Uncover Energy Savings: Benchmarking, Auditing and Troubleshooting
Meet Your Panelist

- Mike Carter
- Justin Kale
NEEA Northwest Industrial Training

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Upcoming In-Class Trainings

To register for a training, click below, or go to the NEEA calendar at http://neea.org/get-involved/calendar and look for it by date and title. Once you find the training you want to register for, click on the title and you will find a description and registration information. Trainings are posted to the calendar as dates are finalized, so please check the calendar regularly or contact the training team at 888-720-6823.

• **Chilled Water and Cooling Towers:**
  
  **Energy Efficiency of Chilled Water Systems and Cooling Towers**
  
  October 28—29: Spokane, WA,
  
  To register for Chilled Water Systems on Oct 28, click [here](http://neea.org/get-involved/calendar).
  
  To register for Cooling Tower on Oct 29, click [here](http://neea.org/get-involved/calendar).
  
  To register for both days, click [here](http://neea.org/get-involved/calendar).
Upcoming In-Class Trainings continued

• **Compressed Air:**
  - Compressed Air Challenge – Level 1
    - November 6: Hermiston, OR, to register click [here](http://neea.org/get-involved/calendar).
    - November 13: Vancouver, WA, to register click [here](http://neea.org/get-involved/calendar).
    - December 11: Nampa, ID, to register click [here](http://neea.org/get-involved/calendar).

• **Electric Motors:**
  - Adjustable Speed Drive Applications and Energy Efficiency
    - November 4: Albany, OR, to register click [here](http://neea.org/get-involved/calendar).

• **Fans:**
  - Fan System Assessment Tools (FSAT)
    - December 2: Twin Falls, ID, to register click [here](http://neea.org/get-involved/calendar).
Upcoming In-Class Trainings continued

• **Lighting:**
  Efficient and Effective Industrial Lighting
  December 9: Yakima, WA, to register click [here](http://neea.org/get-involved/calendar).

• **Pumps:**
  Pumping System Optimization
  October 23: Eugene, OR, to register click [here](http://neea.org/get-involved/calendar).
  Optimizing Pumping Systems: A Measurement-Based Approach
  November 19-20: Port Angeles, WA, to register click [here](http://neea.org/get-involved/calendar).

• **Refrigeration and HVAC:**
  Energy Efficiency for Air Cooled Refrigeration Systems
  November 19: Billings, MT, to register click [here](http://neea.org/get-involved/calendar).
  Energy Efficient Industrial HVAC and Refrigeration Systems
  November 20: Moses Lake, WA, to register click [here](http://neea.org/get-involved/calendar).
Upcoming Webinars

To register for these Portland General Electric (PGE) webinars, go to the NEEA calendar [http://neea.org/get-involved/calendar](http://neea.org/get-involved/calendar) and look for it by date and title. Once you find the webinar you want to register for, click on the title and you will find a description and registration information. **All webinars are free!**

- **Compressed Air:**
  - Compressed Air for Small Industrial (PGE)
    October 23: 8-9am PST, to register click [here](http://neea.org/get-involved/calendar).
  - Compressed Air for Large Industrial (PGE)
    October 23: 10-11 PST, to register click [here](http://neea.org/get-involved/calendar).

- **Recorded webinars**
  - View 20+ recorded webinars anytime, click [here](http://neea.org/get-involved/calendar).
Contents

• Benchmarking
  o Motors
  o VFD Motor Control
  o Compressed Air
  o Cooler/Freezers
  o HVAC
  o Lighting
  o Office Equipment

• Audit Checklists
  o Motors
  o Pumps
  o Boilers
  o Process Operation
  o Compressed Air
  o Hot Water
  o Refrigeration
  o Building Envelope
  o HVAC
  o Lighting
Benchmarking to Identify Waste
Manufacturing
Manufacturing Consumption Patterns

• Motors represent largest end use for most manufacturing segments
  o Chemicals (228 kWh/sqft)
  o Paper Mills (113)
  o Plastic Products (69.15)
  o Pharmaceutical (63.40)
  o Computer & Electronics (57.67)
  o Wood Products (47.16)
  o Transportation Equipment (45.46)
  o Beverage (42.20)
  o Apparel (32.28)
  o Machinery Manufacturing (29.77)

