Building Retro-Commissioning Picture Show Part 2

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Sailing into the Future
Infuse Innovation, Research, and Development into Sustainability

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Learning Objectives

- Understand the motivation and methods for accomplishing Retro-Commissioning (R-Cx)
- Appreciate the value of R-Cx by considering 3 case studies
- Recognize some typical issues uncovered by Retro-Commissioning

What Will Be Covered

- Introduction
- The Retro-Commissioning Process
- Retro-Cx at Area School
- Retro-Cx at Area Office
- Retro-Cx at Area Church
- Interesting Findings from Other Projects
- Summary
- Retro-Cx Resources

Retro-Cx Effort at Area School

Case Study 1

- Built in 1960's
- Several additions in 1980's and 1990's
- Total area of 250,000 ft^2
- 30 Air Handling Units
- Mix of Constant Volume and VAV
- 7 Boilers and 2 Chillers

Main concern is energy consumption

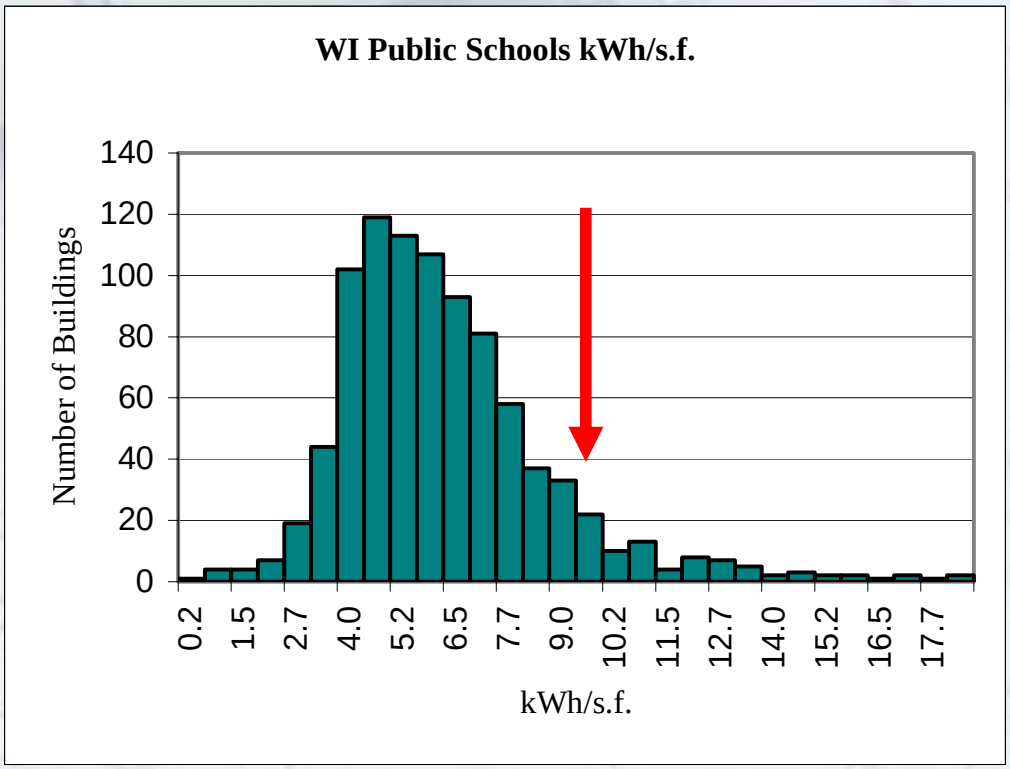
Retro-Cx Effort at Area School

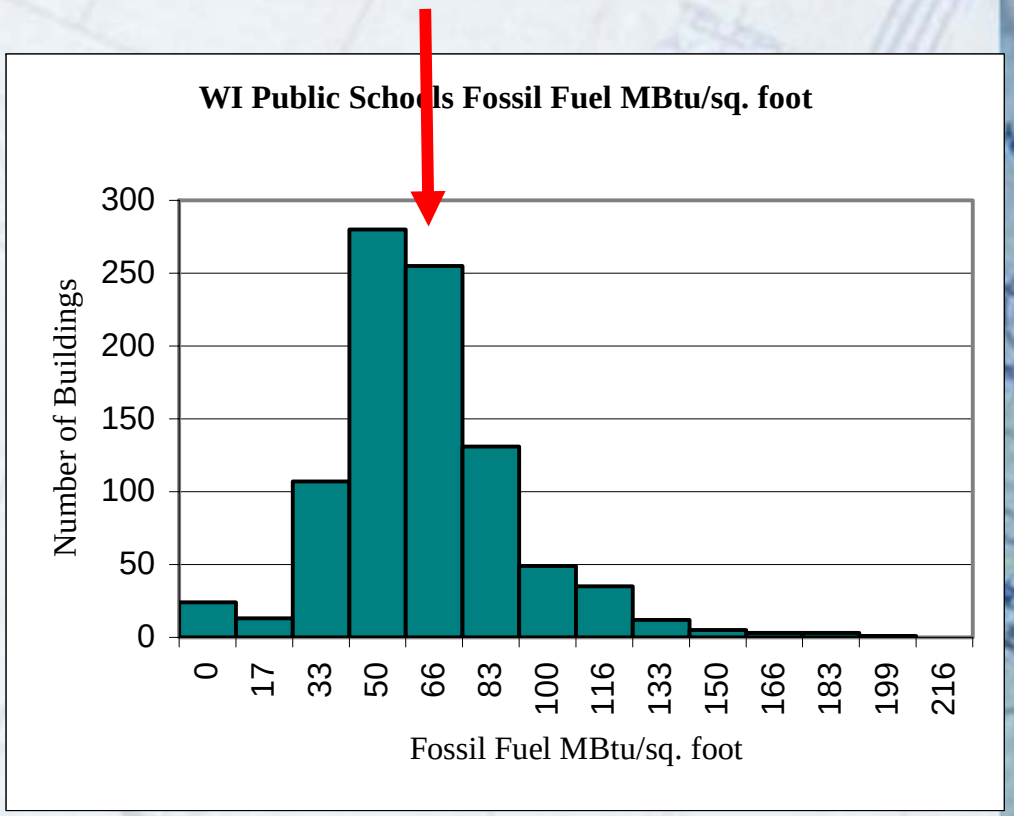
Case Study 1

Annual consumption:

State School Average: 5.5 kWh/sq. foot; 50 MBtu/sq. foot

Case Study School: 9.5 kWh/sq. foot; 62 MBtu/sq. foot





Retro-Cx Effort at Area School
Case Study 1

- A heating system controller was installed to allow for proper sequencing of all boiler units.
- The hot water system has been modified to allow for variable flow operation.
- Schedules have been modified to reflect space occupancy patterns for each air-handling unit zone.
- Economizer modes have been modified to improve comfort and energy efficiency

Retro-Cx Effort at Area School
Case Study 1

- Existing roof-mounted chilled water pipe insulation is badly deteriorated
- It is being replaced with thicker aluminum shielded, weather-resistant insulation

Savings due to improved insulation

	OLD	NEW
Electric Use (kWh)	11,000	1,900
Electric Demand (kW)	18	3

Savings of about $500 / year

Retro-Cx Effort at Area School
Case Study 1

- Existing chillers are being replaced with more efficient and smaller capacity models that have variable speed drive pumps.

- Computer labs and the IT room have been removed from main chilled water system and are now cooled by independent cooling units, *which results in a shorter seasonal operating window for the chillers.*

