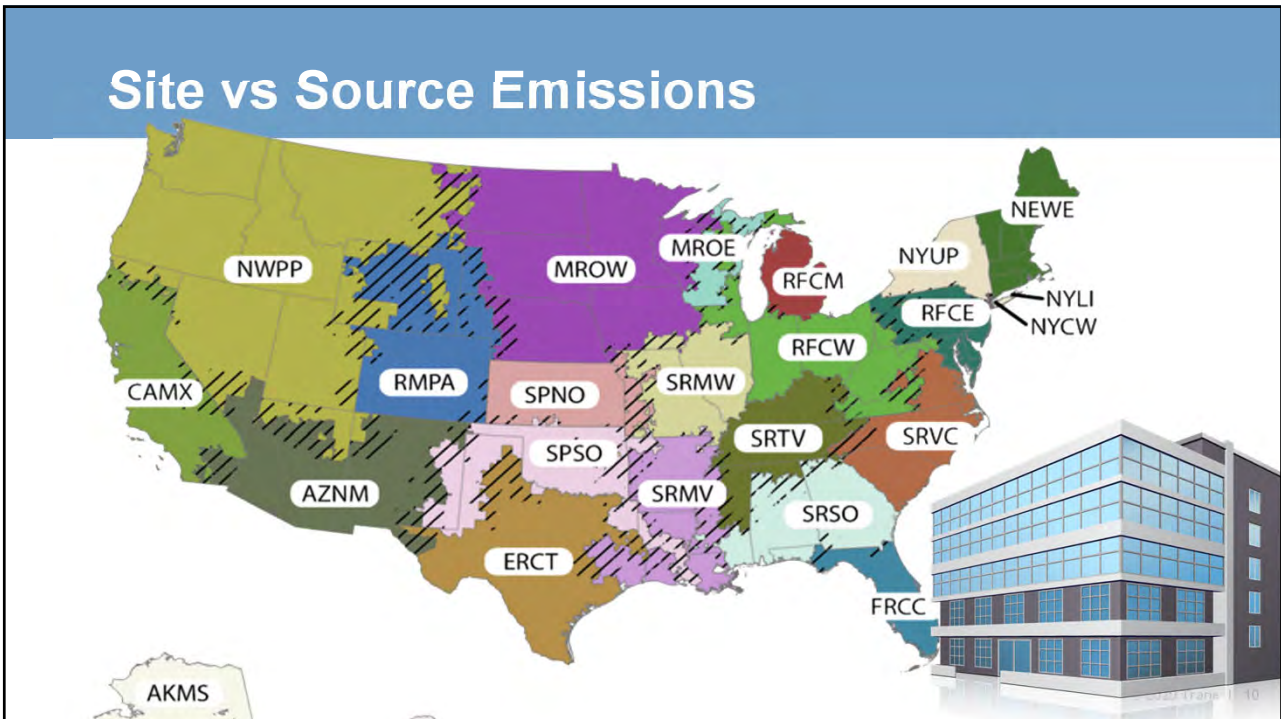
Utilizing electricity in place of burning fossil fuels



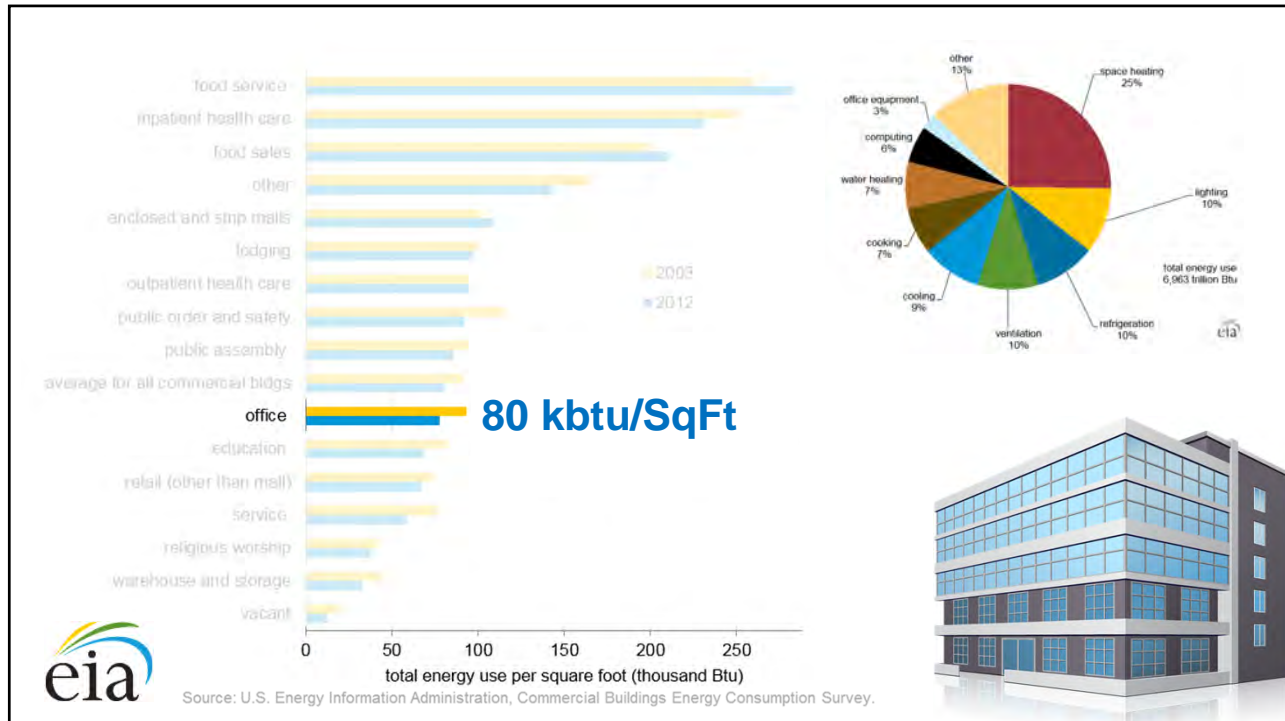
8



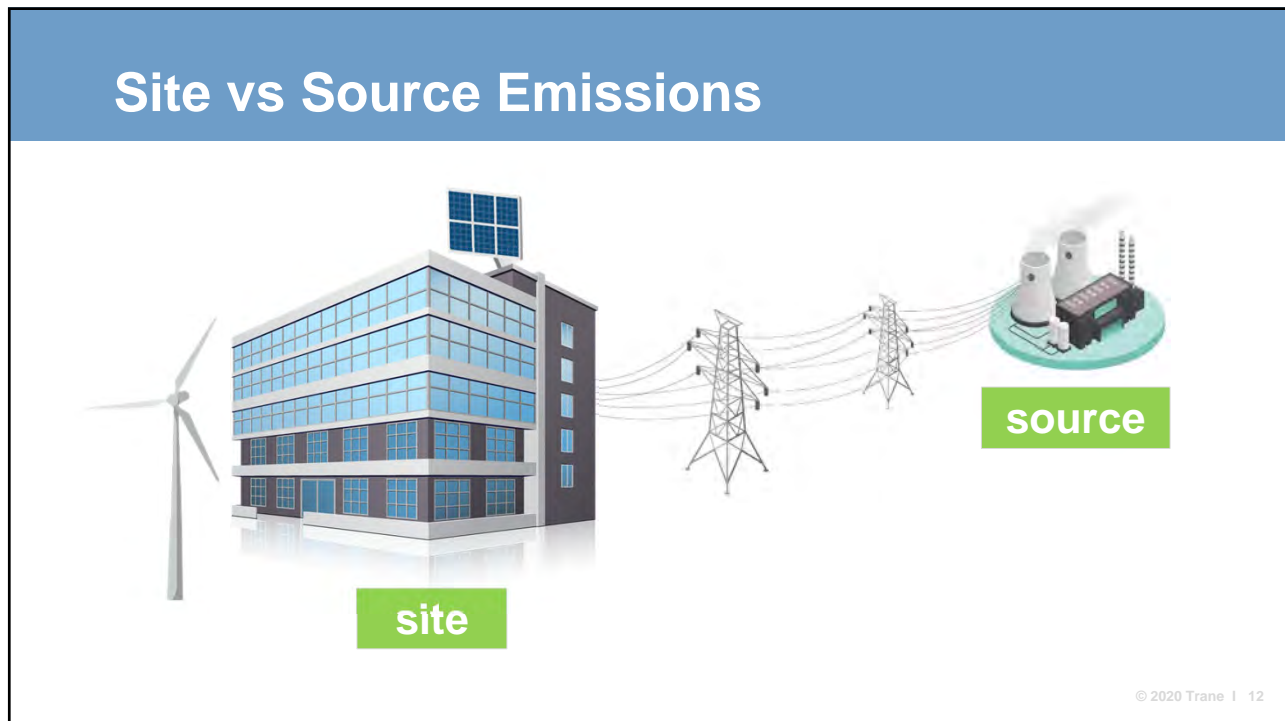
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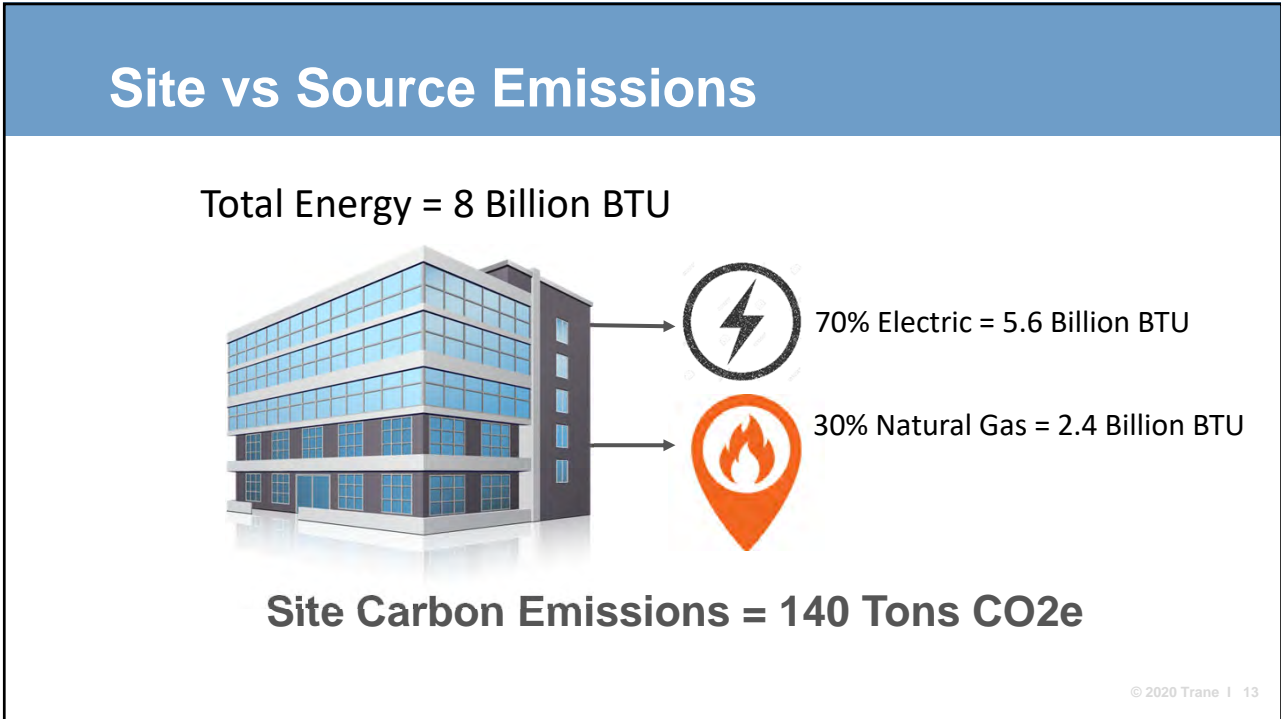
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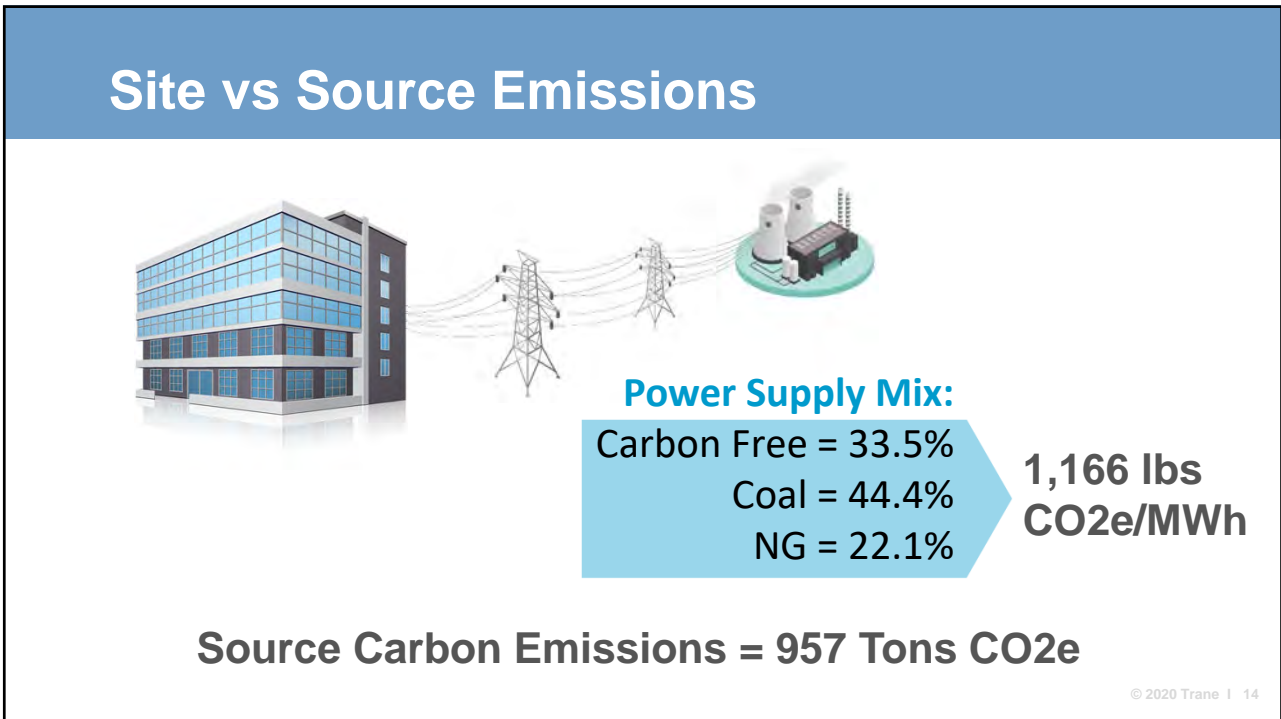
11



