

# REPLACEMENT CONDENSING BOILERS

CenterPoint Energy's 2014 Energy Efficiency  
and Technology Conference

Russ Landry, PE

Senior Mechanical Engineer

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**Mark Hancock, P.E.**  
Senior Mechanical Engineer

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**Brenda Yaritz**  
Senior Loan Officer

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# How Condensing Boilers Outperform Conventional Boilers

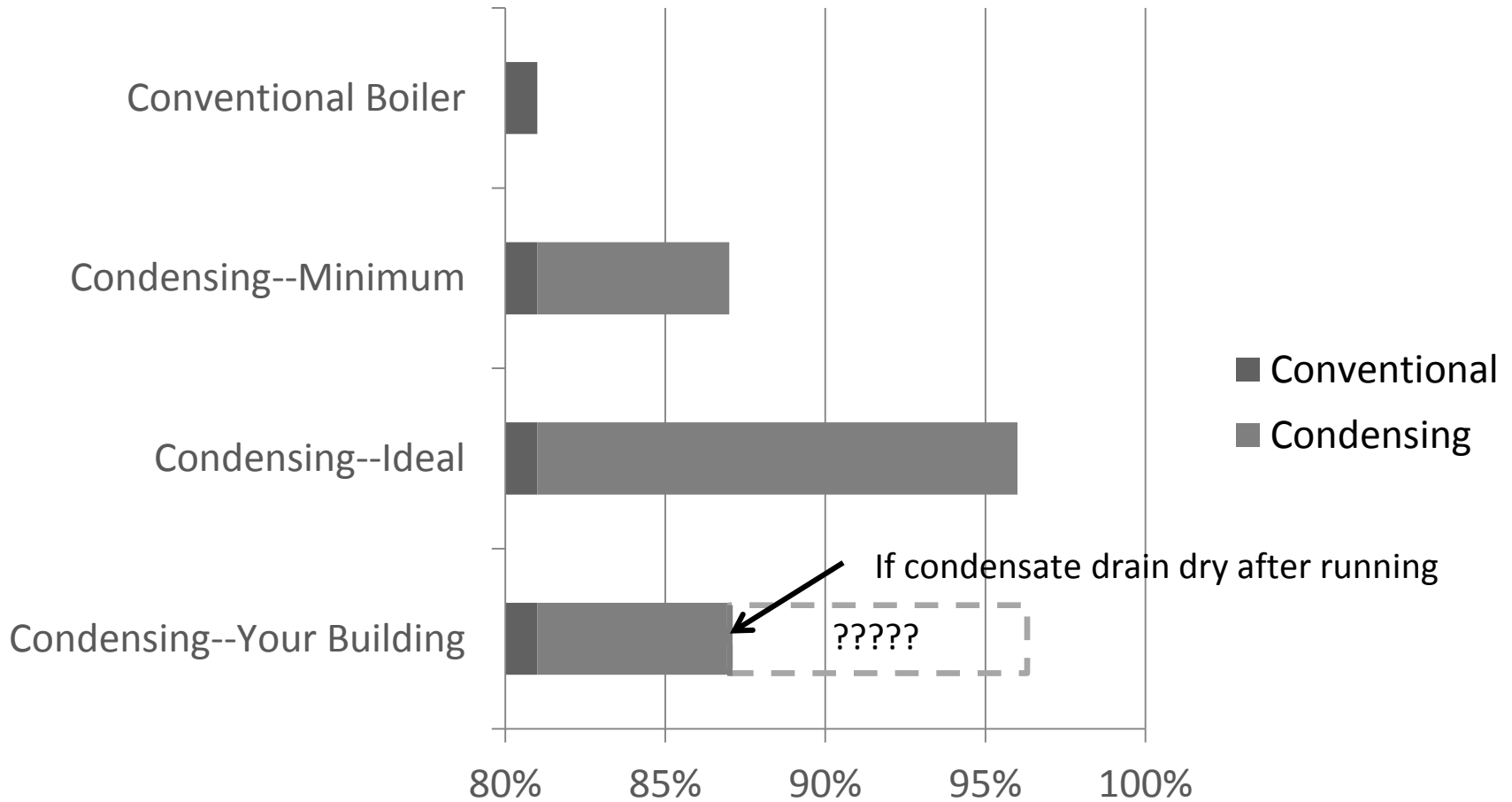
- Conventional Boilers
  - All “steam” goes out the vent
  - Safety factor to prevent condensation limits efficiency
- Condensing Boilers
  - A portion of the steam is used for heating
  - No safety factor

# Condensing Efficiency “Boost”

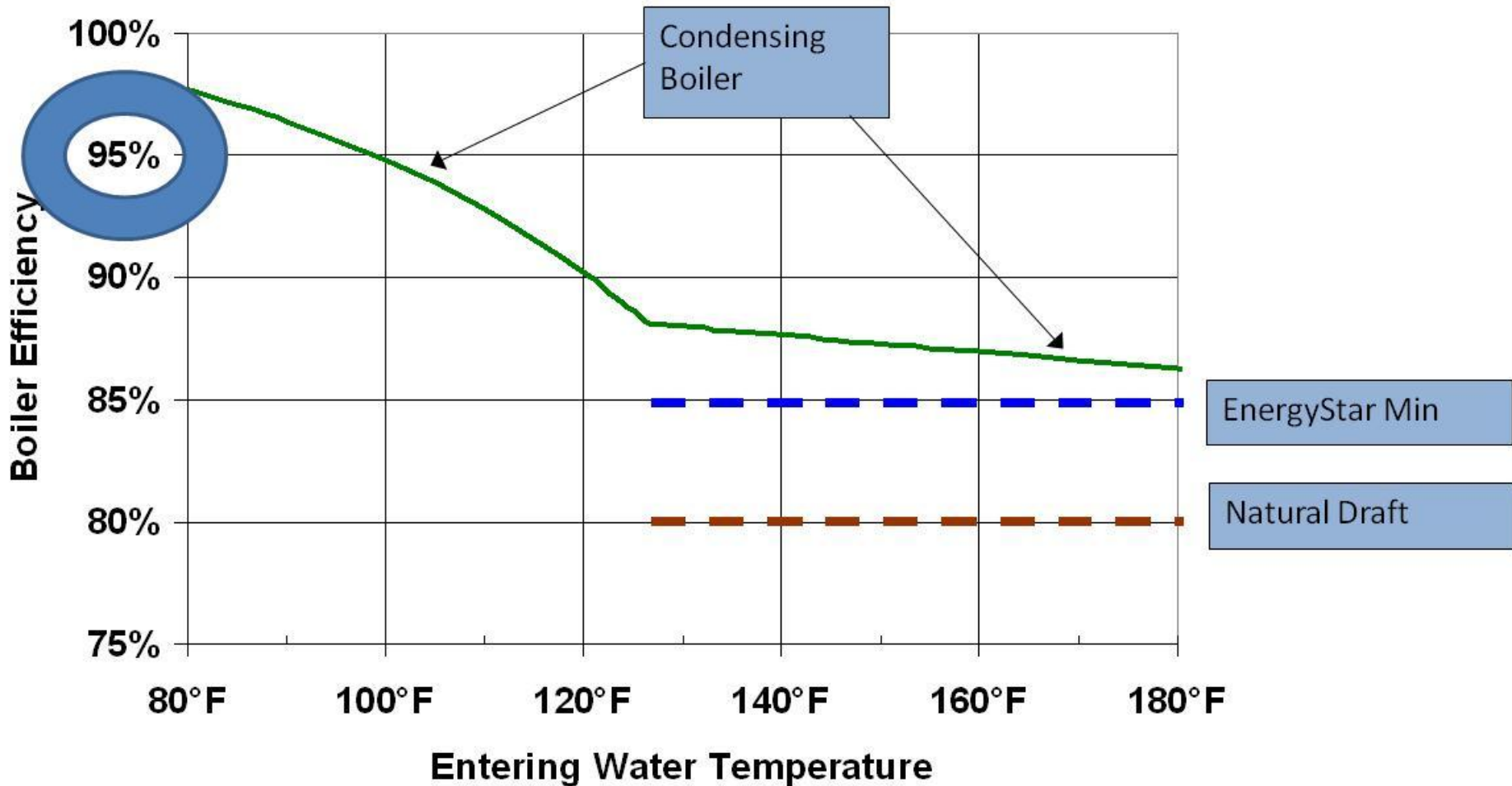
- 1 pound captured steam can heat 50 pounds of water