New

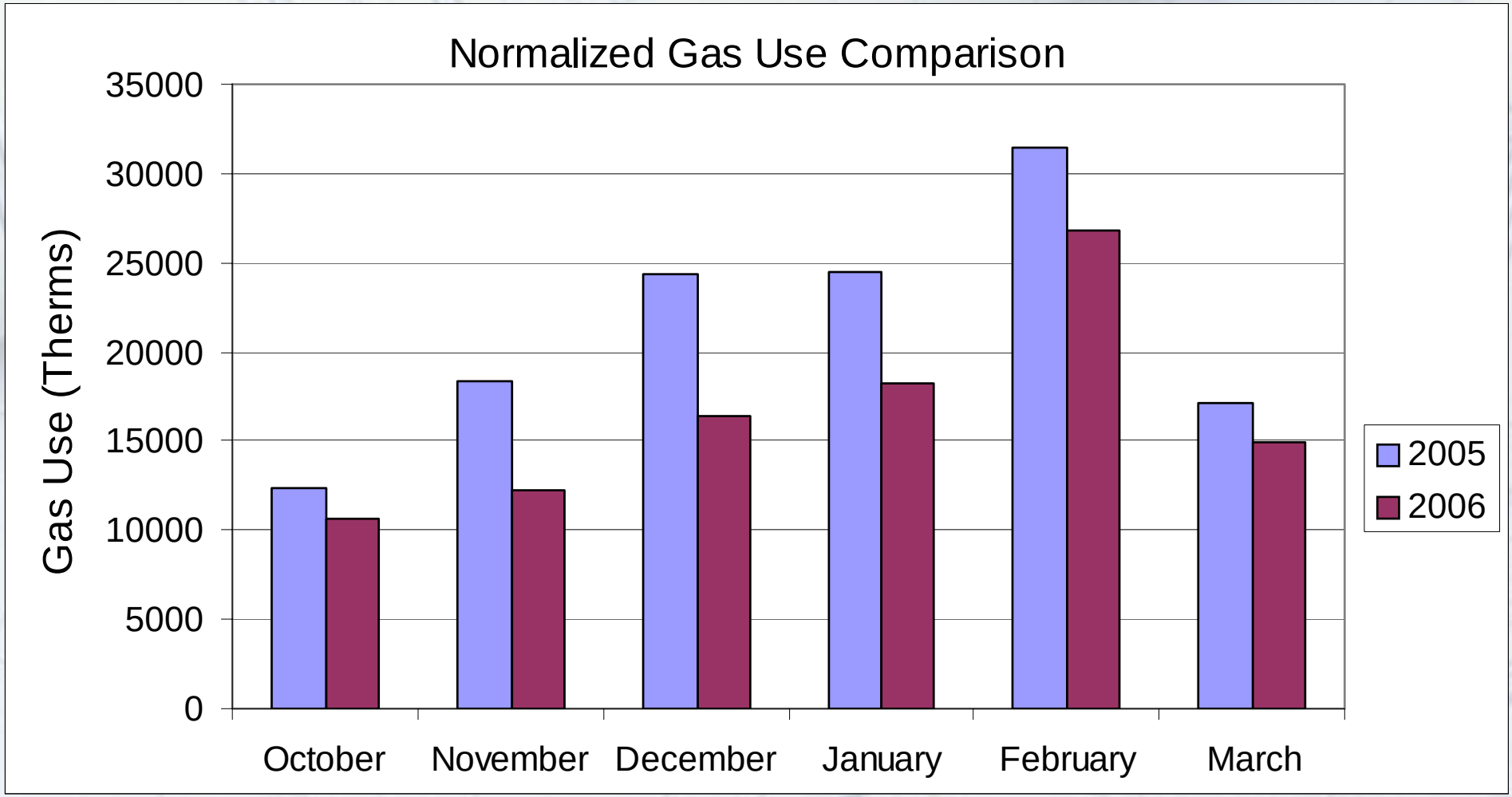
Old

Retro-Cx Effort at Area School
Case Study 1

- Staff have reported problems with “stuffiness” in several spaces
- Perimeter areas of Office and Guidance spaces too cold in winter

