Industrial Decarbonization Peer Exchange

February 22nd, 2023

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APRIL
11-13
2023
Better Buildings
U.S. DEPARTMENT OF ENERGY
Better Buildings, Better Plants
SUMMIT
REGISTER NOW! betterbuildingssolutioncenter.energy.gov/summit
U.S. DEPARTMENT OF
ENERGY

In-Plant Trainings (INPLTs)

- INPLTs teach plant workers how to conduct assessments, use DOE tools, and implement projects.
- **140+** In-Plants, **2400** participants since 2011
- Partners have identified more than **$53M** in energy savings opportunities, to date.
- Most are open to outside participants (host's discretion)

Host Plant Name / City, State	Energy System Type	Date
Legrand / Fairfield, NJ	Treasure Hunt	February 26 - 28, 2023
Lennox / Orangeburg, SC	Compressed Air	March 7 - 9, 2023
Cleveland Cliffs / Middletown, OH	Treasure Hunt	March 7 - 9, 2023
Autoliv / Ogden, UT	Compressed Air	March 38 - 30, 2023
Chemours / New Johnsonville, TN	Steam	April 25 - 27, 2023
Miami-Dade Water and Sewer Development / Hialeah, FL	50001 Ready	TBD
Tyson Foods / Union City, TN	Industrial Refrigeration	TBD
Bendix / Bowling Green, KY	Treasure Hunt	TBD
Lear / Grand Rapids & Roscommon, MI	Treasure Hunt	TBD
Leggett & Platt / Carthage, MO	Treasure Hunt	TBD
Philadelphia Water / Philadelphia, PA	Wastewater	TBD

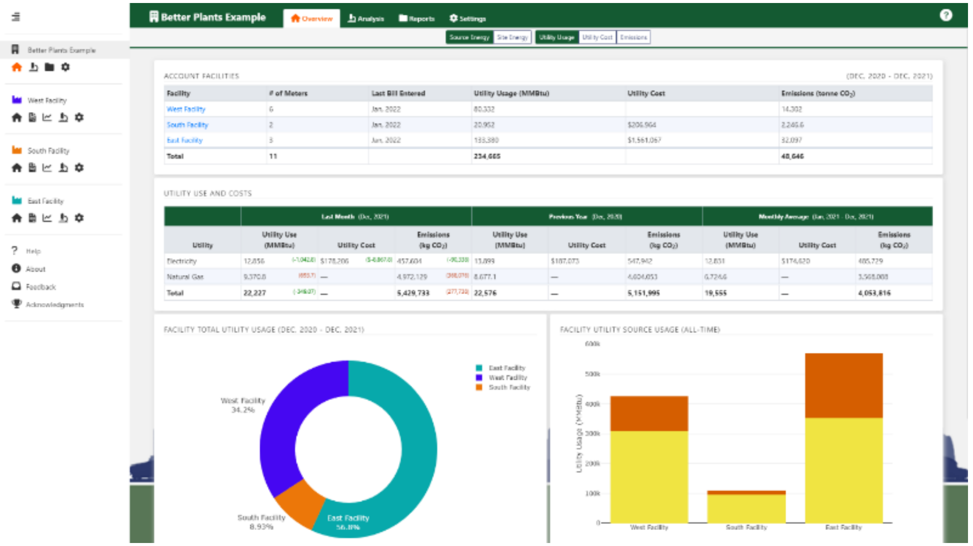
New Tool - VERIFI

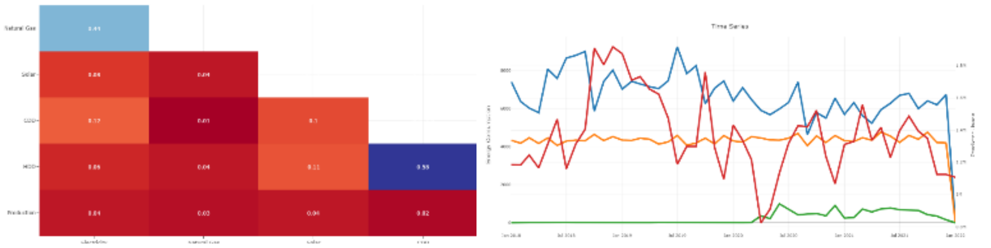
Utility Dashboard and Analysis Tool

- Corporate and facility-level views
- Enter utility bills and see total energy use and carbon in a new way
  - Calendarization of energy data
  - Annual cost, energy use, and limited carbon emissions overview
- Analyze your data and generate a Better Plants Annual Reporting Form or other custom reports
- Will replace EnPI tool and other DOE facility-level, regression utility analysis tools

Being released in Beta-mode

- Updates currently about every two weeks
- Various scorecards to be included
- Feedback is welcome and needed





	Energy (MMBtu)			Incremental Improvement	
Year	Actual	Modeled	Adjusted for Normalization	Total Savings % Improvement	Cummulative Savings
2018	32,240	32,302	32,240	—	—
2019	30,917	31,892	31,831	2.87 %	913.91
2020	19,407	21,232	21,171	8.33 %	2,677.7
2021	20,952	23,176	23,115	9.35 %	4,840

Better Buildings, Better Plants Webinar Series

Diversity, Equity and Inclusion in Climate Planning
February 28th, 2023 - 11:00AM EST
Register here

It's Electric! Electrified Alternatives to Industrial Fossil Fuel Systems
March 7th, 2023 - 11:00AM EST
Register here

For a full list of topics and dates visit the Better Buildings, Better Plants webinar website

Improving Process and Building Heating Through Innovation and Energy Efficiency

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Polls

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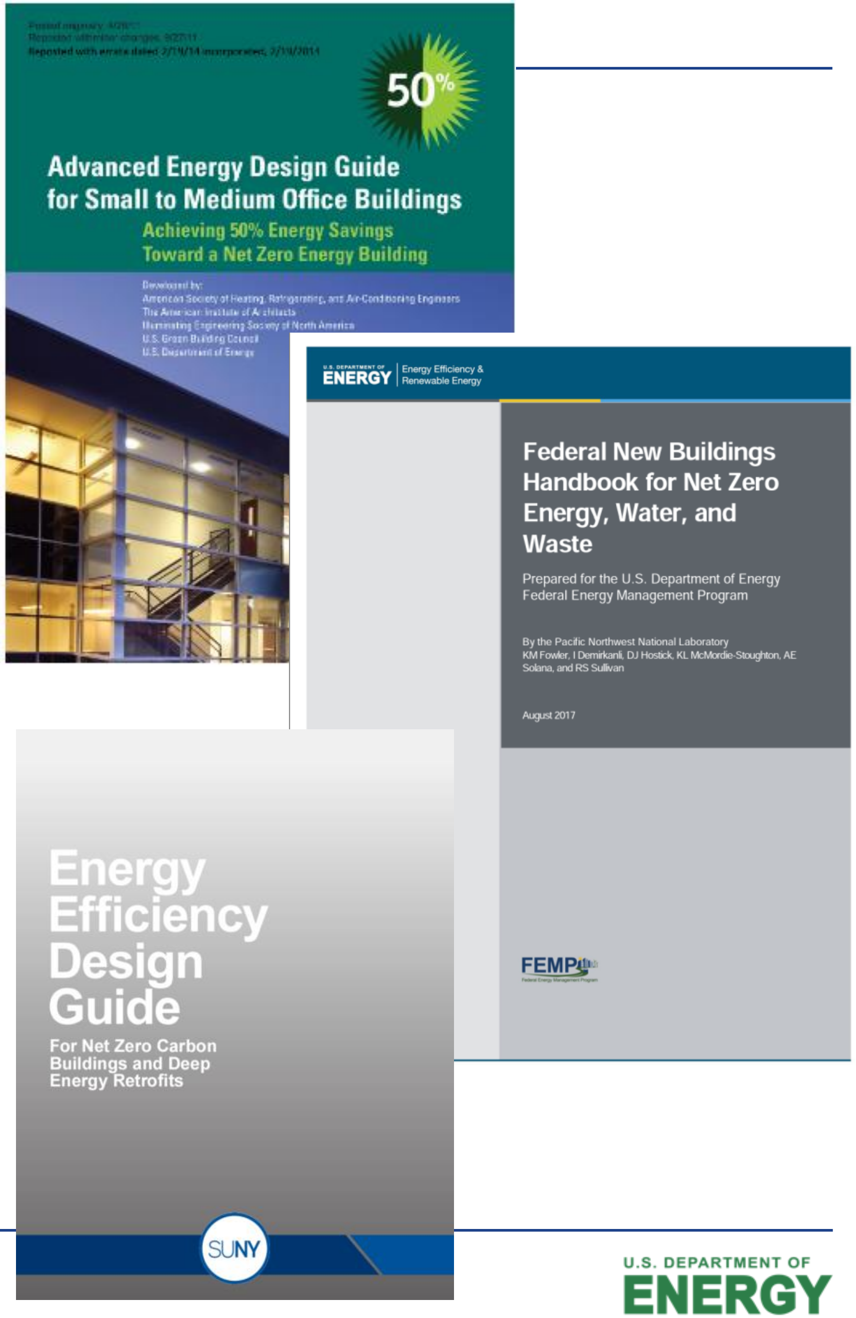
A Few Net Zero Resources