# Condensing Boiler Efficiency Improvement

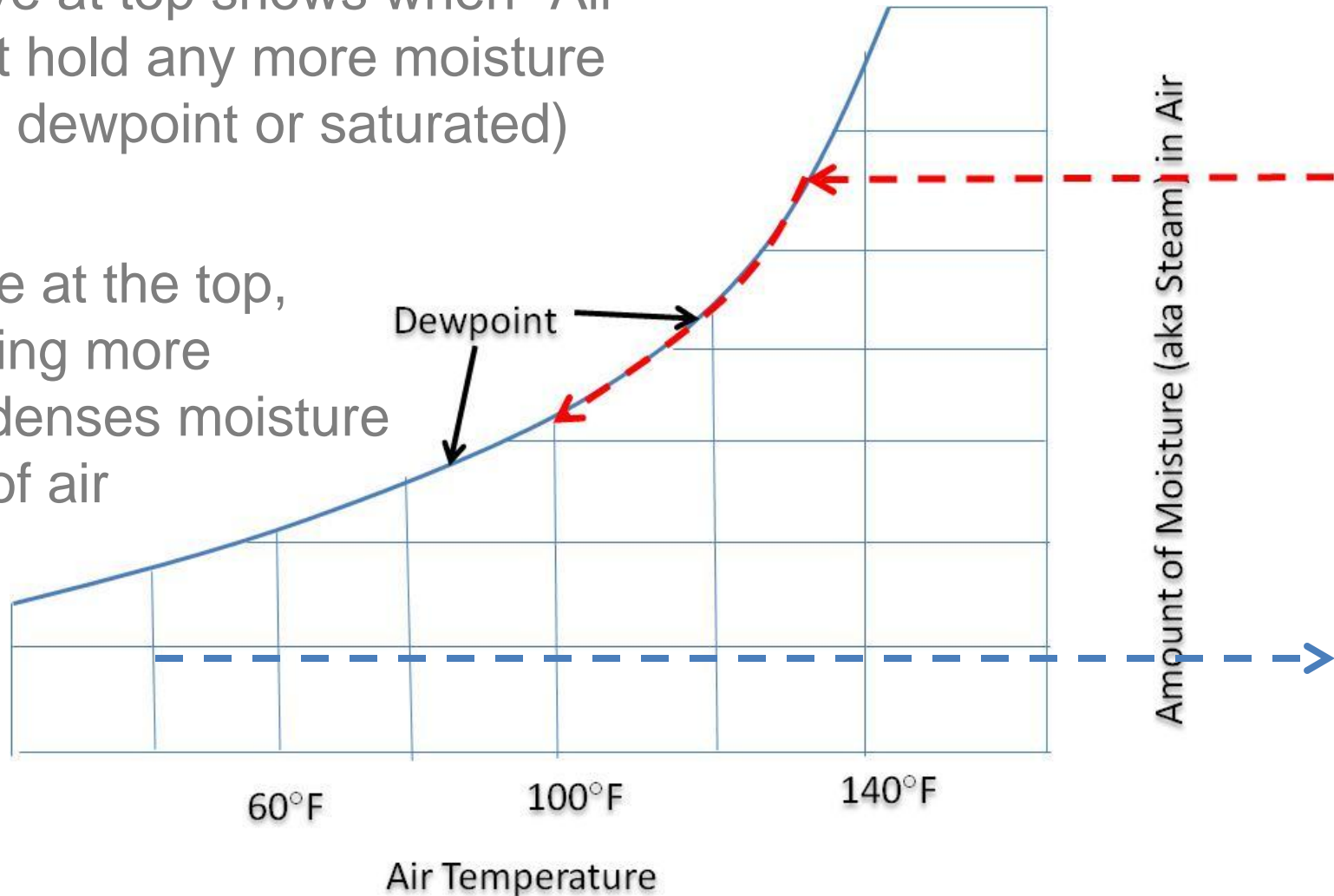


# Getting The “Rated” Efficiency Boost Out of Condensing Boilers (>90% Efficiency)



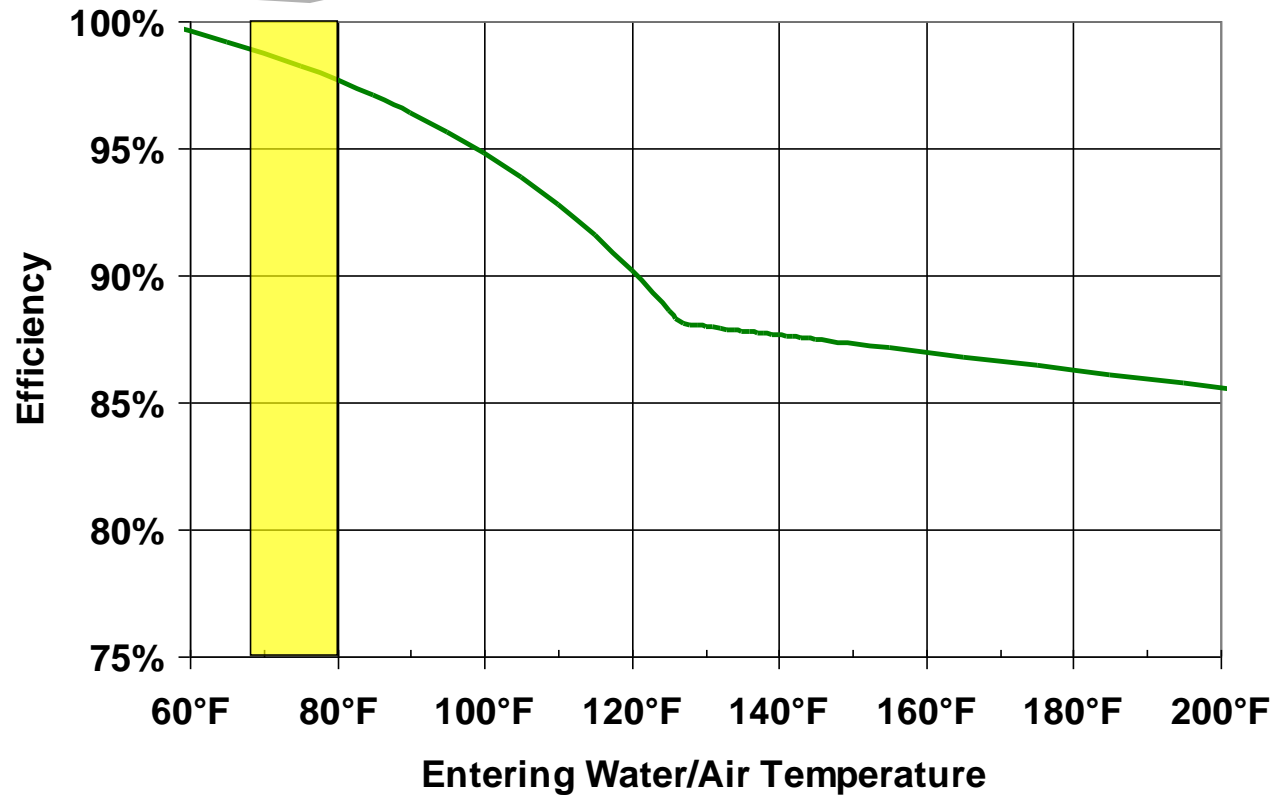
# Chart for Showing Moisture in Air Issues

- Curve at top shows when “Air” can’t hold any more moisture (aka dewpoint or saturated)
- Once at the top, cooling more condenses moisture out of air

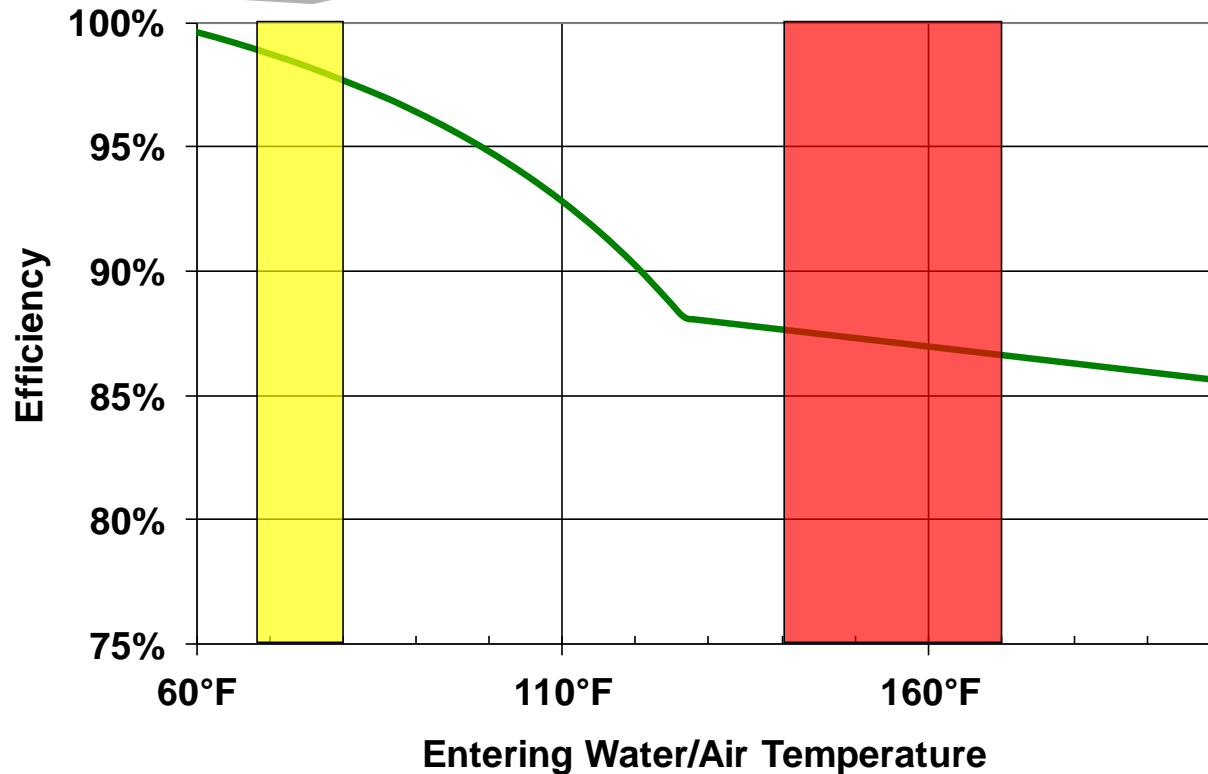




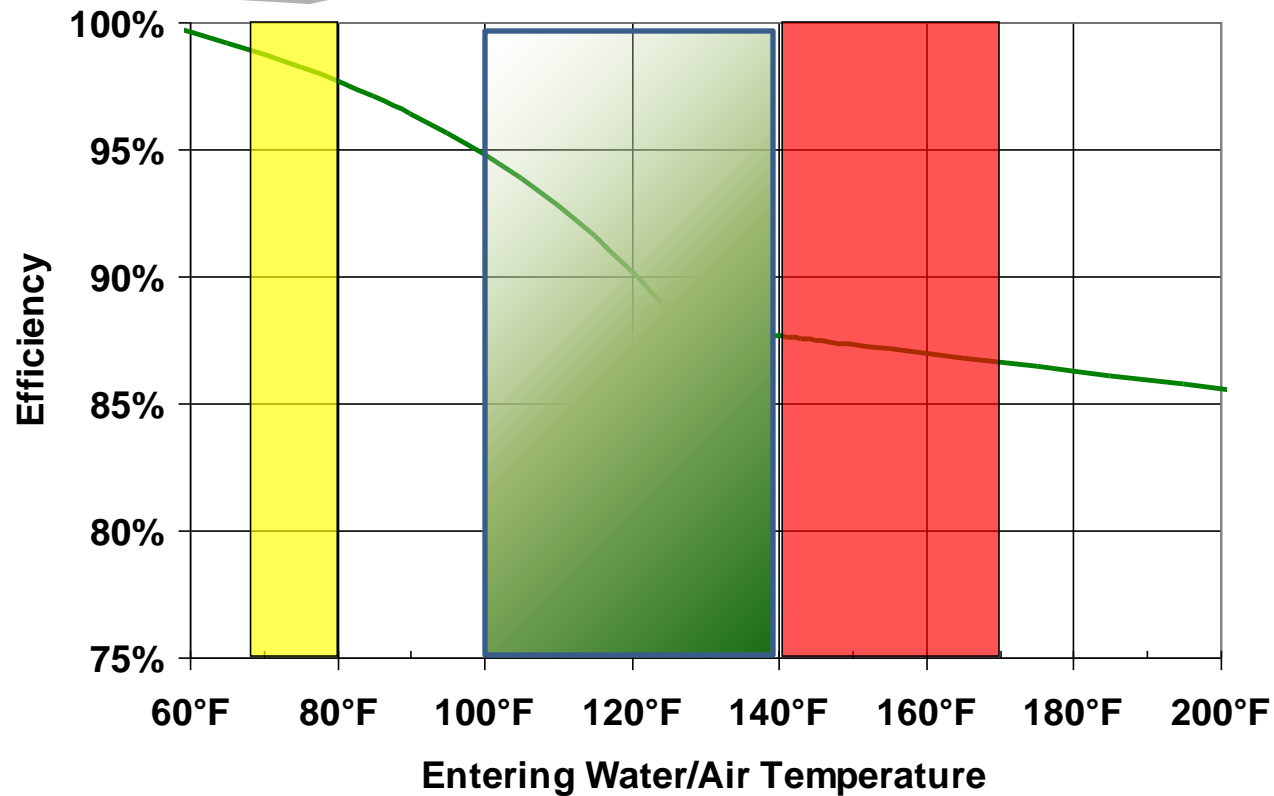
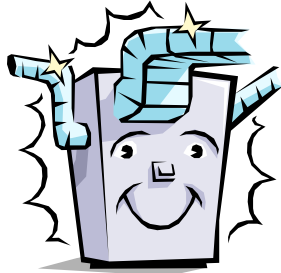
# Applying Condensing Boilers vs Furnaces