Airflow checking and rebalancing results in enhanced occupant comfort and potentially lower operating costs

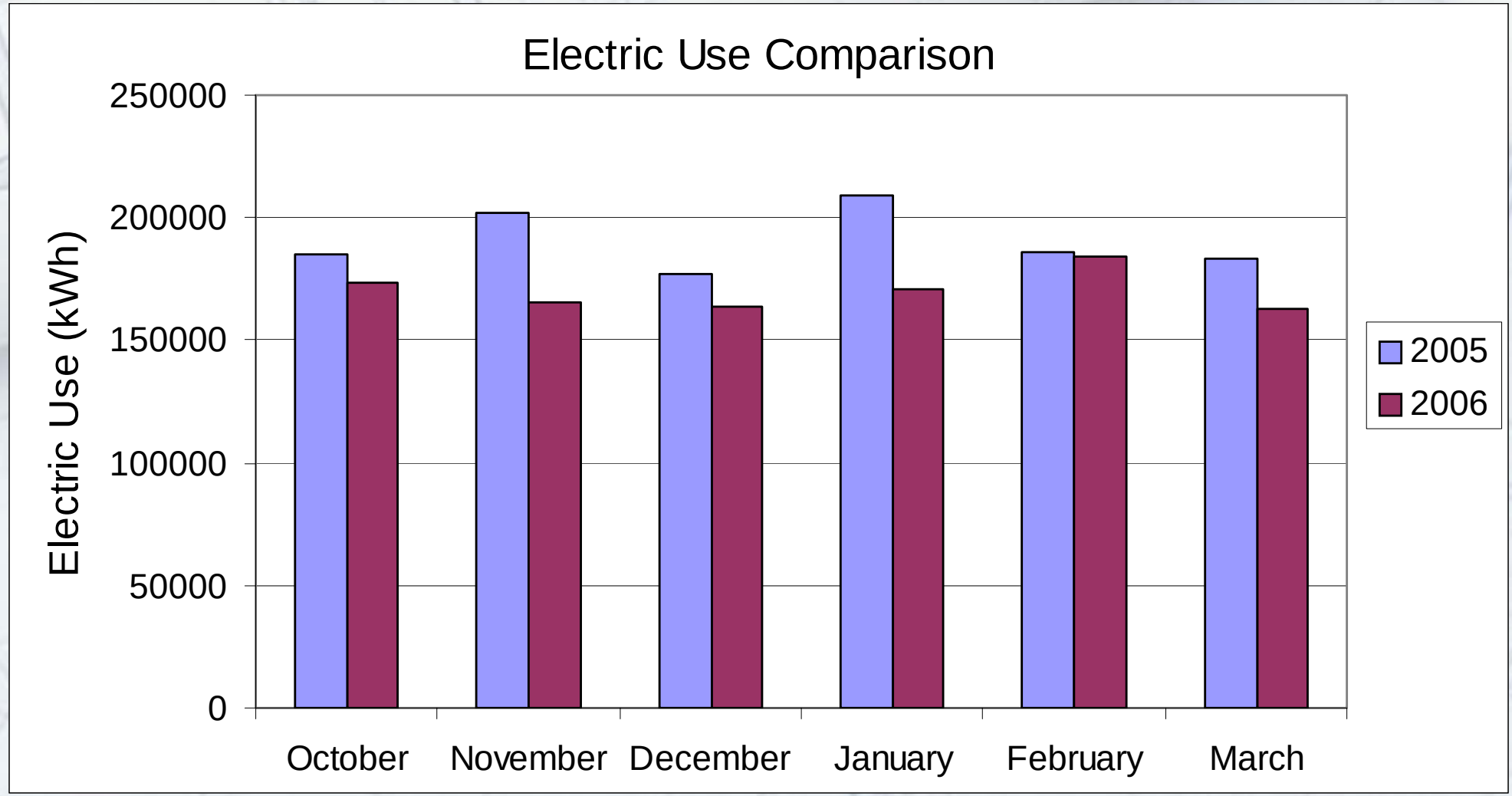
Retro-Cx Effort at Area School
Case Study 1



