ENERGY EFFICIENCY IN COMMERCIAL BUILDINGS

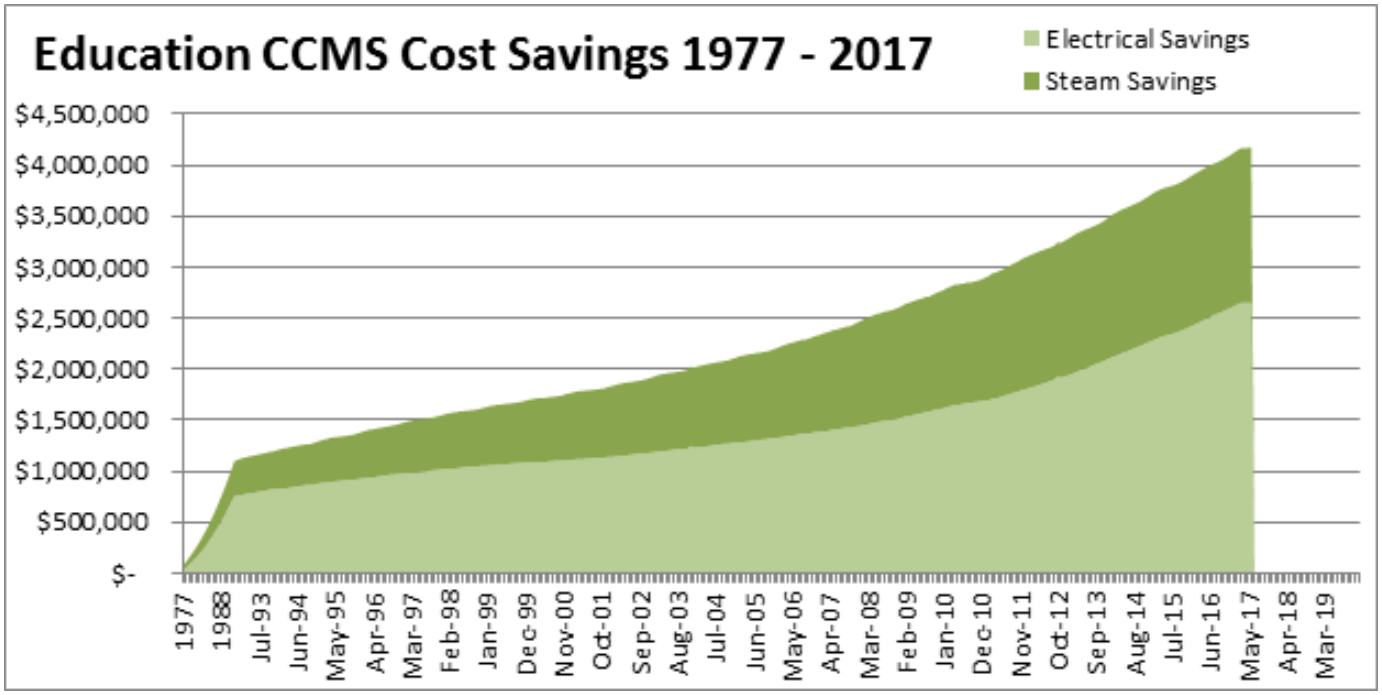
EMTF Saskatoon March 4, 2026

Ken Coutu, P.Eng. (Retired)

Premise

- The way a commercial building is operated plays an important part in its energy efficiency.
- It is possible to improve the operation, and therefore the efficiency of most existing buildings simply by modifying their control system.
- There are opportunities for improving the design and implementation of controls, which affects the operation and therefore the energy efficiency of new commercial buildings

Potential Savings in Existing Buildings



Data from Howard Salisbury, Facilities Management Division Energy Audit

Potential Savings in New Buildings

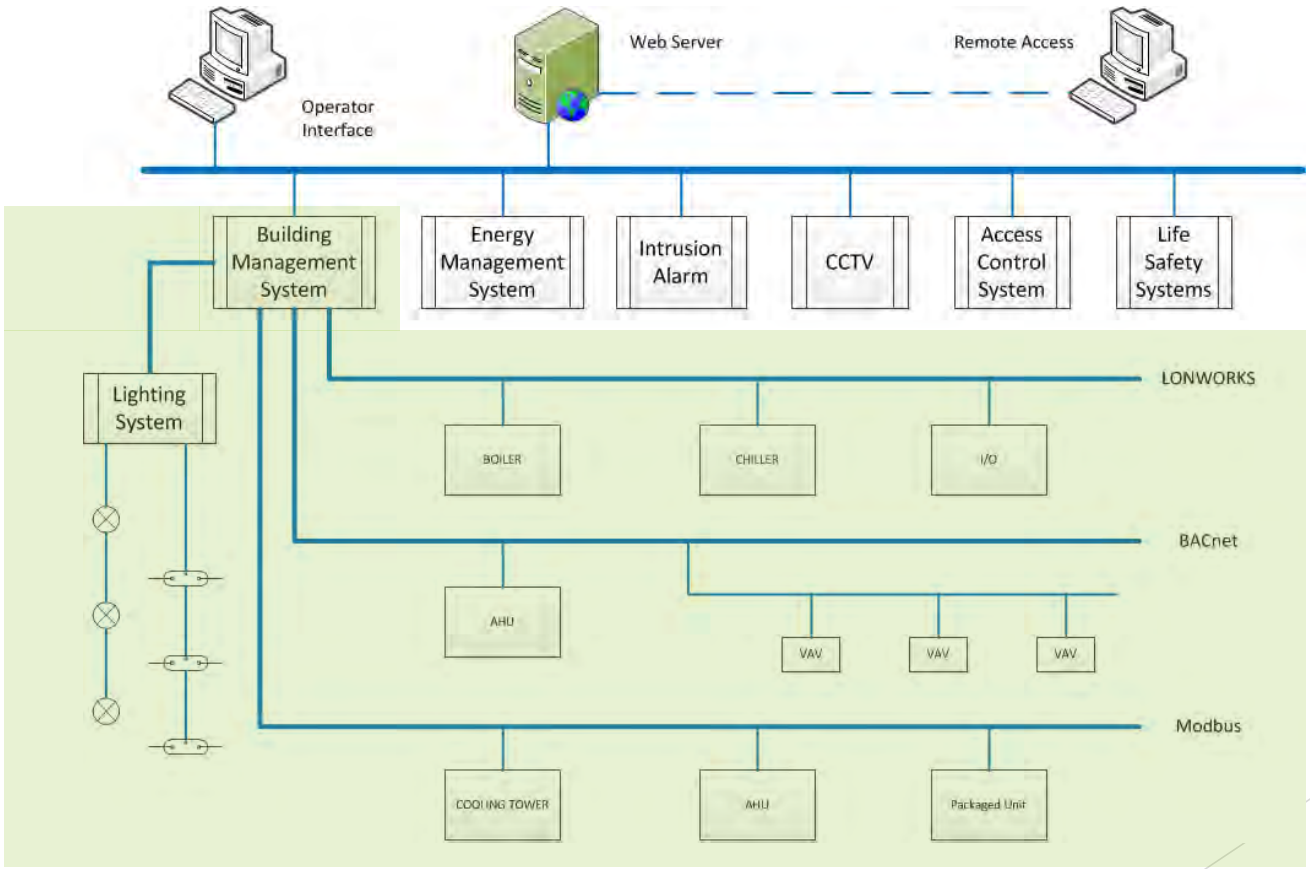
"A proper EMS can avoid energy consumption and costs by 15 to 20 percent."

Best Practices Guide for School Facility Managers
Natural Resources Canada

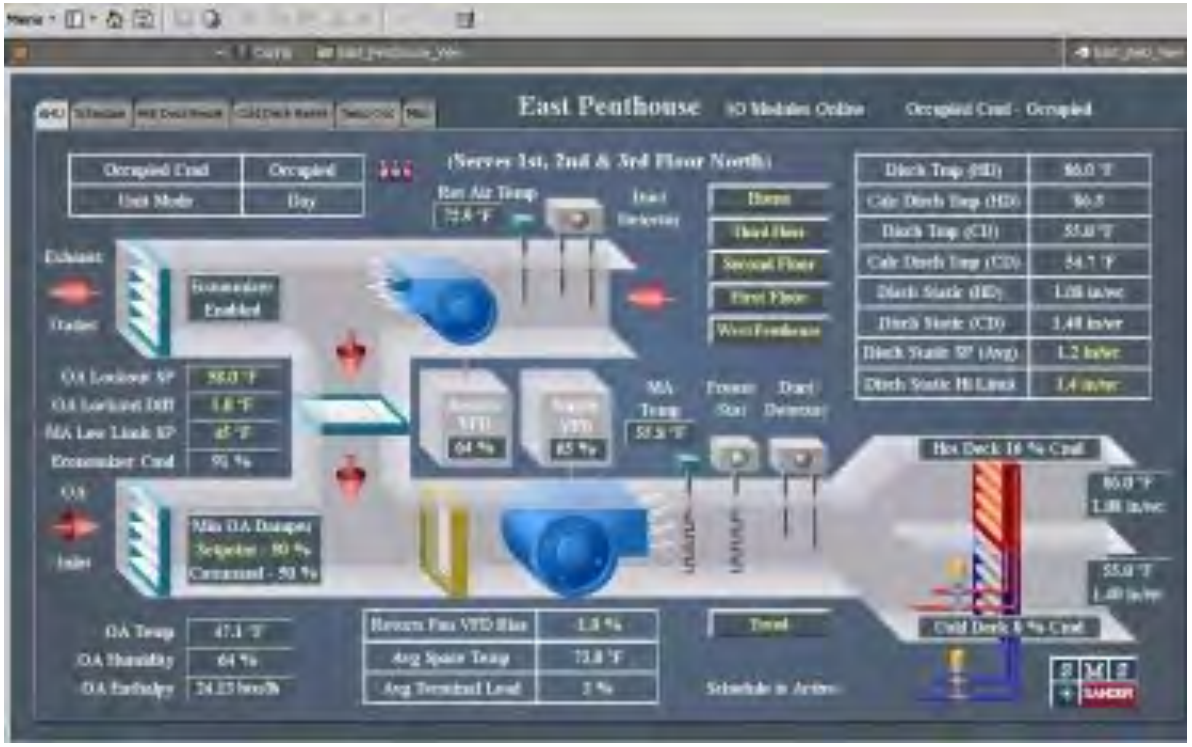
https://natural-resources.canada.ca/energy-efficiency/energy-star/best-practices-guide-school-facility-managers#a

