ECO 8

Modify operation on all air-handler heating valves to allow them to remain under control when the unit is turned off

Background Engineering Information:

1. When air-handlers are shut off, the heating coils on approx. 10 units open fully, to prevent coil freezing. This results in unnecessary overheating of the air-handlers, surrounding space and ductwork.
2. The same coil freeze protection can be achieved by leaving the coil under control of the mixed and discharge air controllers.
3. Based on temperature measurements and visual observation, a reduction of 10,000 Btu/hr for an average of 12 hours/day per unit, for 28 weeks per year is estimated.

Thermal Savings Calculations

Savings due to reduced heat loss:

Fuel savings/year = Btu/hr x hrs/wk x weeks/season = MMBTU/yr

= 10,000 x 84 hrs/wk x 28 wks/yr x 10 units

= 235 MMBTU/yr

Total Fuel Savings: 235 MMBTU/yr x $\frac{1}{.80 \text{ boiler eff}}$ = 294 MMBTU/yr

294 MMBTU/yr x $7.56/MM BTU = **$2,221/yr**

Total Thermal Savings: $2,221/yr

Implementation Cost Estimate:

Sensor calibration and programming: $400/unit x 10 units = $4,000

Implementation Cost Estimate:

Sensor calibration:	$1,000
Programming:	$3,000
Engineering/Commissioning:	$200
Total:	$4,200

ECO 10

Connect (14) recirculating domestic hot water pumps to the EMS and program to operate on building occupancy

Background Engineering Information:

1. Recirculation pumps can be shut off except for about 4 hours daily, ½ on-peak, and ½ off peak
2. Combined pump motor size is 2.7 horsepower.
3. The size of the recirculating lines is ¾"; they run throughout the buildings for approximately 7,000 feet. The heat loss of this insulated pipe is 5.26 Btu/hr/ft.
4. The number of hours that they can be reduced in operation is 7,300 hours/yr.
5. Pipe heat loss information is taken from the National Insulation Manufacturer's Association insulation thickness program, 3EPlus, ver. 4.

Electrical Savings Calculations

Pump motor savings (from reduced runtime):

kWh/yr = hp x .746 kW/hp x 1/motor efficiency x operating hrs/year

= 12.7 hp x .746 kw/hp x 1/.85 motor eff. x 7,300 hrs /yr

= 81,367 kWh/yr

x $.0624/ kWh = **$5,077/yr**

Thermal Savings Calculations

Fuel savings = 5.26 Btu/ft/hr x 7,000 feet x 7,300 hrs/yr

= 269 MMBtu/yr

Total Fuel Savings: 269 MMBTU/yr x $\frac{1}{.80 \text{ boiler eff}}$ = 336 MMBTU/yr

336 MMBTU/yr x $7.56/MM BTU = **$2,540/yr**

Total Electrical and Thermal Savings: $5,077 + $2,540 = $7,617 /yr

Implementation Cost Estimate:

Wiring, relay and controls	$14,600
Programming:	$2,000
Engineering/Commissioning:	$600
Total:	$17,200

ECO 18

Remove inlet vanes and install variable frequency drives (VFD) on supply air-handlers in the Library, Carnegie, & 30 Mac

Background Engineering Information:

1. Based on studies by ASHRAE and independent testing companies, for inlet guide vanes on a fan running at 70% volume, the input power is 71% of full load. For a variable frequency drive at 70% volume, the input power is 38% of full load.
2. These air handling units operate an average of 74 hours per week throughout the year.
3. Combined motor horsepower for the supply fans is 20 hp.

