42nd Annual State Construction Conference

March 2, 2023

NC★DOA
Department of Administration
State Construction Office

Life Cycle Cost Analysis Update

Pivoting Toward Sustainability

Tom Galdi, PE - SCO
Thomas Vu, PE - AEI
3/02/2023

Recent NC Energy Directives

Executive Order 80

Increase Use of Clean Energy Technologies and Energy Efficient Measures

House Bill 951

Utilities to Take Reasonable Steps to Achieve Carbon Neutrality by 2050

National and International Targets

[Paris Agreement and Executive Orders]

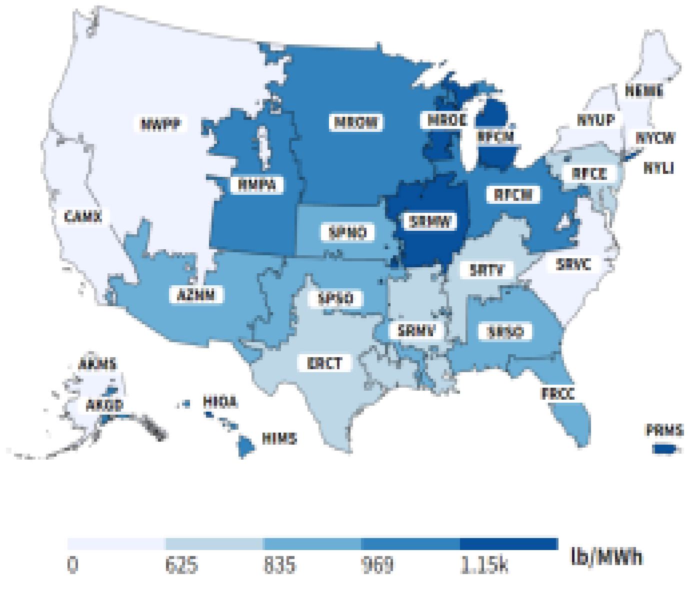
- Power Sector 100% Carbon Free by 2035
- Net Zero Economy by 2050.

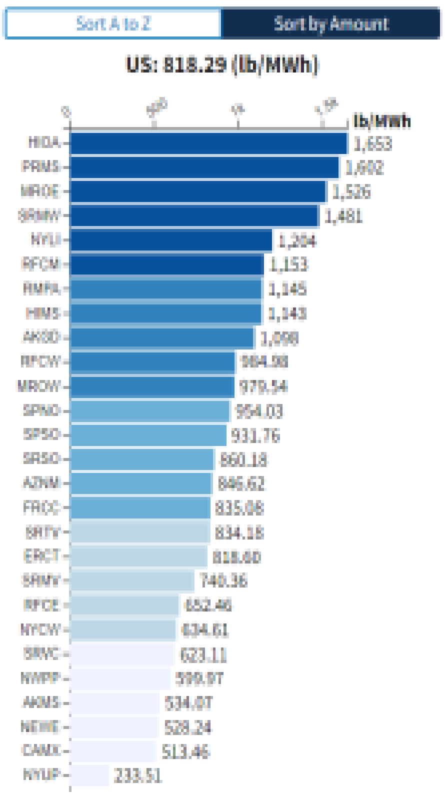
How to Emit Less Carbon

- Efficiency
- Lower GWP Refrigerants
- Electrification

eGRID Emission Factors

CO_2 total output emission rate (lb/MWh) by eGRID subregion, 2020





Report: Replacing coal plants with solar, wind is cheaper

BY CARLY WANNA
Bloomberg

Replacing coal power plants across the United States with renewable energy projects would reduce carbon emissions and require less water.

It would also save money.

Nearly all existing U.S. coal plants require more cash to operate than the cost of replacing them with new wind or solar projects, according to a report published Monday by San Francisco-based climate think tank Energy Innovation.

The finding is in line with past research by BloombergNEF that determined building new solar and wind farms is cheaper than operating existing coal or gas power plants in much of the world.

energy in the U.S. is President Joe Biden's climate legislation, which provides billions of dollars in incentives for clean energy infrastructure.

"The Inflation Reduction Act has made this local replacement and reinvestment scenario so economic and so much cheaper than coal," said Michelle Solomon, a policy analyst at Energy Innovation and the lead author of the report. "It really creates a big opportunity to diversify the economics in coal communities."

The law includes a 10% tax credit for so-called "energy communities," including areas with retired coal plants, to transition to clean energy infrastructure.

The report's authors calculated the costs of operating each of 210 coal plants in the United

well as future maintenance expenditures. They then compared those numbers to costs associated with installing and operating new wind and solar projects nearby. In all but one case, the renewable project required less cash.

Energy Innovation has tracked the costs of new renewable projects in three Coal Cost Crossover reports since 2019. The first report found that running 62% of existing coal capacity in the U.S. cost more than producing the same amount of energy from renewable sources. That increased to 72% in the 2021 edition.

Now, incentives from the Inflation Reduction Act mean the share of coal power that's more expensive has risen to 99%.

The White House's push to move the U.S.

industry groups, as well a some members of Congress – like Democratic Sen. Joe Manchin of West Virginia – who have argued that the plans will strip jobs from communities that need them.

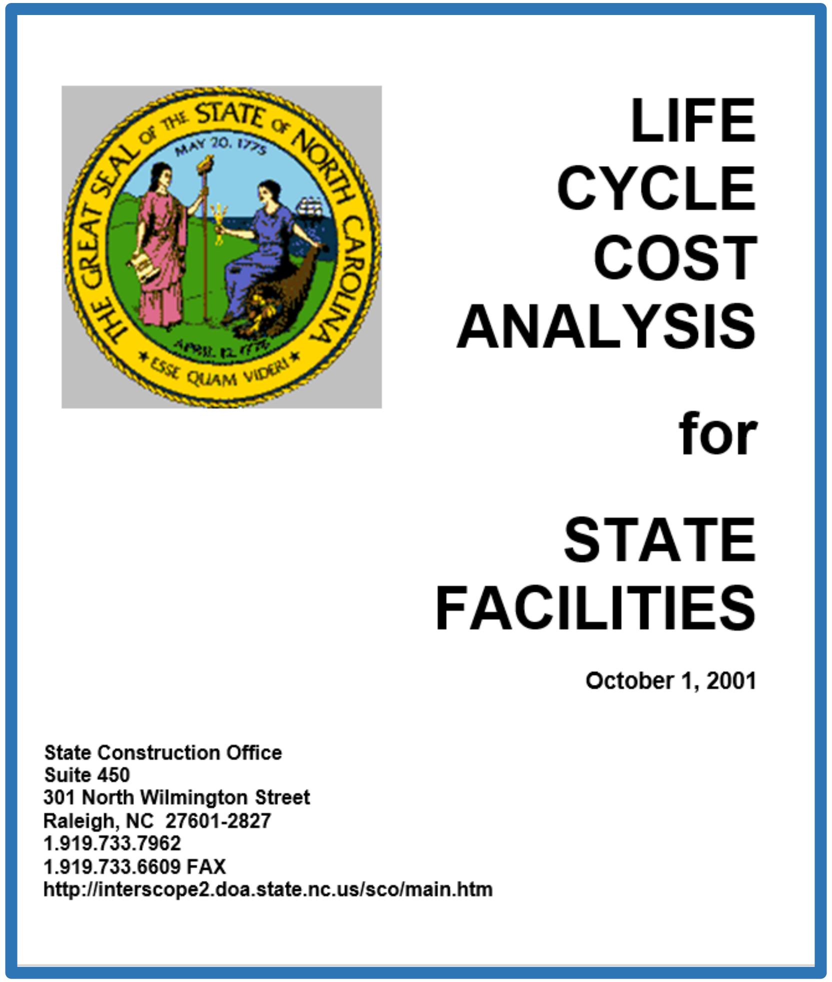
But even with renewables costing less overall, replacing the country's coal plants would require billions in investment, which the study authors say would create economic opportunity. Mike O'Boyle, an author of the report and a director at Energy Innovation, says he hopes the new research will encourage public utilities commissions to invest in renewable energy.

"Those regulators are some of the most important policymakers and actors in the energy transition," said O'Boyle. "Now they've got tools to take a proactive role."

G.S. 143-64.10-15 Energy Policy and Life Cycle Cost Analysis

HIGHLIGHTS

- The State shall take a leadership role in aggressively undertaking energy conservation in North Carolina.
- Facility Designs shall take into consideration the total Life Cycle Cost.
- Energy Consumption Analysis of the facilities ‘Energy Consuming Systems’.



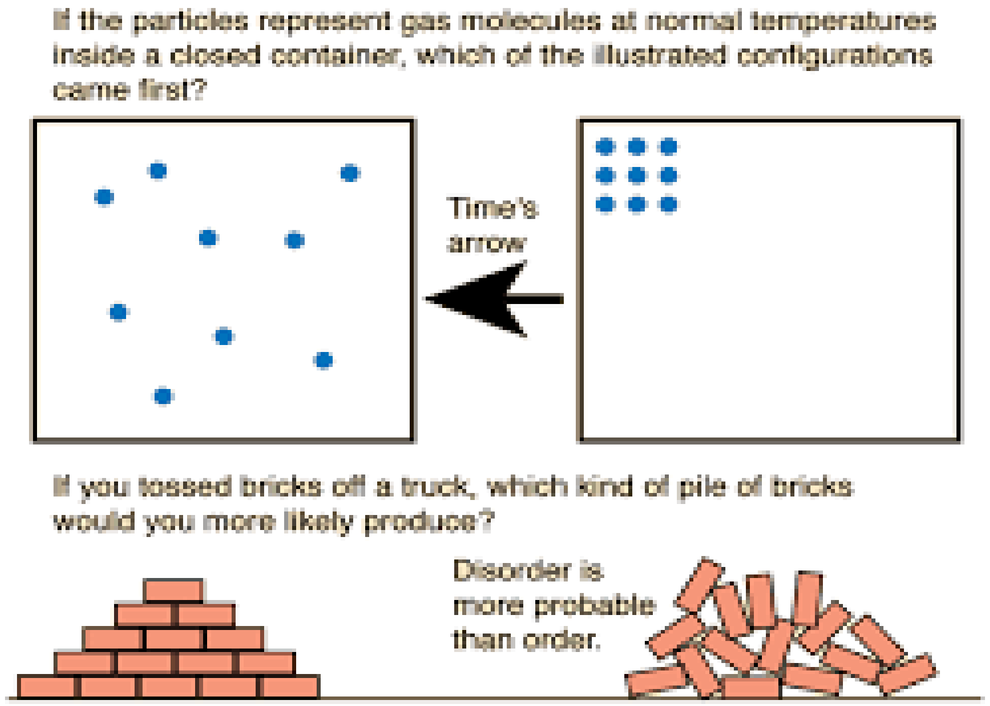
LIFE CYCLE COST ANALYSIS for STATE FACILITIES

October 1, 2001

State Construction Office
Suite 450
301 North Wilmington Street
Raleigh, NC 27601-2827
1.919.733.7962
1.919.733.6609 FAX
http://interscope2.doa.state.nc.us/sco/main.htm

- *“Since the passage of this legislation, the design of new state facilities in North Carolina has not undergone any significant improvement in quality as a result of life cycle costing. The primary reason for this appears to be that life cycle costing is treated as an “academic exercise”, rather than as a design element, by architects and engineers. The goal for this text is to help rectify this situation.”*

2nd Law of Thermodynamics



NC★DOA

LCCA – Why Update

- Due – 22 + years
- SIR Results not Intuitive
- Repetitive Analysis and Results
- Shift Focus

Existing LCC Data Sheets

LIFE CYCLE COST ANALYSIS
FOR STATE FACILITIES

STATE CONSTRUCTION OFFICE
N.C. DEPT. OF ADMINISTRATION
RALEIGH, NORTH CAROLINA

DATA FOR ALTERNATIVE 1

CONSTRUCTION YEAR		
ECONOMIC LIFE	35	Years
INFLATION RATE	3.0%	%

CAPITAL INVESTMENT

CAPITAL	$200,000	$
LOAN/BOND		%
INTEREST RATE		%
LOAN/BOND TERM		Years

ANNUAL OPERATING COSTS AND CONSUMPTION

ELECTRICITY	$20,000	$		KWH
NATURAL GAS		$		MCF
PROPANE		$		GAL
FUEL OIL		$		GAL
COAL		$		TONS

MAINTENANCE	$7,000	$

NON-RECURRING REPAIR/REPLACEMENT COSTS

DESCRIPTION	YEAR	COST	
			$
			$
			$
			$
			$
			$

LIFE CYCLE COST ANALYSIS
FOR STATE FACILITIES

STATE CONSTRUCTION OFFICE
N.C. DEPT. OF ADMINISTRATION
RALEIGH, NORTH CAROLINA

YEAR	CAPITAL $	ENERGY $	MAINTENANCE $	REPAIR/REPLACE $	TOTAL COST
1	$200,000	$20,000	$7,000	$0	$227,000
2	$0	$20,600	$7,210	$0	$27,810
3	$0	$21,218	$7,426	$0	$28,644
4	$0	$21,855	$7,649	$0	$29,504
5	$0	$22,510	$7,879	$0	$30,389
6	$0	$23,185	$8,115	$0	$31,300
7	$0	$23,881	$8,358	$0	$32,239
8	$0	$24,597	$8,609	$0	$33,207
9	$0	$25,335	$8,867	$0	$34,203
10	$0	$26,095	$9,133	$0	$35,229
11	$0	$26,878	$9,407	$0	$36,286
12	$0	$27,685	$9,690	$0	$37,374
13	$0	$28,515	$9,980	$0	$38,496
14	$0	$29,371	$10,280	$0	$39,650
15	$0	$30,252	$10,588	$0	$40,840
16	$0	$31,159	$10,906	$0	$42,065
17	$0	$32,094	$11,233	$0	$43,327
18	$0	$33,057	$11,570	$0	$44,627
19	$0	$34,049	$11,917	$0	$45,966
20	$0	$35,070	$12,275	$0	$47,345
21	$0	$36,122	$12,643	$0	$48,765
22	$0	$37,206	$13,022	$0	$50,228
23	$0	$38,322	$13,413	$0	$51,735
24	$0	$39,472	$13,815	$0	$53,287
25	$0	$40,656	$14,230	$0	$54,885
26	$0	$41,876	$14,656	$0	$56,532
27	$0	$43,132	$15,096	$0	$58,228
28	$0	$44,426	$15,549	$0	$59,975
29	$0	$45,759	$16,015	$0	$61,774
30	$0	$47,131	$16,496	$0	$63,627
31	$0	$48,545	$16,991	$0	$65,536
32	$0	$50,002	$17,501	$0	$67,502
33	$0	$51,502	$18,026	$0	$69,527
34	$0	$53,047	$18,566	$0	$71,613
35	$0	$54,638	$19,123	$0	$73,761
TOT.	$200,000	$1,209,242	$423,235	$0	