Savings of about $30-50,000 / year in gas

Retro-Cx Effort at Area School

Case Study 1



Savings of about $10-20,000 / yr in electricity

Retro-Cx Effort at Area School

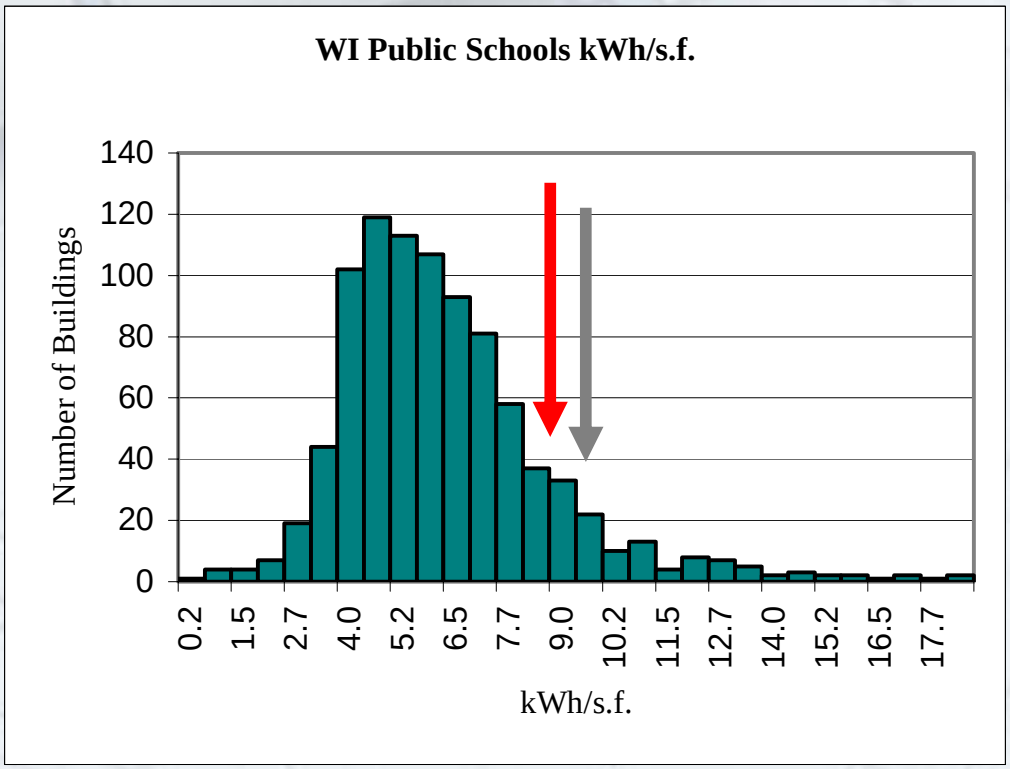
Case Study 1

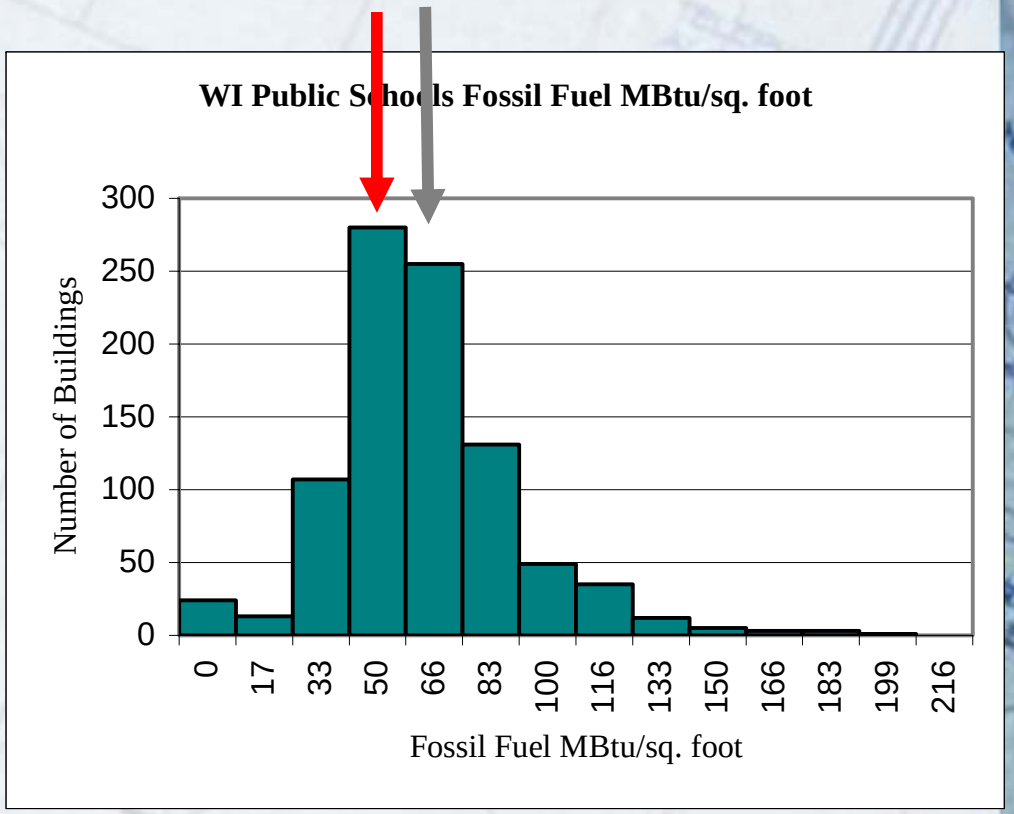
Annual consumption:

State School Average: 5.5 kWh/sq. foot; 50 MBtu/sq. foot

Case Study School before: 9.5 kWh/sq. foot; 62 MBtu/sq. foot

Case Study School after: ~8.5 kWh/sq. foot; ~50 MBtu/sq. foot





Retro-Cx Effort at Area School

Case Study 1

Annual estimated savings:

$40,000 to $70,000