Electrical Savings Calculations

Electrical Demand Reduction:

kW = (71 – 38) % x 20 hp x .746 x 1/ motor efficiency

= .33 x 20 x .746 x 1/ .9

= 5.47 kW

Summer peak reduction savings: 5.47 kW x $10.26 x 4 months = **$224/yr**

Winter peak reduction savings: 5.47 kW x $6.86 x 8 months = **$300/yr**

Electrical savings from fan motor operation:

kWh = kW x hours of operation

= 5.47 kW x 74 hrs/wk x 52 wks/yr = 21,048 kWh

x $.0624/ kWh = **$1,313/ yr**

Total Electrical Savings: $524 + $1,313 = $1,837/yr

Implementation Cost Estimate:

VFD's and installation	$6,000
Controls & Programming:	$2,400
Engineering/Commissioning:	$200
Total:	$8,600

ECO 19

Install variable frequency drives (VFD) and remove inlet vanes on return air fans in Carnegie and Weyerhauser Halls, and Library AHU-3 return fan (5 total)

Background Engineering Information:

1. Based on studies by ASHRAE and independent testing companies, for inlet guide vanes on a fan running at 70% volume, the input power is 71% of full load. For a variable frequency drive at 70% volume, the input power is 38% of full load.
2. These air handling units operate an average of 74 hours per week throughout the year.
3. Combined motor horsepower for the return fans is 14.5 hp.

Electrical Savings Calculations

Electrical Demand Reduction:

kW = (71 – 38) % x 14.5 hp x .746 x 1/ motor efficiency

= .33 x 14.5 x .746 x 1/ .9

= 3.97 kW

Summer peak reduction savings: 3.97 kW x $10.26 x 4 months = **$162/yr**

Winter peak reduction savings: 3.97 kW x $6.86 x 8 months = **$218/yr**

Electrical savings from fan motor operation:

kWh = kW x hours of operation

= 3.97 kW x 74 hrs/wk x 52 wks/yr = 15,277 kWh

x $.0624/ kWh = **$953/ yr**

Total Electrical Savings: $380 + $953 = $1,333/yr

Implementation Cost Estimate:

VFD's and installation	$4,400
Controls & Programming:	$3,200
Engineering/Commissioning:	$200
Total:	$7,800

ECO 37

Provide daylighting sensors to reduce lighting levels in south and west-facing rooms in the Library and Campus Center

Background Engineering Information:

1. Lights in these spaces appear to be on continuously during the day, however because of large windows they only need to operate when outdoor light levels are very low.
2. Assume 75% reduction in on-time for these lights, or an average savings of 8 hours per day.
3. There is an estimated 50 fixtures in these areas, with a combined total draw estimated at 2,500 watts.

Electrical Savings Calculations

Reduction in operating hours:

2,500 watts x 56 hrs/wk x 52 wks/yr = 7,280 kWh/yr

x $.085/kWh = **$620/yr**

Total Electrical Savings = $620/yr

This ECO qualifies for a **Prescriptive Rebate** of $50, for each ceiling-mounted sensor.

Implementation Cost Estimate:

Photocells and rewiring	$4,800
Engineering/Commissioning:	0
Total:	$4,800

ECO 39

Install photocells in the Chapel ambulatory area to turn off lights when the ambient level exceeds a certain level

Background Engineering Information:

1. Aisle lights appear to be on continuously during the day, however because of large windows they only need to operate when outdoor light levels are very low.
2. Assume 75% reduction in on-time for these lights, or an average savings of 8 hours per day.
3. Assume that during peak demand periods in the summer, the lighting will be off, so that during the summer months mechanical cooling also can be avoided due to the reduced heat gain from the lights.
4. There is an estimated 15 fixtures in this area, with a combined total draw estimated at 450 watts.

Electrical Savings Calculations

Reduction in operating hours:

450 watts x 56 hrs/wk x 52 wks/yr = 1,310 kWh/yr

x $.085/kWh = **$111/yr**

Total Electrical Savings = $111/yr

This ECO qualifies for a **Prescriptive Rebate** of $50, for each ceiling-mounted sensor.

Implementation Cost Estimate:

Photocells and rewiring	$500
Engineering/Commissioning:	0
Total:	$500

ECO 40

Convert 3-way heating water valves on AHU's to 2-way, install VFD on heating pumps, and provide for pressure control (5 VFD's, 6 controls total)

Background Engineering Information:

1. The building heating pumps run continuously during the heating season
2. They currently serves three-way valves on the air-handlers and the pumps have no variable frequency drive or other control mechanism
3. The combined pump motor sizes are 35.5 hp
4. Engineering studies by Bell & Gossett and ASHRAE have shown that conversion from full flow to 2-way valves reduces the overall flow on average by 30%.