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Site vs Source Emissions

site





source




	Gas/Electric Today
Total Energy	8 Billion BTU
On Site Natural Gas	2.4 Billion BTU
Electricity	5.6 Billion BTU
Site Carbon CO2 Emissions	140 Tons
Source Carbon CO2 Emissions	957 Tons
Total CO2 Emissions	1,097 Tons


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Site vs Source Emissions

site





source



	Gas/Electric Today	All Electric Today
Total Energy	8 Billion BTU	6.4 Billion BTU
On Site Natural Gas	2.4 Billion BTU	0 BTU
Electricity	5.6 Billion BTU	6.4 Billion BTU
Site Carbon CO2 Emissions	140 Tons	
Source Carbon CO2 Emissions	957 Tons	
Total CO2 Emissions	1,097 Tons	

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Site vs Source Emissions

Power Supply Mix:
 Carbon Free = ~~33.5%~~ 67%
 Coal = ~~44.4%~~ 10%
 NG = ~~22.1%~~ 23%

	Gas/Electric Today	All Electric Today	Gas/Electric 2030
Total Energy	8 Billion BTU	6.4 Billion BTU	
On Site Natural Gas	2.4 Billion BTU	0 BTU	
Electricity	5.6 Billion BTU	6.4 Billion BTU	
Site Carbon CO2 Emissions	140 Tons	0 Tons	
Source Carbon CO2 Emissions	957 Tons	1,094 Tons	
Total CO2 Emissions	1,097 Tons	1,094 Tons	

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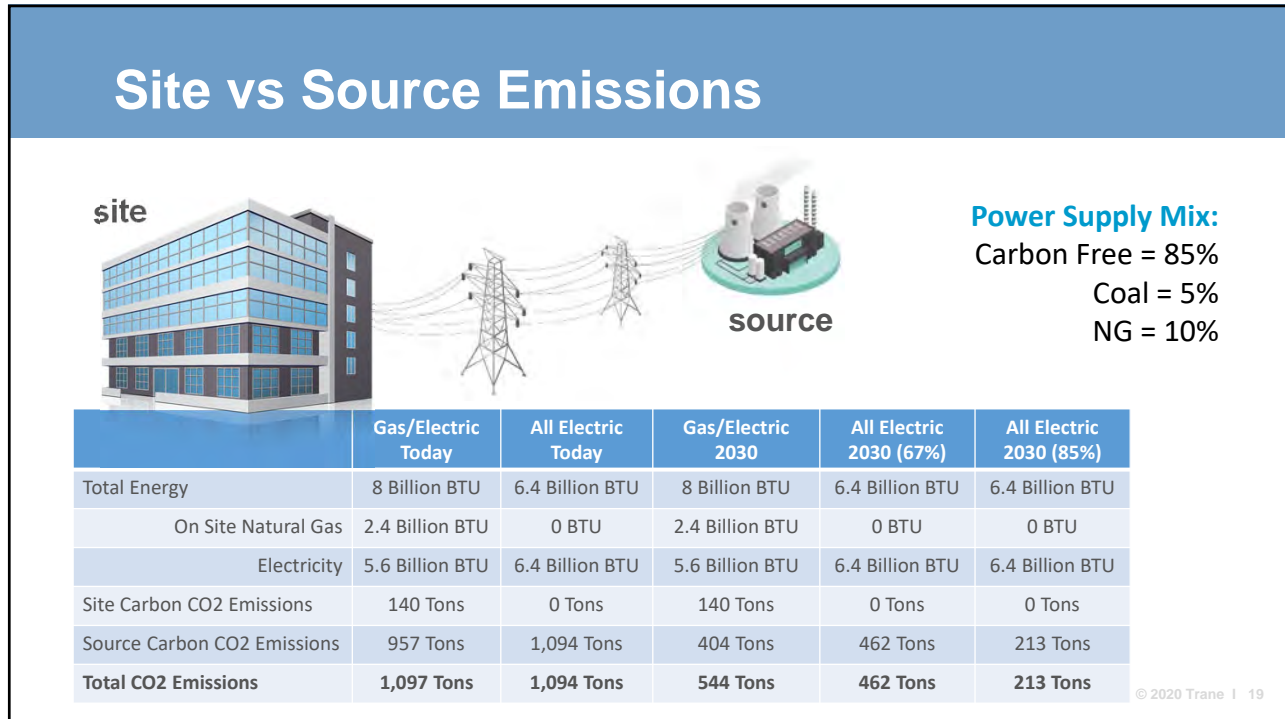
Site vs Source Emissions

Power Supply Mix:
 Carbon Free = ~~33.5%~~ 67%
 Coal = ~~44.4%~~ 10%
 NG = ~~22.1%~~ 23%

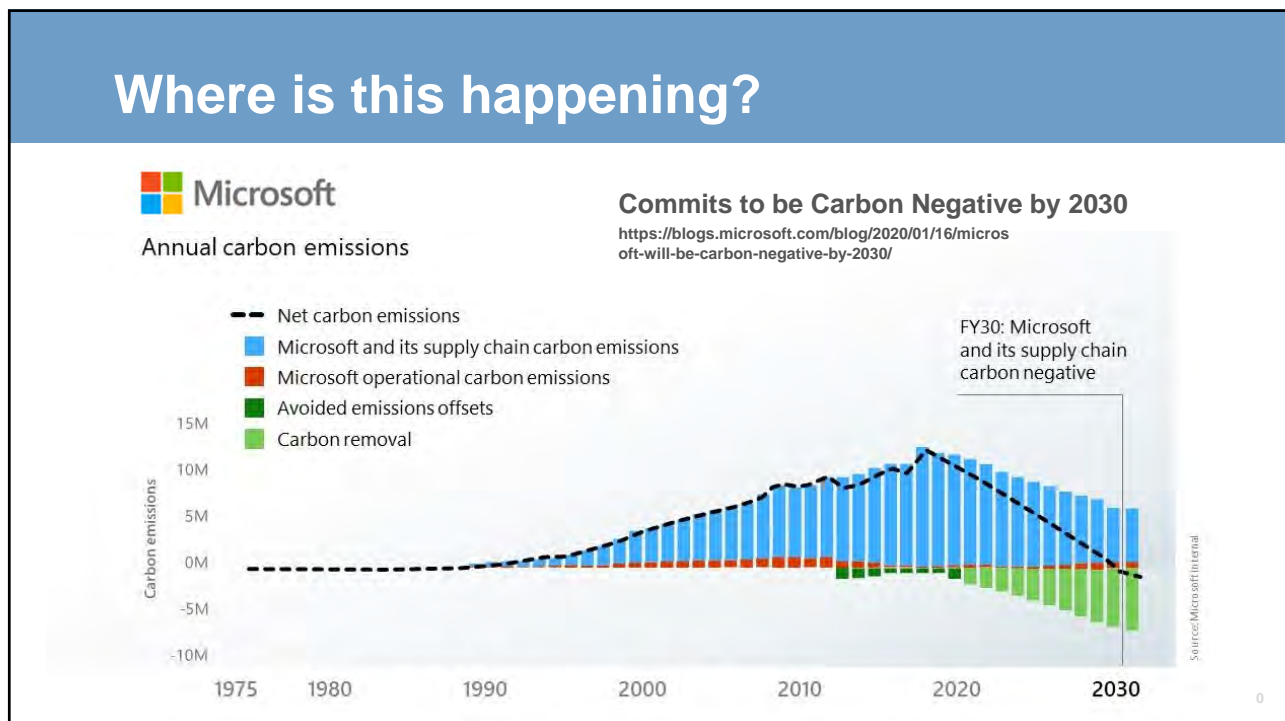
	Gas/Electric Today	All Electric Today	Gas/Electric 2030	All Electric 2030 (67%)
Total Energy	8 Billion BTU	6.4 Billion BTU	8 Billion BTU	6.4 Billion BTU
On Site Natural Gas	2.4 Billion BTU	0 BTU	2.4 Billion BTU	0 BTU
Electricity	5.6 Billion BTU	6.4 Billion BTU	5.6 Billion BTU	6.4 Billion BTU
Site Carbon CO2 Emissions	140 Tons	0 Tons	140 Tons	
Source Carbon CO2 Emissions	957 Tons	1,094 Tons	404 Tons	
Total CO2 Emissions	1,097 Tons	1,094 Tons	544 Tons	

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The screenshot shows the Trane Technologies website. At the top, the logo 'TRANE TECHNOLOGIES' is on the left, and navigation links for 'ThermoKing.com', 'Trane.com', 'TT 129.12 -0.68', and 'Language' are on the right. Below the logo are links for 'Company', 'Brands', 'Sustainability', 'Careers', 'News', and 'Investors'. The main banner features the text 'The Gigaton Challenge' and 'Doing What It Takes to Make a (Huge) Difference' over a background image of a forest. Below the banner are three smaller content blocks: 'One Gigaton of CO₂e' with a commitment statement, '1 Gigaton of CO₂e =' with a map of Europe, and 'Why We Need to Address Decarbonization' with images of aging buildings and energy intensity.

21

The slide is titled 'Decarb Policy Timing' in a blue header. Below the title is a map of the United States with green dots placed in various states, including Washington, Oregon, California, Nevada, Arizona, New Mexico, Texas, Colorado, Utah, Idaho, Montana, Wyoming, North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, Missouri, Illinois, Indiana, Michigan, Ohio, Pennsylvania, New York, Vermont, New Hampshire, Maine, Massachusetts, Connecticut, Rhode Island, and Florida. A copyright notice '© 2020 Trane | 22' is located in the bottom right corner.