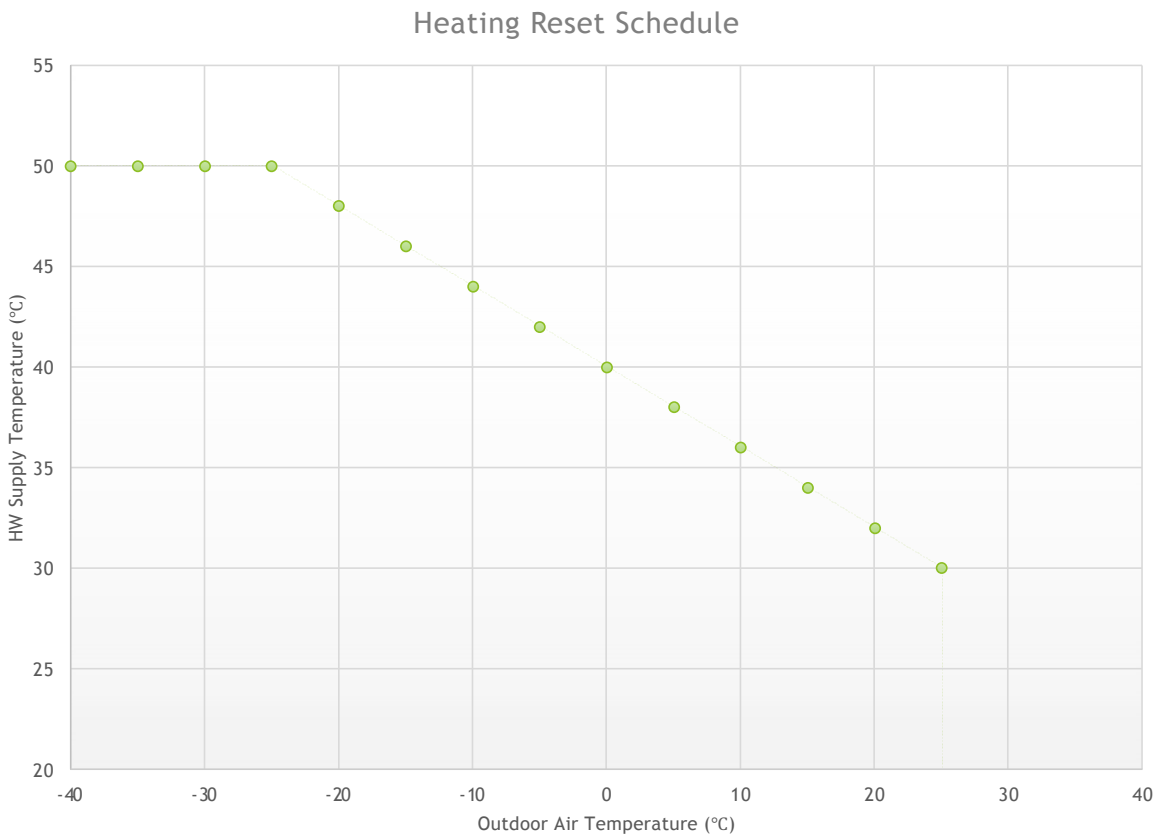
Operator Training

Building Automation System



Typical User Interface




Heating Reset Schedule
HW Supply Temperature (°C)
55
50
45
40
35
30
25
20
-40
-30
-20
-10
0
10
20
30
40
Outdoor Air Temperature (°C)

Variable Air Volume (VAV) System

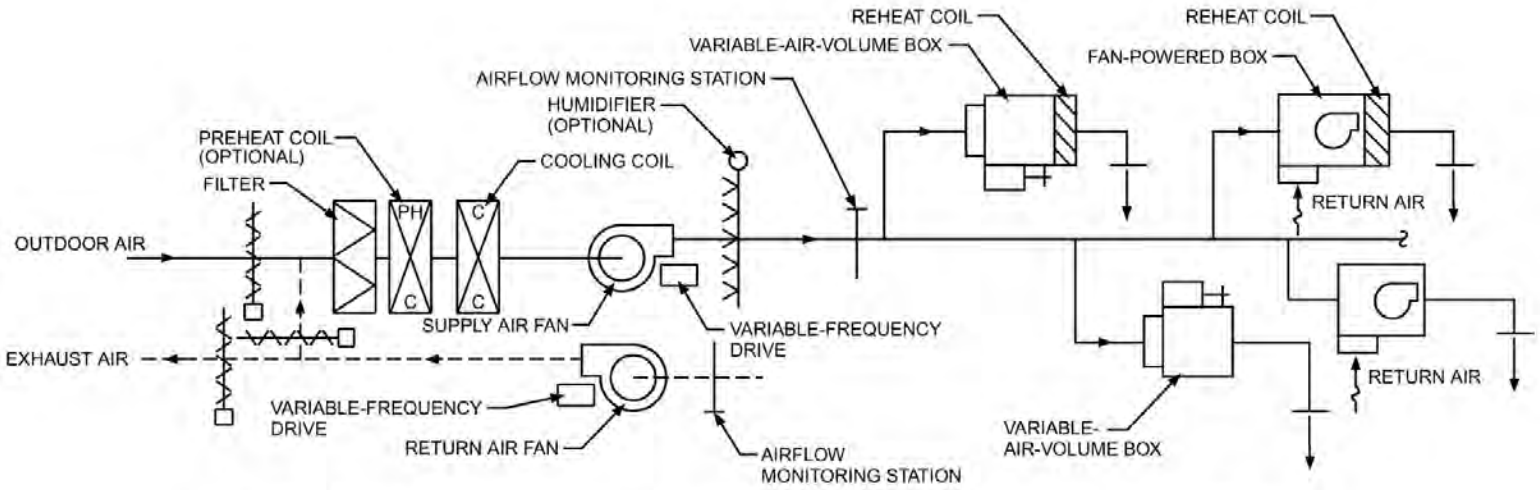
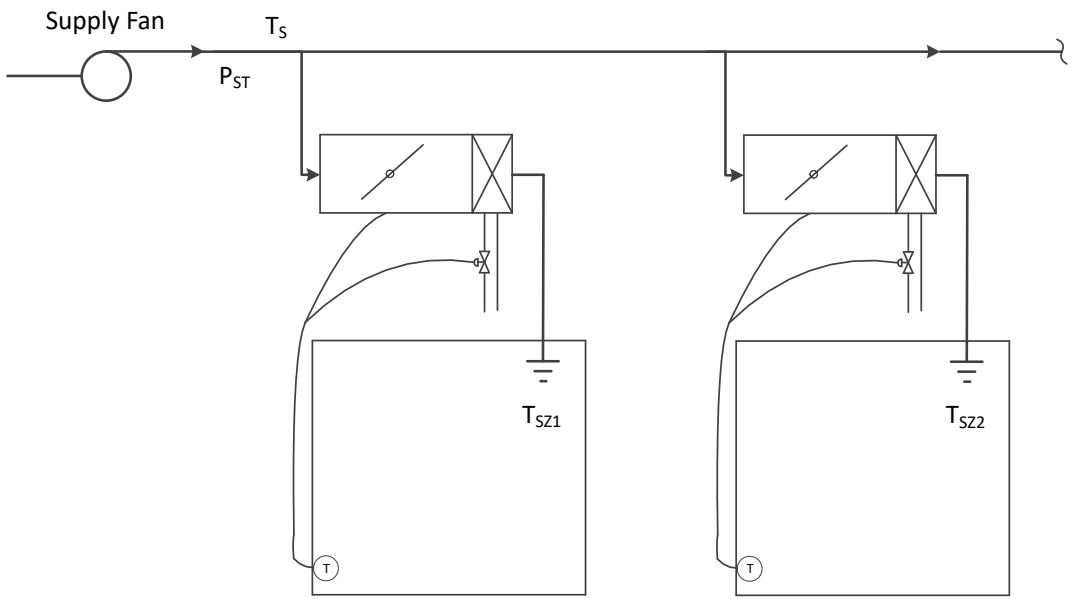


Fig. 10 Variable-Air-Volume System with Reheat and Induction and Fan-Powered Devices
(Courtesy RDK Engineers)

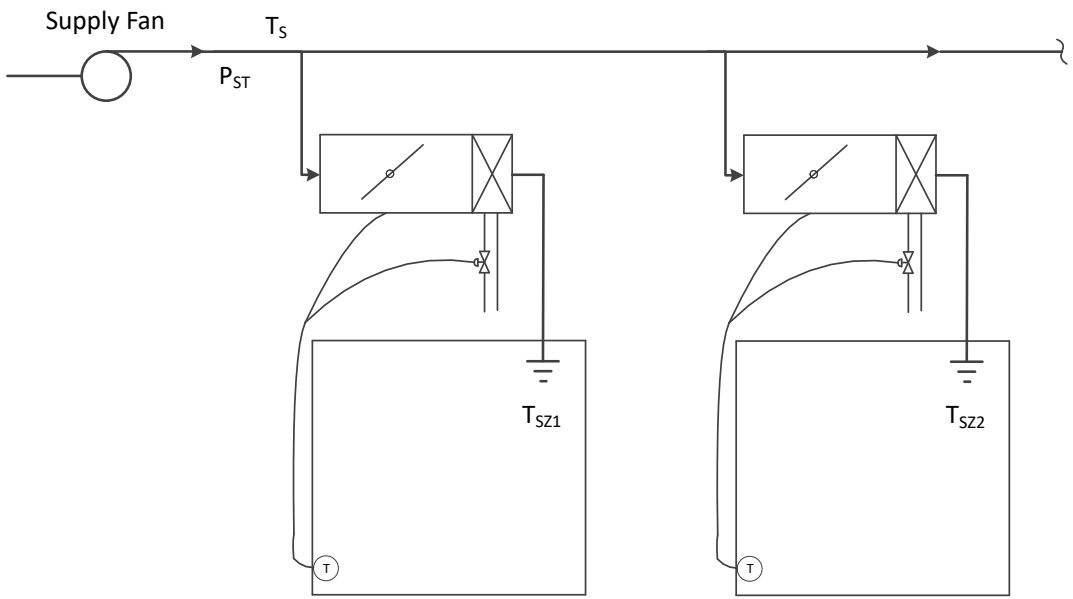
2012 ASHRAE Handbook — (HVAC Systems and Equipment)