Electrical Savings Calculations

Pump motor savings (from reduced flow):

$$HP_2 = HP_1 \times \left(\frac{GPM_2}{GPM_1} \right)^3$$

$$HP_2 = 5 \times \left(0.7 \right)^3$$

HP_2 = 35.5 x .343 = 12.17 hp

Pump motor savings = 35.5 – 12.2 = 23.3 hp

Pump motor savings (from reduced flow):

kWh/yr = hp x .746 kW/hp x 1/motor efficiency x operating hrs/year

= 23.3 hp x .746 kw/hp x 1/.9 motor eff. x 168 hrs/wk x 28 wks/yr

= 90,850 kWh/yr

x $.0624/ kWh = **$5,669/ yr**

Electrical Demand Reduction:

Electrical Savings from demand reduction (pump motor, winter operation):

23.3 hp x .746 kW/hp = 17.4 kW

Summer: 17.4 kW x $ 6.86/ kW x 8 months **= $955**

Total Electrical Savings: $5,669 + $955 = $6,624/yr

Implementation Cost Estimate:

Using $200/ installed hp for VFD plus $1,800 each for controls:

$200 x 35.5 = $7,100 + $10,800 = $17,900

ECO 41

Insulate remaining bare sections of steam/condensate piping in the attic of Bigelow Hall

Background Engineering Information:

1. The steam/condensate water pipe temperature averages 190°
2. The average size of the pipe is approximately 2”
3. The system is hot for approximately 8 months per year
4. 2” of fiberglass insulation would be applied the existing bare pipe
5. Heat loss values are taken from North American Insulation Manufacturer’s Association 3E Plus, version 4.0, for heat loss from horizontal pipe, ASTM C585 steel, with 0.8 emittance, pipe temperature of 190^{o} and 60^{o} ambient temperature.

Thermal Savings Calculations

Heat loss of 2” pipe , bare: 120 Btu/hr-ft

Heat loss of 2” pipe @ 150^{o} with 2 inch fiberglass insulation: 12.5 Btu/hr-ft

Savings: 108 Btu/hr-ft x 200 ft x 6,570 hours/year

= 142 MMBTU/yr

Total Fuel Savings = MMBTU/yr x $\frac{1}{.80 \text{ boiler eff}}$ = MMBTU/yr

= 142 MMBTU/yr x $\frac{1}{.80 \text{ boiler eff.}}$ = 178 MMBTU/yr

x $7.56/MMBTU = **$1,342/yr**

Total Thermal Savings: $1,342/yr

Implementation Cost Estimate:

Pipe insulation installed, @ $10.50/ft x 200 ft. = $2,100

ECO 42

Insulate exterior walls of boilers 1 & 2 in the heating plant, and various steam accessories including valve bonnets

Background Engineering Information:

1. The exterior wall temperature of boilers #1 and 2 averages around 120° when firing
2. There are miscellaneous valve bonnets, pipe sections, and accessories that are uninsulated
3. The system is hot for approximately 8 months per year
4. Various types of fiberglass insulation or sewn blankets can be used to cover these hot surfaces
5. Estimated heat loss from all surfaces is 200,000 Btu/hr.

Thermal Savings Calculations

Savings: 200,000 Btu/hr x 6,570 hours/year

= 1,350 MMBTU/yr

Total Fuel Savings = MMBTU/yr x $\frac{1}{.80 \text{ boiler eff}}$ = MMBTU/yr

= 1,350 MMBTU/yr x $\frac{1}{.80 \text{ boiler eff.}}$ = 1,688 MMBTU/yr

x $7.56/MMBTU = **$12,758yr**

Total Thermal Savings: $12,758/yr

Implementation Cost Estimate:

Insulation cost and installation:	$14,000