Estimated cost to realize savings:

~$35,000

Payback period: 6-10 months

Bonus: Improved comfort and operation

Retro-Cx Effort at Area Office
Case Study 2

- Built in 2004
- 50,000 ft^2
- 35 Water Source Heat Pumps
- Cooling Tower and Boilers
- Above average energy consumption ($1.13 / ft^2 / year)

Retro-Cx Effort at Area Office
Case Study 2

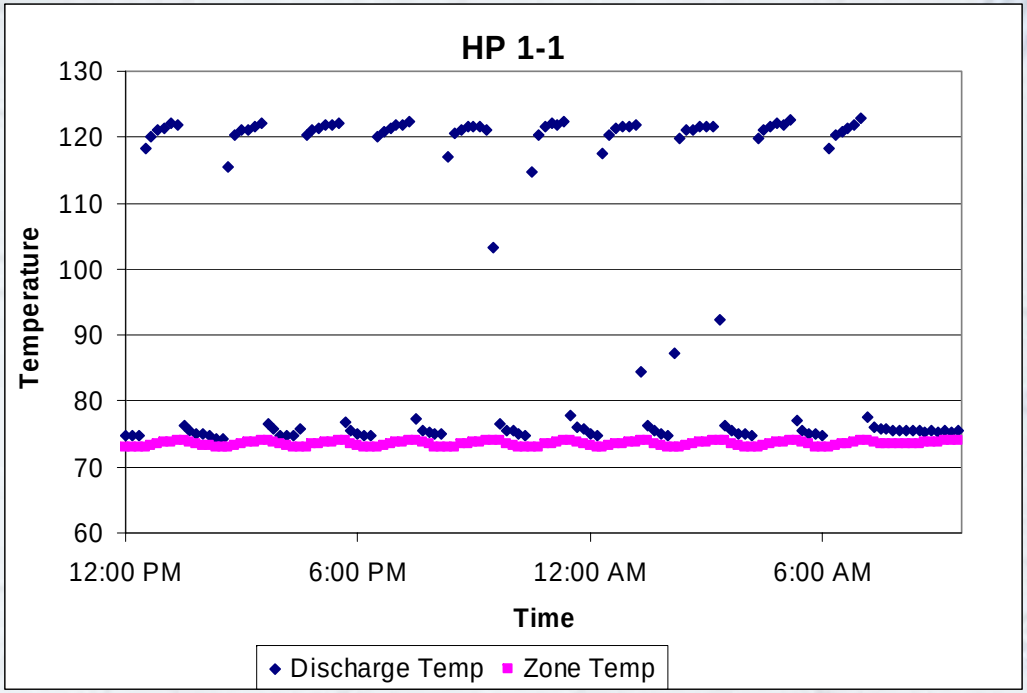
- Both circulating pumps running
- Design drawings refer to each as being sized for 100% load.
- Modify control sequence to bring on 2nd circulating pump only when needed.