TOTAL LIFE CYCLE COST FOR ALTERNATIVE NO.0 $1,832,476

READING SIR SUMMARY SHEETS

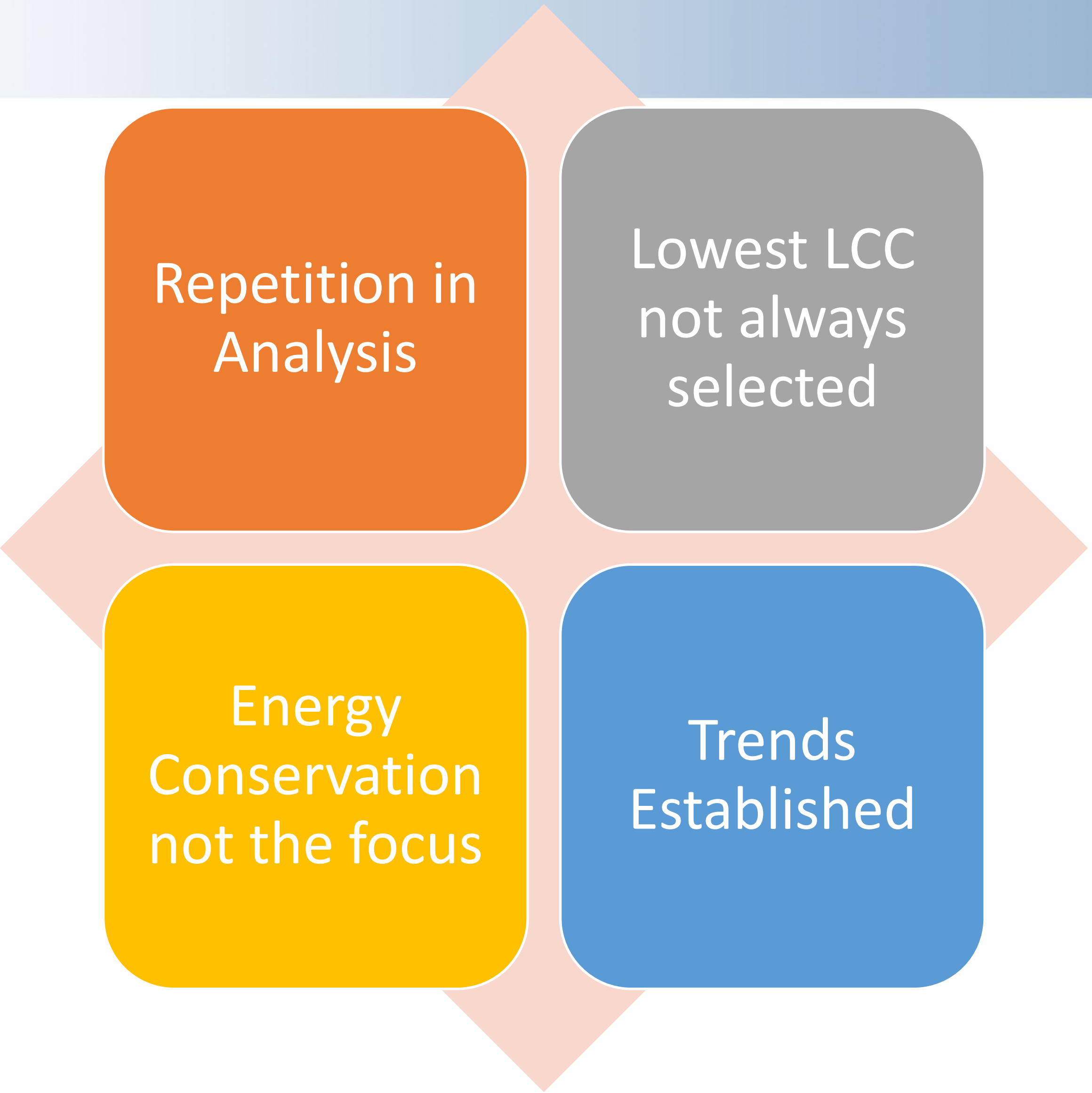
	(A) Alternative ID	(B) Life Cycle Investment Cost	(C) Life Cycle Operating Cost	(D) Increased Investment Cost	(E) Operating Cost Savings	(F) SIR	(G) Rank
	A1.0	$14,800	$362,046	N/A	N/A	N/A	Base Case
2	A1.1	$19,750	$355,791	$4,950	$6,255	1.26	1
3				$0	$0	0.00	2
4				$0	$0	0.00	2
5				$0	$0	0.00	2
6				$0	$0	0.00	2
7				$0	$0	0.00	2
8				$0	$0	0.00	2
9				$0	$0	0.00	2

	(A) Alternative ID	(B) Life Cycle Investment Cost	(C) Life Cycle Operating Cost	(D) Increased Investment Cost	(E) Operating Cost Savings	(F) SIR	(G) Rank
1	P1-1	$14,442	$63,206	N/A	N/A	N/A	Base Case
2	P1-2	$24,071	$48,220	$9,629	$14,986	1.56	1
3	P1-3	$12,837	$30,757	-$1,605	$32,449	-20.22	9
4				$0	$0	0.00	2
5				$0	$0	0.00	2
6				$0	$0	0.00	2
7				$0	$0	0.00	2
8				$0	$0	0.00	2
9				$0	$0	0.00	2

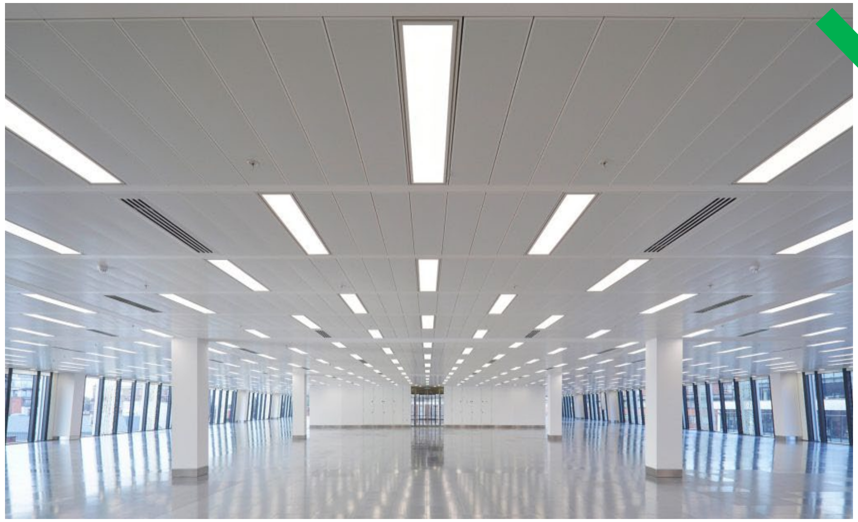
This option is actually the lowest LCC

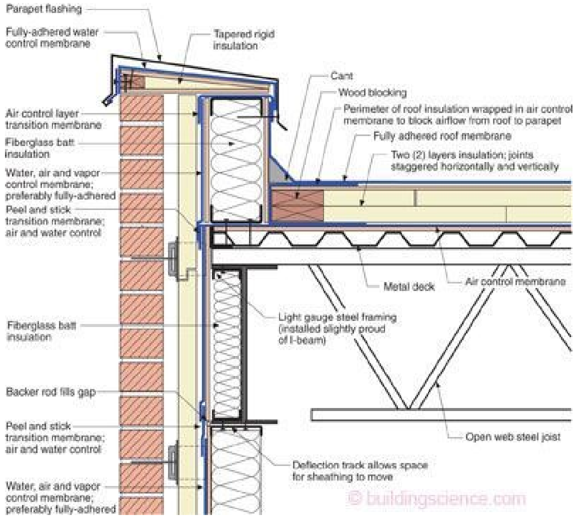
	(A) Alternative ID	(B) Life Cycle Investment Cost	(C) Life Cycle Operating Cost	(D) Increased Investment Cost	(E) Operating Cost Savings	(F) SIR	(G) Rank
1	B0	$840,000	$2,151,348	N/A	N/A	N/A	Base Case
2	H-1	$770,000	$2,134,927	-$70,000	$16,421	-0.23	7
3	H-2	$1,050,000	$2,347,150	$210,000	-$195,802	-0.93	9
4	H-3	$1,190,000	$2,283,603	$350,000	-$132,255	-0.38	8
5				$0	$0	0.00	1
6				$0	$0	0.00	1
7				$0	$0	0.00	1
8				$0	$0	0.00	1

Takeaways from Review of LCCA Reports



Common Results





Moving Forward

USER FRIENDLY INTUITIVE PROCESS

EASY TO COLLECT AND COMPILE ONGOING RESULTS.

MAKE RESULTS PUBLIC TO BE BUILT UPON.

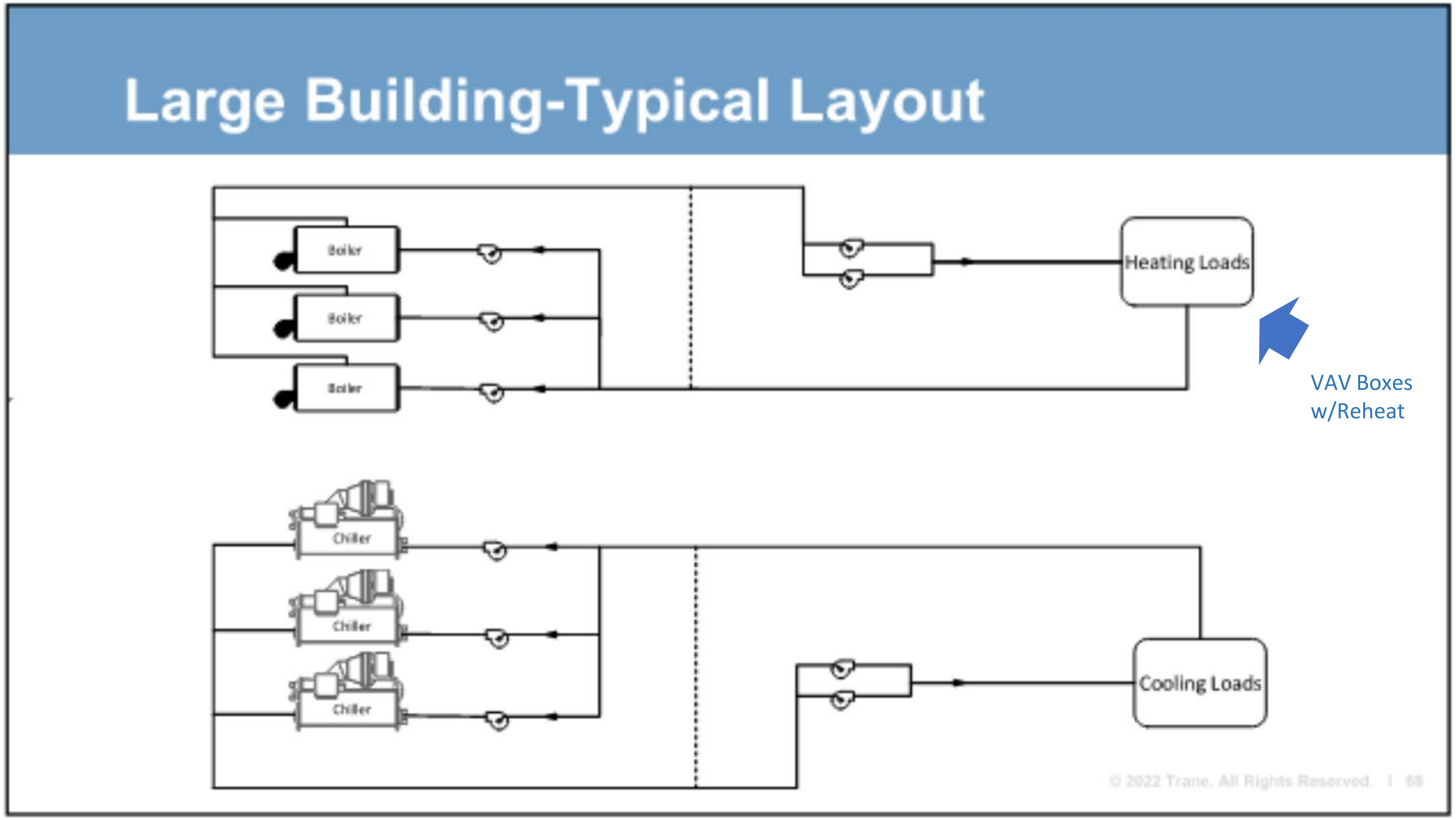
FOCUS MORE ON ENERGY CONSUMING SYSTEMS.

JOIN PUSH TOWARD SUSTAINABILITY.

Notable Updates

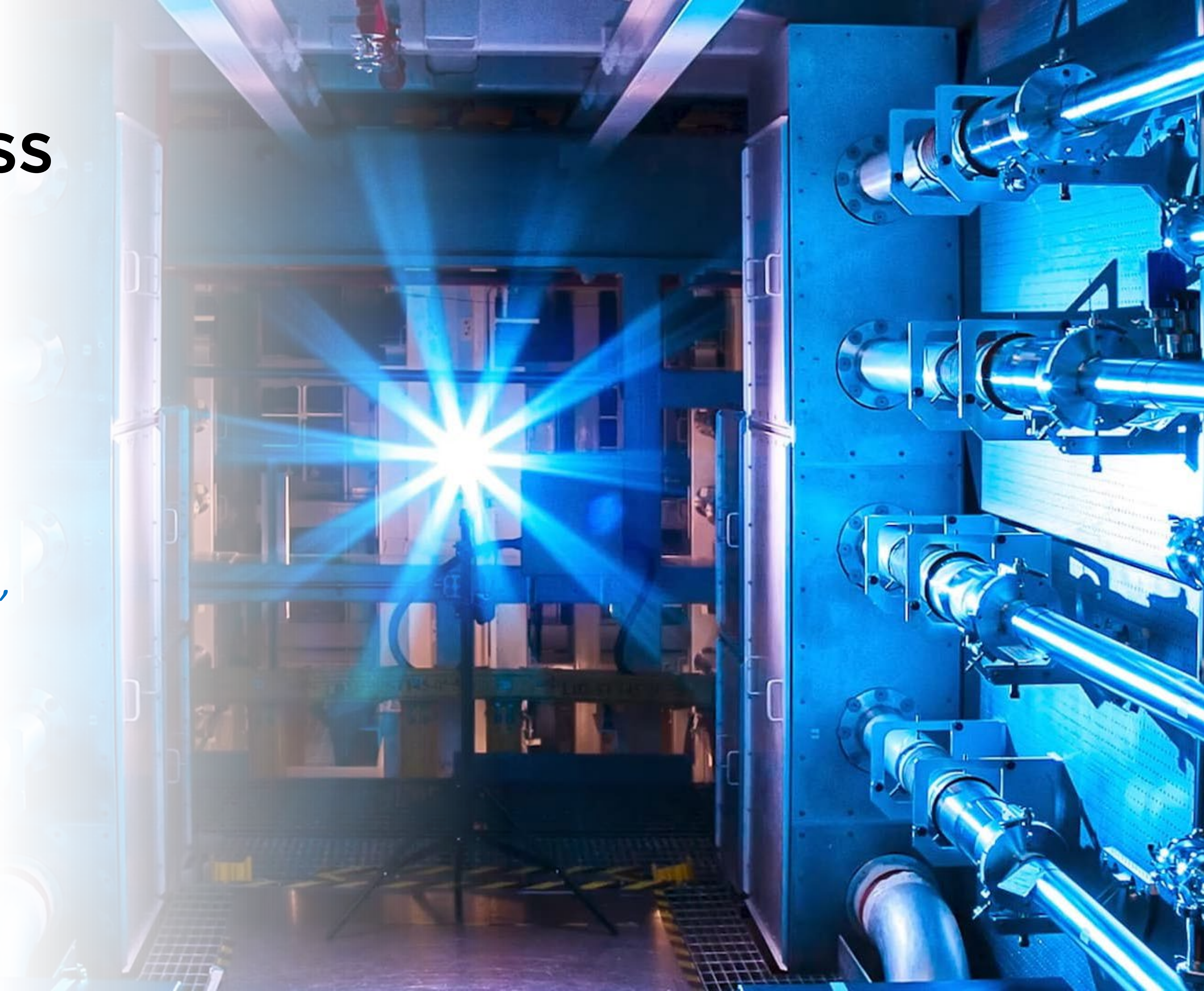
- Comparisons Approved by Owner at Contract Negotiation or Soon After.
- An Expectation of a Minimum Two LCC comparisons.
- HVAC System Comparison Required with One Option Sustainable (Not ‘Business as Usual’).

