Pacific Northwest
NATIONAL LABORATORY
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Large Commercial Buildings: Re-tuning for Efficiency

Economizer Operations: Pre-Re-Tuning and Re-Tuning

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Economizer Fundamentals

The Basics of Air-side Economizers

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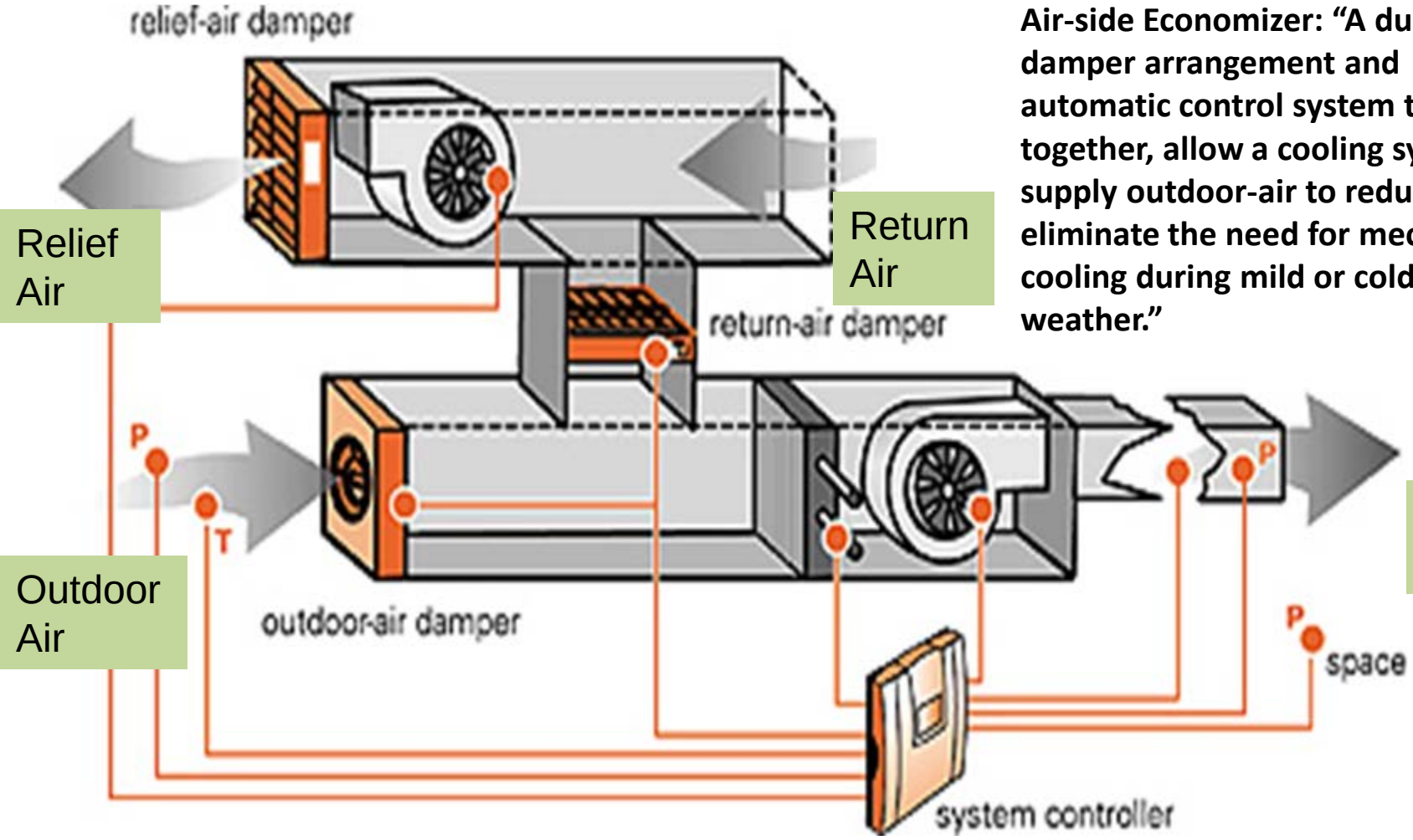


Air-side Economizer: "A duct-and-damper arrangement and automatic control system that, together, allow a cooling system to supply outdoor-air to reduce or eliminate the need for mechanical cooling during mild or cold weather."

