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Simple. Seamless. Smart

FEI rated fans and flue gas thermo-cooling, the last steps in building efficiency.

By Simon Mandeville
Director of Sustainability

Monday, December 2, 2024

Presented by:

Simon Mandeville

Director of Sustainability

Biogprahy:

- 2 years in mechanical engineering,
  3 years in administration/marketing.
- Started in HVAC in 1994 as a trainee wiht a Direct Contact Economizer Manufacturer, working in drafting and piping for 28 years.
- Led steam/hydronic system heat recovery projects at Enviroair Industries from 2010, became a shareholder in 2018.
- Sold assets in Canada to become Director of Sustainability at ENERVEX Integrated Solutions.

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ENERVEX Inc.

- Market leader in Modulating High efficiency exhaust systems, generator exhaust systems and integrated exhaust systems with heat recovery
- 80,000+ sq. ft. facility located in Alpharetta, GA
- Changed name in 2010 to better reflect our commitment to energy efficiency and sustainability

AGENDA

Decarbonization in 2024, what is the status and goal

Part I: New Focus on Fan Efficiency: FEI

Part II: The Last Step: Flue Gas Thermo-Cooling

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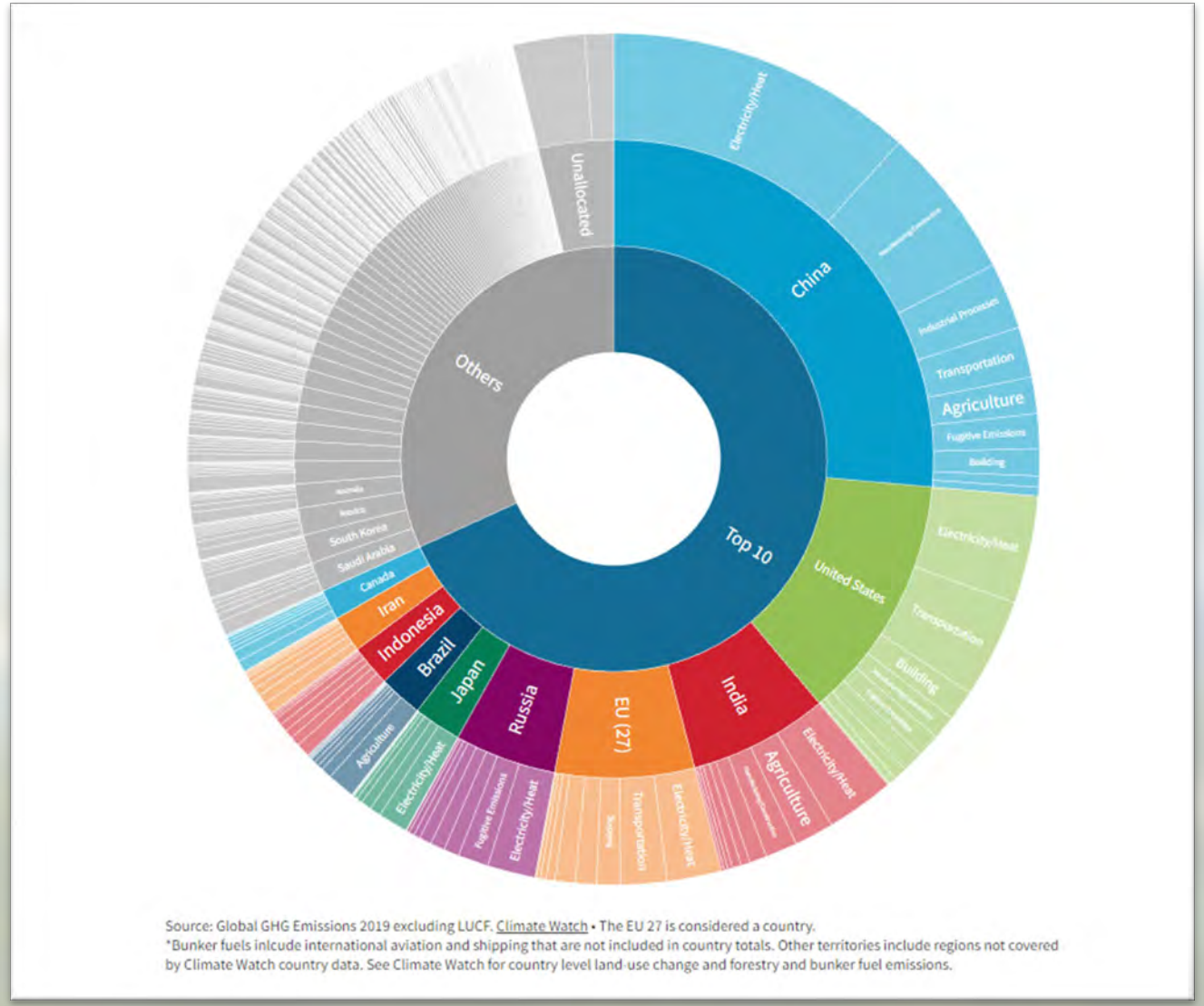
DECARBONIZATION IN 2024, WHAT IS THE STATUS AND GOAL

Monday, December 2, 2024

World CO2 Emissions



Source: Global GHG Emissions 2019 excluding LUCF. Climate Watch • The EU 27 is considered a country.
*Bunker fuels inlcude international aviation and shipping that are not included in country totals. Other territories include regions not covered by Climate Watch country data. See Climate Watch for country level land-use change and forestry and bunker fuel emissions.

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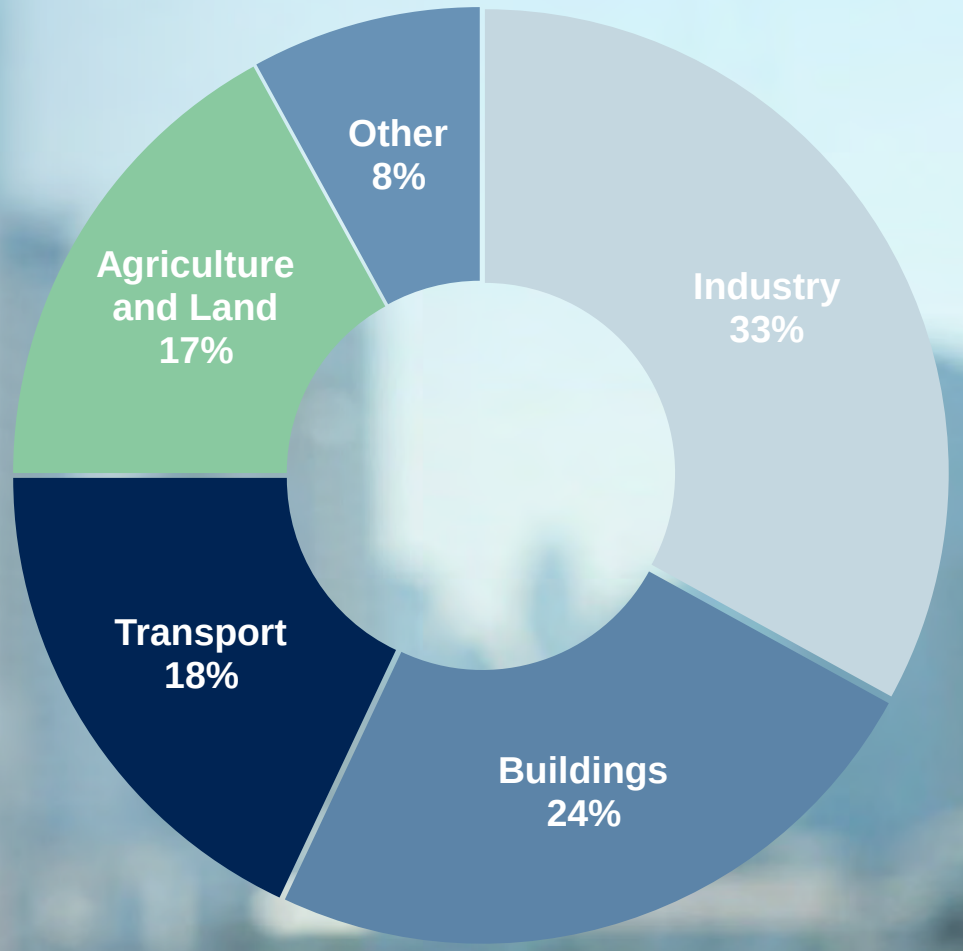
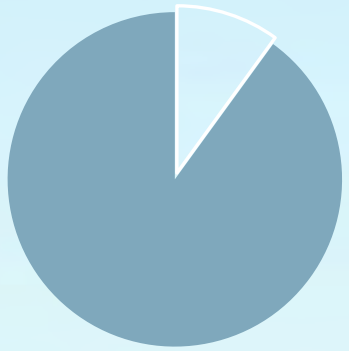
World CO2 Emissions by Sector

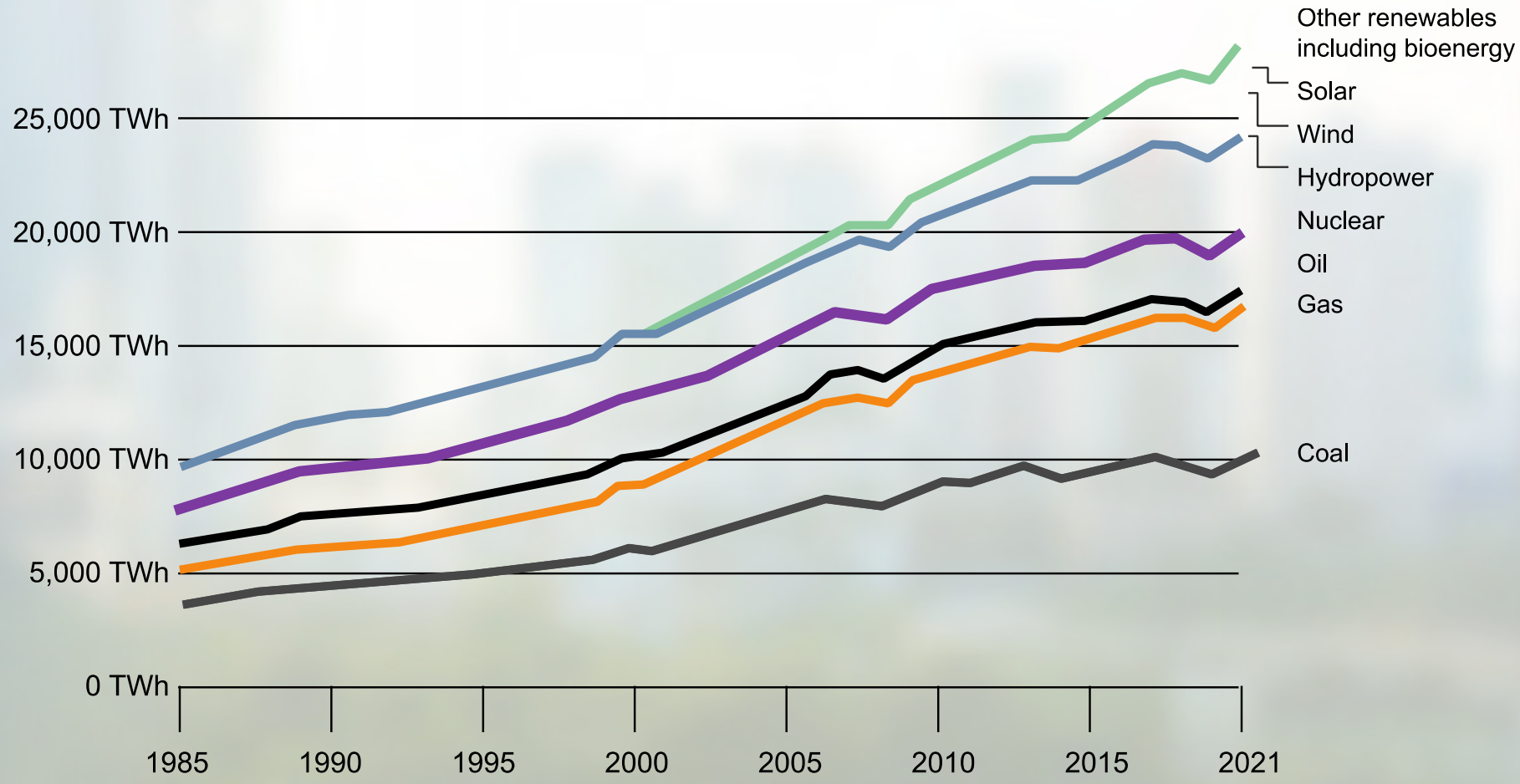




The top ten industries account for 90% of global industry emissions

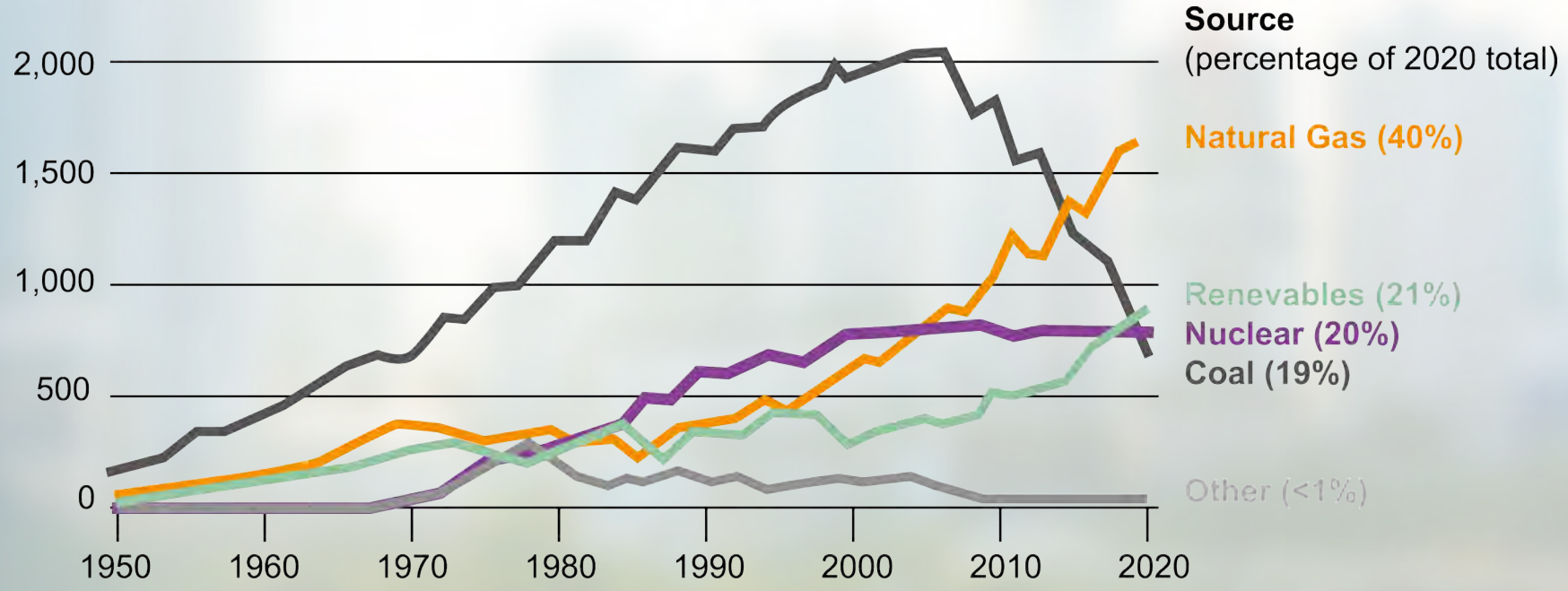
The top three industries account for over 75% of global industry emissions

World Electricity Production Sources



US Electricty Production Sources

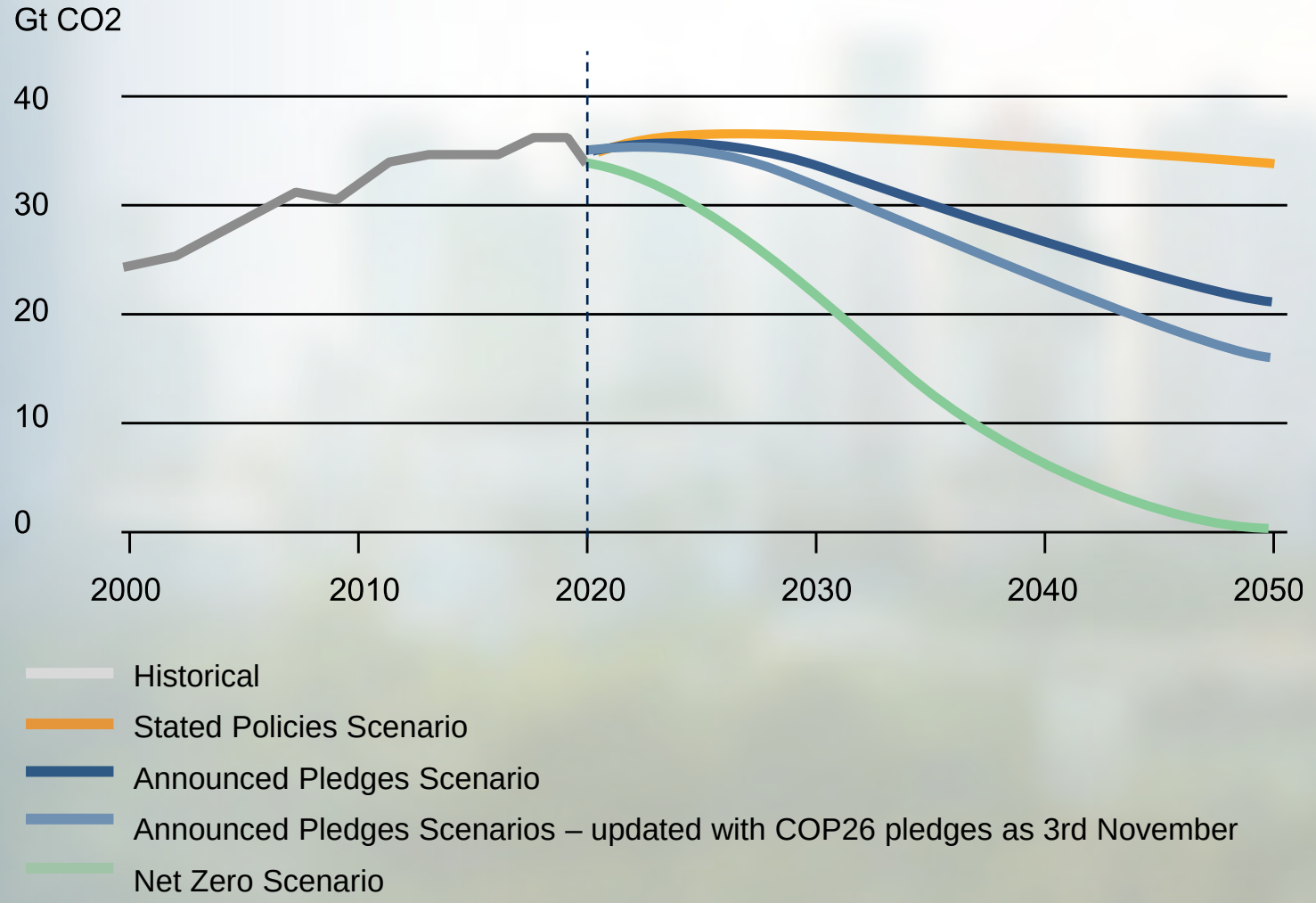
Annual U.S. electricity generation from all sectors (1950 – 2020)



Electricity Production Sources by State

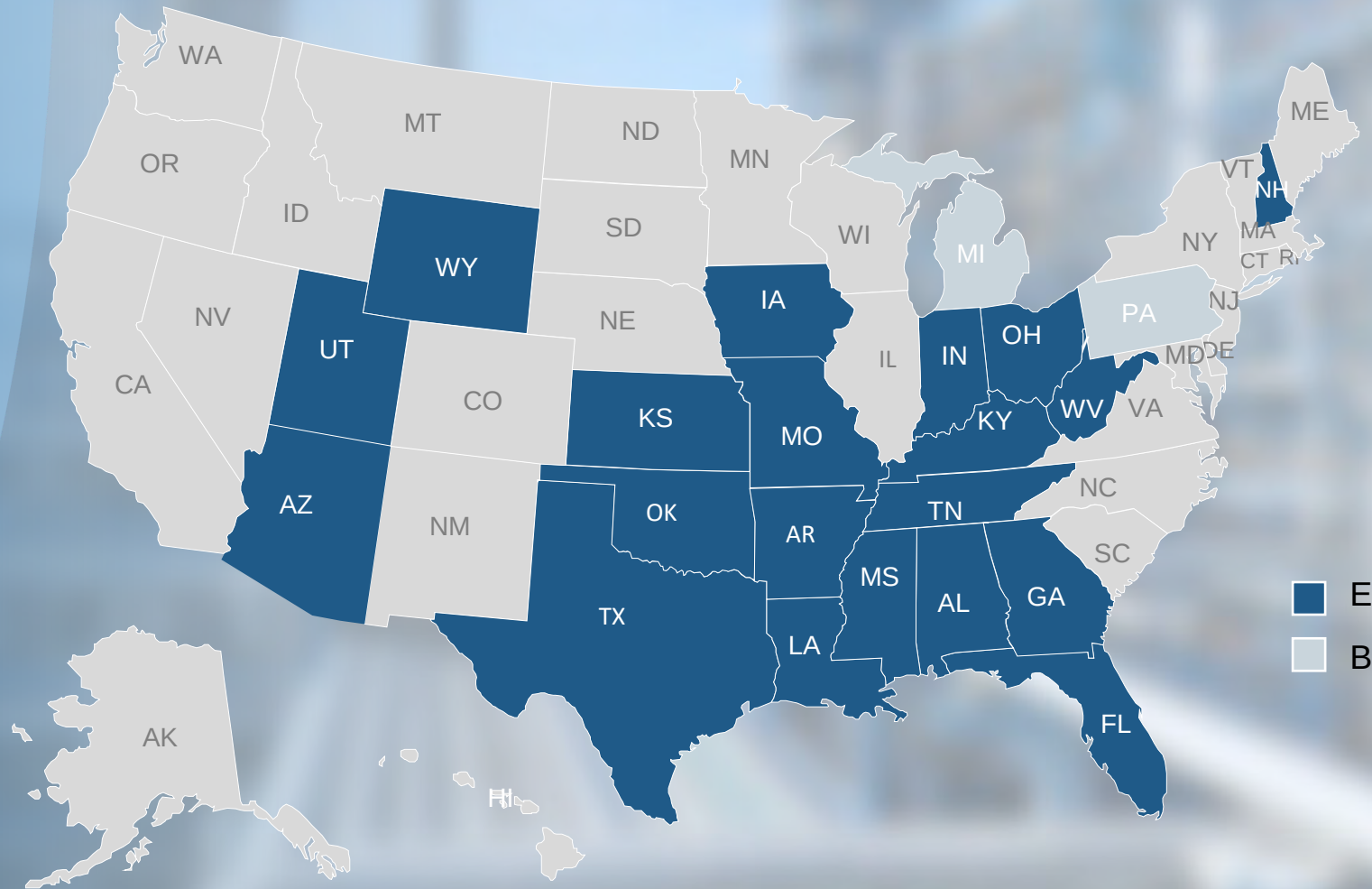
Plans to get to ”net zero”

C02 emissions in World Energy Outlook scenarios over time, 2000-2050



Local Regulation

”Preemption laws” that prohibit municipalities from banning natural gas



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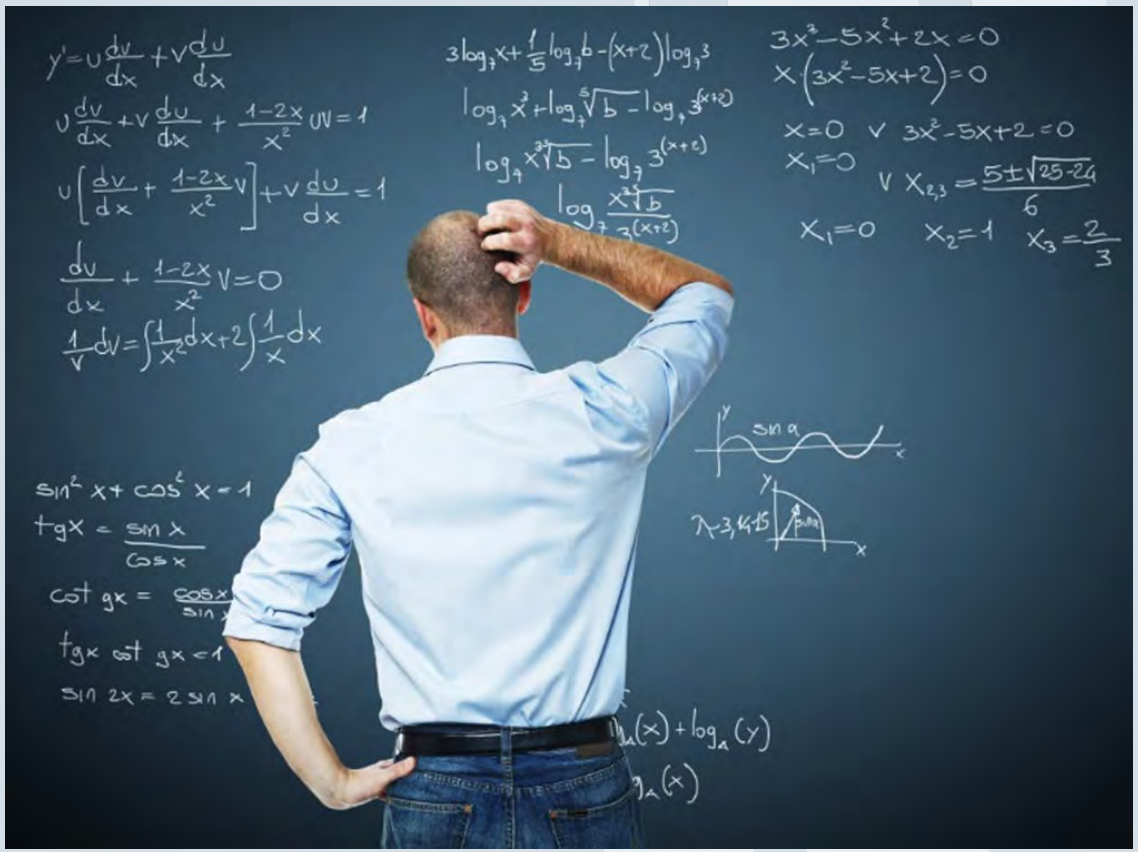
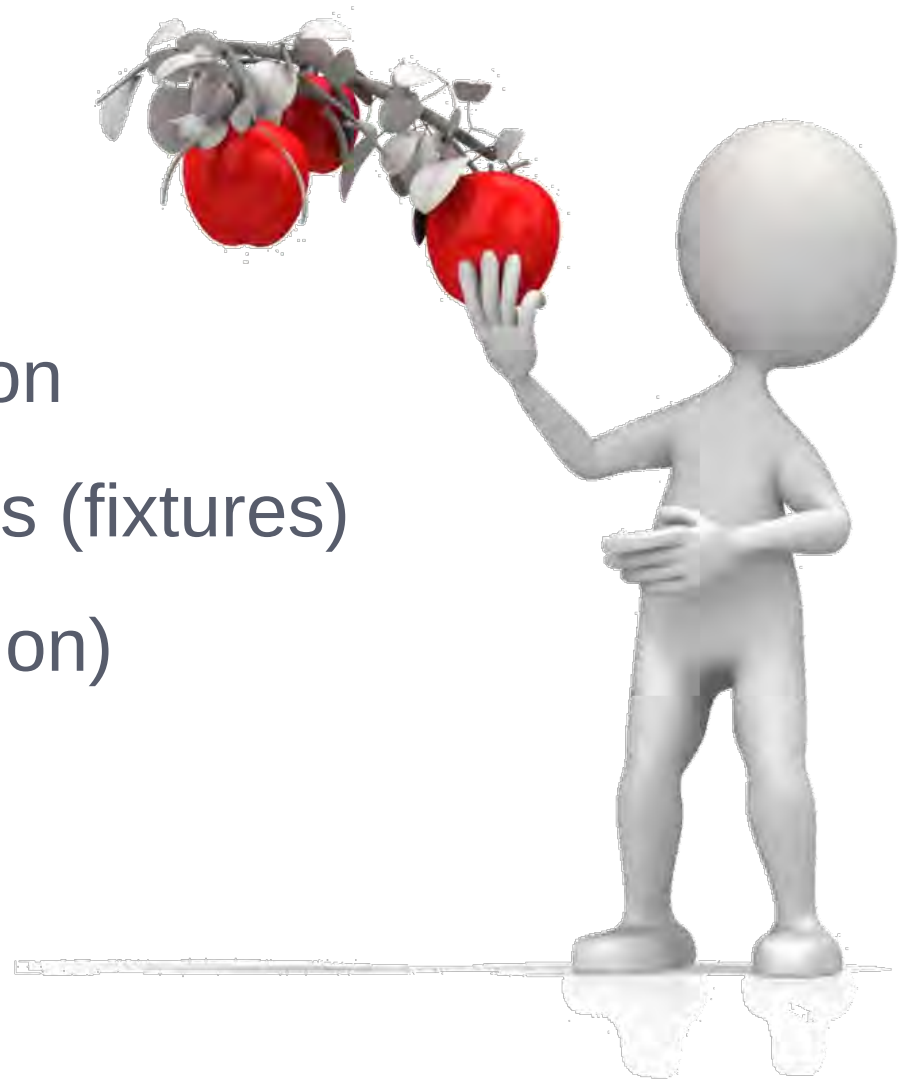
How to reduce our energy consumption in our buildings?



December 2, 2024

LOW HANGING FRUITS

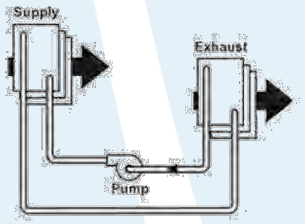
- Lighting retrofit
- Upgrade windows, doors, insulation
- Hot water energy saving measures (fixtures)
- Controls retrofit (building automation)

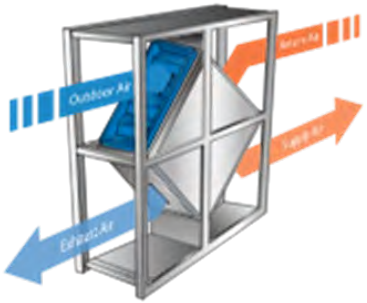


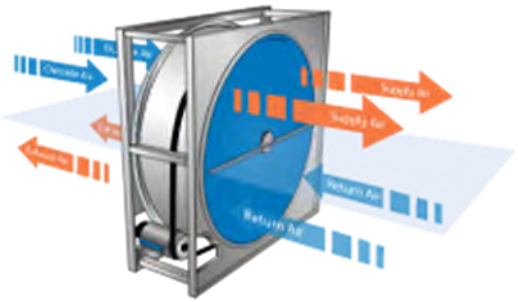
AIR TO AIR HEAT RECOVERY

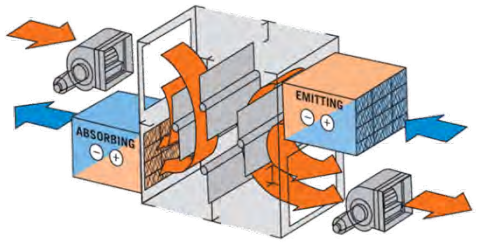
Does not take into account defrost!