By turning off one pump:

7.5 hp: 5.59 kW x 12 hr x 365 days = ~25,000 kW-hr /year : ~$1,225 /yr

Retro-Cx Effort at Area Office
Case Study 2

- A heat pump was observed to have discharge temperatures of 120° F
- High discharge temperature could indicate a faulty sensor, or low air flow among other causes.
- Investigate further with controls contractor.



More efficient system operation and reduced running costs

Retro-Cx Effort at Area Office
Case Study 2

- Winter schedule has complete HVAC system running 24/7
- The controls sequence should be modified to include a night setback mode that has the ERU in unoccupied status and only 1 circulating pump on
- The heat pumps can be brought up to load in a staged manner in the morning to reduce peak consumption

Potential savings on the order of $7,000/year

Retro-Cx Effort at Area Office
Case Study 2

- In several areas of the building the occupants indicated that they feel cold drafts.
- Select areas of the building have been noted by occupants as having indoor air quality issues

Summary: Additional Retro-Cx is beneficial

Retro-Cx Effort at Area Church

Case Study 3

- The facility uses 808,596 kBtu of energy per year. This equates to 74 kBtu/ ft^2/year.
- The average consumption for a similar facility in the mid-west is 53 kBtu/ ft^2/year.
- This facility uses 33% more than average –> i.e. there is a potential to save energy
- 33% reduction in gas and electric consumption will result in a savings of **$4,200 per year**.

Retro-Cx Effort at Area Church
Case Study 3

- During the early afternoon we observed the outside air temperature reading to the BAS to increase to 42°F even though the ambient temperature remained at 18°F.
- Possible solutions:
  - Sensor out of calibration?
  - Sensor located in warm spot?
  - Other……
- Action:
  - Take a look at the sensor location

Retro-Cx Effort at Area Church
Case Study 3

- OA Temp sensor located on West Wall

Retro-Cx Effort at Area Church
Case Study 3

- Unable to maintain design temperature at seat level in the Nave.

- Possible solution:
  - Not enough heating capacity?
  - Too low airflow?
  - Stratification?
  - ???

Retro-Cx Effort at Area Church
Case Study 3

Investigations revealed:

- The return air damper actuator had separated from its anchoring point on the air-handling unit casing.

- This had resulted in the return air damper being in the permanently closed position.

- After reattaching the damper to the unit casing we observed that the Nave and Gathering spaces were warmed up in a relatively short period of time.

Retro-Cx Effort at Area Church
Case Study 3

- The HVAC system was not able to maintain design temperatures

- With an outdoor temperature of 14°F the indoor temperature averaged 64°F while the hot water booster coil serving this area was at 100% of water flow.

- The high ceiling space and resulting stratification requires careful consideration of the diffuser selection in this space.

Retro-Cx Effort at Area Church
Case Study 3

- A gap of 4-5” was noted in the oval soffit at the Transition Space

- A significant portion of the supply air was short circuiting the room and entering directly into the return air plenum.

Retro-Cx Process

Interesting Findings……

Freeze protection in unoccupied mode:

1. Heating valve closed unless freeze stat trips –> heating valve opens.
2. Heating valve modulates to maintain setpoint temperature, ~70°F
3. Heating valve always 100% open in unoccupied mode

What method do you specify?

Most systems use option 3

Retro-Cx Process

Interesting Findings……

- If 100% open heating valve is used for freeze protection in unoccupied mode *at least consider*:
  - Close heating valve when outside air temperature is above 40°F
  - Do not open supply air damper or return air damper to circulate air through AHU in unoccupied mode (in particular in summer)
    - May heat entire building

Retro-Cx Process

Interesting Findings……

The filter access panel for the ceiling-mounted horizontal fan coil unit is obstructed by the wood trusses.

Retro-Cx Process

Interesting Findings……

Condensate traps at the fan coil units are incorrectly installed.
Condensate traps at RTU units not installed

With the installation as above the condensate will back up in the cooling coil drain pan and overflow into room/RTU