Business as Usual



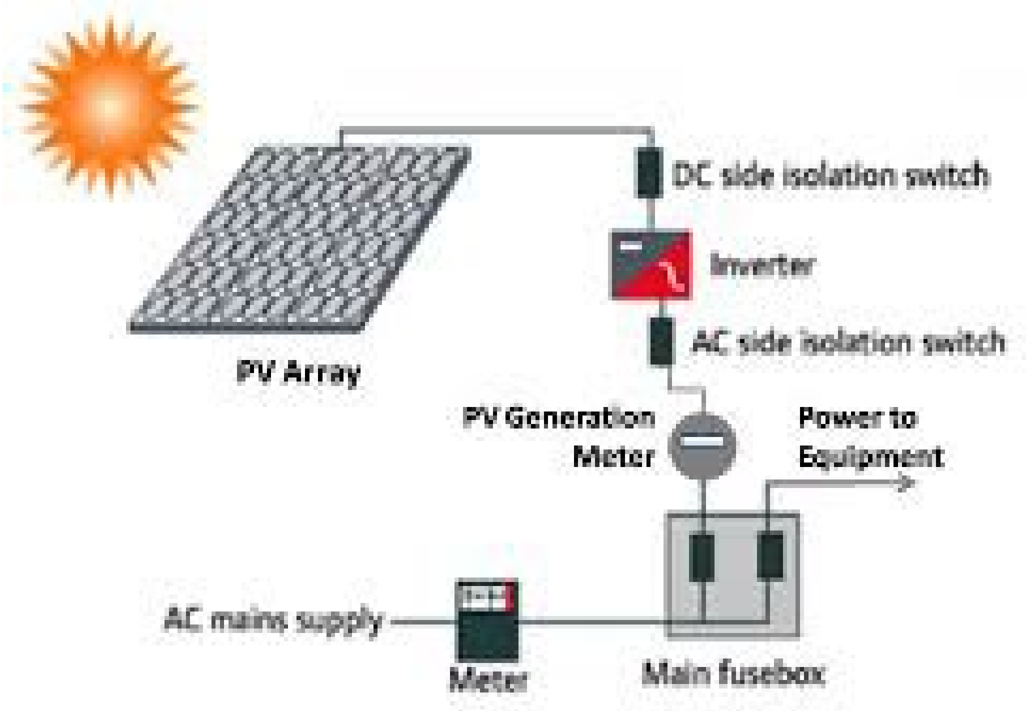
VAV Boxes
w/Reheat

Not Business as Usual?



- *"U.S. Achieves Fusion Energy Breakthrough"*

Photovoltaic



Life Cycle Costing toward Sustainability

Heavy Timber Construction

- *Renewable and Recyclable*

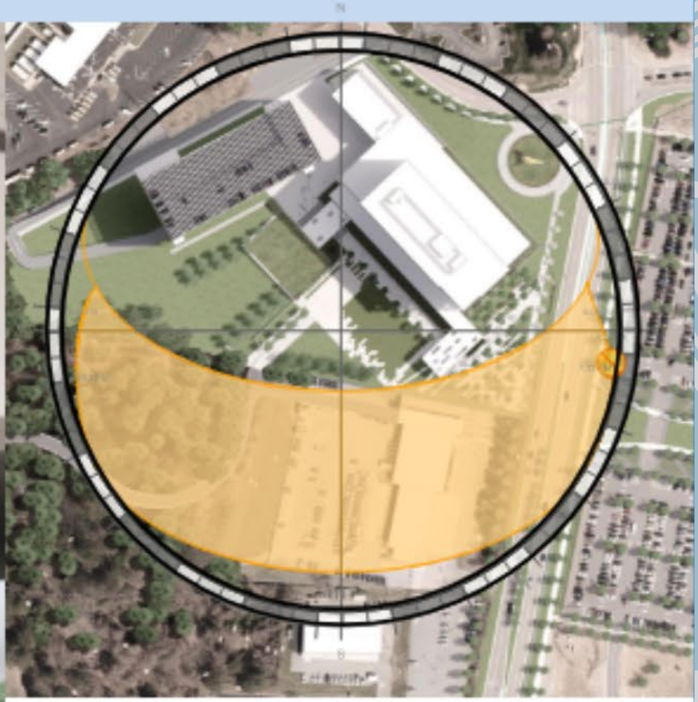
Metal Roofing

- *Recyclable*
- *30-50 year life*

Life Cycle Costing toward Sustainability

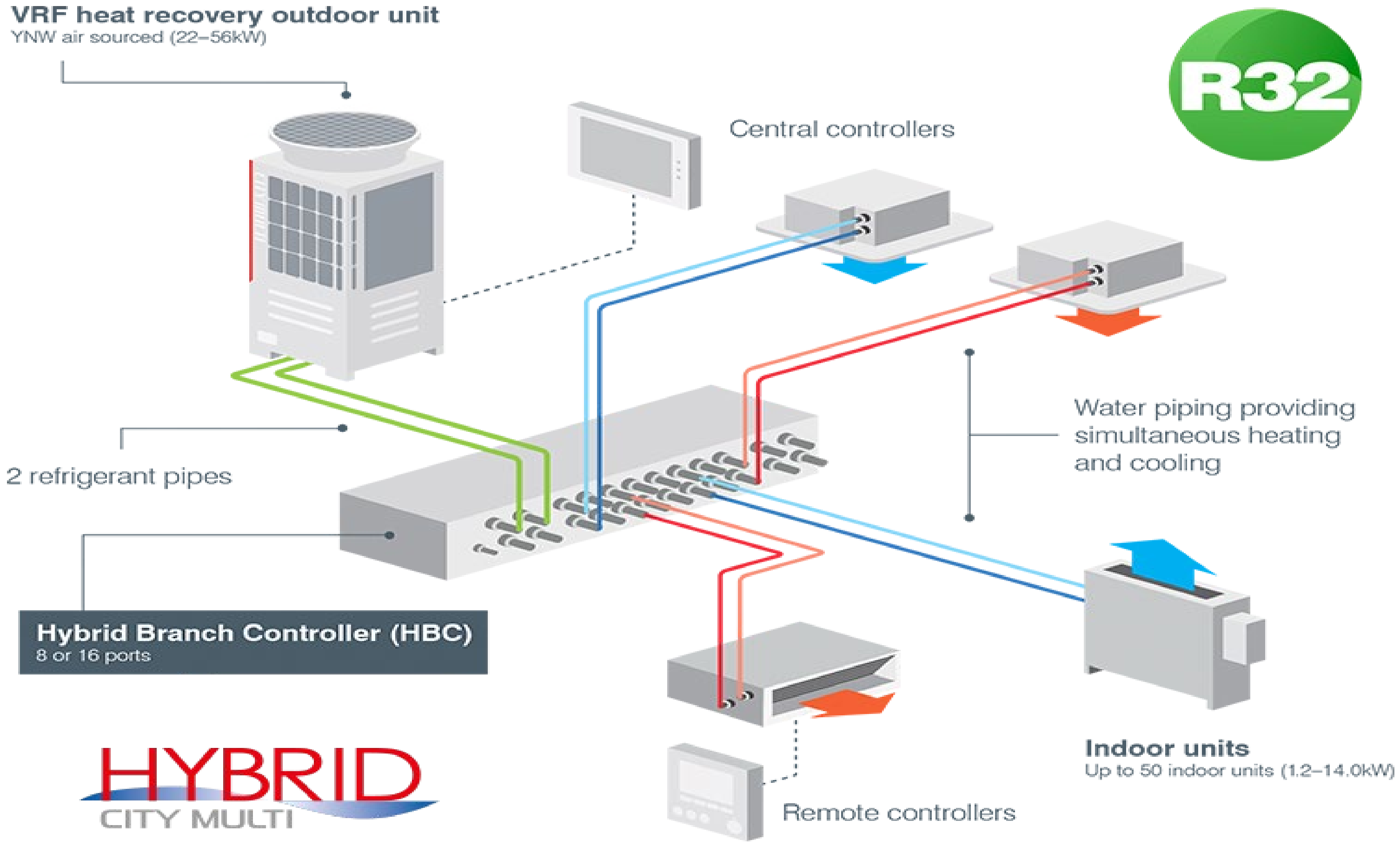
DHHS Campus – Salvaged concrete from demolished parking lots used as sub-base.

Daylighting



- Double-loaded core
- Skylights at deep floor plate
- Low-E glass, with sunshades and ceramic fritting

HVRF (Hybrid VRF)



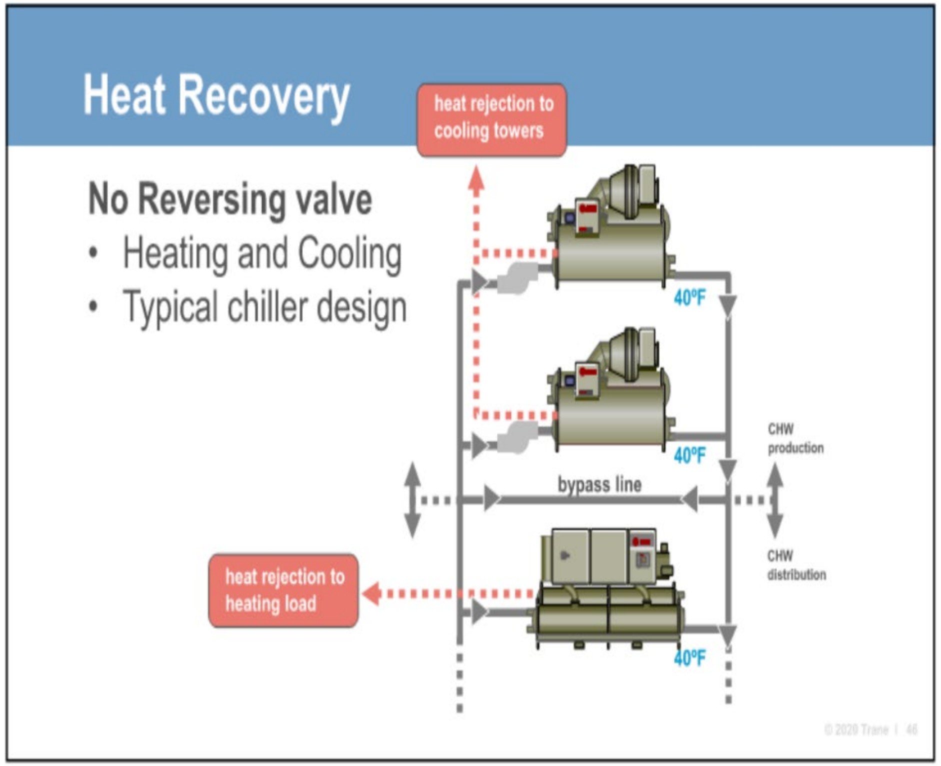
Coming in 2023

Less chance of installation problems

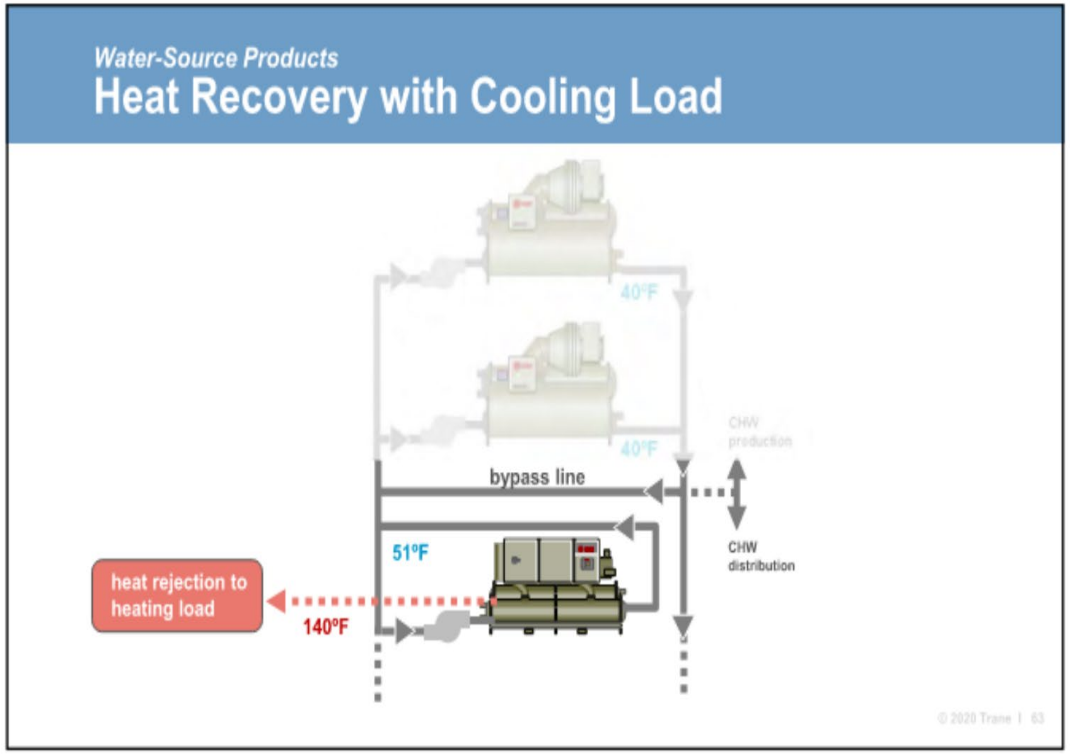
Avoids some upcoming restrictions on refrigerant in egress corridors and refrigerant monitoring requirements.