# Applying Condensing Boilers vs Furnaces

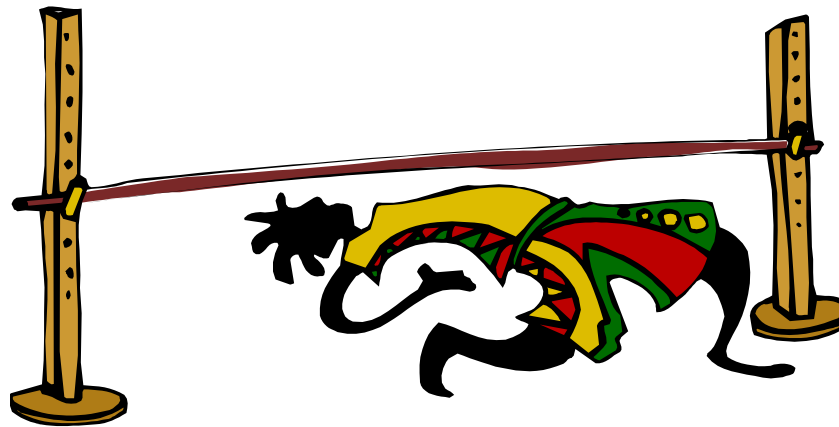


# Applying Condensing Boilers vs Furnaces



# 3 Rules for “Energy Value” of Condensing Boiler System

- 1) Low Return Water Temperature!
- 2) Low Return Water Temperature!
- 3) Low Return Water Temperature!

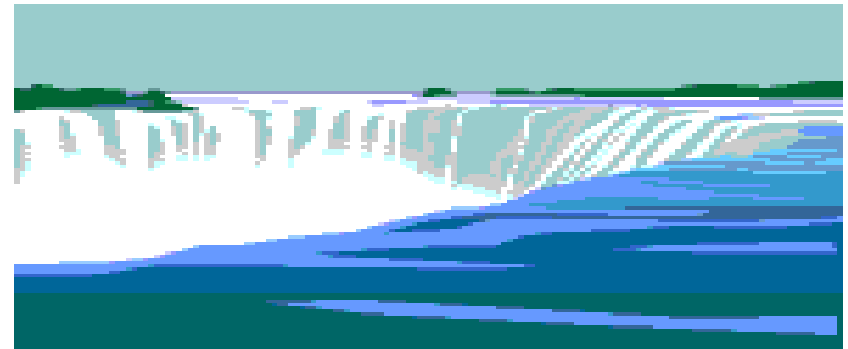


# Getting Heat from One Fluid to Another

- Heat naturally flows “Downhill” from hot to cold
  - The bigger the temperature difference, the faster the heat flows