Source: ASHRAE Standard 90.1-2004

Air-Handling Unit: Economizer (continued)

- Reality:
  - Air-side economizing uses unconditioned outdoor-air to cool (or heat) a space
  - There are 2 air streams we can use for makeup supply-air
    - Outdoor and return
  - Outdoor and return dampers need to sequence together to mix and balance air flow streams to match needs of air-handler discharge conditions
  - In cooling mode, as long as the outdoor-air is cooler than the return-air, we should be using it even if mechanical cooling is required
    - In humid climates, use economizers when outdoor-air temperature is 5^{o}F to 10^{o}F below return-air temperature

Air-Handling Unit: Economizer (continued)

- Which air stream is most efficient to use at a specific condition?
  - Dry-bulb condition cooling comparison
    - If outdoor-air is cooler than return-air, use it (most dry climates)
  - Building is heating, use minimum outdoor-air
    - Do not use outdoor-air when pre-heating or during unoccupied fan operations

Air-Handling Unit: Economizer Operation – What to Look for?

- Purpose
  - To determine whether air-side economizers are operating properly
    - Do economizers open, close, and/or modulate under appropriate conditions?
    - At what temperature compared to the discharge-air temperature?
    - At what apparent control signal values do the economizers open?
    - Does the cooling coil operate (chilled water flow) during economizing?

Air-Handling Unit: Economizer Operation (continued)

- Approach
  - For each air-handling unit with air-side economizer, review plots:
    - Outdoor-air temperature, mixed-air temperature, return-air temperature and discharge-air temperature vs. time
    - Outdoor-air damper position (% open), outdoor-air temperature, and return-air temperature vs. time
    - Outdoor-air damper position and chilled-water valve position (% open) vs. time
  - Look for outdoor-air dampers (economizer) open at unusual times of day or under unusual outdoor temperature conditions
  - Look for outdoor-air dampers not open to economizer under favorable conditions (outdoor-air temperature between 40°F and 60°F)
  - Look for outdoor-air damper not closing to minimum position for freeze prevention when outdoor temperature is less than about 35°F

Air-Handling Unit: Economizer Operation (continued)

- Potential issues to identify
  - Incorrect economizer operation – numerous causes
    - Incorrect control strategy
    - Stuck dampers
    - Disconnected or damaged linkages
    - Failed actuator
    - Disconnected wires
    - Failed, un-calibrated or mis-calibrated sensors
    - 2 X 4 in damper
    - Others?

Air-Handling Unit: Economizer (continued)

- Does the trended data indicate that the outdoor-air damper command is wide open before mechanical cooling is used?
  - If not, this could be indicative of poor economizer control
- Does the trended data indicate that the mixed-air temperature is within 4-5°F (accounting for heat gains from supply fan) of the outdoor-air temperature, when the outdoor-air damper command is wide open?
  - If not, this could be indicative of failed damper actuator, loose linkages or busted damper seals/sections
- Does the trended data indicate that the mixed-air temperature is within 4-5°F of the return-air temperature, when the outdoor-air damper command is at a minimum position?
  - If not, this could be indicative of failed damper actuator, loose linkages, broken damper seals/sections or excess supply-air static pressure/reduced return-air static pressure – all of which can result in failure of the ventilation system to properly use the outdoor- and return-air pathways for proper temperature control
- Is the minimum position 20% or less?
  - If not, this could be part of the problem with excess outdoor-air and excess energy costs for tempering the air streams

Why Economizers Fail and Increase Energy Use

- Jammed or frozen outdoor-air damper
- Broken and/or disconnected linkage
- Nonfunctioning actuator or disconnected wire
- Malfunctioning outdoor-air/return-air temperature sensor
- Malfunctioning controller
- Faulty control settings
- Installed wrong or wired incorrectly