Guidance Documents

- Federal New Buildings Handbook for Net Zero Energy, Water, and Waste
- Advanced Energy Design Guides (ASHRAE - for specific building types)
- Net Zero Energy Buildings | WBDG
- Energy Efficiency Design Guide: For Net Zero Carbon Buildings and Deep Energy Retrofits

Certification Programs

- LEED Zero Building Certifications



Today's Presenter

Edward Kiser, PE

Director of Engineering

World Energy Innovations

Improving Process and Building Heating through Innovation and Energy Efficiency

WORLD ENERGY INNOVATIONS

Presenter: Edward Kiser, PE
February 22nd, 2023

Presentation Summary

Current Condition / Opportunity

- Facility HVAC systems generally 70°F setpoint
- Heating designs generally use high temperature heat sources (180 °F Hot Water, 300+°F steam, etc.)
- Process Heating Efficiencies

Case Study(s)

- Ocean Spray LHV
- Shearer’s Snack Foods
- Healthcare / Research Center, NYC

Transition to Low Temperature Loads

- Positive pressure ventilation system
- Adiabatic humidification
- Lower temperature reheat coil design
- Chilled water coil heating

Optimized Low Temperature Heat Sources

- Steam to Low temperature hot water
- Heat Recovery
- Electrification
- Geothermal

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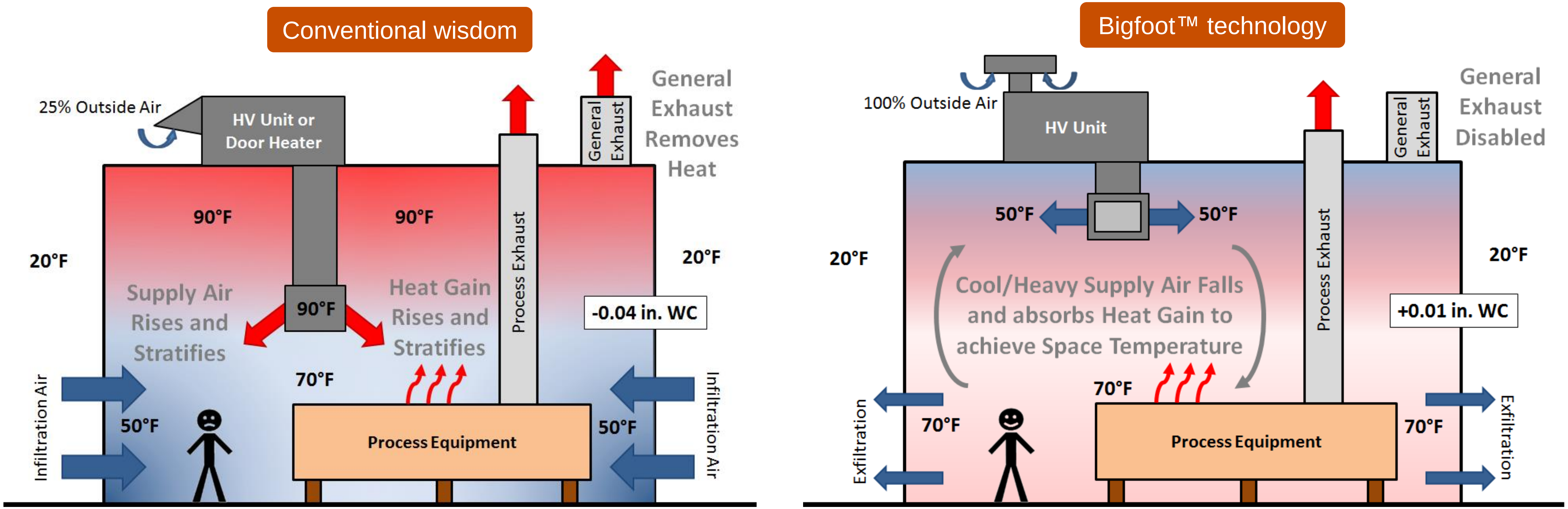
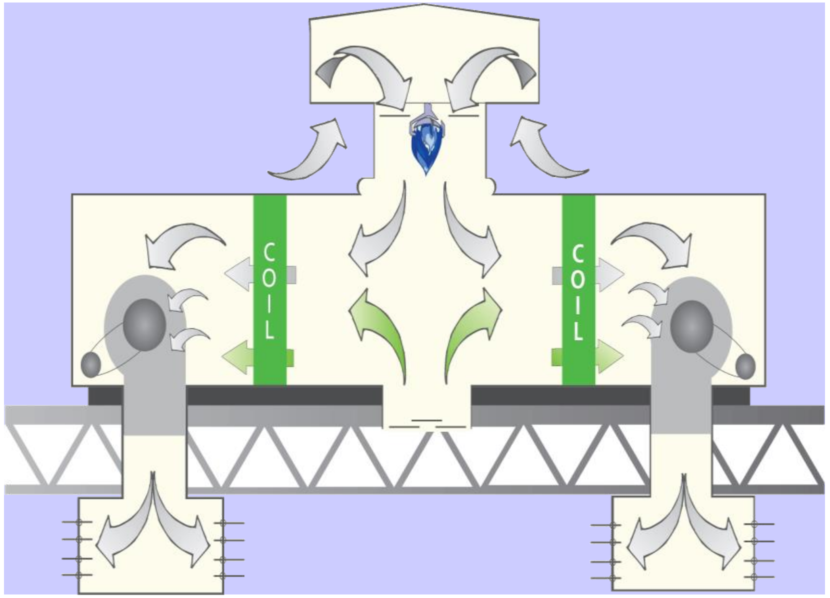
Building Ventilation: Positive Pressurization Heating



- WEI has over 40 years experience pressurizing industrial facilities
- Cool air is heavier than warm air and naturally falls to the floor
- Cool discharge air heating system enables more efficient water heating and heat recovery opportunities
- Minimal ductwork results in first cost savings and fan electrical energy savings
- Full control of pressure, humidity, temperature, results in world class air quality

WORLD ENERGY INNOVATIONS

Building Ventilation: Positive Pressurization



- Lower Blower HP
- Lower Discharge Temperatures
- Even Floor Level Temperature Distribution
- Improved Air Quality

Discharge Head with Minimal Ductwork

Eliminates Unintended Infiltration - No Door Heaters Required

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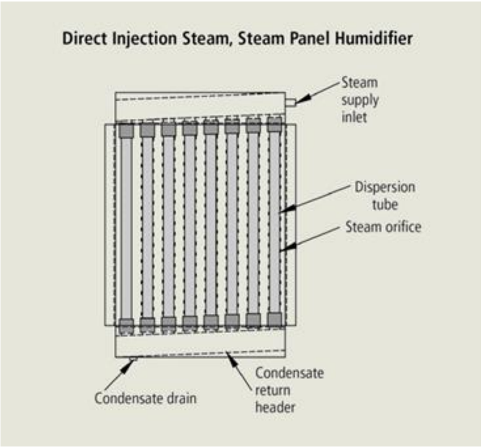
Adiabatic Humidification

Traditional Steam Injection Humidification

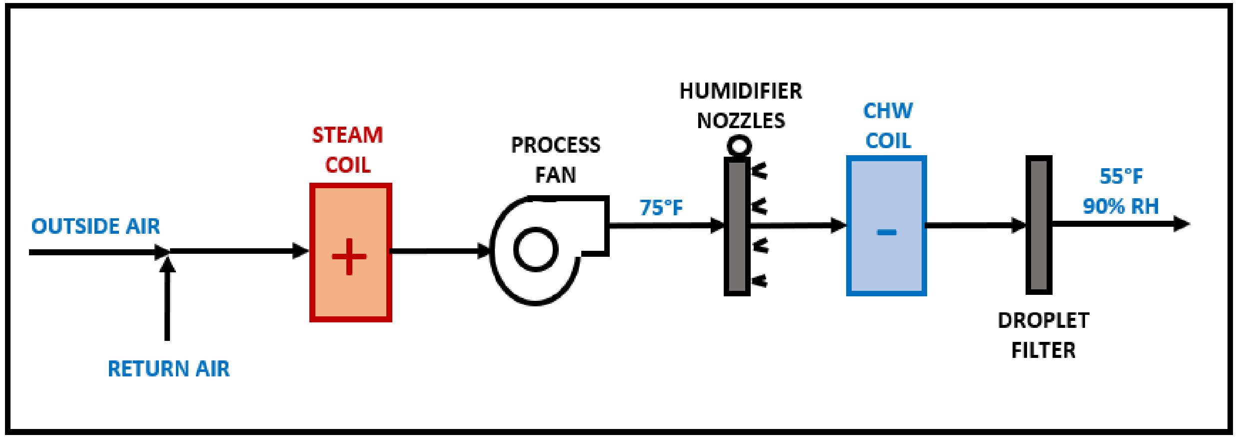
- Requires very warm heat source to generate steam
- Limits heat recovery and other emerging high efficiency technologies
- Raises supply air temperature which may not be needed