• Example
  o \( \frac{4,500,000 \text{ kWh}}{80,000 \text{ ft}^2} = 56 \text{ kWh/ft}^2 \)
Manufacturing Consumption Patterns

- Warehouse energy consumption is dominated by lighting
- Assembly operations are dominated by HVAC
Motors

• Electric motors

Power (kW) = HP x 0.746/eff

Example: What is electrical power for a 200 HP motor?

\[
\text{Power (kW)} = 200 \ \text{HP} \times 0.746/0.90 \\
= 166 \ \text{kW}
\]

Energy consumption = Power (kW) x Run time (hrs)

Example: What is energy consumption per year for a 200 HP motor that runs 10 hours per day, 5 days per week?

\[
\text{Energy consumption} = 166 \ \text{kW} \times 2600 \ \text{Hr} \\
= 431,600 \ \text{kWh}
\]
VFD Motors

- With a VFD, decreasing speed (rpm) by 50% decreases power (HP) by 87%!

Source: Emerson Industrial Automation
Sample Savings from VFD Motors

- Estimating VFD energy savings
  - Assume a 50 HP (41.4 kW) motor operating at reduced speeds (but equivalent flow)

\[
\text{Full load energy consumption} = 41.4 \text{ kW} \times 16 \text{ hr} = 662 \text{ kWh}
\]

\[
\text{VFD energy consumption} = 352 \text{ kWh}
\]

\[
\text{Savings} = 310 \text{ kWh}
\]
Poll Question

• For a manufacturing facility, which end use represents the largest share of electrical intensity?

  a) HVAC
  b) Lighting
  c) Motors
  d) Process heating
Compressed Air Energy Management

- Bottom line cost savings today!
  - Compressed air is the most expensive utility.
  - Compare annual energy cost for 1 hp air motor at $1,358 versus 1 hp electric motor at $194.
  - Easily averages $100 per cfm per year (3-shifts)!

Typical Demand Components

- Excessive Pressure 5%
- Wrong application 20%
- Leaks 25%
- Normal Production 50%
Walk-In Cooler/Freezer Energy Consumption

- Freezer energy consumption is three times that of a cooler
  - Coolers average 14 to 18 kWh/Month/SqFt
  - Freezers average 35 to 45 kWh/Month/SqFt

<table>
<thead>
<tr>
<th>Cooler Avg. kWh/Month</th>
<th>Freezer Avg. kWh/Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>kWh</td>
</tr>
<tr>
<td>6x6, 6x8</td>
<td>660</td>
</tr>
<tr>
<td>8x8, 8x10, 8x12</td>
<td>1120</td>
</tr>
<tr>
<td>10x10, 10x12</td>
<td>1410</td>
</tr>
</tbody>
</table>

Source: U.S. Cooler
Walk-In Cooler/Freezer Energy Consumption

- Knowing amps and volts allows you to estimate kWh

Energy consumption \((1\bigcirc)\) = Amps x Volts x PF x Hours/1000
= \(75A \times 240V \times 0.8 \times 480\) Hours/1000
= 6910 kWh/Month

Energy consumption \((3\bigcirc)\) = Amps x Volts x 1.73 x PF x Hours/1000
= \(75A \times 240V \times 1.73 \times 0.8 \times 480\) Hours/1000
= 11,970 kWh/Month

<table>
<thead>
<tr>
<th>Component (240V)</th>
<th>Rated Amps</th>
<th>Total Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Compressors</td>
<td>15A</td>
<td>45A</td>
</tr>
<tr>
<td>9 Condenser Fans</td>
<td>2A</td>
<td>18A</td>
</tr>
<tr>
<td>6 Evaporator Fans</td>
<td>2A</td>
<td>12A</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>75A</strong></td>
<td></td>
</tr>
</tbody>
</table>
Water Heating

• It takes one Btu to raise the temperature of one pound of water one degree Fahrenheit
  ○ 1 gallon = 8.34 pounds; 3,412 Btu = 1 kWh

• Energy Factor (EF) = \[\frac{\text{energy in the heated water used daily}}{\text{total daily energy consumption of the water heater}}\]