Water Source Equipment

Heat Recovery Chiller

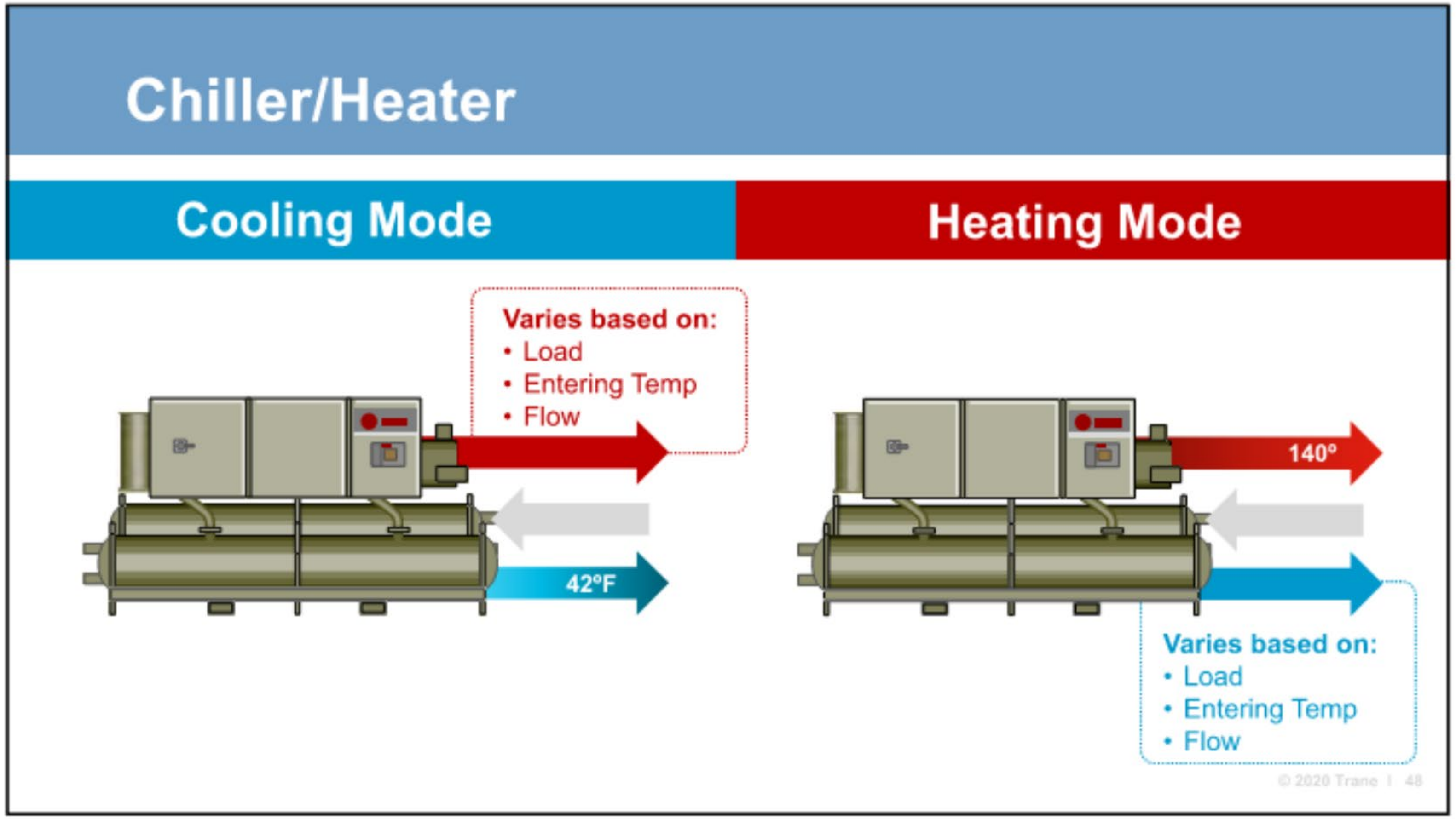


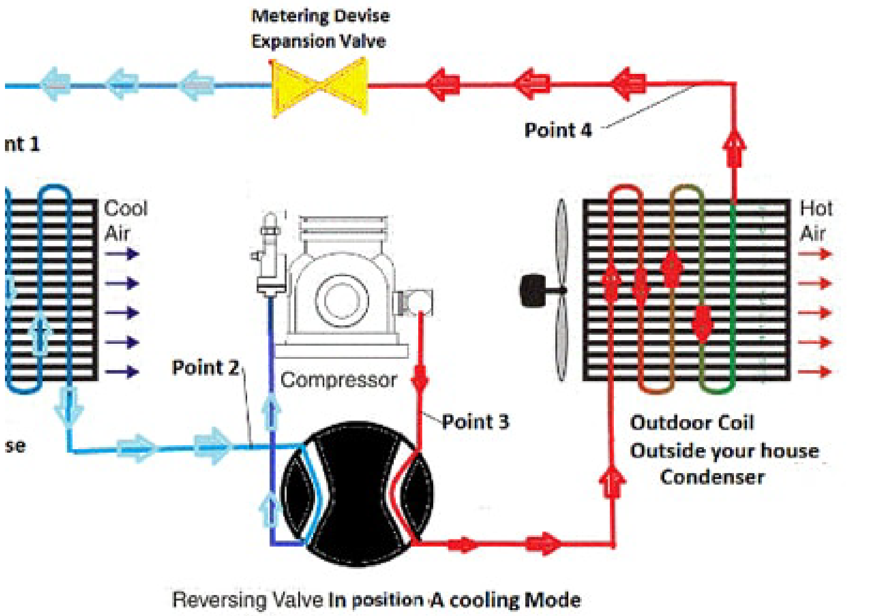
Heater



Water Source Equipment

Same machine as HR chiller and Heater. No reversing valve. Internal controls determine mode.





Air Source Heat Pumps

DOE Cold Climate Heat Pump Challenge

Performance Requirements

Seasonal Heating

- 8.5 HSPF2 (ASHRAE Region V)
- Heating at 5°F [-15°C]
- Minimum COP of 2.1-2.4 at 5°F
- Capacity ratio of 100% for 5°F capacity to 47°F capacity
- Minimum turndown ratio at 47°F
- Compressor cut-in and cut-out temperatures

Heating at -15°F [-26°C] (optional)

- HP operation at -15°F as measured by compressor cut-in and cut-out temperatures

Product Prototype (Late 2021 / Early 2022) → Lab Testing (2022) → Field Testing (Winter 2022-2023 or 2023-2024) → Deployment Programs / Commercialization (2024)

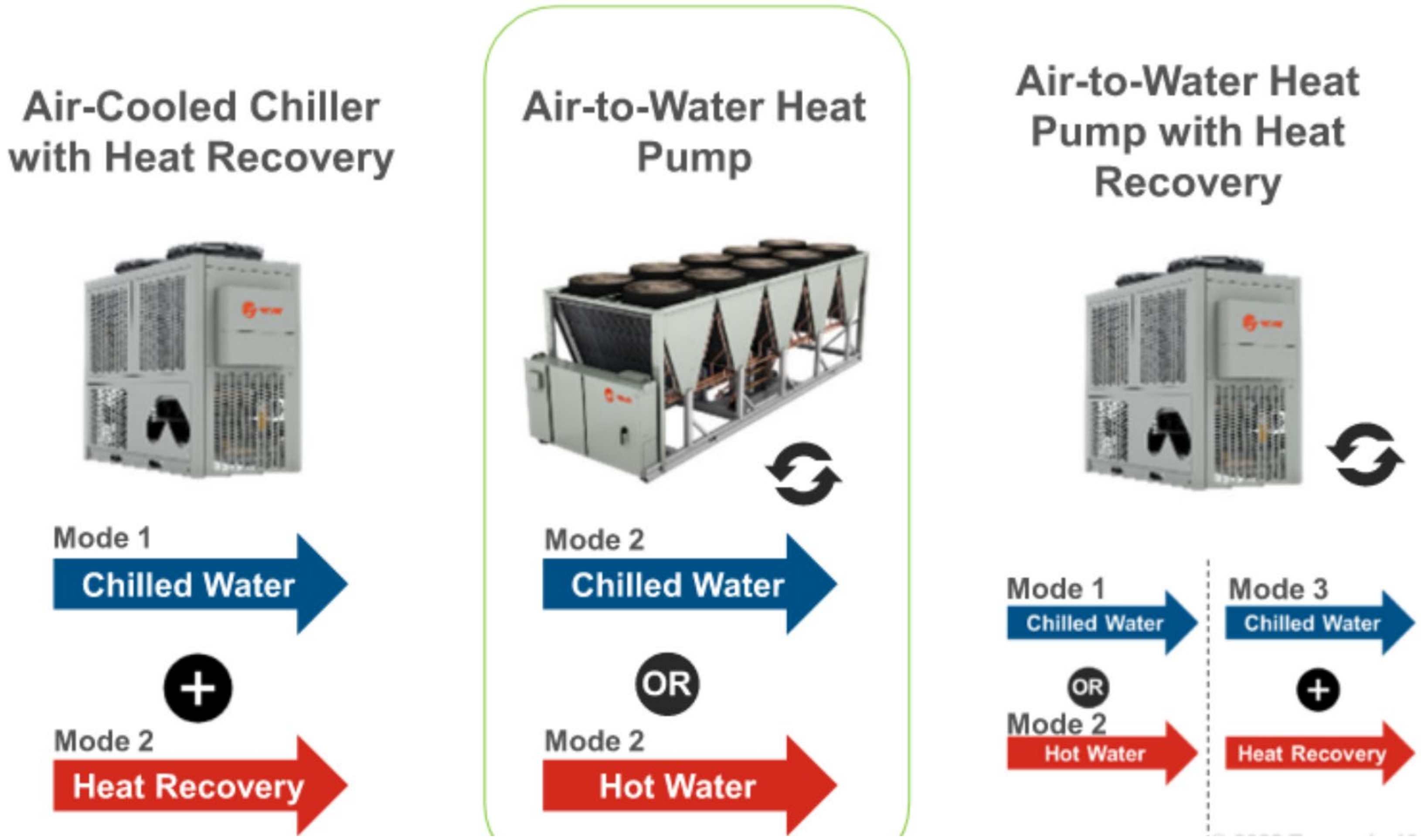
2024 NCECC - 2021 ICC - ASHRAE 90.1-2019 - Includes Air to Water Heat Pumps

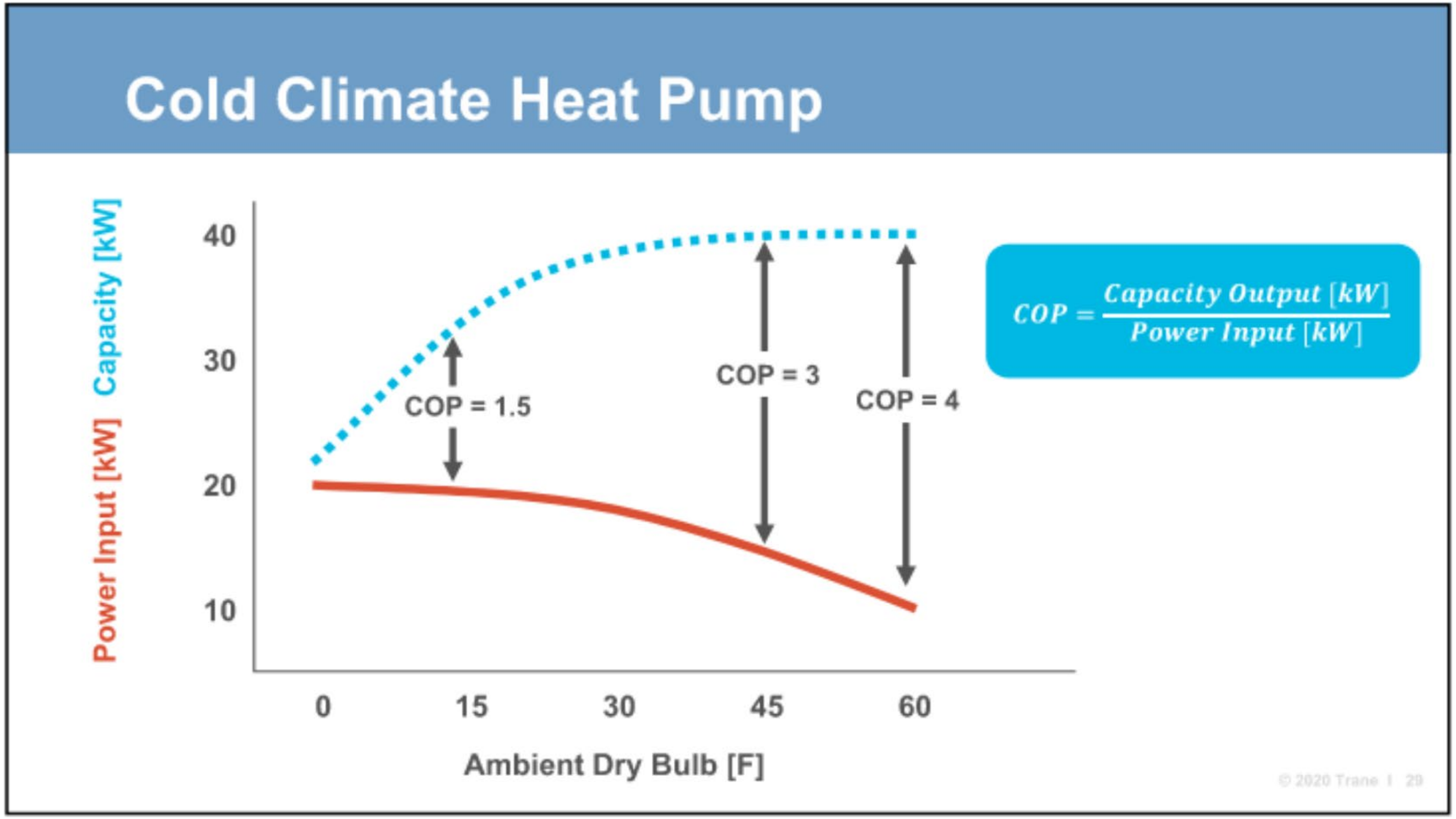
Equipment Type	Size Category Refrigerating Capacity Ton	Cooling-Operation Efficiency Air-Source (EER, FL/IPLV), Btu/W-hr		Heating Source Conditions OAT (db/wb) °F	Heat Pump Heating Full Load Efficiency (COPh), W/W Entering/Leaving Heating Liquid Temperature			Test Procedure
		Path A	Path B		Low 95°F/105°F	Medium 105°F/120°F	High 120°F/140°F	
Air-source	<150	≥9.595 FL ≥13.02 IPLV.IP	≥9.215 FL ≥15.01 IPLV.IP	47 db 43 wb	≥3.290	≥2.770	≥2.310	AHRI 550/590
				17 db 15 wb	≥2.029	≥1.775	≥1.483	
	>150	≥9.595 FL ≥13.30 IPLV.IP	≥9.215 FL ≥15.30 IPLV.IP	47 db 43 wb	≥3.290	≥2.770	≥2.310	
				17 db 15 wb	≥2.029	≥1.775	≥1.483	

Per ASHRAE 90.1-2019 Addendum y (approved December 9. 2-21)