Adiabatic Humidification

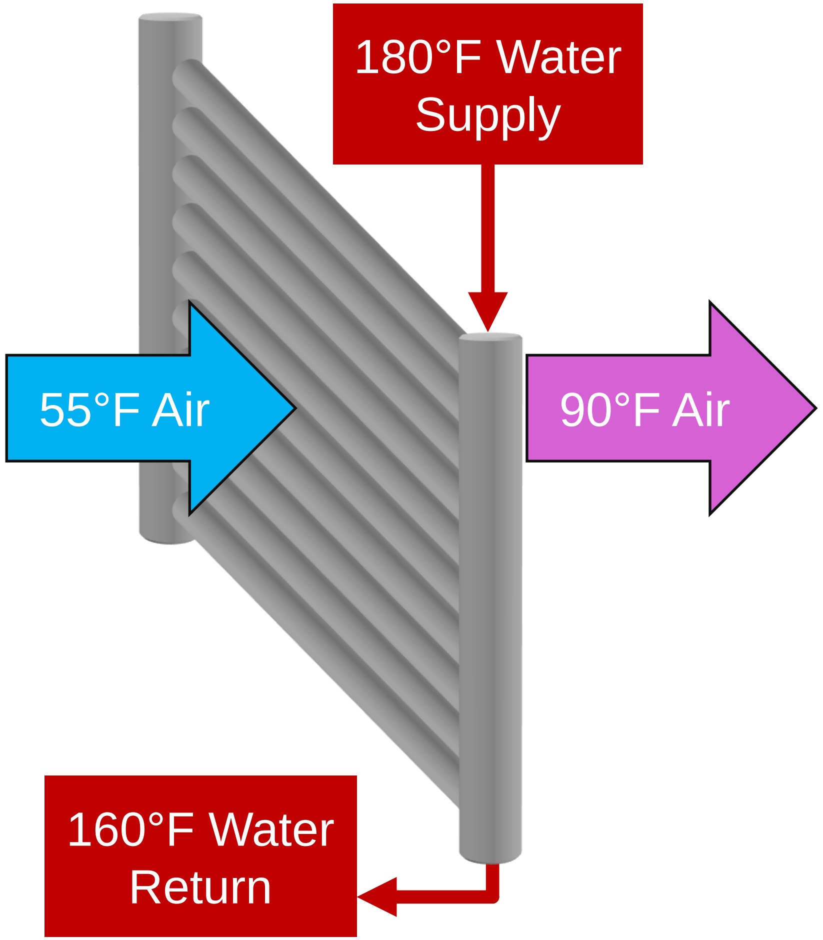
- Steam elimination Strategy
- Adiabatic systems only require 75°F Air Temperature for normal applications
- Low temperature hot water can provide the heat for humidification vaporization
- Adiabatic humidification cools the air which can reduce the chilled water load during warm and dry ambient conditions

AIR HANDLING UNIT WITH HEATING/COOLING COILS AND ADIABTAIC HUMIDIFIER NOZZLES

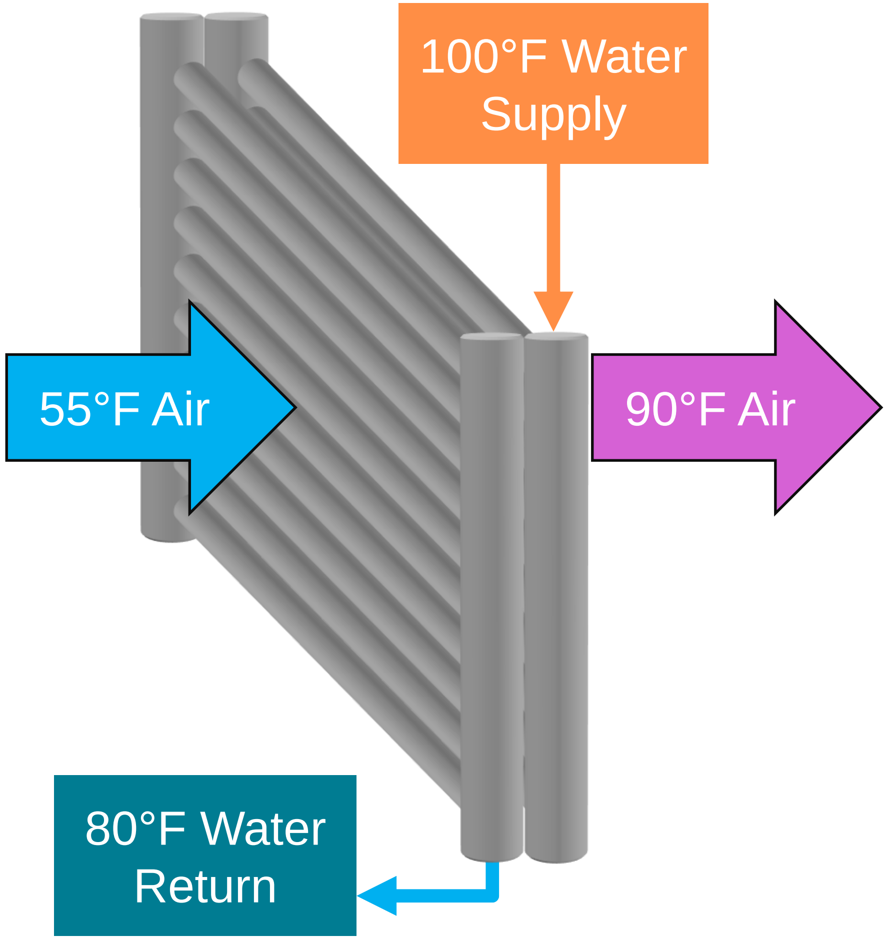


Low Temperature Reheat System

Higher Temperature Single Row Coil



Low Temperature Double Row Coil



Low Temperature may require adding a row to the Reheat coil

Added pressure drop is minimal, especially if bypass is included for cooling

Water Temperature Delta is equal so water flow is equal

Low temperature return is ideal for heat recovery, heat pumps, and more

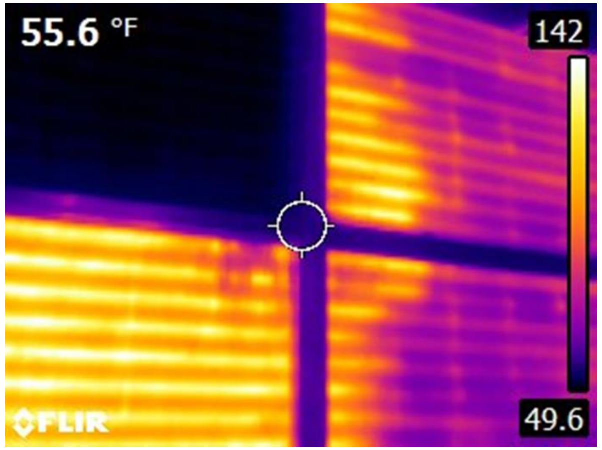
Chilled Water Coils – Used for Preheat

Why?

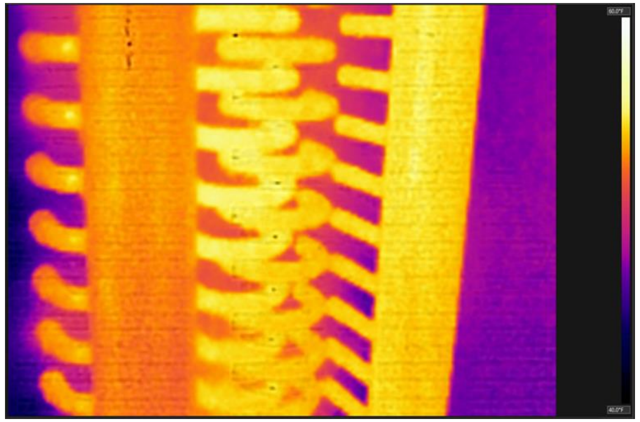
- Chilled Water coils are great heaters
  - Heat air from 0°F to 55°F with <65°F warm water supply
- Convert AHU preheating with existing equipment
- Low temperature heating benefits
- Better supply temperature uniformity

How?