<table>
<thead>
<tr>
<th>Type</th>
<th>EF Minimum</th>
<th>Energy Factor Delivery Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ENERGY STAR</td>
<td>ASHRAE 90.1-2007</td>
</tr>
<tr>
<td>Gas Storage</td>
<td>0.67</td>
<td>0.53</td>
</tr>
<tr>
<td>Gas Tankless</td>
<td>0.82</td>
<td>0.53</td>
</tr>
<tr>
<td>Heat Pump WH</td>
<td>2.0</td>
<td>0.86</td>
</tr>
<tr>
<td>Electric Storage</td>
<td>0.97</td>
<td>0.86</td>
</tr>
</tbody>
</table>
Water Heating

- Example: 50-gallon electric water heater requires 4,727 kWh/yr based on the following assumptions
  - EF = 0.93
  - Temperature setpoint = 135°F
  - Inlet water temperature = 58°F
  - Temperature rise = 135°F – 58°F = 77°F
  - Daily hot water demand = 64 gallons

Energy consumption = pounds of water x temperature rise ÷ efficiency

\[
= 64 \text{ gal/day} \times 365 \text{ day/yr} \times 8.34 \text{ lb/gal} \times 77\text{F} \times 1 \text{ Btu/lbF} \\
\div 3,412 \text{ Btu/kWh} \div 0.93 \\
= 4,727 \text{ kWh per year} \\
= 230 \text{ therms equivalent (EF = 0.65)}
\]
Water Heating

• First-Hour Rating (FHR)
  o The amount of hot water in gallons a storage water heater can supply per hour (starting with a tank full of hot water).
  o Typically 80% of storage + 100% recovery rating
  o Example: FHR = (50 gal x 0.8) + 21 GPH = 61 GPH

• Gallons Per Minute (GPM)
  o The amount of hot water in gallons a tankless water heater can supply per minute over a 77°F temperature rise.
  o 3 GPM of 105°F hot water
    • Equivalent to 2 GPM of 130°F water
Poll Question

- Freezer energy consumption is ________ that of cooler energy consumption.
  a) Three times (3X)
  b) Five times (5X)
  c) Ten times (10X)
Office Space
Average Office Consumption Patterns

- Cooling/ventilation and lighting accounts for approximately 75% of consumption
  - Cooling/ventilation is 6.6 to 8.0 kWh/ft\(^2\)
- Average large office annual electricity intensity is 15.8 to 16.9 kWh/ft\(^2\)/yr
Average Office Consumption Patterns

• How to calculate your usage for comparison

  o 1,500,000 kWh = 18.75 kWh/ft$^2$
    80,000 ft$^2$

  o 18.75 kWh/ft$^2$ > 16.40 kWh/ft$^2$
    • Possible improvement opportunities

Source: ENERGY STAR
Estimating HVAC Billing

• HVAC costs, typically the largest portion of your bill, can be estimated by using cooling load hours.

• When heating with natural gas, establish lowest cooling load hour month electrical consumption as a baseline to estimate the air conditioning portion of your bill:
  - Most other end uses such as lighting and office equipment are fairly constant over the year.
  - Almost all of the month-to-month increases in energy consumption are due to air conditioning.
HVAC Monthly Billing

- Use **baseline** consumption in winter months to estimate cooling portion of bill

- Subtracting winter months baseline from actual will give a good estimate of cooling energy consumption
  - Use 80% of January/February energy consumption as a baseline

<table>
<thead>
<tr>
<th>Monthly Electricity Consumption, kWh (1,000s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>Actual</td>
</tr>
<tr>
<td>Base</td>
</tr>
<tr>
<td>Δ</td>
</tr>
</tbody>
</table>

Example: \[
\frac{750,000 \text{ kWh}}{80,000 \text{ ft}^2} = 9.4 \text{ kWh/ft}^2/\text{yr} \quad (\text{vs. 6.6-8.0 cooling + ventilation})
\]
HVAC Monthly Billing

- When **heating with electricity**, establish lowest HVAC load hour month electrical consumption as a baseline to estimate the HVAC (cooling plus heating) portion of your bill
  - Typically spring or fall month
HVAC Monthly Billing