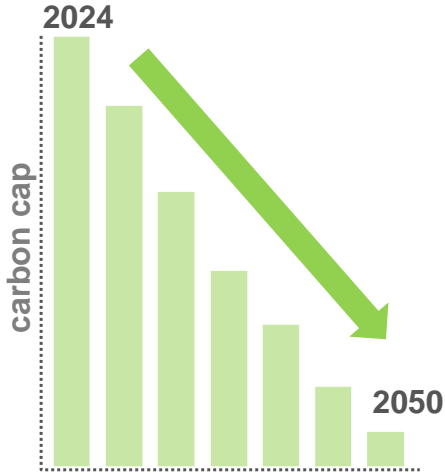
22



Example of Policy: Local Law 97

Carbon cap = Sq Ft x Building Type Factor

fuel oil (#2 / #4)
district steam
natural gas
electricity



carbon cap

2024

2050

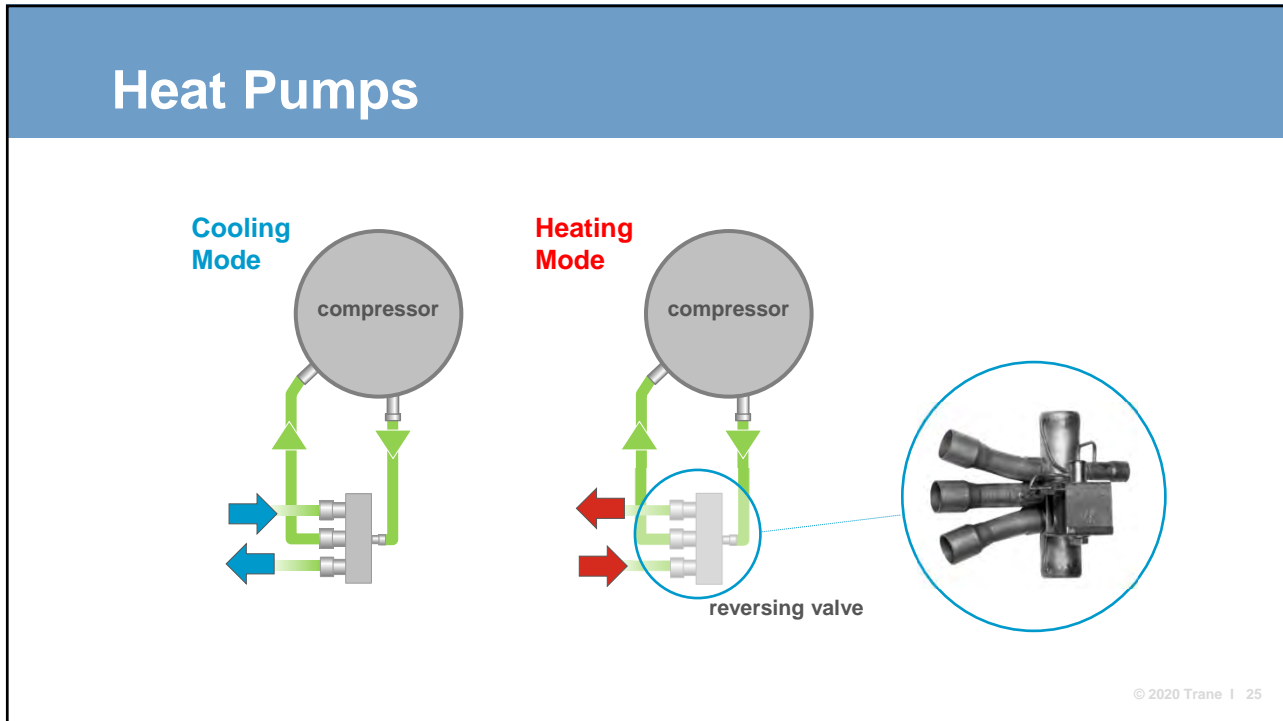
23

Sections

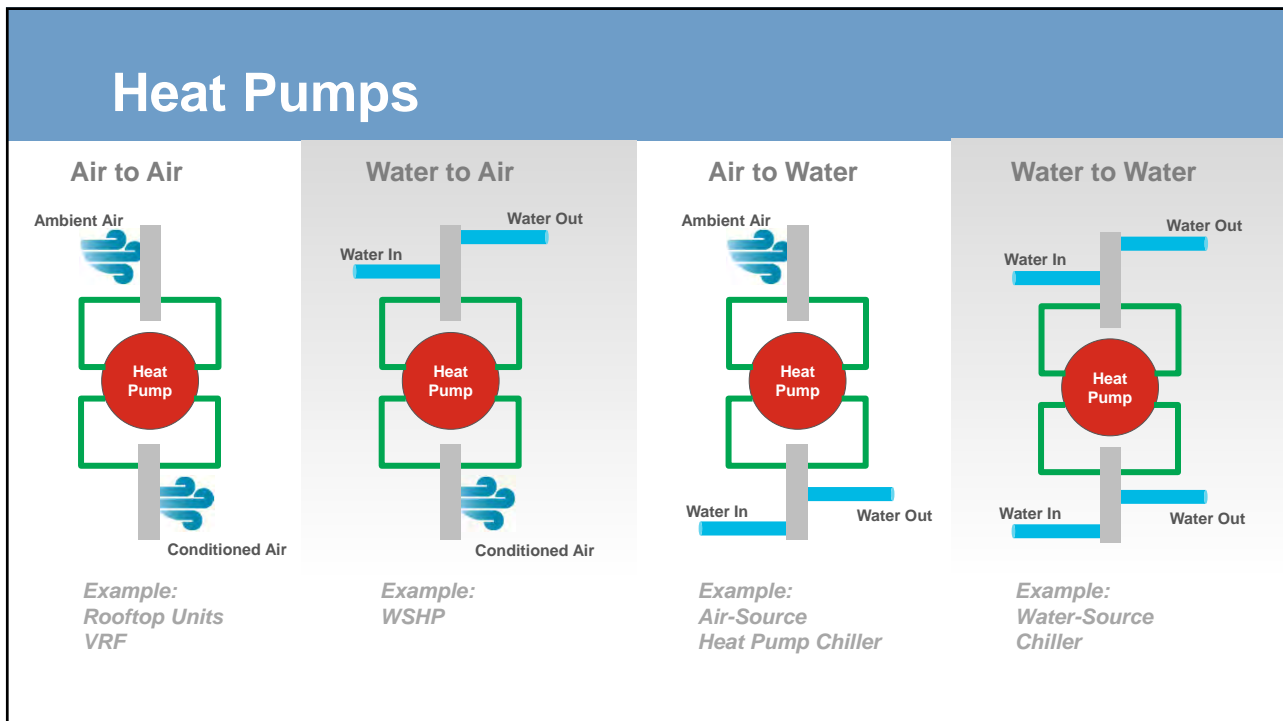
- What is Decarb / Electrification
- Heat Pump Considerations
- Product Solutions

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24



25



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Cold Climate Heat Pumps

Lat:40.779N Long:73.969W Elev:130 StdP:14.63 Time zone:-5.00 Period:95-14 WBAN:94728

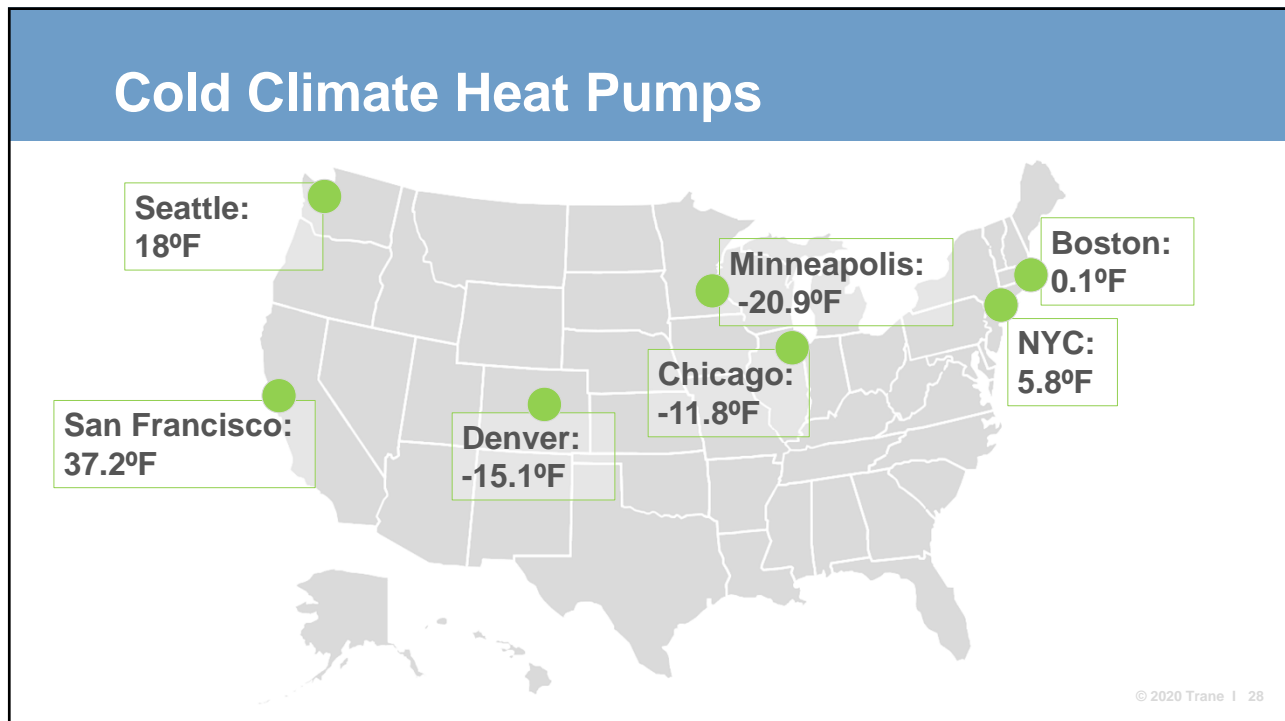
Annual Heating and Humidification Design Conditions														
Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB			MCWS/PCWD to 99.6% DB		
	99.6%	99%	99.6%		99%		0.4%			1%				
	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD		
1	13.5	17.5	-5.0	4.2	16.4	-0.9	5.3	20.7	20.8	31.7	19.0	30.2	9.9	300

Annual Cooling, Dehumidification, and Enthalpy Design Conditions															
Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB				MCWS/PCWD to 0.4% DB			
		0.4%		1%		2%		0.4%		1%		2%			
	DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD	
7	14.1	91.0	73.7	88.0	72.4	85.3	71.3	76.7	85.4	75.4	83.1	74.3	81.3	6.1	260

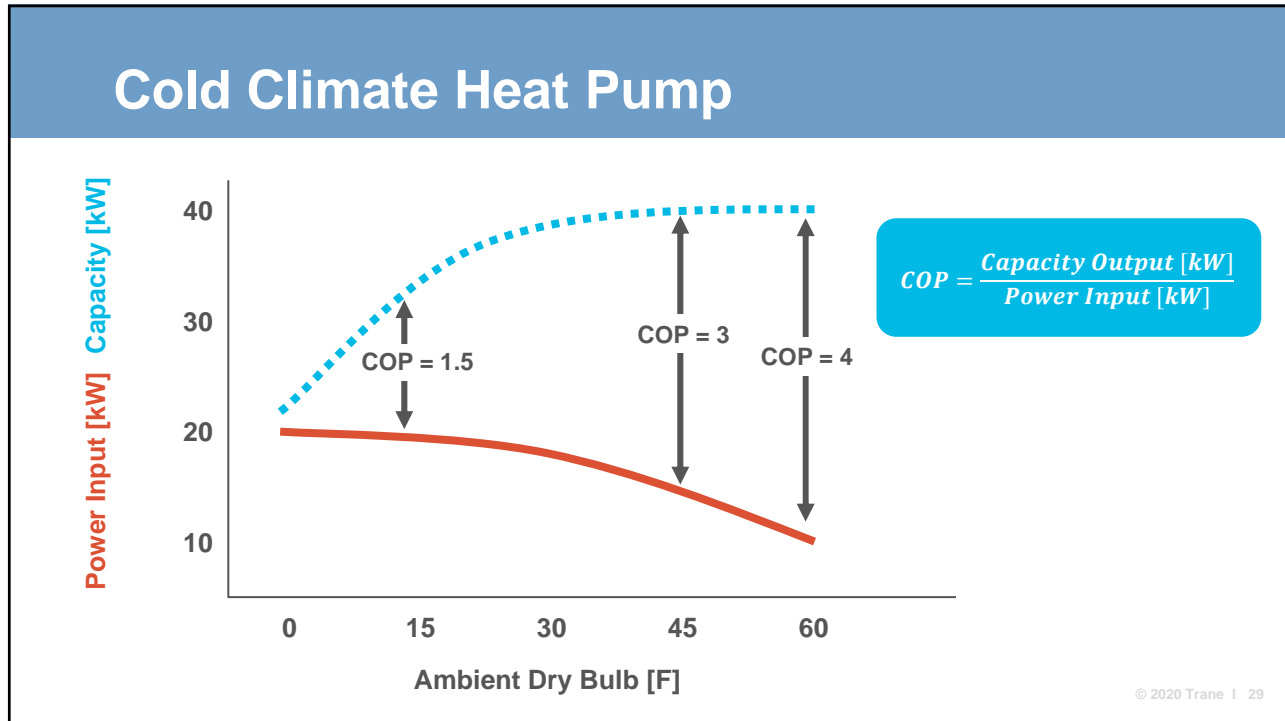
Extreme Annual Design Conditions															
Extreme Annual WS			Extreme Annual Temperature						n-Year Return Period Values of Extreme Temperature						
1%	2.5%	5%	Mean		Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years		
			Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	
18.4	16.2	13.6	9.3	95.8	4.9	3.9	5.8	98.6	2.9	100.9	0.1	103.1	-3.5	105.9	
			DB												
			WB	6.8	79.3	4.2	1.3	3.7	80.3	1.2	81.1	-1.1	81.8	-4.2	82.8