- Circulating Pump and Heat Source (HEX)
- Isolation of Chilled Water System cold supply
- Safeties are required to prevent possible freeze issues
- Preheat must be upstream of humidification system



Steam Coil Thermal Image

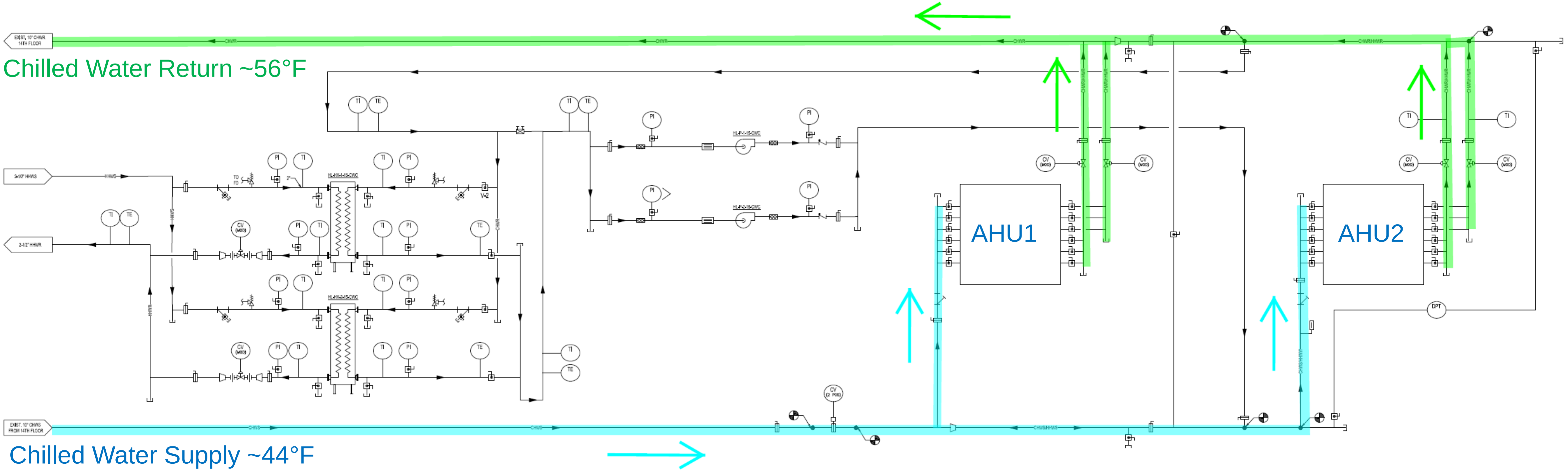

Hot Water CWC Coil U-Bends Thermal Image


CWC System HXs

WORLD ENERGY INNOVATIONS

Chilled Water Coils – Used for Preheat

Cooling Operation



- Chilled water flows as originally designed
- Heating pumps and heat exchangers are disabled

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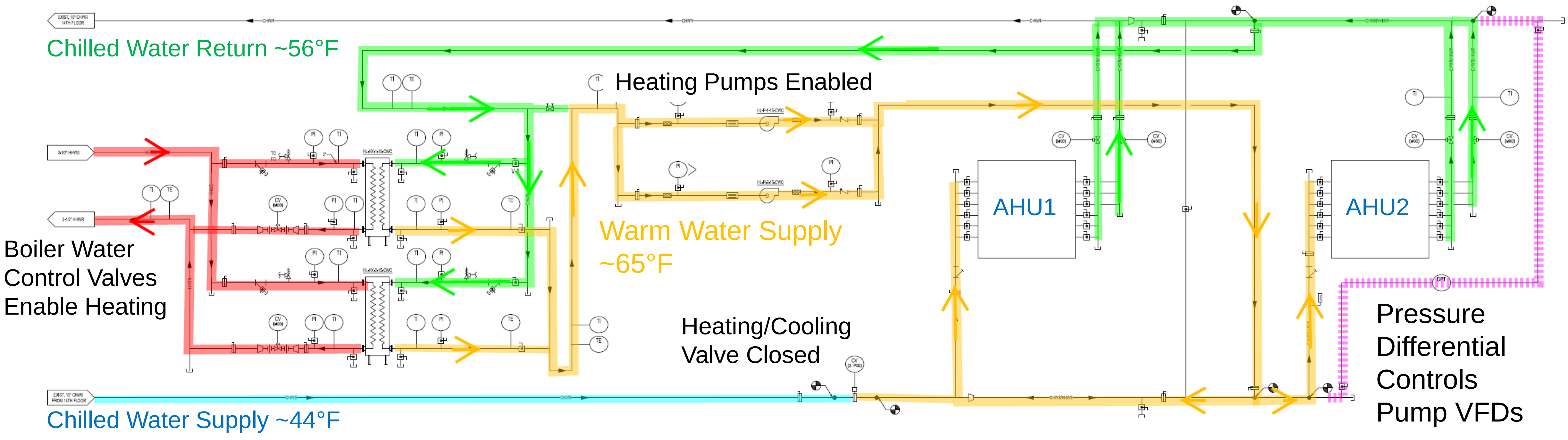
Heating Operation

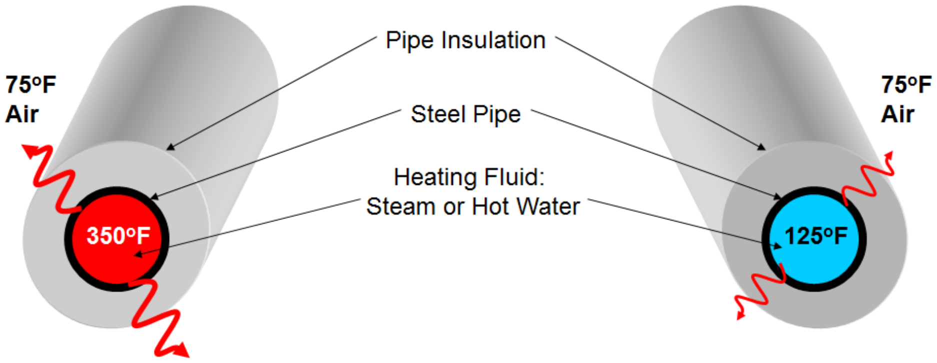


- Chilled water supply is isolated with a control valve
- Heating pumps and heat exchangers are enabled to circulate warm water through the AHU Cooling Coils only

Steam Elimination

Steam Elimination

- Identified large steam distribution systems as energy and water efficiency opportunities
- Several alternate heating and recovery systems to minimize or eliminate steam
- Secondary cost reductions



Heat Loss	Steam Boiler System Efficiency Loss	Hot Water System Efficiency Loss
Heater Skin Loss	1%	0.1%
Combustion Exhaust Losses	17% to 35%	2% to 20%
Blowdown Losses	Negligible	Negligible
Deaerator Losses	1%	0%
Distribution System Thermal Losses	5% to 15%	1%
Load Heat Extraction Losses	2% to 10%	0%
Leak Losses	1% to 5%	0%
Condensate Losses	1% to 11%	0%
Total Losses	28% to 78%	3.1% to 21.1%
System Efficiency	**22% to 72%**	**79% to 97%**
Average Efficiency	**50%**	**90%+**