- For all-electric HVAC, use baseline consumption in spring/fall months to estimate HVAC portion of bill
- Subtracting baseline from actual will give a good estimate of HVAC energy consumption
  - Use 80% of May (or September) energy consumption as a baseline

| All-Electric Monthly Electricity Consumption, kWh (1,000s) |
|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|
|             | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Total |
| Actual      | 245 | 210 | 190 | 110 | 78  | 90   | 138  | 102 | 80   | 80  | 175 | 210 | 1,500 |
| Δ           | 183 | 158 | 128 | 48  | 16  | 28   | 76   | 40  | 18   | 18  | 113 | 158 | 984   |

Example: \( \frac{984,000 \text{ kWh}}{80,000 \text{ ft}^2} = 12.3 \text{ kWh/ft}^2/\text{yr} \) (vs. 12.2 to 12.6 cool/heat/vent)
HVAC Equipment Capacity

- An alternative to baselining energy consumption is using nameplate capacity, efficiency, and weather data to estimate HVAC energy consumption
  - Annual Cooling Load Hours (CLH)
    - Portland, OR  364 CLH
    - Boise, ID     701 CLH
    - Yakima, WA    425 CLH
  - Typical equipment efficiency
    - Rooftop unit  1.3 kW/ton FLV
    - Chiller       0.8 kW/ton FLV

Example: HVAC consumption = Load (tons) x FLV x CLH
= 300 tons x 1.3 kW/ton x 701 hours
= 273,400 kWh (vs. 168,000 @0.8 kW/ton)

- Intensity = \(\frac{273,400 \text{ kWh}}{40,000 \text{ ft}^2}\) = 6.8 kWh/ft\(^2\)/yr  (vs 7.6-8.0 cooling + ventilation)

<table>
<thead>
<tr>
<th>FLV (kW/ton)</th>
<th>COP</th>
<th>EER</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>5.9</td>
<td>20</td>
</tr>
<tr>
<td>0.75</td>
<td>4.7</td>
<td>16</td>
</tr>
<tr>
<td>1.0</td>
<td>3.5</td>
<td>12</td>
</tr>
<tr>
<td>1.5</td>
<td>2.3</td>
<td>8</td>
</tr>
</tbody>
</table>
HVAC Savings Estimate

- Use Full Load Value (kw/ton) efficiency ratings to estimate energy savings from upgrading to new HVAC equipment
  - A 10% to 20% energy savings from a new rooftop unit is a reasonable assumption
    - Existing: Rooftop unit  1.3 kW/ton FLV (9.0 EER)
    - Proposed: Rooftop unit  1.1 kW/ton FLV (10.9 EER)

Example: HVAC consumption = Load (tons) x FLV x CLH

Existing = 300 tons x 1.3 kW/ton x 701 hours = 273,400 kWh
Proposed = 300 tons x 1.1 kW/ton x 701 hours = 231,330 kWh

Annual energy savings = 42,070 kWh
HVAC Savings Estimate

• There may be demand savings as well as energy savings from upgrading to new HVAC equipment

Existing: Rooftop unit 1.3 kW/ton FLV (9.0 EER)
Proposed: Rooftop unit 1.1 kW/ton FLV (10.9 EER)
Demand savings = 0.2 kW/ton

Energy savings ($) = 42,070 kWh x $0.07/kWh
= $3,000 per year

Demand savings ($) = (0.2 kW/ton) x 300 tons x $8/kW x 8
= $3,840 per year

Total savings ($) = $6,840 per year
Poll Question

- Is the electrical intensity for industrial space higher or lower than the intensity for office space?
  a) Higher
  b) Lower
  c) About equal
Determining Energy-Saving Lighting Opportunities

- Average large office lighting electricity intensity is 4.88 to 5.03 kWh/ft²/yr
- A walk-through lighting inventory can be used to estimate lighting intensity
- A four-step procedure is used to estimate actual lighting intensity
  1. Identify # lamps/lamp type
  2. Use wattage table
  3. Estimate annual burn time
  4. Measure floor area

\[
\text{Energy consumption (kWh) = Power (kW) x Time (hrs)}
\]
Determining Energy-Saving Lighting Opportunities

Example: 40 4-lamp 4-foot T12 fixtures
12 hours/day, 5 day/week burn time
(3,120 hrs annually)
3,520 sqft floor area

Energy consumption = 40 x 144 watts x 3120 hrs ÷ 1,000W/kW
= 18,000 kWh

Electricity intensity (T12) = 18,000 kWh/3,520 sqft
= 5.11 kWh/sqft (>5.03)