Type	Recovery	Published efficiency*
Run-Around loop	Sensible	30-55%
Caloduc (Heat Pipe)	Sensible	30-50%
Enthalpy cube	Sensible/total	50-70%
Heat wheel	Total	60-80%
Dual core technology	Total	80-95%









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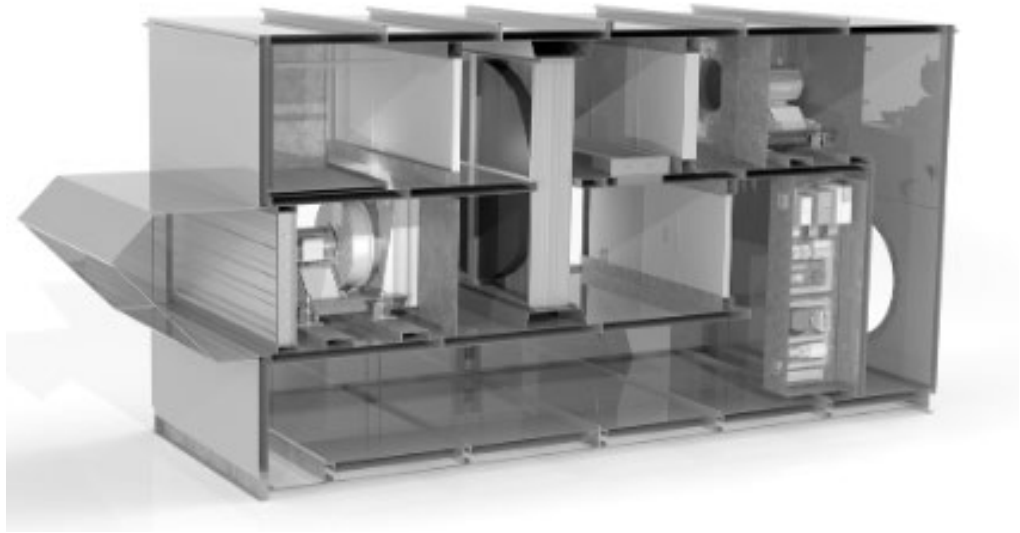
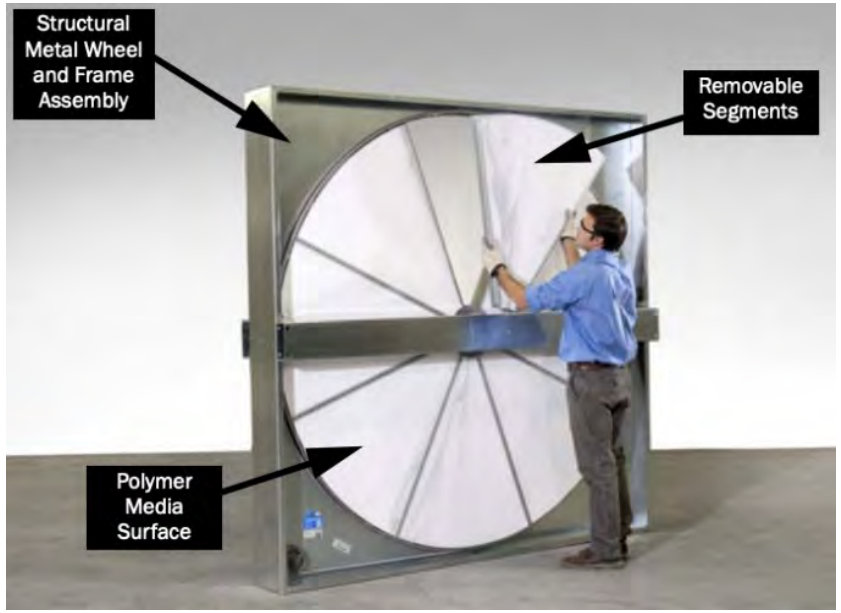
HEAT RECOVERY UNIT WITH HEAT WHEEL

Application: Exhaust air heat recovery

Key features:

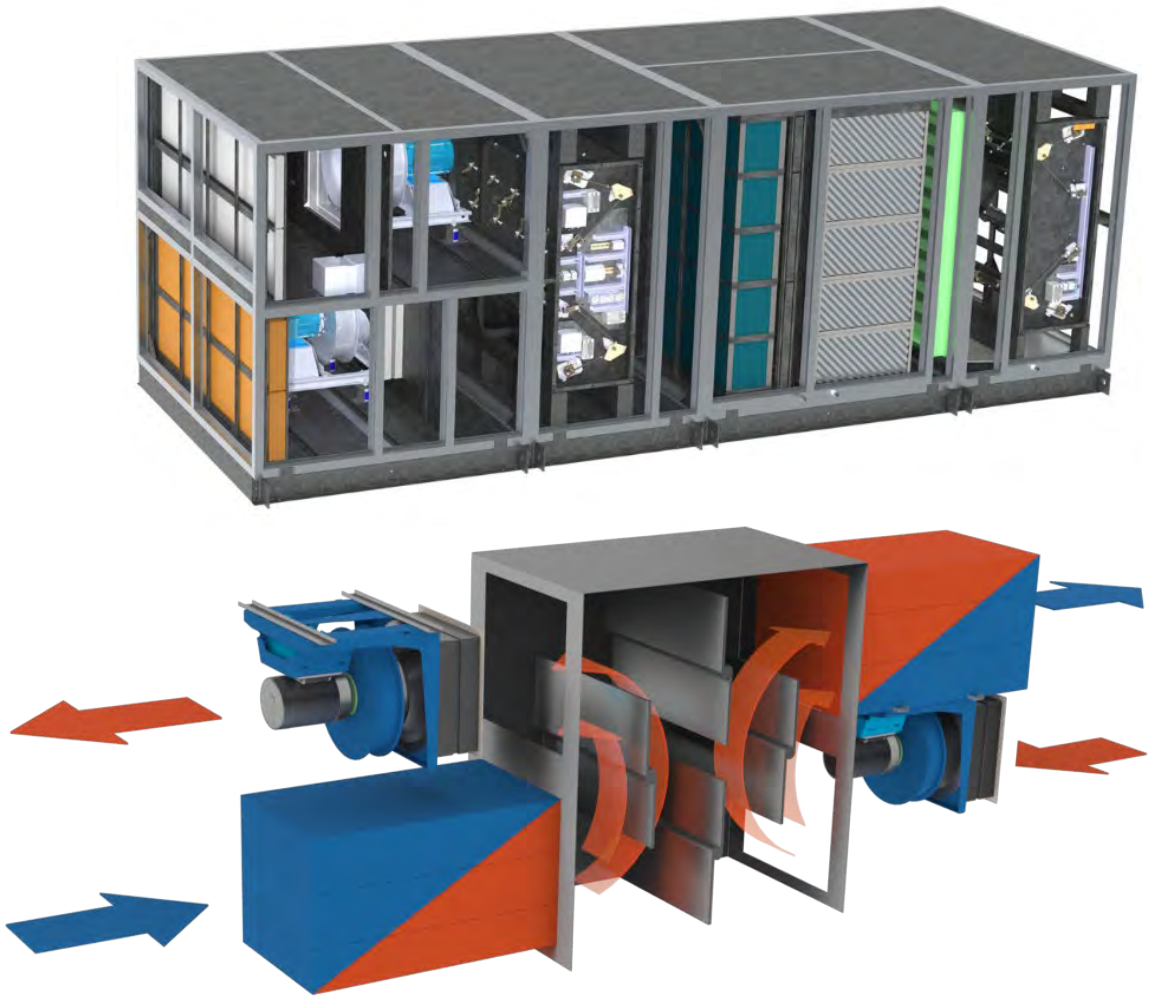
- Winter sensible efficiency: 75% +/- 5%
- Winter latent efficiency: 75% +/- 5%
- Summer sensible efficiency: 75% +/- 5%
- Summer latent efficiency: 75% +/- 5%
- Defrost required
- Cross-contamination from 1 to 3%





DUAL CORE® HEAT RECOVERY UNIT

2,000 to 20,000 CFM



YEAR ROUND SENSIBLE AND LATENT ENERGY RECOVERY
&
MOST EFFICIENT TECHNOLOGY ON THE MARKET

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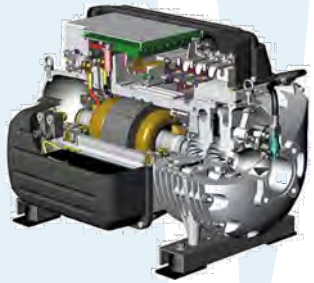
EQUIPMENT UPGRADE

Monday, December 2, 2024

Chillers upgrade

Oil-free magnetic-bearing compressors



High efficiency Inverter air/water heat pumps

Heat recovery chillers

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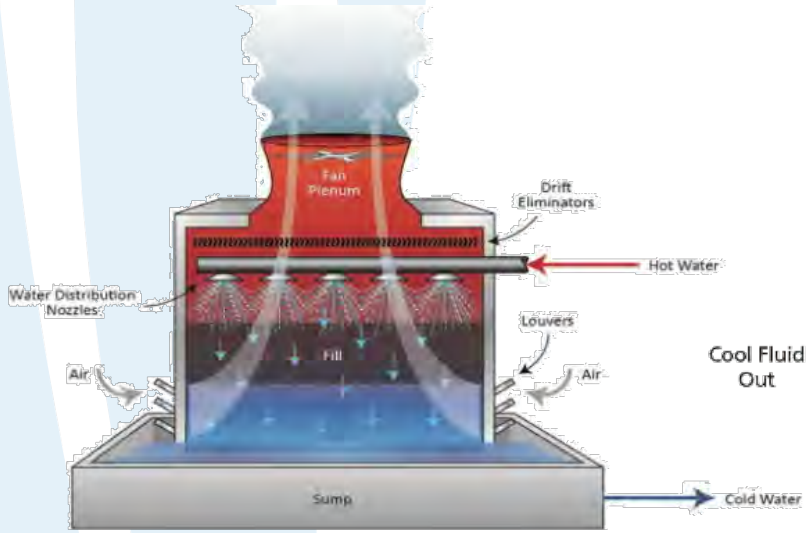
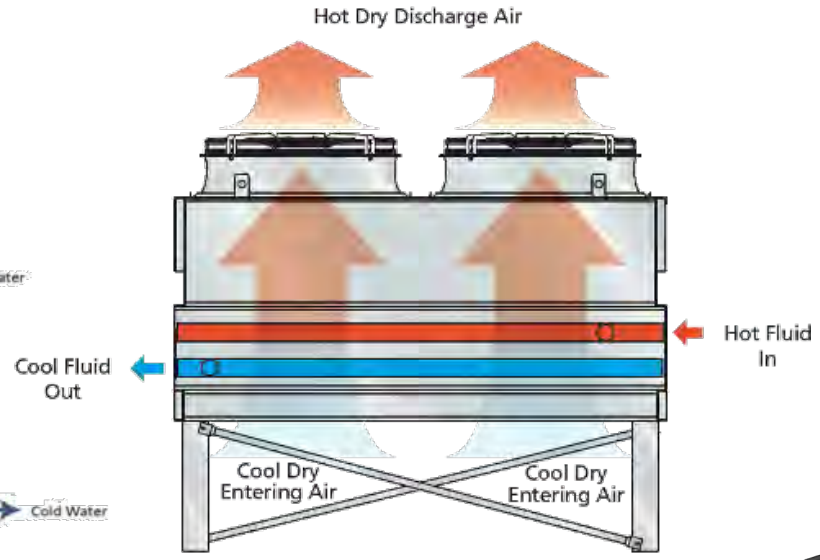
Cooling Tower Upgrade

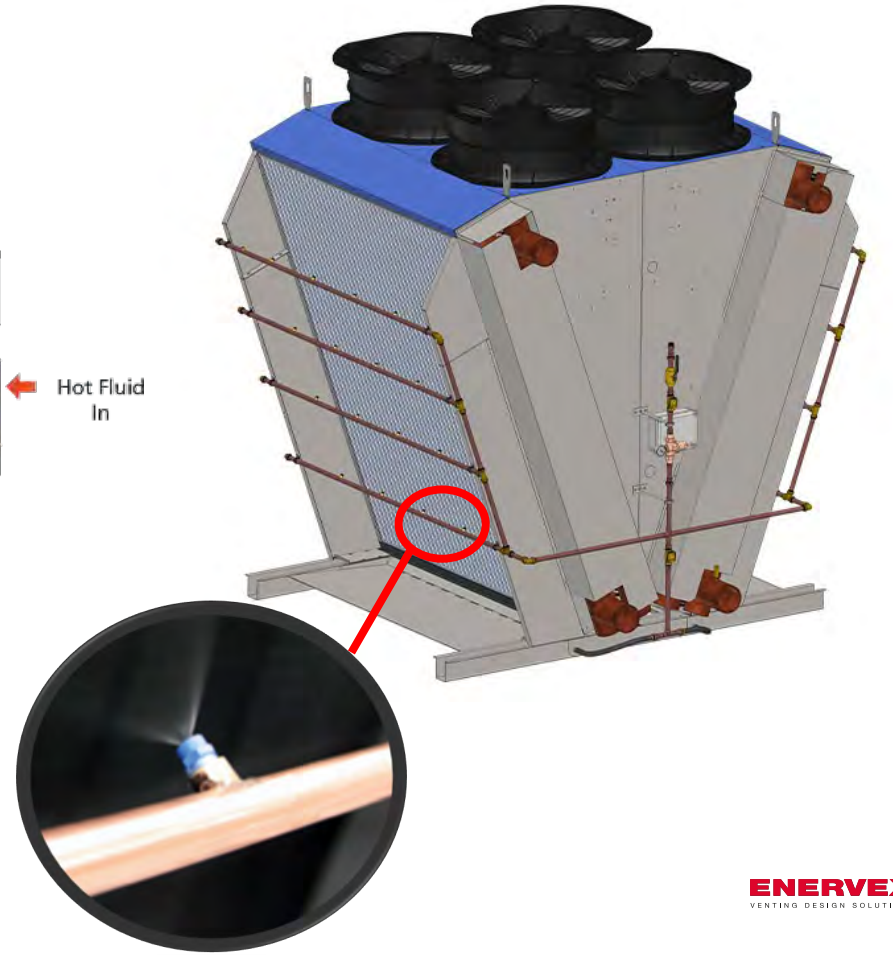
Evaporative cooling towers



Dry coolers

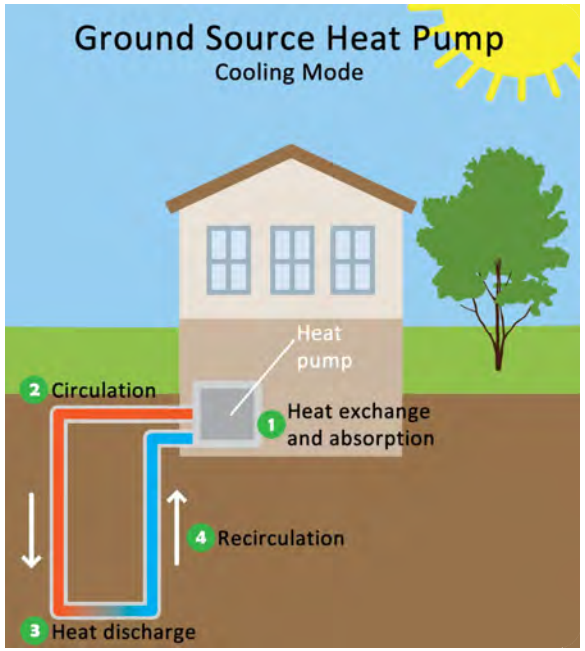


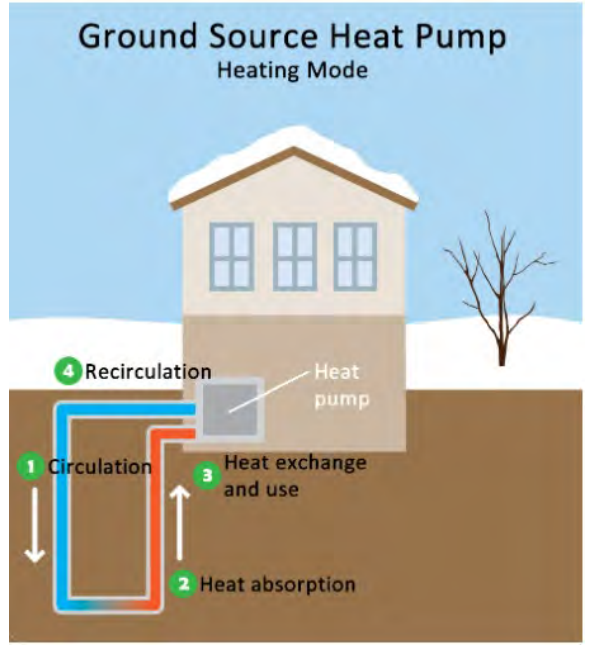
Hybrid Adiabatic Cooling Systems



GEOTHERMAL GROUND SOURCE HEAT PUMPS

- Super efficient
- Lowest energy consumption
- No CO2 emissions
- Requires a lot of space and often we cannot meet the full load.
- Super expensive
- Needs heating and cooling back-up
- Designed for low temperature heating loops, so hard for retrofits





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New hi-temp air source CHILLERS/HEATERS

- HI temperature heat pumps (180°F)
- New refrigerants
- Expensive
- Performances at low temps
- Back-up heat required
- Amp draw / infrastructures
- How is the electricity we will use being produced?

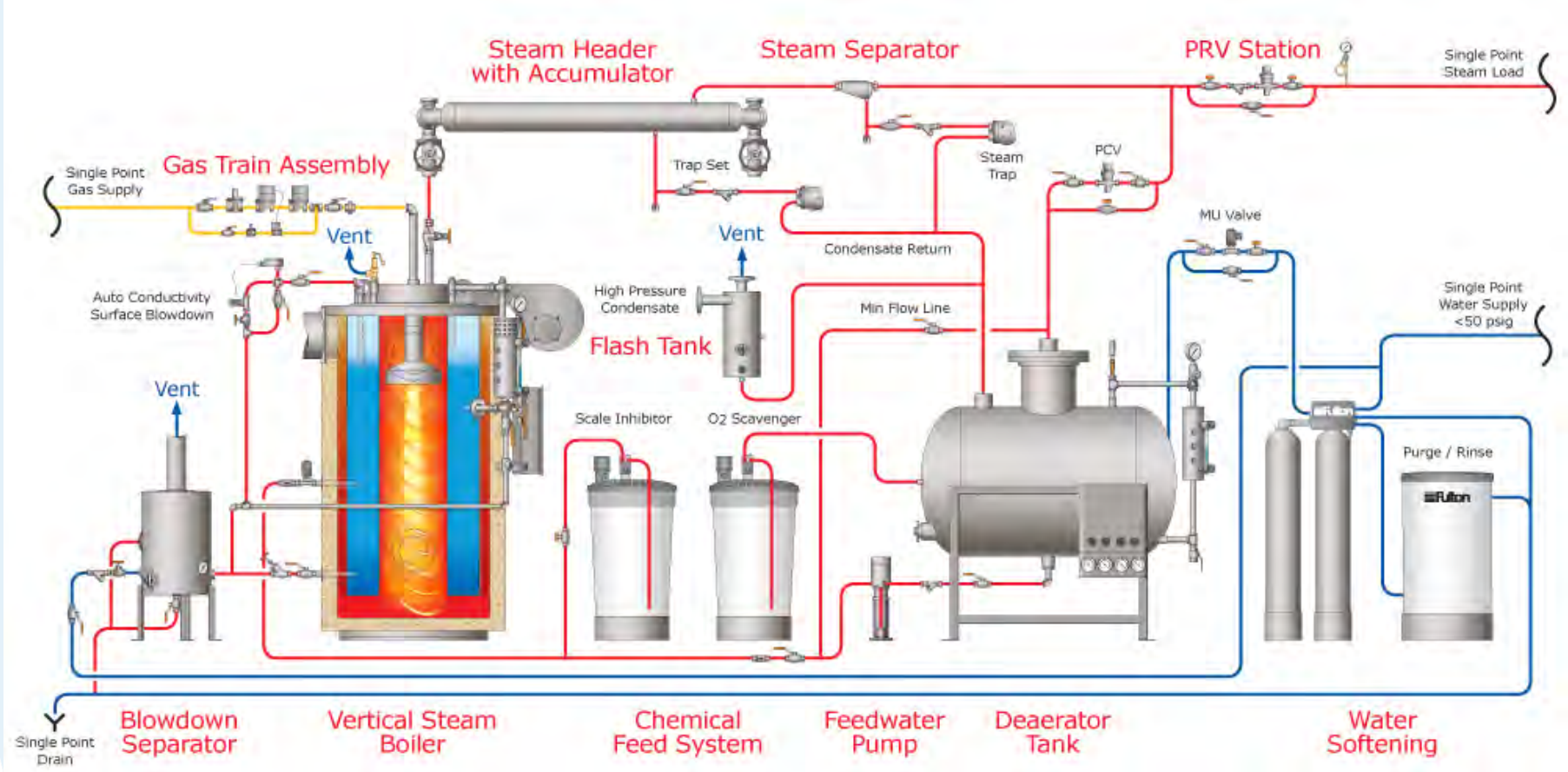
STEAM BOILERS EVOLUTION

OLD TECHNOLOGY
80% MAX EFFICIENCY @ 0 PSIG

NEW HIGH EFFICIENCY
MAX 86%

ENERVEX VENTING DESIGN SOLUTIONS

STEAM BOILER SYSTEM EFFICIENCY : UNDER 60%



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BOILER/WATER HEATER EVOLUTION

OLD TECHNOLOGY 80% MAX EFFICIENCY

HIGH EFFICIENCY
MAX 87%

CONDENSING
MAX 100%

ENERVEX VENTING DESIGN SOLUTIONS

Part I : New Focus on Fan Efficiency: FEI

FAN ENERGY INDEX

AMCA

- Capacity Testing
- Sound Testing
- Fan Energy Index

ENERVEX certifies that the BEF 450x shown herein is licensed to bear the AMCA Seal. The ratings shown are based on tests and procedures performed in accordance with AMCA Publication 211 and AMCA Publication 301 comply with the requirements of the AMCA Certified Ratings Program.

FAN ENERGY INDEX (FEI)

AMCA

- Not-for-profit manufacturer association
- Established 1917 with six member companies in USA
- Now global with almost 400 companies

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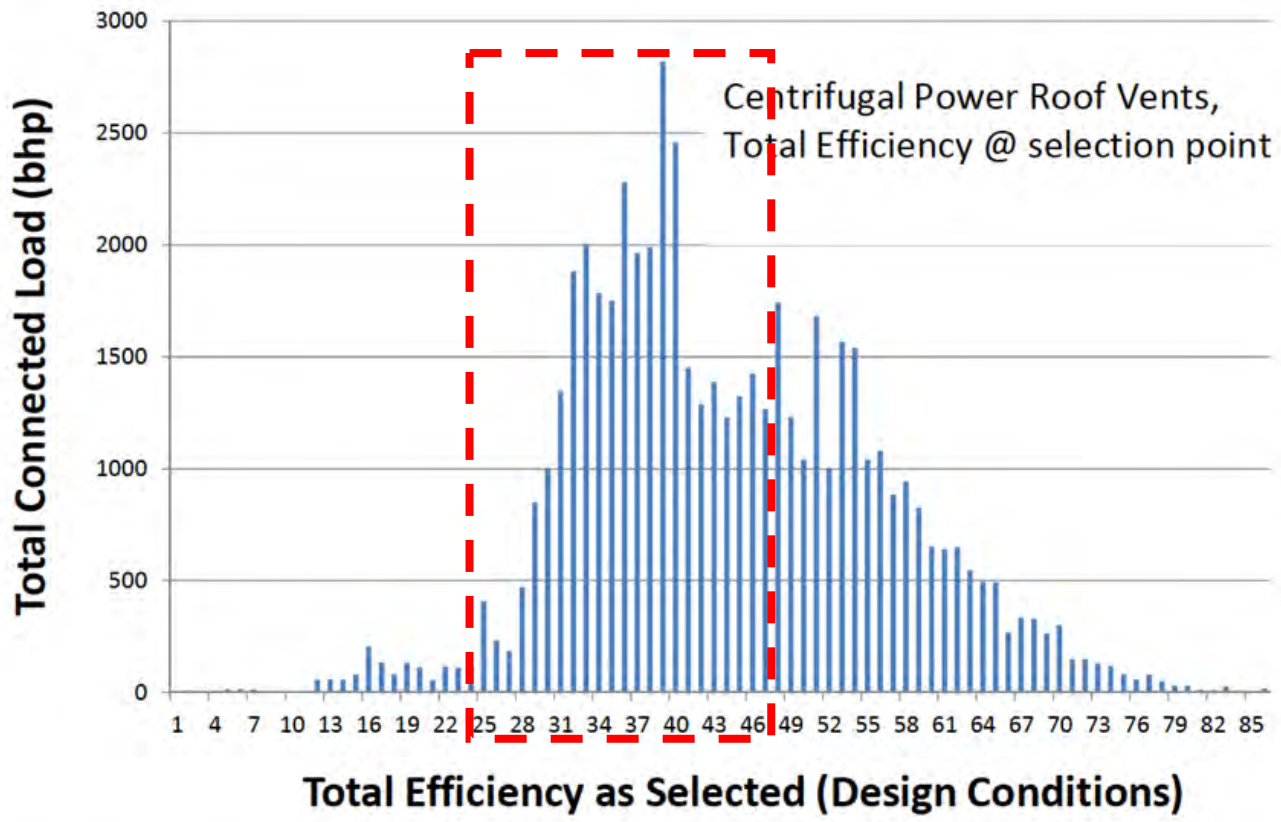
FAN ENERGY INDEX

FEI aims to shifts Selections to Higher Efficiencies



Based on AMCA database of 1.3 million fan selections, 45% of USA market

ENERVEX VENTING DESIGN SOLUTIONS

FAN ENERGY INDEX

Fan Efficiency Grade - FEG

- FEG limited to impeller and fan design efficiency
  - Not wire-to-air
  - Omits motor and drive efficiencies
- Efficiency measured at total efficiency only; part-load not covered
- FEG ratings apply to all fan-model sizes
  - Same FEG rating regardless of fan size

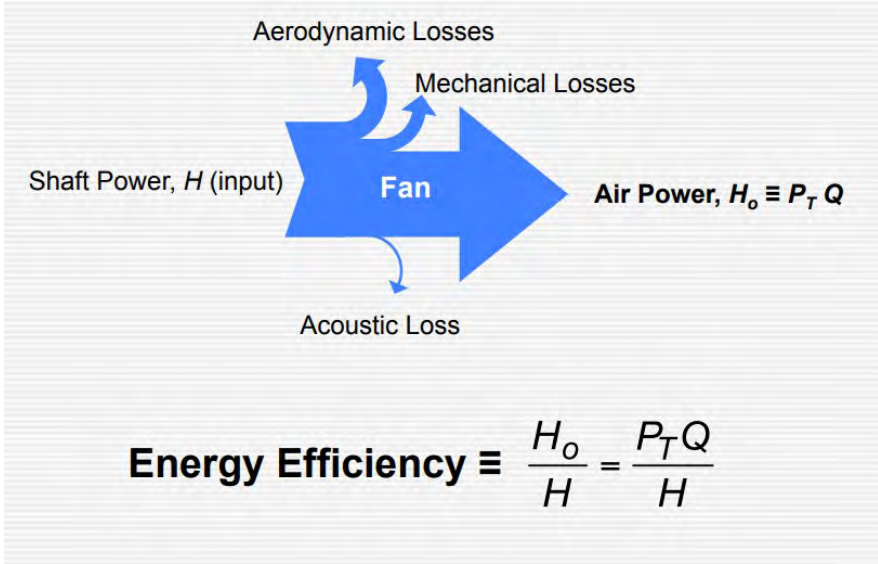
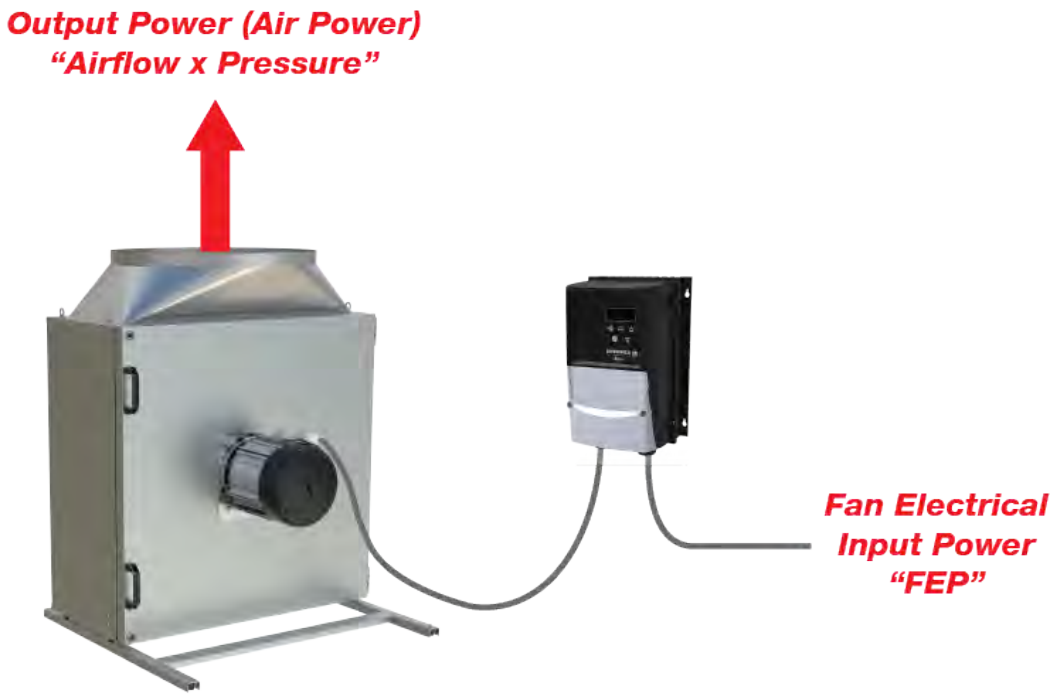


*Image Source ASHRAE Annual Meeting 2012. Dr. Michael Brendel

FAN ENERGY INDEX

Fan Energy Index - FEI

- The Fan Energy Index is calculated as a ratio of the baseline electrical power over the fan's actual electrical input power.



FAN ENERGY INDEX

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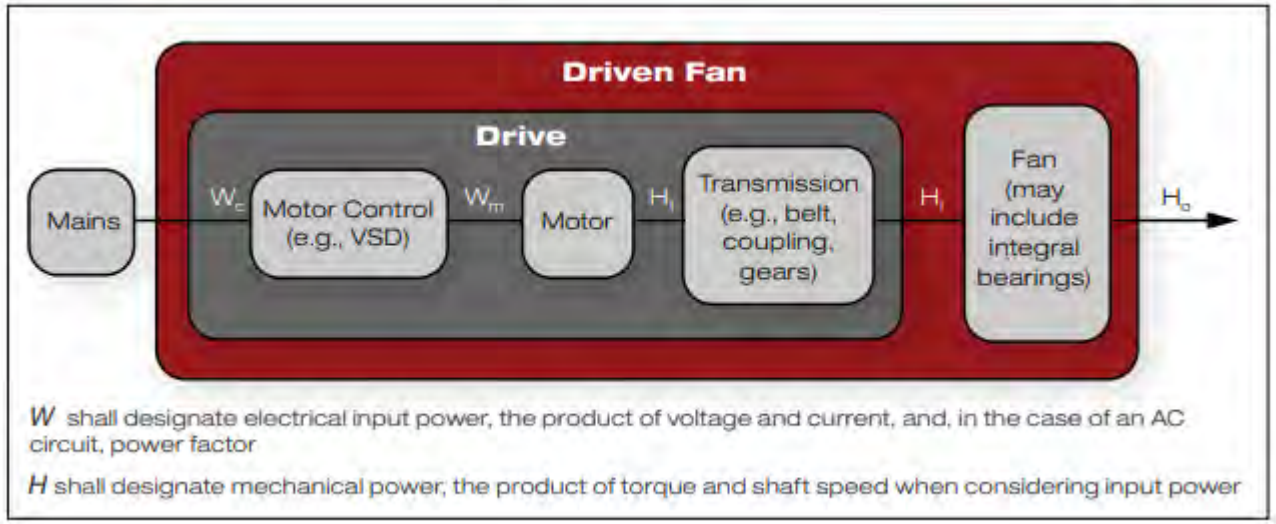


FAN ENERGY INDEX

FEI is Superior

- Wire-to-air – covers fan, transmission, motor, speed control
- Part-load conditions
- Static or total pressure, as appropriate
- Includes fans testable to AMCA210 / ISO 5801

FAN ENERGY INDEX

Calculating FEI

- Defined in AMCA 208:

$$FEI = \frac{Reference\ Fan\ Electrical\ Input\ Power}{Actual\ Fan\ Electrical\ Input\ Power}$$

$$FEI = \frac{FEP_{ref}}{FEP}$$

  - FEP_{ref} and FEP calculated at the same airflow and pressure
  - FEI is a relative measure of power required for a given duty point – relative to the *Reference Fan*

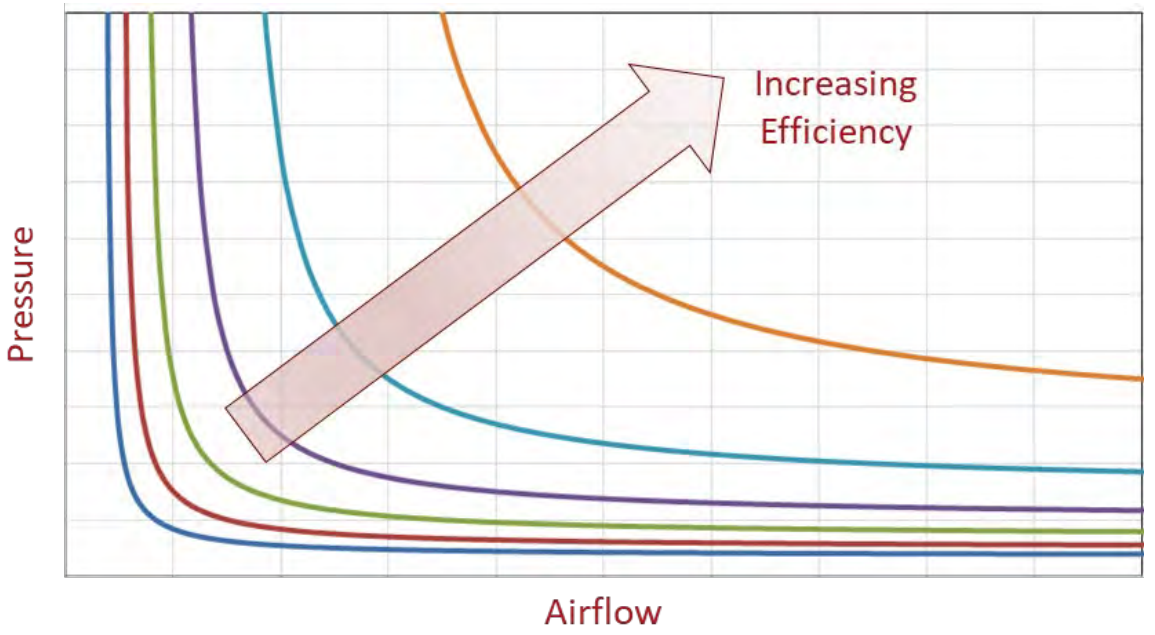
*Source AMCA – Introducing FEI – the AMCA Fan Energy Index

FAN ENERGY INDEX

The Reference Fan

- Think of the Reference fan as the “Reasonably Efficient Fan”
  - Established by DOE and the fan industry
  - Later documented in AMCA 208
- Empirical function of fan efficiency vs. airflow and pressure:

1. Independent of:
   - Fan type
   - Fan size
   - Motor Type
   - Belt or direct drive
2. Fixed in time



*Source AMCA – Introducing FEI – the AMCA Fan Energy Index

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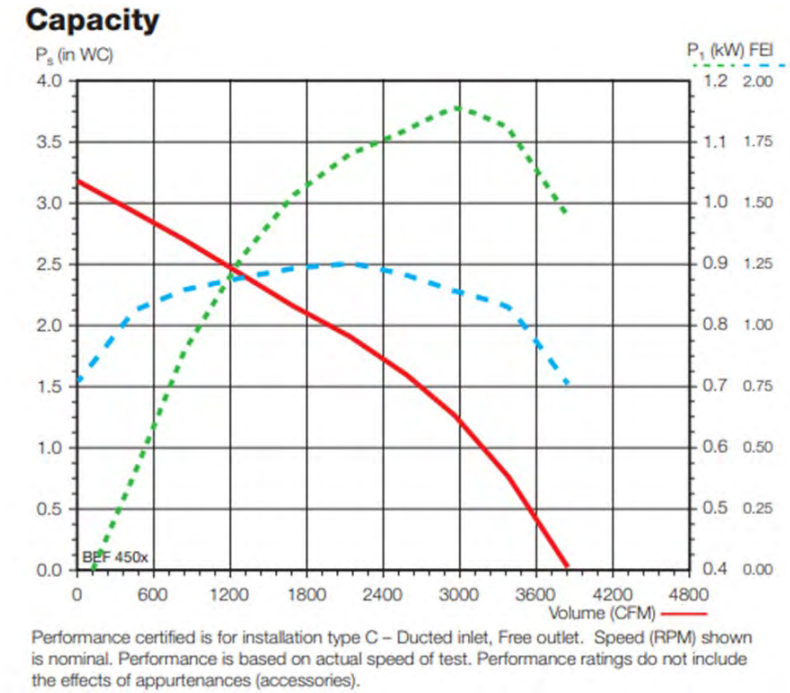
FAN ENERGY INDEX

Fan Selection

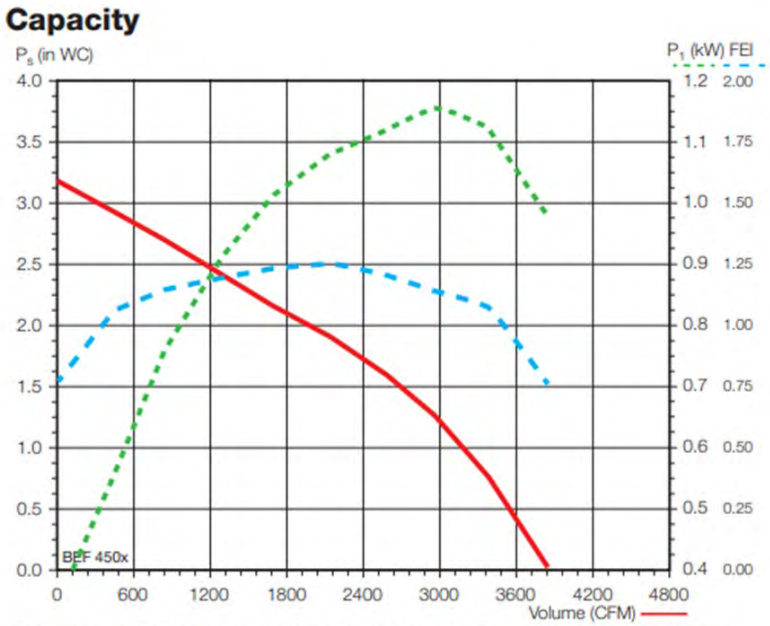
- Fan efficiency is highly dependent on where the fan is operating on the fan curve
- Fans typically selected to provide airflow at a designated duty point
  - Airflow
  - Pressure
  - Air Density



FAN ENERGY INDEX

Fan Selection

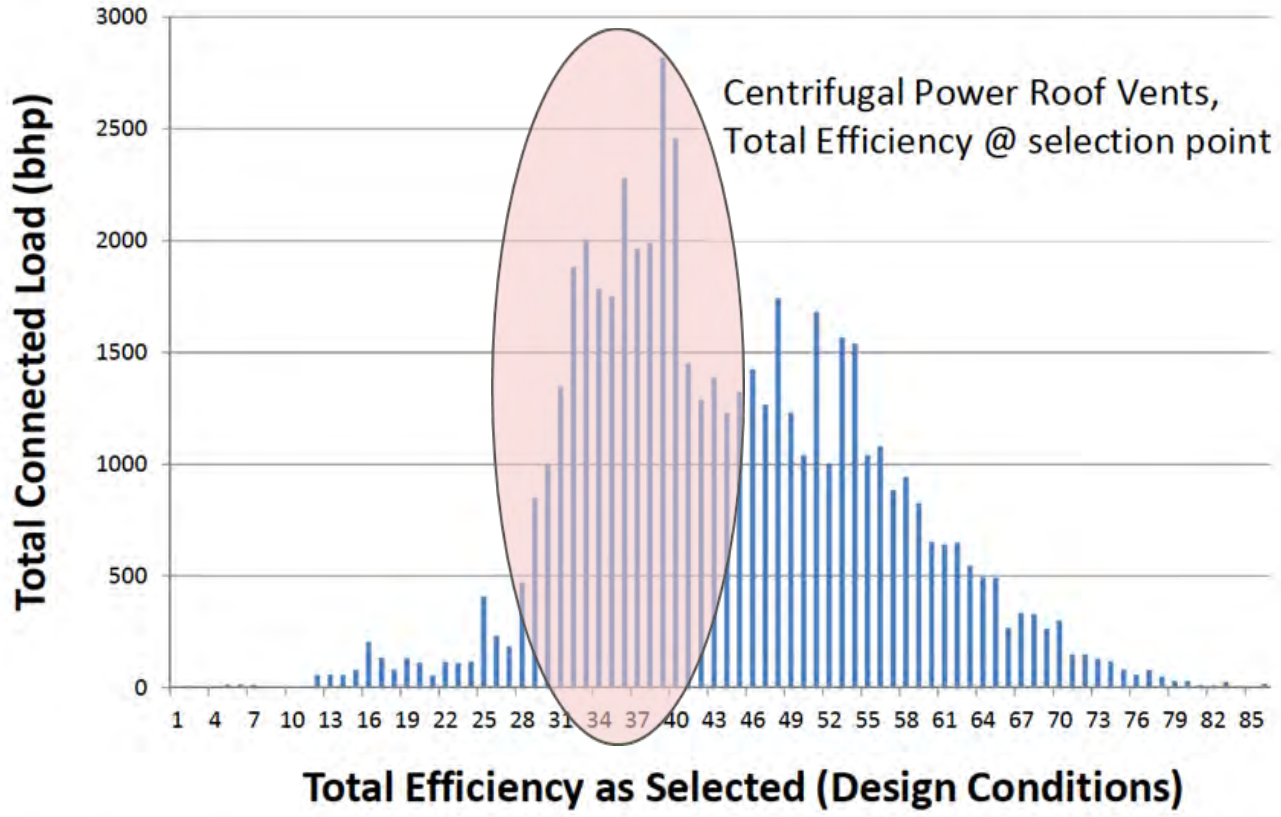
- FEI enables comparisons of
  - Different fan types
  - Different fan sizes
  - Different motor and drive combinations



Performance certified is for installation type C – Ducted inlet, Free outlet. Speed (RPM) shown is nominal. Performance is based on actual speed of test. Performance ratings do not include the effects of appurtenances (accessories).