VAV Operation



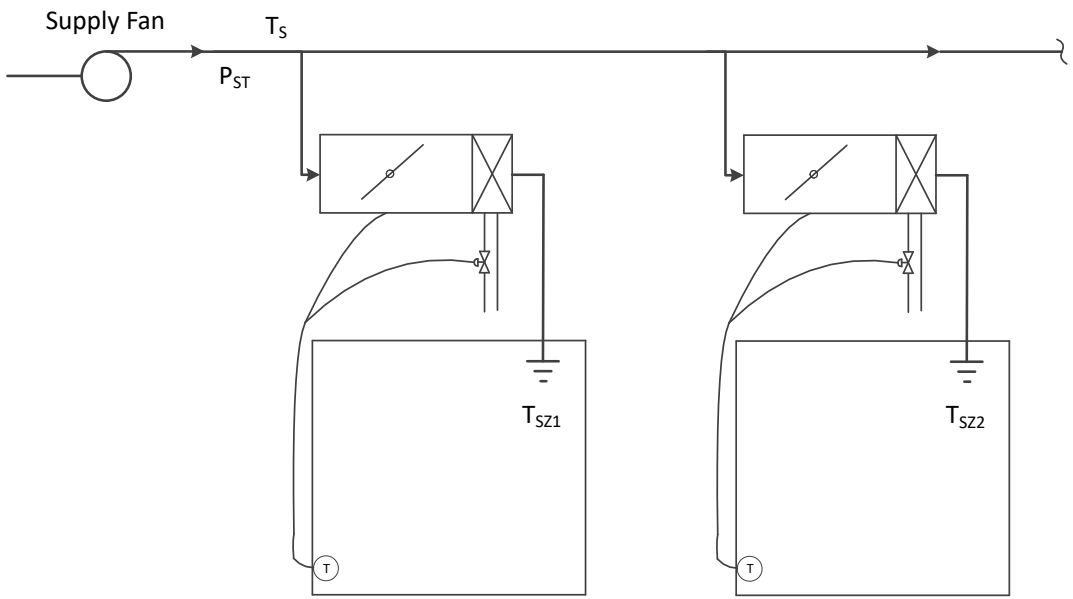
- The thermostat senses room temperature and controls the damper and the reheat coil.
- The damper can increase or decrease airflow to the zone.
- The reheat coil can only increase the temperature of the air supplied to the room.

VAV Supply Air Flow



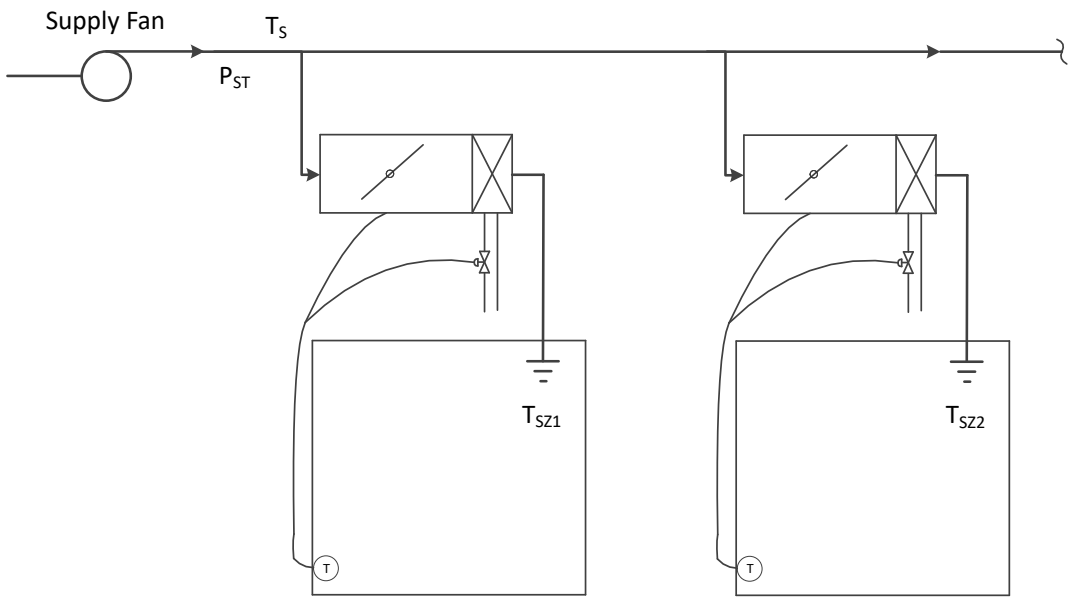
- There is a minimum airflow in the VAV box to ensure minimum fresh air ventilation requirements are met.
- A rule of thumb is that it takes twice that amount of air to heat the space and six times that amount to cool the space.

VAV Cooling



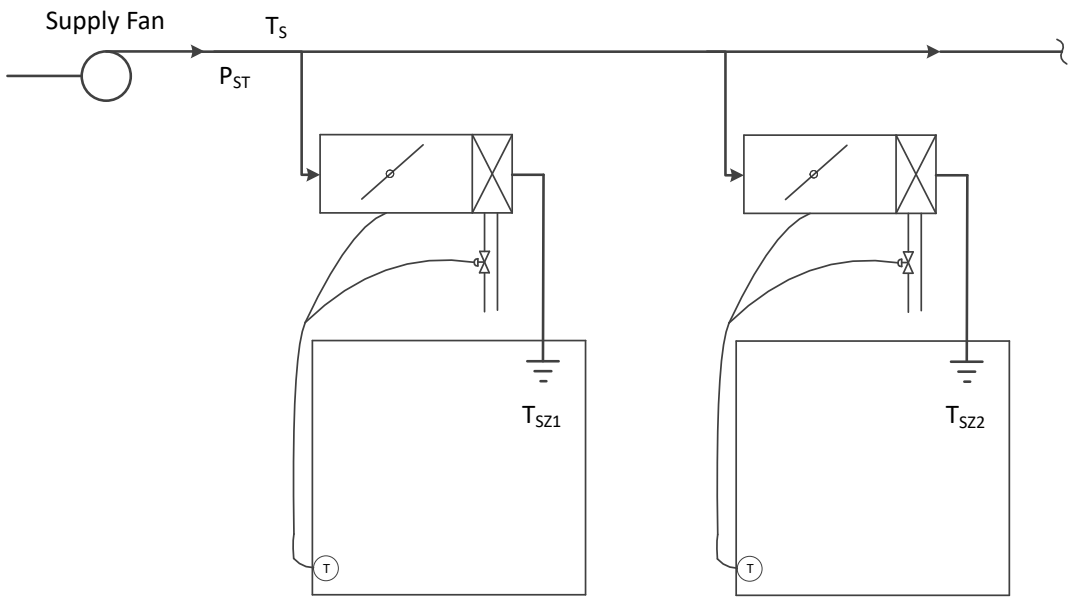
- The supply air temperature (labelled T_s) needs to be kept colder than the room temperatures in order to provide cooling.
- If the thermostat determines that cooling is required, the VAV box will increase airflow to the zone until space cooling requirements are met.
- The lower the supply air temperature (T_s), the less air is required for cooling.

VAV Heating



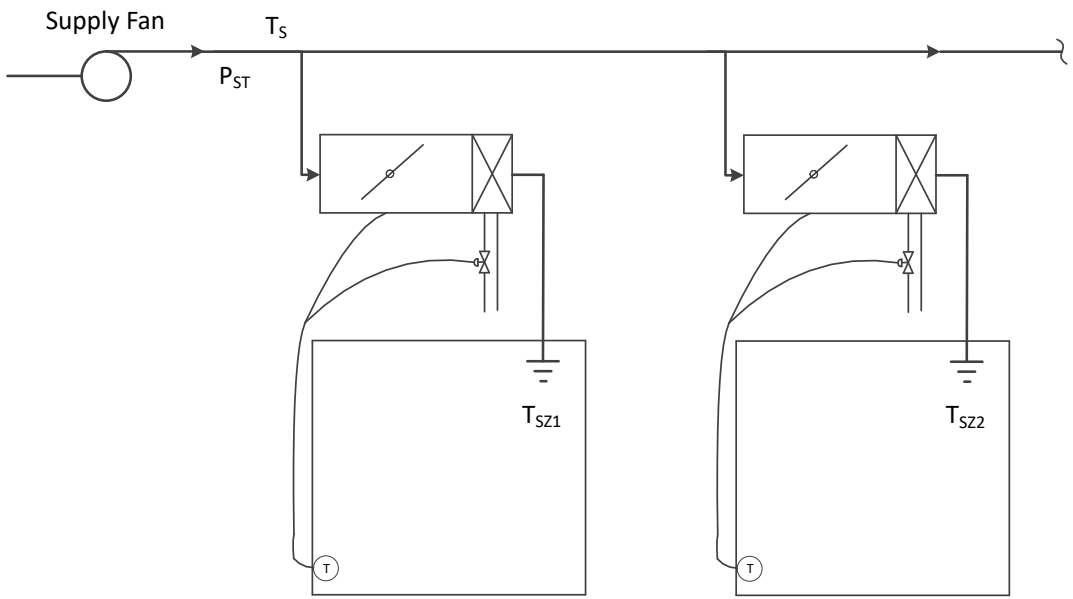
- If there is a heating requirement in the zone, the airflow is first reduced to the minimum. Then reheat is turned on and if that is insufficient, the damper opens up to send in more air.
- The lower the supply air temperature, the higher the reheat needed for heating.