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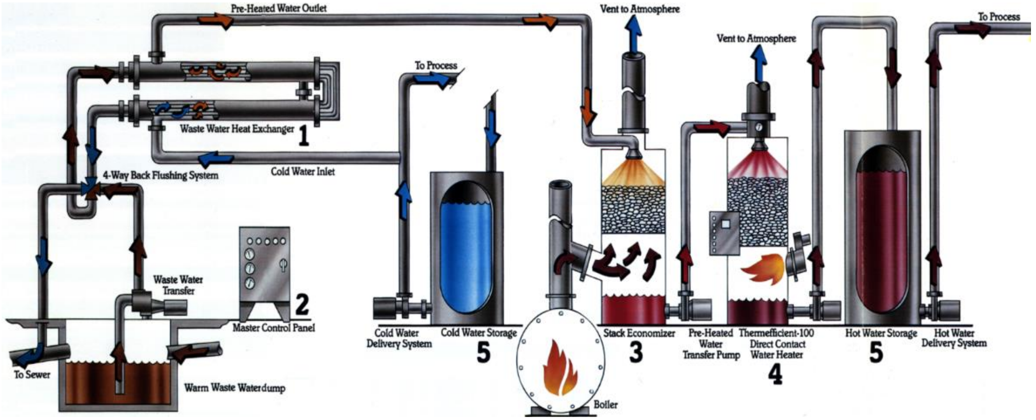
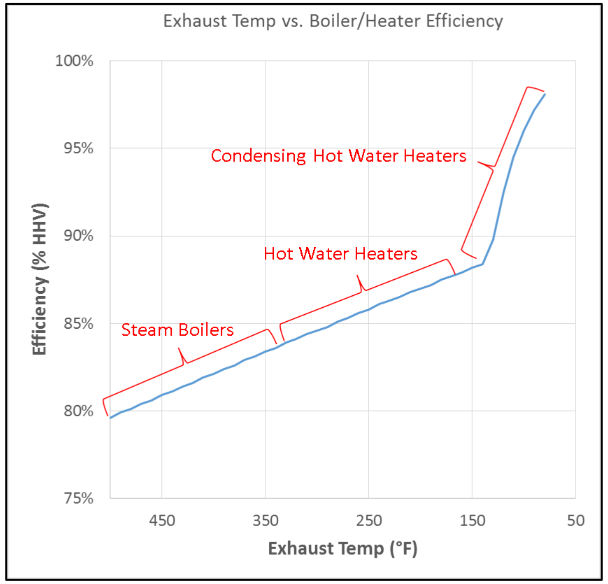
Low Temperature Hot Water





- Heating efficiency improves with Lower Temperature Hot Water
- Heat Recovery Opportunities expand with Lower Temperature Hot Water
- Electrification integrates with Lower Temperature Hot Water

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Electric Heating Alternatives - Waste Heat Chillers / Heat Pumps

Electric Chillers and Heat Pumps transfer heat from between fluids

Typical Water-Cooled Chiller Operating Temperatures and Performance

- 44F Evaporator
- 95F Condenser
- Cooling COP = 5.0
- Heating COP = 6.0
- Simultaneous COP = 11.0

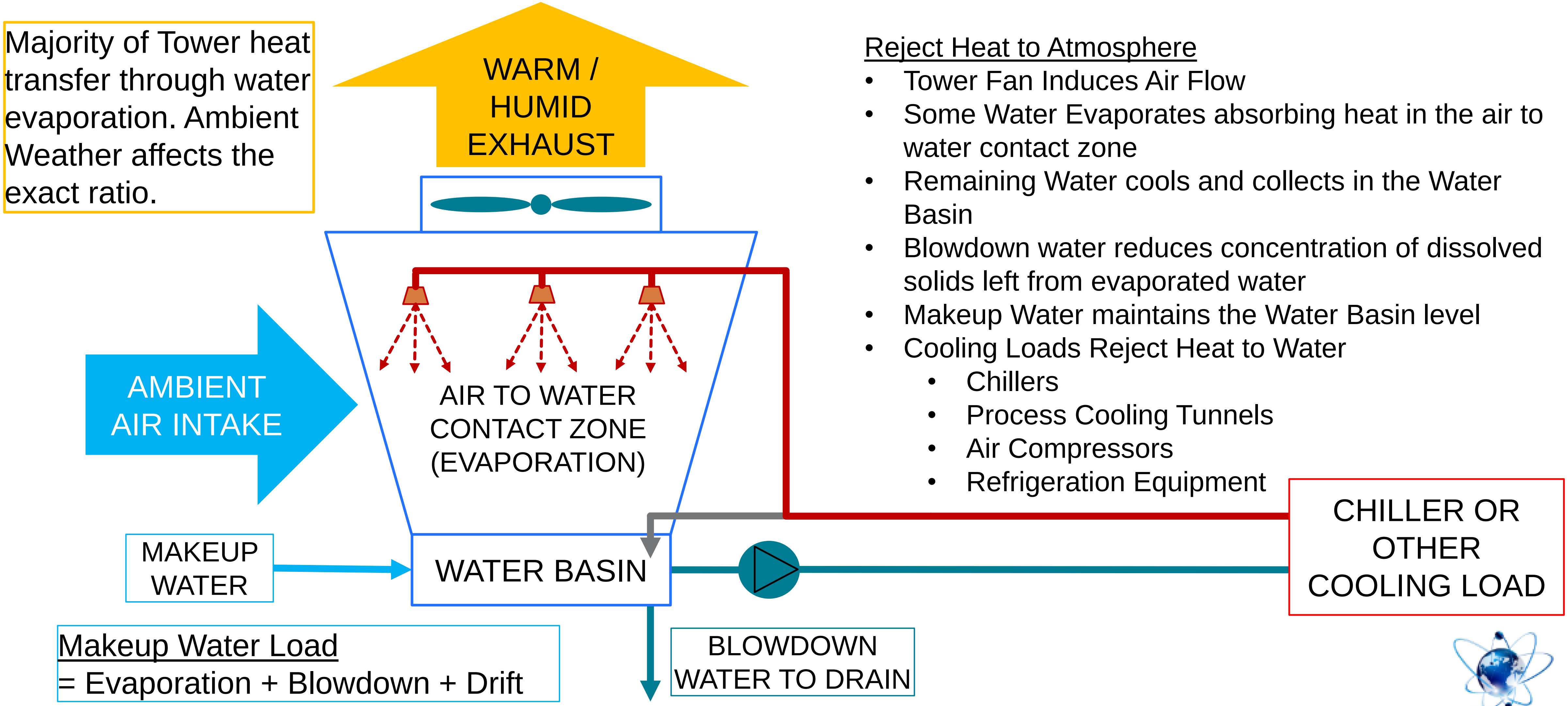
Chiller COP is inversely proportional to the Temperature Difference between the Evaporator and the Condenser

Waste Heat Chillers / Heat Pumps are best paired with lower temperature hot water heating systems

Typical Chiller
Heating Coefficient of Performance (COP) = 6.0

WORLD ENERGY INNOVATIONS

Cooling Tower: Conventional Operation



Makeup Water Load
= Evaporation + Blowdown + Drift

Reject Heat to Atmosphere

- Tower Fan Induces Air Flow
- Some Water Evaporates absorbing heat in the air to water contact zone
- Remaining Water cools and collects in the Water Basin
- Blowdown water reduces concentration of dissolved solids left from evaporated water
- Makeup Water maintains the Water Basin level
- Cooling Loads Reject Heat to Water
  - Chillers
  - Process Cooling Tunnels
  - Air Compressors
  - Refrigeration Equipment

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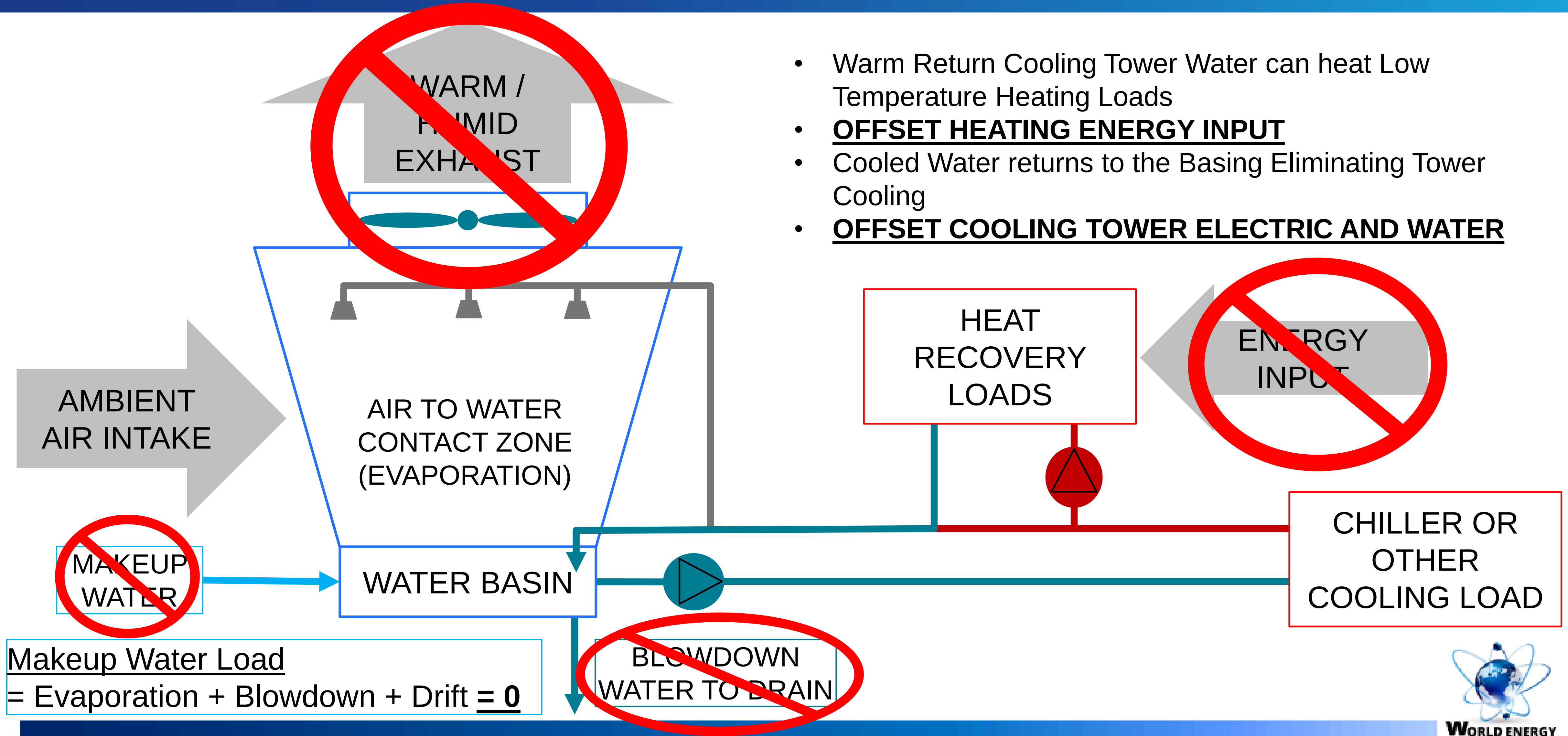
Cooling Tower: Heat Recovery Optimized Operation