Electricity intensity (T8) = 3.47 kWh/sqft (<4.88)
Lighting Controls

• Lighting occupancy sensors
  o Turn off lights based on foot traffic

Example: Meeting room with six 4-lamp F34T12 fixtures
Savings = 6 x 144w x 3120 hour x 0.5 = 1350 kWh
= $135 @ $0.10/kWh

• Lighting bi-level switching
  o Allows you to reduce light output in one step when full illumination is not required

• Dimmers
  o Reduces light output for setting mood or for multimedia events

• Daylight sensors (Photocells)
  o Dims or turns off lighting when free daylight is available
Lighting Controls

- Wattage Reduction from New Technology

- **Energy Consumption**
  - 400-W metal halide
  - 275-W LED

- **Time**

- **Savings**
Lighting Controls

- Implement Time Scheduling

Savings

12 AM  6 AM  Noon  6 PM  12 AM
Lighting Controls

- Implement Occupancy Controls
Lighting Controls

• Implement Task Tuning
Lighting Controls

• Implement Daylight Harvesting
Lighting Controls

• Implement Personal Control
Personal Appliances

• Another focus for best-in-class office operations is employee personal appliances that circumvent energy-efficiency efforts
  o Employee personal appliances can cost up to $135 annually per office!

• To limit expenses related to personal appliances, offices…
  o Require formal request for personal appliances
  o Charge for privilege of using personal appliances

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Average Power (watts)</th>
<th>Annual Operating Hours</th>
<th>Annual Energy (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Space Heater</td>
<td>1,500</td>
<td>500</td>
<td>750</td>
</tr>
<tr>
<td>Mini-fridge, 3ft³</td>
<td>150</td>
<td>Year-round</td>
<td>320</td>
</tr>
<tr>
<td>Microwave</td>
<td>1,000</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>Portable Fan</td>
<td>180</td>
<td>500</td>
<td>90</td>
</tr>
<tr>
<td>Coffee Pot/Warmer</td>
<td>300</td>
<td>250</td>
<td>75</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1360</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sample Savings From Equipment Settings

- Office equipment with idle and sleep mode features are energy-saving replacements when it is time to upgrade

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop Computer</td>
<td>100</td>
<td>60</td>
<td>6</td>
<td>$12</td>
<td>$16</td>
<td>$56</td>
</tr>
<tr>
<td>CRT Monitor (15&quot;)</td>
<td>60</td>
<td>40</td>
<td>4</td>
<td>$7.70</td>
<td>$10</td>
<td>$37</td>
</tr>
<tr>
<td>LCD Monitor (17&quot;)</td>
<td>35</td>
<td>8</td>
<td>2</td>
<td>$2.50</td>
<td>$3.90</td>
<td>$9.20</td>
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<tr>
<td>Laptop</td>
<td>65</td>
<td>15</td>
<td>1</td>
<td>$4.60</td>
<td>$5.30</td>
<td>$15</td>
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<tr>
<td>Laser Printer</td>
<td>350</td>
<td>85</td>
<td>20</td>
<td>$26</td>
<td>$29</td>
<td>$96</td>
</tr>
<tr>
<td>Fax Machine</td>
<td>300</td>
<td>75</td>
<td>10</td>
<td>$12</td>
<td>$19</td>
<td>$69</td>
</tr>
<tr>
<td>Copier (small)</td>
<td>300</td>
<td>75</td>
<td>20</td>
<td>$13</td>
<td>$26</td>
<td>$76</td>
</tr>
<tr>
<td>Copier (large)</td>
<td>1,400</td>
<td>350</td>
<td>40</td>
<td>$55</td>
<td>$82</td>
<td>$315</td>
</tr>
</tbody>
</table>

*Assumes $0.10/kWh, 2085 operating hours per year, 20% full power, 60% overall idle mode, 20% sleep mode for computers and monitors, 50% idle mode and 45% sleep mode for printers, faxes, and copiers. Equipment is turned off for 6675 hours.

**Assumes $0.10/kWh, 8760 operating hours per year, same 8-hour/5-day mode, and either sleep or idle for non-work hours (work day nights and weekends). Equipment is never turned off.