Data shown from ASHRAE Standard 90.1-2019 Table 6.8.1-16 Addendum y

More "Not Business As Usual" Equipment





Cold Climate Heat Pump
Power Input [kW]
Capacity [kW]
40
30
20
10
0
15
30
45
60
Ambient Dry Bulb [F]
COP = 1.5
COP = 3
COP = 4
$COP = \frac{Capacity\ Output\ [kW]}{Power\ Input\ [kW]}$
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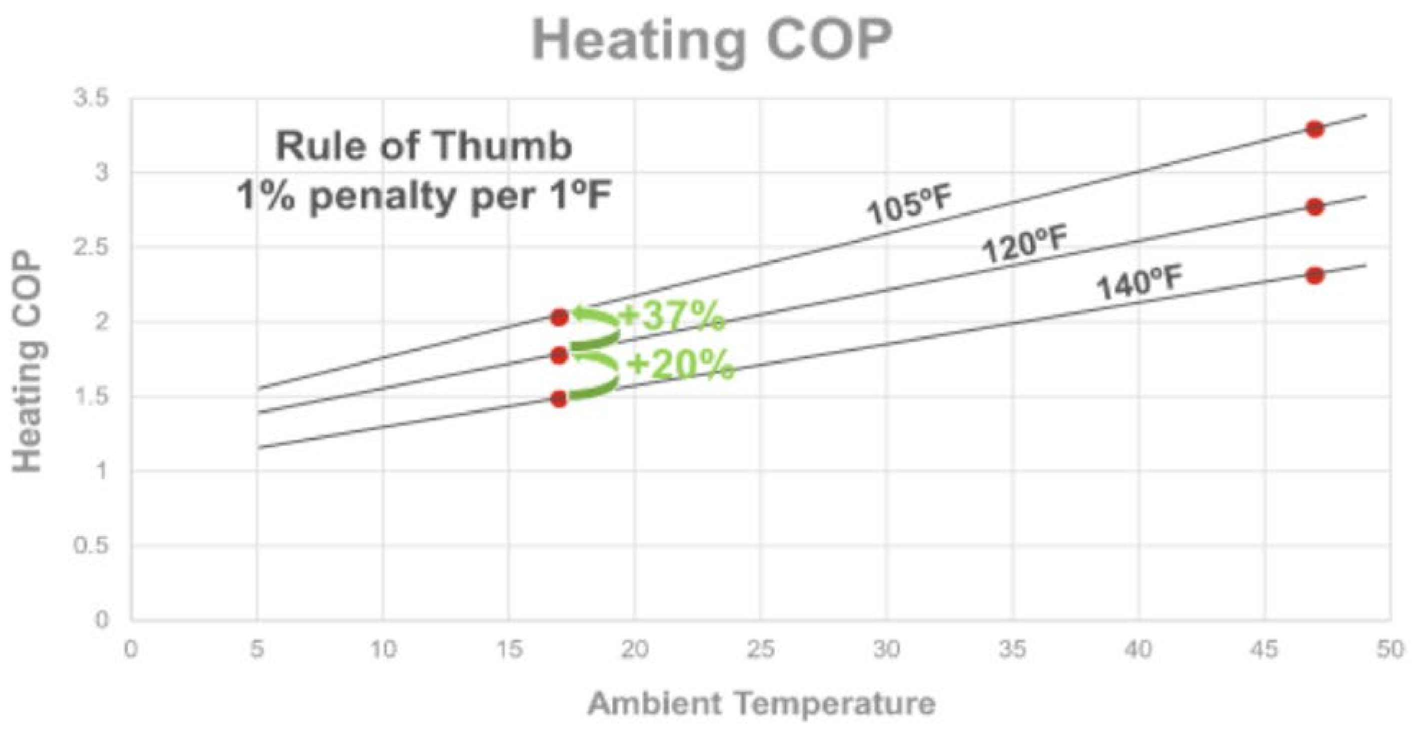
Hot Water Supply Temperature

What is needed by the zone equipment?

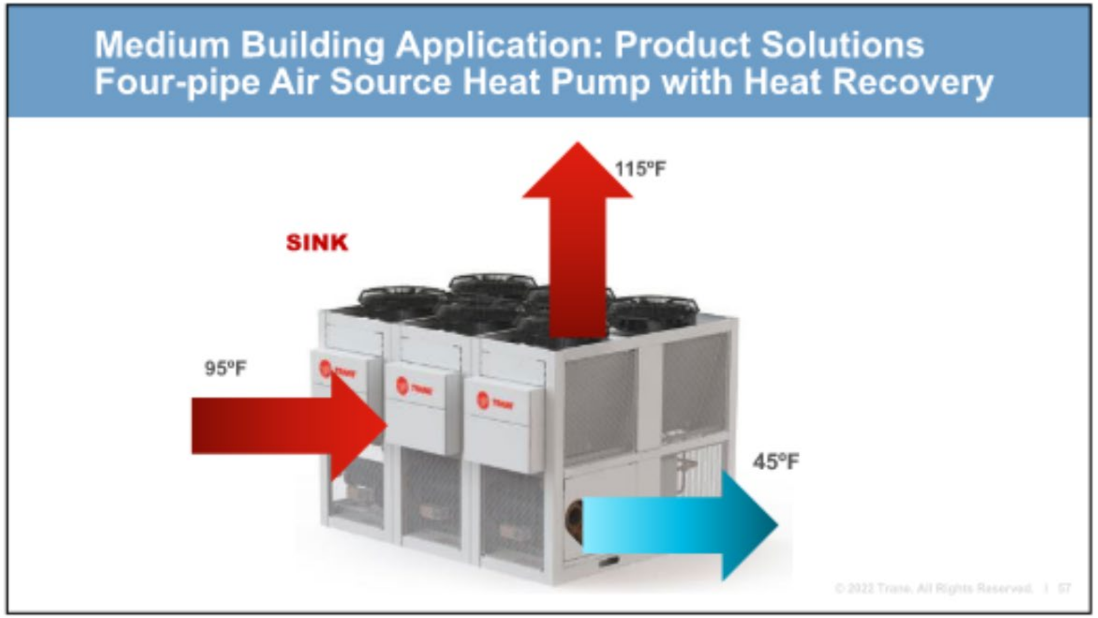
- Most equipment can be selected for space heating with 100ºF to 110ºF hot water

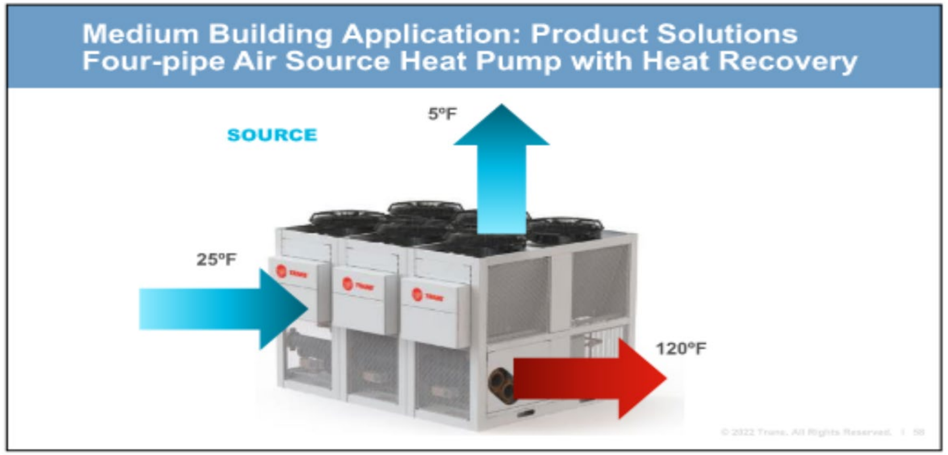
Equipment	Minimum Hot Water Supply Temperature
DOAS Air Handler	>80F
Central Air Handler/VAV	95-105F
Single Zone VAV AHU	100-105F
VAV boxes (4row)	95-105F
Fan Coil Units w/ Changeover coil	100-115F