- Warm Return Cooling Tower Water can heat Low Temperature Heating Loads
- **OFFSET HEATING ENERGY INPUT**
- Cooled Water returns to the Basing Eliminating Tower Cooling
- **OFFSET COOLING TOWER ELECTRIC AND WATER**

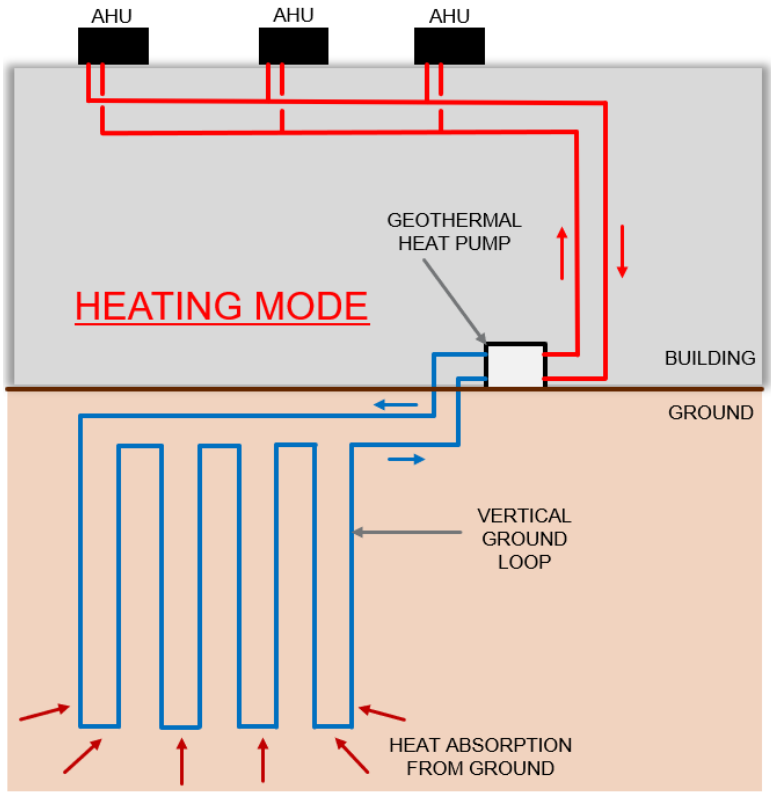


Geothermal

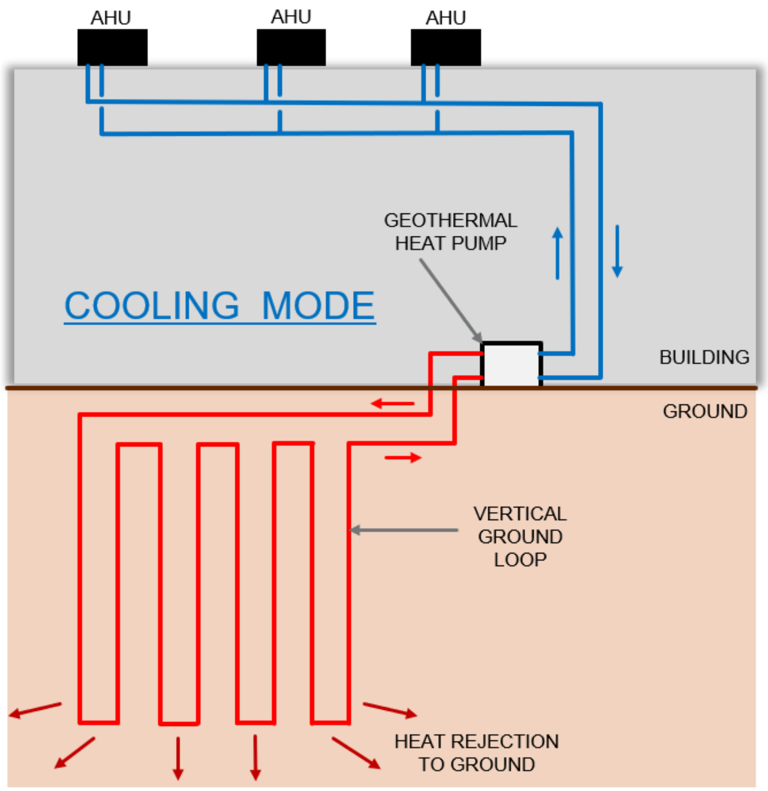
- Efficient heat sink
- Open or closed underground water loop
- HVAC System can utilize chilled or hot water generated by the heat pumps to cool or heat the building.
- Design Balance of Summer Heat Rejection and Winter Heat Absorption
    - Supplemental heating or cooling as needed

Benefits:

- Efficient Electrification
- Energy Efficiency / Savings
- Reduced emissions
- Long life



Winter Heating Mode
Absorb Heat from the Ground into the Geothermal Water Loop



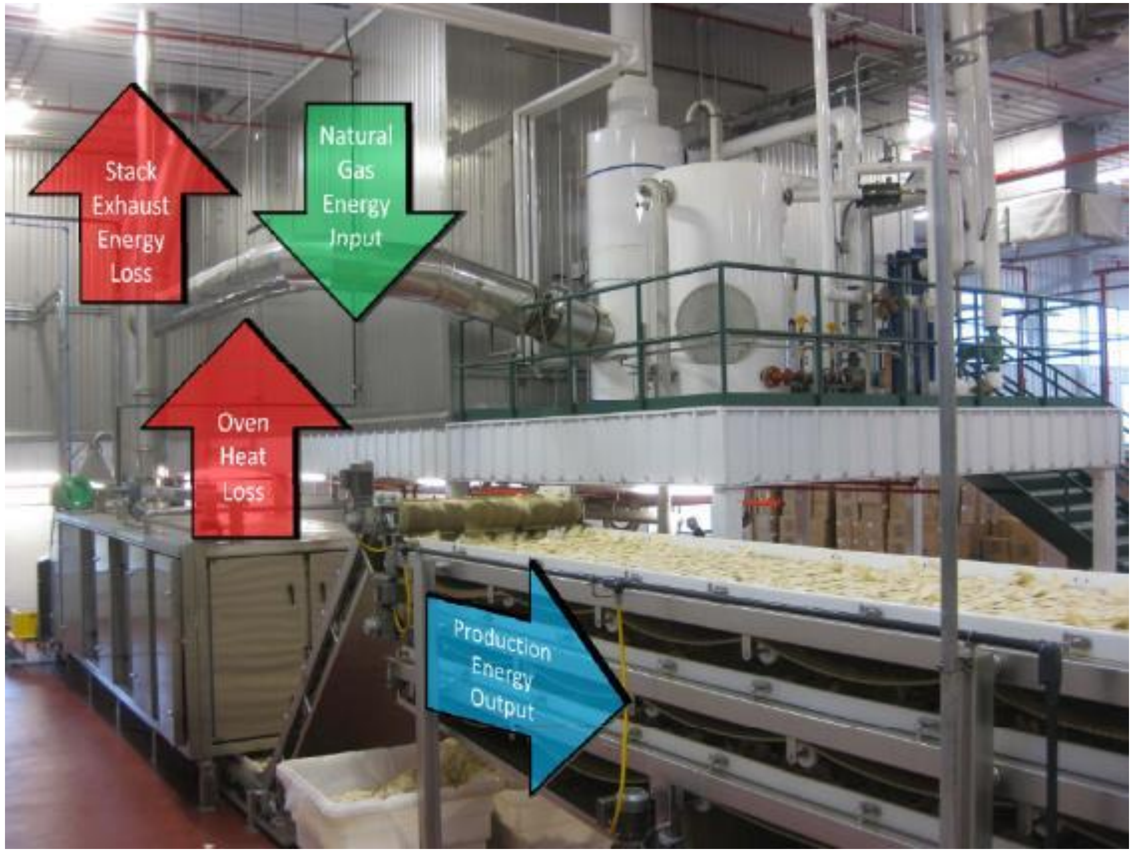
Summer Cooling Mode
Reject Heat from the Geothermal Water Loop into the Ground