Wired poorly

Jammed/Frozen Damper

Disconnected Damper

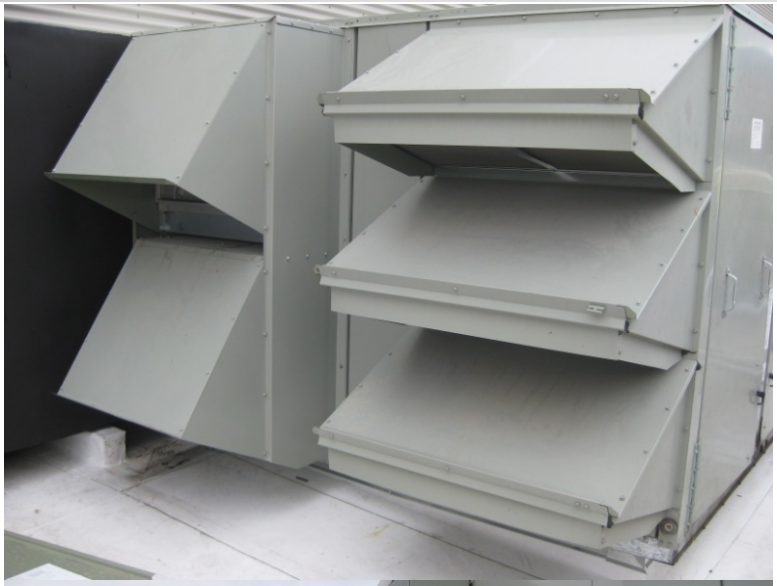
Source: Financial Times Energy

Packaged Rooftop Units with Economizers are Often Neglected, Hard to Access, or Installed Poorly