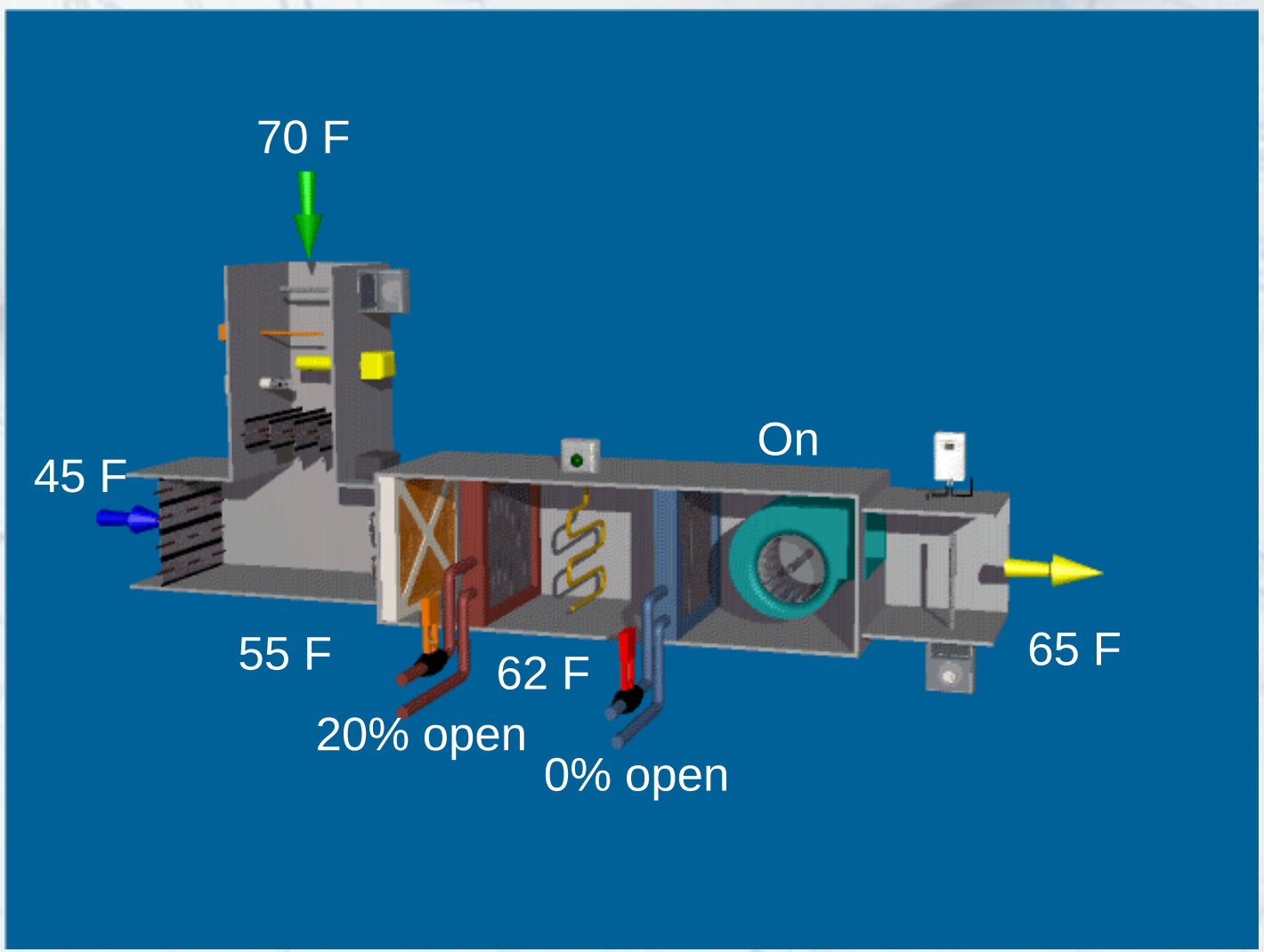
Retro-Cx Process

Interesting Findings……

Ductless mini-split units have been installed with minimal clearance at either side.