- The bigger the area, the faster the heat flows



# Getting Heat into a Space in a Building: “Typical” Central System



Gas, Coal or Oil  
3,500 – 4,000°F

Avg Boiler Water 170°F

Boiler

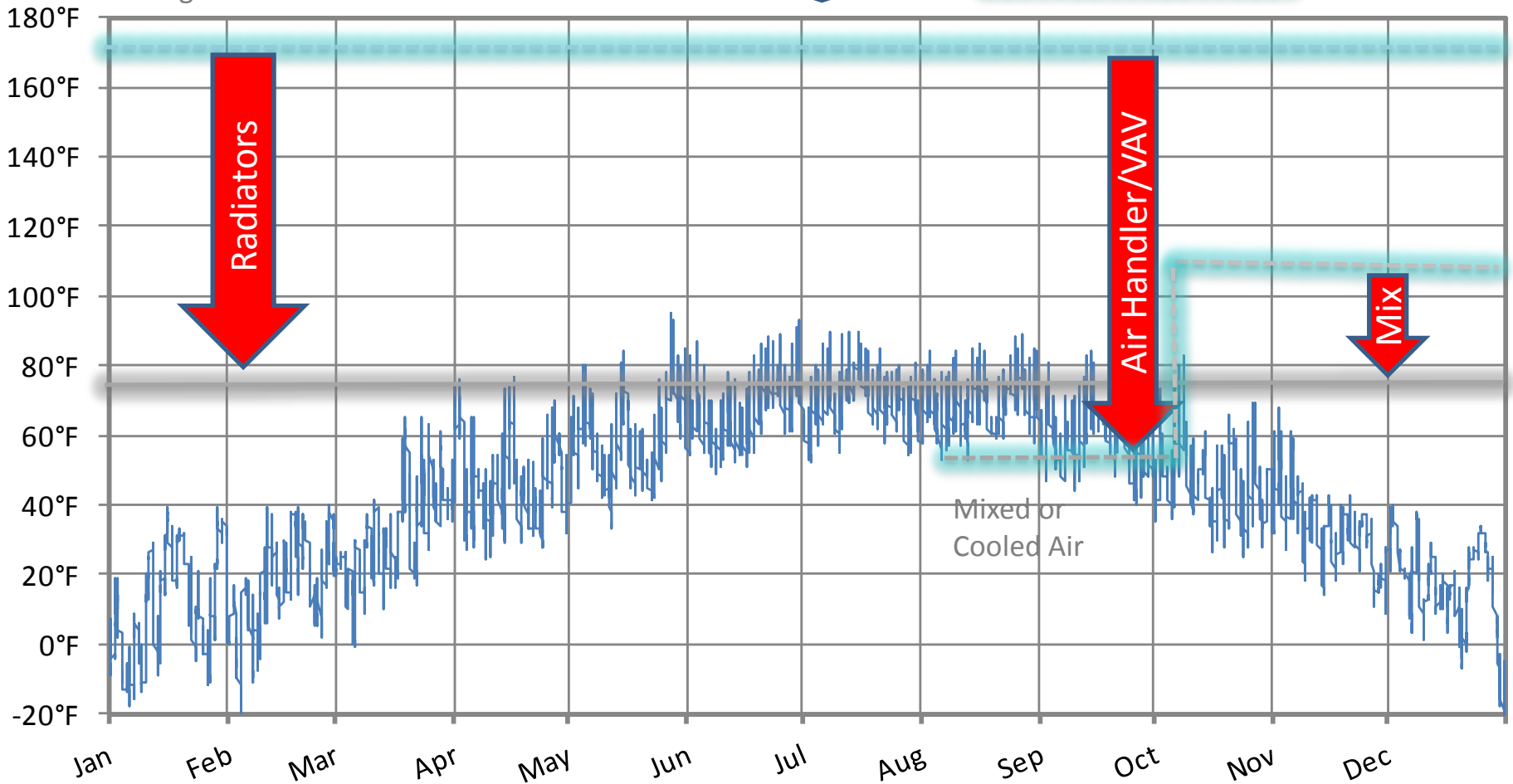
~350 to 400°F

Radiators

Air Handler/VAV

Mix

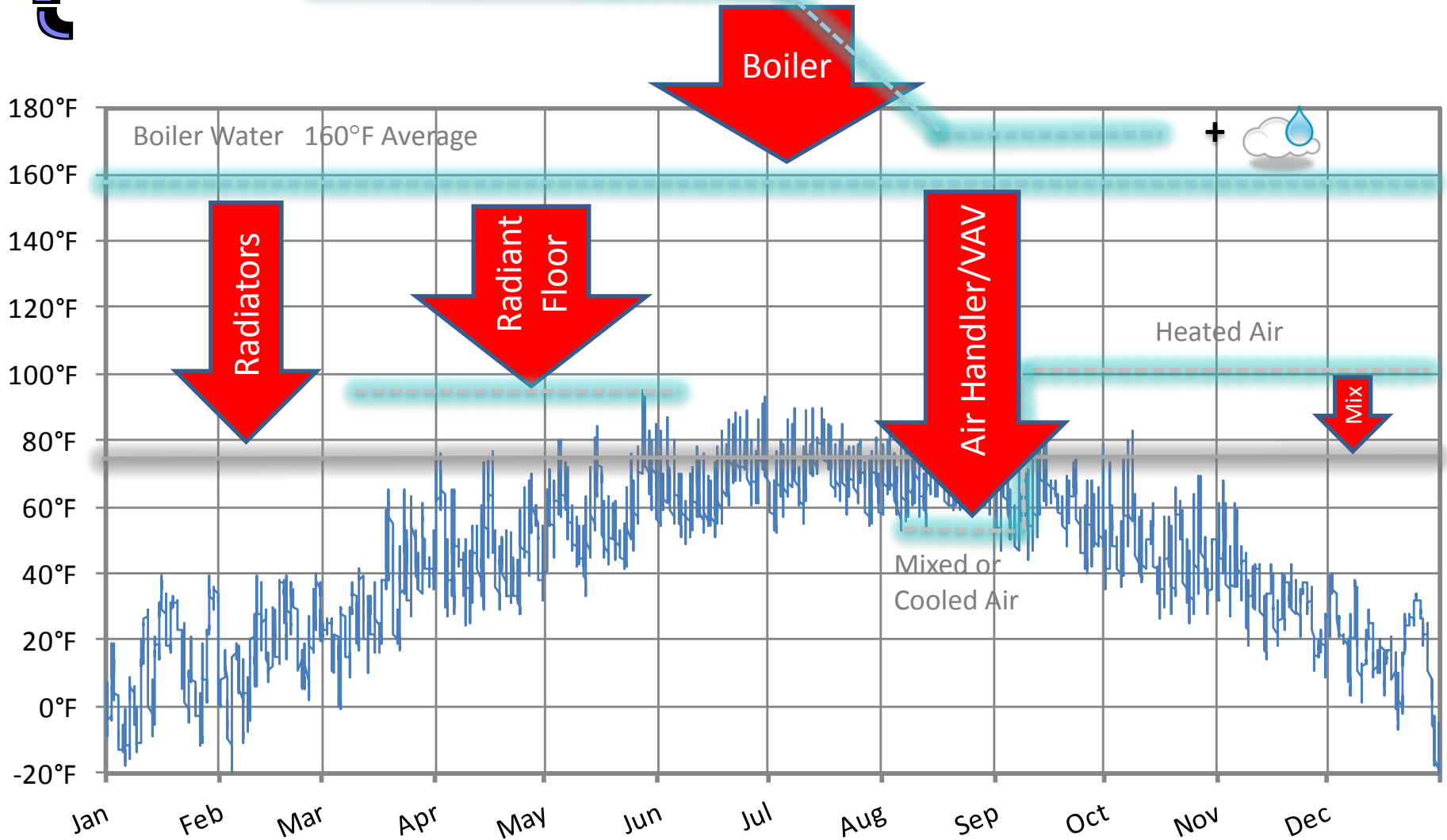
Mixed or  
Cooled Air





# Central System Designed for Condensing Boiler

Gas at 3,500°F





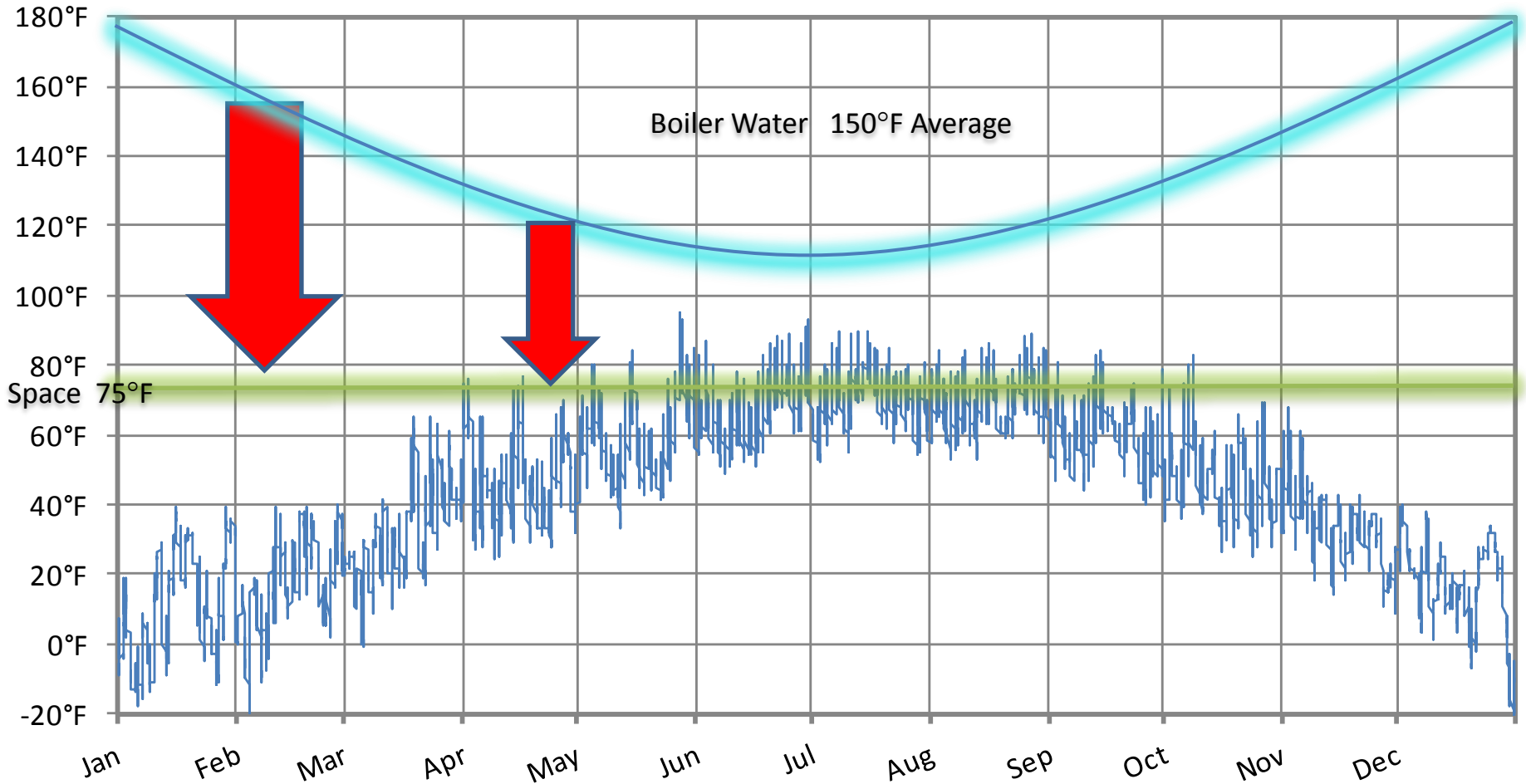
# System and Load Affects on Condensing Boiler Efficiency “Boost”

- Outdoor reset control
  - Lower return water temperature = condensing boiler efficiency improvement
  - Reduces load from overheating and pipe heat loss
- Lower flow (e.g. pump VSD & 2-way valves)
  - Pump energy savings
  - Low return water temperature = condensing boiler efficiency improvement



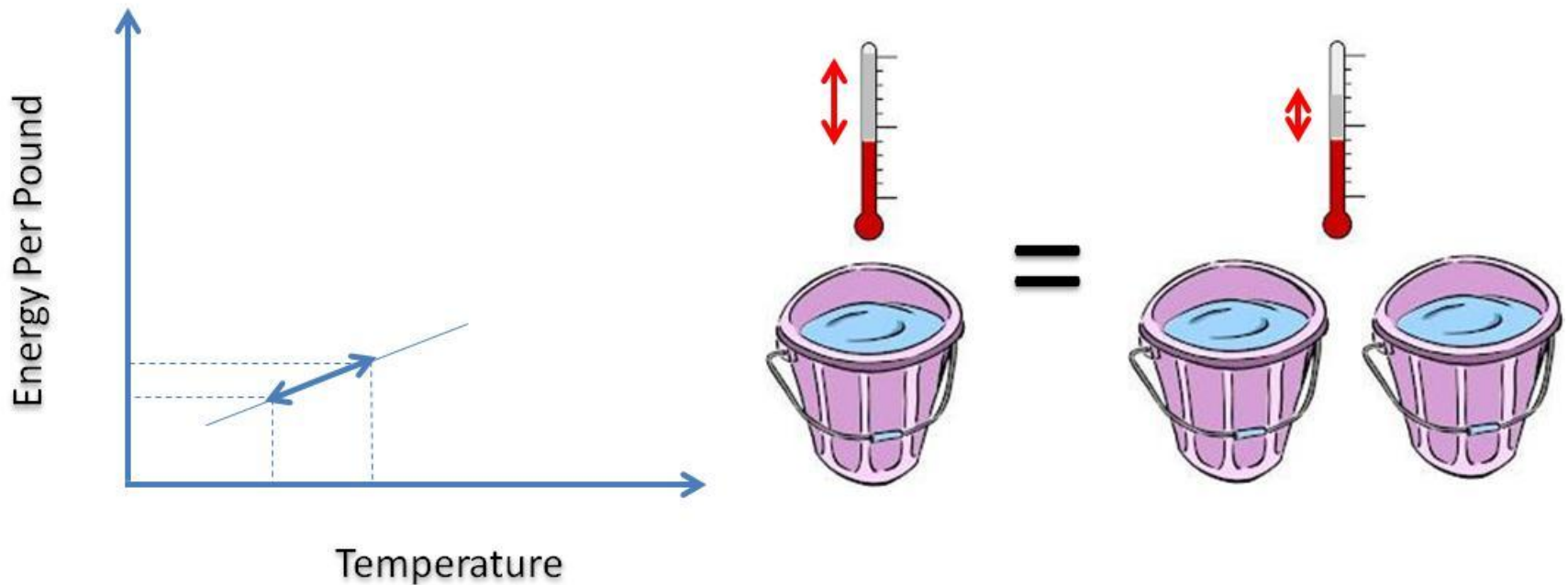
# Outdoor Reset Lowers Water Temperature

As the heating load goes down, less temperature difference is needed to drive the heat flow.



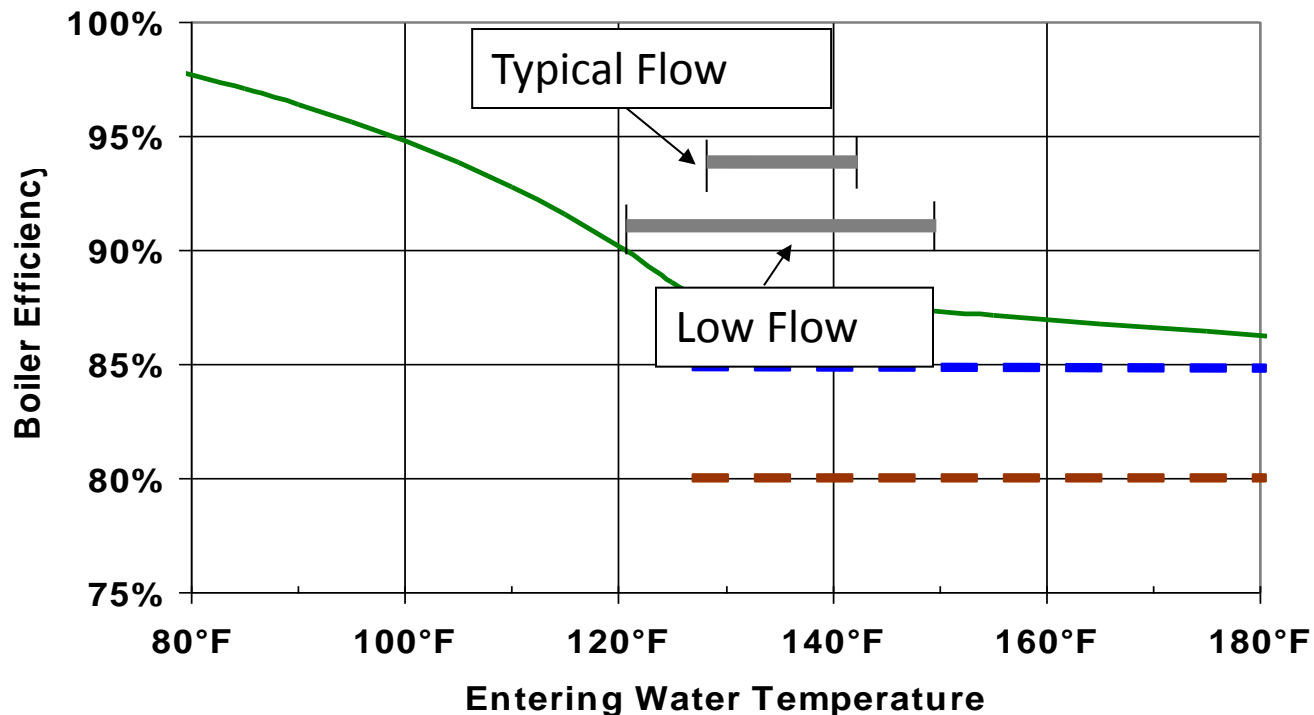
# Reducing Flow in Buildings

- Heat carried by water or air
  - Depends on temperature change (TD or  $\Delta T$ )
  - Depends on water or air flow rate