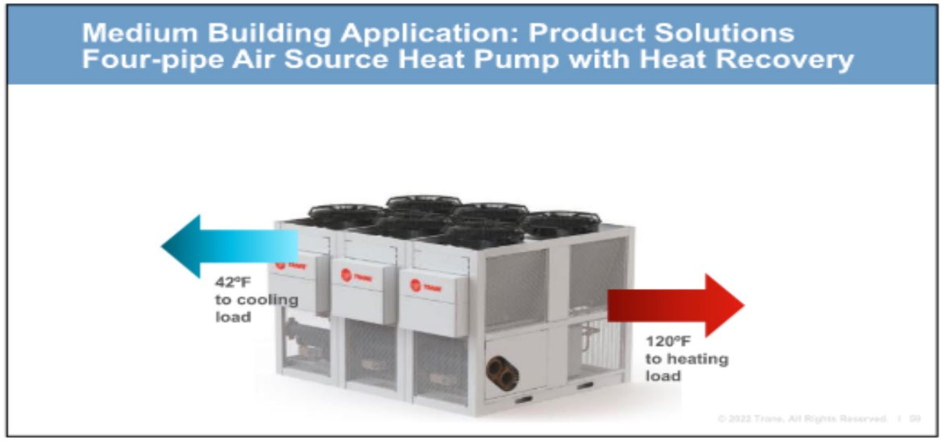
Hot Water Temperature Impacts



Air Cooled Heat Pump Equipment



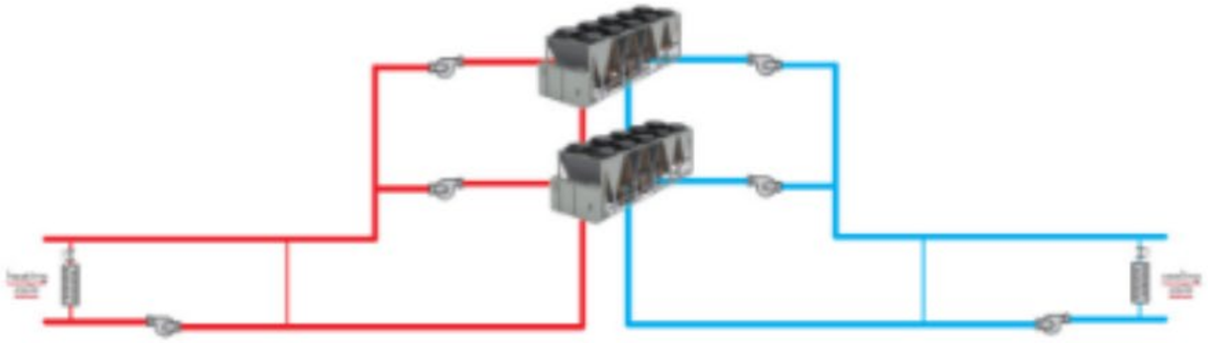




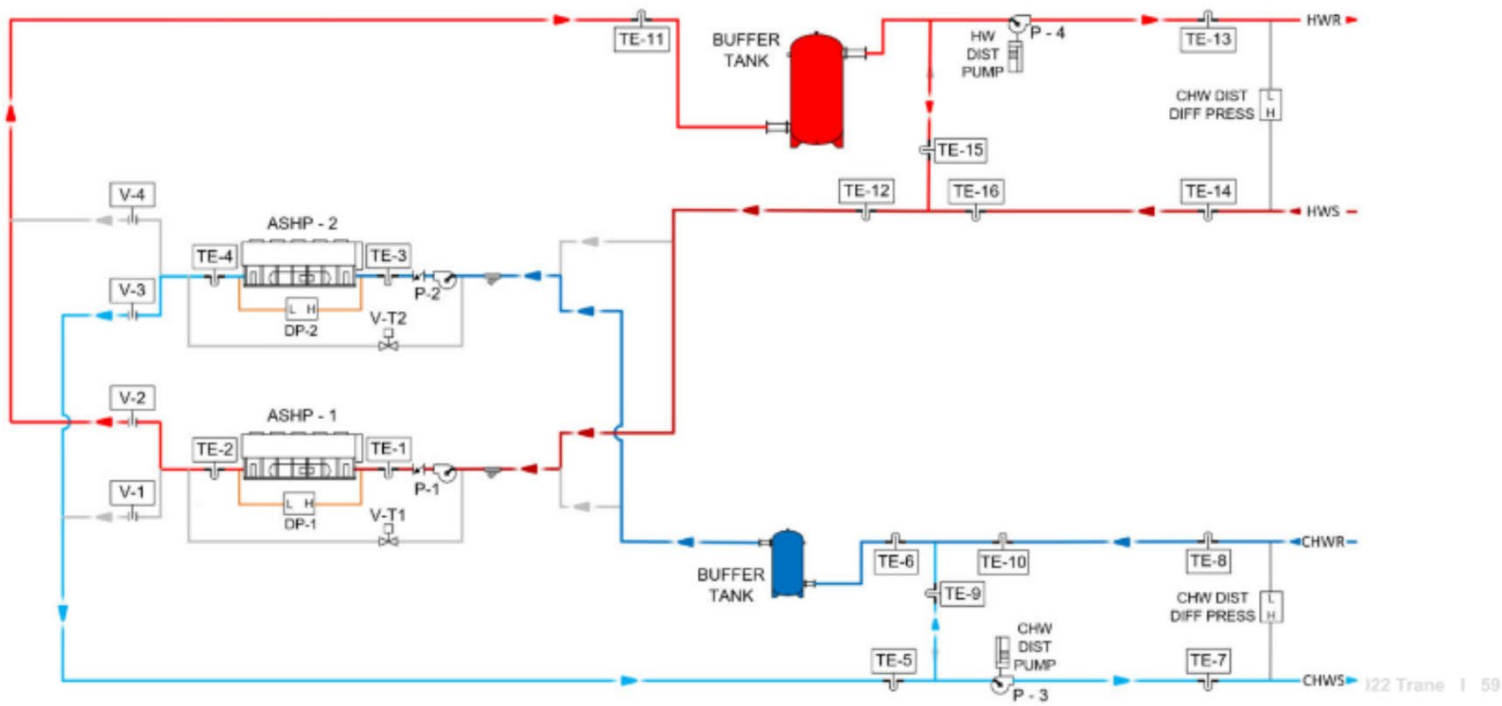
Air Cooled Heat Pump Equipment

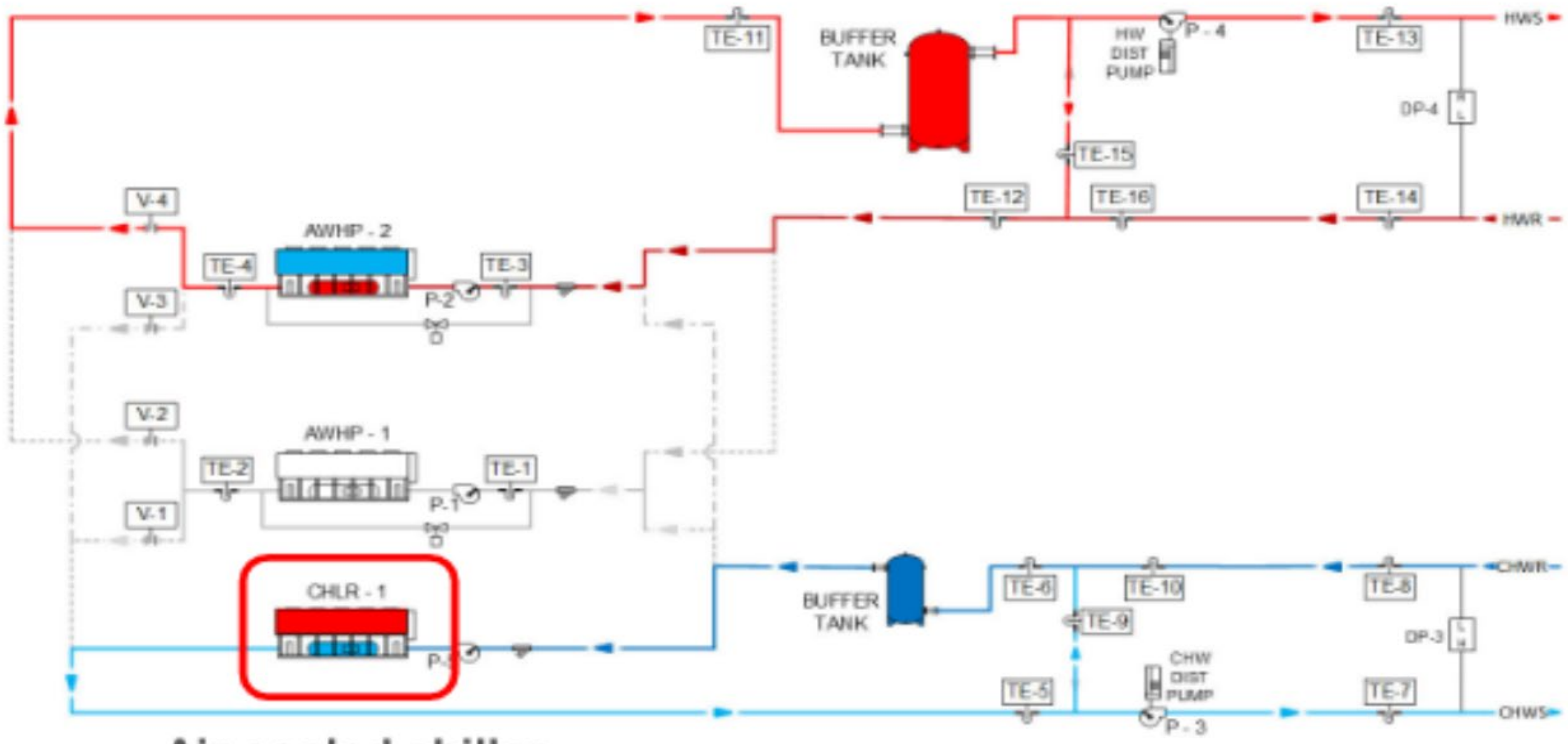
Medium Building Application

- Single unit can replace chiller and boiler
- Includes back up

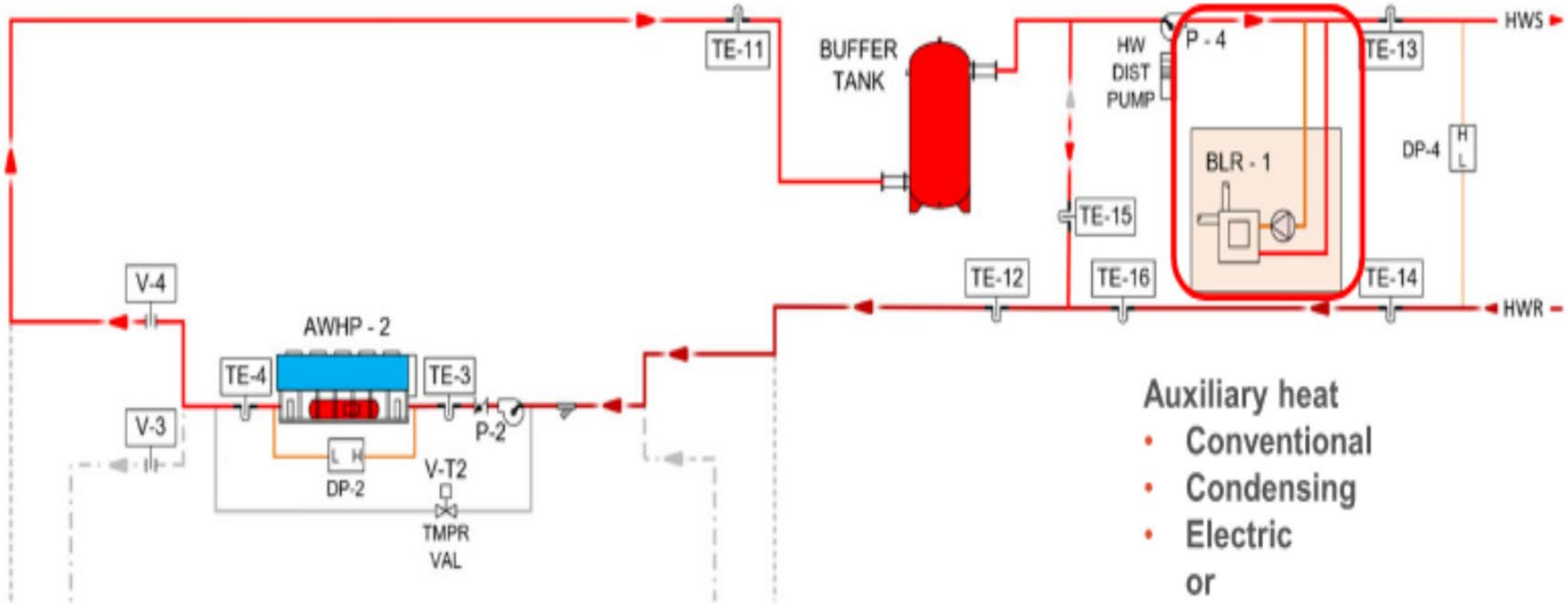


System Configurations and Options
Base System





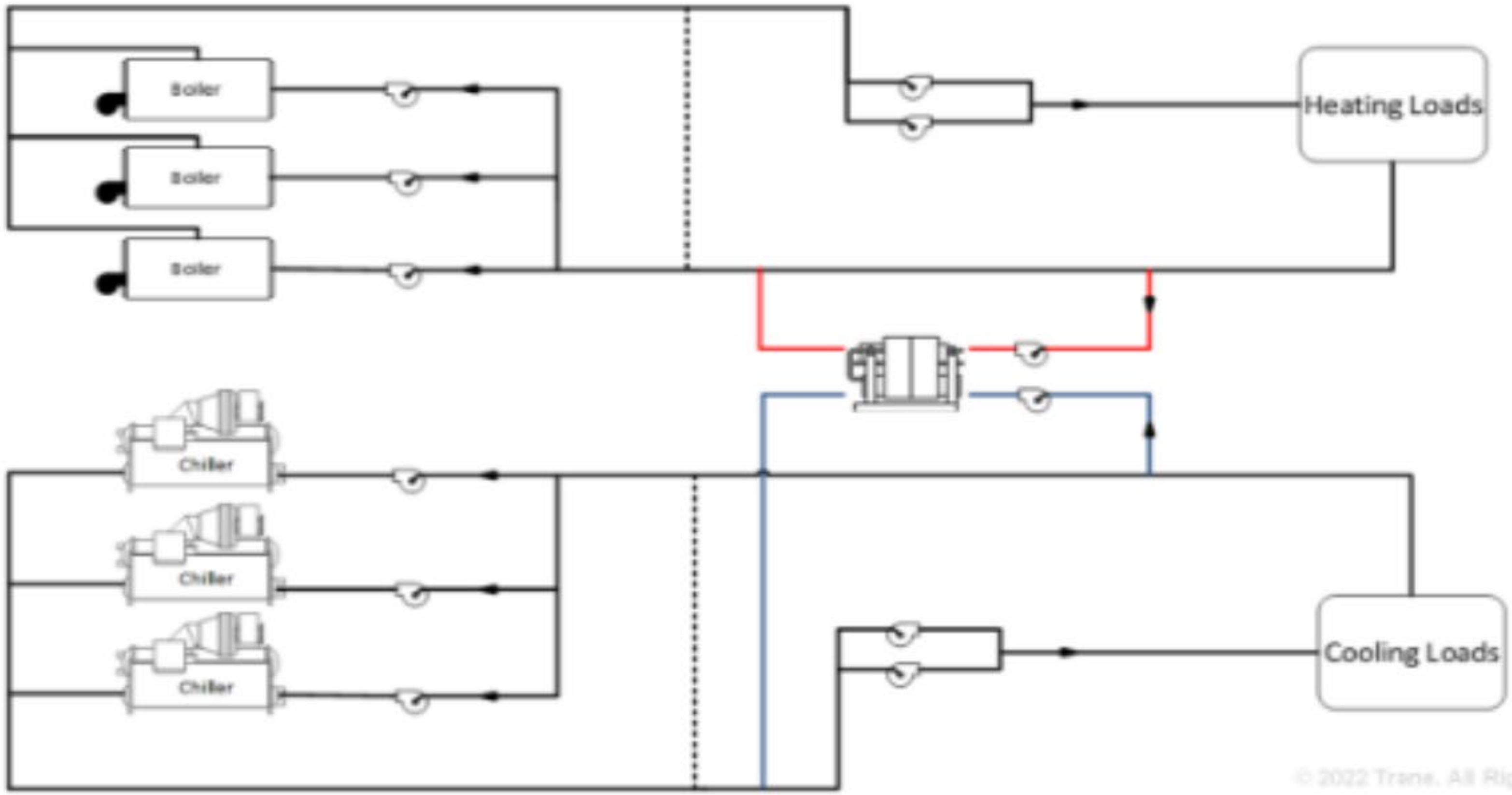
Air cooled chiller



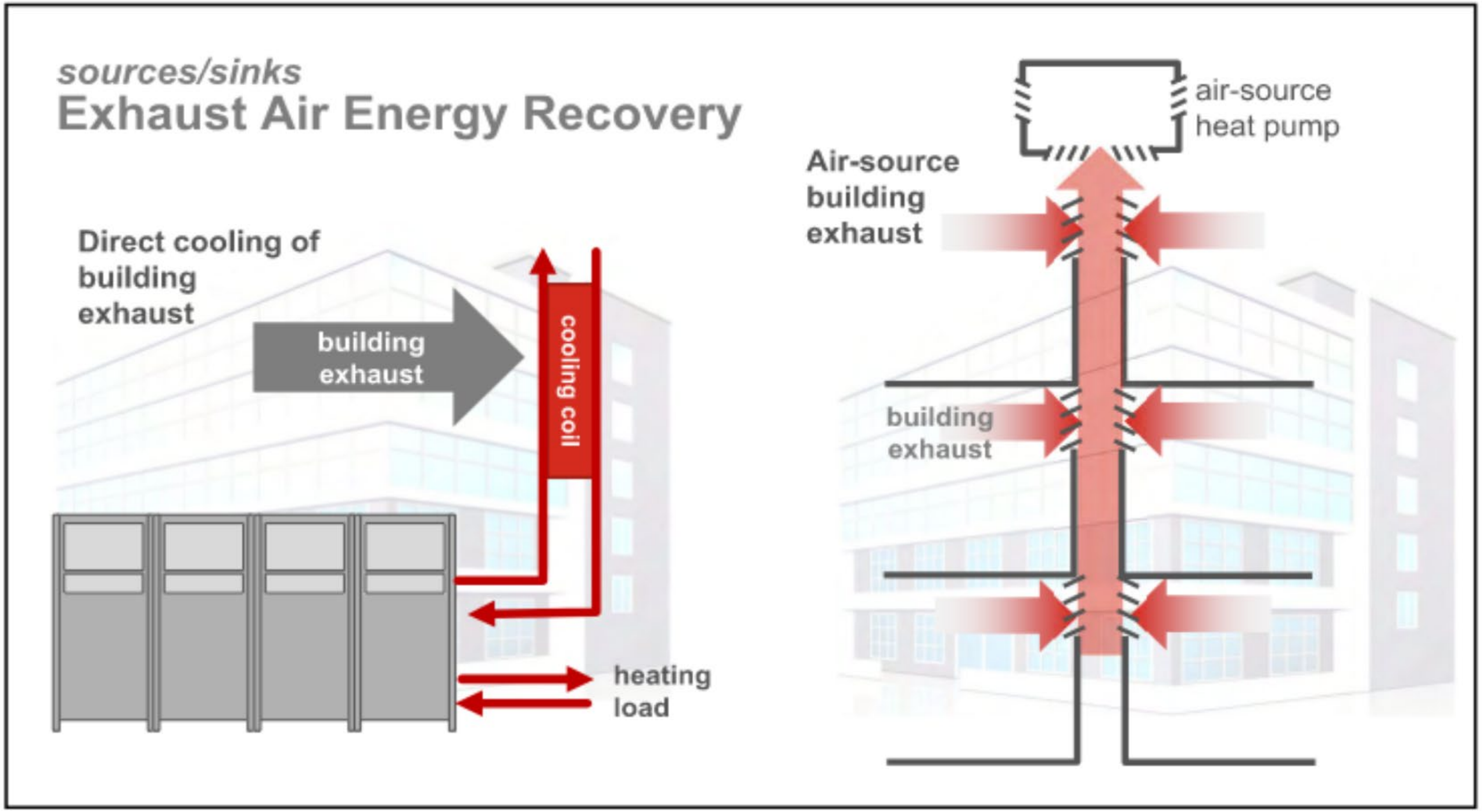
Auxiliary heat

- Conventional
- Condensing
- Electric
  or
- In-space electric

Large Building – Heat Recovery



NC★DOA


sources/sinks
Exhaust Air Energy Recovery
Direct cooling of building exhaust
building exhaust
cooling coil
heating load
air-source heat pump
Air-source building exhaust
building exhaust

How Tesla's Ingenious Heat Pump Gives It An Edge Over Other Electric Cars

Tesla's effective heat pump helps maximize the car's power in all weather conditions, making it a triumph card against other EVs.

BY MILICA CIKUSA   PUBLISHED 7 DAYS AGO

LIFE CYCLE COST ANALYSIS

NC State Construction Office

Project Name: Sample Bldg
SCO ID:
Prepared By:

inflation rate	3.8 %			Adjustment Fctr	1.002	
discount rate	3.6 %					
OPTION 1 DESCRIPTION				**OPTION 2 DESCRIPTION**		
DOAS w/Chilled water Cooling and HW heat.				Doas similar to Option 1 but includes heat pipe heat recovery.		
ECONOMIC LIFE 1	25	yrs		**ECONOMIC LIFE 2**	20	yrs
Analysis period	25	yrs				
CAPITAL COST	$720,000			**CAPITAL COST**	$1,404,000	
ENERGY COST	$554,554	/yr		**ENERGY COST**	$445,000	/yr
ANNUAL MAINT.		/yr		**ANNUAL MAINT.**	$1,000	/yr
Life Cycle Cost	$14,909,825			Life Cycle Cost	$13,049,639	
LCC Rank	2				1	

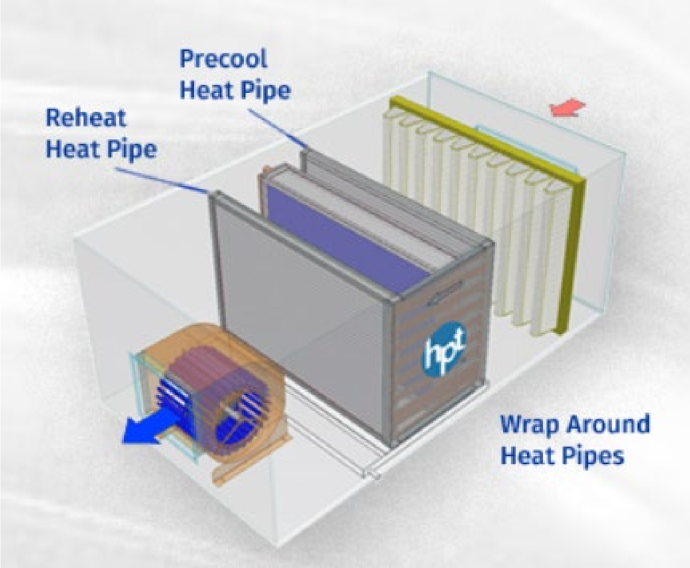
Payback 6.3 yrs

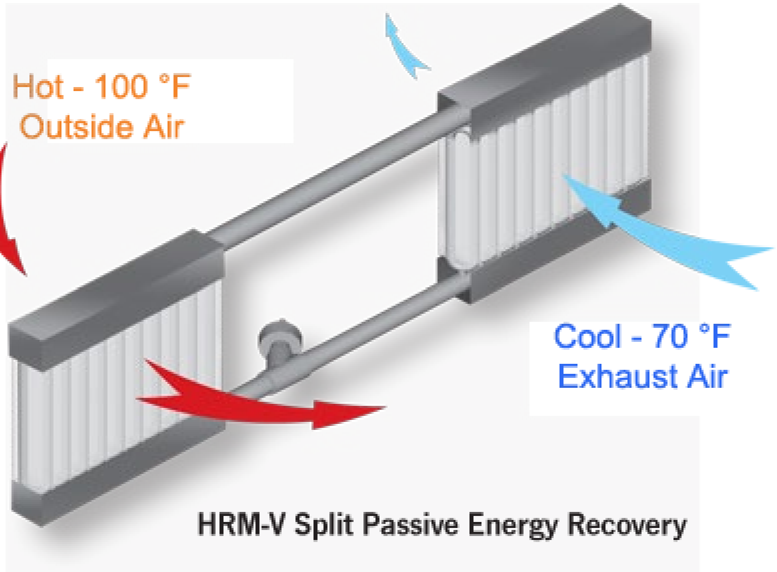
(Negative payback means lowest capital cost option has lowest annual costs also)

Comparison Summary, Results and Implementation: The resulting LCCA compared DOAS HVAC systemagainst a DOAS HVAC system with a Wrap Around system. A $1000 annual maintenance contract is included with the heat pipe. The LCCA shows a payback period of 6.3 years during the 25 year analysis period. The heat pipe option will be implemented.