Sources: Manufacturers’ specifications, Energy Star (DOE), and Office Equipment Energy Savings Calculator (LBL)
Use Efficient Settings and Equipment

- Offices can save approximately $70 per year per computer just by using sleep mode

### Annual Energy Cost (24 Hours/Day, 7 Days/Week)

<table>
<thead>
<tr>
<th></th>
<th>No Sleep Mode</th>
<th>Sleep Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desktop computer</td>
<td>$56</td>
<td>$16</td>
</tr>
<tr>
<td>CRT monitor (15”)</td>
<td>$37</td>
<td>$10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$93</strong></td>
<td><strong>$26</strong></td>
</tr>
</tbody>
</table>
Use Efficient Settings and Equipment

- Replacing CRT monitors with LCD saves up to $20 per year

<table>
<thead>
<tr>
<th></th>
<th>No Sleep Mode</th>
<th>Sleep Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>CRT monitor (15&quot;)</td>
<td>$37</td>
<td>$10</td>
</tr>
<tr>
<td>LCD monitor (17&quot;)</td>
<td>$ 9</td>
<td>$ 4</td>
</tr>
<tr>
<td>Total</td>
<td>$28</td>
<td>$6</td>
</tr>
</tbody>
</table>
Audit Checklists
Audit Checklists

• Motor Operation
  - Motors are sized to run near rated load
  - Replaced motors meet NEMA premium efficiency
  - Voltage unbalance <3%
  - Reduced voltage starter or VFD is used to reduce starting current
  - VFD used for variable torque loads
  - Power factor is corrected if justifiable
Audit Checklists

• Pump Operation
  - Pumps are sized to run near rated load
  - Pump demand reduction
  - Impeller trimming for constant loads
  - Use of VFD control for variable loads
Audit Checklists

• Boilers/Steam Systems
  - Jack-shaft controls are inspected and calibrated
  - Excess air not over 15%
  - Steam trap leaks detected and repaired
  - Heat recovered from steam condensate during blowdown
  - Boiler tube heat transfer surfaces are clean
  - Inspect boiler access openings for leaks
  - Improve water quality to reduce deaerator vent rate
  - Insulate steam pipes and other hot surfaces
Audit Checklists

• Process Operation
   Remove power from unused transformers
   Industrial heat pumps considered
    • <250°F final temperature
    • <100°F total lift
    • <0.5 MMBtuh waste heat source
   Radio Frequency/Microwave heating/drying
    • <750°F final temperature
    • Thickness <6” food; <18” wood
   Induction process heating considered
    • Simple geometries
Audit Checklists

- Compressed Air Operation
  - Two-stage preferred to single-stage
  - Bad applications replaced with actuators/fans
  - Leaks are fixed
  - Variable speed controls used for trim units
  - Reduce blow off set-point (typically below 75%)
  - System pressure reduced to minimum required
  - Use ¾" diameter hose for >3 HP tools or >50' lengths
  - Heat recovery integrated with air-cooled compressors
Audit Checklists

• Hot Water Operations
  - Hot water heater(s) and pipes are insulated
  - Thermostat temperature set to 120°F
  - Low-flow pre-rinse spray valves are used
  - Water leaks are fixed
  - Microwave ovens are used for thawing, partial cooking, and reheating (instead of hot water)
  - Dishwashers are fully loaded before washing
Audit Checklists

• Refrigeration Operation

- Ambient air relative humidity levels are between 40% to 55%
- VFD/ECM evaporator fan controllers used for refrigerators
- Floating head pressure controls are used with compressors
- Heat recovery systems used with condensers
- Air doors/strip curtains used on freezer doors
- Condensation sensor used with anti-sweat heater
Audit Checklists

• Refrigeration Maintenance
  ❏ Evaporator and condenser coils are clean
  ❏ Refrigerant charge is adequate
  ❏ Check for unusual noise, vibration, and performance reductions of the compressors/motors
  ❏ Worn and/or leaky door seals are replaced
  ❏ Verify operation and efficiency of defrost timers and moisture sensors to ensure optimal performance
  ❏ Clean and disinfect condensate drain pans
Audit Checklists

• Building Envelope
  - Check and verify insulation levels
  - Fill in outside air leaks with a low expanding foam
  - Replace cracked or missing window and door caulking
  - Install solar film or blinds for windows with south exposure
  - Replace cracked or missing weather-stripping
  - Air doors/curtains used for loading docks
Audit Checklists