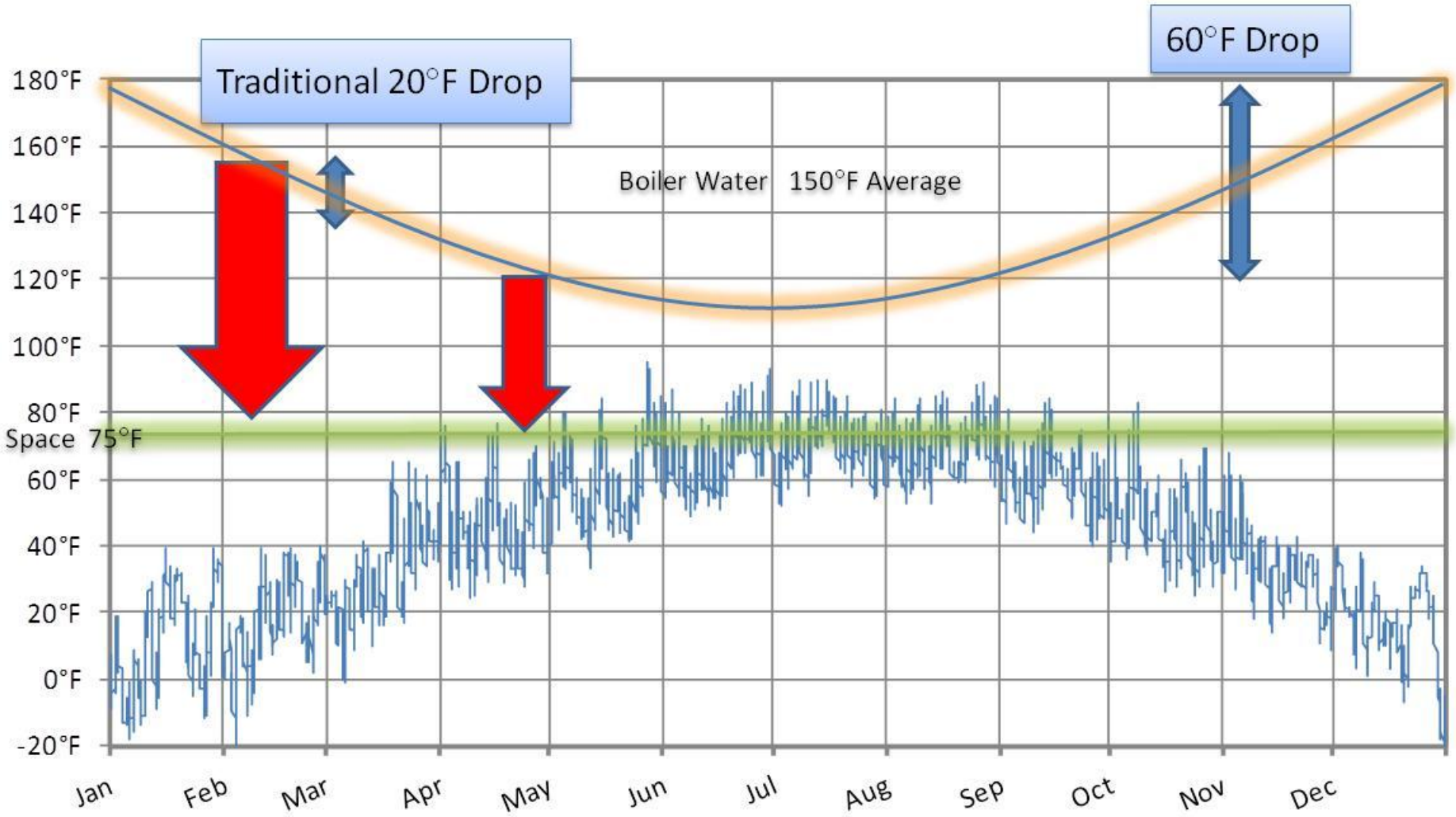


# System Piping: Driving return water temperature down

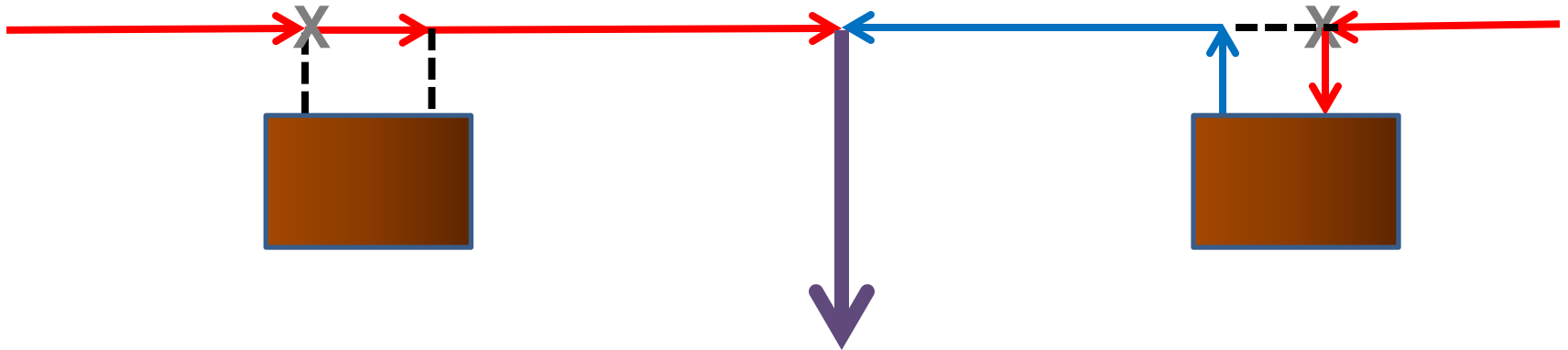
- Avoid 3-way/4-way valves on main line
- Reduced flow brings down return temperature
- If mixed boilers – cold water & max load to condensing