FAN ENERGY INDEX

AMCA 2012 Data



Based on AMCA database of 1.3 million fan selections, 45% of USA market

A lot of fans have poor selections -they are not properly sized for running conditions

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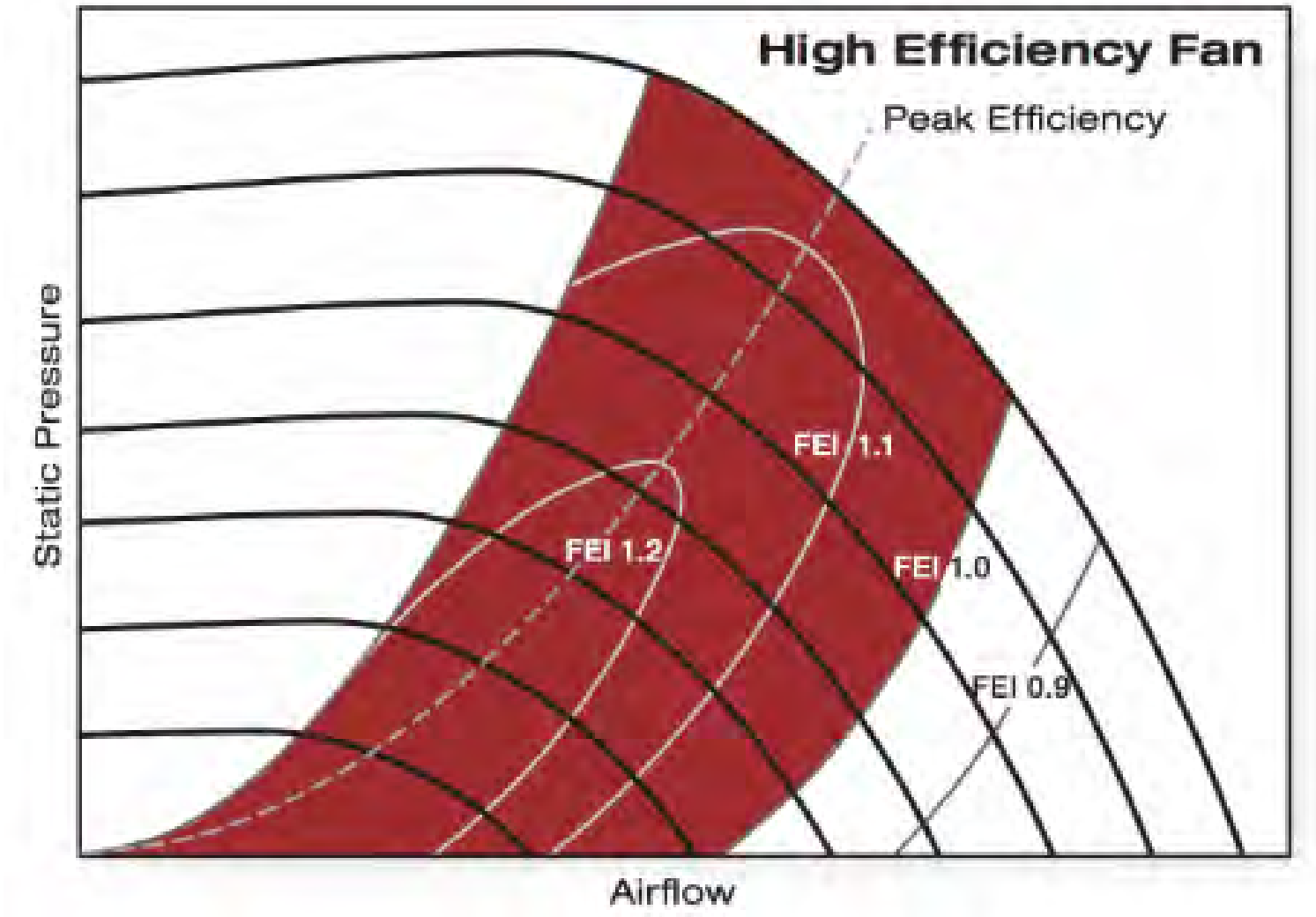
FAN ENERGY INDEX

Bubble Curve

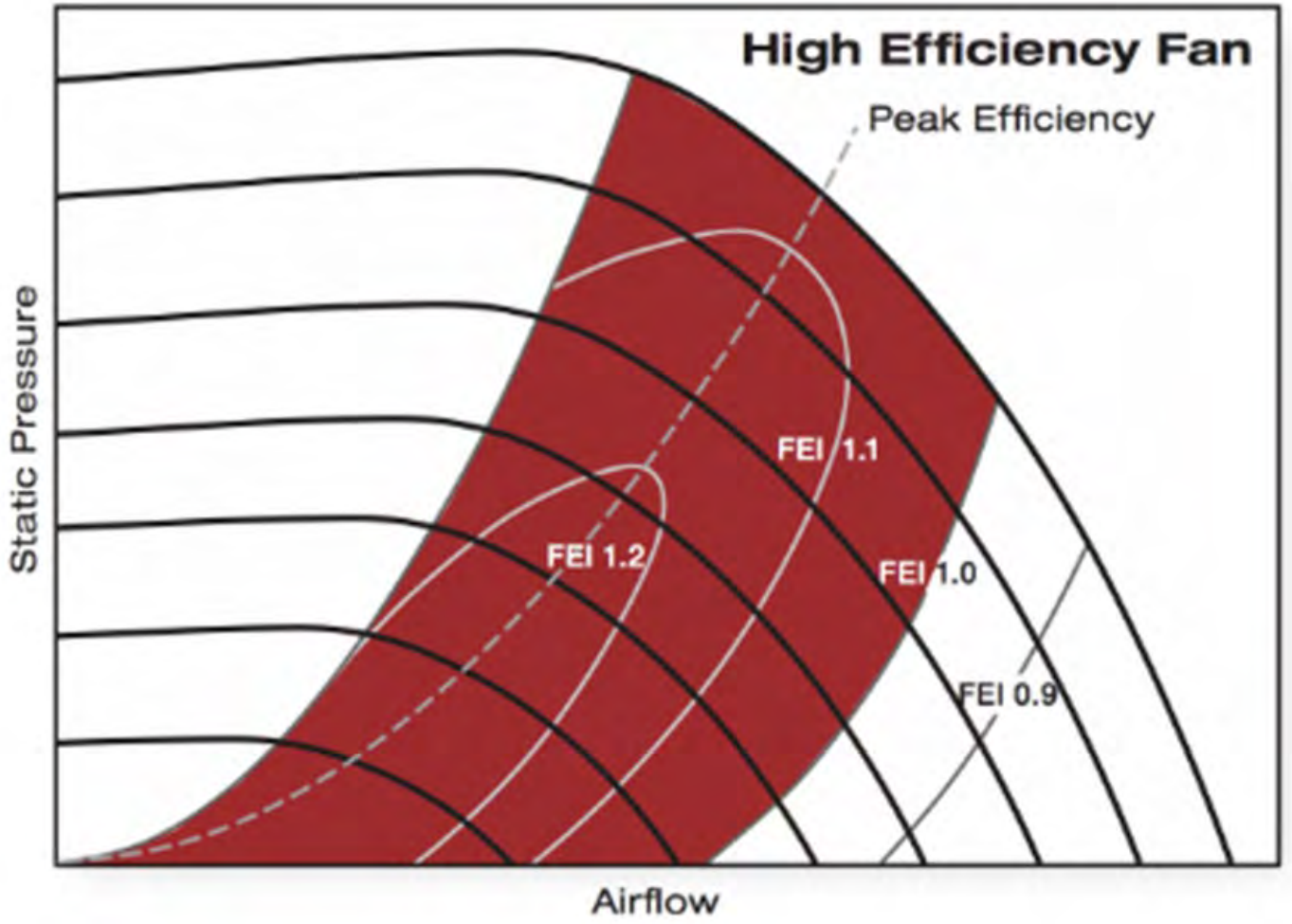
Illustrates FEI at different speeds



FAN ENERGY INDEX

"Rules of Thumb"

- Slower rotational speed = higher FEI rating
- If fan meets FEI requirement at peak condition, fan likely to meet FEI requirement at lower flow conditions



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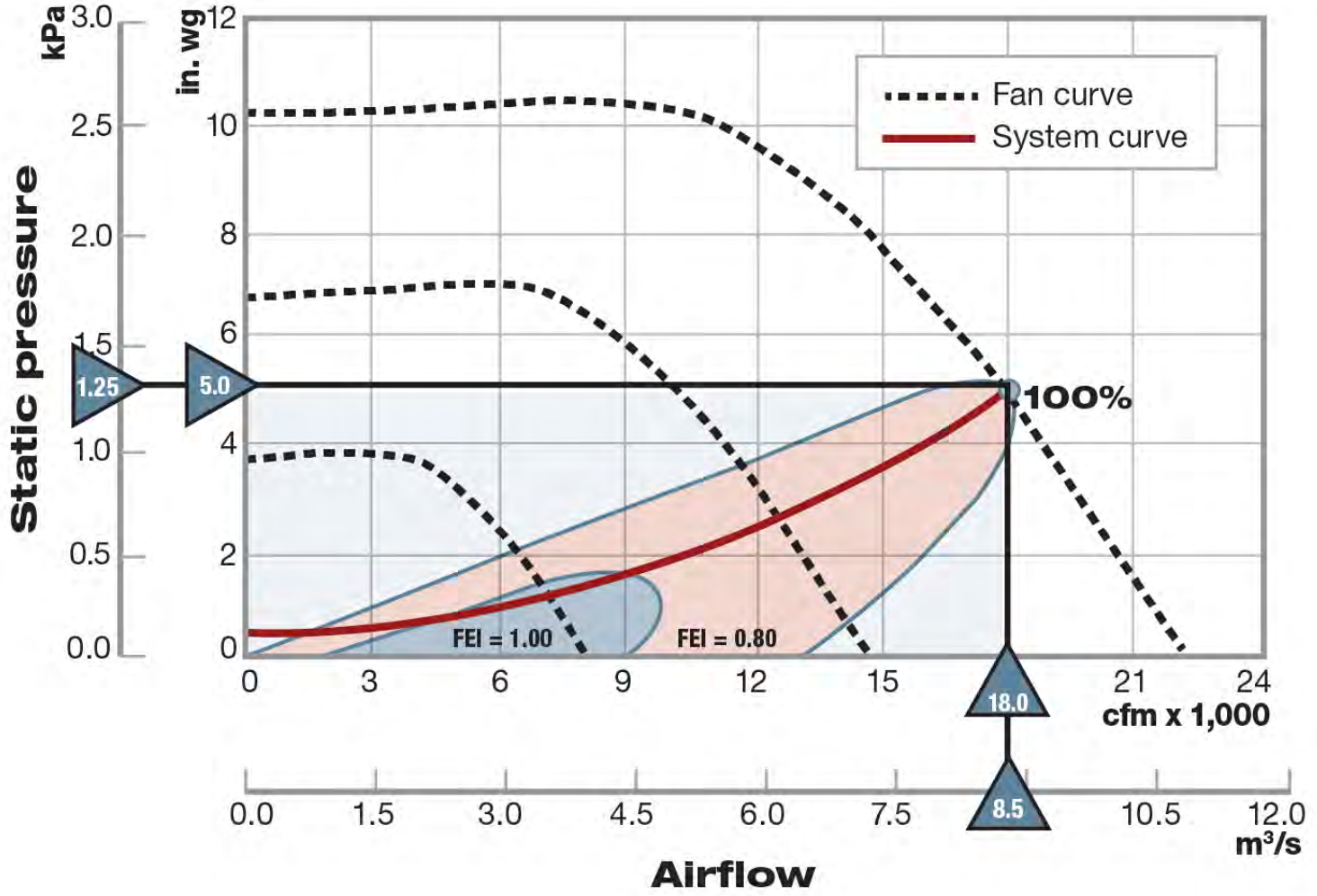
FAN ENERGY INDEX

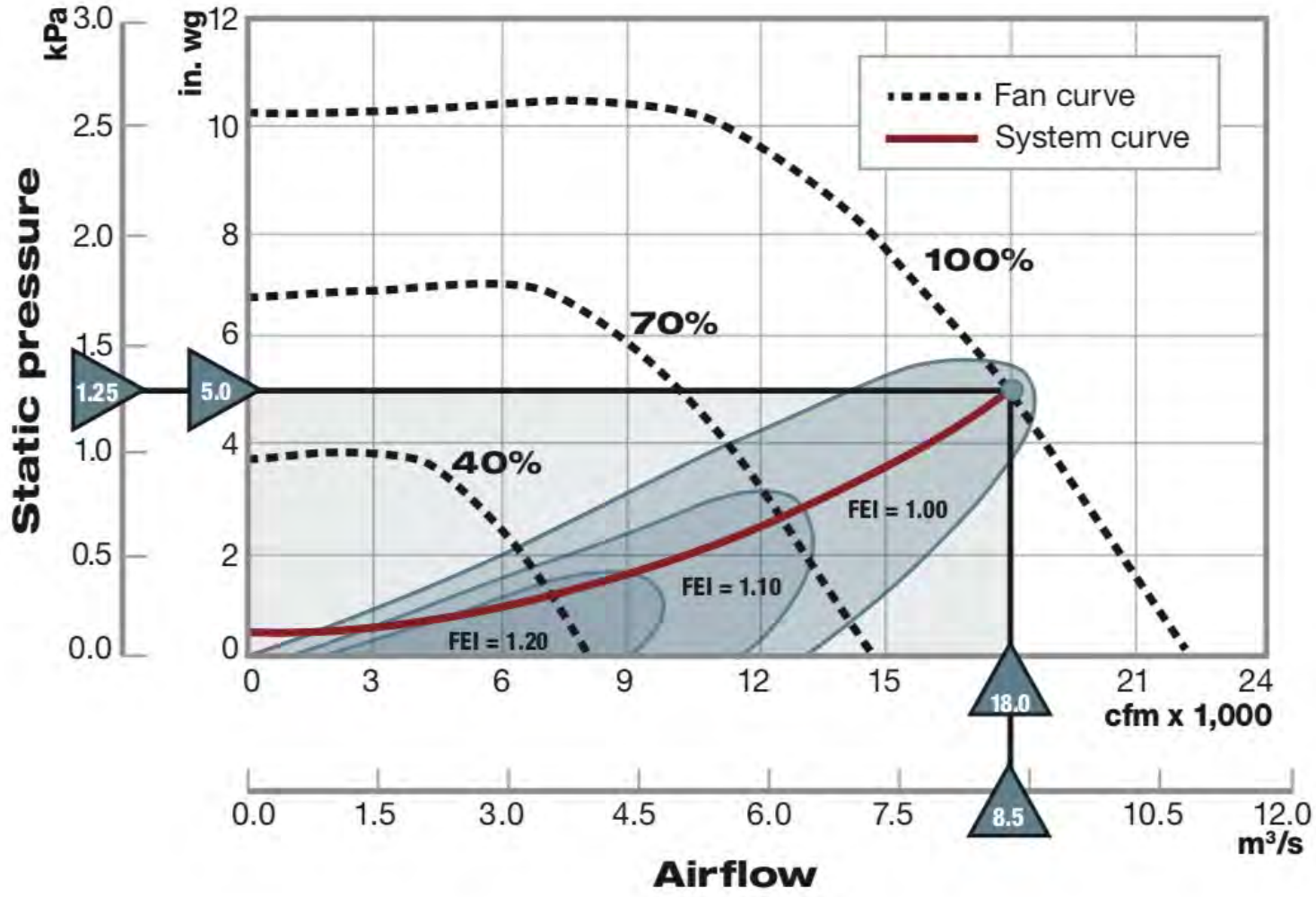
Case for Larger Fans: 18” Backward-inclined fan



*Source AMCA – Introducing FEI – the AMCA Fan Energy Index

FAN ENERGY INDEX

Case for Larger Fans: 22” Backward-inclined fan



*Source AMCA – Introducing FEI – the AMCA Fan Energy Index

FAN ENERGY INDEX

Sizing/Selection Example:

- ASHRAE 90.1-2019:
  - FEI ≥ 1.00 at fan system design conditions (duty point)
  - FEI ≥ 0.95 for VAV
    - Air Flow Rate: 2,000 CFM
    - Static Pressure: 0.25” WC

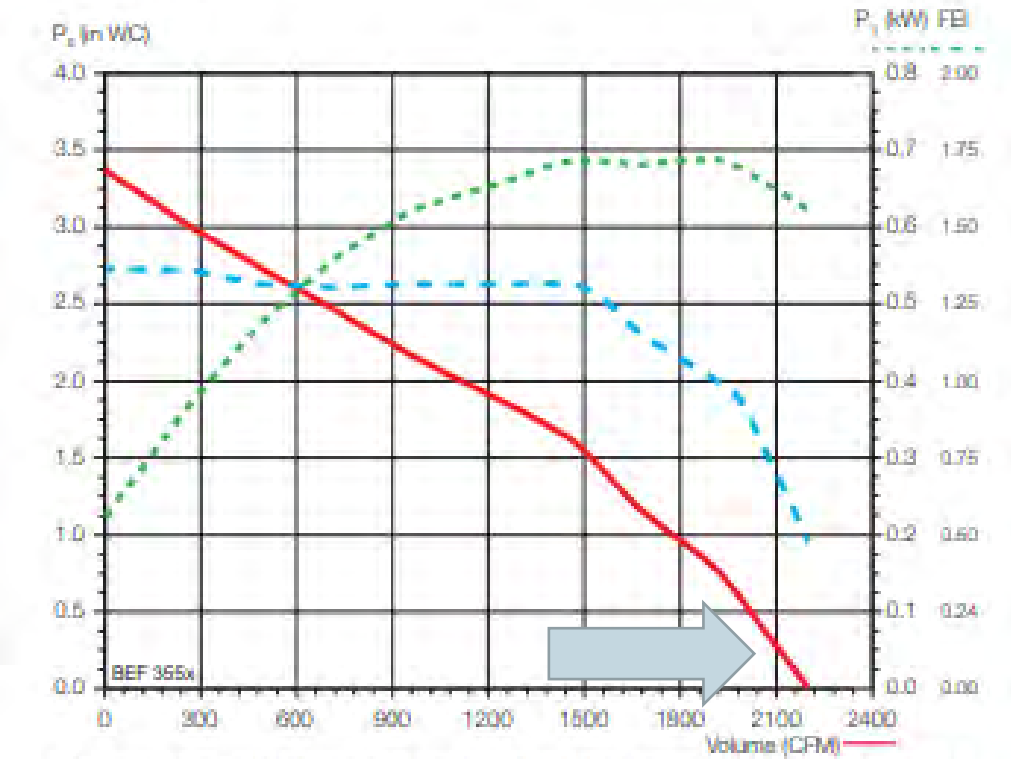
FAN ENERGY INDEX

Example:

BEF355x

CFM	Static Pressure
2,000	0.25

Capacity



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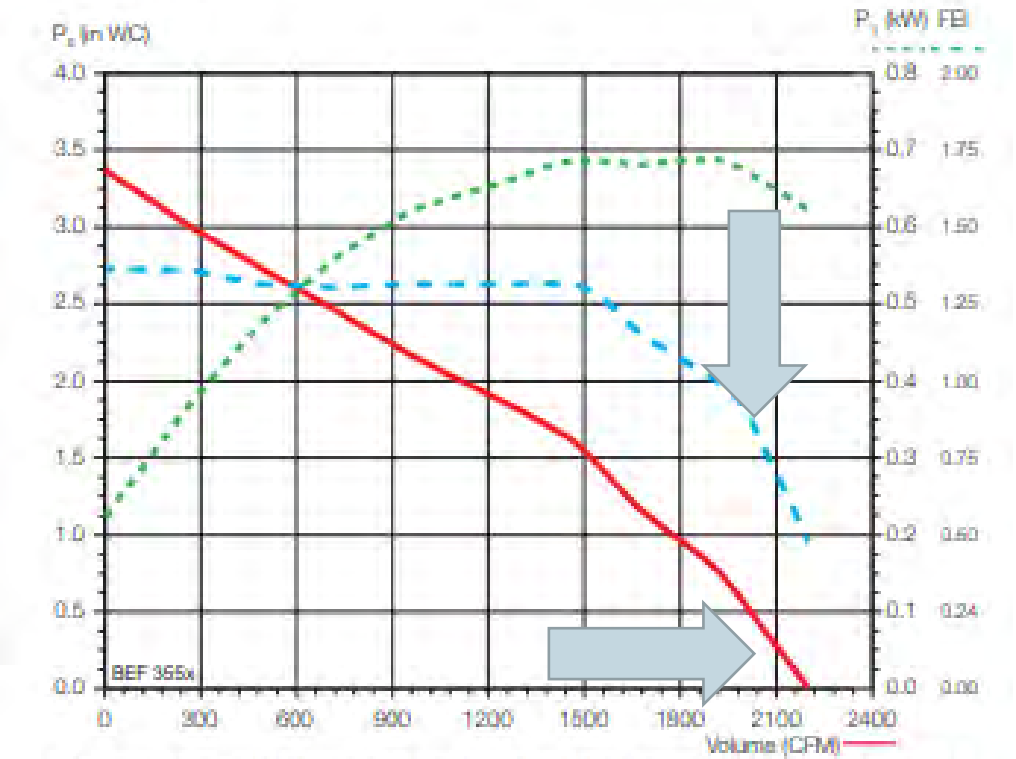
FAN ENERGY INDEX

Example:

CFM	Static Pressure	FEI
2,000	0.25	0.9

Capacity



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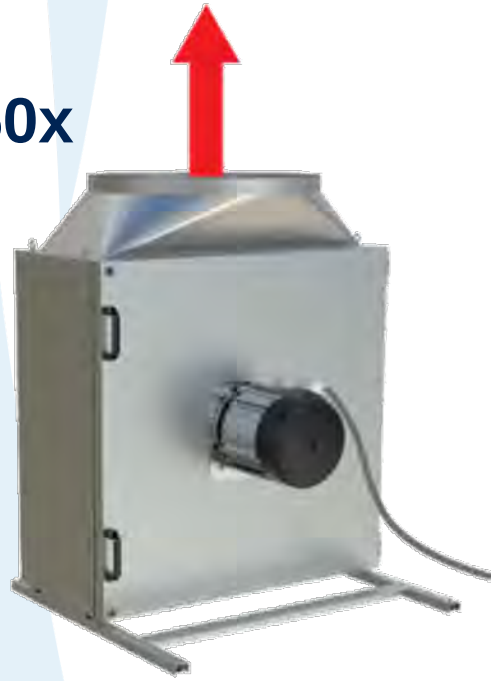
FAN ENERGY INDEX

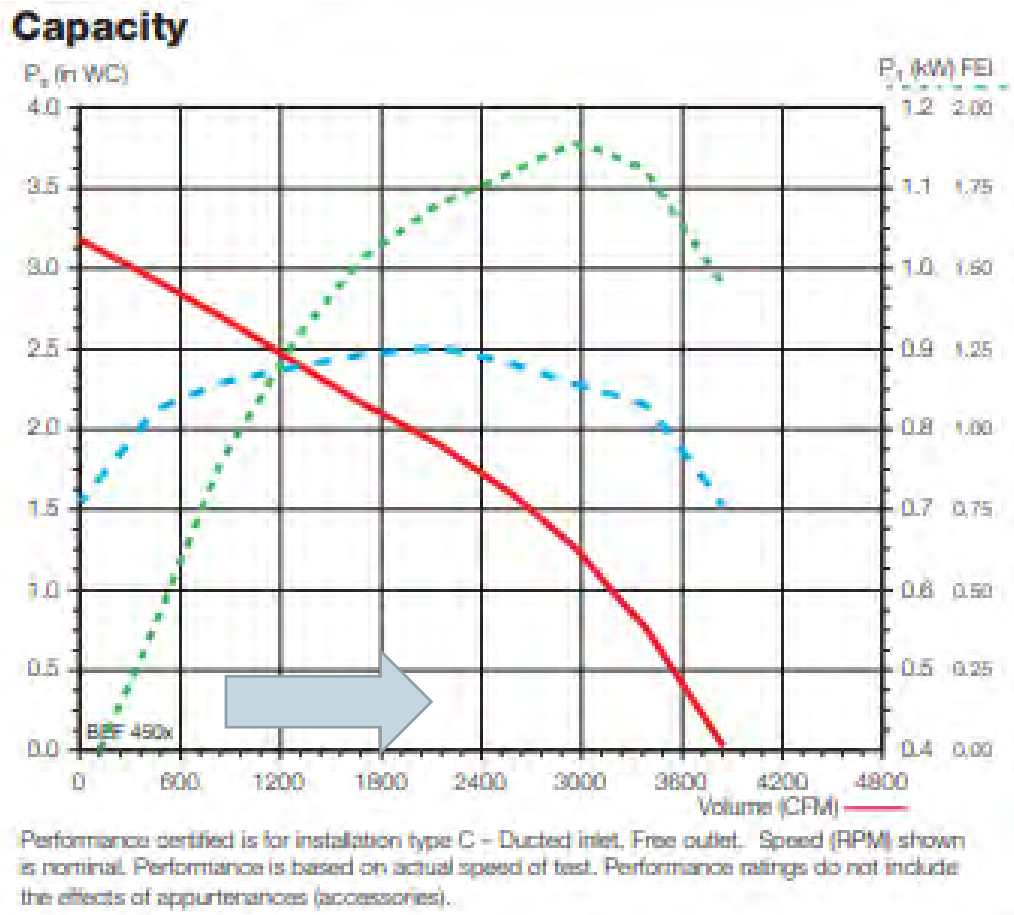
Example:

Output Power (Air Power)
"Airflow x Pressure"

BEF450x



CFM	Static Pressure
2,000	0.25



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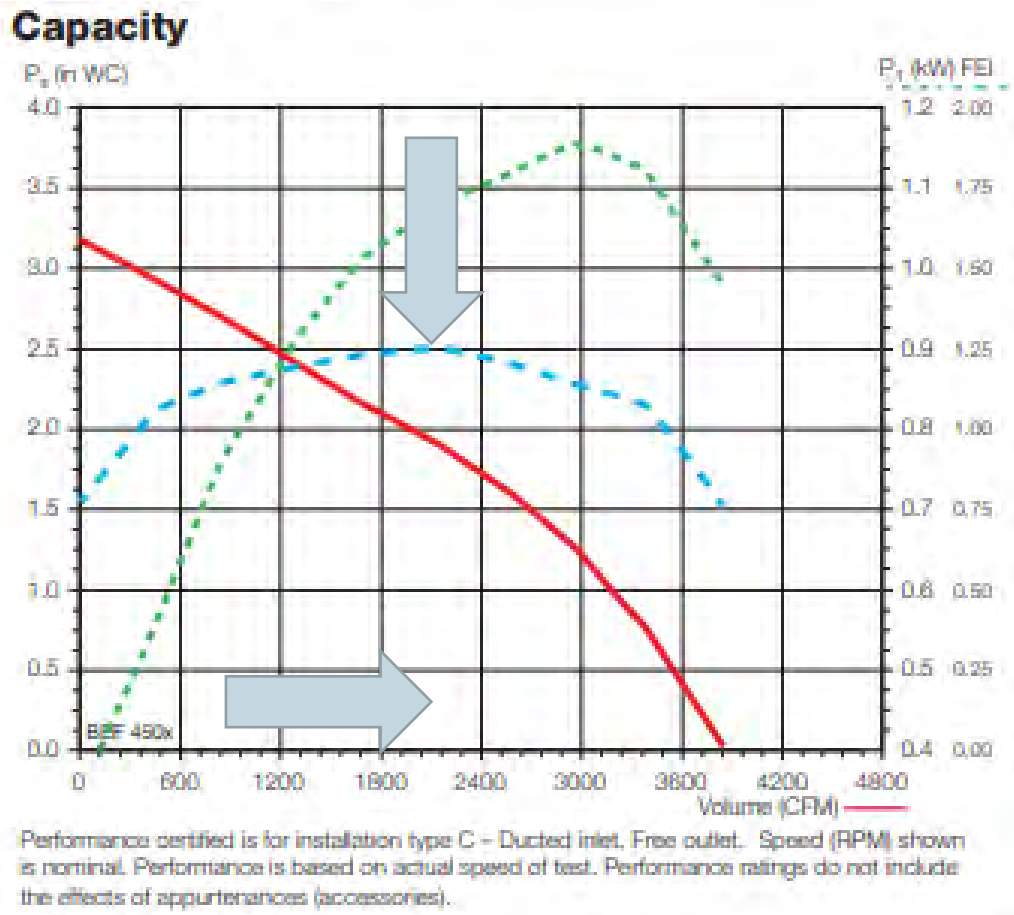
FAN ENERGY INDEX

Example:

CFM	Static Pressure	FEI
2,000	0.25	1.25



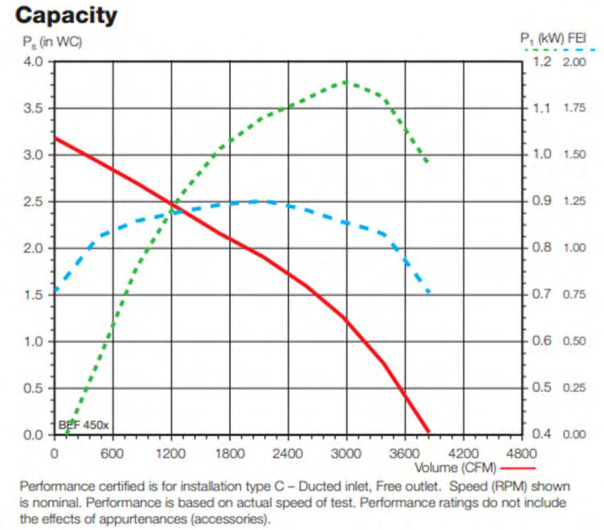
Performance certified is for installation type C – Ducted inlet, Free outlet. Speed (RPM) shown is nominal. Performance is based on actual speed of test. Performance ratings do not include the effects of appurtenances (accessories).

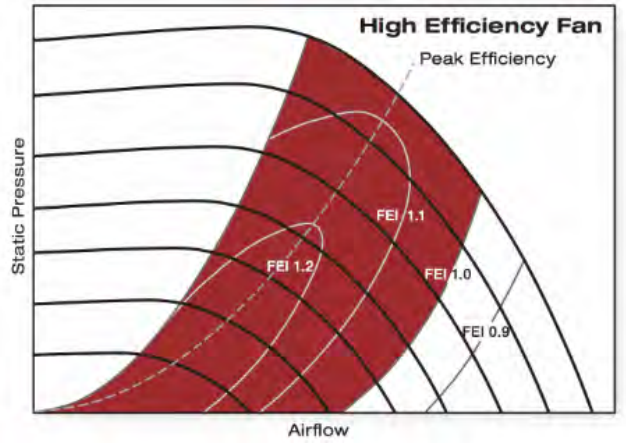
ENERVEX VENTING DESIGN SOLUTIONS

BENEFITS OF FEI

Clarity for Consumers

- FEI ratings provide actual efficiency of fan or fan system at the duty point.
- Fan Efficiency Grade (FEG) rated fans based on the ability to convert mechanical shaft power or impeller power (for direct driven fans) to air power. Does not account for motor or drives.
- Smaller fans have less efficiency than larger fans at same duty point; however, with FEG both fans could have same FEG rating. FEI varies by duty point.