• HVAC Operation
  - The recommended winter temperature is 68°F (50°F setback)
  - The recommended summer temperature setting is 78°F with 55% relative humidity (84°F setforward)
  - Programmable thermostats are used
  - Economizers are used for >4.5 tons (ASHRAE 90.1-2010)
  - Chilled water temperature raised 5°F to 10°F during spring and fall
  - Check air handler damper actuators for movement and sealing
Audit Checklists

• HVAC Maintenance
  - Furnace filters are replaced on a monthly or bi-monthly schedule
  - Registers have free airflow
  - Thermostats and ventilation controls are covered and locked
  - Check for unusual noise, vibration, decrease in performance, or compressors/motors
  - Seal ductwork leaks
  - Inspect/clean condenser tubes and coils
  - Clean and disinfect condensate drain pans
Audit Checklists

• Lighting Operations
  - Occupancy/vacancy sensors for low foot-traffic areas
  - Photocells for all-night outdoor lighting
  - Timers in parking lots and restricted-access areas
  - Dimming controls take advantage of daylighting
  - Illumination levels are verified
  - No more than one lamp per ballast is removed in delamping
Audit Checklists

• Lighting Operations

- T12 fixtures replaced with T8/T5
- Probe-start metal halides replaced with fluorescent
- Halogen spots replaced with metal halide
- Incandescent A-bulbs replaced with CFL
- Exit signs use LED lamps
- Illumination levels are verified
- Lights turned off in unoccupied areas or during non-working hours
Audit Checklists

• Lighting Maintenance
  - A lamp upgrade program is in place
  - Ballasts that are not in use are de-energized
  - Lamps and fixtures are cleaned for maximum illumination
  - Broken fixtures are repaired/replaced
  - Reflectors are added to existing lighting
  - Lighting panels and switches are labeled
Case Studies

• FUJIFILM Hunt Chemicals (Dayton, TN)
  o 120,000-square-foot site; $897,000 a year (electric and natural gas)
  o Excessive downtime due to chronic air compressor failures
  o Compressed air audit findings:
    • Compressors set to run at 120 PSIG
      o Delivering 90 to 95 PSIG
      o Dropping as low as 80 PSIG
    • Production Line 1 had excess capacity
    • Significant leaks
  o Solutions
    • Increasing the system’s storage capacity to handle peaks and valleys
    • Lowering air compressor operating pressure to 105 PSIG
    • Repairing system leaks with a Leak Detection and Repair (LDAR) program
  o Resulted in 15% energy savings (<2 year payback)
    • Ultimately operating the facility with one compressor.
Case Studies

- **Mid-South Metallurgical (Murfreesboro, TN)**
  - Provides precision and specialty heat treating services
  - Three facilities that occupy 21,000-square-feet of space
    - Facilities operate 24 hours a day, 5-1/2 days a week
  - Covered and insulated two barium chloride salt baths while not in use to reduce heat losses
    - Produced annual electricity cost savings of approximately $53,000.
  - Replaced 44 older 400-watt metal halide fixtures with 88 new 8-foot fixtures with 4 lamp F32T8 fluorescent bulbs
    - Reduced annual lighting operation and maintenance costs by 52%.
  - Energy optimization system reduced peak demand from 873 to 688 kW
Case Studies

- Volvo Trucks (Dublin, VA)
  - Goal: Reduce overall energy consumption by 25% in just one year
    - Energy manager and energy advisor positions created
    - Established a multi-disciplined energy committee
  - Three assessments: process heating, fans, compressed air
    - Obtained savings verification from an independent contractor
  - Company incentivized employee ideas (25 teams)
    - Prizes and corporate recognition
  - Savings of 546,543 kilowatt hours (kWh) per month, approximately $33,000 in monthly cost
    - Turn down the building temperature by 5 degrees ($30,000/month savings)
    - Turn off outside loading dock lights at night ($1,200/month)
    - Installed radiant heating system in the plant’s shipping building
      - 80% reduction in the building’s natural gas usage (<2.5 year payback)
Poll Questions

• How valuable has this Webinar been to you?
  a) Not valuable
  b) Slightly
  c) Moderately
  d) Very
  e) Extremely
Helpful Resources

- Air-Conditioning, Heating, and Refrigeration Institute (AHRI)