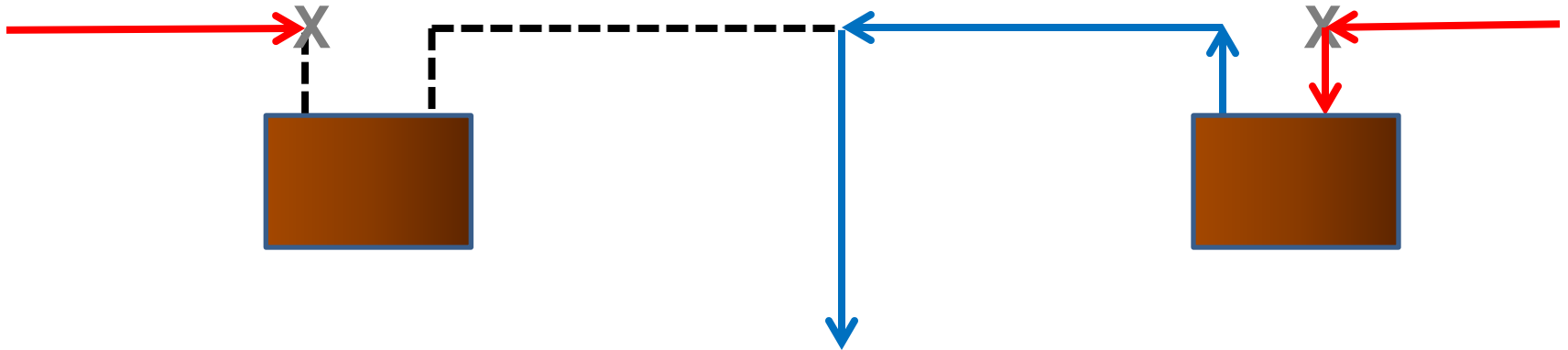
# Combined Outdoor Reset & VSD



# Reducing Flow & Return Temp: 3-Way Valves

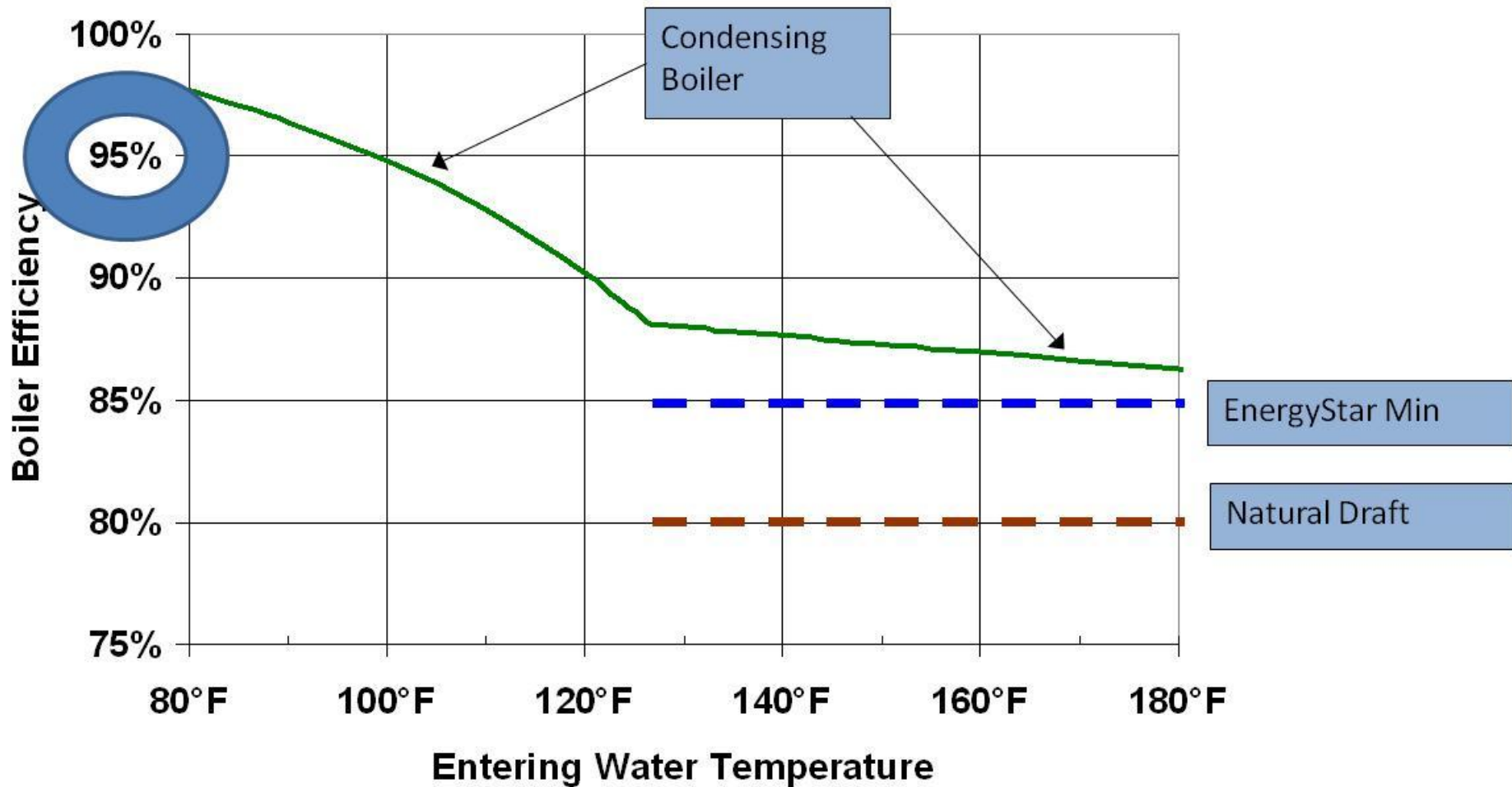


# Reducing Flow & Return Temp: 2-Way Valves



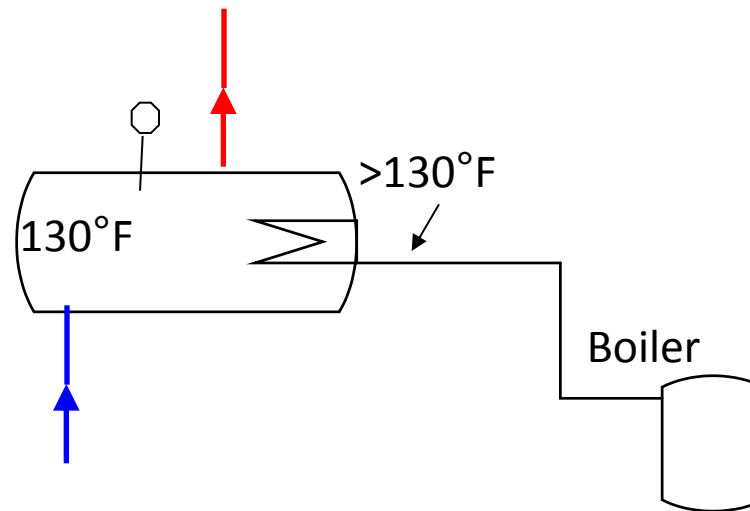
- Lower Temperature
- Lower Flow

# Getting The “Rated” Efficiency Boost Out of Condensing Boilers (>90% Efficiency)





# Service Hot Water: Driving Return Water

- Traditional coil-in tank requires high boiler temperatures
  - Efficiency > traditional water heaters
  - Efficiency sacrificed with condensing equipment








# Key Design & Application Considerations: Preventing Problems

- General load & system issues
  - Ability to provide adequate heat w/low return temperatures
  - Ability to reduce flow rate w/out branch balance problems
  - 2-way valves on loads to replace 3-way valves
- Product-specific issues
  - Control coordination
  - Small water passages in old cast iron system
  - Pressure drop compatibility with system
  - Flow rate compatibility (short-cycling)
  - Dual temperature inlets



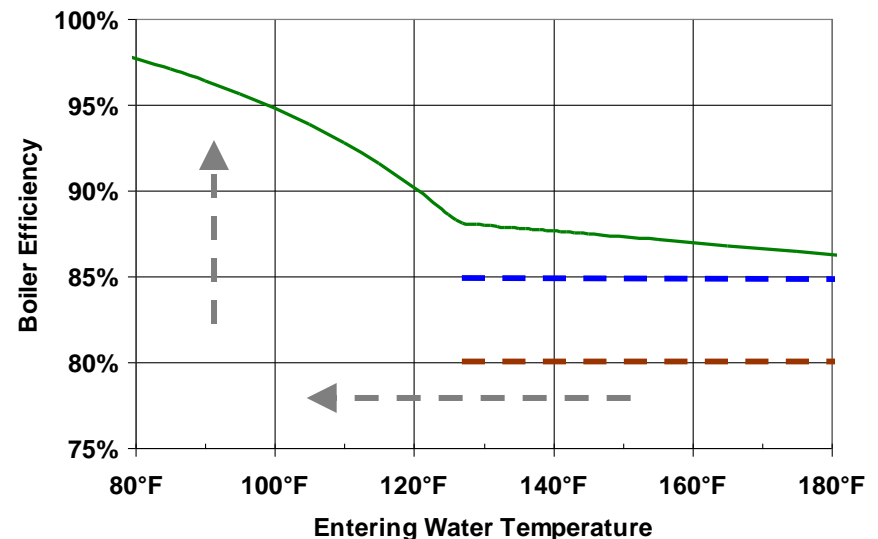
# Key Design & Application Considerations: Preventing Problems (cont.)

- Venting Considerations
  - Design and installation details to deal with condensate
  - Sidewall venting can cause moisture problems with large boilers
  - Orphaned water heater
  - Vent cost key factor @bottom of hi-rise



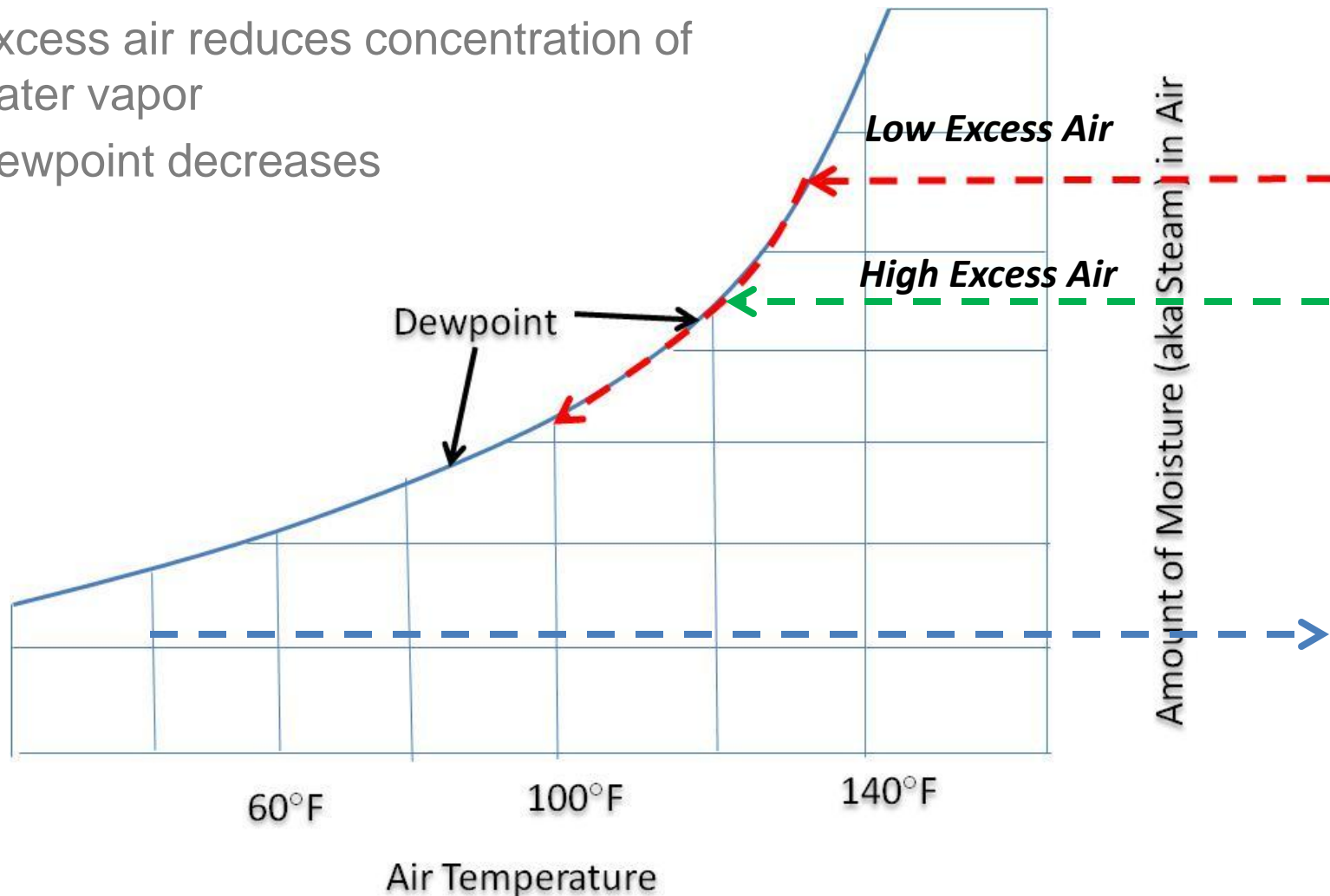
# Key for Condensing Boiler Efficiency: Driving Return Water Temperature Down

- ☑ Space heating elements
- ☑ System piping
- ☑ System control—pump
- ☑ System control—temperature
- ☑ Service hot water

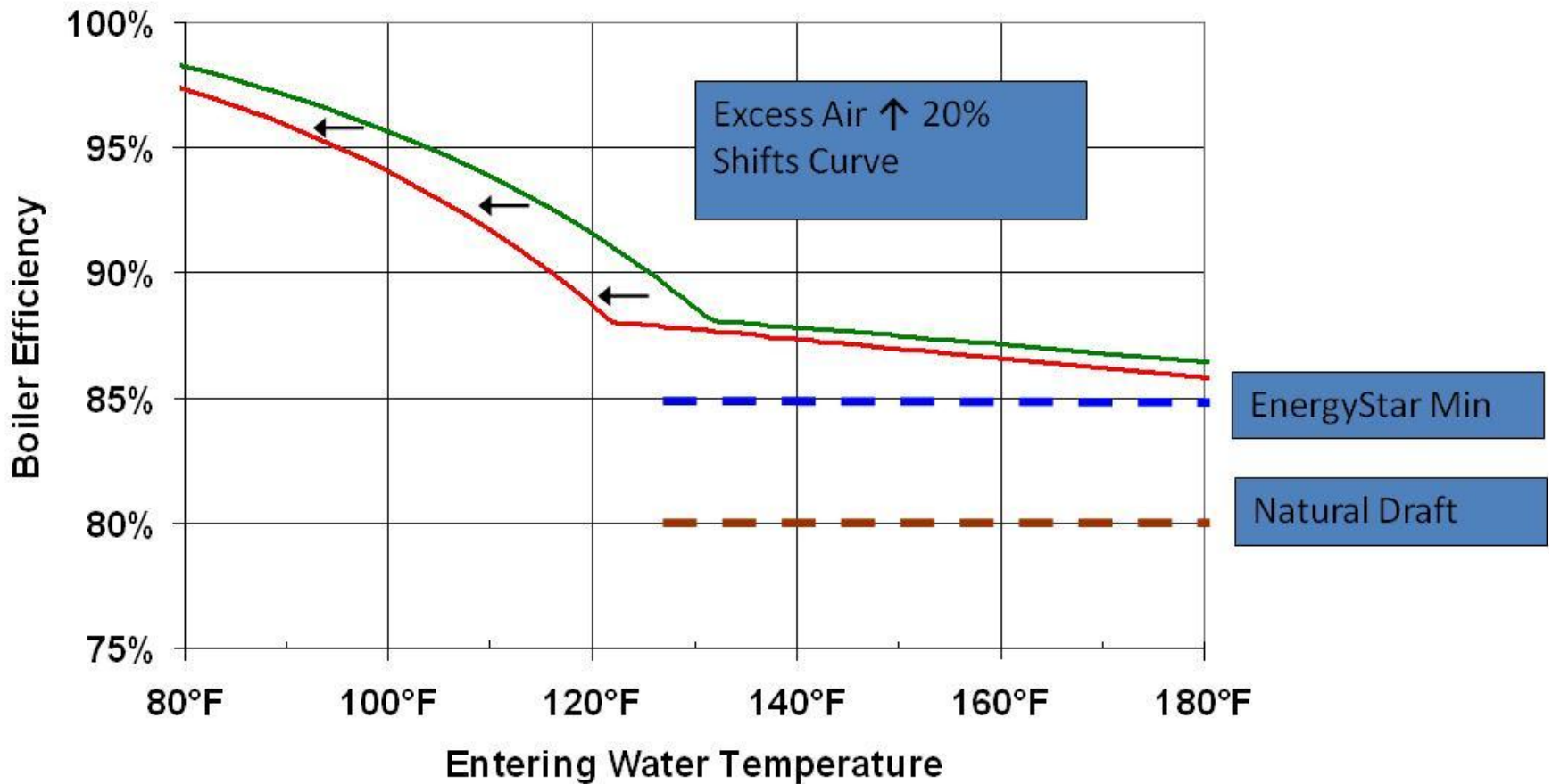


# Condensing Boiler Sensitivity to Excess Air

- Controlling excess air even more important
  - Excess air reduces concentration of water vapor
  - Dewpoint decreases