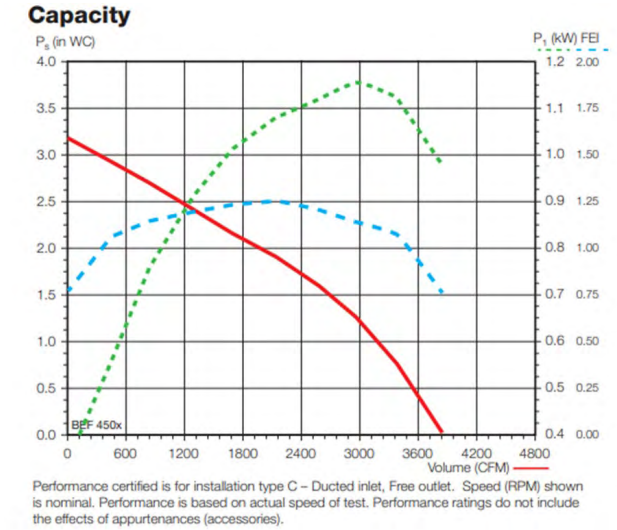
*Source AMCA – Introducing FEI – the AMCA Fan Energy Index

ENERVEX VENTING DESIGN SOLUTIONS

BENEFITS OF FEI

Flexible Application for Designers

- FEI provides engineers to determine the size of fan based efficiency point, allowing them to consider:
  - Higher-than-code savings
  - Acoustics
  - Form Factor
  - Weight
  - Budget
  - Availability



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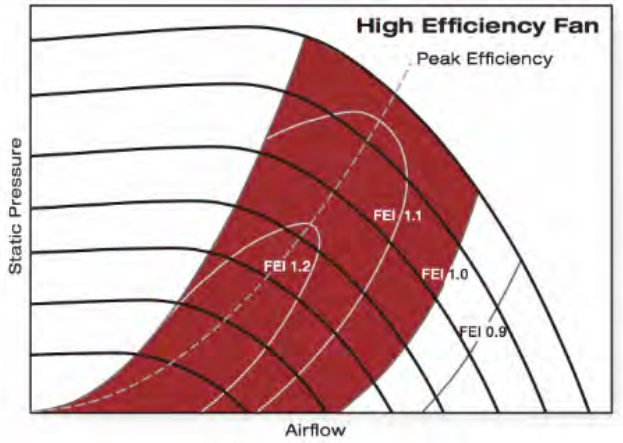
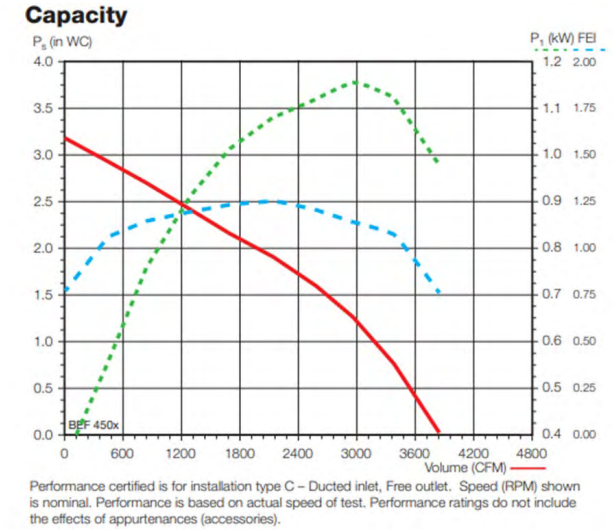


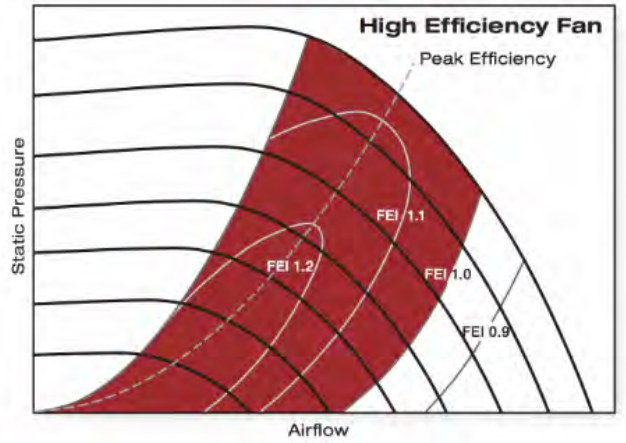
*Source AMCA – Introducing FEI – the AMCA Fan Energy Index

BENEFITS OF FEI

Simplicity

- Intuitive metric that directly reflects power consumed by the fan
- Simpler enforcement since the efficiency is shown at duty point on a curve, code officials need simply to check submittals and labels for FEI ratings and the engineer's selected duty point



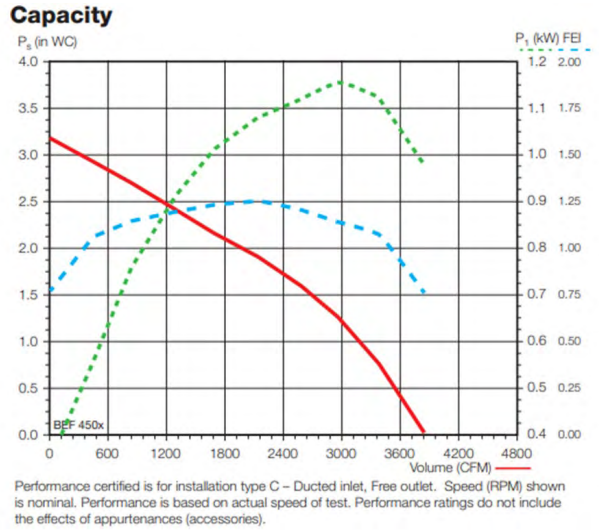


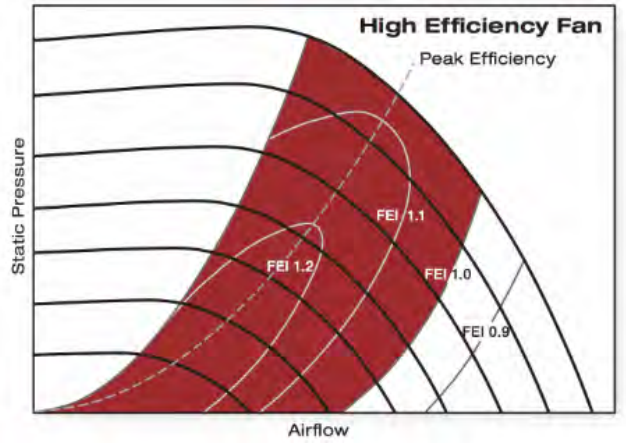
*Source AMCA – Introducing FEI – the AMCA Fan Energy Index

BENEFITS OF FEI

Great Energy Savings

- Fans with higher FEI ratings will have higher efficiency over a larger range of operating point than peak efficiency
- FEI covers low-pressure fans, such as power roof ventilators, which are exempt from energy codes and standards
- FEI tilts selections towards more efficient motors and drives
- FEI encourage more efficient fan types





FAN ENERGY INDEX

Codes, Standards, and Regulations

- Model Energy Standard - ASHRAE 90.1
- Model Energy Code - International Energy Conservation Code (IECC) – 2021
- Model high performance building (green) building standard/code – ASHRAE 189.1 / International Green Construction Code (IGCC) – 2020
- State Building Codes
  - California Title 20
  - California Title 24
  - States that adopt ASHRAE 90.1 or IECC
- U.S. Department of Energy (DOE) – Currently stalled.

Regulatory or voluntary-program body	Possible FEI requirement
U.S. Department of Energy	FEI ≥ 1.0 at design point
ANSI/ASHRAE/IES Standard 90.1 or International Energy Conservation Code	FEI ≥ 1.0 at design point
ANSI/ASHRAE/USGBC/IES Standard 189.1	FEI ≥ 1.1 at design point
Utility incentive programs	FEI ≥ 1.1 at design point

ENERVEX® VENTING DESIGN SOLUTIONS

*Source AMCA – Introducing FEI – the AMCA Fan Energy Index

FAN ENERGY INDEX

Baseline for ASHRAE 90.1 and IECC

FEI ≥ 1.00 for constant speed
FEI ≥ 0.95 for variable speed
FEI calculated at “fan system design conditions”

Regulatory or voluntary-program body	Possible FEI requirement
U.S. Department of Energy	FEI ≥ 1.0 at design point
ANSI/ASHRAE/IES Standard 90.1 or International Energy Conservation Code	FEI ≥ 1.0 at design point
ANSI/ASHRAE/USGBC/IES Standard 189.1	FEI ≥ 1.1 at design point
Utility incentive programs	FEI ≥ 1.1 at design point

Covered:

- Standalone fans (including PRVs) ≥ 1.00 HP (0.89 kW)
- Embedded fans and fan arrays > 5.0 HP (4.1 kW)

Exempt:

- Fans embedded in equipment that is regulated or 3rd party-certified for air performance or energy performance
- Reversible tunnel ventilation fans
- Fans for high temperatures, explosive atmospheres, high temperatures, or emergency conditions
- Ceiling fans
- Fans not in scope of AMCA 208

ENERVEX® VENTING DESIGN SOLUTIONS

*Source AMCA – Introducing FEI – the AMCA Fan Energy Index

FAN ENERGY INDEX

Green/Stretch Codes

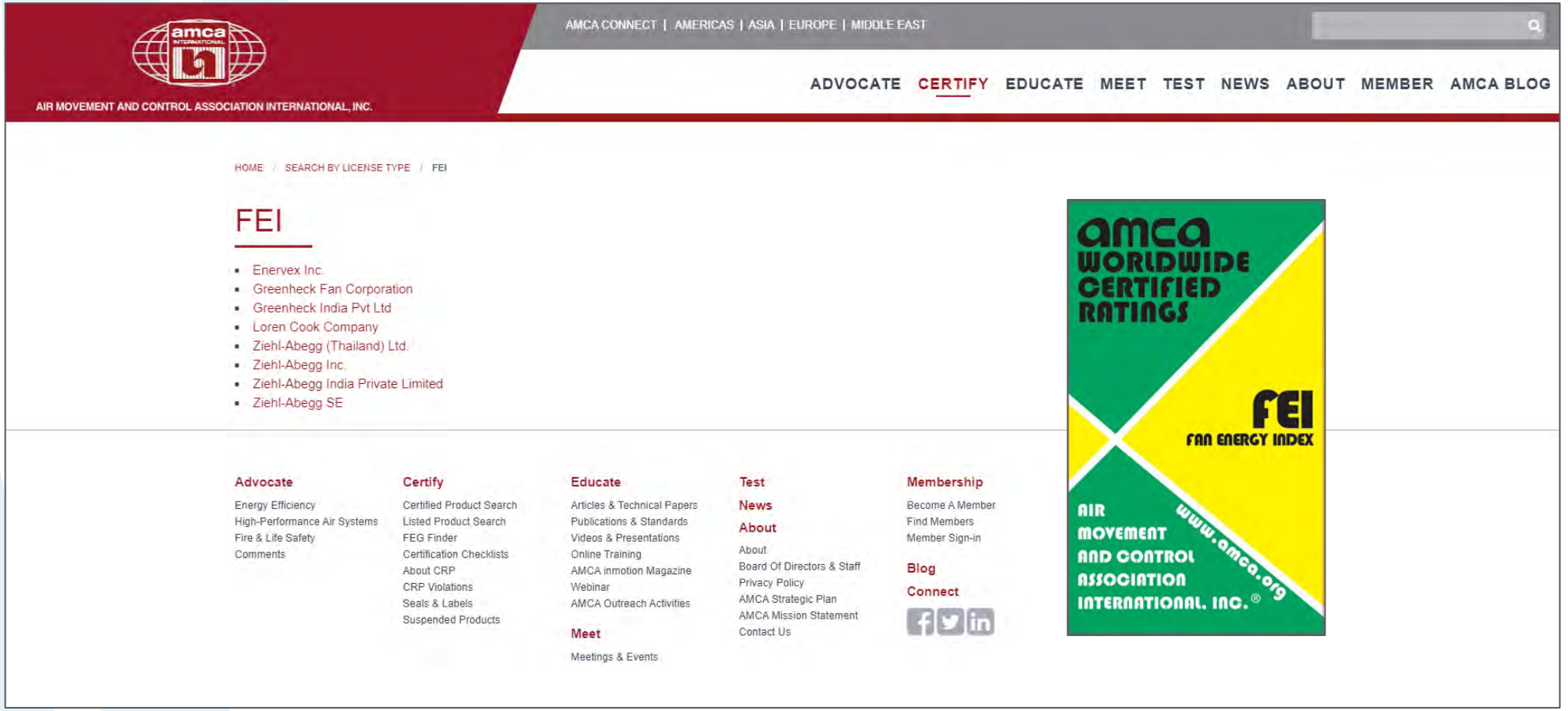
- ASHRAE 90.1-2020 and IGCC 2021
- FEI ≥ 1.10 for covered fans
- No exemptions from baseline
- No removal of exemptions from baseline
- Level does not change for constant or variable speed

Regulatory or voluntary-program body	Possible FEI requirement
U.S. Department of Energy	FEI ≥ 1.0 at design point
ANSI/ASHRAE/IES Standard 90.1 or International Energy Conservation Code	FEI ≥ 1.0 at design point
ANSI/ASHRAE/USGBC/IES Standard 189.1	FEI ≥ 1.1 at design point
Utility incentive programs	FEI ≥ 1.1 at design point

*Source AMCA – Introducing FEI – the AMCA Fan Energy Index

FAN ENERGY INDEX

Setting the Benchmark



FAN ENERGY INDEX

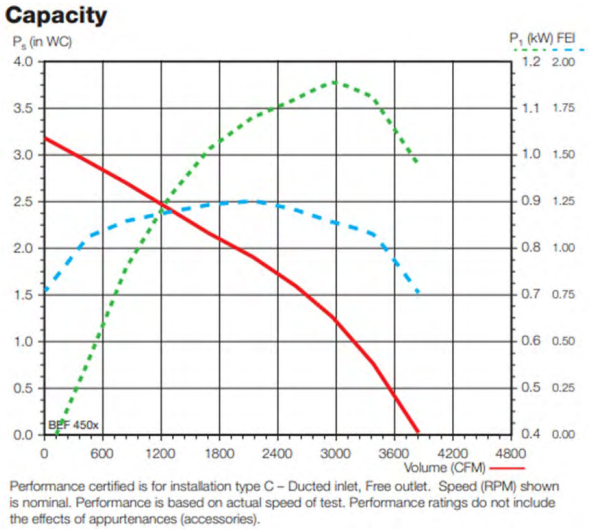
AMCA Certified Rating Program

- Verify certifications 24/7 at www.amca.org/certify
- Specifications should read that products are *certified* by AMCA International or licensed to bear the AMCA Certified Ratings Program Seal
  - Not just “tested in accordance with” an AMCA standard

FAN ENERGY INDEX

Setting the Benchmark

- Required by Energy Code
- Extremely high efficiency fans
- Design flexibility
- Easy to prove efficiency
- Provides better argument for early upfront cost for long term savings



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FEI and Modulating Systems

- FEI tilts selections towards more efficient motors and drives
- FEI encourage more efficient fan types
- FEI seems to push towards larger fan selection

Ultra Modulating Systems:

- Bathroom exhausts
- Dryer exhausts
- Kitchen exhausts
- Boiler and water heaters exhausts

ENERVEX MODULATING FANS & DRAFT CONTROL SYSTEMS

Variable Speed Fans and dampers

- Ultra high turndown EC MOTORS
- Certified for indoor and outdoor installation
- AMCA FEI Certified
- Extremely low noise level

Standarized pre-approved Controls

- Integrated safety system
- Multiple appliance interlock capability
- Fast reaction times
- Highly stable control signal, assuring accurate fan operation
- **All stock parts**

ENERVEX
VENTING DESIGN SOLUTIONS

Innovating Fan Design

The BEFx is a high performing, variable volume centrifugal exhaust box fan designed for indoor and outdoor installation.

Can be used for special exhaust or exhaust of lint-laden air or to supply make-up air and combustion air.

Suitable for bathroom, kitchen or clothes dryer exhaust in a multi-story apartment building.

Variable-volume AMCA FEI Certified centrifugal fan with a capacity of more than 6,000 CFM (up to 28,000 CFM).

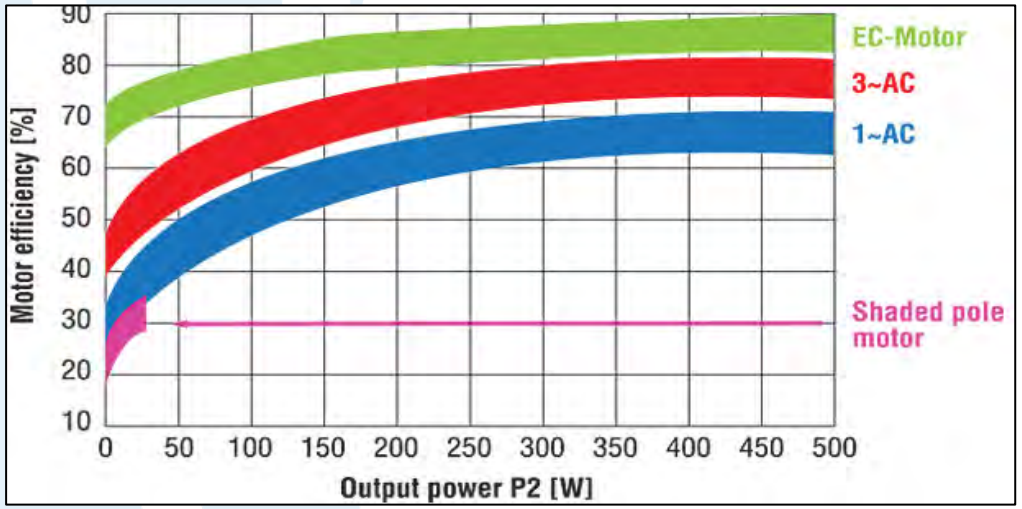
EC MOTORS

- EC motors are brushless DC motors with external electronics.
- The rotor contains permanent magnets, and the stator has a set of fixed windings.
- A circuit board continually switches the phases in the fixed windings to keep the motor turning. Because the speed of the motor is controlled by the commutation electronics, these motors are not limited to synchronous speeds.
- DC motors and EC motors have typically been reserved for smaller power output applications, filling such applications as small fans, pumps, servomotors and motion control systems.
- However, advances in electronics and materials are allowing larger output motors, up to the 15kW (20Hp) and higher.

INDUCTION VS EC

Pros & Cons

- **Efficiency**: The most common reason for choosing an EC motor over an AC motor. With an EC motor, the commutation is done by the electronics reducing the losses internal to the motor. See chart below.
- **Voltage Variation:** EC Motors are not completely dependent on voltage and frequency, small changes in voltage do not have an effect on motor output, and 50 or 60 Hz can be used without a performance difference. This means regardless of what voltage or frequency is coming out of the wall, or what country that wall is in, the motor will always perform the same.
- **VFD: On**e benefit of AC motor is that a VFD is not required to operate – this results in lower cost for the AC system – But since we currently speed control nearly all the fans with a VFD, this benefit is not realized.



Speed: Our EC motors can be run at any speed (much greater than the AC motors) as long as there is enough supply power (voltage)

Weight: EC motors have a signifigant size & weight advantage over equal power AC motors.

Cost: The motors currently cost less than the equivalent power AC motors from Baldor.

ENERVEX VENTING DESIGN SOLUTIONS

MOTOR CONTROLLER

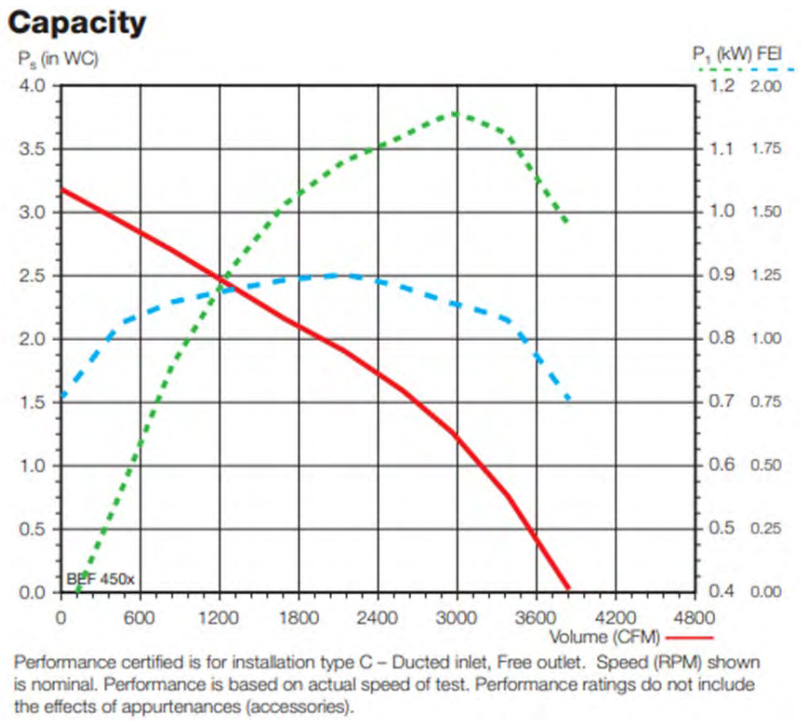
ENERVEX EDRIVE

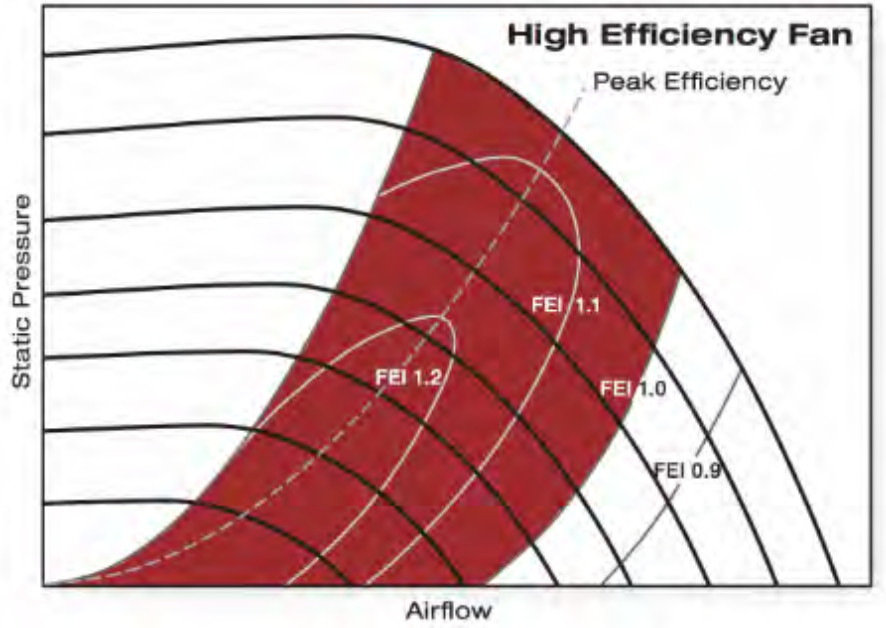
- UL Listed
- Internal Category C1 EMC input filter and brake chopper and have flying start capability
- Built-in keyboard and Bluetooth connectivity
- Programmable via PC with OptiTools Studio
- Able to communicate via Modbus RTU
- Rated for 150% overload for 60 secs and 175% for 2 secs
- Max. 300ft wire length between EDrive and Motor

FAN ENERGY INDEX

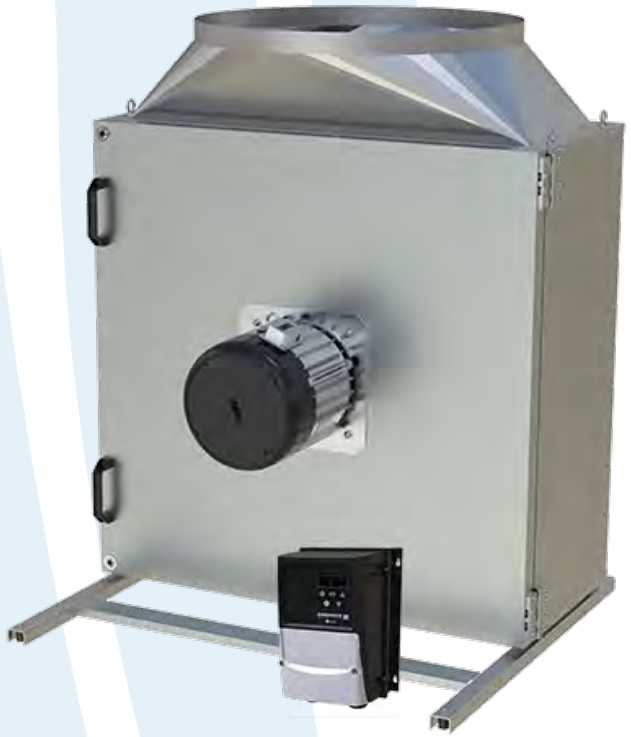
Setting the Benchmark

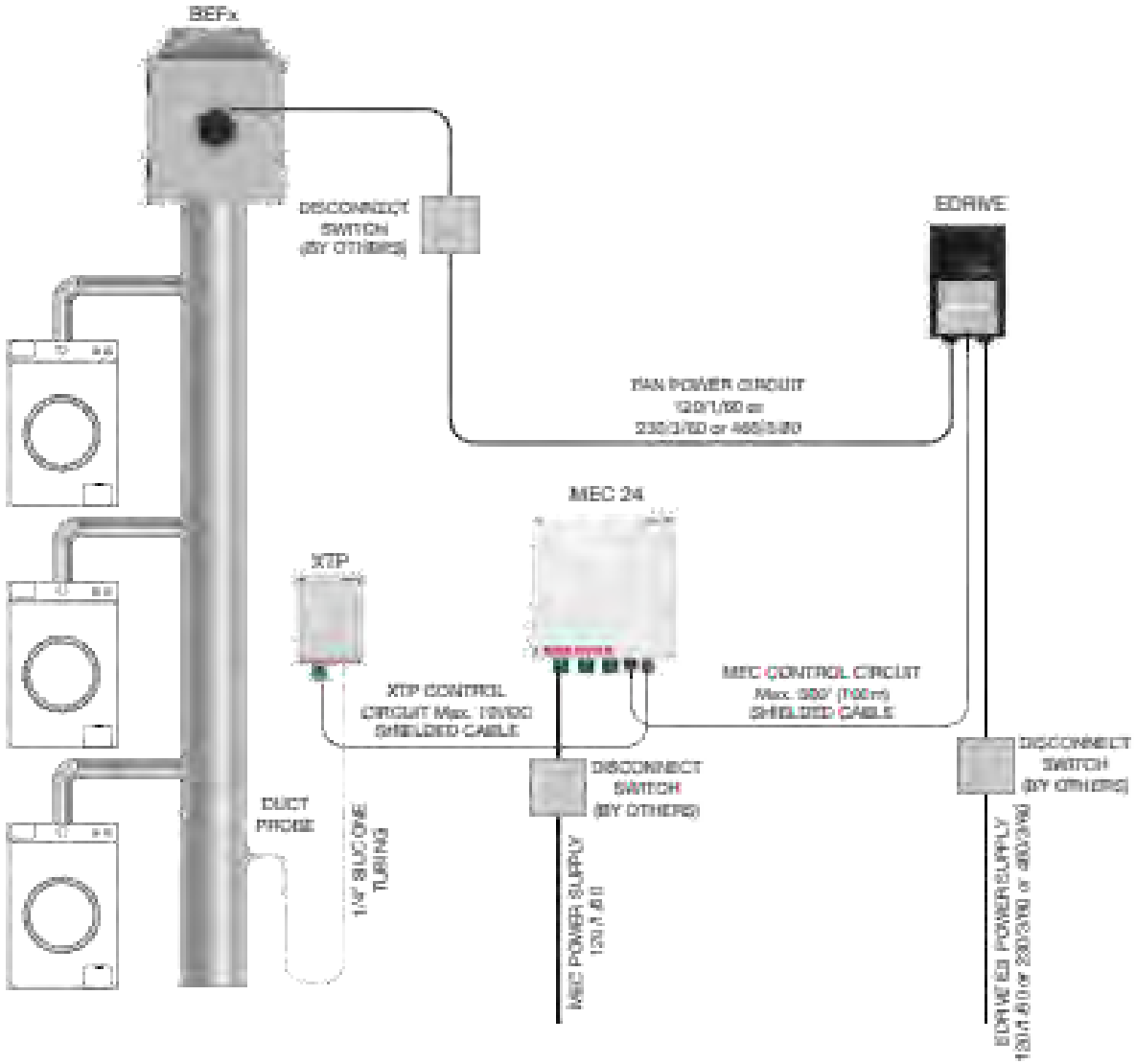
- BEF315x up to 1.50 FEI
- BEF355x up to 1.25 FEI
- BEF450x up to 1.25 FEI
- BEF500x up to 1.20 FEI
- BEF560x up to 1.20 FEI
- BEF630x up to 1.30 FEI
- BEF710x up to 1.30 FEI
- BEF800x up to 1.30 FEI





Complete System Efficiency





ENERVEX
VENTING DESIGN SOLUTIONS

ENERVEX®
VENTING DESIGN SOLUTIONS

Simple. Seamless. Smart

APPLICATIONS

Monday, December 2, 2024

TYPICAL EXHAUST SYSTEMS - DRYERS

Individually vented
or power-vented

Common Power Vented
Single speed fan

Common Power Vented
modulating speed fan

ENERVEX
VENTING DESIGN SOLUTIONS

TYPICAL EXHAUST SYSTEMS - BATHROOMS

Individually vented
or power-vented

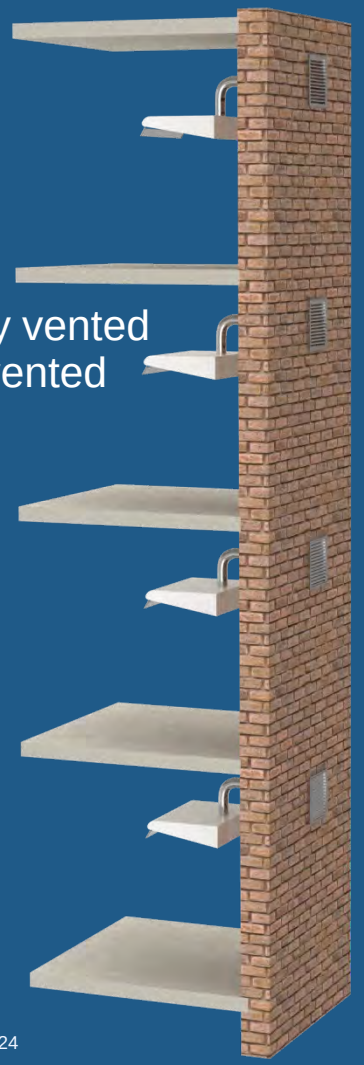
Common Power Vented
Single speed fan

Common Power Vented
Modulation speed fan

ENERVEX®
VENTING DESIGN SOLUTIONS

TYPICAL EXHAUST SYSTEMS - KITCHENS

Individually vented
or power-vented



Common Power Vented
Single speed fan

Common Power Vented
Single speed fan

ENERVEX
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TYPICAL EXHAUST SYSTEMS

Sidewall Exhaust

Pros

- Least amount of engineering required.
- No excess conditioned air is exhausted

Cons

- New dryers have a MAX equivalent length of 25’ from outside wall
- Over usage of electricity
- Over heating and cloth damage
- Unsightly outdoor louvers that clog with lint over time
- A higher fire hazard
- Smells and pressure issues

TYPICAL EXHAUST SYSTEMS

Common Exhaust via **Single Speed Fan**

Pros

- Relatively inexpensive
- Allows appliances to be located near an internal chase

Cons

- Least efficient
- Can cause noise issues for tenants closest to fan
- Requires a louver or relief damper at the bottom of the shaft
- Without relief damper (happens often) energy waste balloons
- No connectivity to BMS or alarm monitoring due to lack of controls

ENERVEX® VENTING DESIGN SOLUTIONS

COMMON MODULATING EXHAUST SYSTEMS

Dryers

(central Location)

Dryers

Bathroom

Kitchen

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TYPICAL EXHAUST SYSTEMS

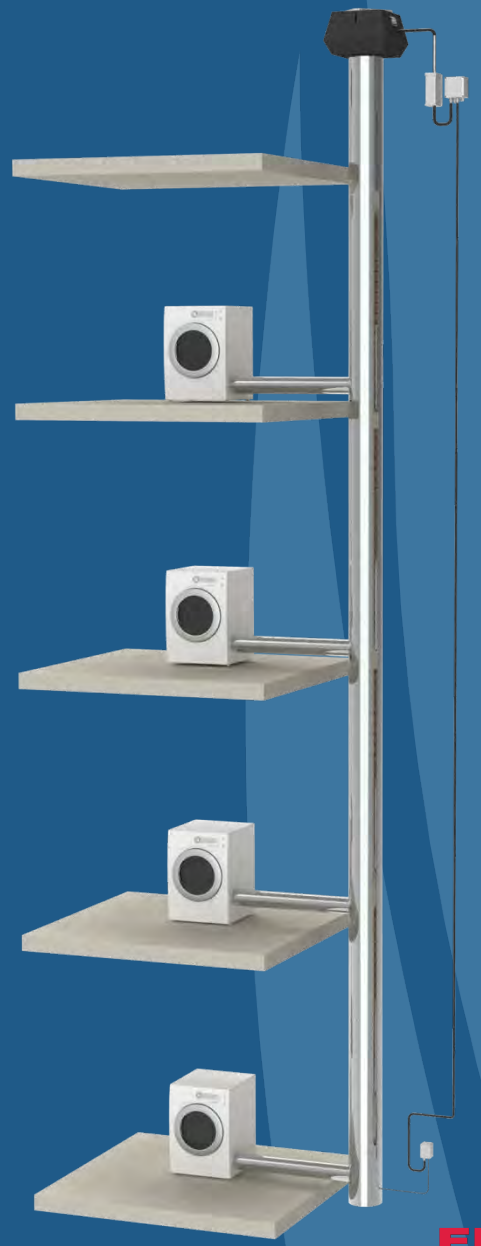
Common Exhaust via **Variable Speed Fan**

Pros

- Near the efficiency of the sidewall exhaust method
- Allows appliances to be located near an internal chase
- Can be connected to BMS and has integrated alarm function
- Extremely quiet – duct noise often overpowers fan noise

Cons

- Can be 10-20% more expensive than a single speed system
- Can be engineering heavy

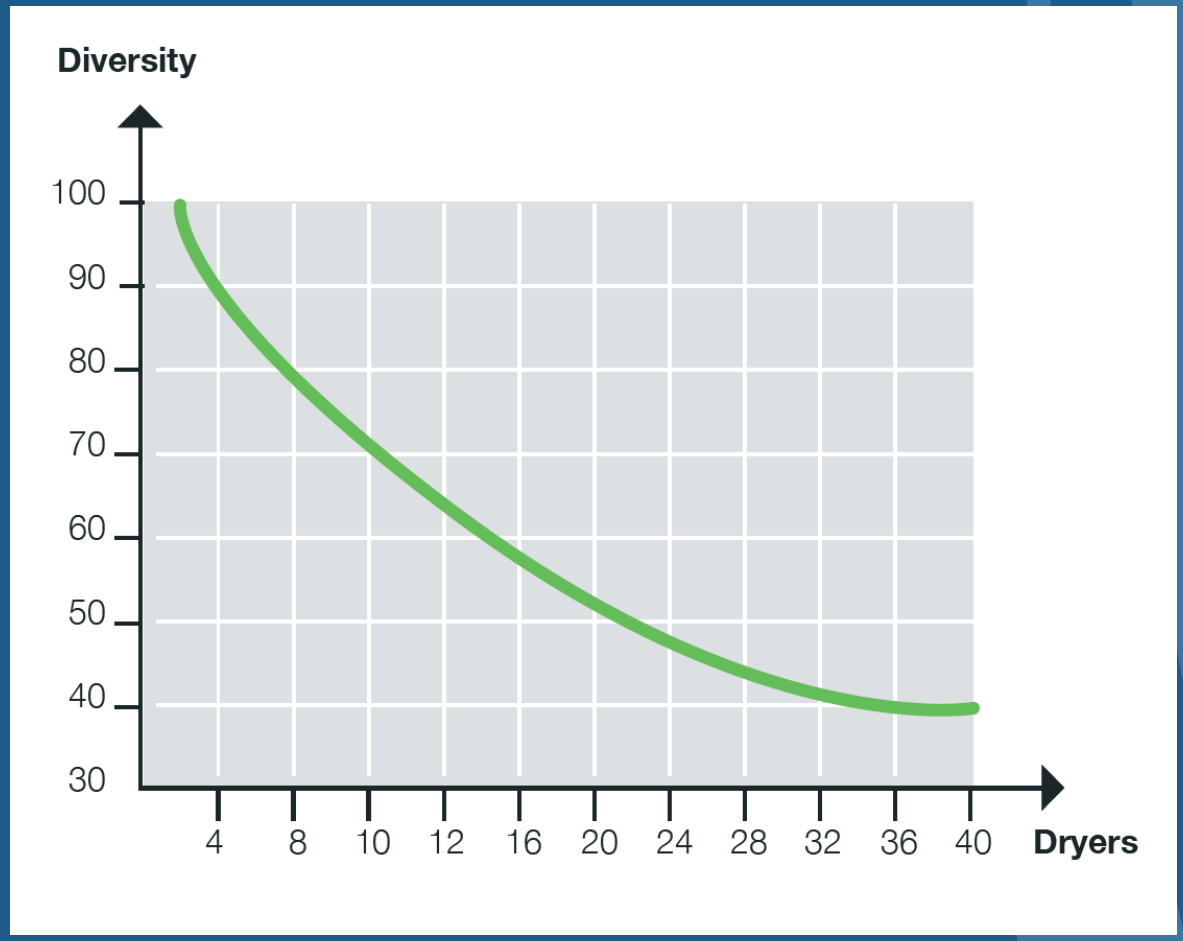


ENERVEX® VENTING DESIGN SOLUTIONS

OPERATING AND DESIGN CONSIDERATIONS

Diversity Factor

How many dryers are operating at a given time?