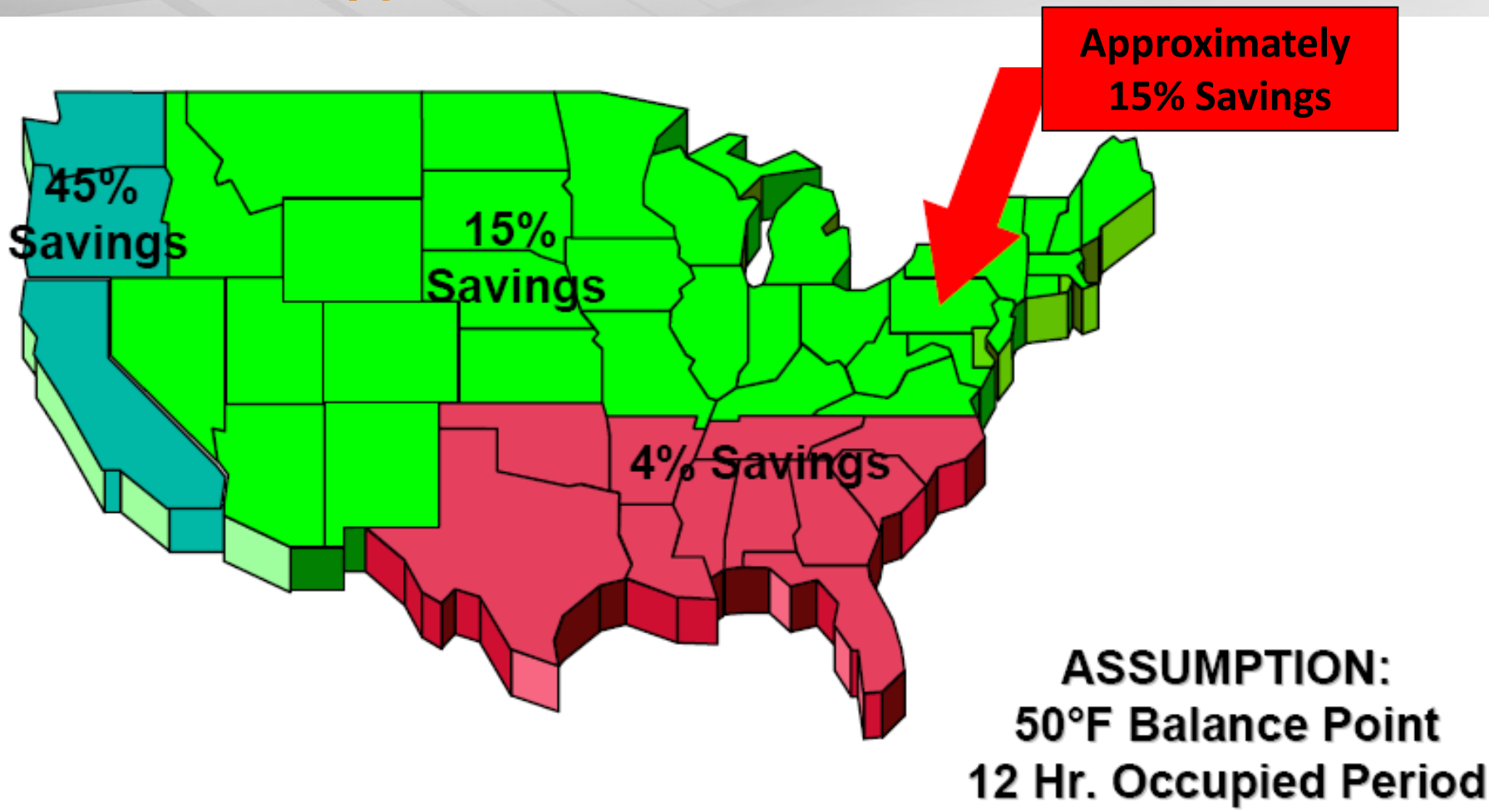
Poorly Installed Packaged Rooftop Units

- Economizer installed next to heat source from condenser

Inefficient Designs Contribute to Poor Air Circulation at Intake Air