# Traditional Factor of Burner “Excess Air”



# Acknowledgements

- This project was supported in part by a grant from the Minnesota Department of Commerce, Division of Energy Resources through the Conservation Applied Research and Development (CARD) program





# Project Overview: Condensing Boiler Optimization

- Market Study & Site Selection
- Monitoring & Analysis of 12 Building
  - 4 Education
  - 4 Multifamily
  - 4 Government/Office
- Industry Survey of CIP Program Options
- Dissemination





# Minnesota's Condensing Boiler Market: Preliminary Findings

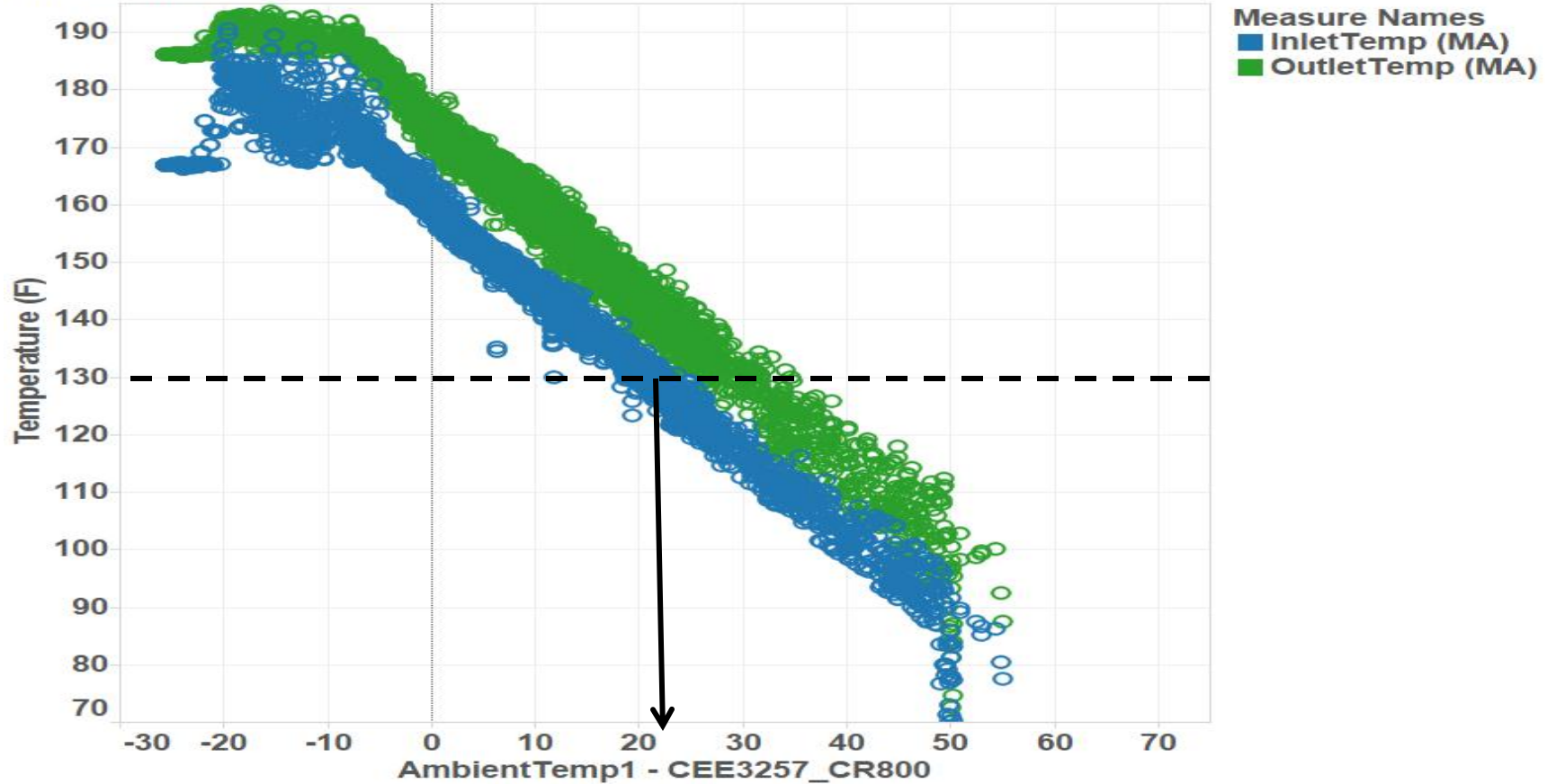
- Condensing boilers have become the default choice
- Used in all building types that have space heating boilers
- Manufacturer's reps acknowledge often suboptimal situations
- Part-load efficiency improvements may be significantly overstated in some cases