OPERATING AND DESIGN CONSIDERATIONS

Case Study

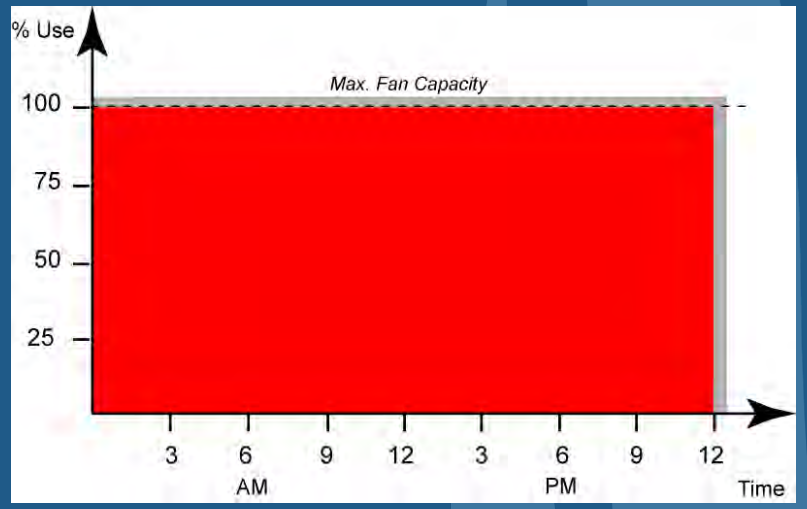
Test result from 2-year test by Enbridge Gas, Toronto, and NGTC, National Gas Technology Centre, Montreal

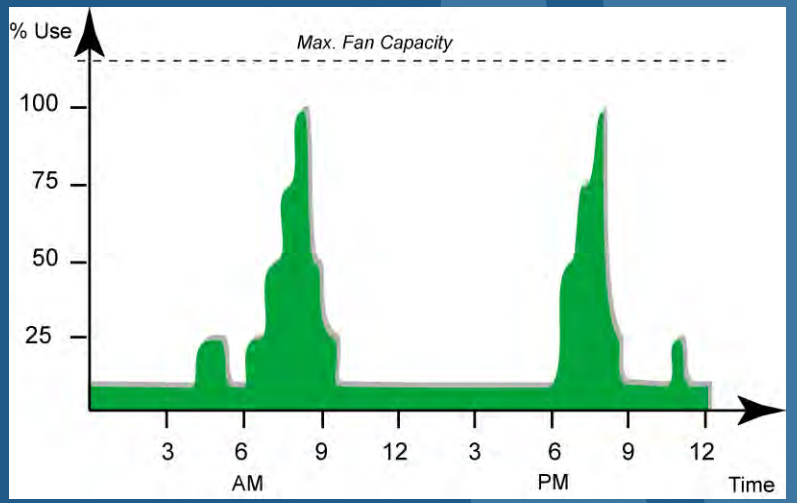
2 Year Study Performed by Third Party Testing Agency

ENERVEX supplied 8 systems

- 4 Modulating Fan Systems
- 4 Single Speed Fans Systems

Ran each system for an entire year collecting data. After first year, systems were switched and ran for an additional year collecting data.





ENERVEX VENTING DESIGN SOLUTIONS

OPERATING AND DESIGN CONSIDERATIONS

Case Study

Conditioned Air Savings (cu.ft./day)					
Laundry Utilization Profile			Conditioned Air Loss to the Outside (cu.ft./day/dryer		
% Dryers in Operation	Laundry Profile (%/day)	Laundry Profile (min/day)	MDVS	Fixed Speed	Savings
100	1.5	22	1,318	1,422	104
75	3.9	56	2,550	4,356	1,806
50	8.6	124	3,739	10,793	7,054
25	16.7	240	5,308	21,656	16,348
0	69.3	998	7,062	105,830	98,768
TOTAL	100	1,440	19,977	144,057	124,080

1 Therm = 100 cuft of gas			Cost per unit $	Savings when using variable speed	Savings per dryer
Lost Heating:	m3 gas/year	3,795		0	0
	cuft/year	134,020	0.0177	2,372	593
Lost Cooling:	kWh/year	2,957	0.245	725	181
TOTAL SAVINGS - $				3,097	774

Savings per bathroom
387

Bathroom exhaust savings should equal 50% of dryer savings.
Each bathroom fan exhausts 100 cfm compared to a dryer's 200 cfm.

OPERATING AND DESIGN CONSIDERATIONS

Case Study

Reduced CO2 Emissions per Dryer	Lbs/Year
Heating	1,641
Cooling	224
Fan Power	985
Total	2,851

OPERATING AND DESIGN CONSIDERATIONS

Case Study - Park Potomac

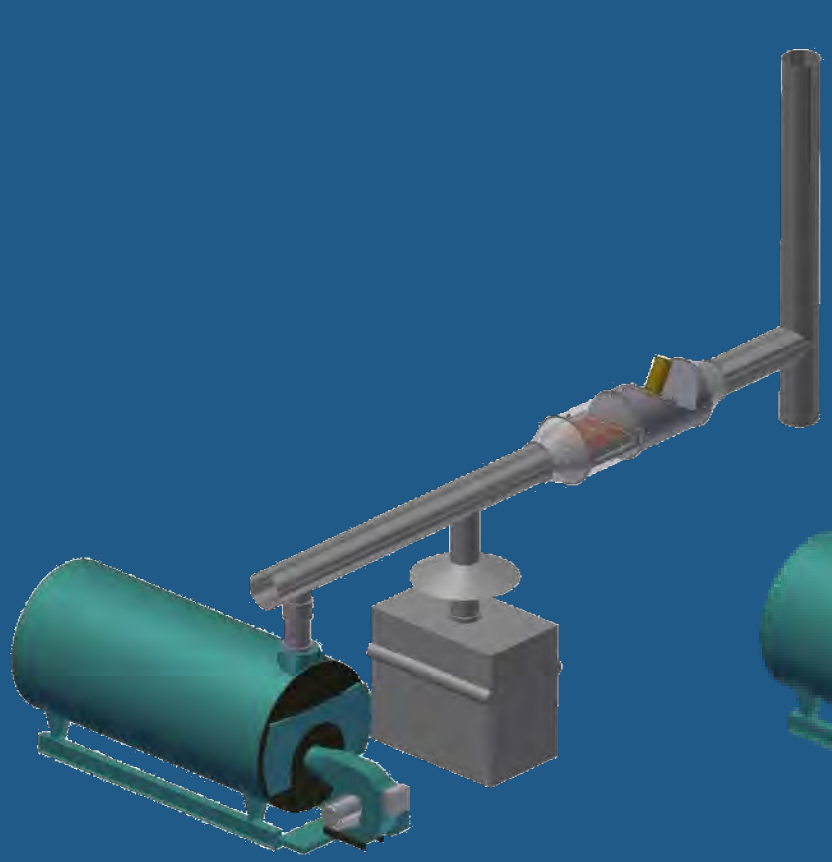
Project:

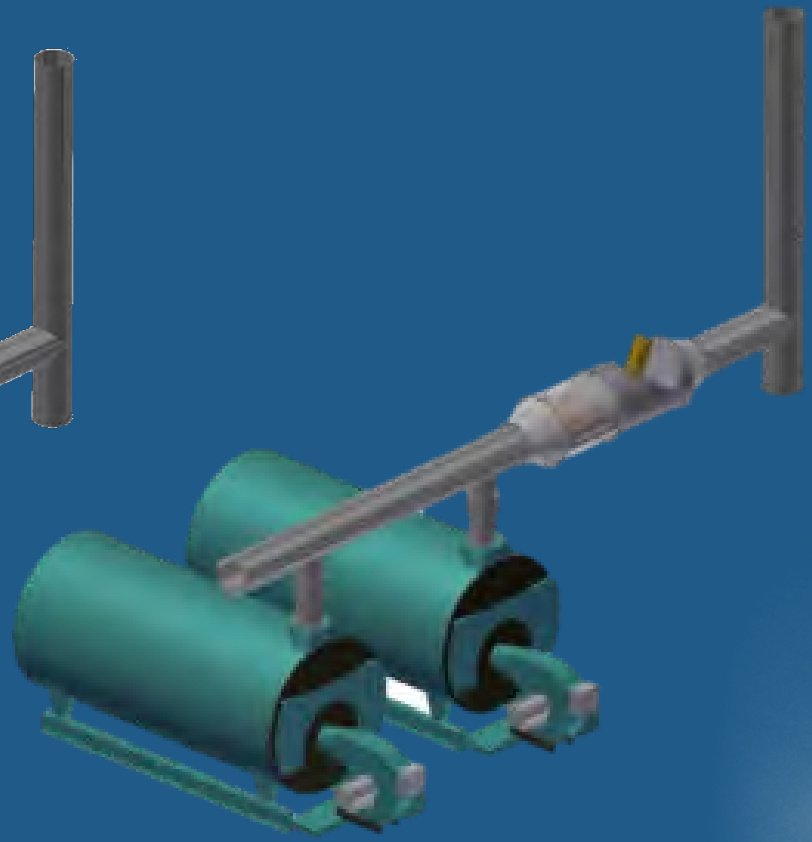
- 14 single-speed fans at full capacity exhausting 87 kitchen hoods in 14 shafts
- Noise and vibration complaints

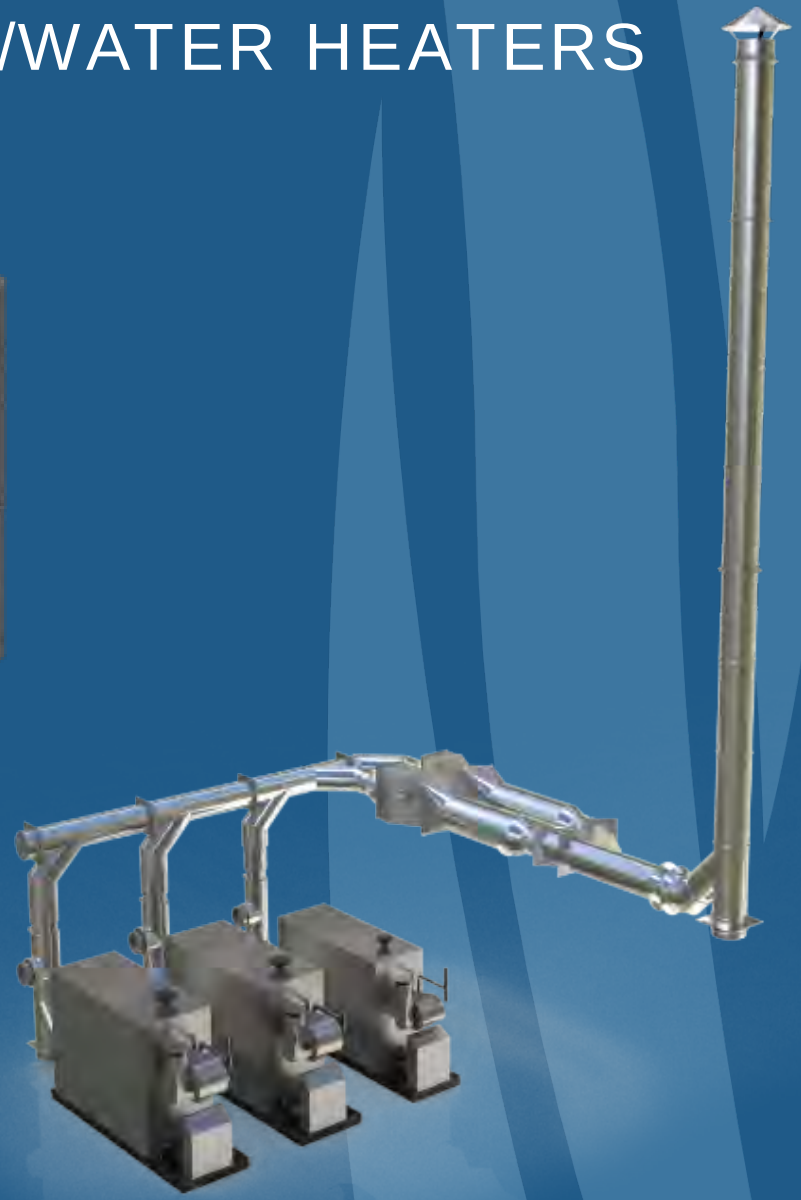
Solution

- 14 MBES Demand Controlled Exhaust System to replace existing fans
  - Annual savings of $77,000 from reduced exhaust rates and minimized loss of conditioned air.
  - Total upgrade cost $60,000 (installed)
  - Payback: 8 months, 5-Yr ROI: 632%

TYPICAL EXHAUST SYSTEMS – BOILERS/WATER HEATERS







ENERVEX® VENTING DESIGN SOLUTIONS

Boiler Exhaust Solutions

90% of alarms are related to evacuation/ventilation problems:

- Air switch not proven
- Ignition failure
- flame failure
- Flame lost early in run
- blocked flue

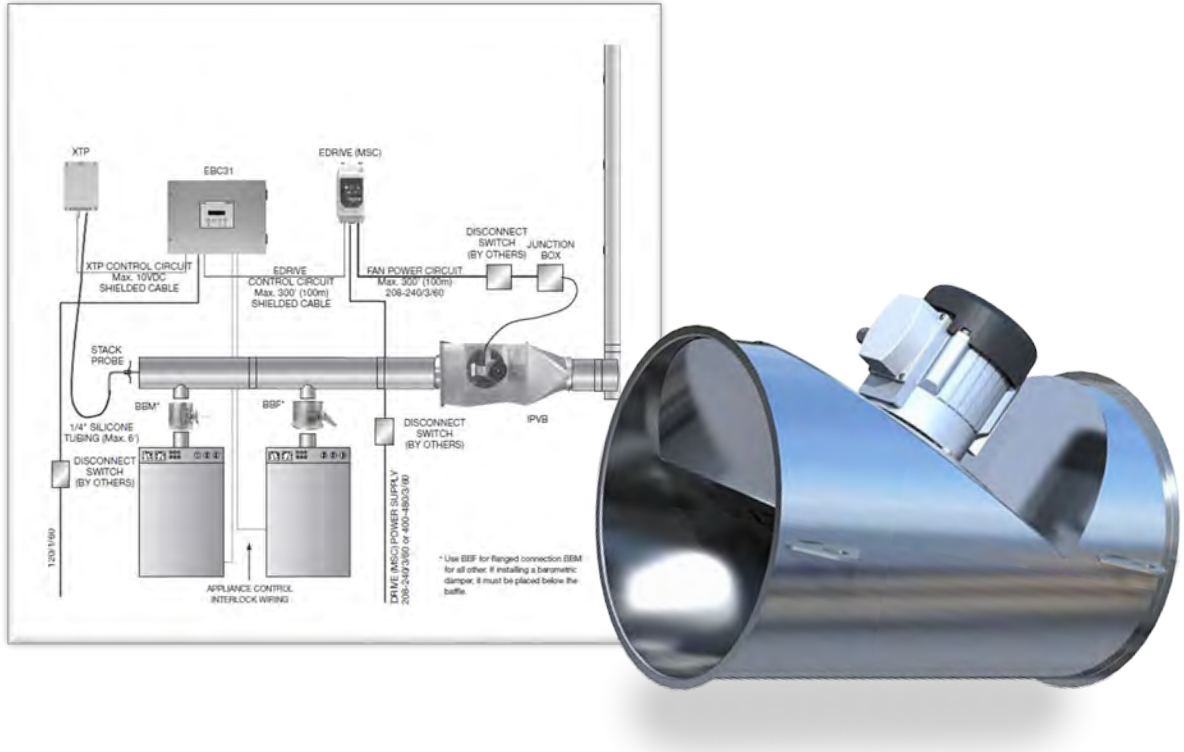
Boiler alarm issues

Location related issue: Wind

The Allenway - 360 Ridelle Ave - Toronto

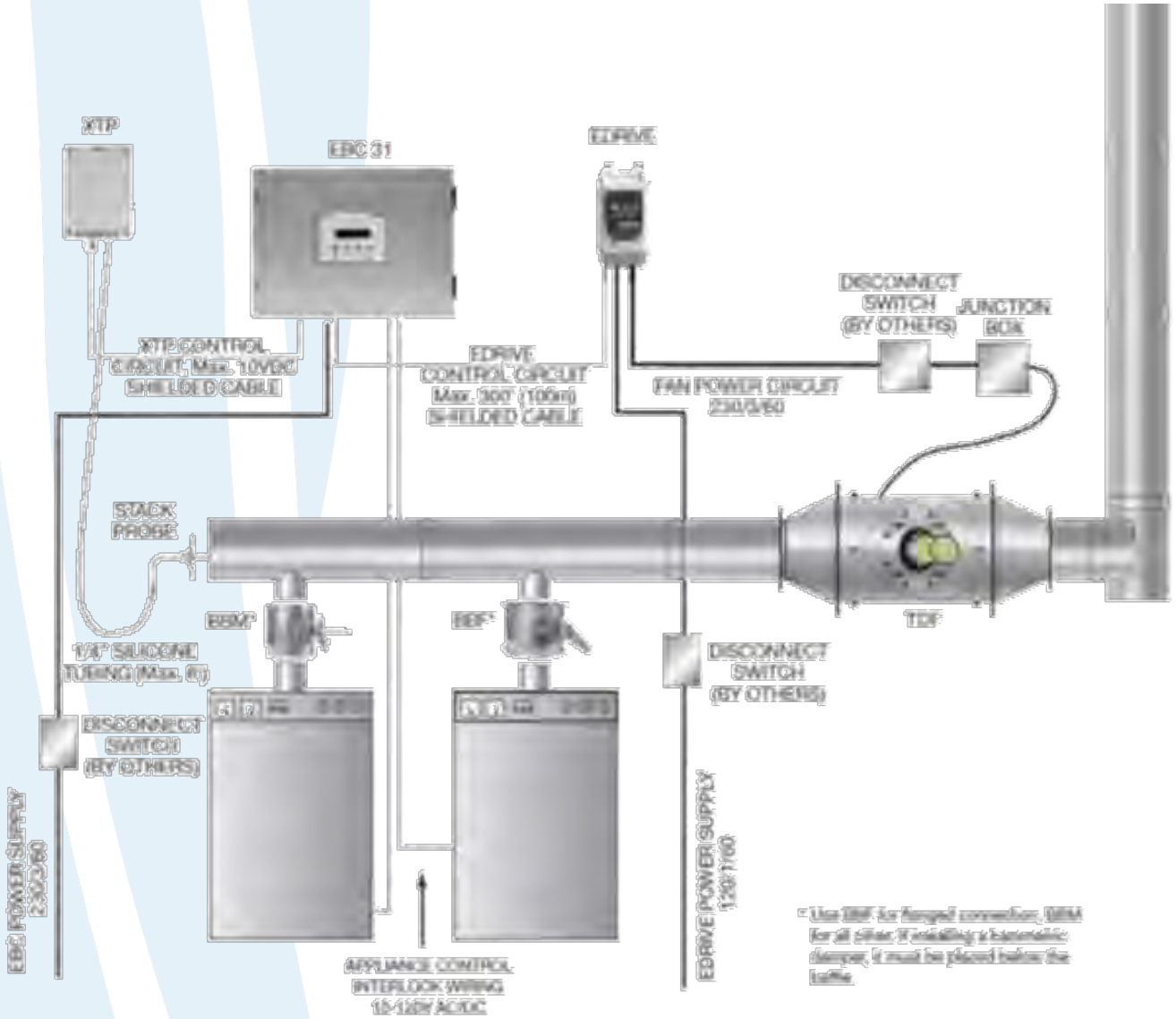
Initial Solution:

Enervex Fan Exhaust System



ENERVEX® VENTING DESIGN SOLUTIONS

Chimney Automation System Inline (CASI)



TDF

- 0-29,000 CFM (450-49,300 m3/h)
- ½" flanges or bolt-flanges
- Stainless Steel 316L Housing and Backward-curved Impeller
- EC-Motor, TEFC, Class H w/ insulated rotor/shaft system and stainless-steel shaft
- 1400°F (760°C) / 1800° (980°C) intermittent Temp Rating
- 2-Year Factory Warranty, 10-Year Warranty Against Corrosion Perforation
- UL 378, UL 705, CSA3-B255-M81, CSA C22.2 No. 113-12 Listings

ENERVEX® VENTING DESIGN SOLUTIONS

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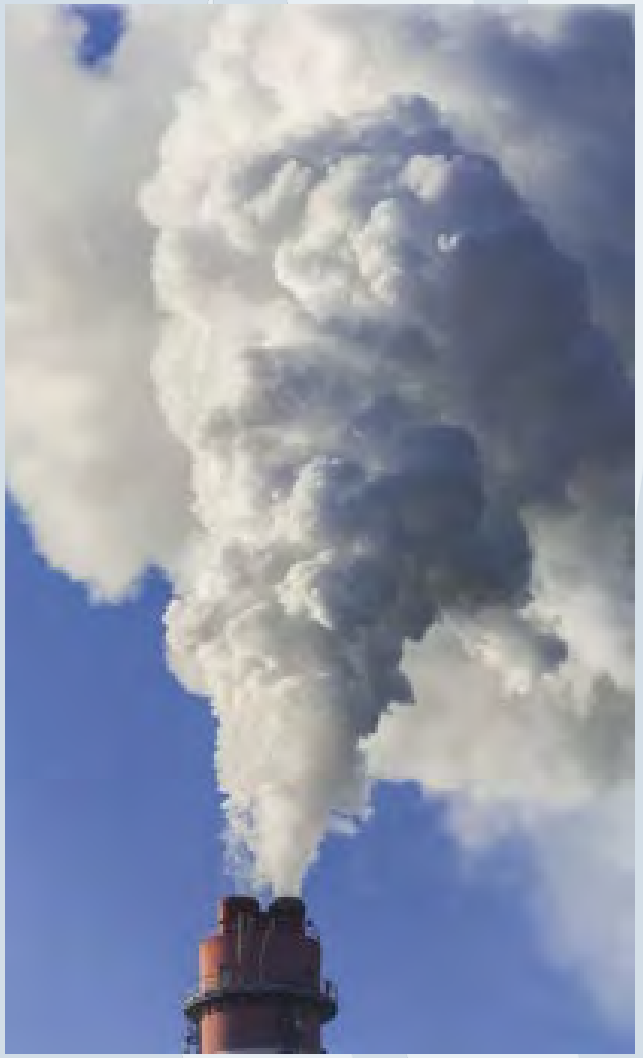
Simple. Seamless. Smart

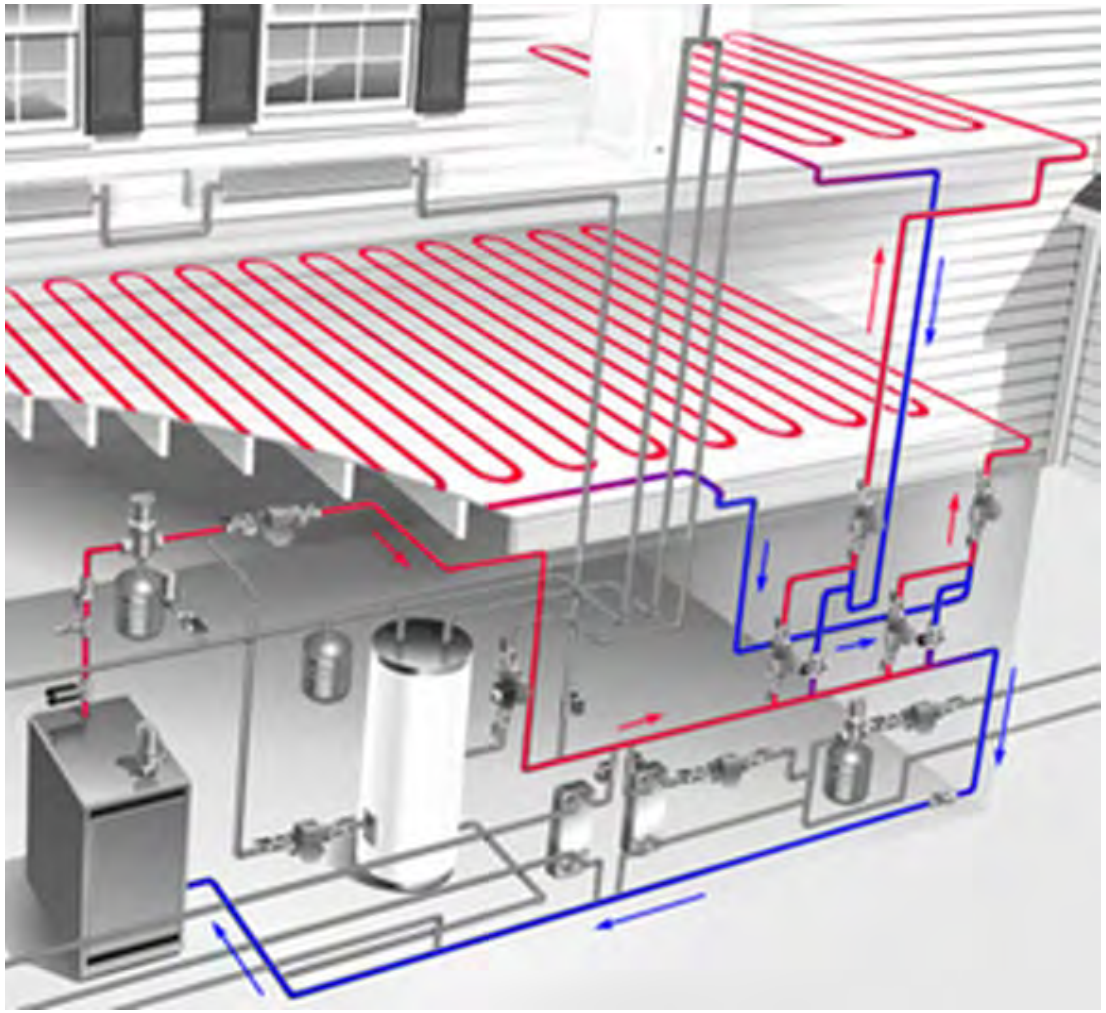
Part II: The Last Step: Flue Gas Thermo-Cooling



REFRESH : HYDRONIC HEATING SYSTEMS

- As steam systems are very inefficient, we went to hydronic system.
- We use ‘’industry standard’’ water loop temperatures of 180°F supply/160°F return <u>even if we only need to maintain 70°F room temp.</u>

Why?



HYDRONIC BOILER/WATER HEATER EVOLUTION

OLD TECHNOLOGY 80% MAX EFFICIENCY

HIGH EFFICIENCY
MAX 87%

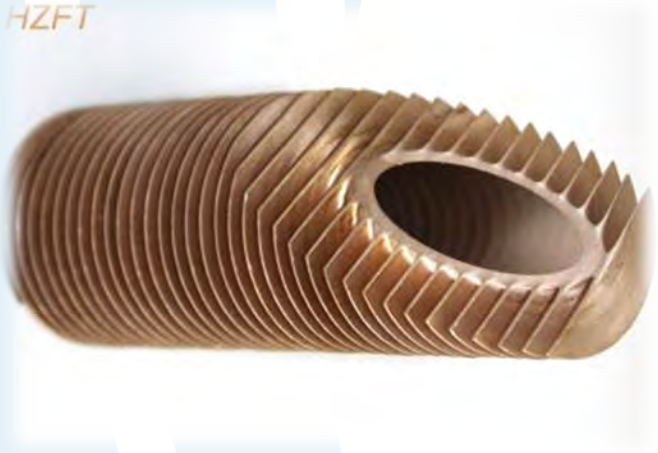
ENERVEX VENTING DESIGN SOLUTIONS

Boiler evolution

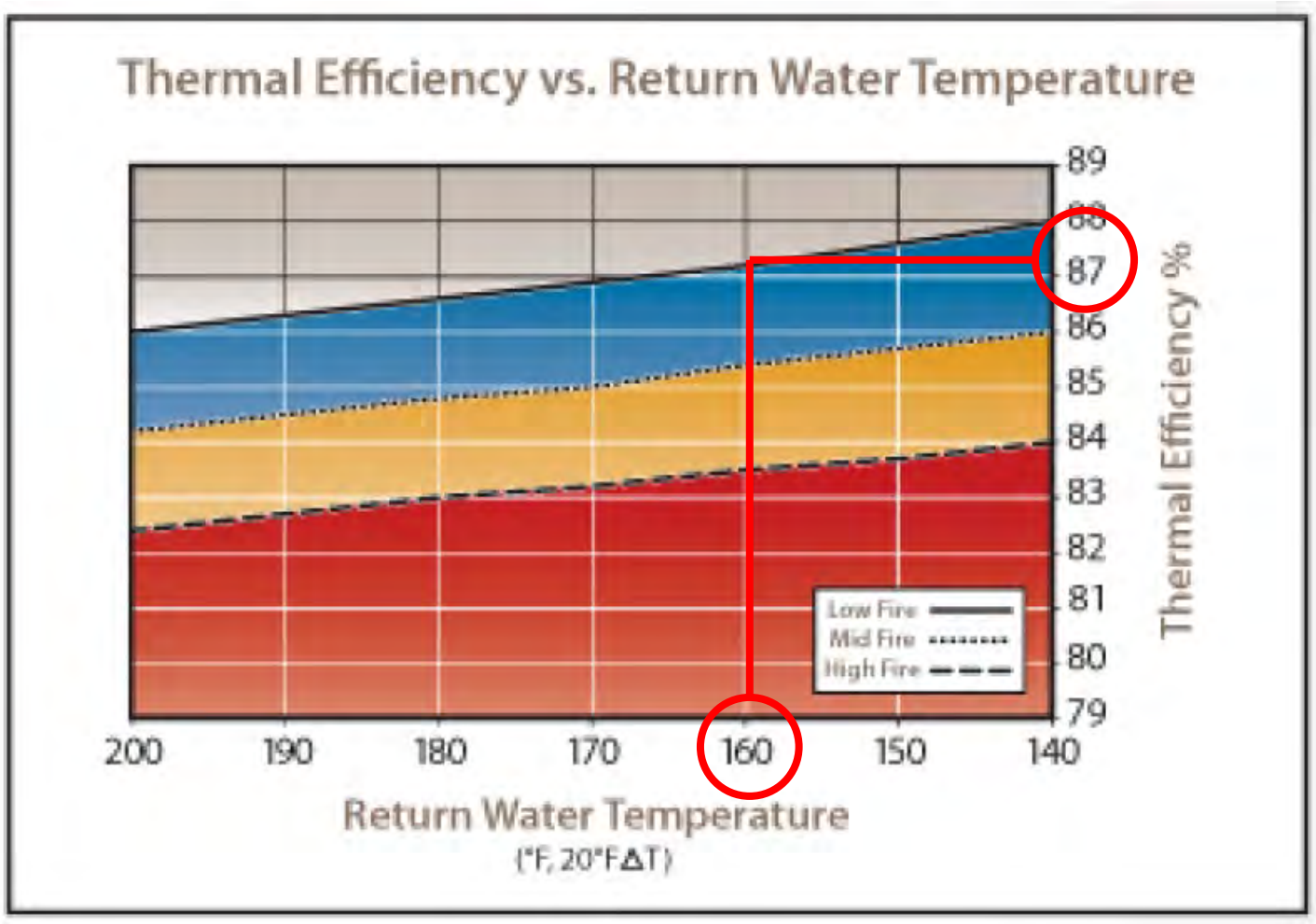
How we made the boilers more efficient

There where 2 easy ways that we could do this:

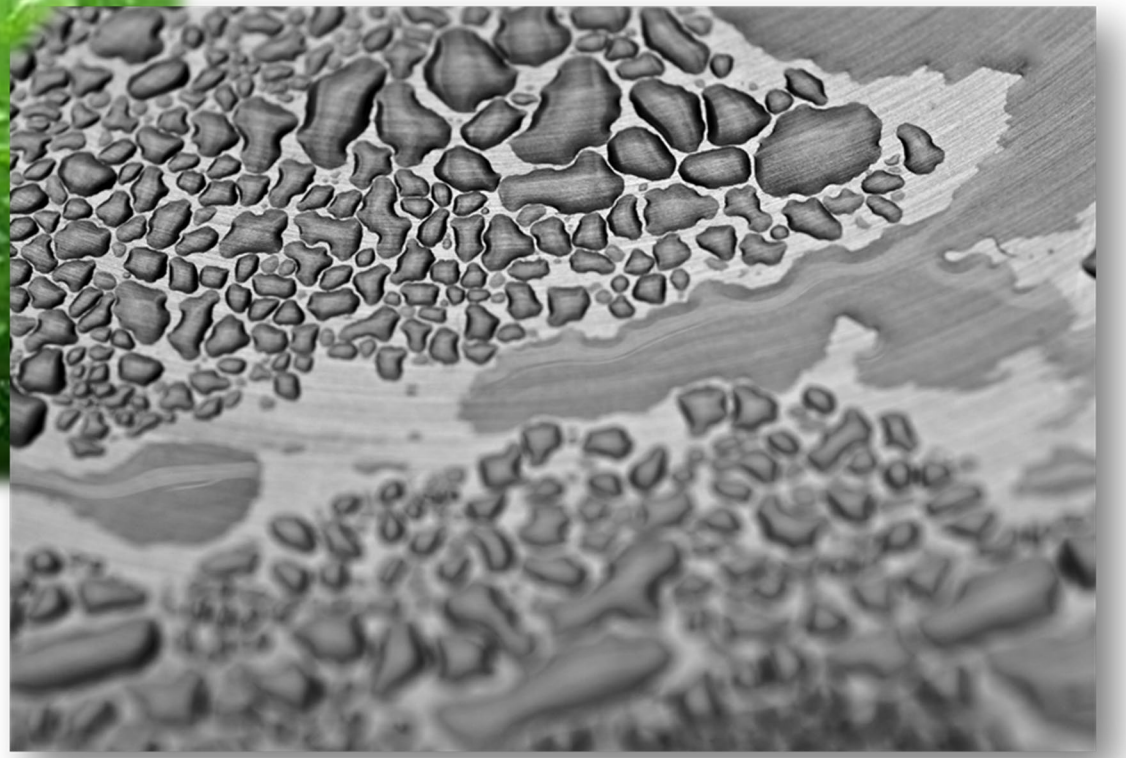
1. Add heat transfer surface
2. Use a material with better heat transfer



Limits of high efficiency boilers



Condensing Boiler 101



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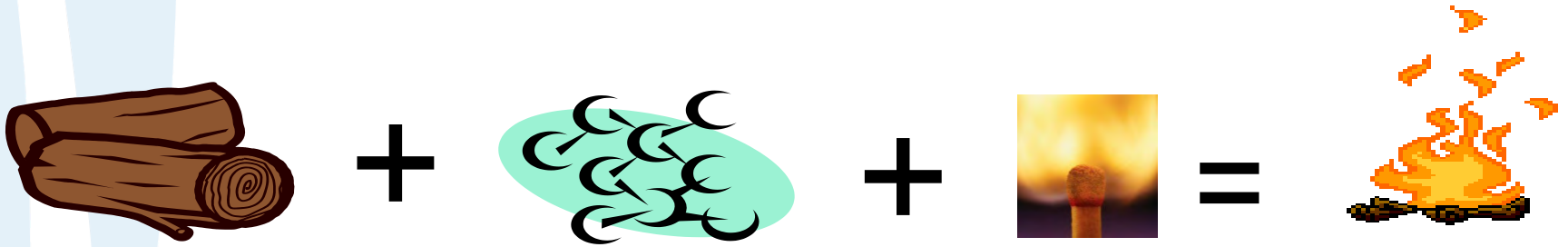
VENTING DESIGN SOLUTIONS