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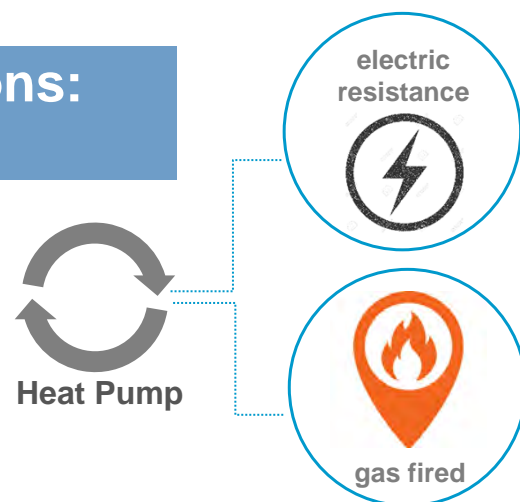
30

Defrost: Occupant Comfort



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Heat Pump Considerations: Dual/Auxiliary Fuel



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Sections

- What is Decarb / Electrification
- Heat Pump Considerations
- Product Solutions
 - Split Systems
 - Packaged Units
 - Applied Systems
 - Potable/Domestic Water Systems

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Split System Heat Pumps

Sizes: <20 Tons

Applications:


- Classrooms
- Small Office
- Small Retail

Options:

- + Dual / Aux Fuel
- X Cold Climate Operation

Retrofits Capability:

do-able difficult



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Variable Refrigerant Flow (VRF)

Sizes: <40 Tons

Applications:


- Schools
- Office
- Mixed Use

Options:

- + Dual / Aux Fuel
- + Cold Climate Operation
- + Smart Defrost

Retrofit Capability:

do-able difficult



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35

Roof Top Unit (RTU) Heat Pump

Sizes: <20 Tons

Applications:


- Classrooms
- Small Office
- Retail
- Warehouse/Distribution Center

Options:

- + Dual / Aux Fuel
- ✗ Cold Climate Operation

Retrofit Capability:

do-able difficult



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Packaged Terminal Heat Pump

Sizes: <3 Tons

Applications:

- Hotels
- Apartments
- Dormitory
- Long Term Care

Options:

- + Dual / Aux Fuel
- ✗ Cold Climate Operation

Retrofit Capability:



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Water Source Heat Pump (WSHP)

Sizes: <25 Tons

Applications:

- Apartments
- Office
- School
- Clinic

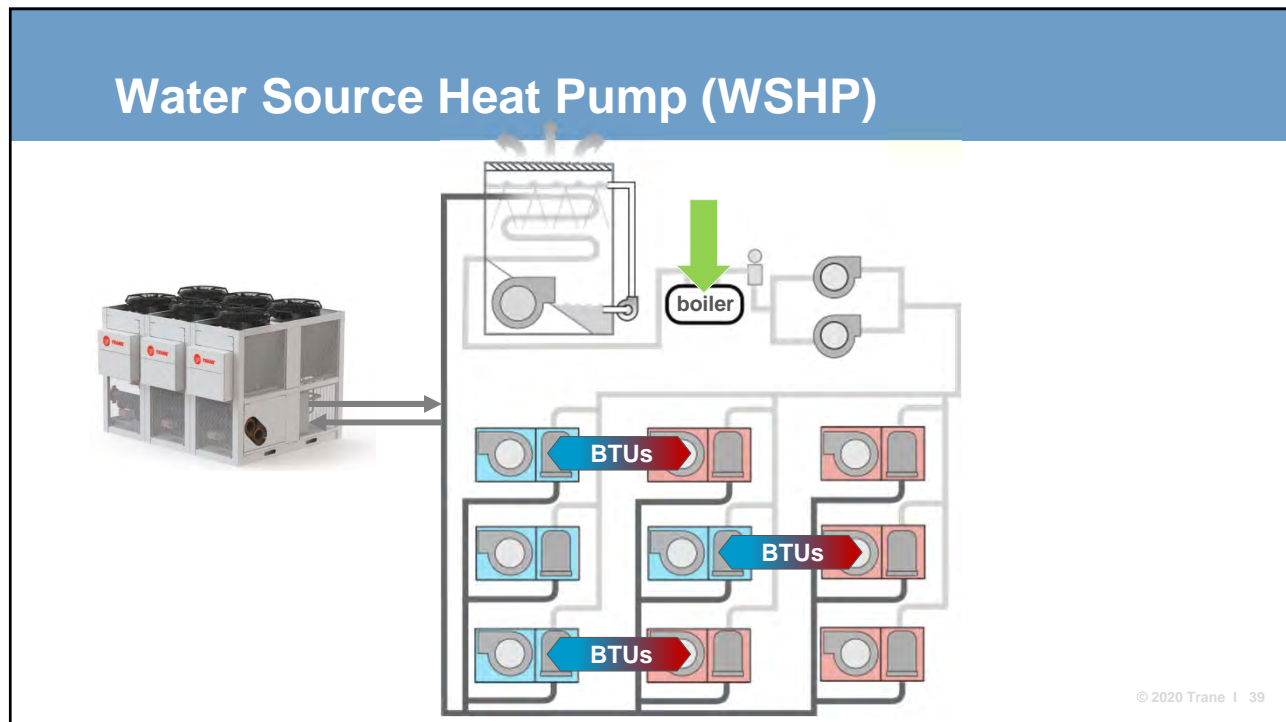
Options:

- + Dual / Aux Fuel
- + Cold Climate Operation



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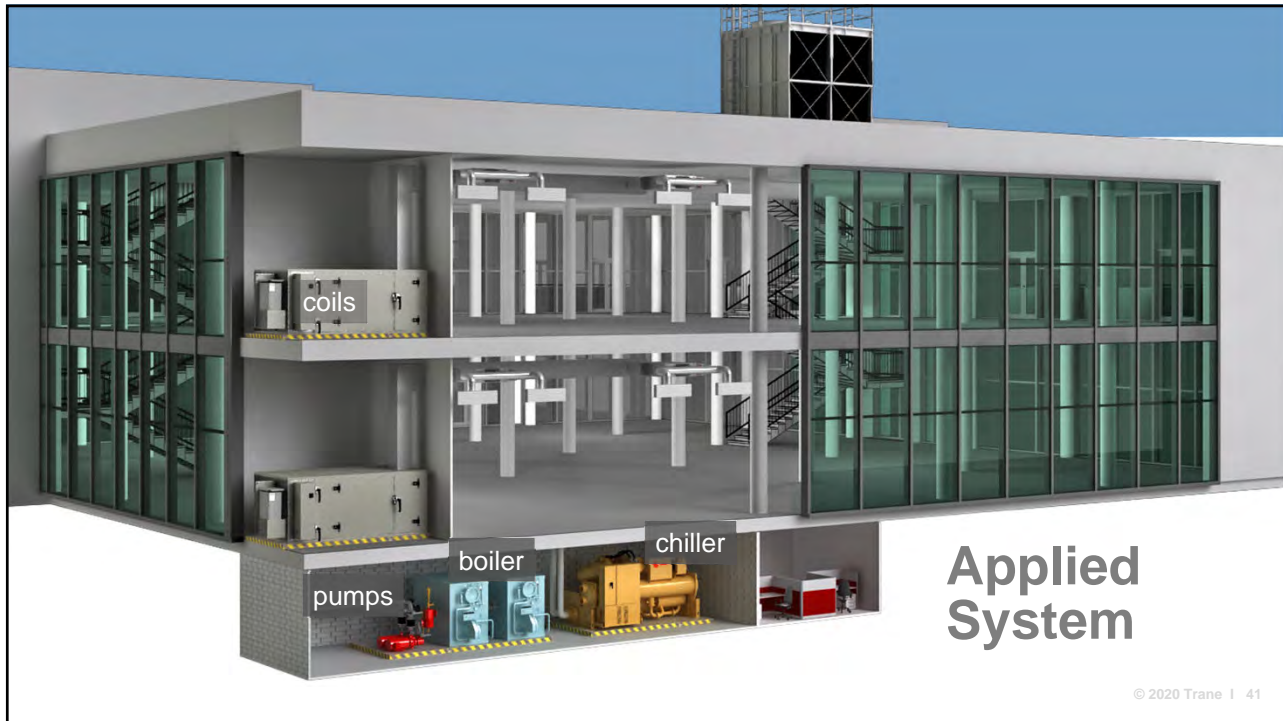
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Applied Systems

- Introduction to Applied Systems
- Descriptions
 - Heat Pump and Heat Recovery
- Products
 - Air Source and Water Source
- Applications
- Source/Sinks





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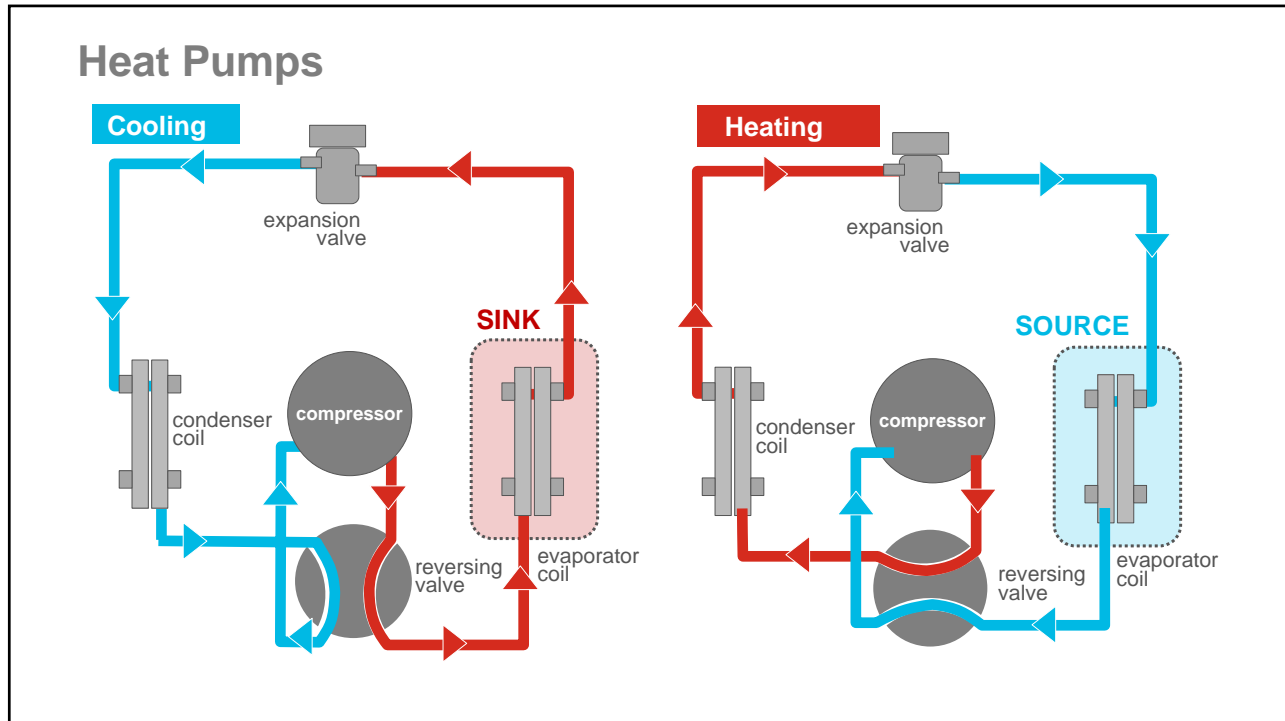


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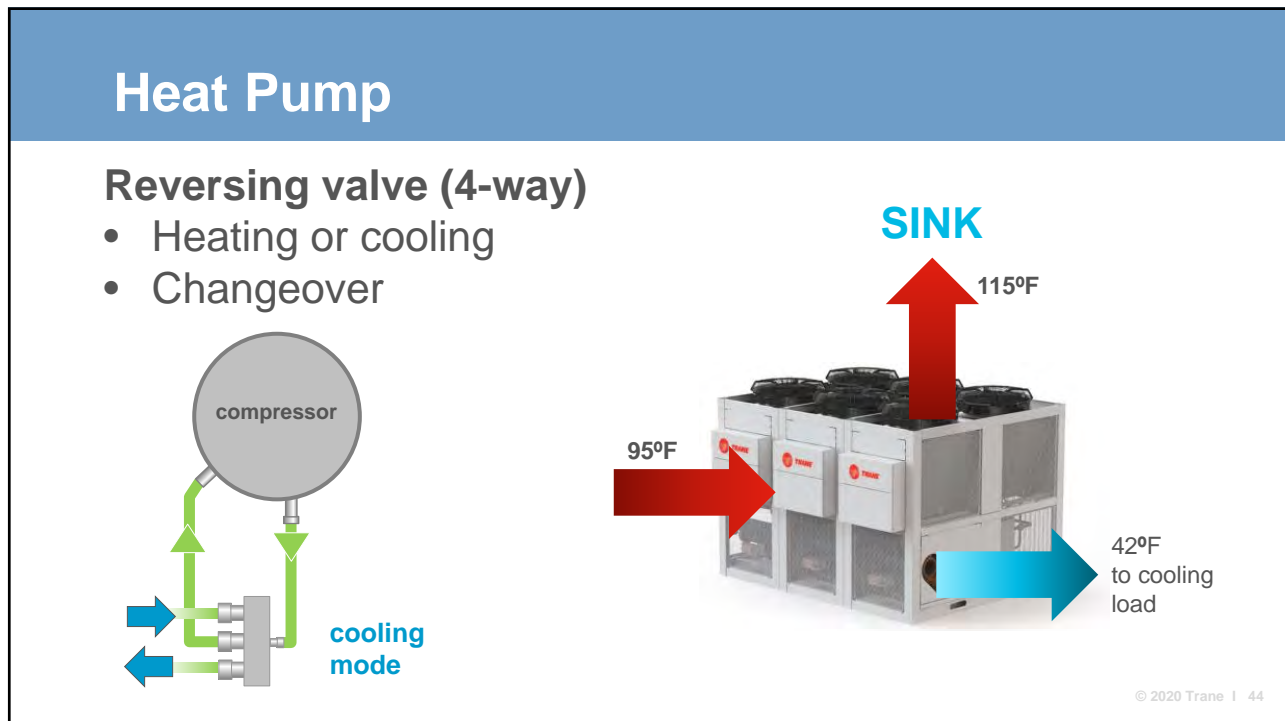
Descriptions