WORLD ENERGY INNOVATIONS

Process Optimization - Ventilation & Process Heat Recovery Integration

Verify the baseline operation:

- **Identified the paths of heat loss**
  - Product Flow
  - Oven Skin Heat Loss
  - Oven Exhaust
- **Worked with OEM to reduce airflow through the new oven**
  - Baseline 1.32 cfm / lb/hr
  - Design 0.31 cfm / lb/hr
- **Improved the overall oven efficiency**
  - Baseline = 1,687 btu/lb
  - Design = 900 btu/lb
- **Designed Heat Recovery after Optimizing the Process**



Oven energy performance illustration

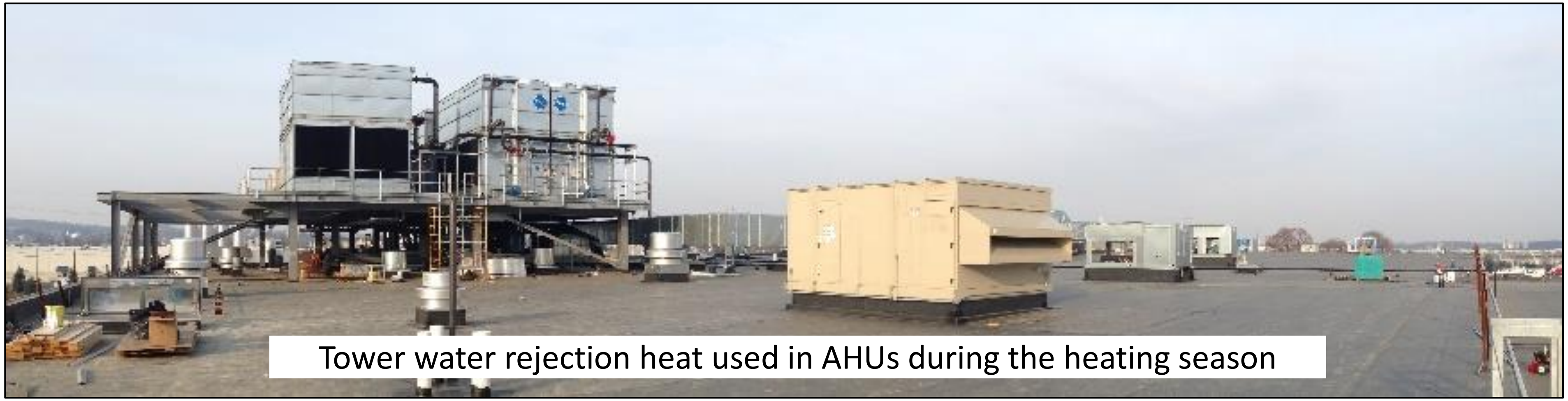
Process Heat Recovery - Ventilation & Process Heat Recovery Integration

Hot Fill Bottle Cooler Heat Rejection

- Moderate temperature heat recovery preheats juice
- Lower temperature heat rejected to Cooling Tower

Tower Water Heat Recovery

- AHUs – 95°F water heating coils
- AHUs act as Cooling Tower in winter



World Energy Innovations

Case Studies

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Ocean Spray Cranberries, Beverage Facility – Lehigh Valley, PA

- Hot Water heated Pasteurizers instead of steam (first at Ocean Spray)
- Positive Pressure HVAC system design using low temperature (95°F) Hot Water Heating
- Heat Recovery from the Process Cooling Towers
- Modular Chilled Water System design
- Summer Heat Tempering to reduce Factory Heat Index using production chilled water capacity when available
- WEI Utility Service Agreement (USA) exceeds $1,068,000 savings guarantee through Monitor & Verification
- System has reduced CO2e emissions by over 89,000 Tons

Breinigsville, PA Facility opened in 2014

Contract Year	Electric Savings (KWH)	Natural Gas Savings (MCF)	Electric CO_2 Reduction (Ton)	Natural Gas CO_2 Reduction	Total CO_2 Reduction (Ton)
1	4,940,615	159,616	1,717	9,814	11,531
2	5,150,547	167,252	1,790	10,284	12,073
3	5,277,524	161,639	1,834	9,938	11,772
4	5,204,885	145,604	1,809	8,953	10,761
5	5,235,518	147,123	1,819	9,046	10,865
6	5,247,064	146,216	1,823	8,990	10,814
7	5,266,287	148,108	1,830	9,107	10,937
8	5,259,272	146,346	1,828	8,998	10,826
Total	41,581,712	1,221,904	14,450	75,130	89,579

WORLD ENERGY INNOVATIONS

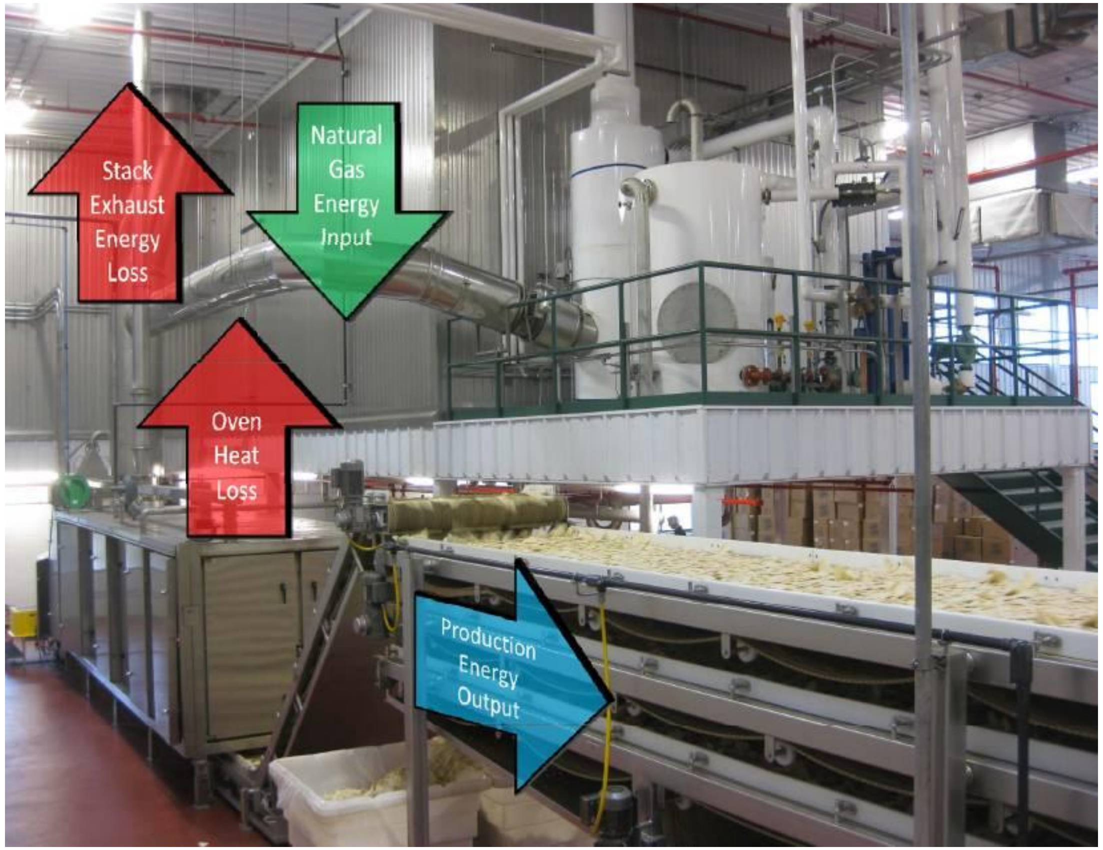
New Plant Construction

World's first LEED® Platinum

Food Manufacturing Plant

Results:

- **95% reduction** in building heating from waste heat recovery
- **Tortilla Oven Optimization**
  - Reduced total energy use **plus**
  - **50%** capacity increase
- Overall, new facility uses **30% less energy per pound of product**.