What is combustion



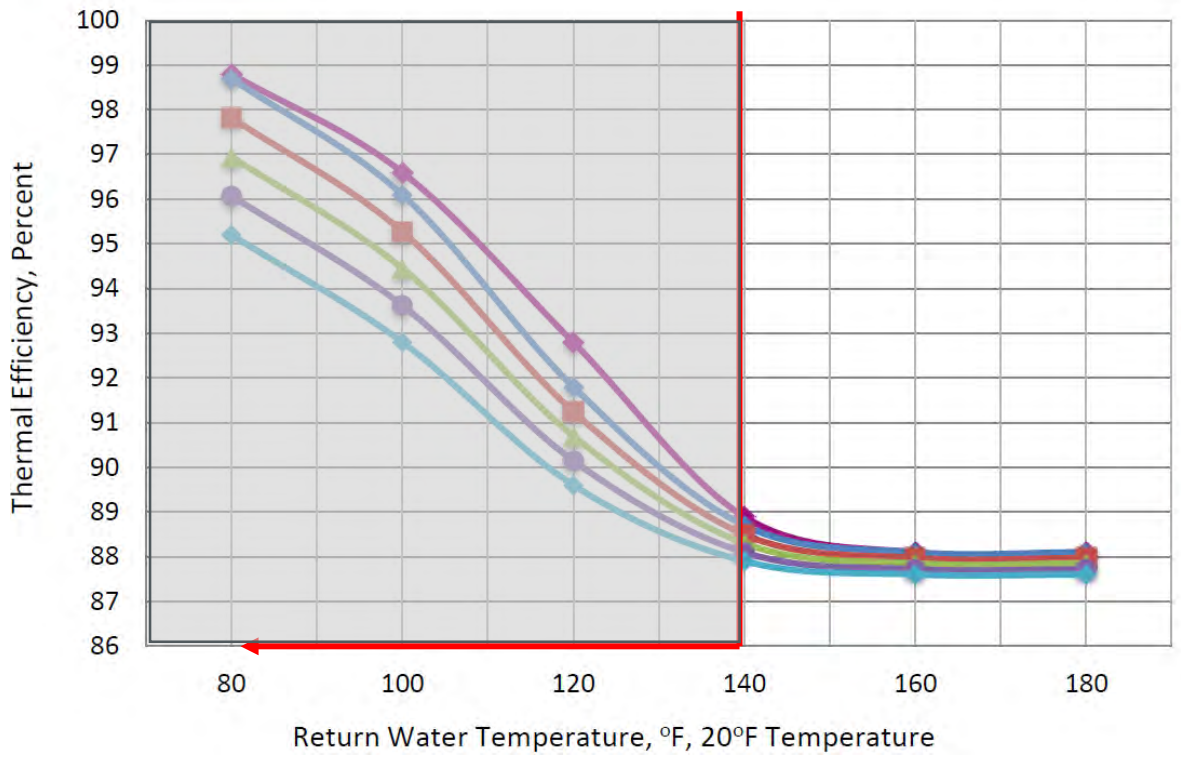
COMBUSTIBLE + AIR + ENERGY = HEAT+ WATER + OTHERS

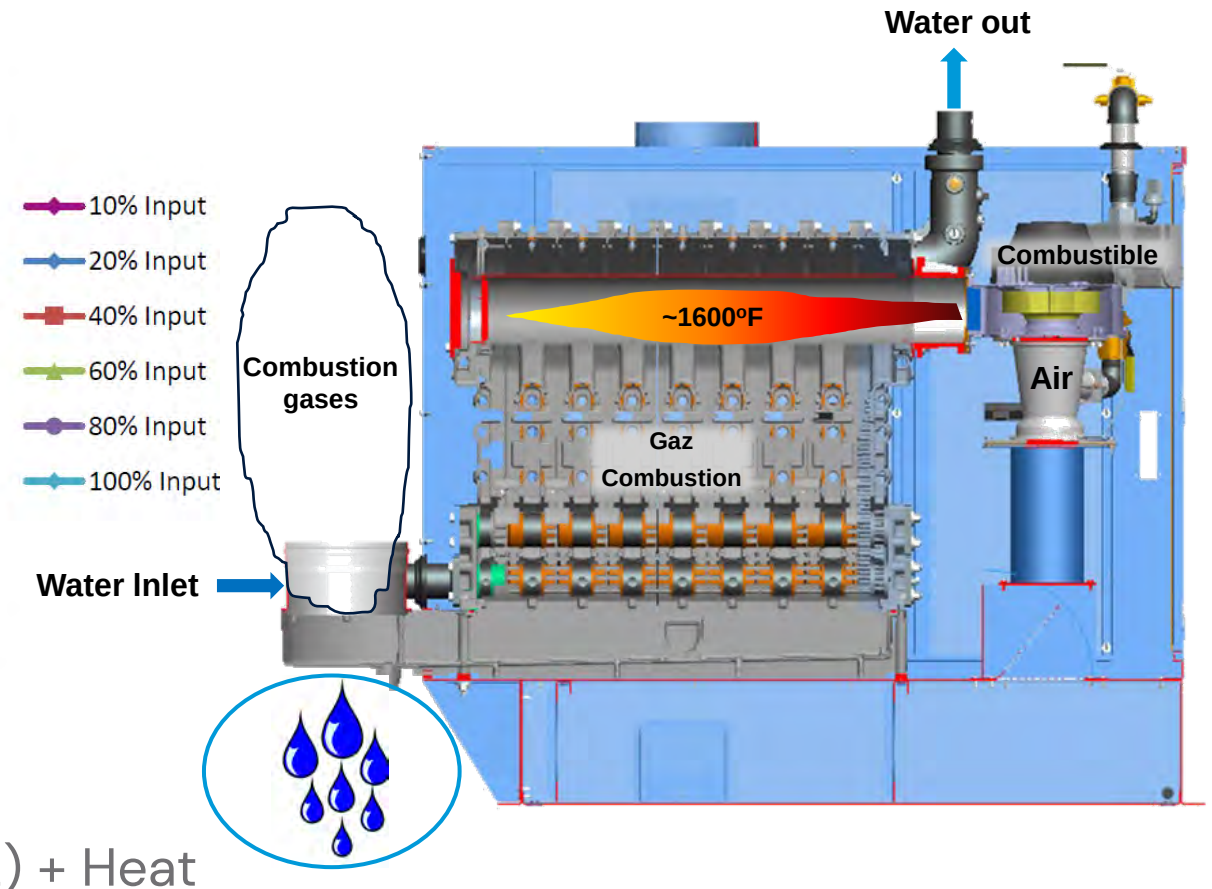
CH_4 (NATURAL GAS) + (O_2 + N_2) = HEAT + H_2O + CO_2 + N_2 + O_2

What is condensation

- The phenomenon of changing phase from a gas to a liquid of any mather
- In order to condense a gas in the air, we need to reach a relative humidity level of 100%
- Typical Natural gas flue gases have a RH level of 10-12% at 400°F
- Natural gas flue gases reach 100%RH around 138°F
- By lowering the flue gases below 138°F we can transform some of the water vapor to it's liquid form on the boiler metal surface.
- We can therefore recover 1,000 btu/hr per pound of water we create
- In respecting physics laws, we can actually get 100 % efficiency

Condensing boilers: You got to get lower...





$$CH_4 + 2(O_2 + 3.76N_2) \Rightarrow CO_2 + 2H_2O + 2(3.76N_2) + \text{Heat}$$

Lower flue temp below due point

- Latent Energy (970 BTU/1 lb)

HYDRONIC BOILER/WATER HEATER EVOLUTION

HIGH EFFICIENCY
MAX 87%

CONDENSING
MAX 100%

ENERVEX VENTING DESIGN SOLUTIONS

REFRESH ON HOW WE GOT TO DO HYDRONIC HEATING

Why did we use ‘’industry standard’’ loop temperatures of 180°F supply/160°F return even if we only need to maintain 70°F room temp?

To protect the boilers (140°F + 20°F = 160°F)

So what did we do in order to maximize the condensing boilers efficiency?

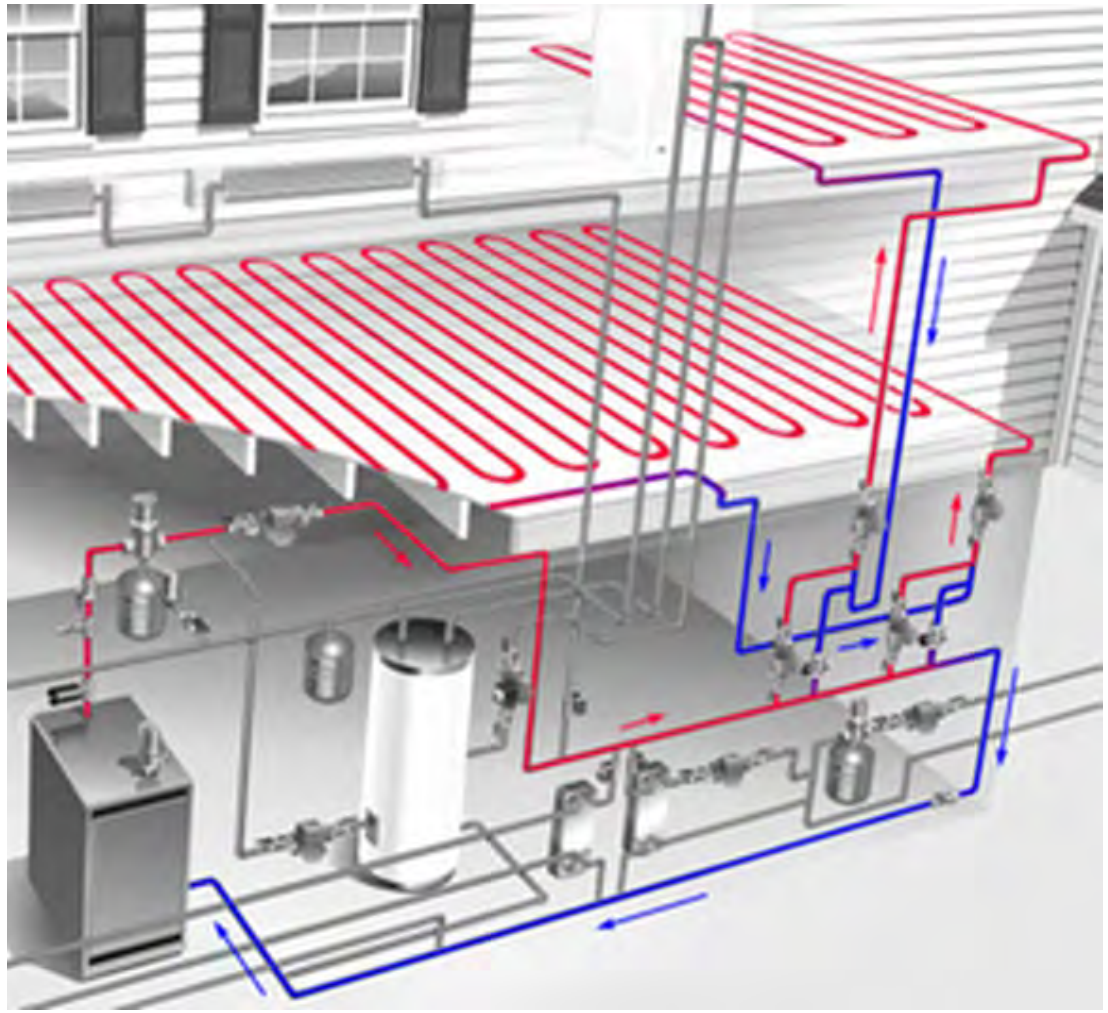
> We designed with new radiators, terminal units, fan coils, low temp hydronic radiant floors & snow melt, etc. that can take lower temperature water.

And how about the existing buildings?

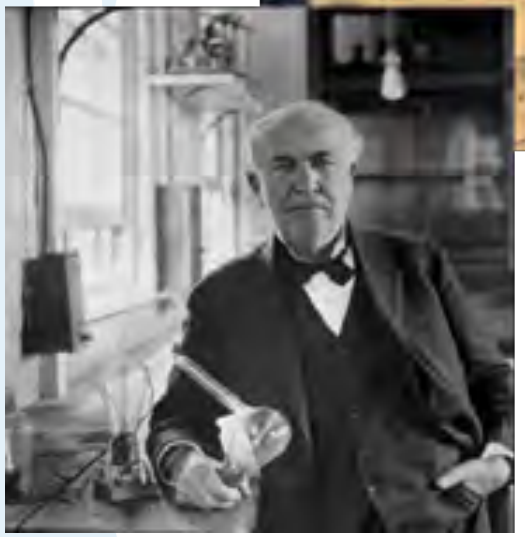
Limitation of hydronic systems

Heat sinks limit the efficiency of the boilers:

- Heat air at around 70°F
- Heat potable water up to 140°F
- Snow melt (sometimes)



EVOLUTION



What is the flue gases thermocooling concept

- Use chimneys as a ‘’free energy source’’ in the same way as a geothermal well.
- Quench all the energy to the point of having exhaust gases at or below ambient temperatures.
- Bring our heating systems over 100% efficiency
- Reduce to the bare minimum the carbon footprint

ENERVEX®
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Simple. Seamless. Smart

APPLICATIONS

Monday, December 2, 2024

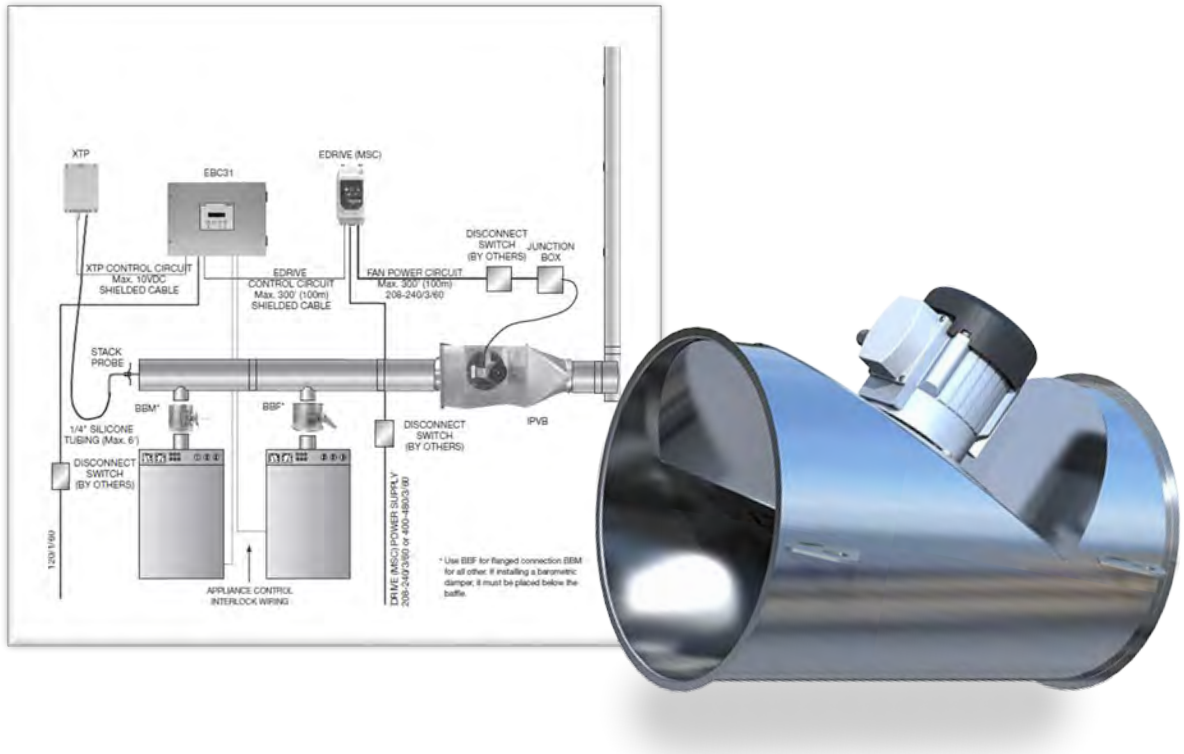
Boiler alarm issues

Location related issue: Wind

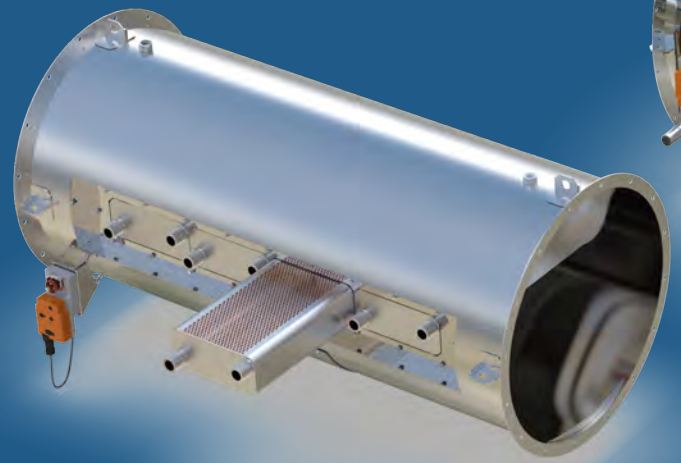
The Allenway - 360 Ridelle Ave - Toronto

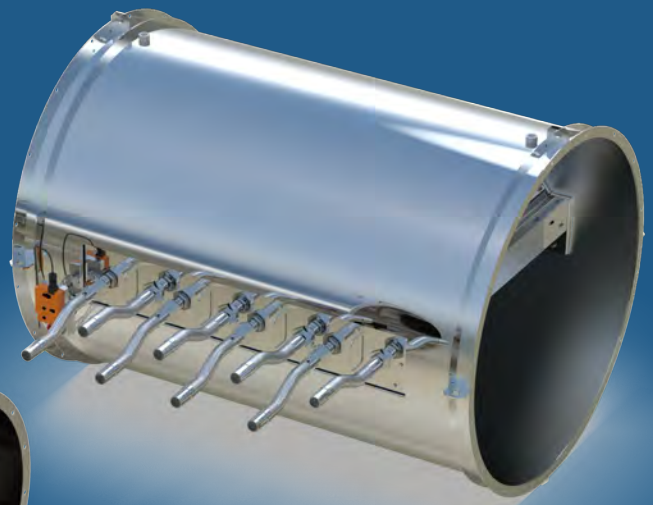
Initial Solution:

Enervex Fan Exhaust System



ENERVEX VHX UNIT





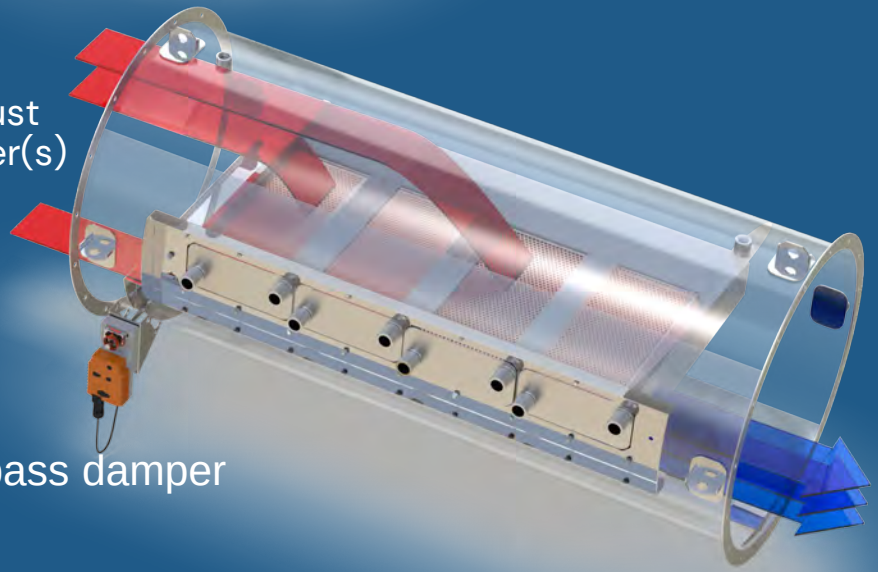
Indirect with condensing capabilities on gas and propane

Sized from 500 MBH and up

100% SS316L

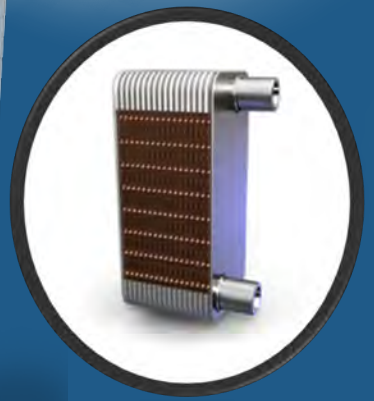
Integrated bypass control damper

Hot exhaust from boiler(s)



Hot exhaust from boiler (50%)

Cooled exhaust from boiler (s)



By-pass damper

ENERVEX
VENTING DESIGN SOLUTIONS

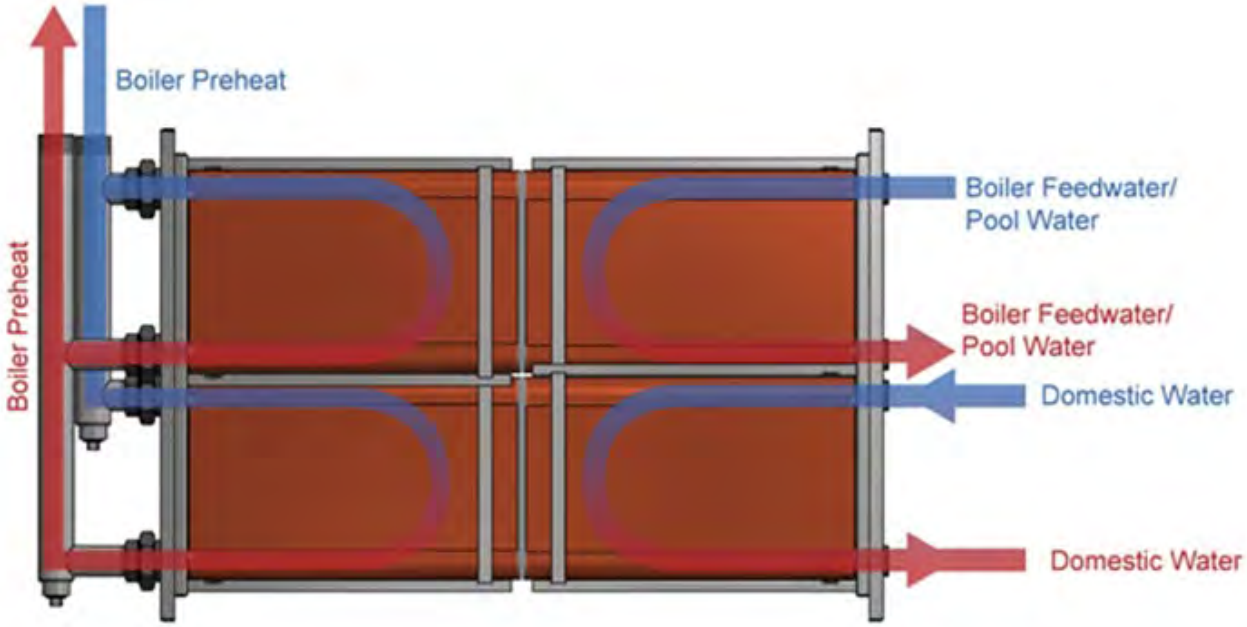
Multires Decarbonisation solution

Flue Gas Thermo Cooling Introduced

The Allenway - 360 Ridelle Ave - Toronto

Solution:

VHX Exhaust Heat Recovery System



HYDRONIC BOILER RETROFIT

- 2 hot water ‘’water tube boilers’’
- 12,000,000 btu/HR INPUT each
- Average load is 30% of max.
- 100% redundancy
- Fairly new micro modulating burners
- 180°F supply heating loop

Initial project is to replace with new condensing boilers.

HYDRONIC BOILER RETROFIT

Initial project is to replace with 4 new 4mmbtu/hr condensing boilers and install an indoor/outdoor schedule for 850,000$.

Loop return
160°F

350°F

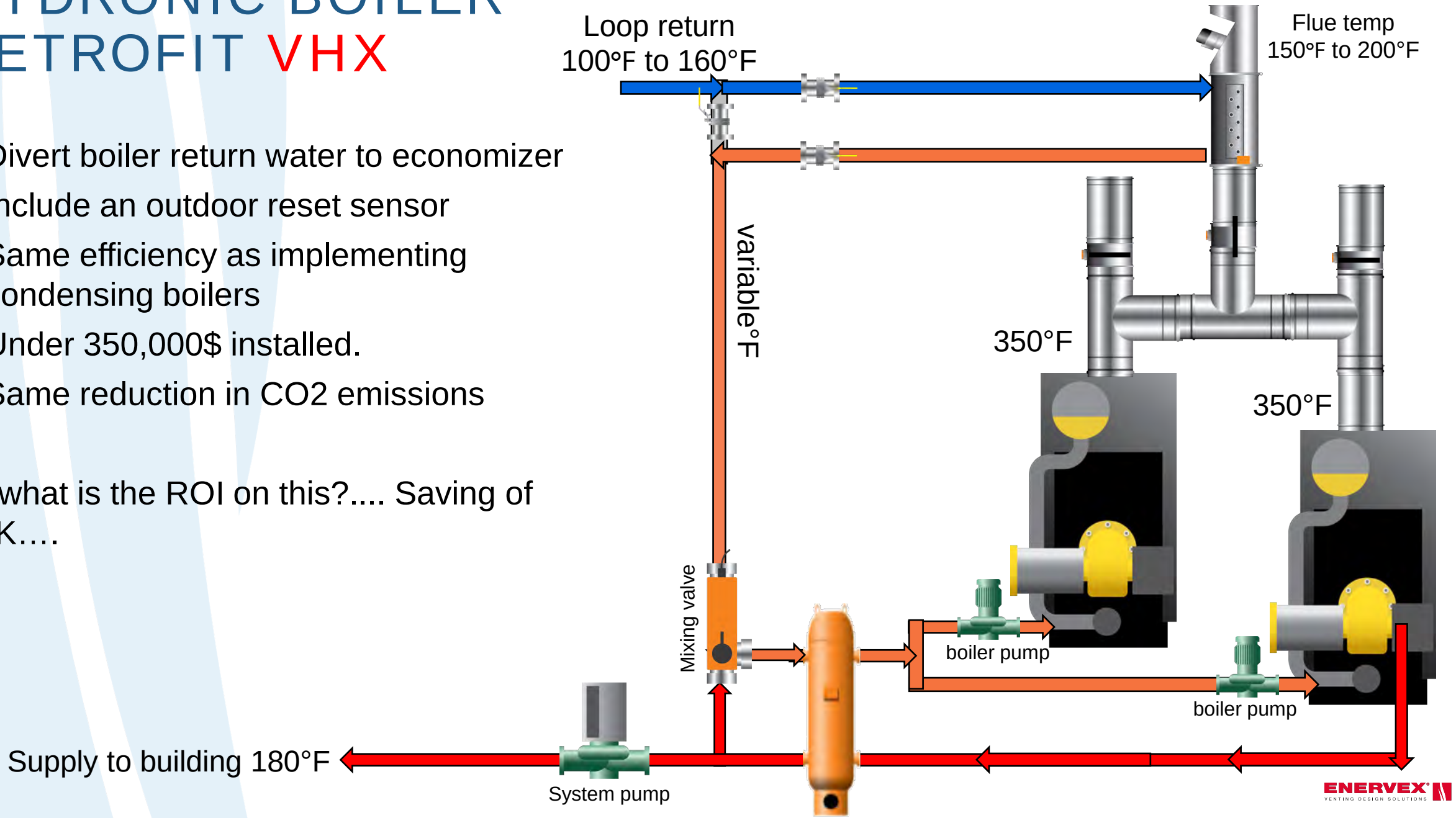
350°F

Supply to building 180°F

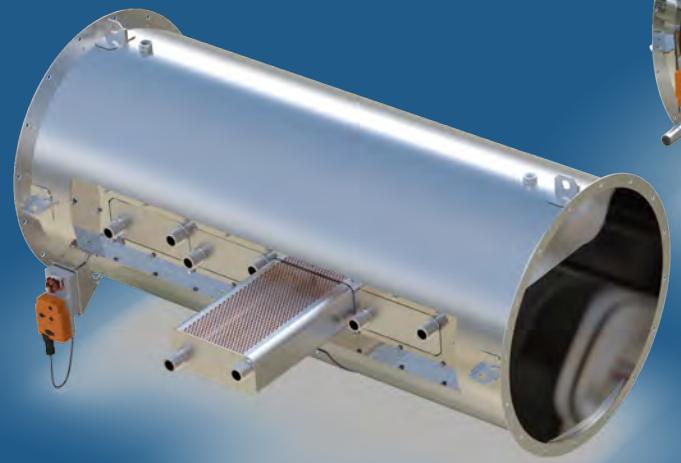
HYDRONIC BOILER RETROFIT VHX

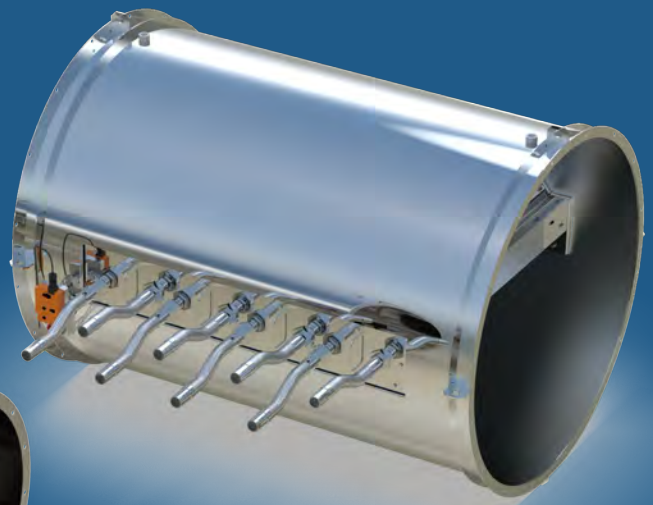
- Divert boiler return water to economizer
- Include an outdoor reset sensor
- Same efficiency as implementing condensing boilers
- Under 350,000$ installed.
- Same reduction in CO2 emissions

So, what is the ROI on this?.... Saving of 500K….



ENERVEX VHX UNIT





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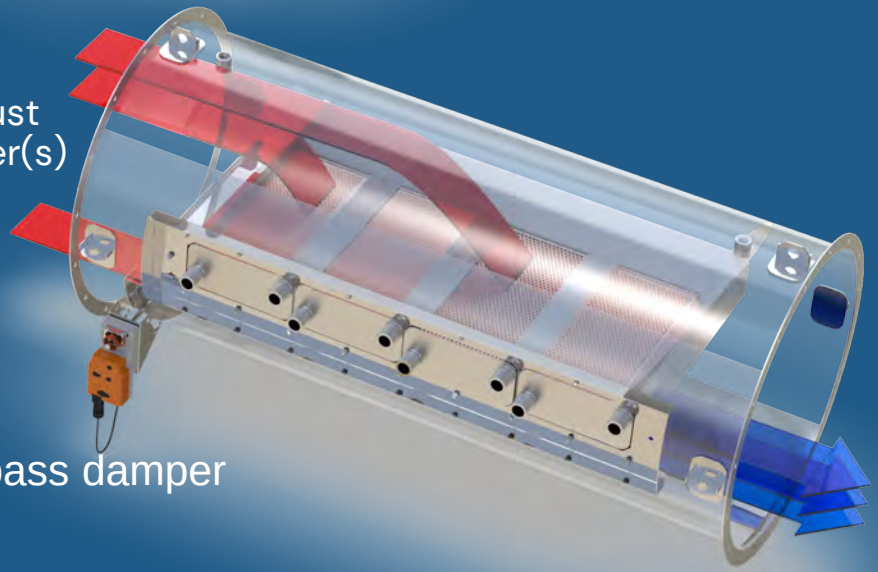

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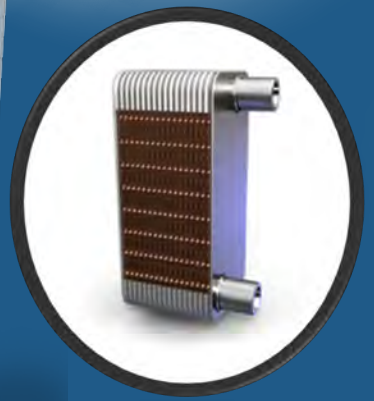


By-pass damper

ENERVEX
VENTING DESIGN SOLUTIONS

ENERVEX TIME PROVEN MODULATING FANS & DRAFT CONTROL SYSTEMS

Variable Speed Fans and dampers

- Ultra high turndown EC MOTORS
- Certified for indoor and outdoor installation
- AMCA FEI Certified
- Extremely low noise level

Standarized pre-approved Controls

- Integrated safety system
- Multiple appliance interlock capability
- Fast reaction times
- Highly stable control signal, assuring accurate fan operation
- **All stock parts**

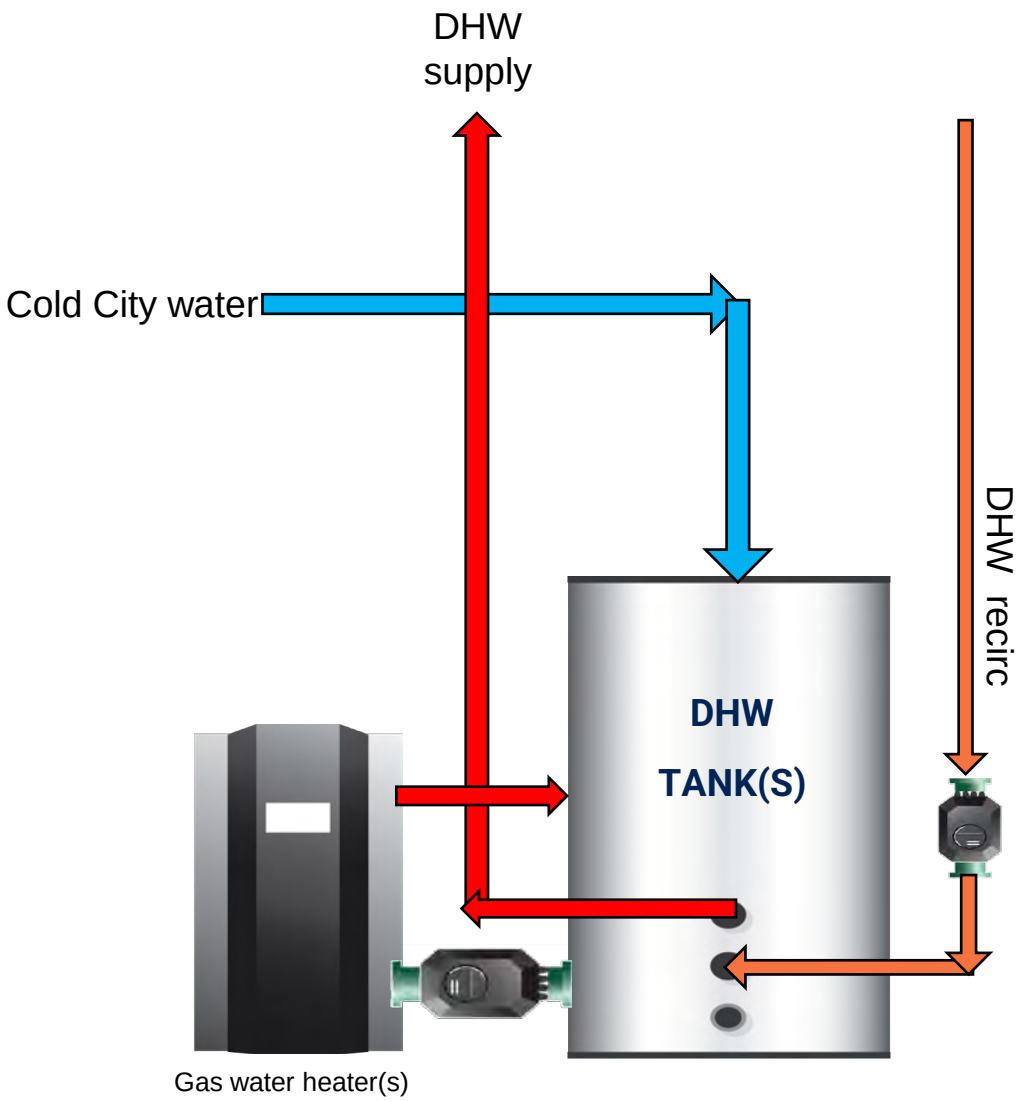
ENERVEX
VENTING DESIGN SOLUTIONS

HYDRONIC BOILER RETROFIT
Can we do better?