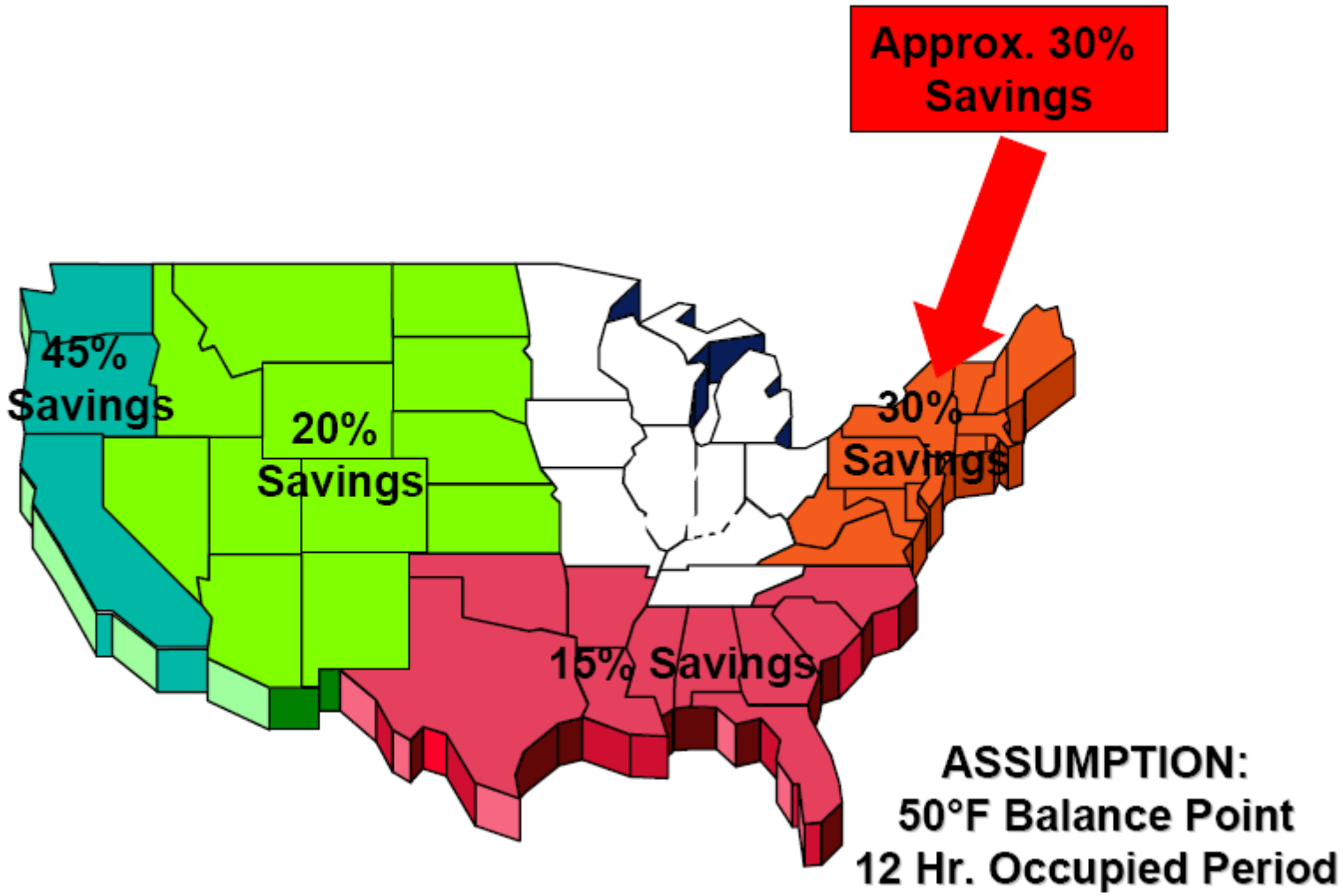


Potential Economizer Savings from High Limit Enthalpy Control



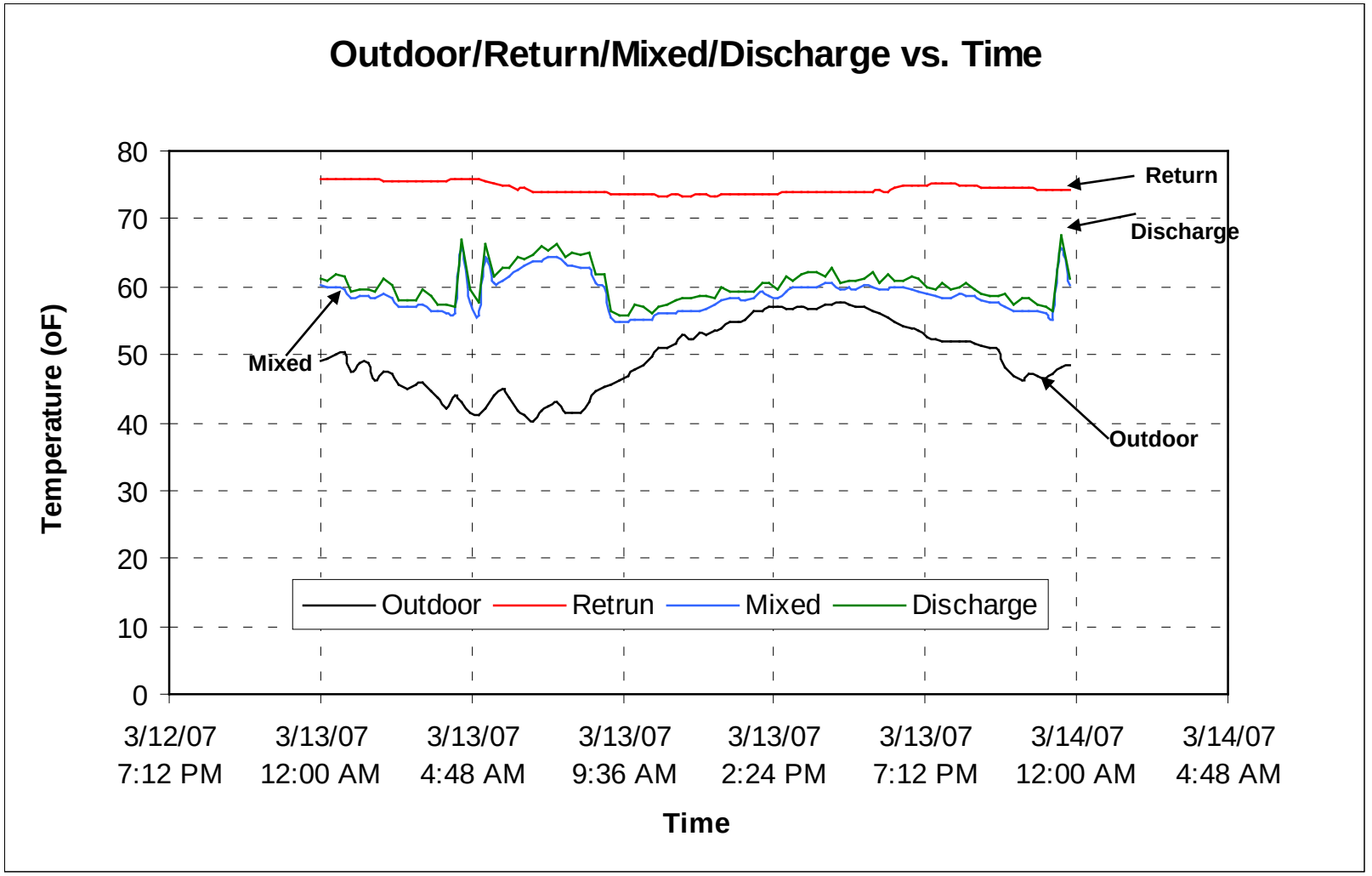
Source: Honeywell Controls