HEAT PUMP 	HEAT RECOVERY 
CHILLER/HEATER 	HEATER 

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Heat Pump

Reversing valve (4-way)

- Heating or cooling
- Changeover

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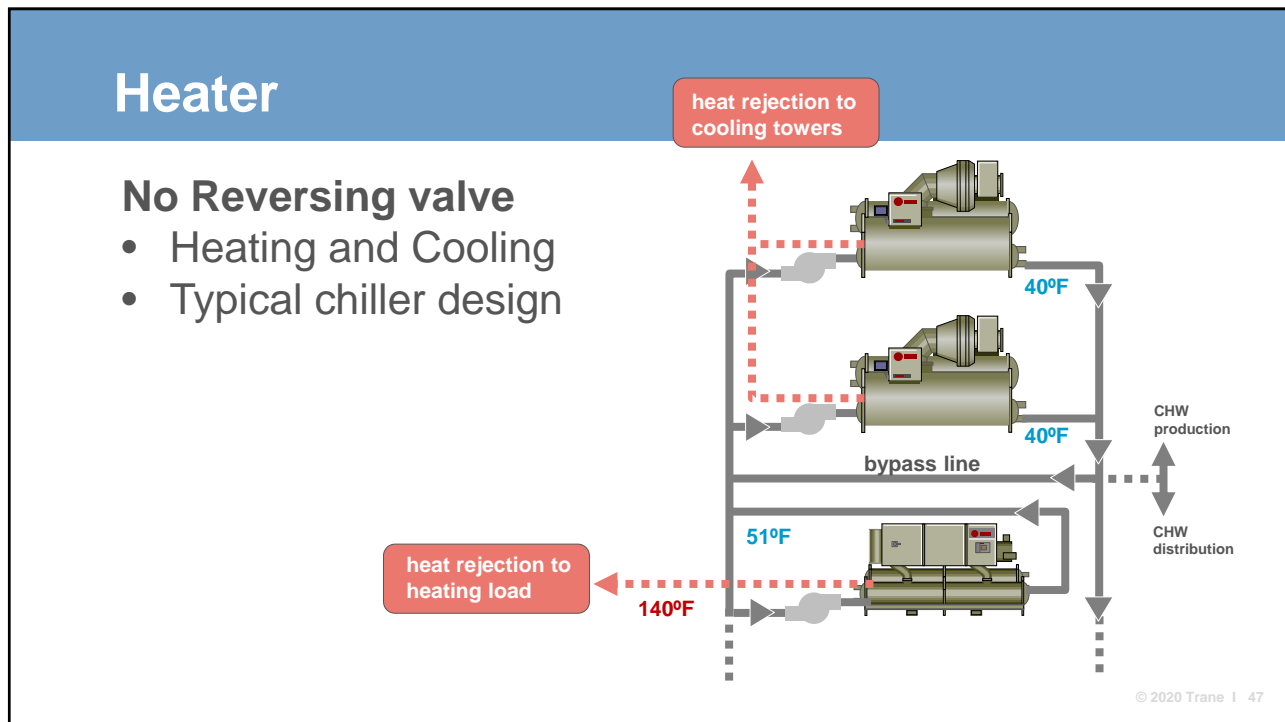
Heat Recovery

No Reversing valve

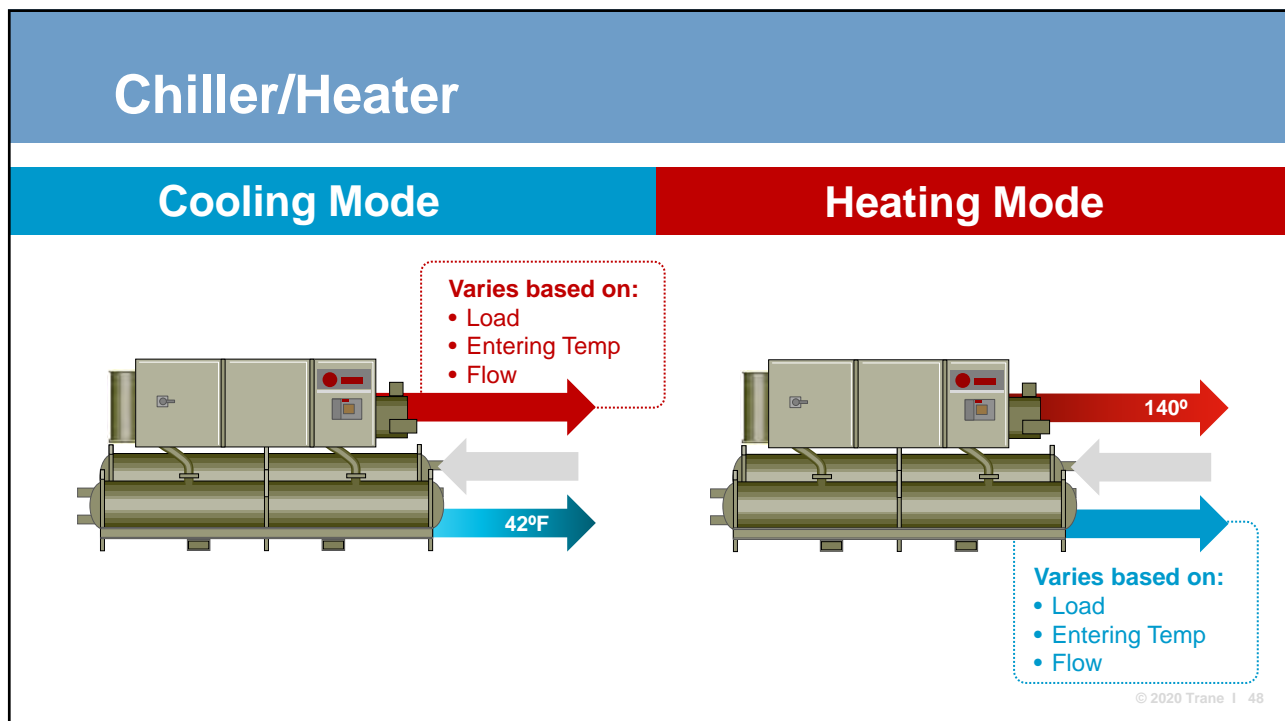
- Heating and Cooling
- Typical chiller design

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Products

- **Air Source**
 - Apps
- **Water Source**
 - Apps

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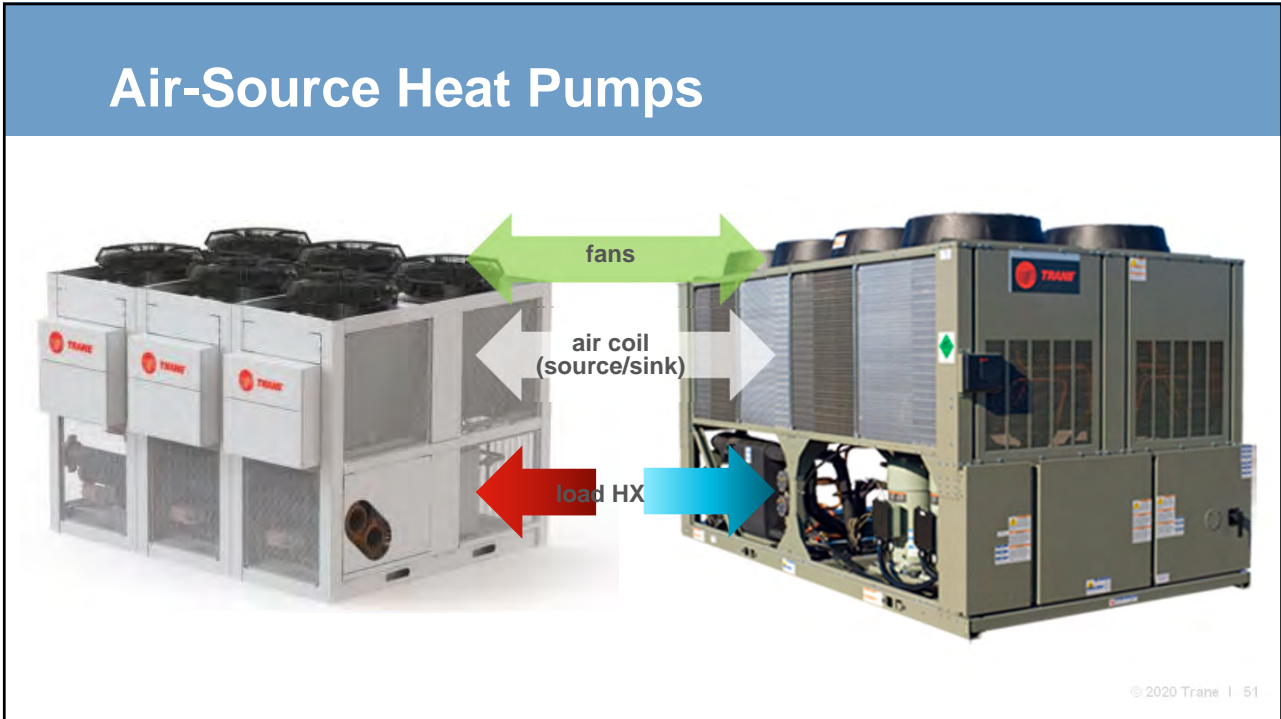
49

Air-Source Products

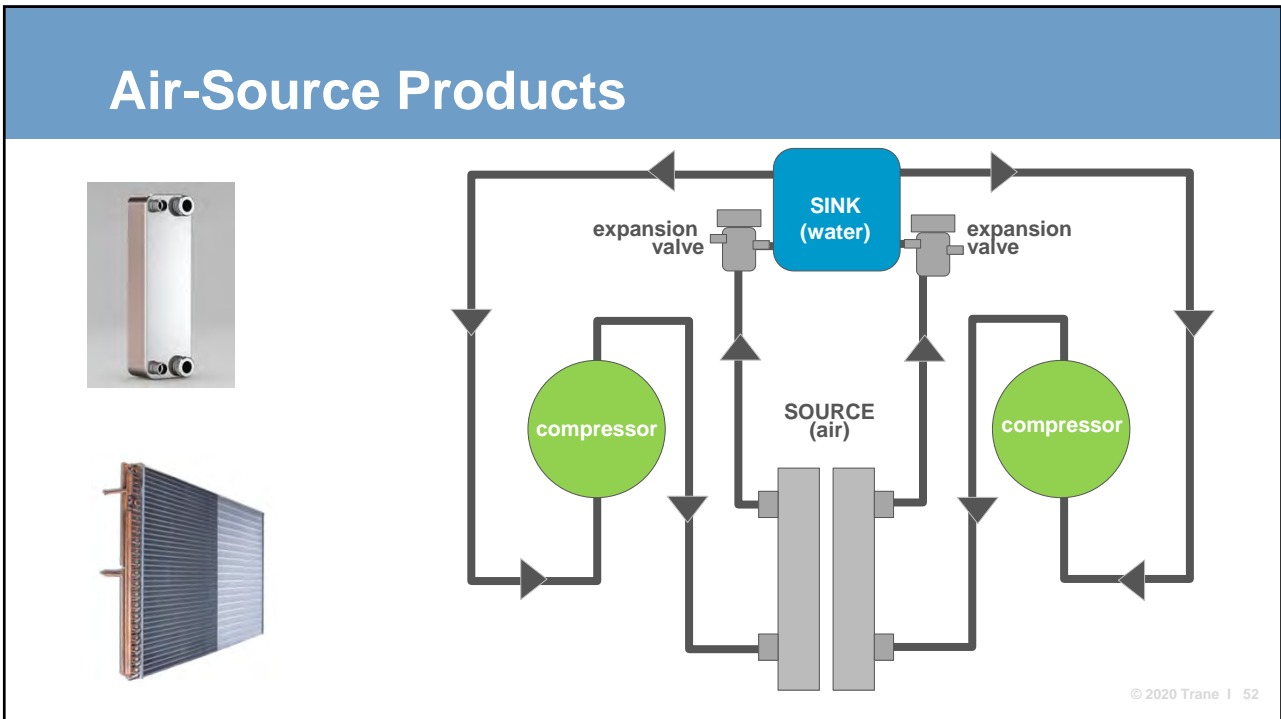
The diagram illustrates the heat flow for two air-source HVAC units. The left unit, labeled "SOURCE", has a blue arrow pointing left at 25°F and a blue arrow pointing up at 5°F. A red arrow points right from its bottom at 120°F to a heating load. The right unit, labeled "SINK", has a red arrow pointing left at 95°F, a red arrow pointing up at 115°F, and a blue arrow pointing right at 42°F to a cooling load.