VAV Supply Air Temperature Tradeoff



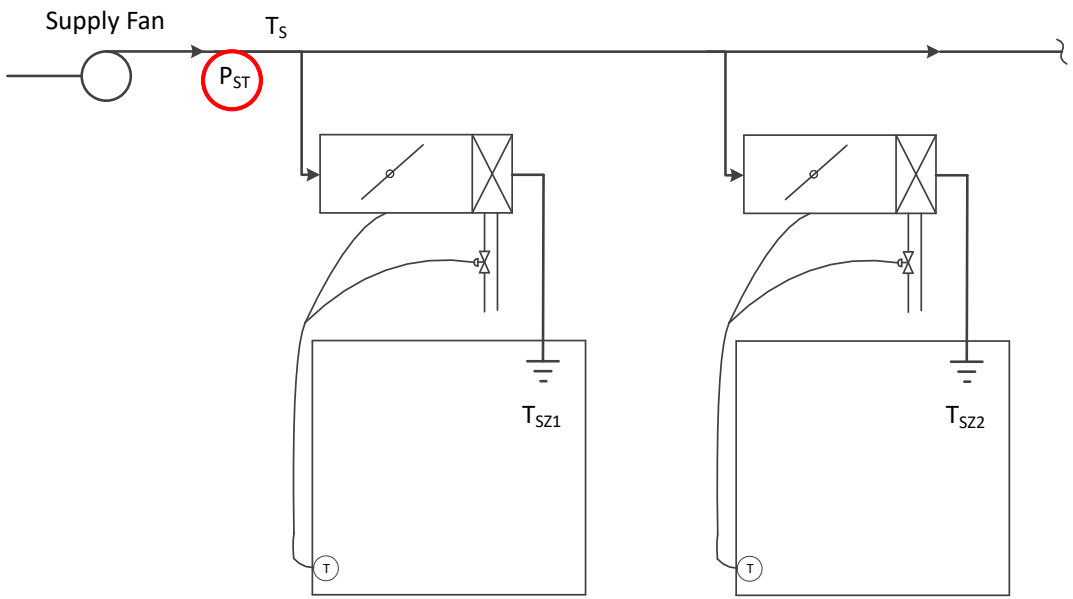
- If the supply air temperature (T_S) is lowered, cooling airflow requirements are lowered while heating reheat requirements are increased.
- Energy savings result from slowing the supply and return fans with VFDs and from using less reheat.

Simple VAV T_S Control



- A careful analysis shows that energy savings are maximized when the VAV boxes are open as much as possible.
- Simple controls schemes may only reset T_s with outdoor air temperature, but you need a very conservative reset to ensure space temperature compliance.

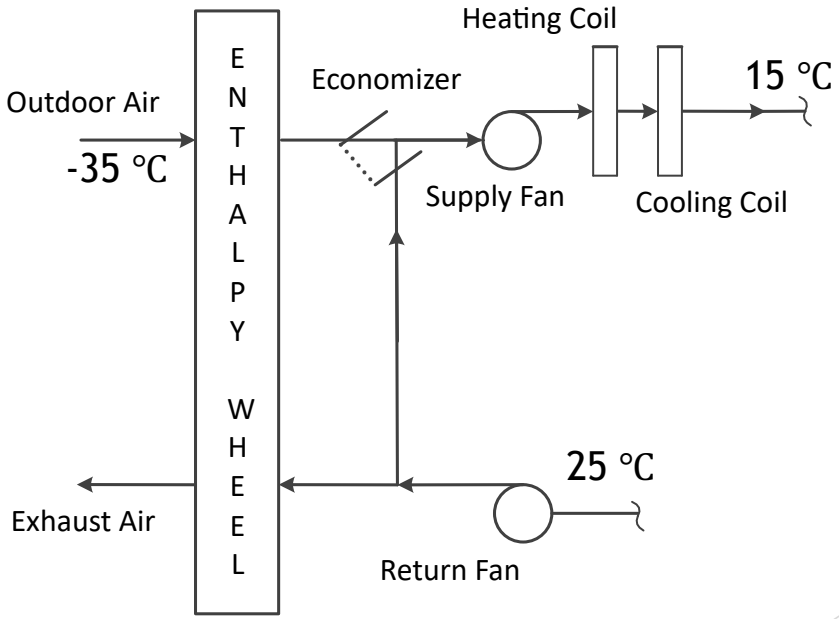
Advanced VAV T_S Control



- Advanced control schemes can poll each of the VAV boxes to see what they are doing and control T_s to ensure that there is at least one box that is fully open.
- This is accomplished by a trim and response technique.

Economizer Control

- The general idea behind an economizer is to bring in more fresh air than is required for ventilation purposes when outdoor air is closer in condition to supply air setpoint than is return air.
- Generally this is done by comparing Supply, Return and Outdoor Air temperature.
- Often, even if humidity is not being controlled, this is not the most energy efficient method.
- Comparing Supply, Return and Outdoor Air enthalpy sometimes produces more efficient results. This requires an additional measurement of Supply, Return and Outdoor humidity.



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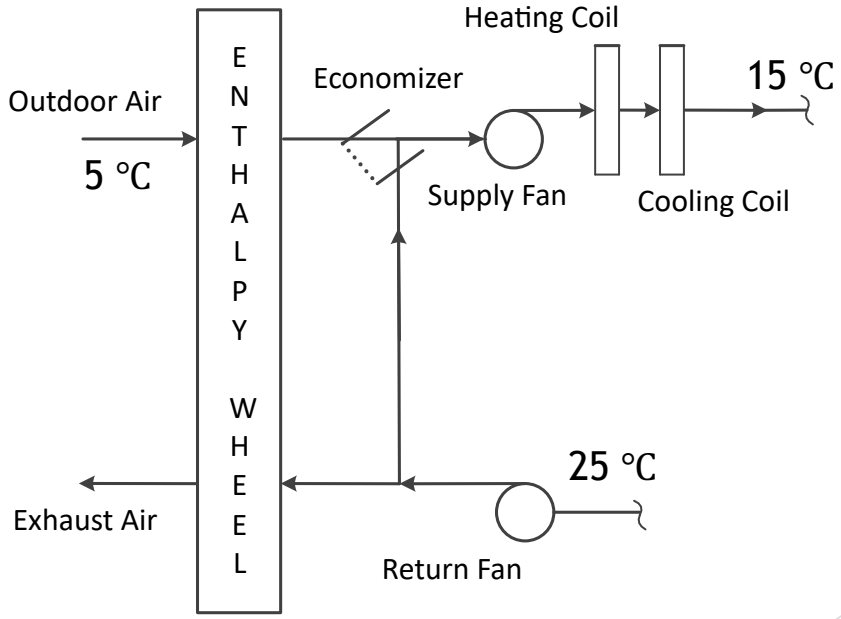
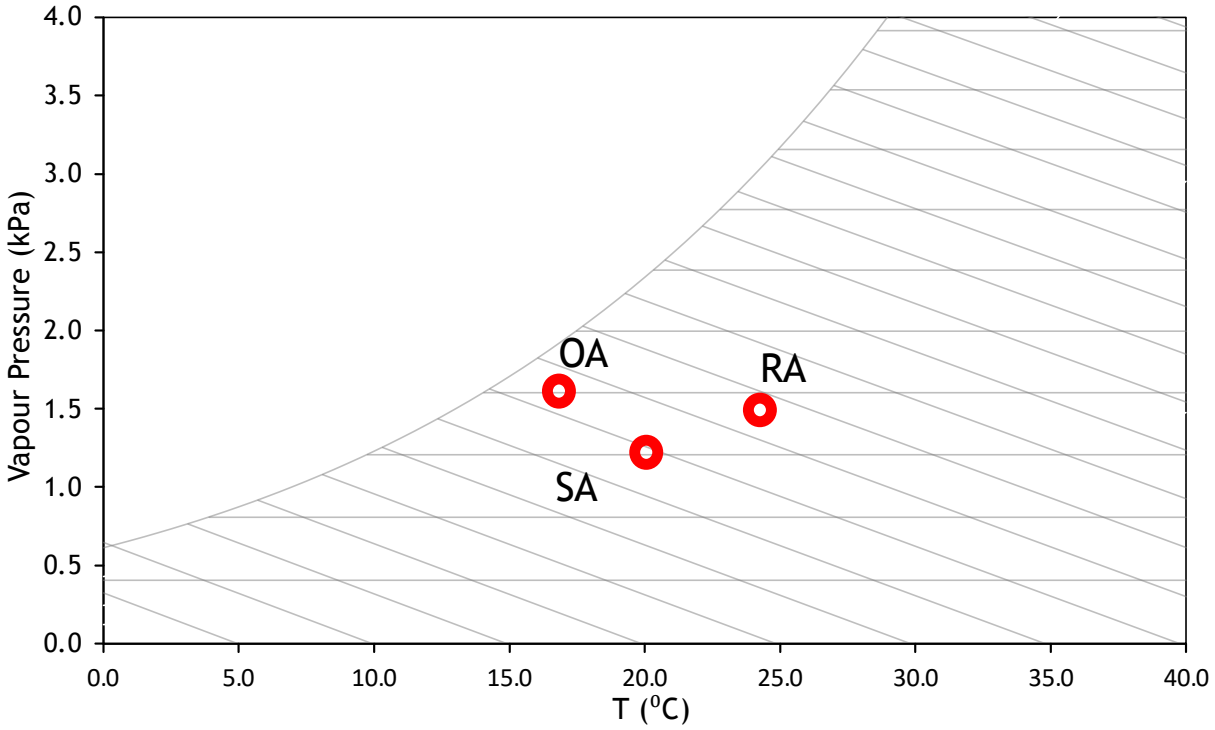