Potential Economizer Savings from Differential Enthalpy Control



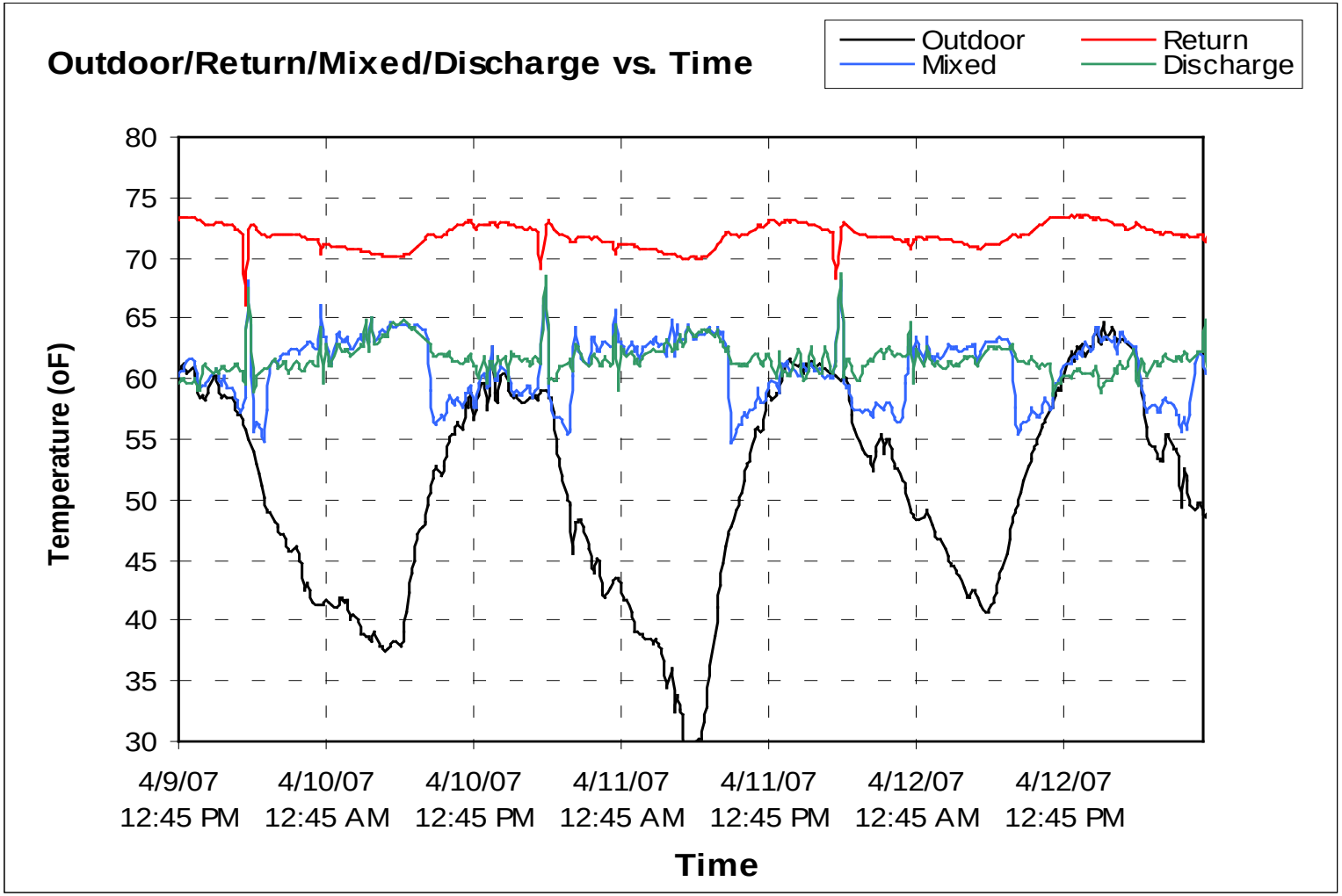
Source: Honeywell Controls

Air-Handling Unit: Economizer Operation - Example use of Graphs (1 Day)