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Air-Source Products

Packaged or Modular?




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Air-Source Products

Packaged



- 2-200+ tons
- Lower cost
- Ideal for larger projects
- Pumps

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Air-Source Products

Modular

- Multiple circuits
- Redundancy
- Flexible capacity
- Good for variable flow
- Pump package



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Applications

- Air Source
 - **Off-load Boiler**
 - WSHP
 - Lower temp hydronics
- Water Source
 - Heating with a cooling load
 - Heating without a cooling load

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Air-Source Applications
Off-load boiler load (preheat)

Limitations

- Temperatures

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Air-Source Applications
Water-source Heat Pump (loop tempering)

Applications:

- WSHP (loop tempering)

Design Considerations

- Loop temperatures (60-90°F common)
- Ambient (down to 0°F)

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Air-Source Applications
Lower Temperature Hydronics


HOT WATER TEMPERATURE

Applications:


- Lower temp hydronics

Design Considerations

- Loop temperatures (90-120°F common)
- Ambient (down to 0°F)
- Defrost



INCREASED SYSTEM EFFICIENCY



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Products

- Air Source
 - Apps
- **Water Source**
 - Apps

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Water-Source Products

Wide range of options...



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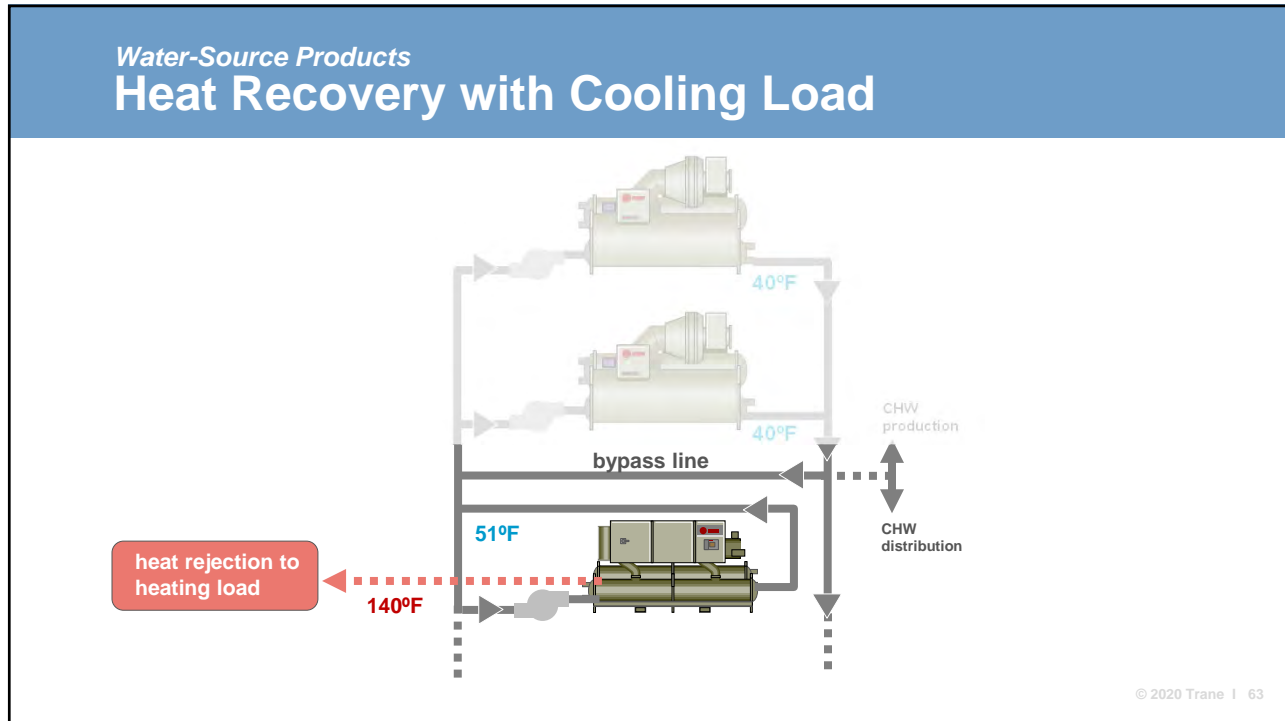
61

Applications

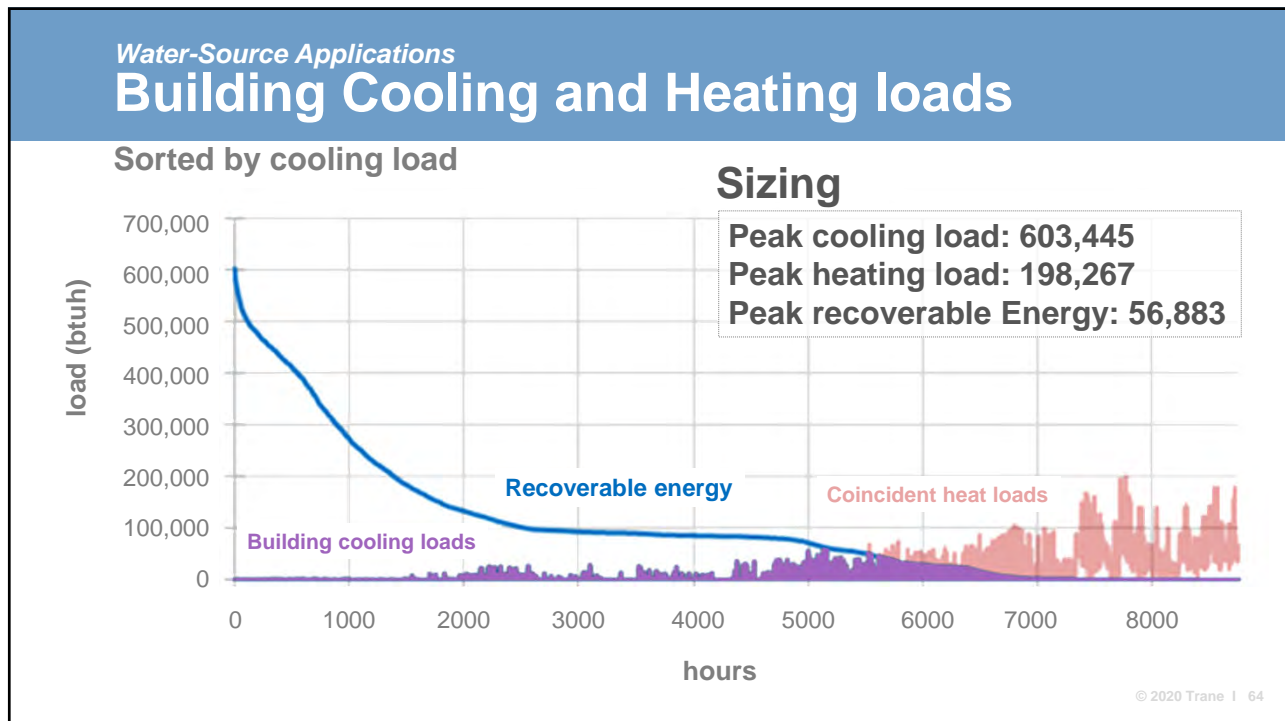
- Air Source
 - Off-load Boiler
 - WSHP
 - Lower temp hydronics
- Water Source
 - **Heating with a cooling load**
 - Heating without a cooling load

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Applications

- Air Source
 - Off-load Boiler
 - WSHP
 - Lower temp hydronics
- Water Source
 - Heating with a cooling load
 - **Heating without a cooling load**


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Water-Source Products

Heat Recovery without Cooling Load

How can I find BTU's to make heat?