Enervex DCX HTHP system

- Tackle the other user in the room, the DHW system.
- Keep the existing hydronic loop system.
- Cool down the flue gases below ambient air temperature.
- Bring the system to over 105% efficiency.
- The **ABSOLUTE** solution in energy efficiency at the source.

Nearby heat sink: DHW system



ENERVEX DCX UNIT

Fully condensing heat recovery system

Sized from 200MBH to 120,000MBH

Atmospheric vessel requires no supervison

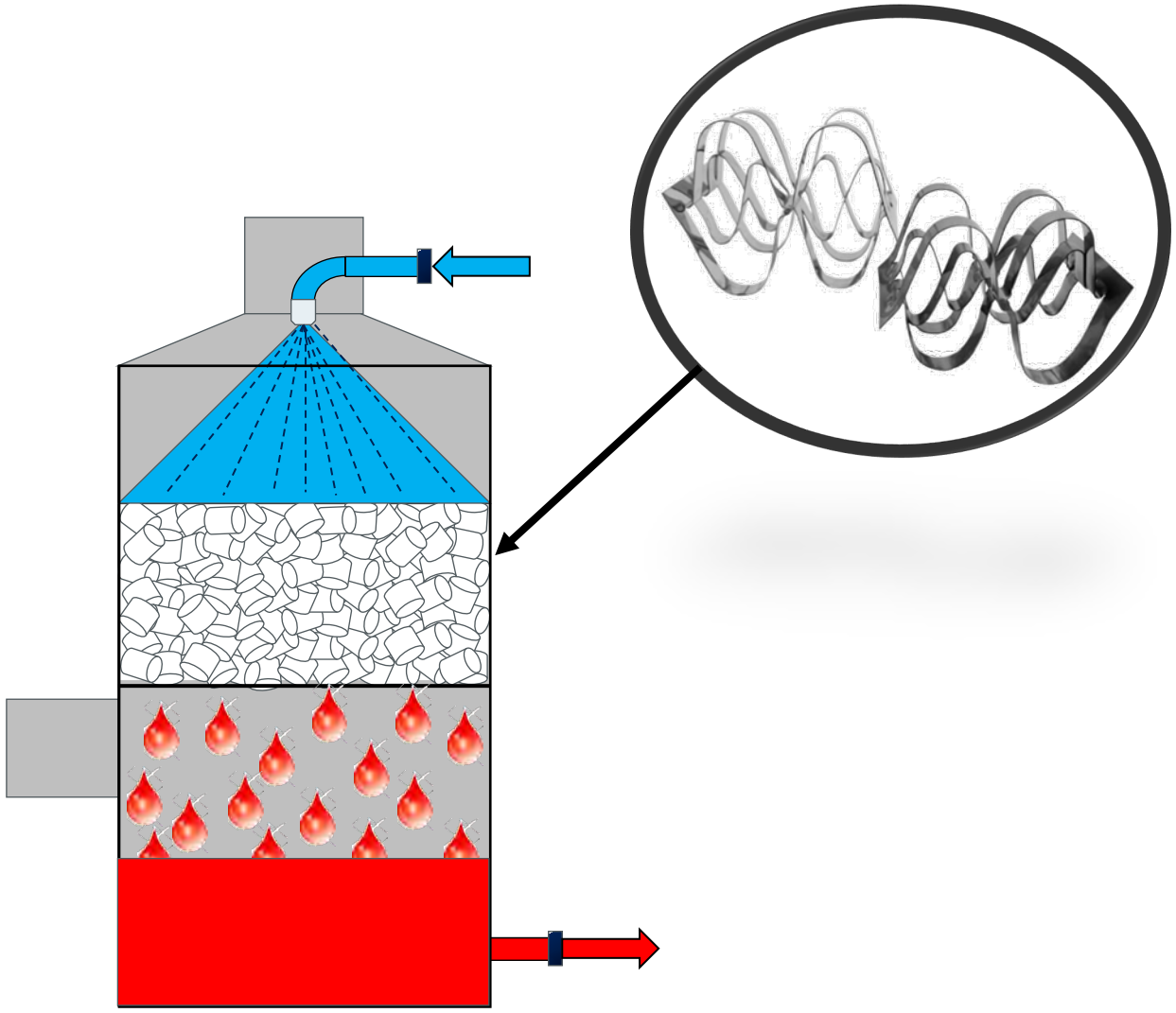
100%SS316L

Can condense and reach 100% efficiency on:

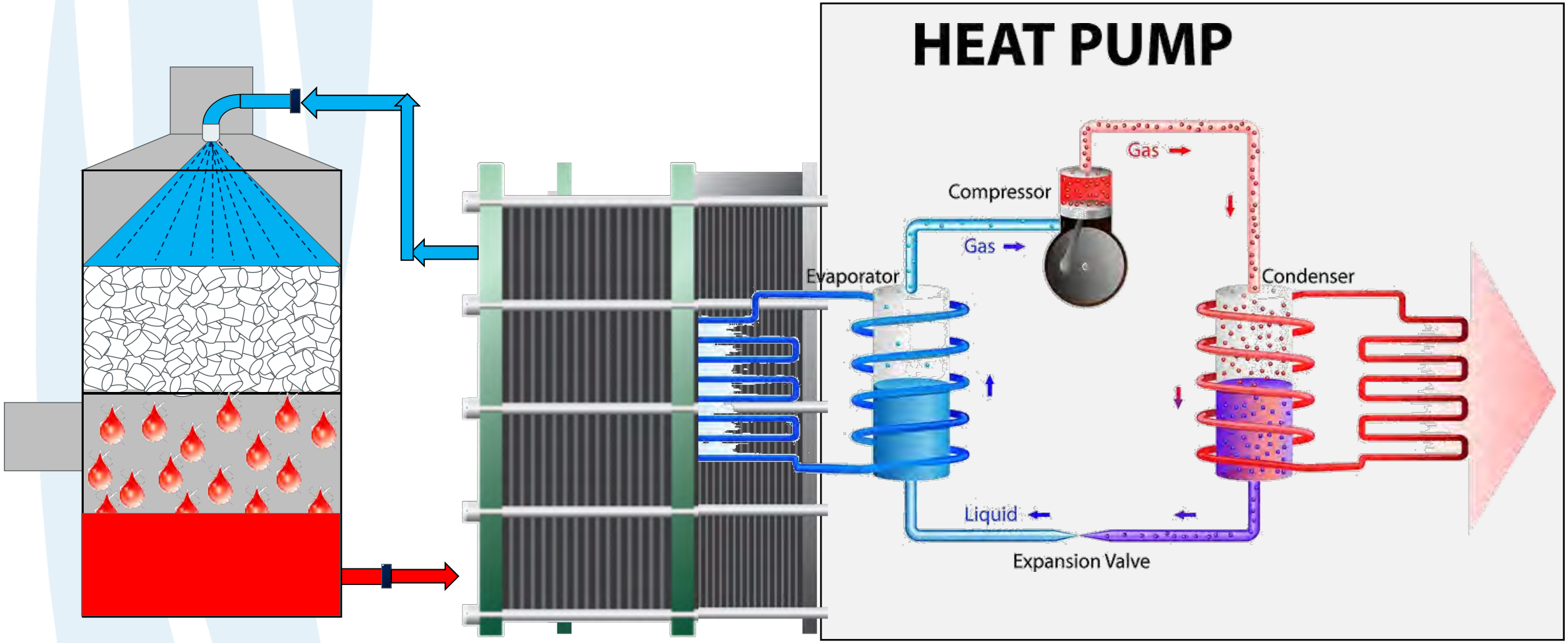
- Natural Gas
- #2 Fuel Oil
- Low sulfur Biomass
- Hot humid gases or air streams

ENERVEX
VENTING DESIGN SOLUTIONS

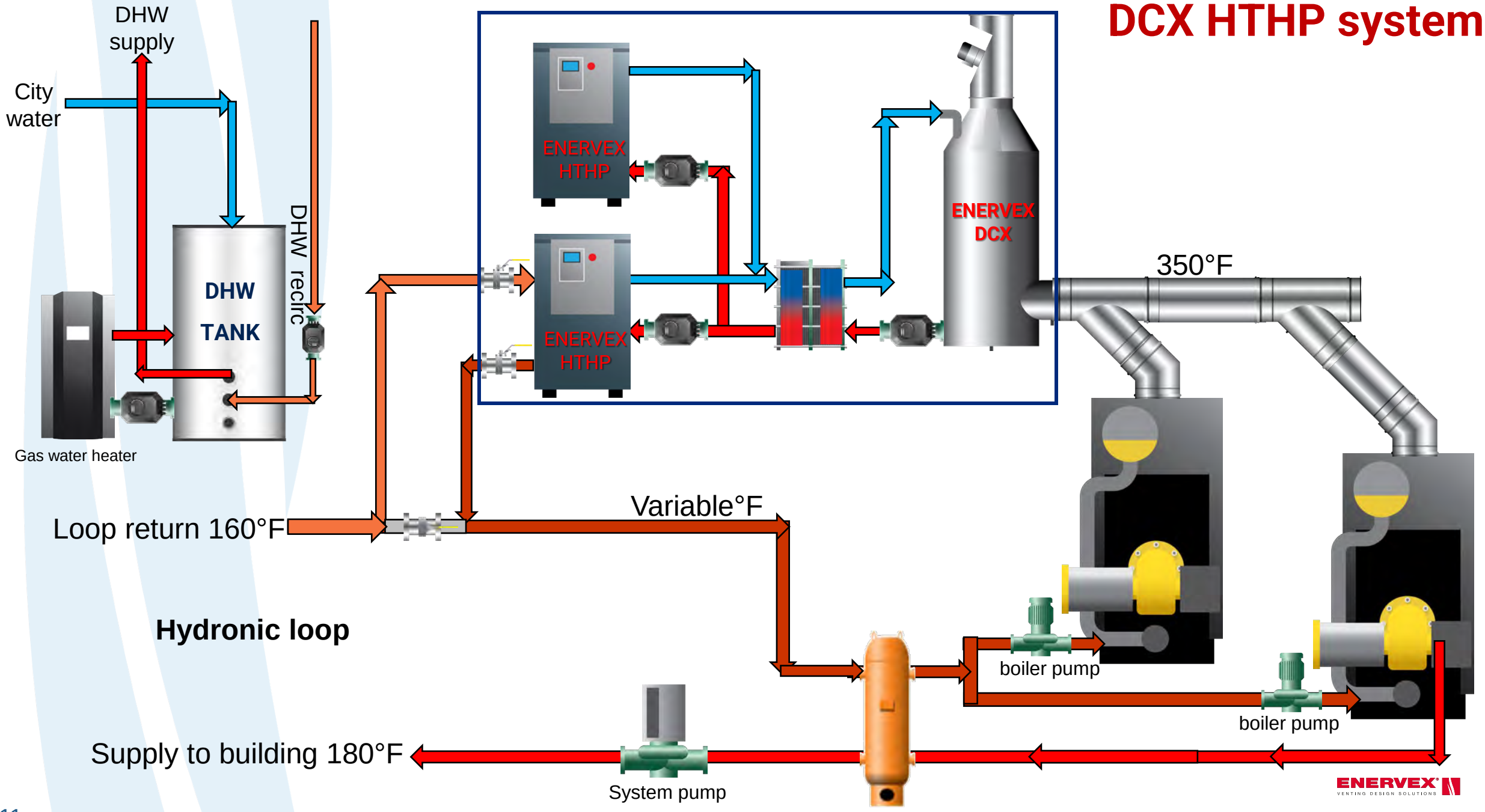
DCX unit



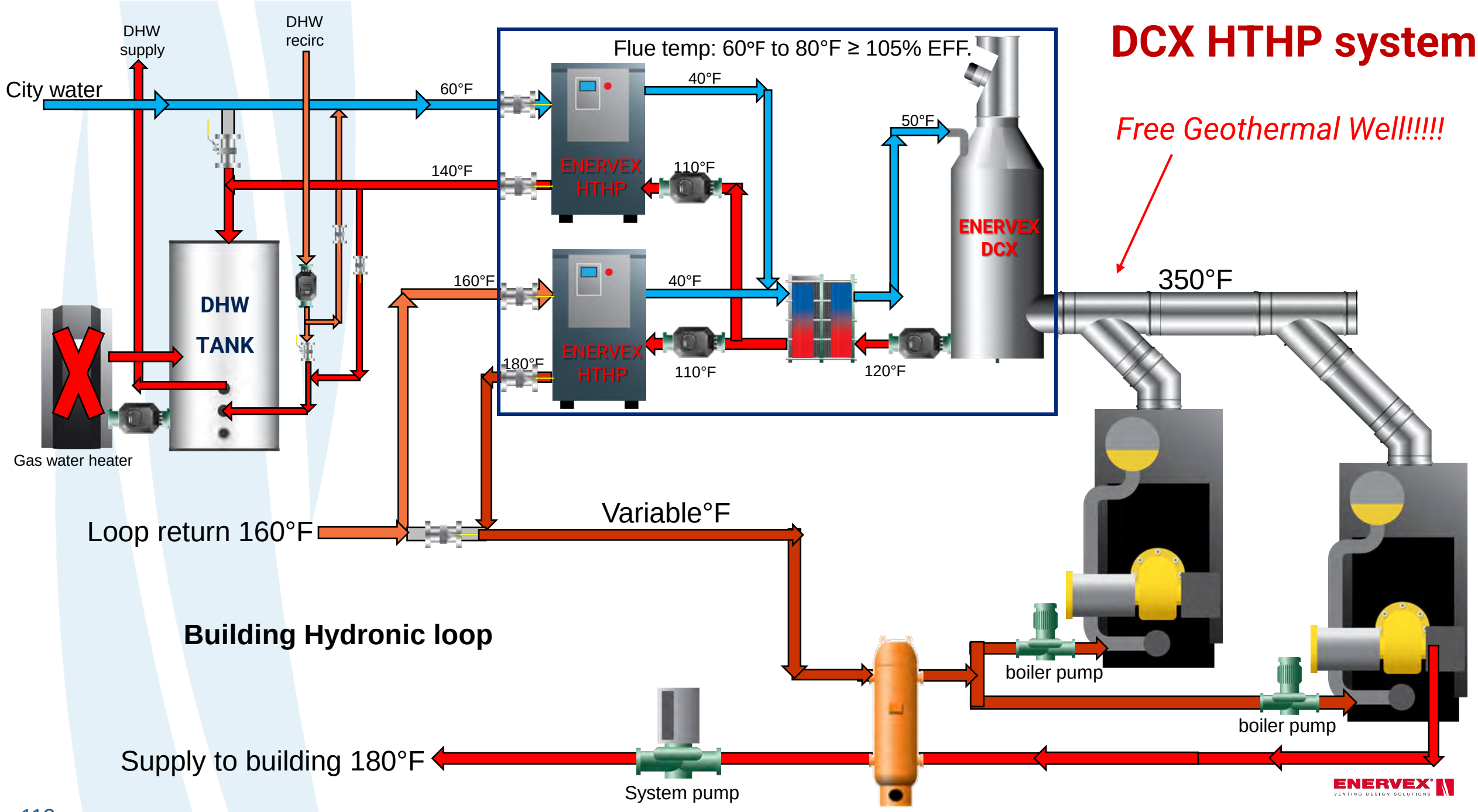
Enervex High temperature Heat Pumps (HTHP)



DCX HTHP system



DCX HTHP system



DECARBONIZATION SOLUTIONS

Enervex DCX HTHP system

Multi story building retrotit

Gas price; $1.20/therm

Electrical cost: $0.20Kwh

Total gas/year : 300,000 Therms

ENERGY SAVINGS			
YEARLY GAS USAGE:		300,000	THERMS
btu output @ 80%eff		2,777,778	btu/hr required
output from boilers		2,259,099	btu/hr required
load done by heat pumps		518,679	btu/hr
equivalent in KW with COP		39.0	KwH
yearly electrical cost	$	71,708	per year
new boiler input 100% efficient		2,259,099	btu/hr
yearly gas cost:	$	221,645	per year
TOTAL ENERGY BILL:	**$**	**293,352**	**per year**
OLD GAS BILL:	$	360,000	PER YEAR
TOTAL SYSTEMS ENERGY SAVINGS	$	66,648	PER YEAR
NEW GAS THERMS PER YEAR:		197,897	THERMS
THERMS OF GAS SAVED PER YEAR:		102,103	THERMS
TONS OF CO2 SAVED PER YEAR:		**541**	**METRIC TONS**
LAW 97 Co2 tax			PER METRIC TON
TOTAL LAW 97 CO2 TAX SAVINGS	$	-	PER YEAR
Total yearly savings	**$**	**66,648**	**PER YEAR**
BUDGET SUPPLY AND INSTALL	$	850,000	
INITIAL PROJECT INVESTMENT	$	850,000	
SIMPLE R.O.I.		-	YEARS

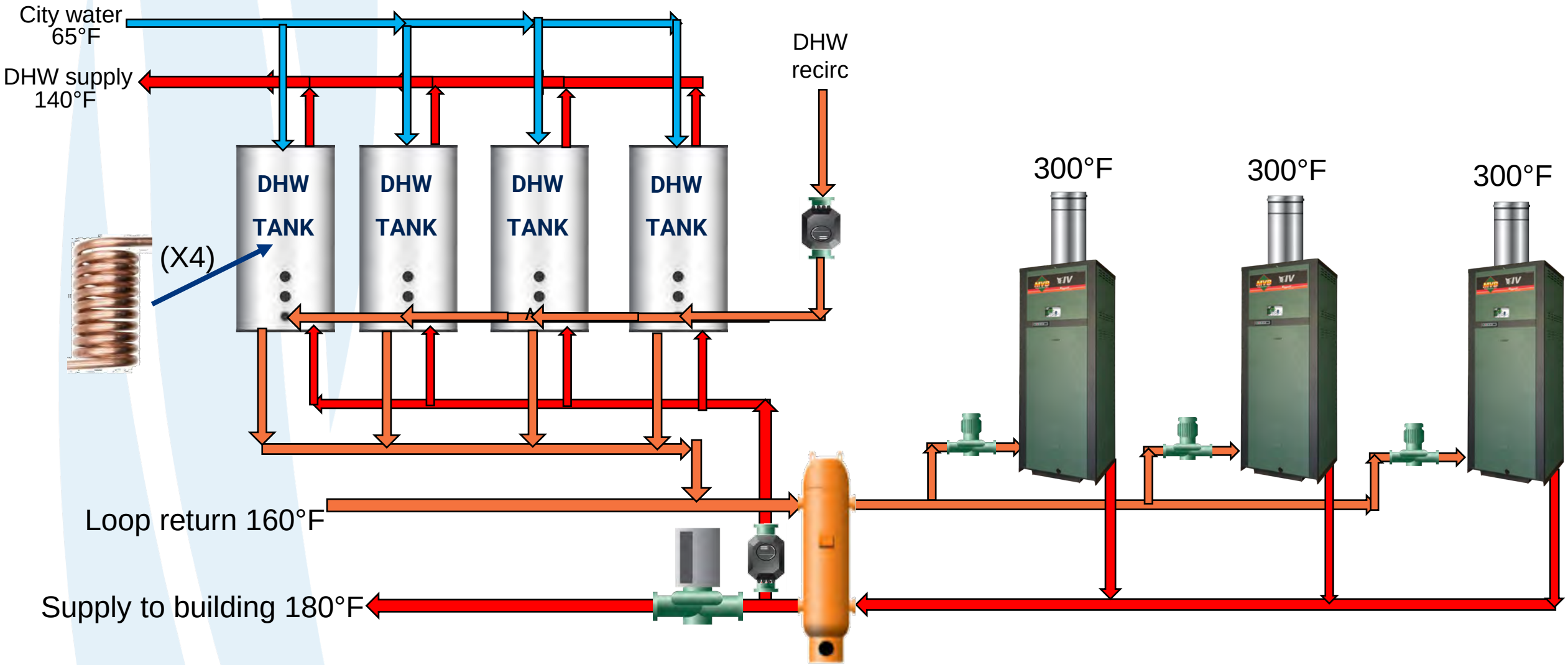
ENERVEX VENTING DESIGN SOLUTIONS

Multi-residential

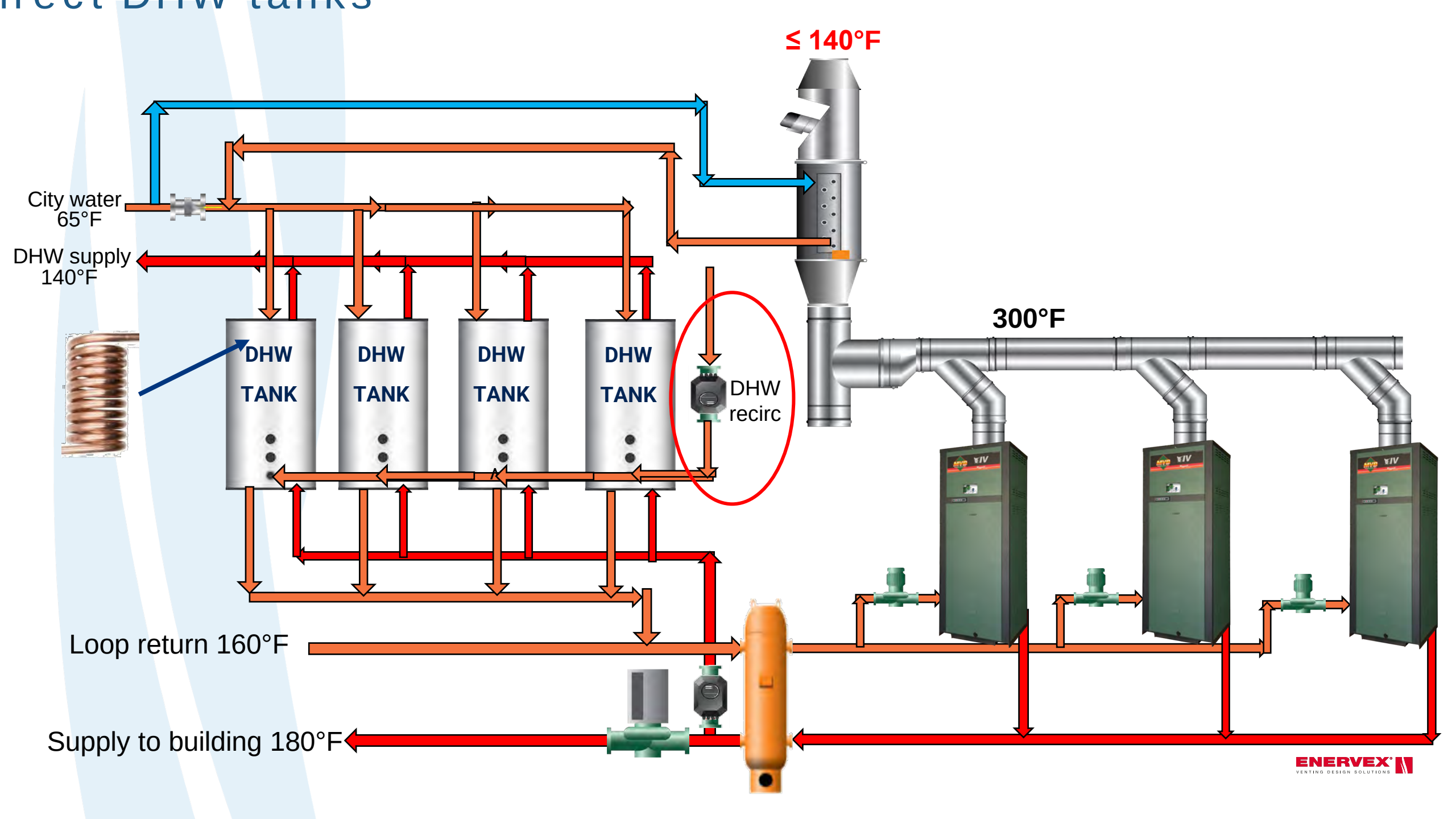
- Three (3) 3,000 MBH CAT I Mid-Efficiency copper fin boilers
- Indirect DHW heating with coil in tank
- N+1
- Mandate carbon emissions reduction options

ENERVEX VENTING DESIGN SOLUTIONS

Multi-res + Indirect DHW tanks

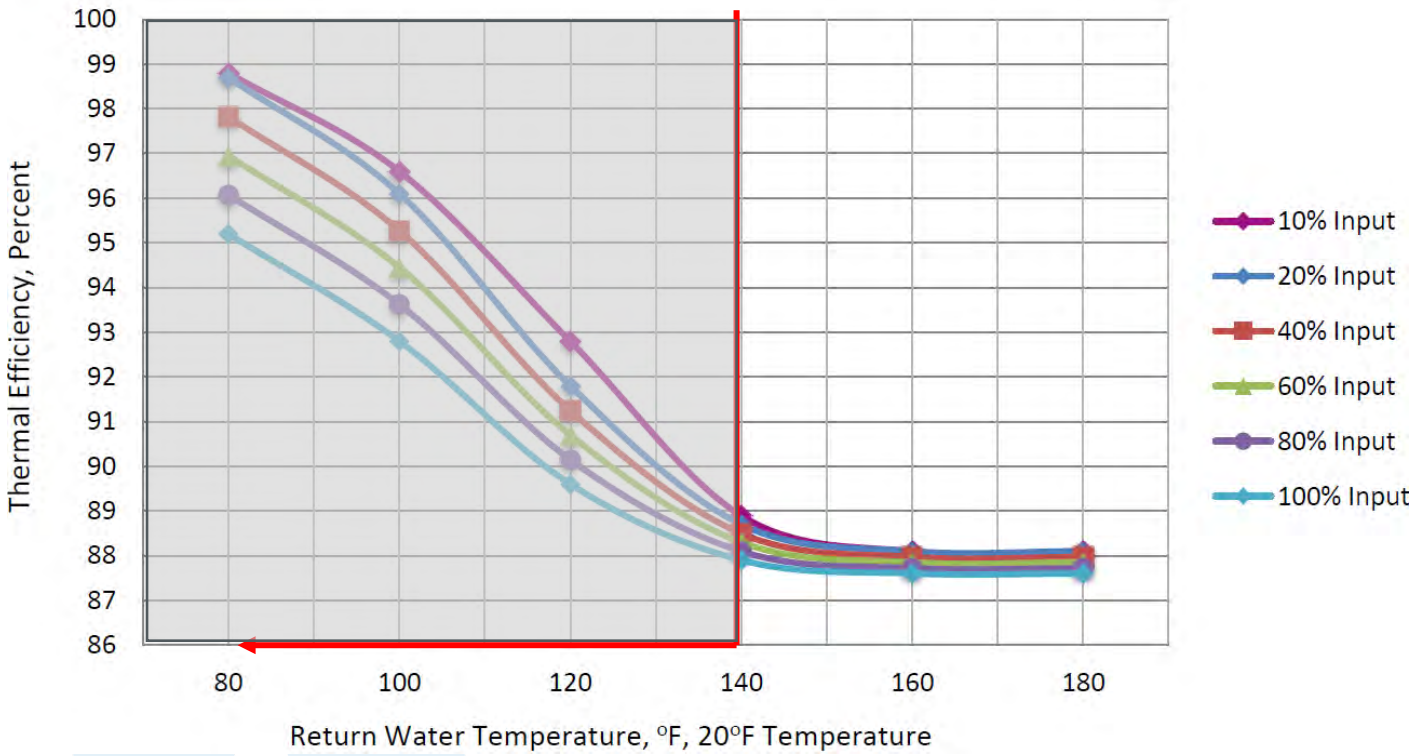


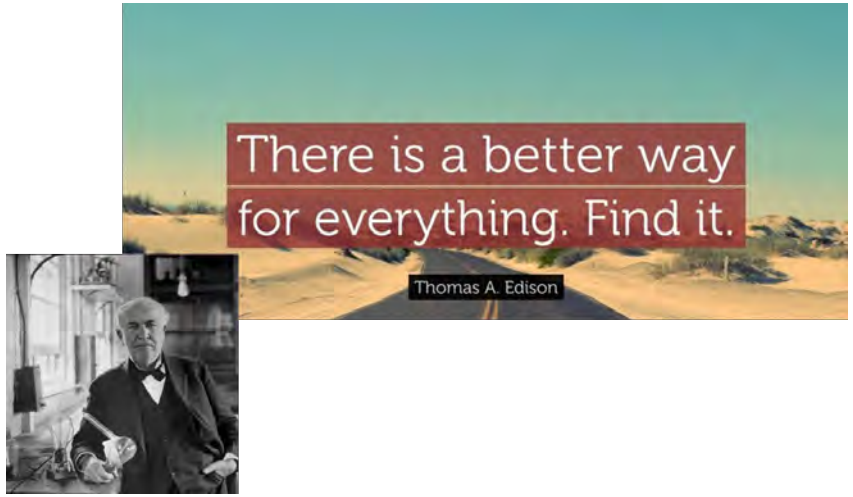
Indirect DHW tanks



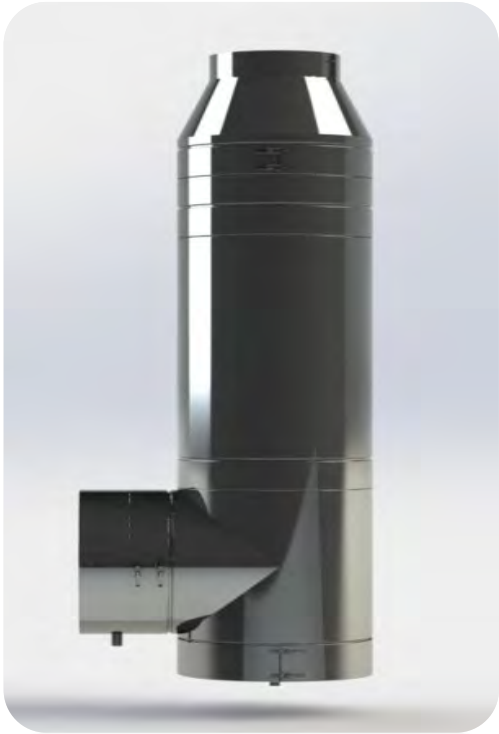
Can we do better?

You got to get lower…

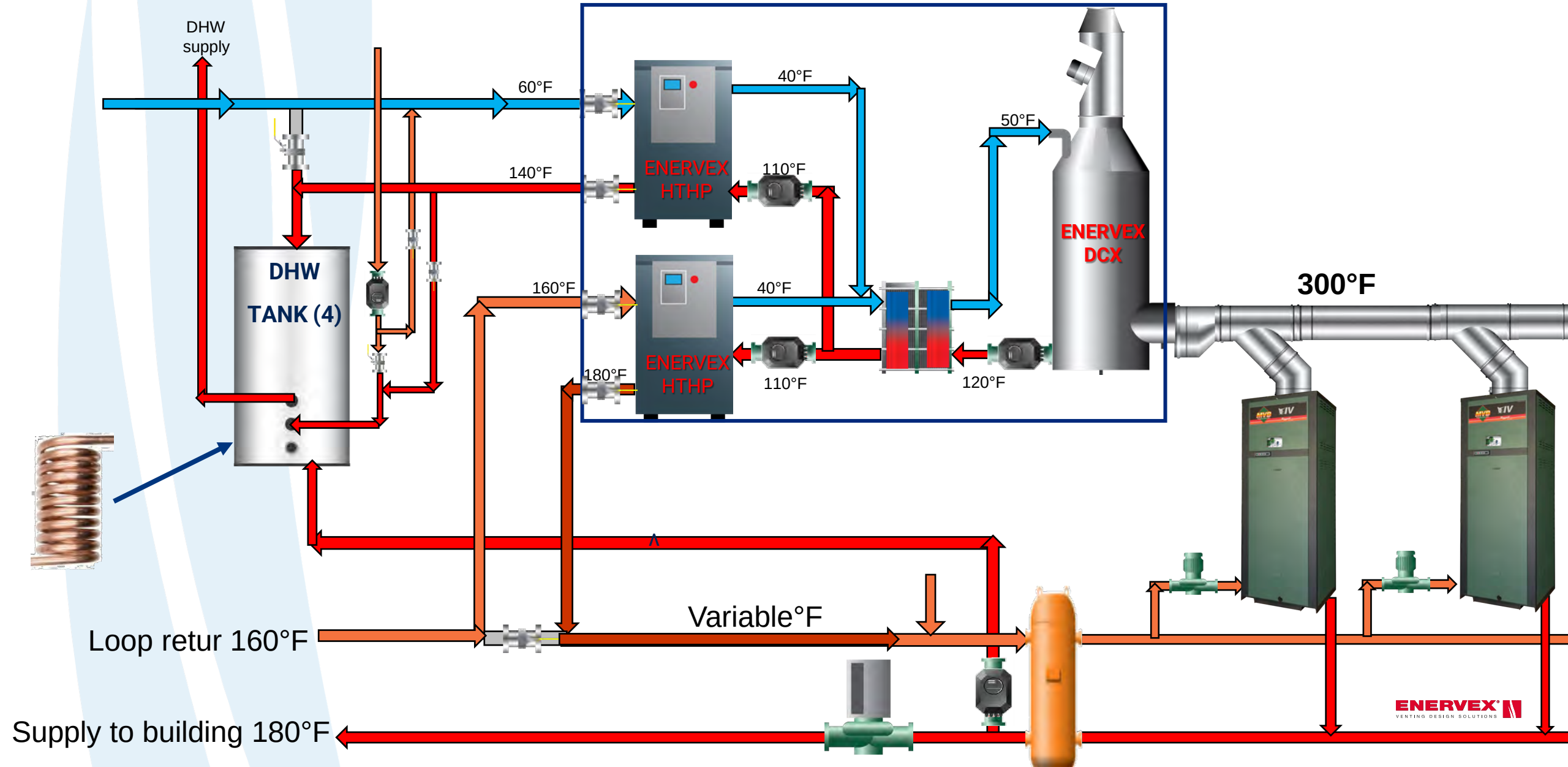




Enervex DCX HTHP system

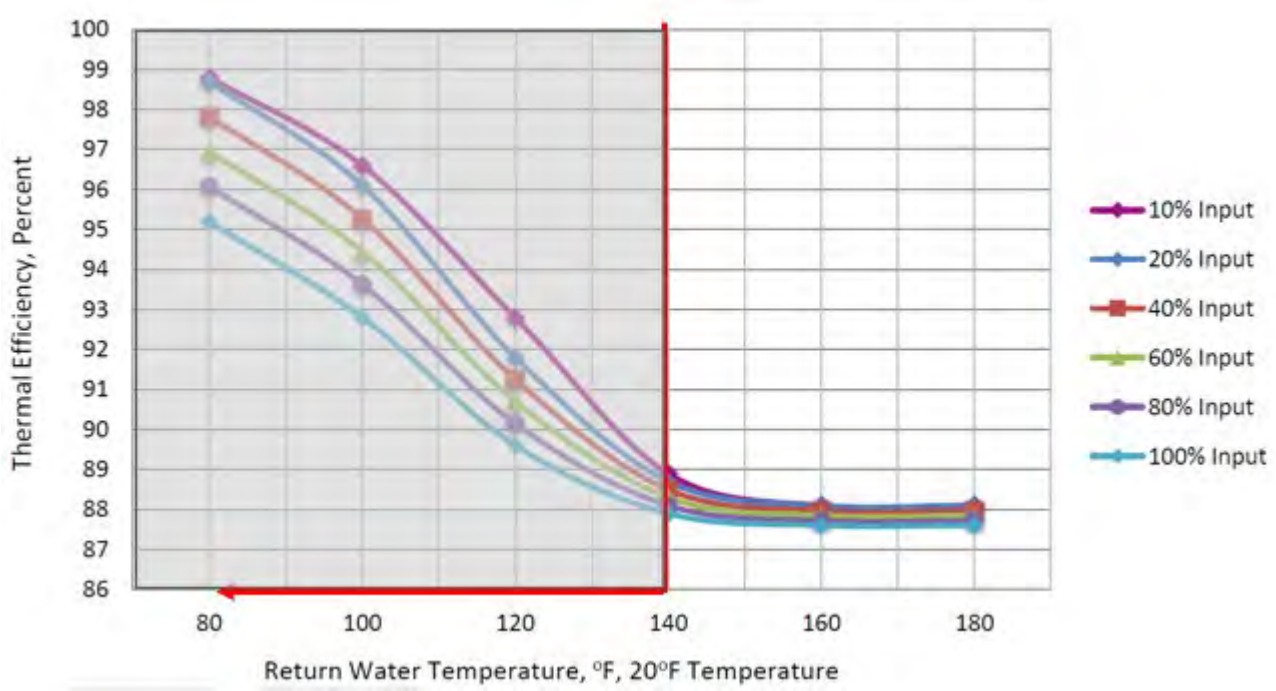


Multi-res Indirect DHW tanks



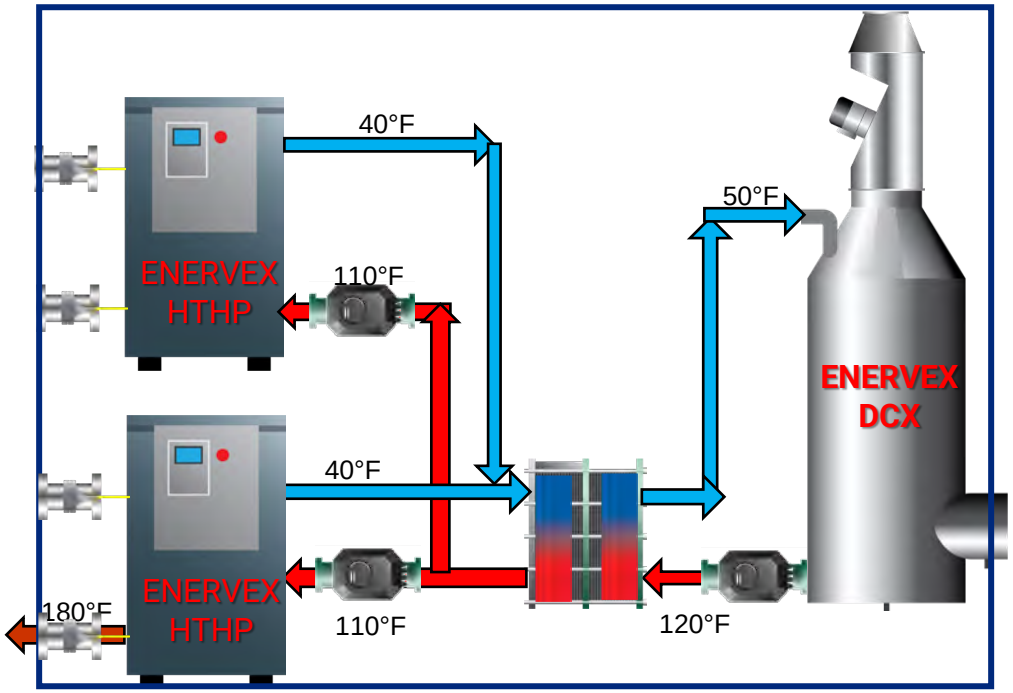
DECARBONIZATION SOLUTIONS

Condensing boiler(s)



Enervex DCX HTHP system

Flue temp: 60°F to 80°F ≥ 105% EFF.