Example of Good Operation

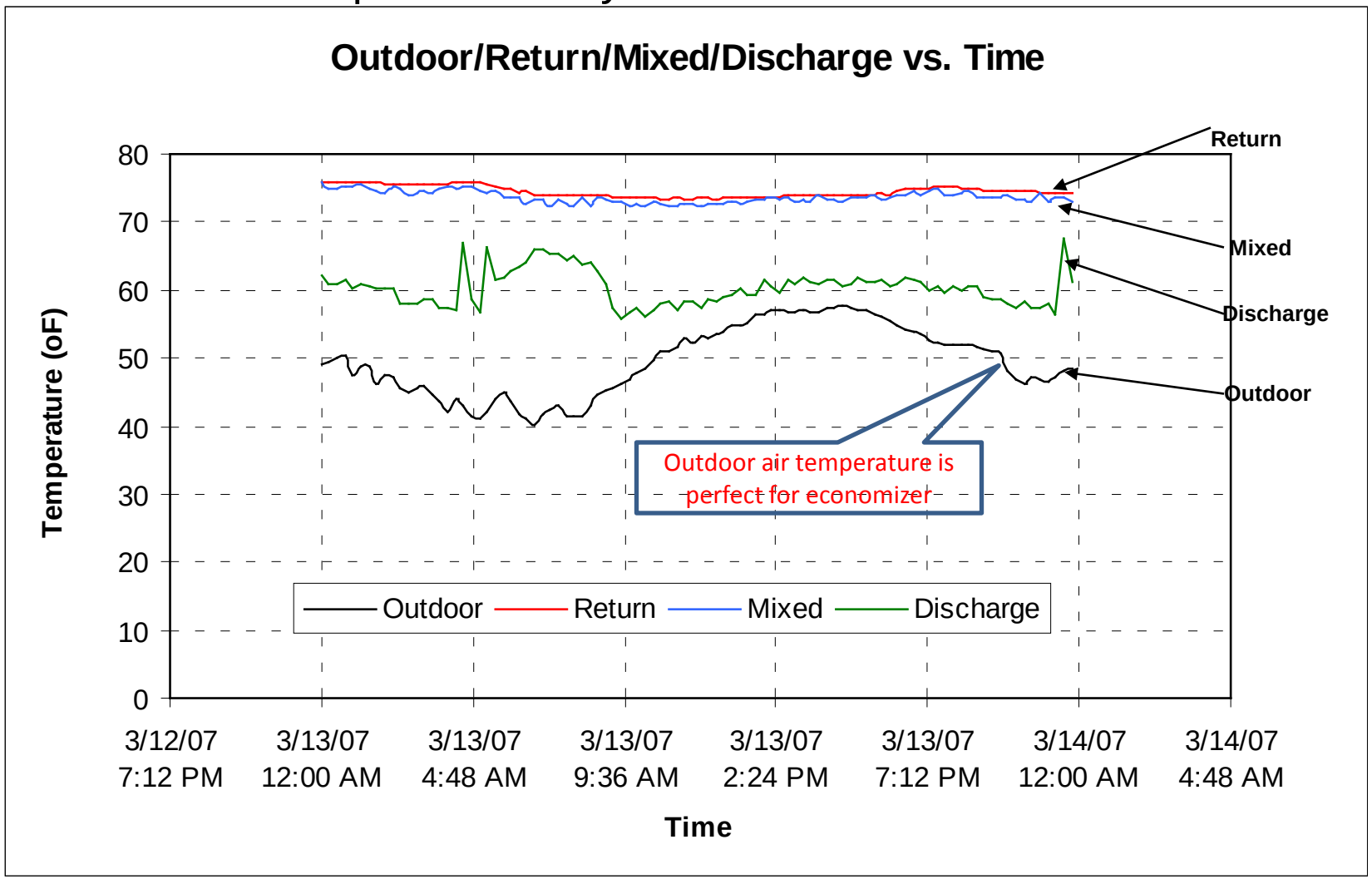
Air-Handling Unit: Economizer Operation - Example use of Graphs (3 Days)



Example of Good Operation

Air-Handling Unit: Faulty Economizer Operation - Example use of Graphs (1 Day)