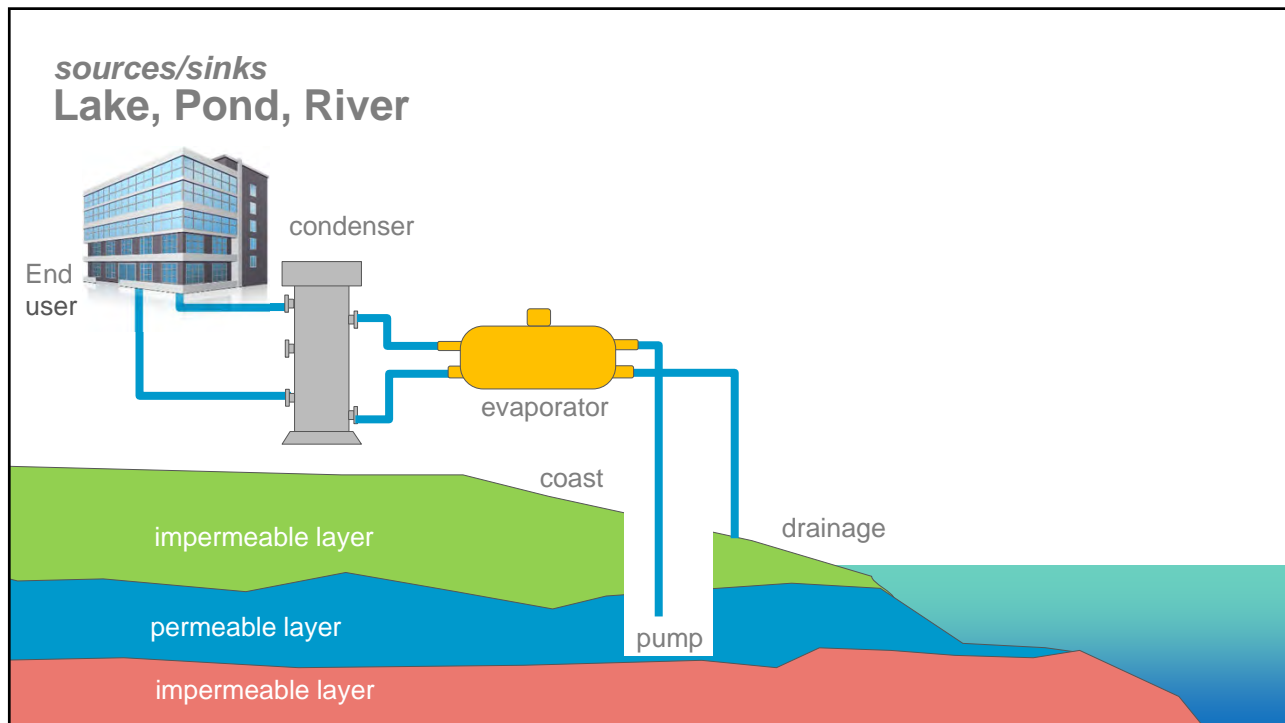


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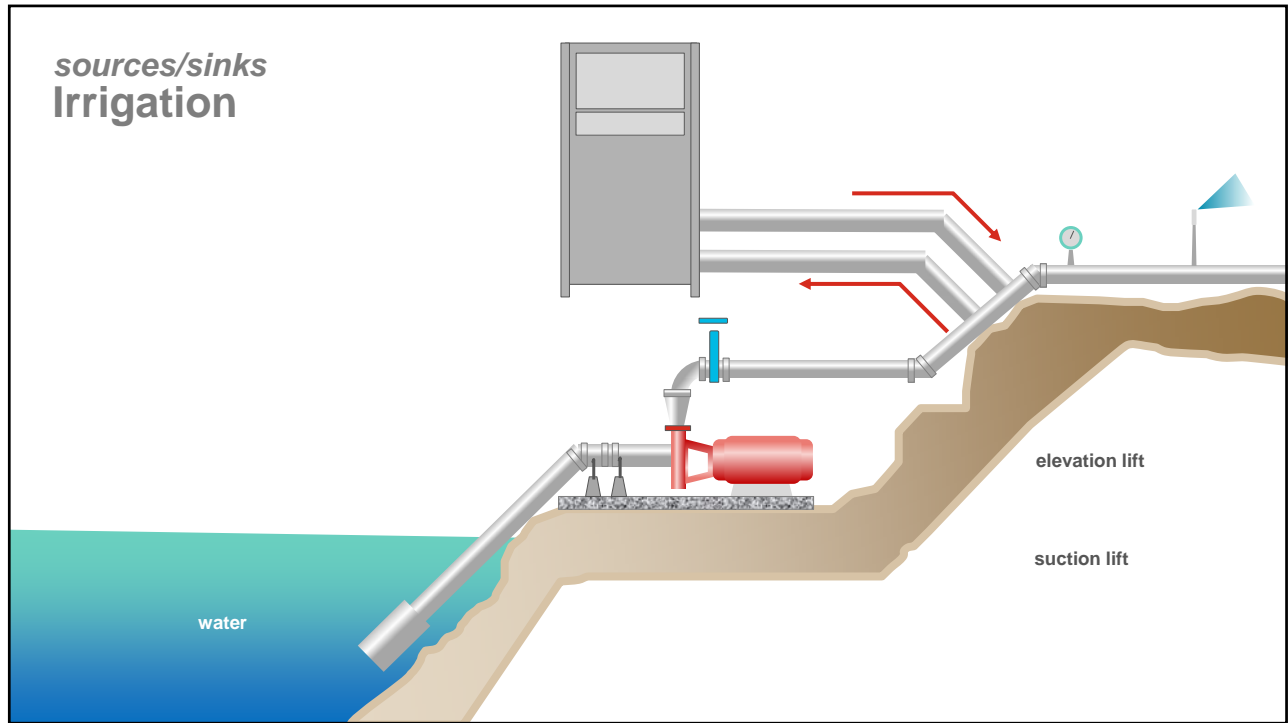
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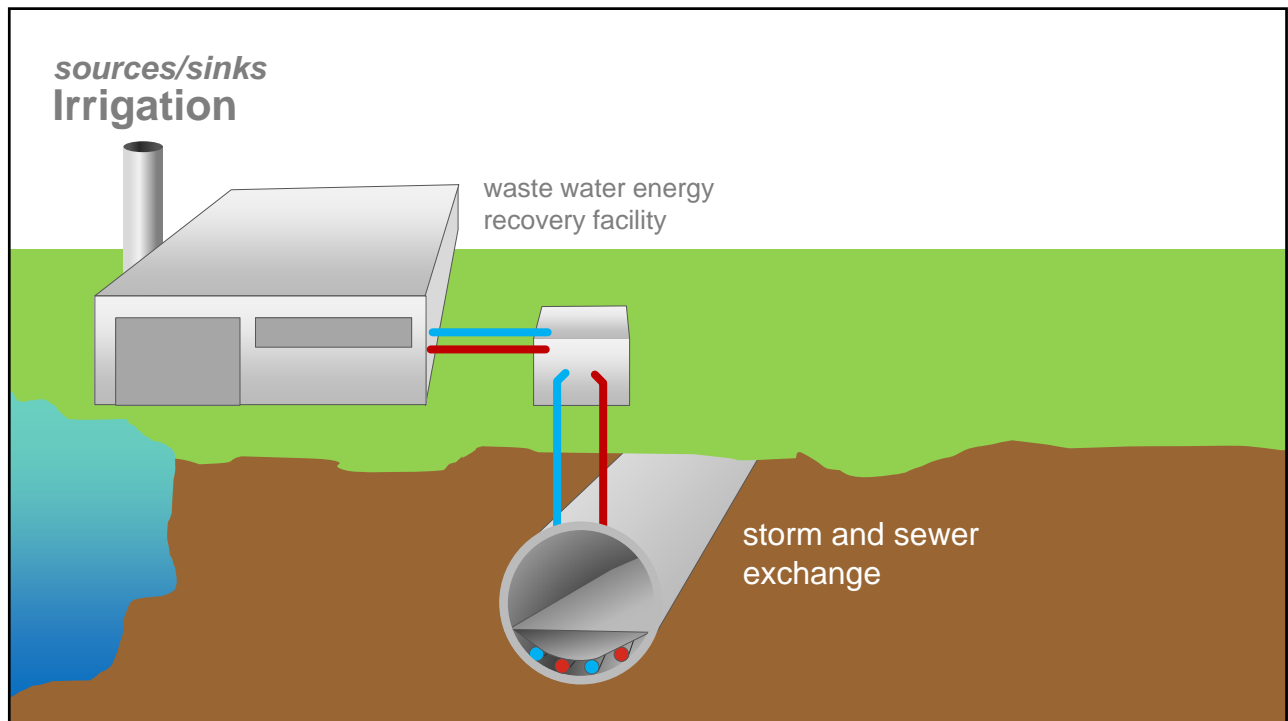
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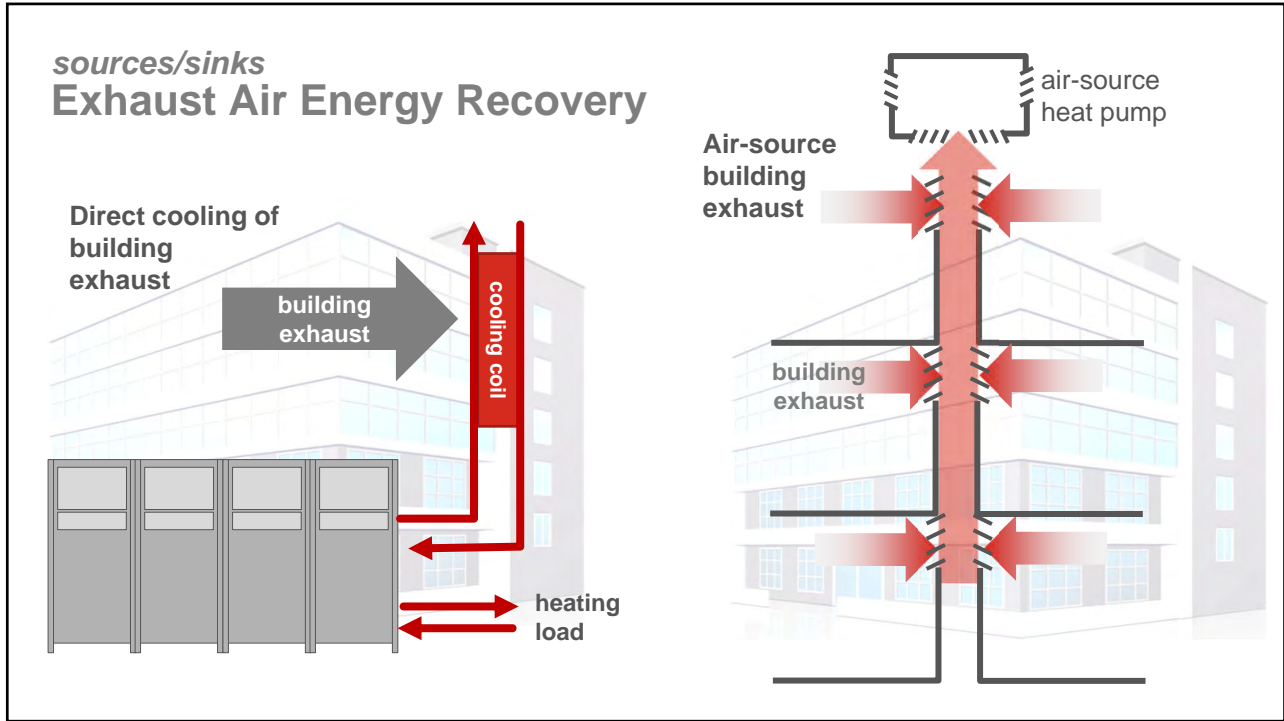
68



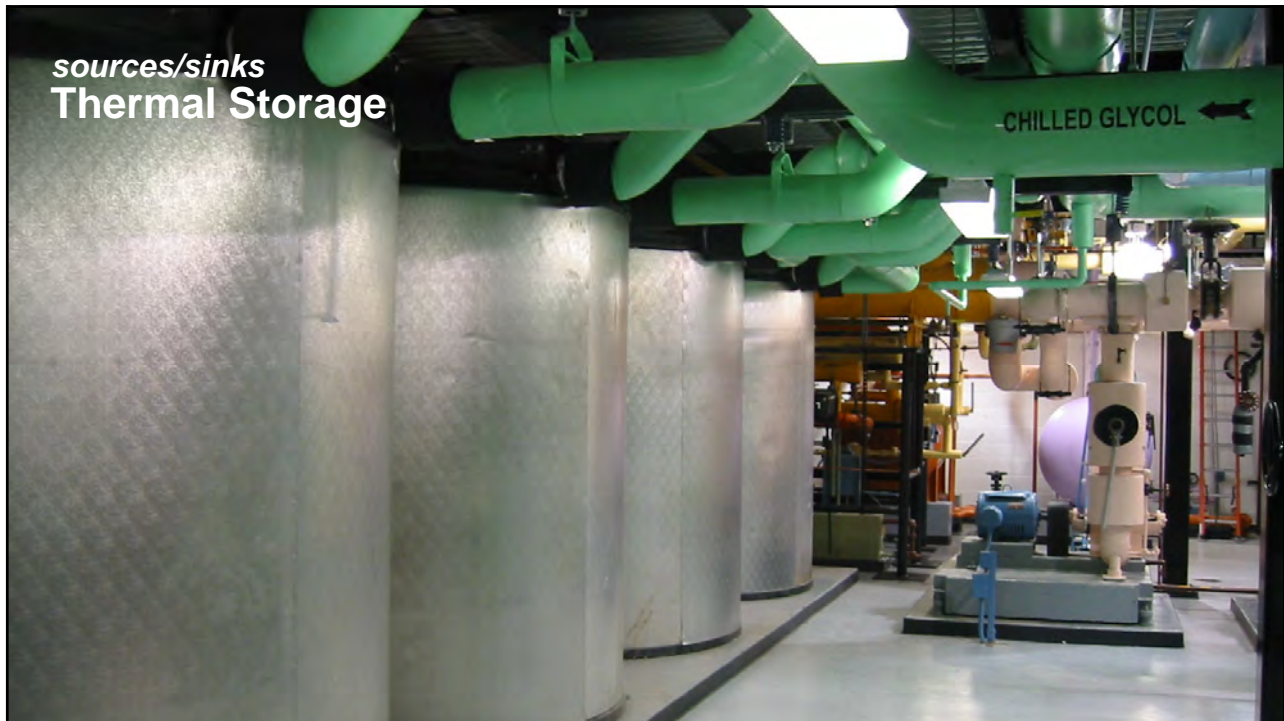
69



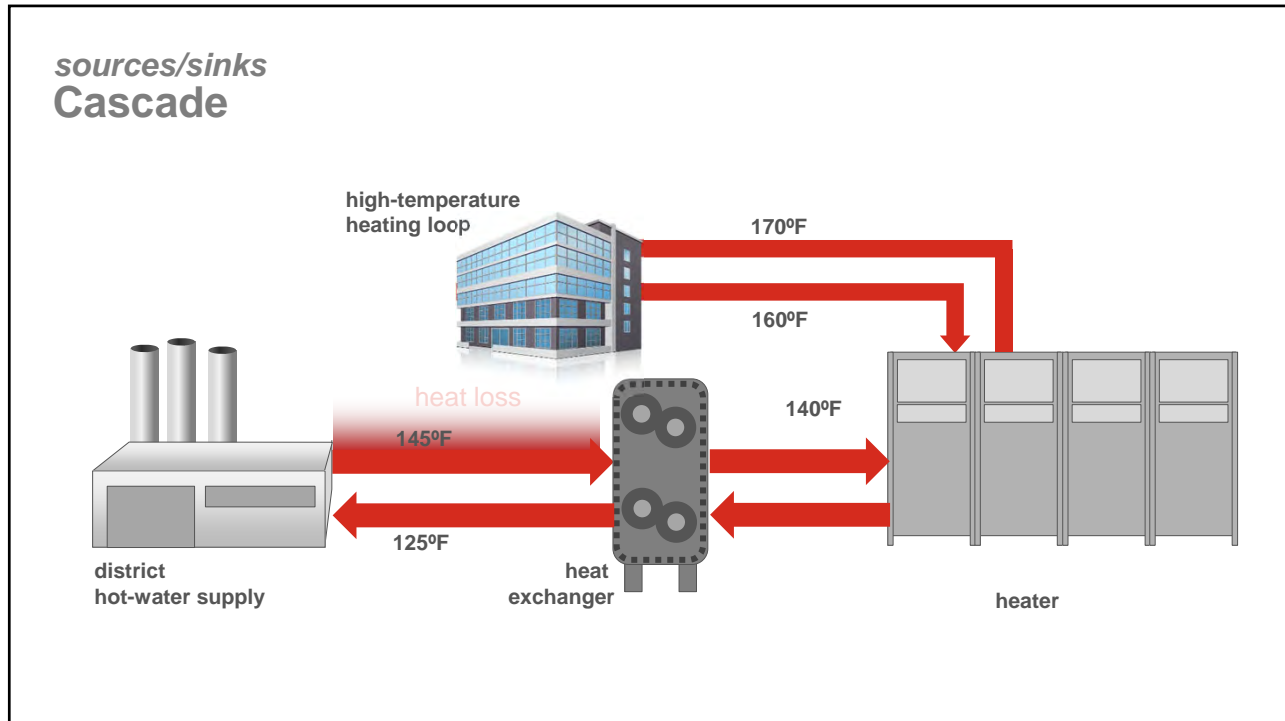
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Sections