Professional Seal

Heat Pipes


Precool
Heat Pipe
Reheat
Heat Pipe
Wrap Around
Heat Pipes


Hot - 100 °F
Outside Air
Cool - 70 °F
Exhaust Air
HRM-V Split Passive Energy Recovery

Results Available for Public Use

Life Cycle Cost Analysis Summary of Evaluations

	SCO ID #	Owner	Eng/ Arch.	Project	Disc. A/M/E	Option 1 (Baseline)	Option 2 (Evaluated)	Payback (yrs)	Sel. (1 or 2)
1	20-22343	NCSU	AEI	Int. Sci. Bldg.	A	Glazing - Solarban double pane	Glazing - Solarban triple pane	120.2	1
2	20-22343	NCSU	AEI	Int. Sci. Bldg.	A	Roof - R30	Roof - R50	528.2	1
3	20-22343	NCSU	AEI	Int. Sci. Bldg.	A	Wall - R21	Wall R-30	158	1
4	20-22343	NCSU	AEI	Int. Sci. Bldg.	M	DOAS w/wrap around heat pipe	DOAS w/Konvecta High Performance Wrap System	8.2	2
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									

PV & Battery (Microgrid)

- United Therapeutics (RTP)
- Net-Zero cGMP Warehouse
- No OnSite Fossil Fuels
- Ballasted Rooftop Solar (563 kW)

PV & Battery (Microgrid)

- Tesla Megapack ilo Diesel Generators
- Operate in ‘Island Mode’ without Utility Power
- 6.2 mWh / 1.54 kW Total Lithium Iron Phosphate (LFP) Battery
  - Assumed Zero PV Contribution
  - Assumed 8 Hour Fire Pump (Code) – 1,000 kWh
  - 24 Hour Full Facility – 2,724 kWh
  - 48 Hour Cold Storage – 1,586 kWh

Heat Recovery Chillers

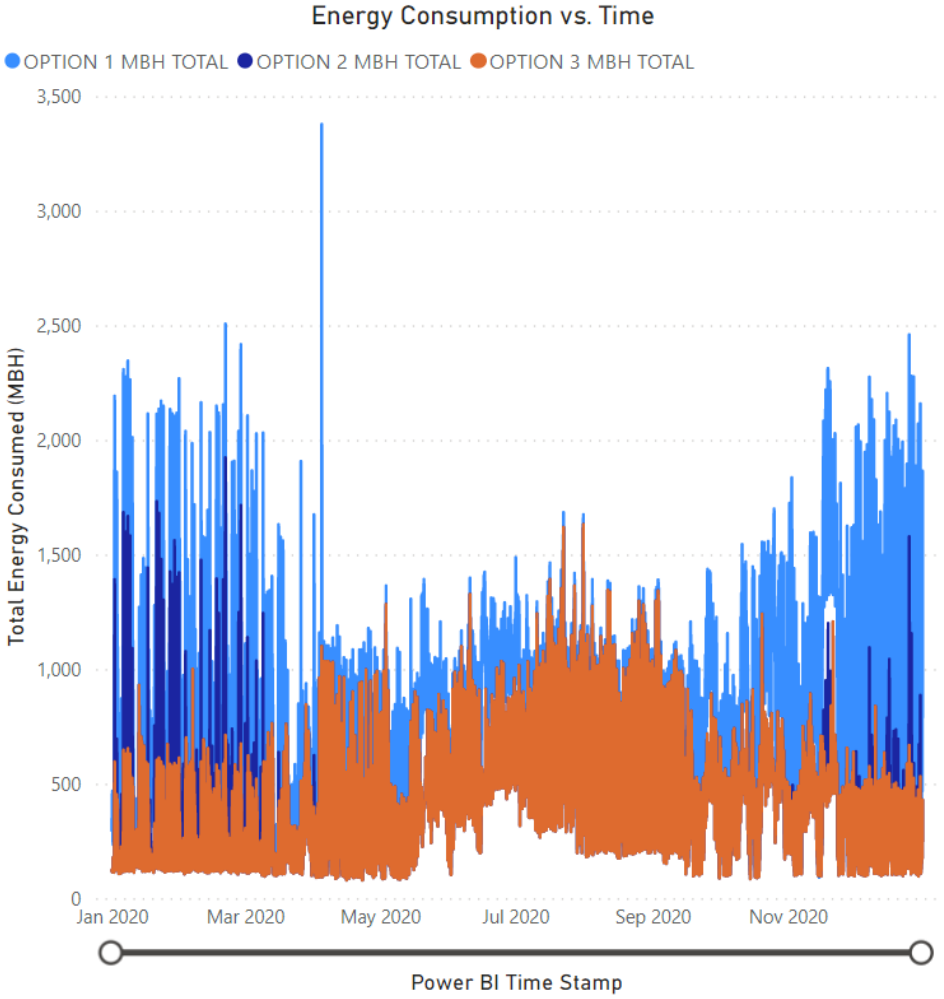
- University of Virginia
- Conversion MTHW (230F) LTHW (170F)
- 1800-ton York CYK
- 42F Chilled Water
- 30 MMBH 170F Heating Hot Water
- 1.62 kW/Ton (COP=2.17)
- Reduces utility costs by over $1M per year and eliminates 20k metric tons of CO2 emissions per year

Retrofits – Going All Electric Heating

STEP 4 Hill & Haynes: ENERGY USAGE ⓘ

Phase

All



Option 1 - Like for Like

Total NG Demand (mmBTU)

3,641

Air Cooled Chillers (kWh)

972,405

Option 1 - Total Energy Consumed (MBH)

6,013,013

Option 2 - HRC'S

Boiler Usage (kWh)

61,394

HRC Usage (kWh)

209,769

Air Cooled Chillers (kWh)

780,118

Option 2 - Total Energy Consumed (MBH)

3,584,868

Option 3 - ASHP'S

Air Source Heat Pump (kWh)

18,127

HRC Usage (kWh)

209,770

Option 3 - Total (kWh)

780,117

Option 3 - Total Energy Consumed (MBH)

3,437,329

Retrofits – Going All Electric Heating

STEP 5 Hill & Haynes: **LCCA TOOL**

RESET - AEI ESTIMATES

REMOVE ACC CREDIT

Option 1 - First Cost

670000

Option 2 - First Cost

1730000

Option 3 - First Cost

1150000

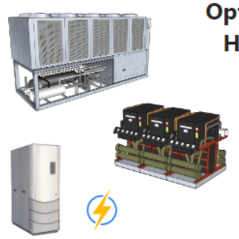
Electricty Cost ($/kWh)

Natural Gas Rate ($/kCFH)

6.80

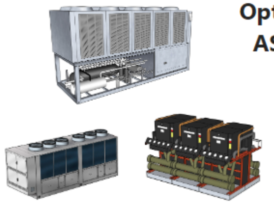
Option 1
Like for Like

First Cost	Annual Energy Cost	Life Cycle Cost
$670,000	$119,499	$6,039,013



Option 2
HRC

First Cost	Annual Energy Cost	Life Cycle Cost
$1,730,000	$92,513	$5,886,550



Option 3
ASHP'S

First Cost	Annual Energy Cost	Life Cycle Cost
$1,150,000	$88,705	$5,135,483

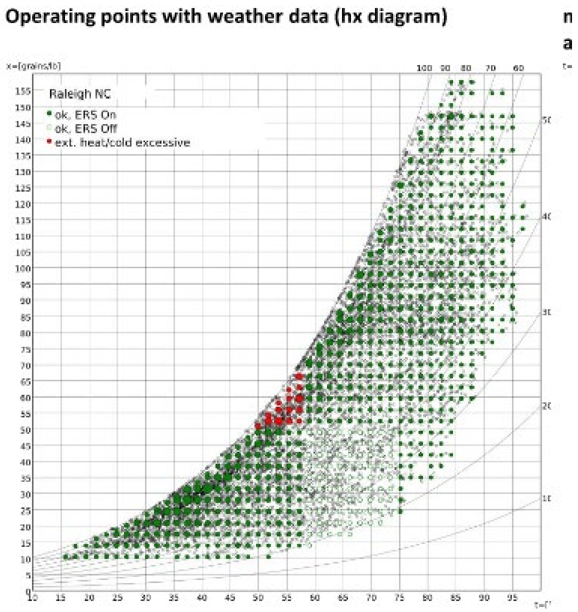
Electrical Escalation	Natural Gas Escalation	Discount Rate (Nominal):	Comparison Time Frame
2%	2%	5%	20

Affiliated Engineers

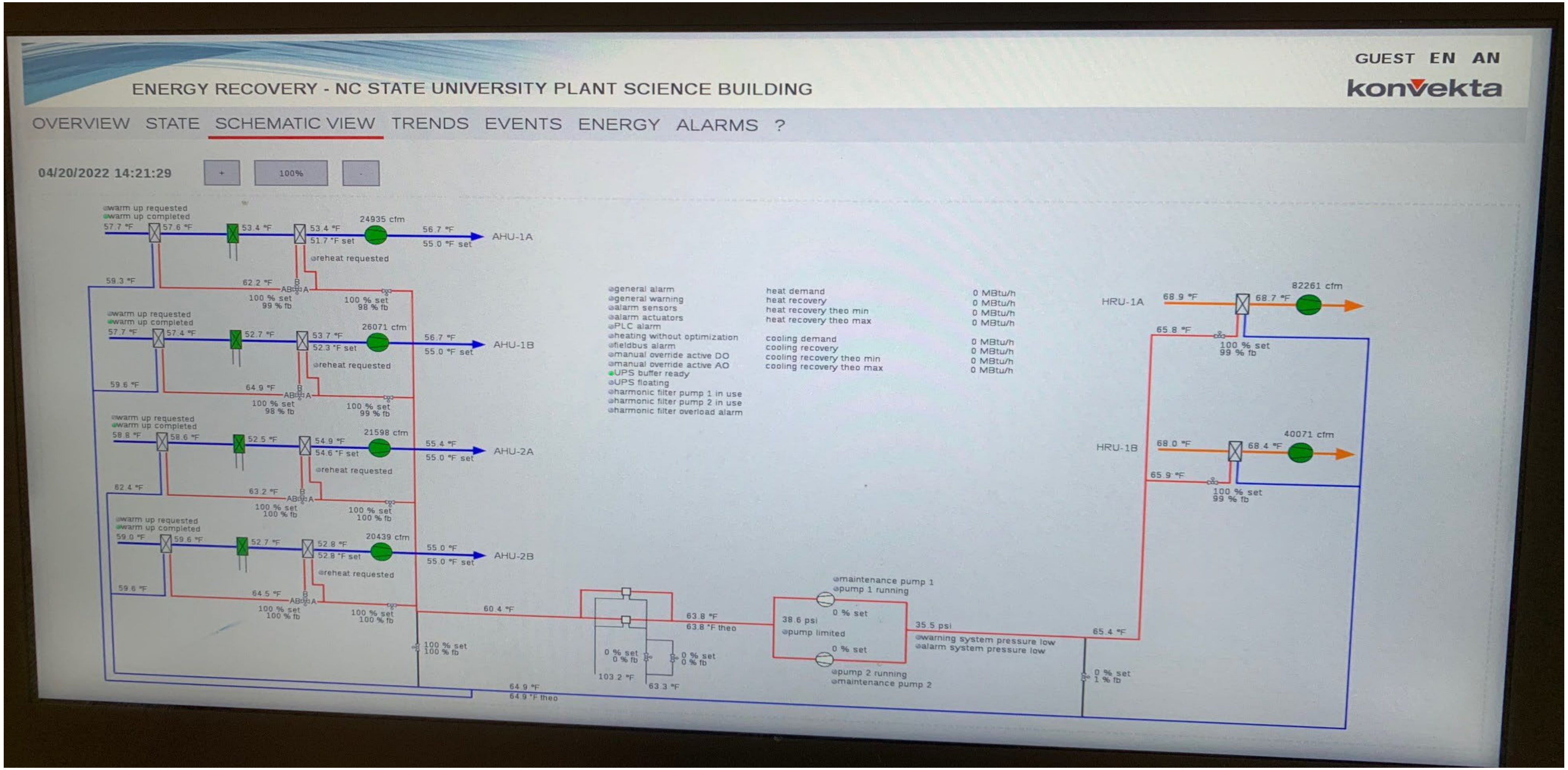
Enhanced Energy Recovery

- NC State Plant Science Building
- Enhanced Energy Recovery Loop & Skid

Results energy calculations: **Reduction of heating energy: 97%** **Reduction of cooling energy: 19%**	without ERS	with ERS	nr of hours	nr of hours with external heat/cold
	(MMBtu)	(MMBtu)	(h)	(h)
heating requirement	13'223.6	269.7	7'968	864
including reheating after dehumidifying	(6'726.5)	(16.5)	(4'699)	(209)
cooling requirement	30'185.8	24'166.3	5'491	5'491