Economizer Control



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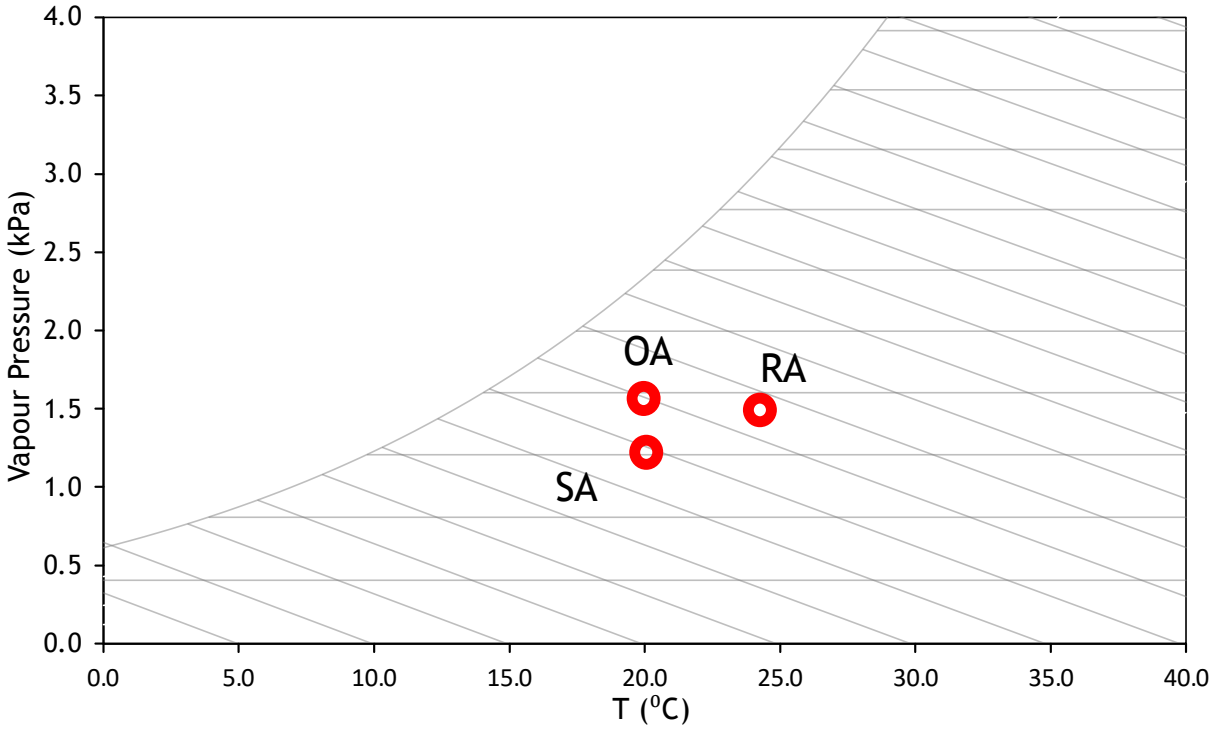
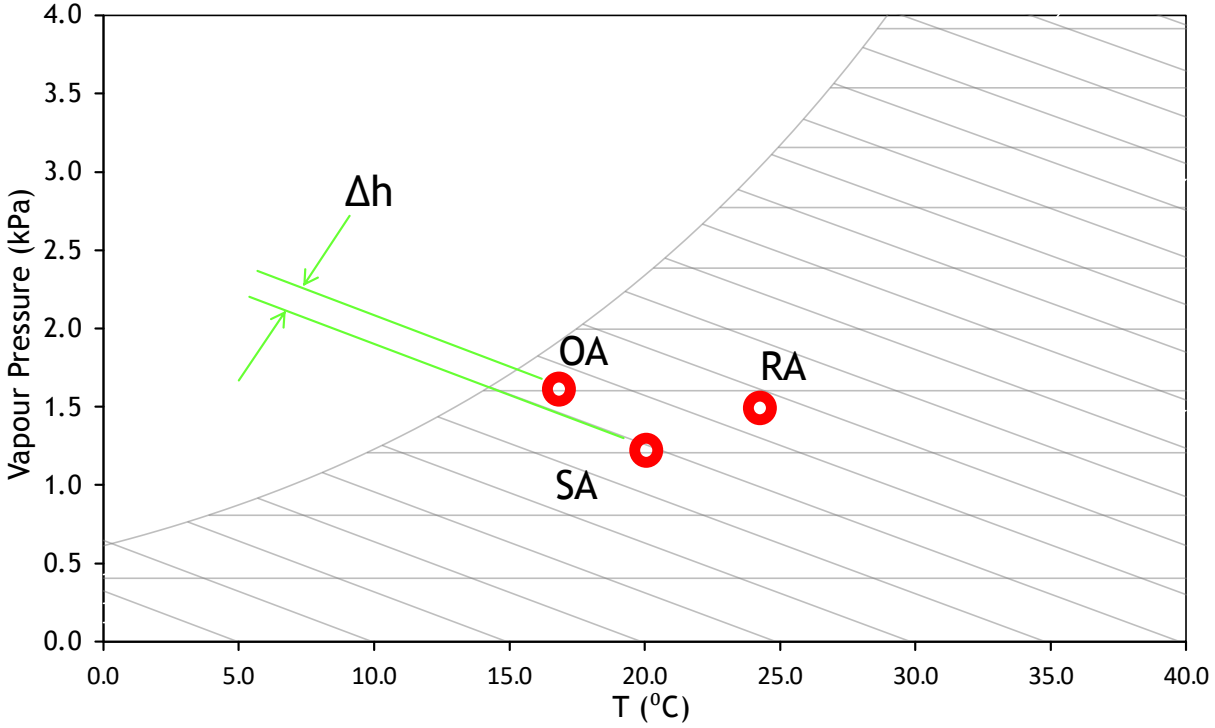
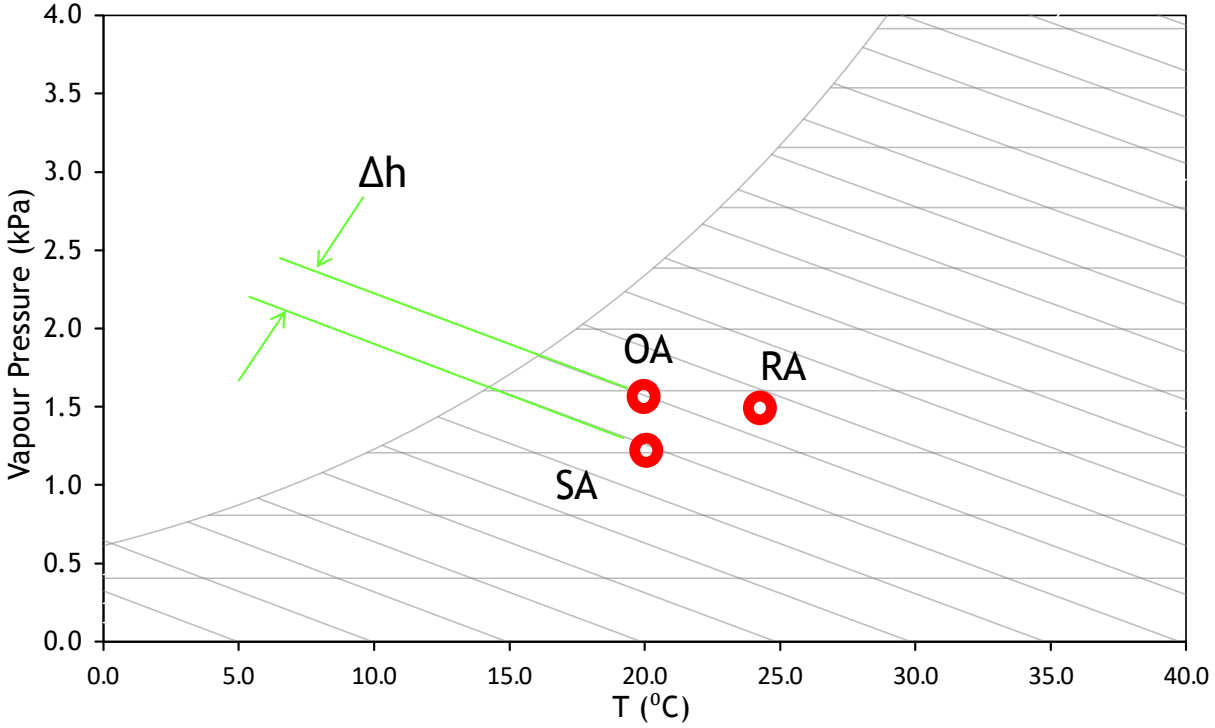