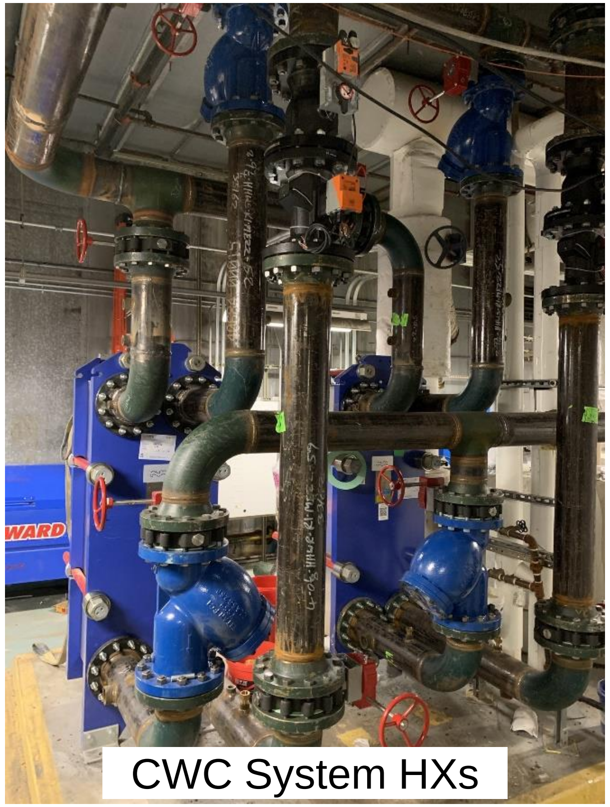


***WEI** works with Food & Beverage companies, co-packers & suppliers to improve productivity & reduce energy costs*

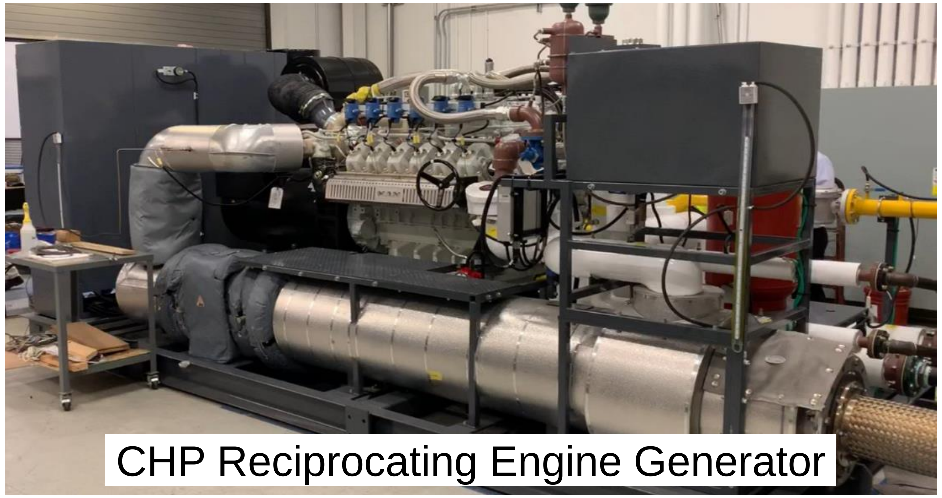
Healthcare / Research Center - New York, New York

- 2,400,000ft2 Healthcare and Laboratory Cancer Center
- Steam Campus Conversion to Hot Water
- 3.3 MW Combined Heat and Power Generators
- Adiabatic Humidification
- 24v DC LED Lighting

24V DC Lighting



CWC System HXs



CHP Reciprocating Engine Generator

New Domestic HW Heater

WORLD ENERGY INNOVATIONS

Thank you!
Questions?

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419-463-0020

Water-Cooled Chillers – How They Work

<u>Refrigeration</u> - **Transferring heat from a low temperature area to a high temperature area**

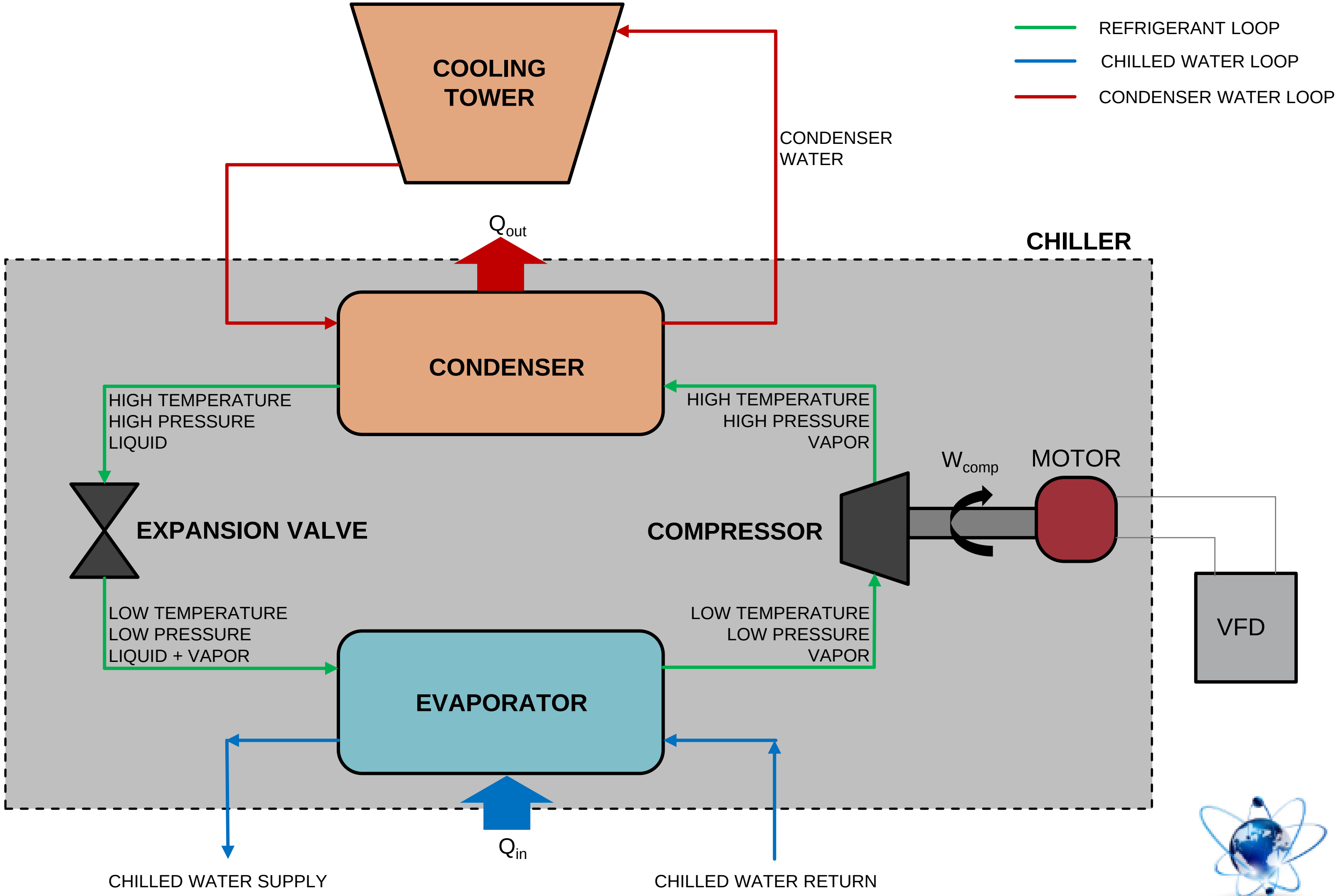
1) Evaporator
Chilled water heat is absorbed by refrigerant evaporation.

2) Compressor
Refrigerant compression increases pressure and temperature.

3) Condenser
Condenser water absorbs heat from refrigerant condensation.

4) Expansion Valve
Refrigerant expansion reduces pressure and temperature.

$Q_{out} = Q_{in} + W_{comp}$
Q_{out} = Heat Rejected at Condenser
Q_{in} = Heat Absorbed at Evaporator
W_{comp} = Compressor Work



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Question & Answer

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