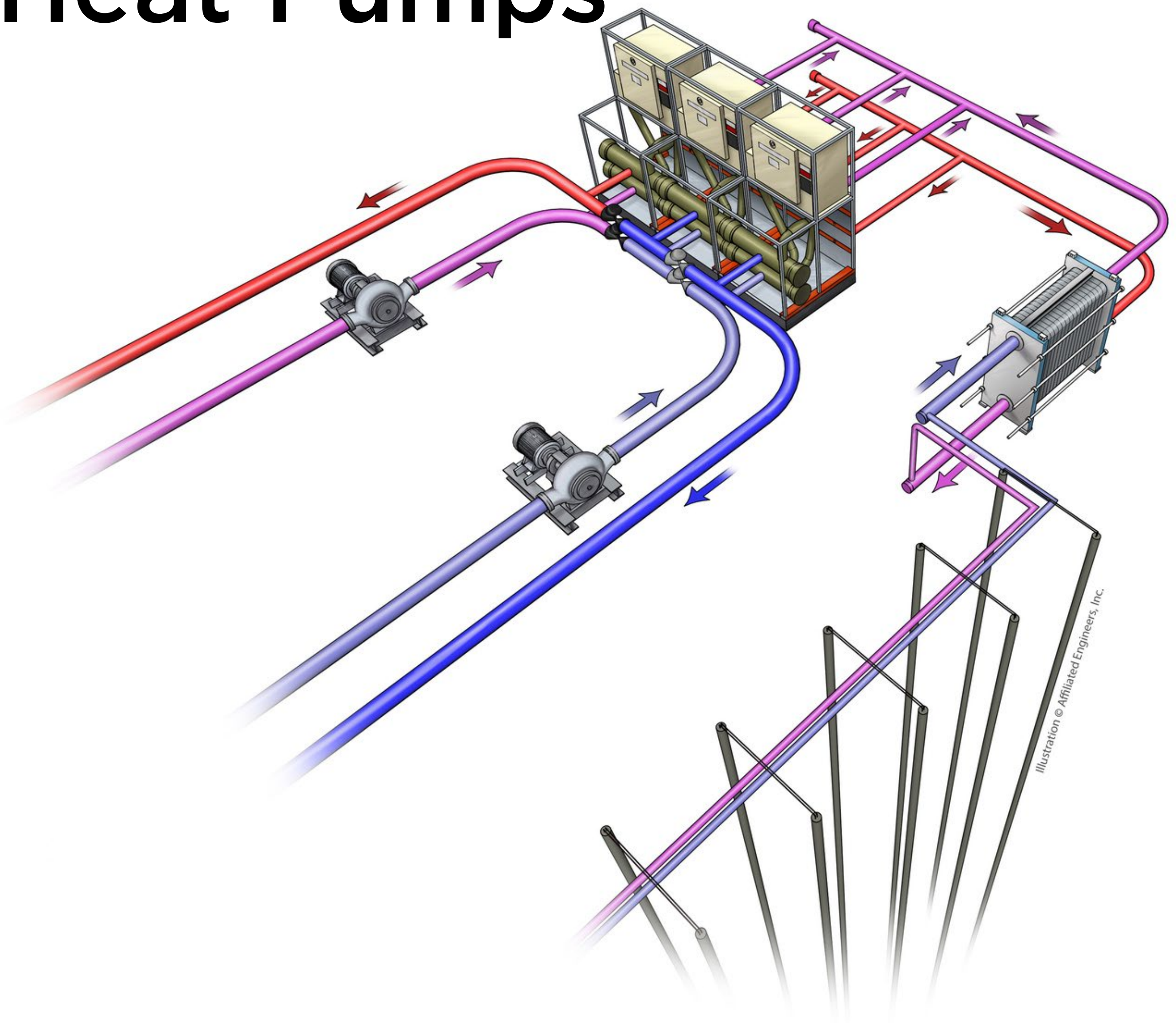


Enhanced Energy Recovery

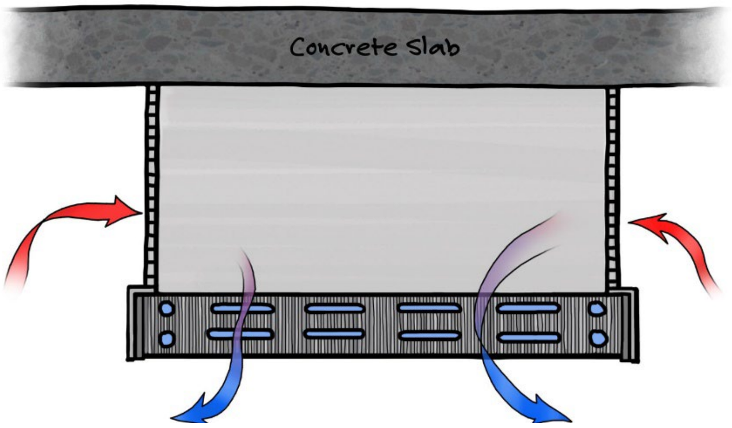


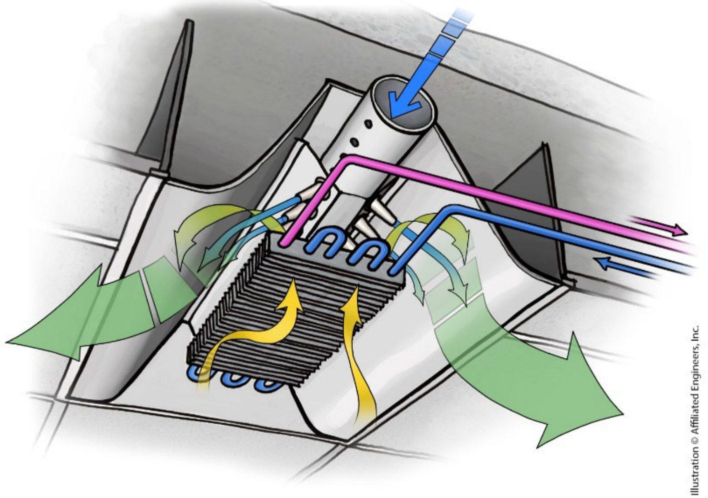
Ground-Souce Heat Pumps

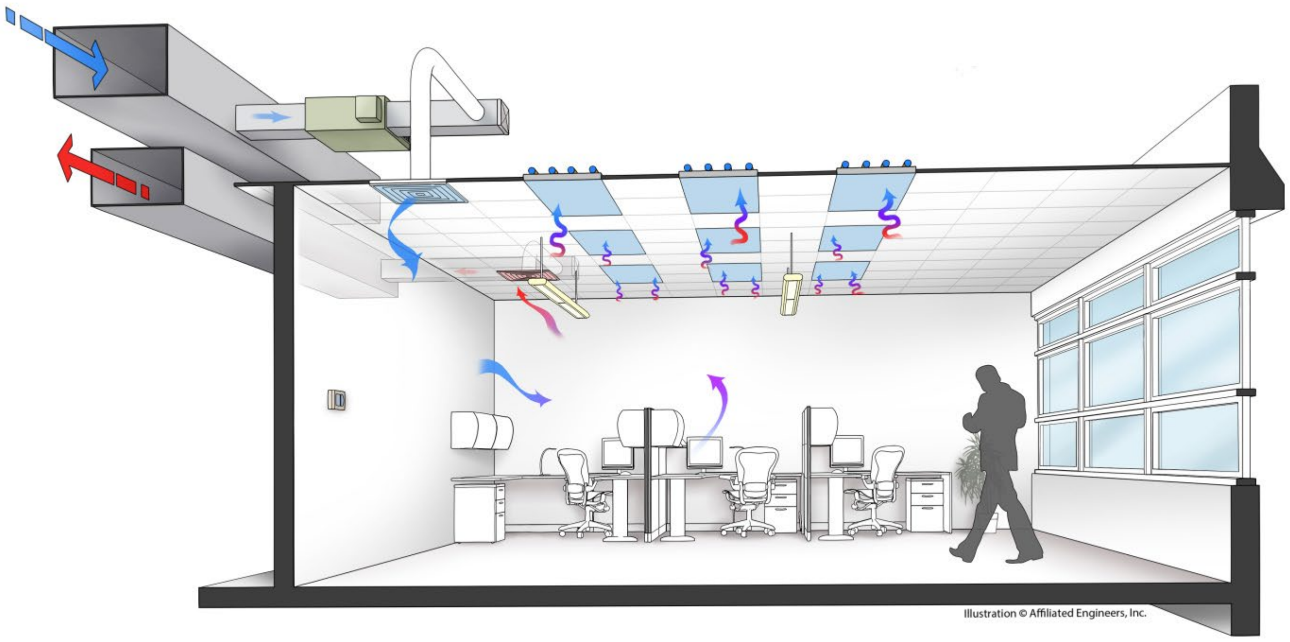
- City of Durham Mist Lake Facility (171k gsf)
- 500-ton ground-source heat pump
- 500 ft. deep bores, 180 bores total.
- $50k annual cost savings over 50 years



De-Coupled HVAC Systems







20-30% energy savings compared to all-air VAV reheat systems

Active Chilled Beams

Passive Chilled Beams

Radiant Ceiling Panels

2023 State Construction Conference

AEI / Affiliated Engineers, Inc.

Radiant Floors

Passive Strategies

- Ryerson Education Facility (16k gsf, Lake County, IL)
- PHIUS Zero 2021
- Super insulated and ultra-airtight building envelope
- Downsized mechanical equipment
- R-90 Roof
- R-60 Walls
- Glazing Assembly U-value: 0.138

Equipment Bidding – G.S. 143-64.12

- *"The Department of Administration shall develop and implement policies, procedures, and standards to ensure that state purchasing practices improve energy efficiency and take the cost of the product over the economic life of the product into consideration".* (Life Cycle Bidding is not specifically required)

Chiller LCC Bidding

Can Bid a second chiller type

BID DATA FORM - ATTACH TO FORM OF PROPOSAL

CHILLERS 200 TONS & LARGER

PROJECT OWNER: ____________________
PROJECT TITLE: ____________________
SCO ID #: ____________________

Electricity Cost $/kwh ____________
Life Cycle (yrs) ____________

Designer Data

Chiller Utilization Profile					
Load %	Load (tons)	Hours per Year	Entering [1] Cond. Water (deg F)	Leaving [1] Cond. Water (deg F)	Outdoor Air Dry Bulb [2] (deg F)
100		88	85	95	95
75		3679	75	85	80
50		3942	65	75	65
25		1051	65	75	55

Note 1: Leave blank for air cooled chillers.
Note 2: Dry bulb temperature for air cooled chillers.

Vendor Data

Base Bid Chiller Performance				
Alternate number	Alt # M - 1A	Alt # M -1B	Alt # M - 1C	Alt # M - 1D
Manufacturer Name	Manuf. 1	Manuf. 2	Manuf. 3	Manuf. 4
Model Number				
Input KW @ 100 % Load				
Input KW @ 75 % Load				
Input KW @ 50 % Load				
Input KW @ 25 % Load				
Bid Price ($)				

Calculation

1st year energy ($)	$0	$0	$0	$0
Life Cycle Cost	**$0**	**$0**	**$0**	**$0**

Vendor Data

Higher Eff. Preferred Alternate Chiller Performance				
Alternate number	Alt # M - 2A	Alt # M - 2B	Alt # M - 2C	Alt # M - 2D
Manufacturer Name	Manuf. 1	Manuf. 2	Manuf. 3	Manuf. 4
Style				
Model Number				
Input KW @ 100 % Load				
Input KW @ 75 % Load				
Input KW @ 50 % Load				
Input KW @ 25 % Load				
Bid Price (S)				

Calculation

1st year energy ($)	$0	$0	$0	$0
Life Cycle Cost	$0	$0	$0	$0

Cooling Tower LCC Bidding

BID DATA FORM - ATTACH TO FORM OF PROPOSAL

COOLING TOWERS 200 TONS & LARGER

PROJECT OWNER: ______
PROJECT TITLE: ______
SCO ID #: ______

Electricity Cost $/kwh ______
Life Cycle (yrs) ______
Range EWT-LWT (F) ______

Designer Data

Cooling Tower Utilization Profile					
Load %	Load (tons)	Flow (GPM)	Hours Per Year[1]	Leaving Water (deg F)[1]	Outdoor Air Wet Bulb (deg F)[1]
100			88	85	78
75			3679	75	66
50			3942	65	54
25			1051	65	46

Vendor Data

Cooling Tower Performance				
Alternate number	Alt # M - 3A	Alt # M - 3B	Alt # M - 3C	Alt # M - 3D
Manufacturer Name	Manuf. 1	Manuf. 2	Manuf. 3	Manuf. 4
Dimensions LxWxH				
Model Number				
Input KW @ 100 % Load				
Input KW @ 75 % Load				
Input KW @ 50 % Load				
Input KW @ 25 % Load				
Vertical Tower Lift (ft)				
Spray Nozzle Pres. (ft)[2]				
First Cost ($)				

Calculation

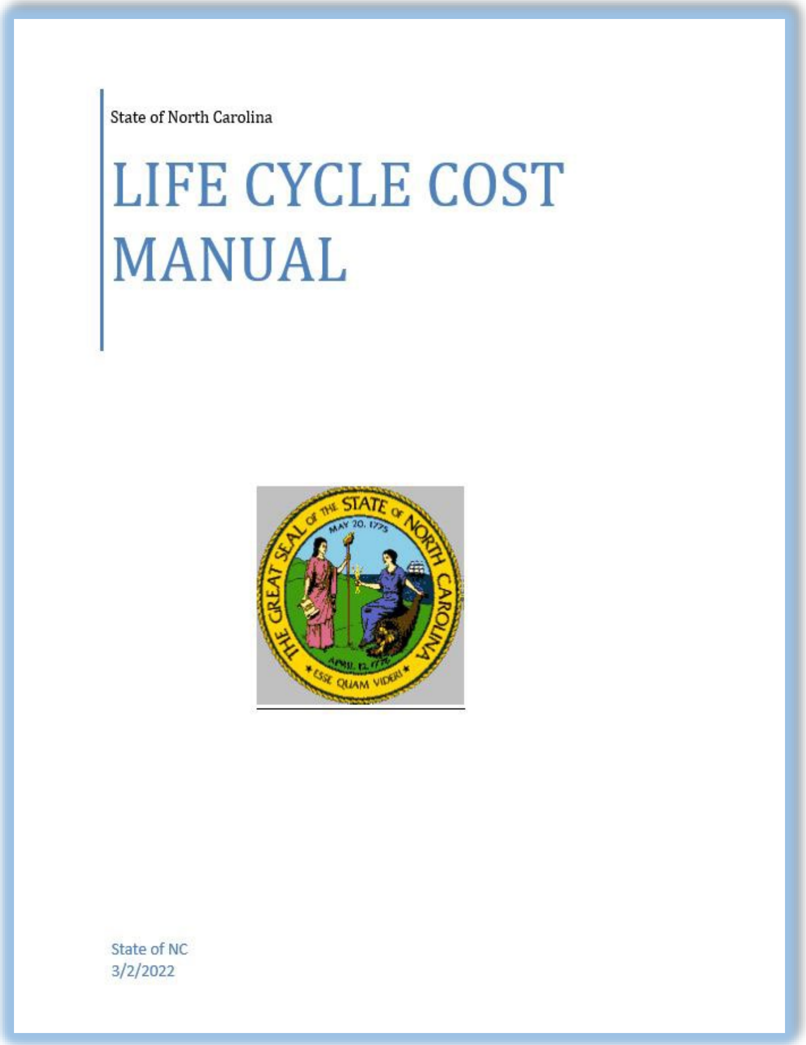
Tower Energy Cost ($)	$0	$0	$0	$0
Tower Pumping Cost ($)	$0	$0	$0	$0
Total Life Cycle Cost ($)	$0	$0	$0	$0

1. Default data may be edited by engineer if project specific data available.
2. Spray nozzle pressure applicable to counterflow towers only.

Default Data is Provided

Pump Energy is now Taken into Account.

https://ncadmin.nc.gov/businesses/state-construction/forms-and-documents#design-review


State of North Carolina

LIFE CYCLE COST MANUAL

State of NC
3/2/2022

NC DOA
Department of Administration
State Construction Office

THE END

Questions?

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