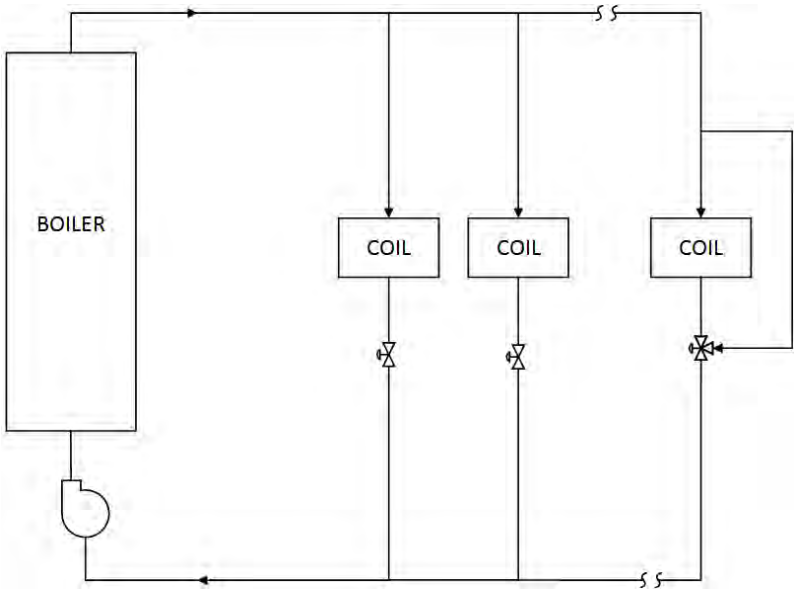
Economizer Control



Economizer Control

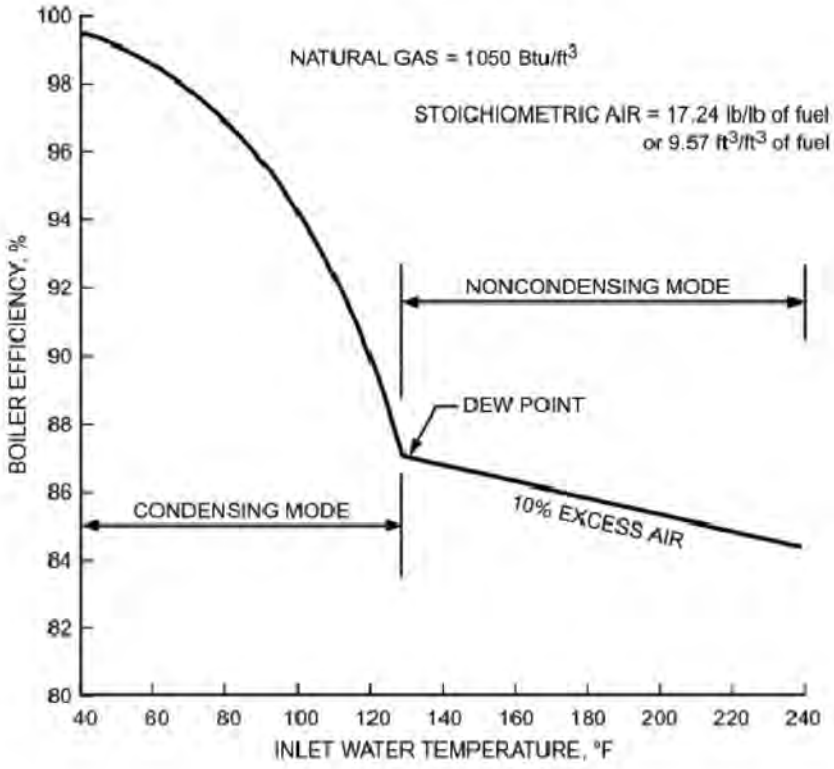


Simple Heating System



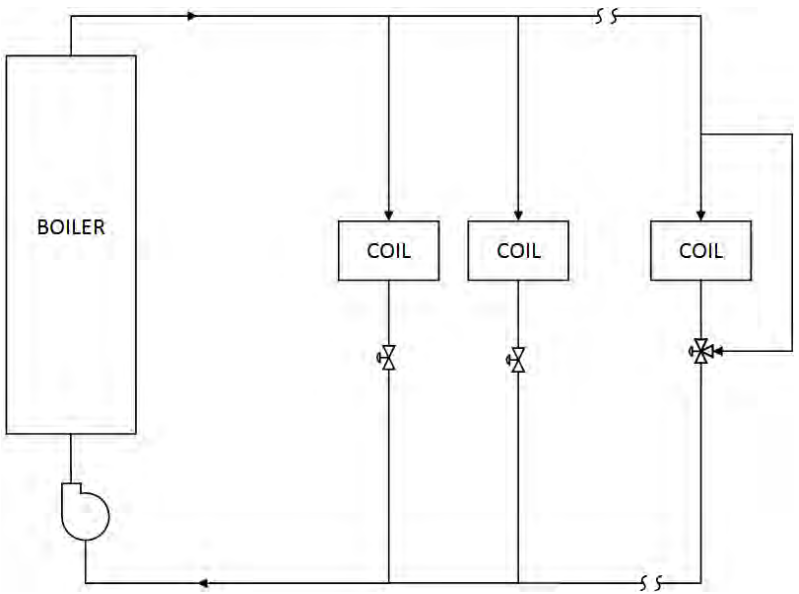
- Simple heating systems can have simple controls, but there are still several variables.

Boiler Efficiency



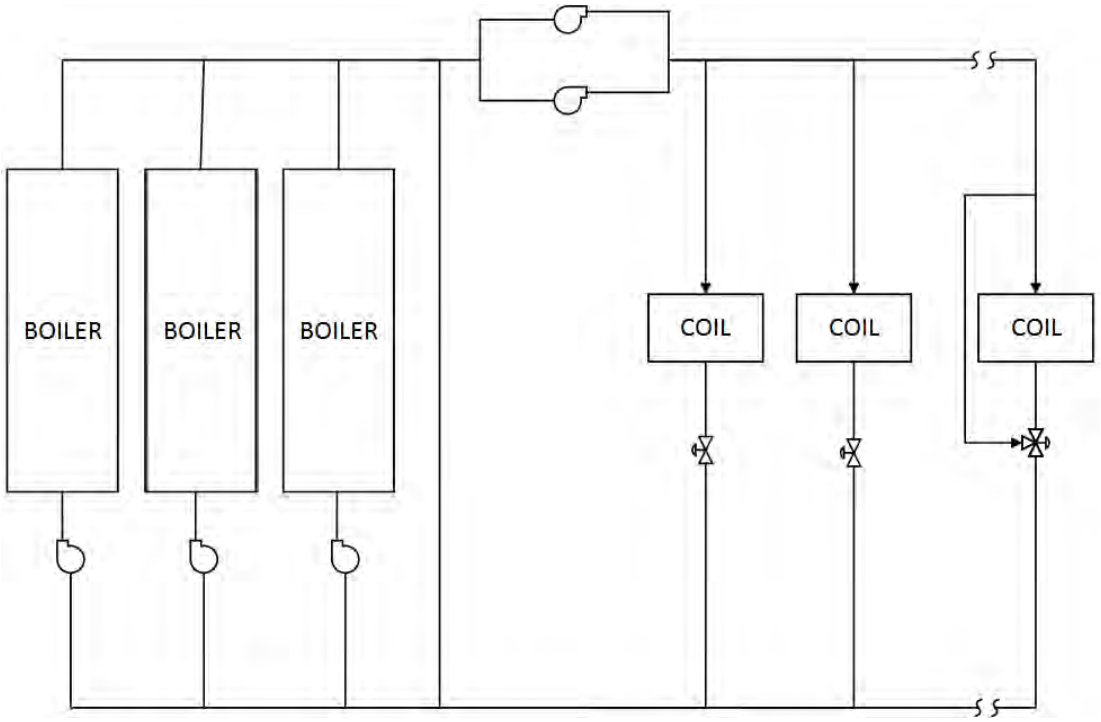
Source: ASHRAE Handbook

Simple Heating System



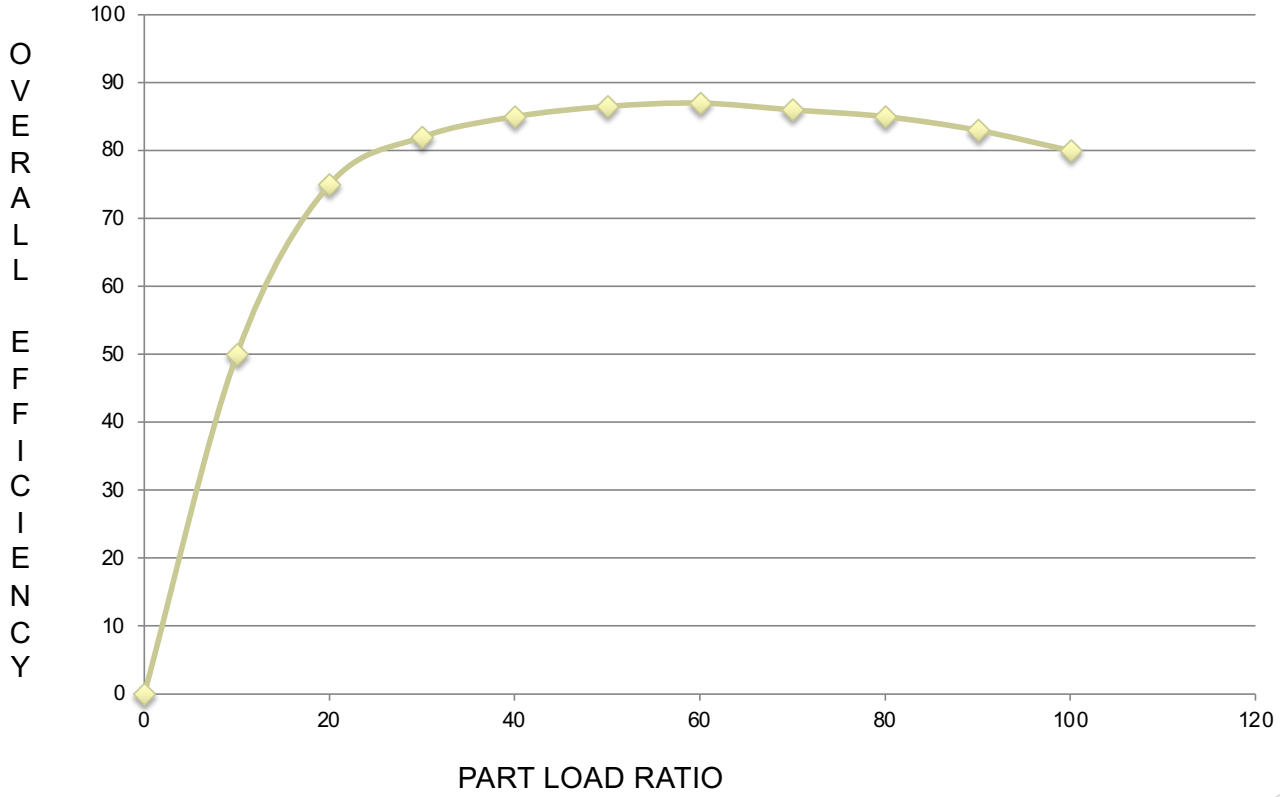
- A typical simple control scheme is to reset the boiler supply water temperature with outdoor air temperature. But this misses operation at the peak efficiency of the boiler.
- A better control scheme is to lower the boiler water flow rate to the minimum and control the boiler flame rate to the return water temperature. The water flow is only increased if the heating load is not maintained.