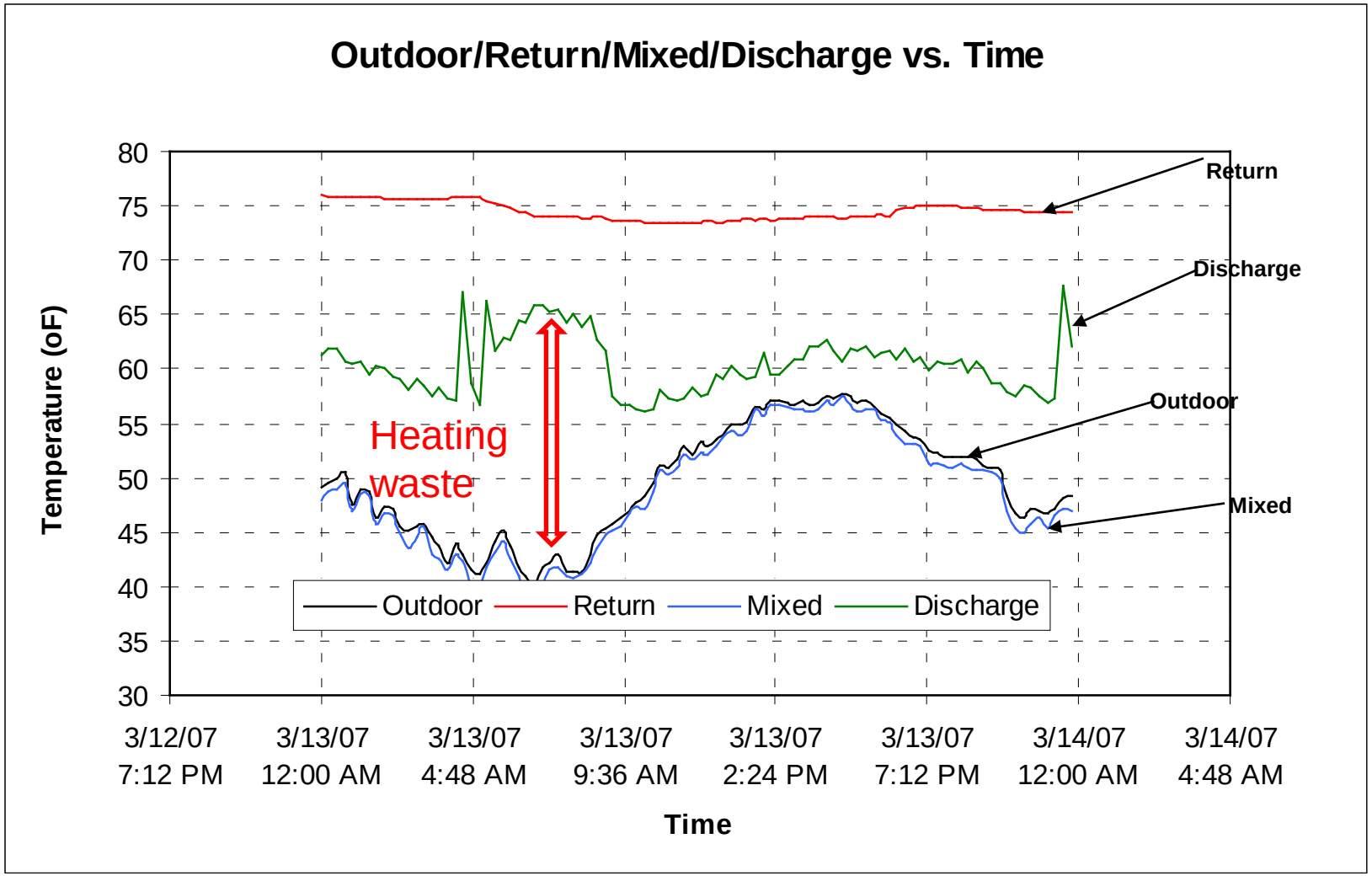
- Outdoor-air damper stuck fully closed



Example of Bad Operation

Air-Handling Unit: Faulty Economizer Operation - Example use of Graphs (1 Day)

- Outdoor-air damper stuck fully open



Example of Bad Operation

Air-Handling Unit: Suggested Economizer Operating Ranges

- Set economizer operating range as wide as possible
  - between 30°F and 75°F for dry climates
  - between 30°F and 68°F for normal climates
  - between 30°F and 65°F for humid climates

Air-Handling Unit: Economizer Operations

- Use economizer to control supply-air temperature directly when outdoor-air temperature is lower than the supply-air set point
  - Chilled water valve should be closed to avoid damper and valve fighting
- An averaging temperature sensor should be used for the mixed-air temperature measurement
  - Most mixing chambers do not achieve complete mixing of the return-air and outdoor-air before reaching the cooling coil

Air-Handling Unit: Dehumidification

- Very costly to operate
- Do not set relative humidity set point below 50%, preferably 55% to 60%
- Use chilled water reset to bring chilled water down (42°F), but only when dehumidification is required, otherwise, chilled water temperatures should stay warmer (48°F)
- Use lower air flows at air-handlers to give time for air to stay on coils
- Use lower discharge-air temperature set point associated with lower static set points to prevent zones from overcooling
- Try to avoid reheat functions - tricky to balance

QUESTIONS?