HEALTHCARE SOLUTIONS

ENERVEX®
VENTING DESIGN SOLUTIONS

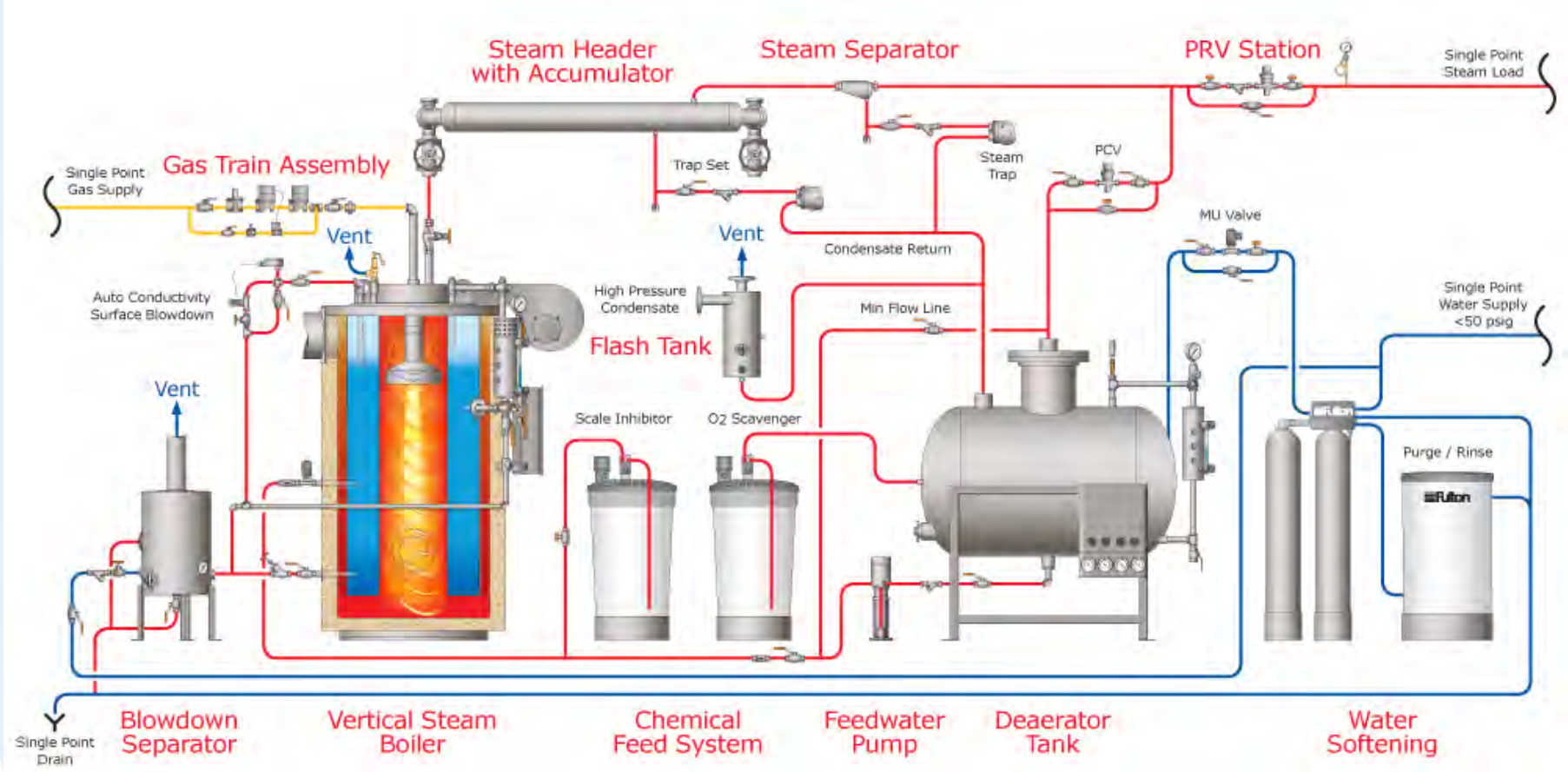
STEAM BOILERS EVOLUTION

OLD TECHNOLOGY
80% MAX EFFICIENCY @ 0 PSIG

NEW HIGH EFFICIENCY
MAX 86%

ENERVEX®
VENTING DESIGN SOLUTIONS

STEAM BOILER SYSTEM EFFICIENCY : UNDER 60%



ENERVEX
VENTING DESIGN SOLUTIONS

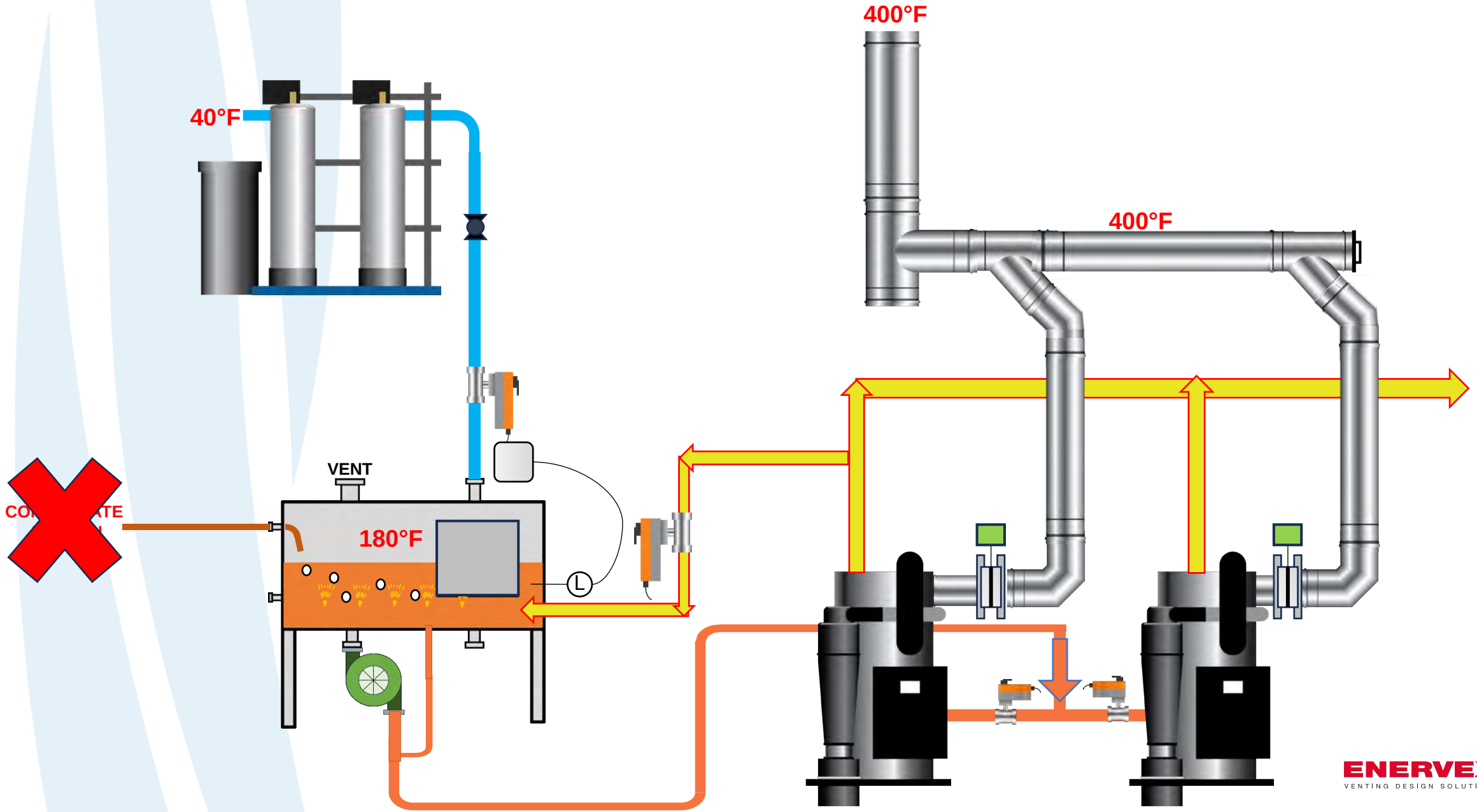
60 BHP Sterilization & Humidification system

Design basis:

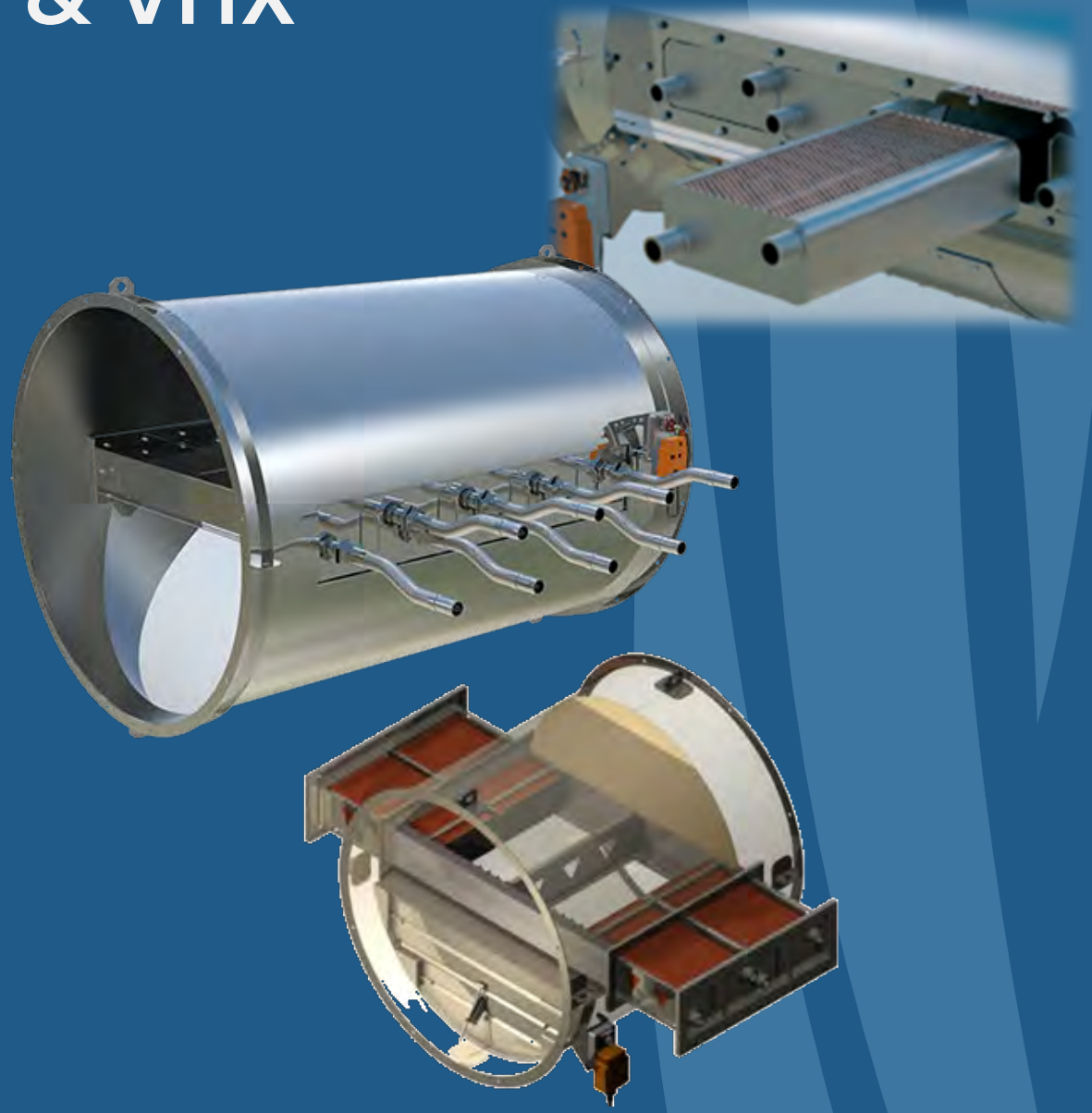
- 2 x 30BHP Steam low pressure boilers
- 2 Boilers operates at 66% average load average 6 months
- 1 boiler at 50% average load 6 months
- NG flue gases at 400 °F @ 30%EA
- Gas price : $10/DT
- Potential Incentives: TBD
- Average cold water temp: 60degF

ENERVEX®
VENTING DESIGN SOLUTIONS

STEAM SYSTEM

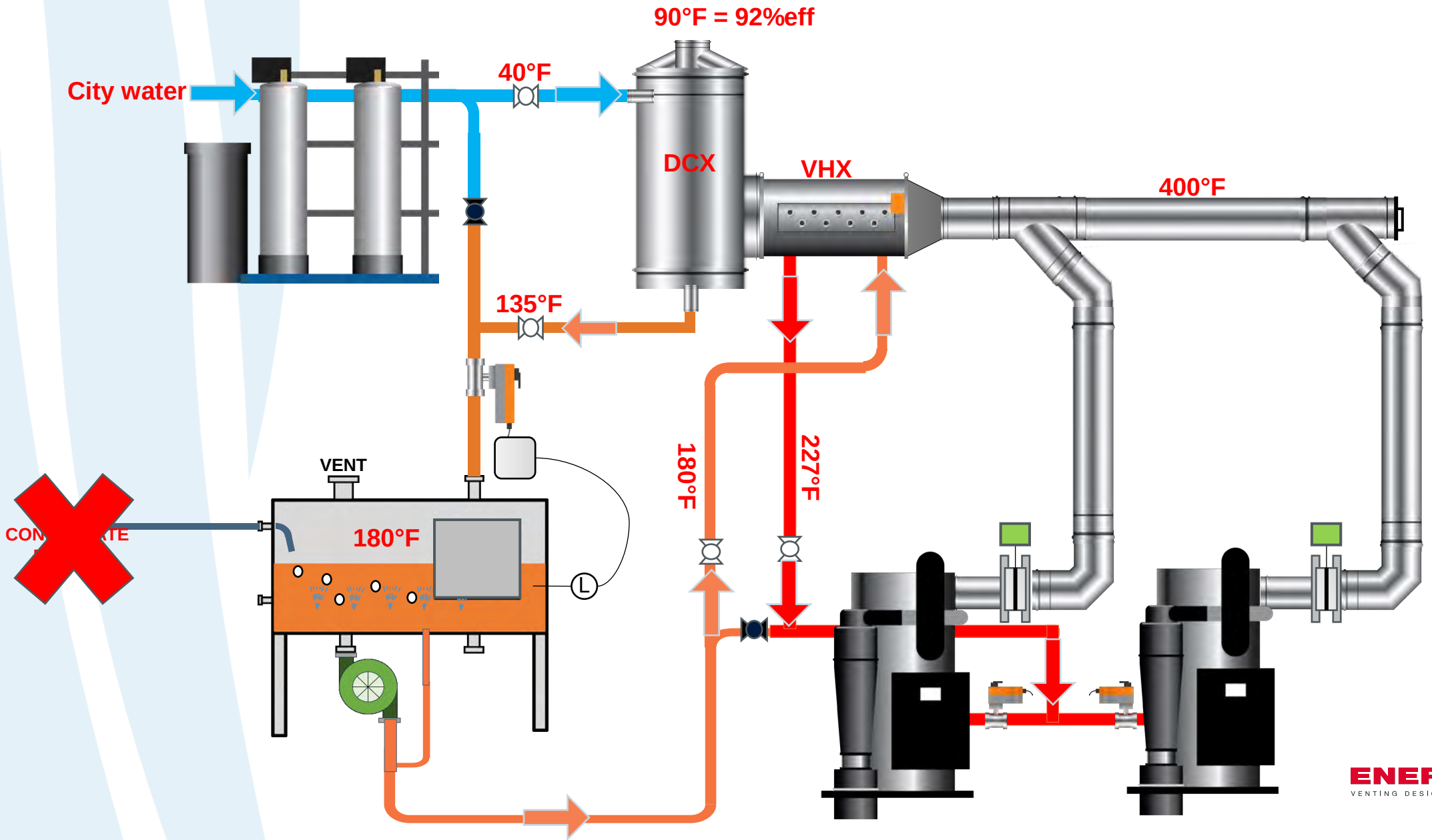


Enervex DCX & VHX



ENERVEX®
VENTING DESIGN SOLUTIONS

ENERVEX VHX/DCX SYSTEM



ENERVEX®
VENTING DESIGN SOLUTIONS

OTHER APPLICATIONS

ENERVEX®
VENTING DESIGN SOLUTIONS

Craft Brewing & Distilleries

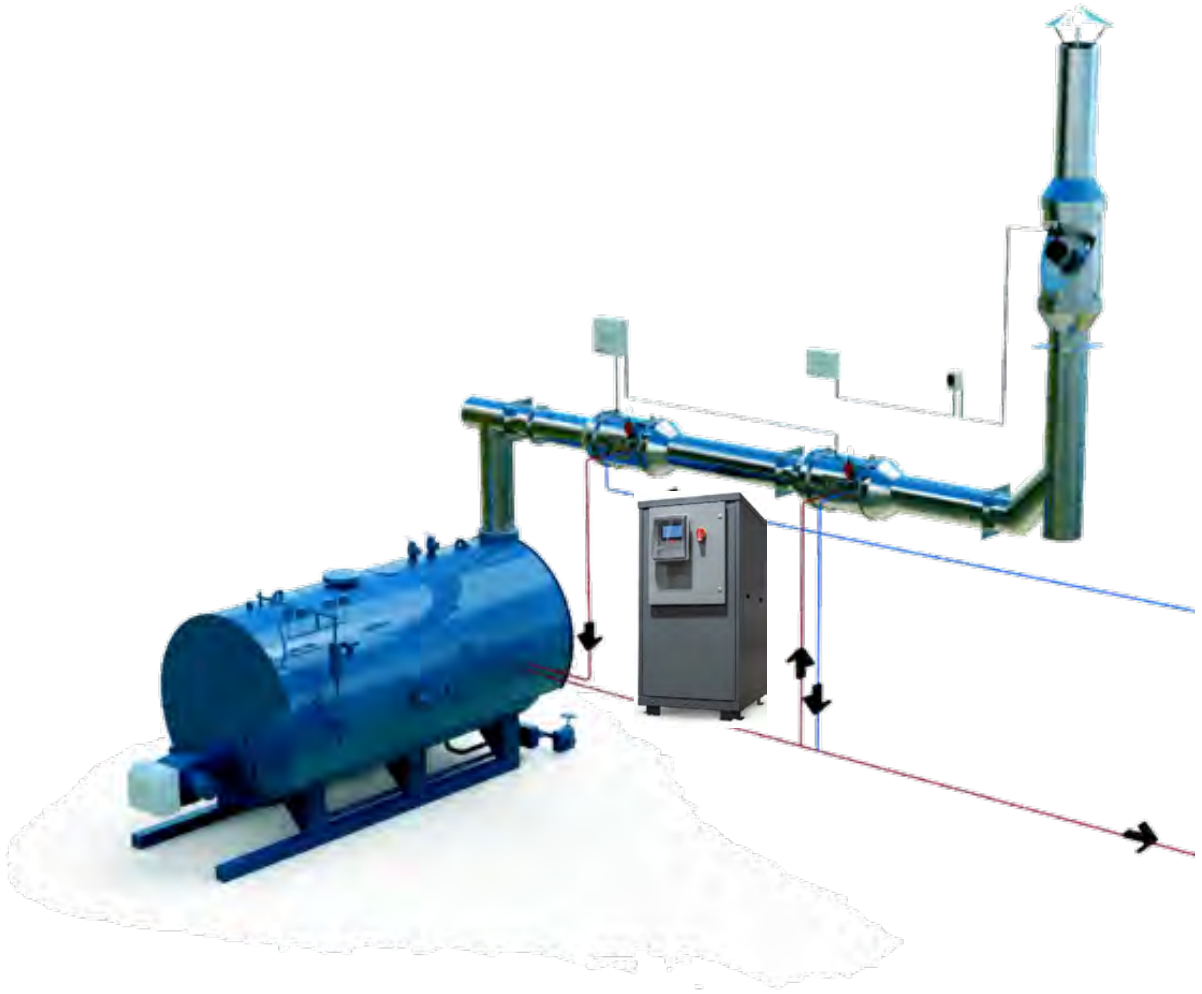
Breweries & Distilleries use steam for mainly 2 reasons which are: Heating the Mash by circulating steam in the double wall of the "kettle".

They might inject live steam in the cereal in order to create the Mash as well.

The distillers use steam. Distillation is the process of separating alcohol from water via evaporation and condensation. The base alcohol is heated, and certain parts of it are captured. This process purifies and concentrates the remaining alcohol, which will ultimately be the final spirit.

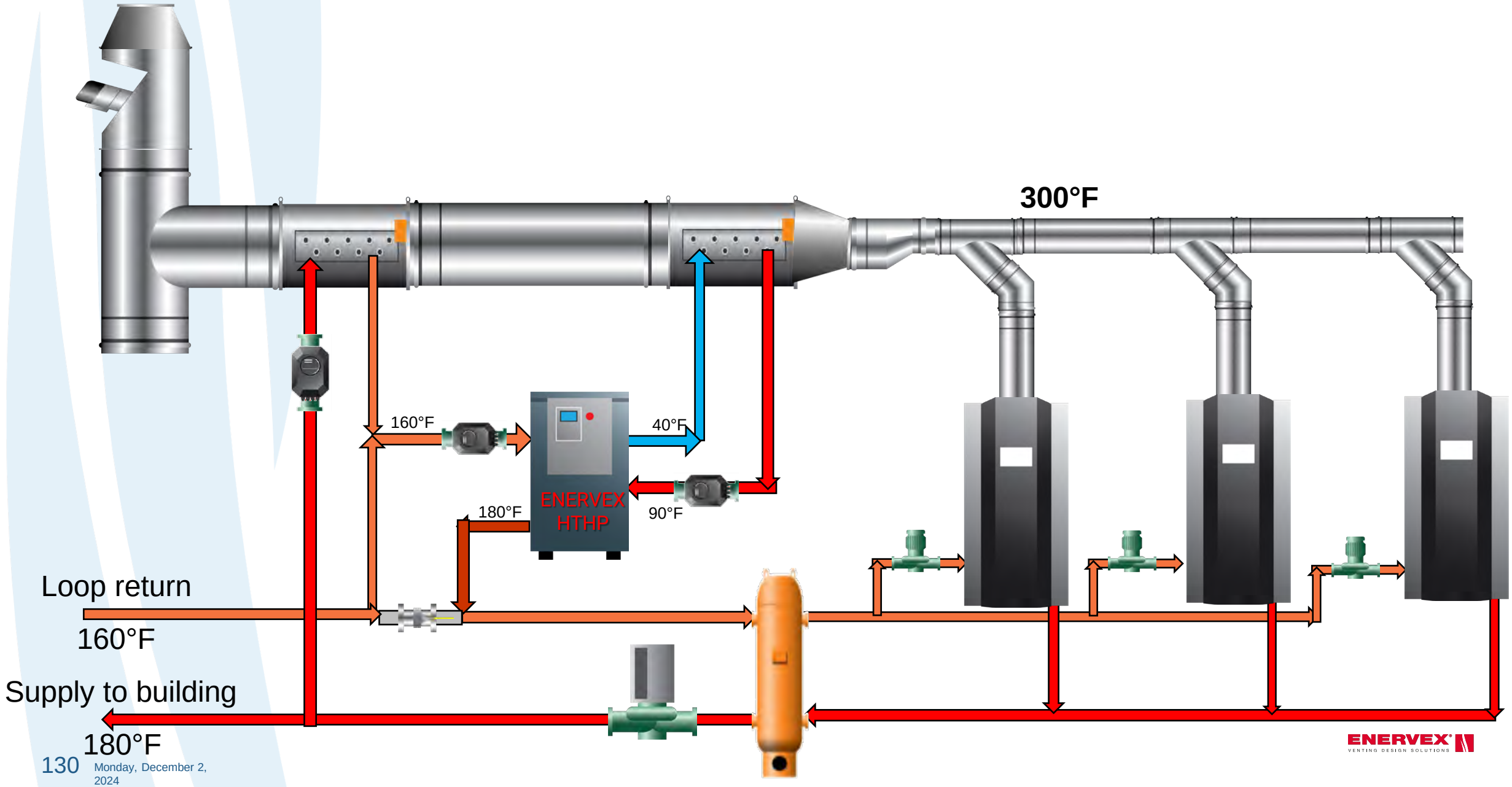
They also use steam to sterilize or produce Process hot water for cleaning and sanitation.

PLUME ABATTEMENT WITH A ROI

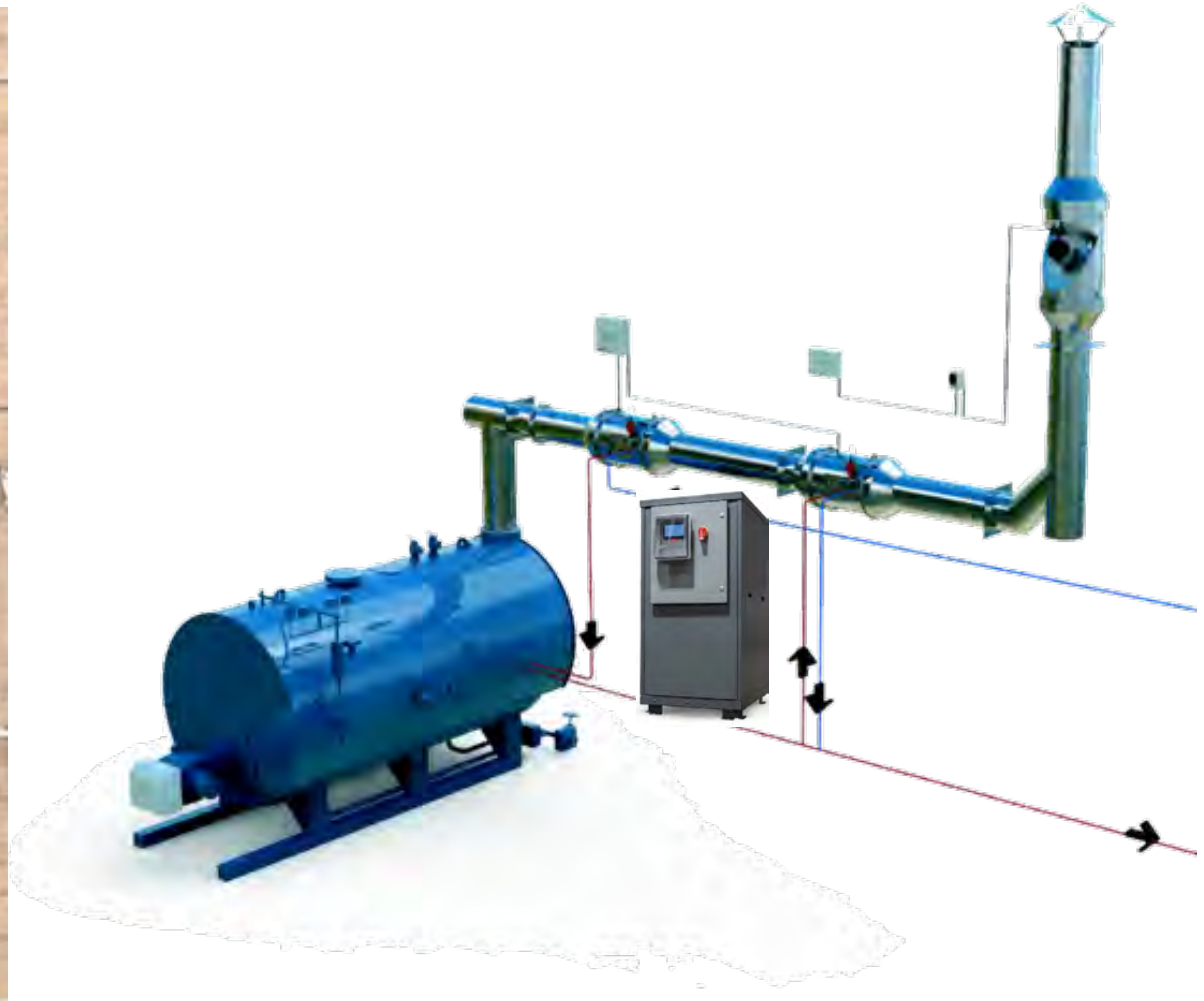


ENERVEX VENTING DESIGN SOLUTIONS

Plume abatement



PLUME ABATTEMENT WITH A ROI



Food Processing

Food Processing is a Growing Market and will most of the time require steam and/or Thermal Oil and sometimes both. The steam is used for many applications:

- Feather removal by the boiling and/or scalding method.
- Indirect cooking in heat exchangers or double jacketed kettles.
- Direct injection cooking either in mixture or in a room (curing for example)
- Pressurization/concentration
- Sterilization of tools
- Sanitation water
- Boiler make-up water pre-heating
- Space and fresh air heating

Pharmaceutical

The pharmaceutical industry can have a need for better quality steam. The steam is used for:

- Direct Injection in the product
- Drying and compressing
- Sterilization
- Sanitation water production
- Make-up water pre-heat

In older plants, also used for space and fresh-air heating.

ENERVEX
VENTING DESIGN SOLUTIONS

Industrial Applications

There are many Industrial markets that use steam.

The most common being chemical processing, steel making, automotive, mining, plating and coating, washdown (trucks, city buses, trains), Plastics.

The steam can be used for:

- Indirect process heating
- Direct injection in the product
- Precise room or plant humidity control (electronics)
- Pressurization/concentration
- Sterilization
- Basin heating, process and sanitation water
- Boiler make-up water pre-heating
- Space and fresh air heating

Central & District Power Plants

There are different kinds of Central & District power plants. Mostly we will see these in:

Large Colleges & Universities such as Princeton, U of T, Concordia, U of M.

Cities like New York, Montreal (CCUM)

The steam is produced for:

- Space heating
- Fresh air heating
- Domestic hot water
- Boiler Make-up water preheating
- Boiler burner air preheat

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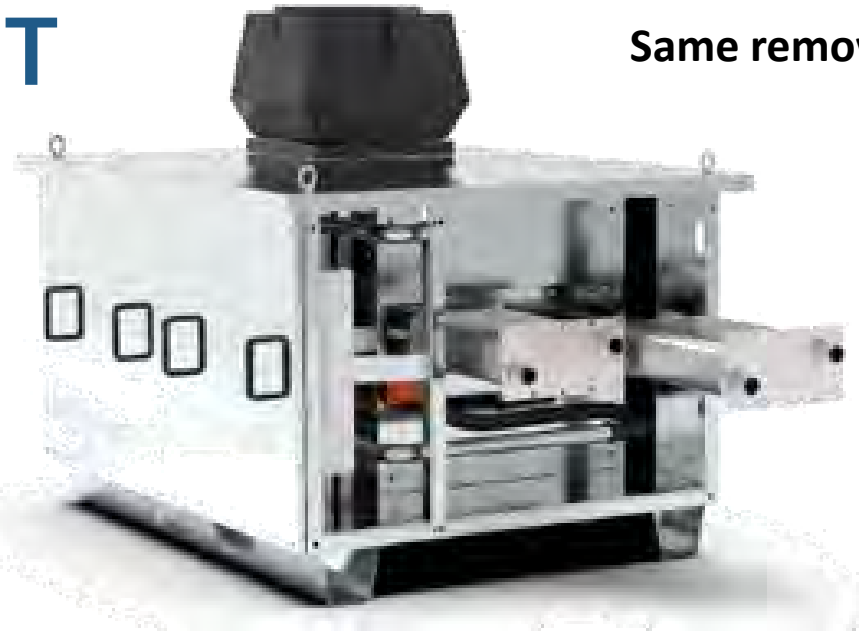
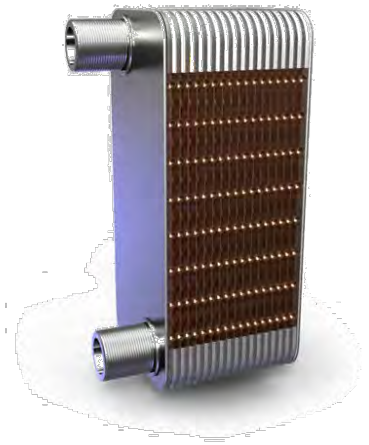
ENERVEX RHX UNIT

Same removeable modules then the VHX





Integrated Bypass

Fully packaged water side

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Simple. Seamless. Smart

QUESTIONS?

By Simon Mandeville
Director of Sustainability