- DOE commercial lighting solutions tool
  - [https://www.lightingsolutions.energy.gov](https://www.lightingsolutions.energy.gov)

- Food service technology center
  - [http://www.fishnick.com/](http://www.fishnick.com/)

- Improving Compressed Air System Performance sourcebook
  - [http://www.compressedairchallenge.org](http://www.compressedairchallenge.org)
Helpful Resources

• Energy Auditing Software
  o EnerSys Analytics - Energy Profile Tool
  o InterEnergy Software - Building Energy Analyzer Pro
  o DOE Industrial Facilities Scorecard
  o DOE Integrated Tool Suite/Plant Energy Profiler
  o ENERGY STAR - Portfolio Manager
NEEA Northwest Industrial Training

• **Provided by:**
  Northwest Regional Industrial Training Center:
  (888) 720-6823
  industrial-training@industrial.neea.org

• **Co-sponsored by your utility and:**
  Washington State University Extension Energy Program
  Bonneville Power Administration
  Northwest Food Processors Association

• **Utility incentives and programs:**
  Contact your local utility representative
To register for a training, click below, or go to the NEEA calendar at http://neea.org/get-involved/calendar and look for it by date and title. Once you find the training you want to register for, click on the title and you will find a description and registration information. Trainings are posted to the calendar as dates are finalized, so please check the calendar regularly or contact the training team at 888-720-6823.

- **Chilled Water and Cooling Towers:**
  
  **Energy Efficiency of Chilled Water Systems and Cooling Towers**
  
  October 28—29: Spokane, WA,
  
  To register for Chilled Water Systems on Oct 28, click [here](http://neea.org/get-involved/calendar).
  
  To register for Cooling Tower on Oct 29, click [here](http://neea.org/get-involved/calendar).
  
  To register for both days, click [here](http://neea.org/get-involved/calendar).
Upcoming In-Class Trainings continued

- **Compressed Air:**
  
  Compressed Air Challenge – Level 1
  November 6: Hermiston, OR, to register click [here](http://neea.org/get-involved/calendar).
  November 13: Vancouver, WA, to register click [here](http://neea.org/get-involved/calendar).
  December 11: Nampa, ID, to register click [here](http://neea.org/get-involved/calendar).

- **Electric Motors:**
  
  Adjustable Speed Drive Applications and Energy Efficiency
  November 4: Albany, OR, to register click [here](http://neea.org/get-involved/calendar).

- **Fans:**
  
  Fan System Assessment Tools (FSAT)
  December 2: Twin Falls, ID, to register click [here](http://neea.org/get-involved/calendar).
Upcoming In-Class Trainings continued

• **Lighting:**
  Efficient and Effective Industrial Lighting
  December 9: Yakima, WA, to register click [here](http://neea.org/get-involved/calendar).

• **Pumps:**
  Pumping System Optimization
  October 23: Eugene, OR, to register click [here](http://neea.org/get-involved/calendar).
  Optimizing Pumping Systems: A Measurement-Based Approach
  November 19-20: Port Angeles, WA, to register click [here](http://neea.org/get-involved/calendar).

• **Refrigeration and HVAC:**
  Energy Efficiency for Air Cooled Refrigeration Systems
  November 19: Billings, MT, to register click [here](http://neea.org/get-involved/calendar).
  Energy Efficient Industrial HVAC and Refrigeration Systems
  November 20: Moses Lake, WA, to register click [here](http://neea.org/get-involved/calendar).
Upcoming Webinars

To register for these Portland General Electric (PGE) webinars, go to the NEEA calendar [http://neea.org/get-involved/calendar](http://neea.org/get-involved/calendar) and look for it by date and title. Once you find the webinar you want to register for, click on the title and you will find a description and registration information. **All webinars are free!**

- **Compressed Air:**
  - **Compressed Air for Small Industrial (PGE)**
    October 23: 8-9am PST, to register click [here](http://neea.org/get-involved/calendar).
  - **Compressed Air for Large Industrial (PGE)**
    October 23: 10-11 PST, to register click [here](http://neea.org/get-involved/calendar).

- **Recorded webinars**
  View 20+ recorded webinars anytime, click [here](http://neea.org/get-involved/calendar).
Thank You

• Please take our online survey