Complex Heating System



More complex heating systems require more complex controls but may have more opportunity for energy savings.

Boiler Efficiency



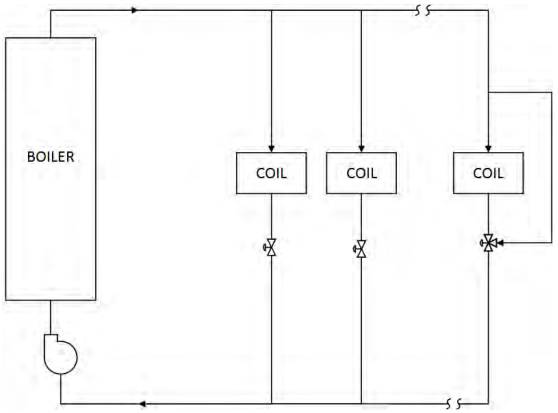
Boiler Efficiency – Other Factors

- Outlet Temperature
- Water Flow Rate
- Cycling
- Air/Fuel Ratio

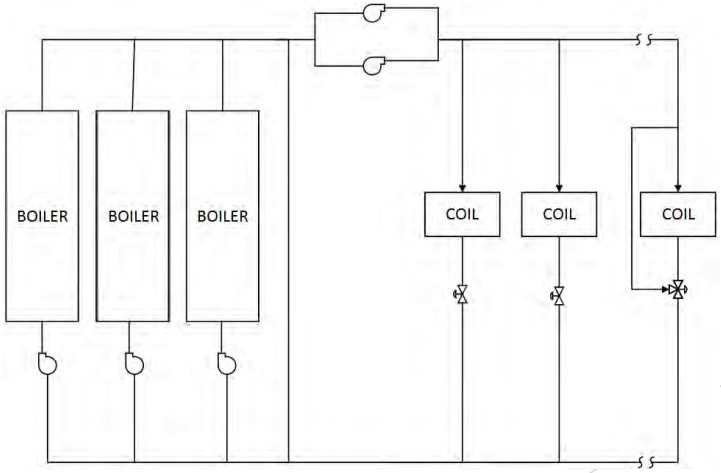
Other Boiler Considerations

- NOx Production
- Excessive Wear on Boiler Components
- Nuisance Shutdowns
- Thermal Shock
- Condensing in Non-condensing Boilers

Controlling a Heating System



- Supply Water Temperature Reset
- VFDs on Secondary Circulation Pumps
- Boiler Sequencing
- Flue Gas Analysis



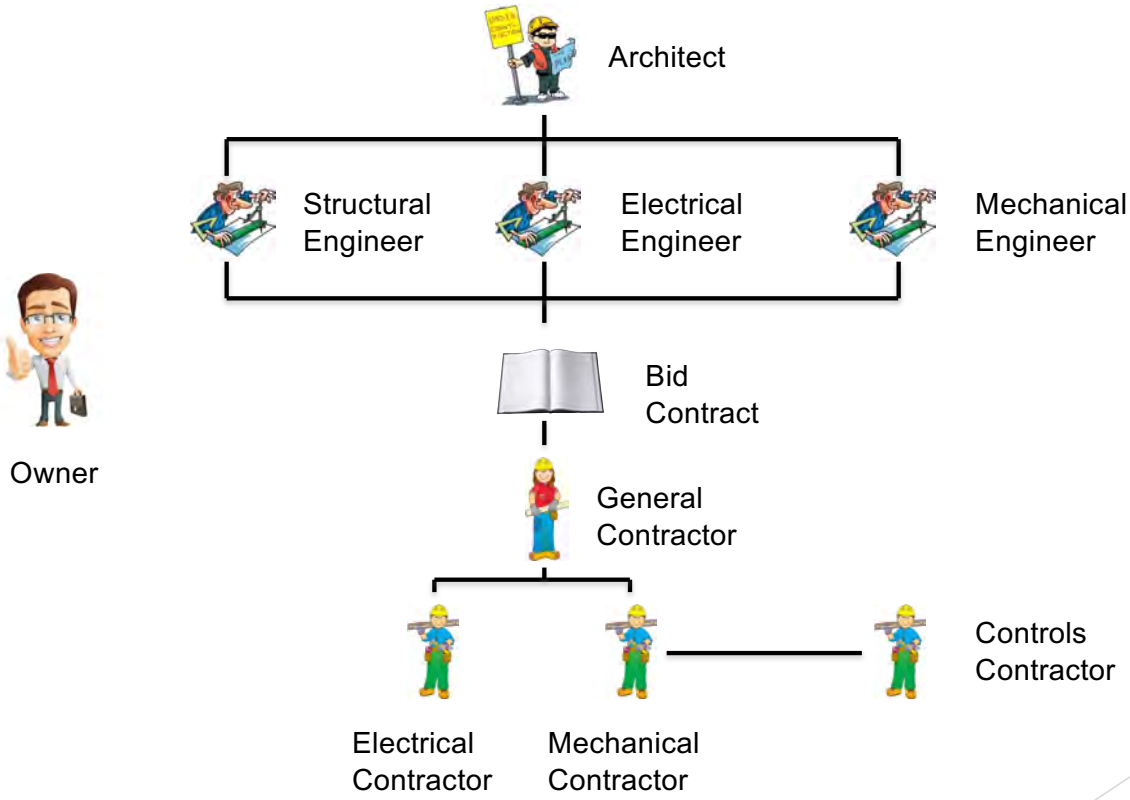
Controlling a Cooling System

- Similar issues exist for cooling systems incorporating chillers
- Supply Water Temperature Reset
- VFDs on Circulation Pumps
- Chiller Sequencing
- Cooling Towers

Case Study

- Art Gallery of Windsor
  - Connected to District Energy System
  - Baseline Energy Consumption $390,000/Year
  - Fourteen Energy Management Options (EMOs) were identified
  - Five of the EMOs were controls related
  - Supply Air Temperature Reset on AHU-4
  - Enthalpy Control for AHU-4
  - Humidification Boilers upgraded Fuel-Air Mixtures
  - Humidification Boilers Programming
  - Variable Frequency Drives on AHU-2, AHU-4 and AHU-6
  - These five measures alone saved $140,000 in energy costs yearly
  - 35% Energy Savings for controls work

New Building Design/Construction



Controls Contract

Current Process

- Mechanical Contractor picks the Controls Contractor
- Least Expensive Option that meets Bid Contract is the Best
- Owner has little say in controls implementation

Improved Process

- Include Controls contract as a Cash Allowance
- Provide Evaluation Criteria based on Owner's Requirements
- Controls Contract is awarded separately

Sample Evaluation Criteria

Criteria	Scoring
Stipulated Bid Price	
Typical Equipment Requirements	
Estimated Hours Over Next Four or Five Years	
Total base price	
Points	**1000**
Partnership	
Labour rate	
Muliplier	
Cost per VAV	
Service work	
Schedule	
Project Management	
References	250
Partnership agreement	150
Schedule	100
Points	**500**
Technology	
Compliance	200
Architecture	30
System Expandability	20
Product Life Cycle	20
Global Access	5
Remote Access	5
BACnet	10
OEM Integration	5
Third Party Software	5
Programmability	20
Graphic Programmibility	15
Trending Capability	30
Spare Points	10
Engineering Units	5
Optimum Start/Stop Routines	30
Intelligent Automation	
Functions	40
Network	50
Points	**500**
Total	**2000**

- Base cost is sum of:
  - Stipulated Bid Price
  - Estimated Capital Cost over Five Years
  - Estimated Labour Cost over Five Years
- Other criteria include:
  - Project Management Capabilities
  - Technology
  - Future Expandability
  - Additional Capability
  - Interoperability

One Problem With Building Automation

- Building Automation has extensive and impressive capabilities.
- But it only works if its working.

Commissioning

"The Commissioning Process is a quality-oriented process for achieving, verifying and documenting that the performance of facilities, systems and assemblies meets defined objectives and criteria."

ASHRAE Guideline 0

Commissioning

- The commissioning process will allow you to understand the building dynamics and optimize the control loops to provide better occupant comfort and reduced energy consumption.
- In other words, it helps to ensure the Building Automation is not only working but optimized.

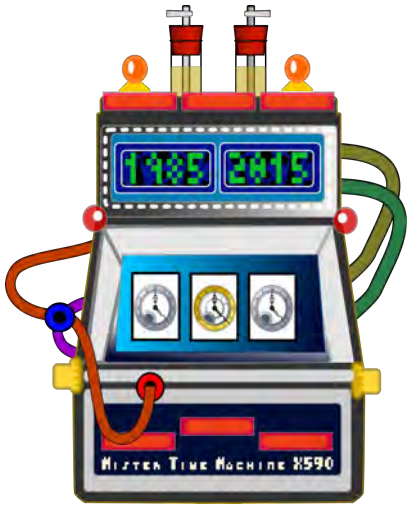
Three Stages of Commissioning

- Initial Commissioning – performed at the time of construction.
- Retro-commissioning or Re-commissioning – performed after the building is completed and has been running for a while.
- Continuous Commissioning – performed continuously.