- What is Decarb / Electrification
- Heat Pump Considerations
- **Product Solutions**
 - Split Systems
 - Packaged Units
 - Applied Systems
 - Potable/Domestic Water Systems

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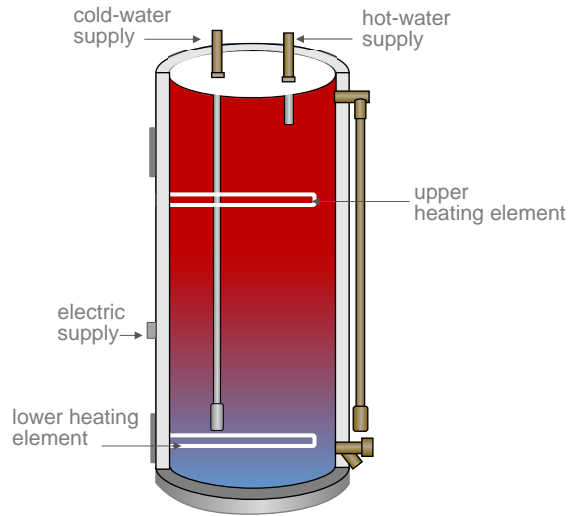
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Potable Hot Water Electric Resistance

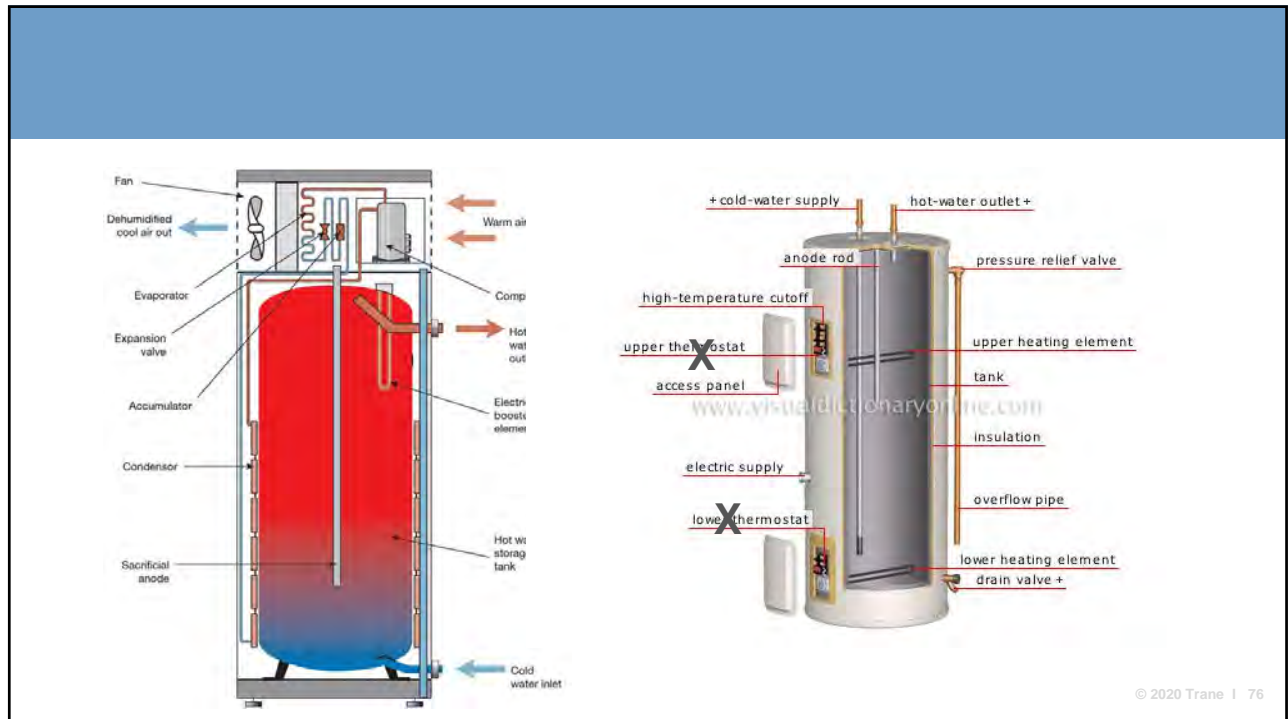
**Output Capacity:
15-350 MBH**

Considerations:

- Electric service
- Storage capacity
- Cost to operate



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Potable Hot Water Electric Packaged Heat Pump

Output Capacity:
15-60 MBH

Considerations:

- First cost
- Space impacts

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Potable Hot Water-Split Heat Pump

Outside

Inside

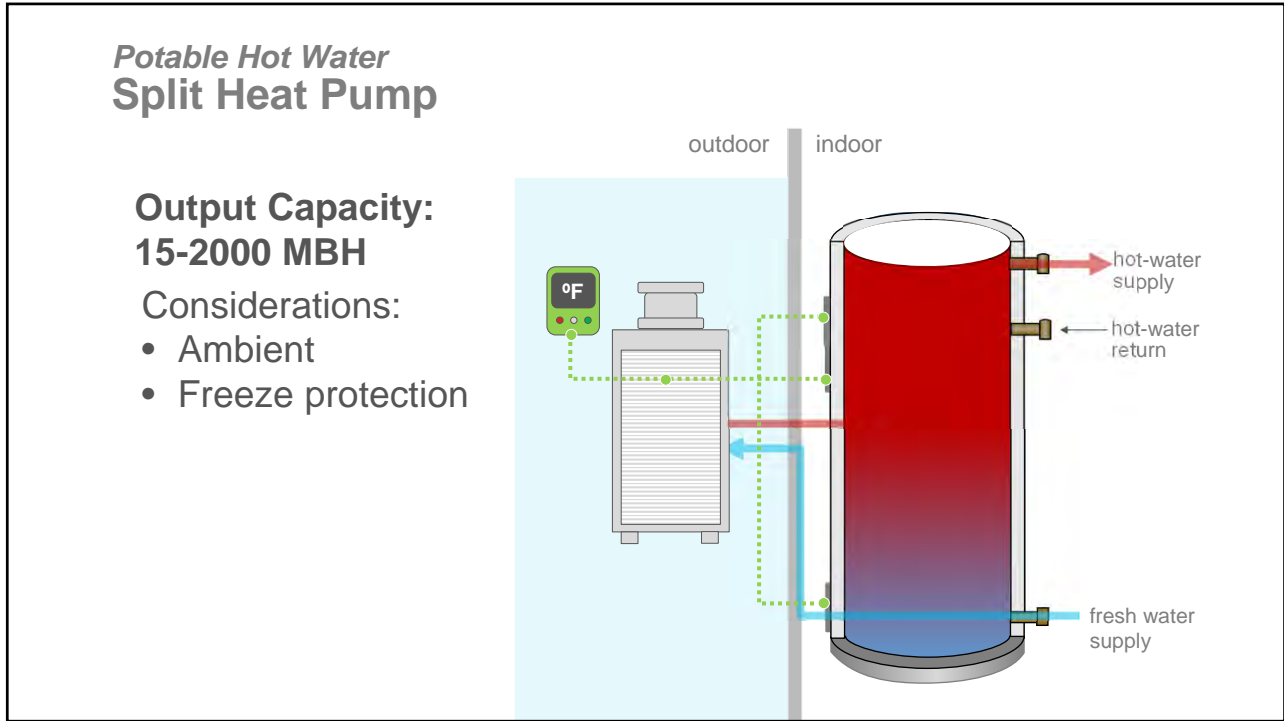
Output Capacity: 15-2,000 MBH

Considerations:

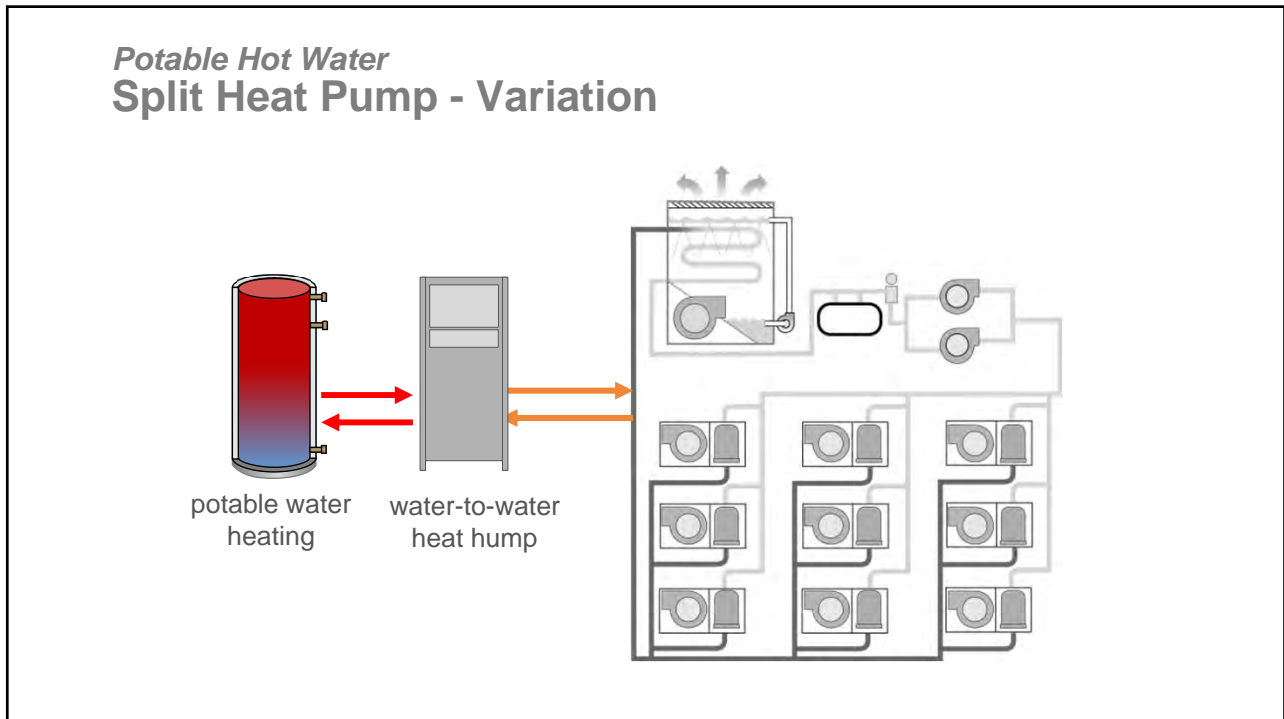
- Ambient
- Freeze Protection

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Where to Learn More

The collage features three main items:

- Engineers Newsletter:** Volume 12-4, Issue 12-4, titled "Indoor Agriculture: HVAC System Design Considerations". It includes an article on "Understanding Plant Biology" with a photo of a man in a lab coat.
- Applications Engineering Manual:** "Chilled-Water VAV Systems" (May 2012, SYS-APM008-EN) featuring a 3D rendering of a building's HVAC system.
- Applications Engineering Manual:** "Waterside Heat Recovery in HVAC Systems" featuring a schematic diagram of a heat recovery system.
- Video Player:** A circular inset showing a live video session with three participants (two men and one woman) sitting at a table.

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Self-Paced Learning

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Filters 151 results

Topic

- Acoustics
- Airside Designs
- Building Automation & Controls
- Energy & Environment
- HVAC Fundamentals
- Safety, Codes and Standards
- VRF and Ductless
- Waterside Designs

ASHRAE Standard 189.1-2011 Update
 Type: Online Course | Price: Free | Credits: 1

ASHRAE Standard 62.1
 Type: Online Course | Price: Free | Credits: 2

ASHRAE Standard 62.1-2004: Ventilation Rate Procedure
 Type: Engineers Newsletter Live DVDs | Price: \$30 | Publish Date: Sep 1, 2005

ASHRAE Standard 62.1-2010

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Resources

Decarbonization/Electrification of HVAC Systems

https://www.pge.com/en_US/about-pge/environment/what-we-are-doing/clean-energy-solutions/clean-energy-solutions.page?WT.mc_id=Vanity_cleanenergy

<https://www.epa.gov/energy/egrid-subregion-representational-map>

<https://www.eia.gov/consumption/commercial/>

<https://www.xcelenergy.com/>

<https://www.comed.com/Pages/default.aspx>