# Water Temperatures: Outdoor Temperature When 130°F Reached

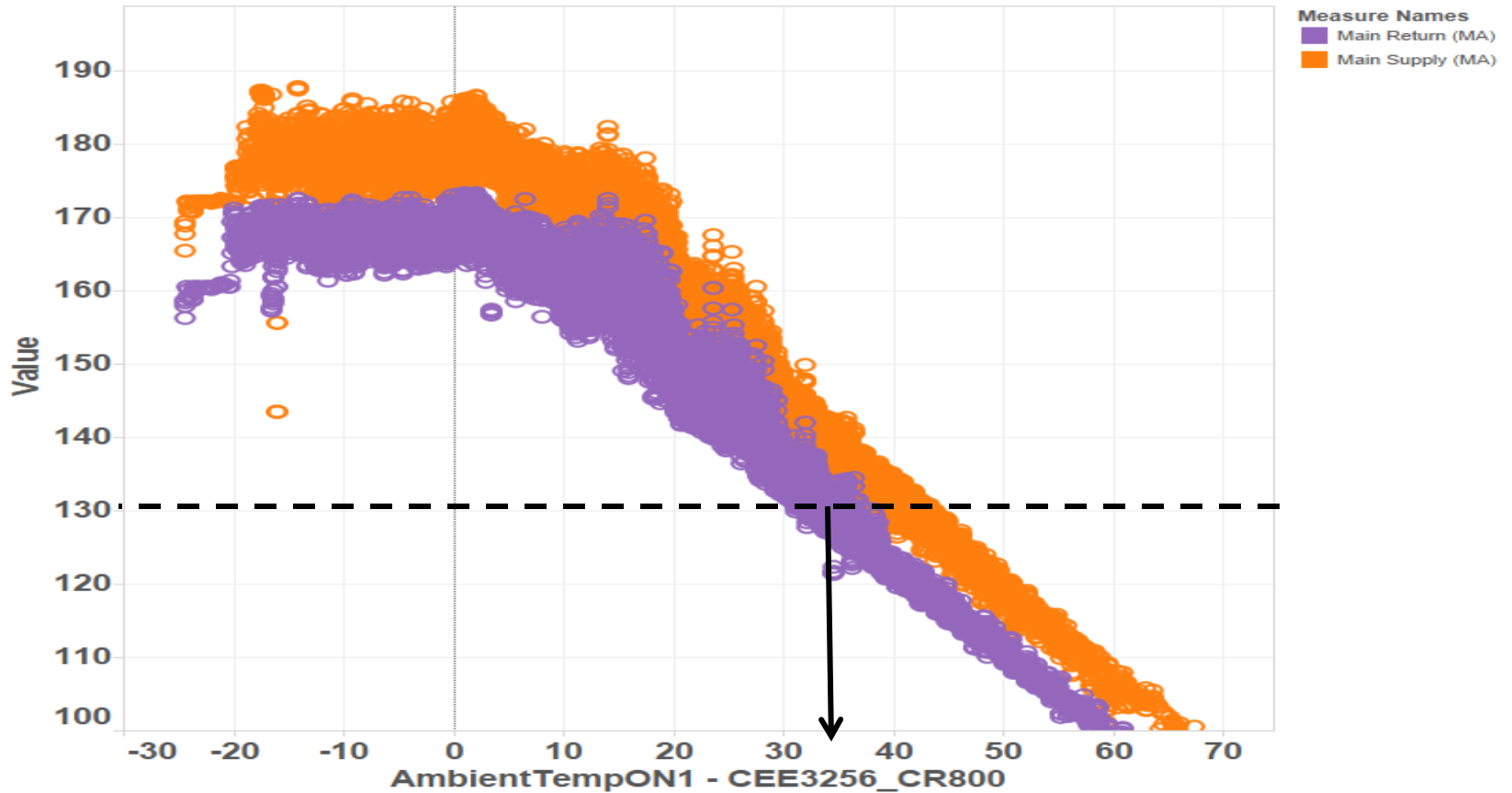
Boiler Temps vs OAT



Preliminary Results

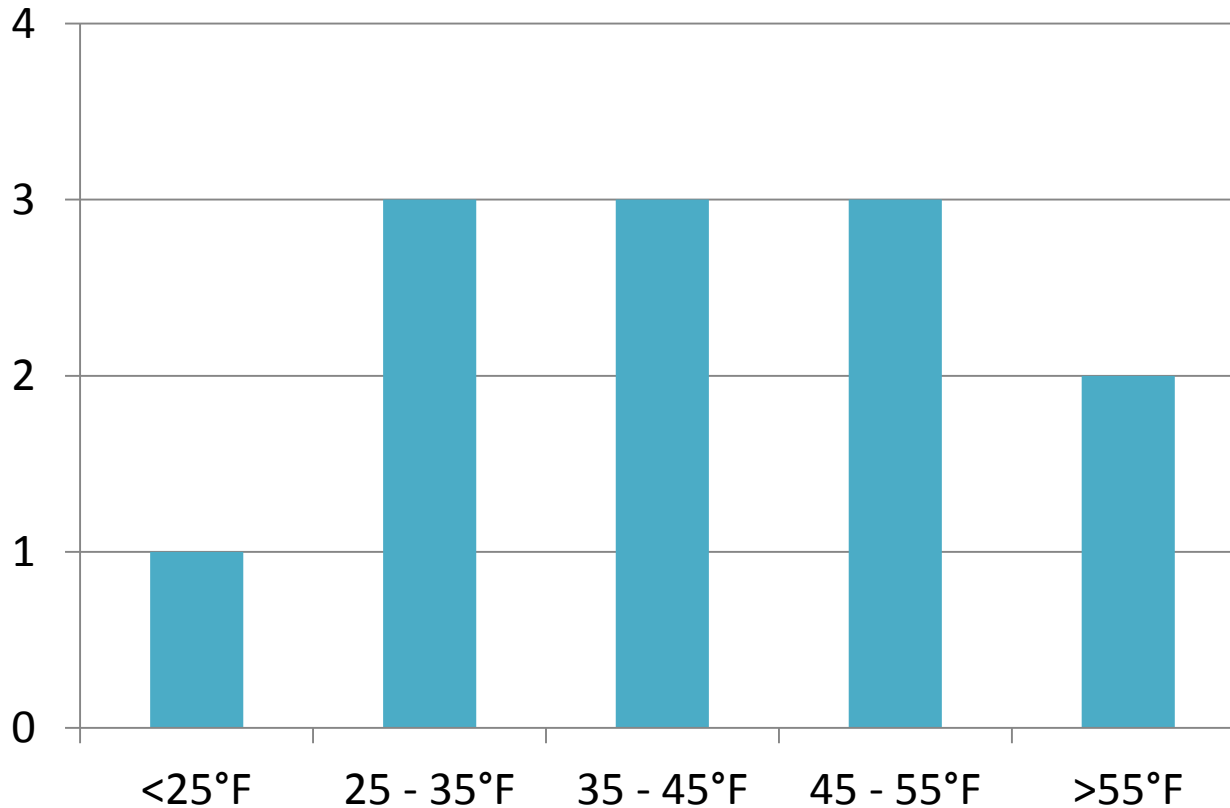
# Water Temperatures: Outdoor Temperature When 130°F Reached

Main Return vs OAT



Preliminary Results

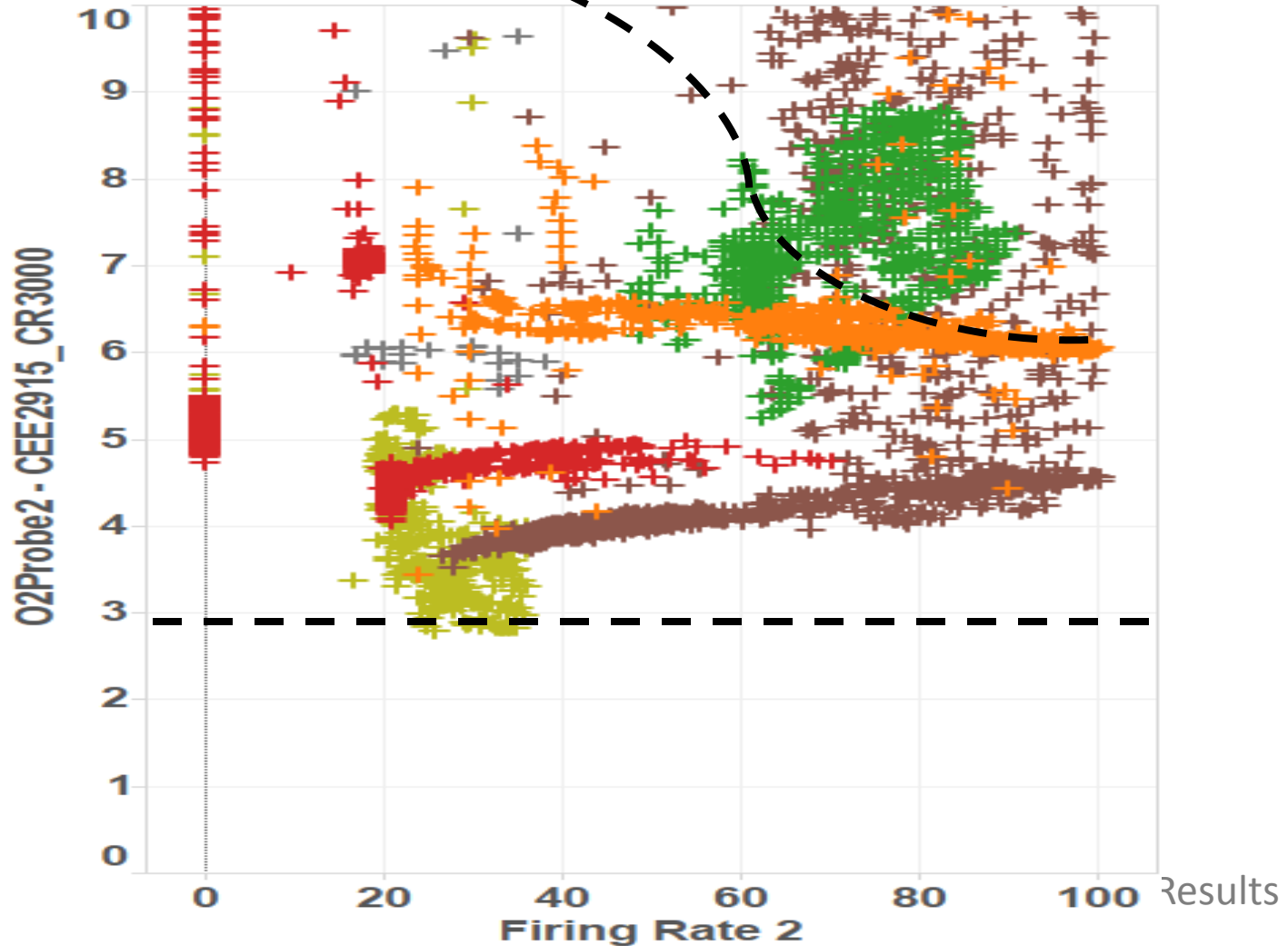
# Water Temperatures: Outdoor Temperature When 130°F Reached

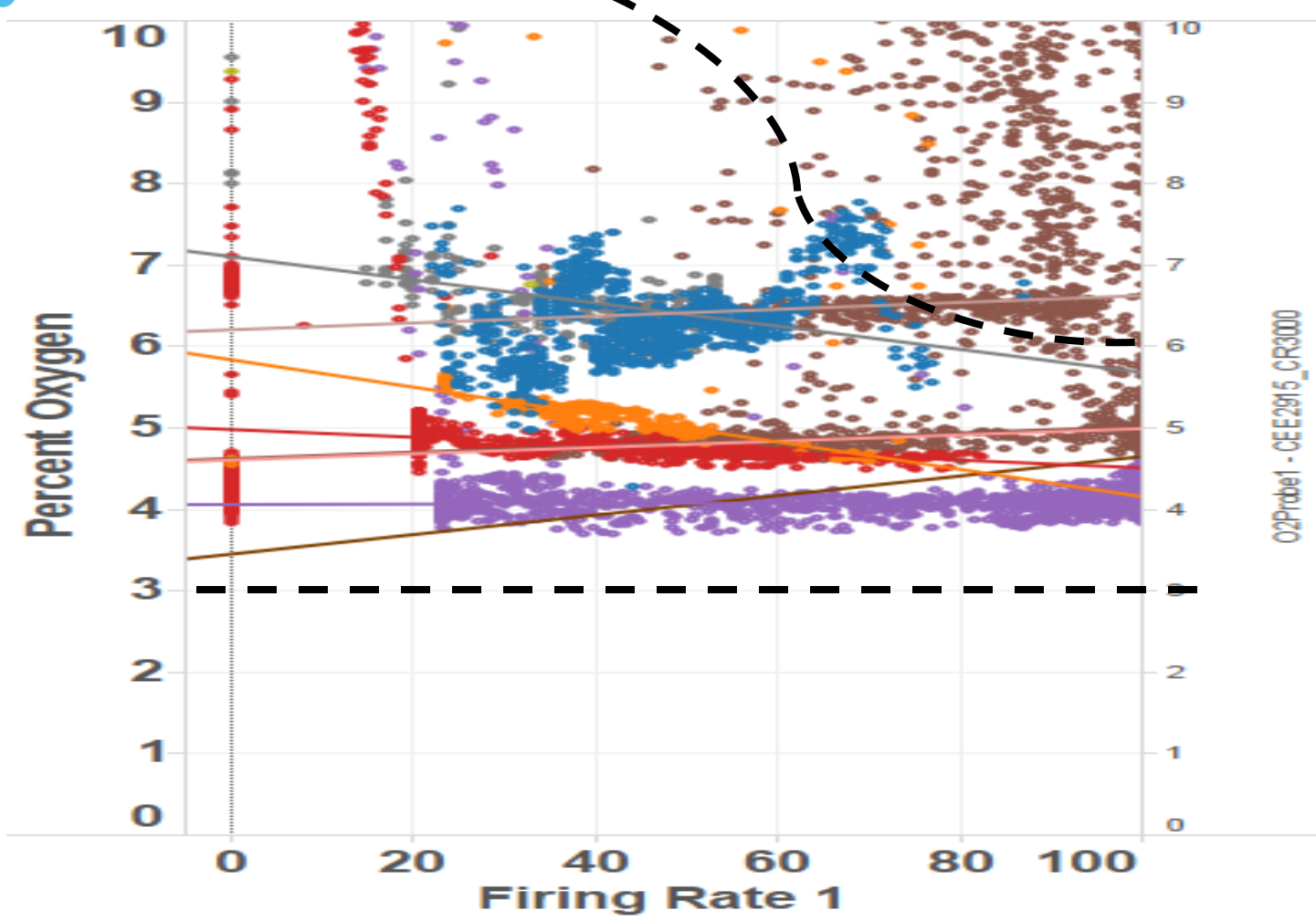


Preliminary Results

# Excess Air Variations

O1 vs. OAT w/ firing rate > 10 All





Preliminary Results

# • In Conclusion...

- Condensing boilers can be a great, green investment
- Success depends on different approach by all
  - Minimize return water temperature!
    - Outdoor reset control
    - Reduce flow through building
    - Solve zone specific issues
  - Boiler tuning of air-fuel ratio is even more critical with condensing boilers
  - Control coordination must be well thought out & verified





# Resources...

- High Efficiency Boiler Information
  - Air-Conditioning, Heating, and Refrigeration Institute ([www.ahrinet.org](http://www.ahrinet.org))
  - EnergyStar.gov
  - California Energy Commission web site
  - Consortium for Energy Efficiency  
[www.cee1.org/gas/gs-blrs/gs-blrs-main.php3](http://www.cee1.org/gas/gs-blrs/gs-blrs-main.php3)  
[www.cee1.org/gas/gs-blrs/Boiler\\_assess.pdf](http://www.cee1.org/gas/gs-blrs/Boiler_assess.pdf)
  - CEE web site

THANK  
*you!*

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