Three Stages of Maintenance

Reactive

Preventative



Proactive

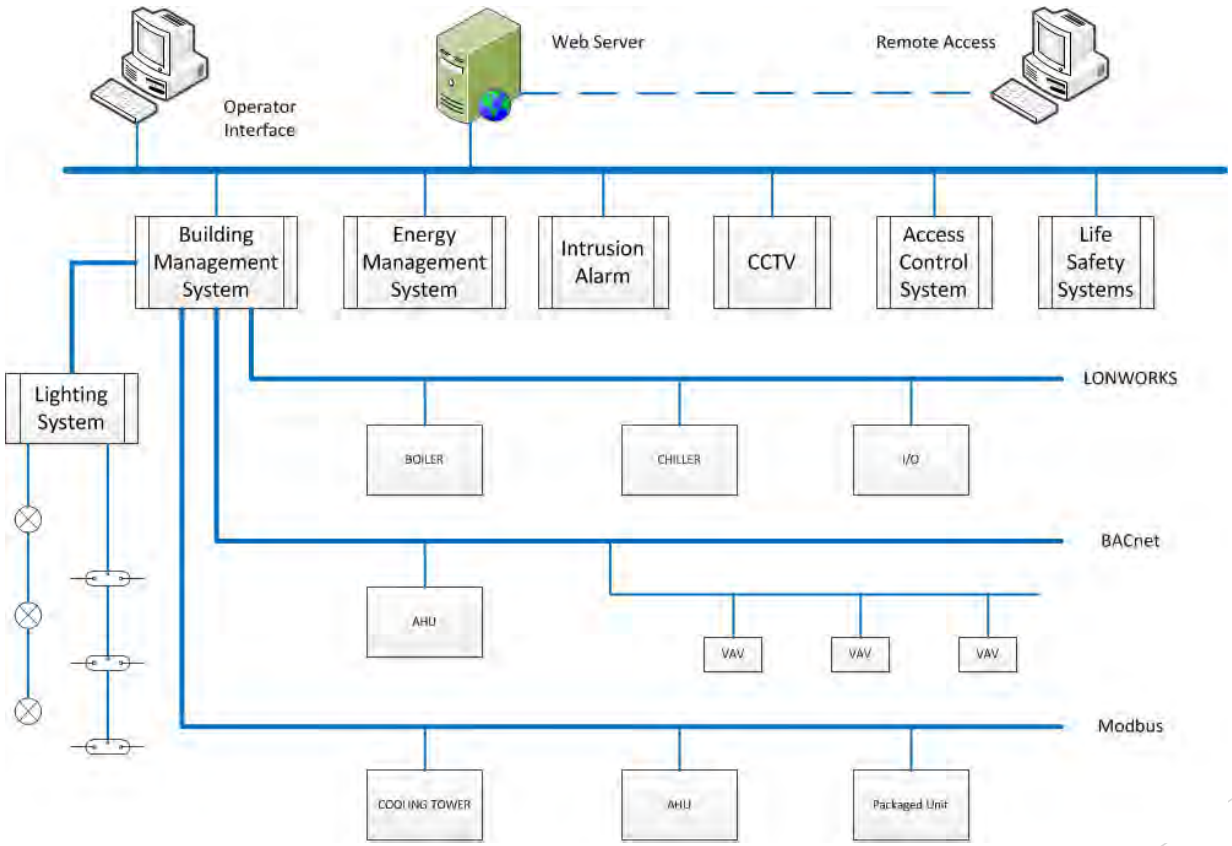
Continuous Commissioning

- The best way to move from Reactive and Preventative Maintenance to Proactive Maintenance is through Continuous Commissioning.
- The best way to provide Continuous Commissioning is through software.

EMIS and FDD

- Energy Management Information System
  - Comprises hardware to measure energy consumption, software to analyze the data and people to take action
  - Capable of quick responses to small variations in energy consumption
- Fault Detection and Diagnosis
  - Capable of identifying and diagnosing equipment failures, control sequence failures and operational changes

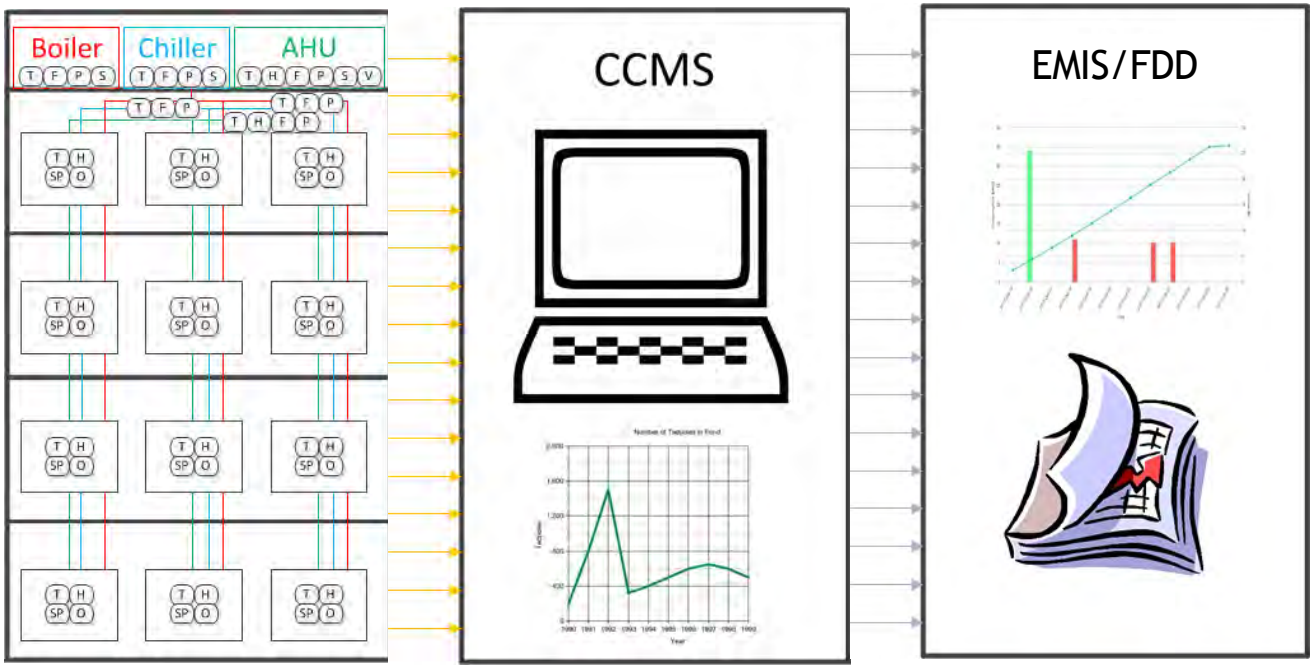
Building Automation System



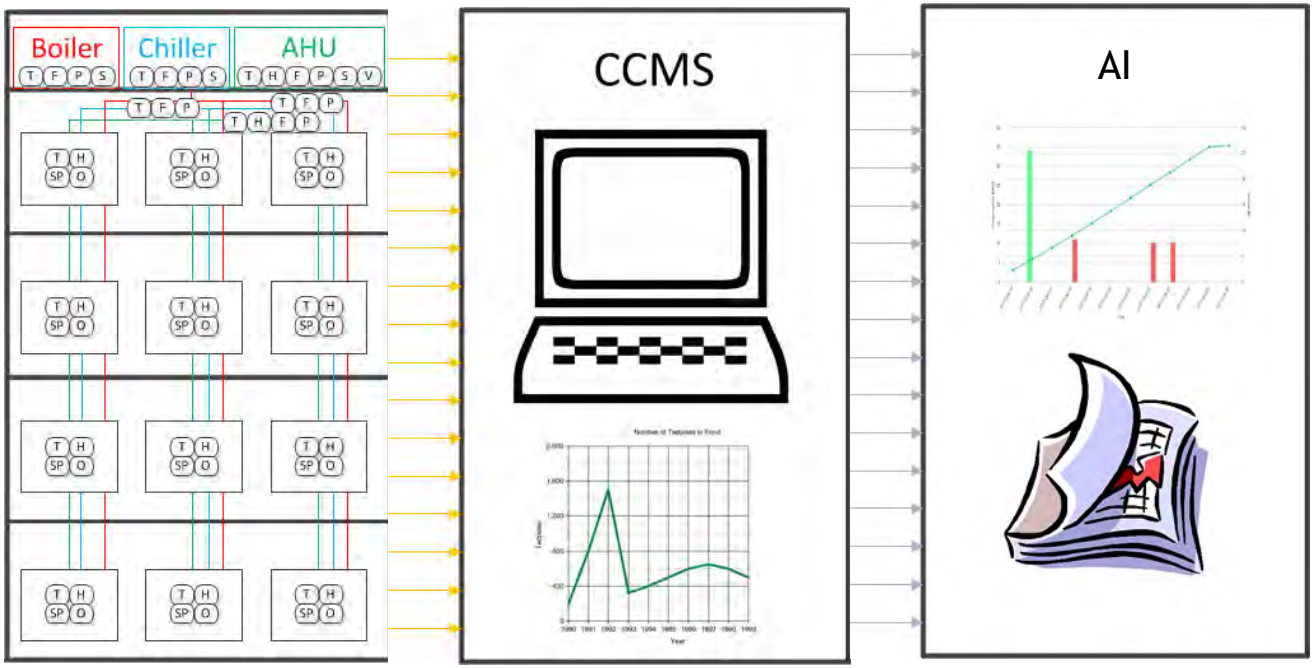
Building

Controls

EMIS/FDD



Building Controls AI



Conclusion

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- It is possible to improve the operation, and therefore the efficiency of most EXISTING buildings simply by modifying their control system.
- There are opportunities for improving the design and implementation of controls, which affects the operation and therefore the energy efficiency of NEW commercial buildings

Thank You