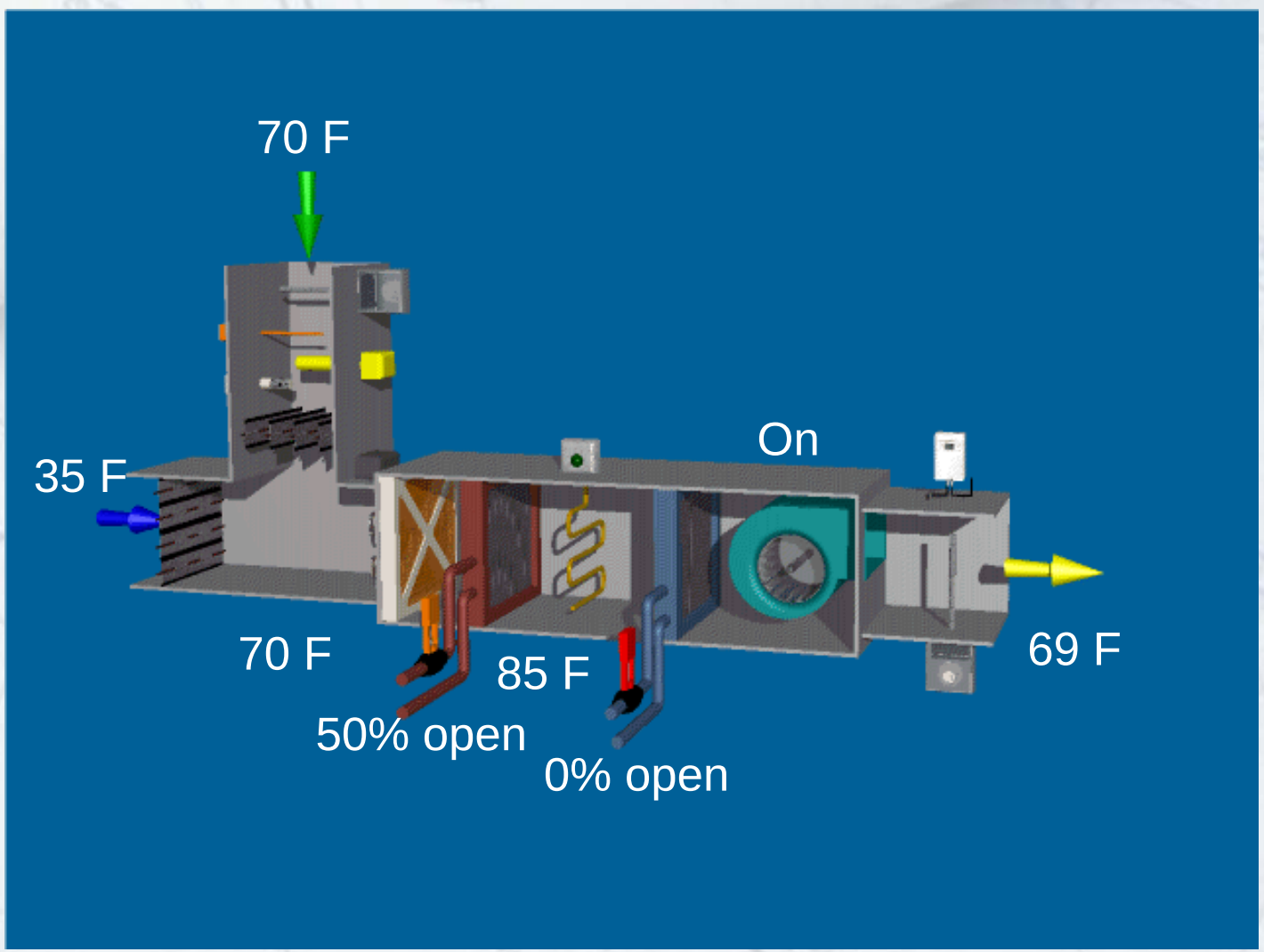
Manufacturer’s installation instructions recommends 2” minimum on both left and right sides.

Retro-Cx Process
Interesting Findings……



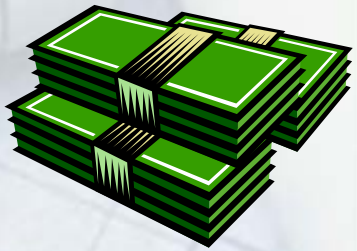
Economizer mode and reheating –> waste of energy!

Retro-Cx Process
Interesting Findings……

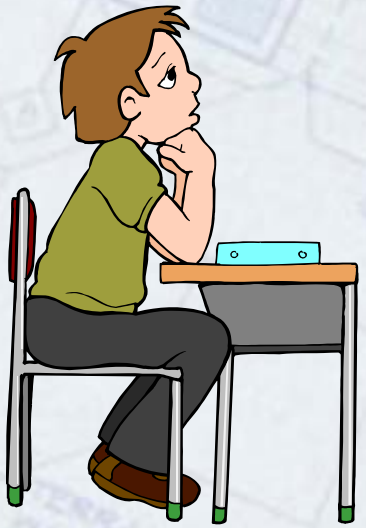


Fan belt broken – > Current sensor not adjusted to give alarm

The Retro-Cx process Summary



- Dollar savings from lower utility bills
  - Can quantify energy and water savings
    - Depends on existing operating costs and anticipated improvements.
    - Improvements can be evaluated using simple payback or LCC method
- Non-monetary savings difficult to quantify
  - Increased productivity and learning
  - Reduced time and aggravation
  - Improved health and happiness



The Retro-Cx process

Summary

- Most existing buildings are performing well below their potential as have not experienced QA process such as Retro-Cx
- Retro-Cx process is used to optimize building systems so that they operate efficiently and effectively
- Goal of ensuring comfort and productivity of the building occupants accompanies the goal of cost savings

Retro Cx Resources

P | E | C | I

http://www.peci.org/

Commissioning CA Cx Collaborative

http://www.cacx.org/

BCxA Building Commissioning Association

http:// www.bcxa.org

ASHRAE Advancing HVAC&R to serve humanity and promote a sustainable world

http://www.ashrae.org

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Questions or Comments??

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