Uncovering Hidden Energy Savings – Benchmarking, Auditing, and Troubleshooting

February 25, 2014
Meet Your Panelists

Consumers Energy Subject Matter Experts:

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Contents

• Benchmarking
  - Office Buildings
  - Retail outlets
  - Hospitals
  - Hotels
  - Grocery stores
  - Restaurants
  - Manufacturing

• Audit Checklists
  - Building Envelope
  - HVAC
  - Lighting
  - Hot Water
  - Refrigeration
  - Kitchen Operations
  - Motors
  - Processes
  - Compressed Air
Energy Efficiency Rebates

• Consumers Energy offers over 250 different rebates
• Easy to implement & cost effective
  - Lighting
  - HVAC
  - Water heating
  - Plug loads
  - Building controls
  - Kitchen equipment
  - Variable speed drives
Benchmarking to Identify Waste
Office Buildings

Working to Deliver the Energy You Need, Whenever You Need it; that’s our Promise to You
Average Office Consumption Patterns

- Lighting and cooling/ventilation accounts for approximately 70% of electric consumption
  - Lighting is 5.54 kWh/ft²
- Space heating dominates gas consumption.
• How to calculate your usage for comparison

- $1,500,000 \text{kWh} = 18.75 \text{kWh/ft}^2$  
  $80,000 \text{ft}^2$

- $18.75 \text{kWh/ft}^2 > 15.60 \text{kWh/ft}^2$

  • Possible improvement opportunities

Source: ENERGY STAR
• 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.

![Cooling Load Hours Graph](image-url)
• 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 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>(\Delta)</td>
</tr>
</tbody>
</table>

Example: \[
\frac{477,000 \text{ kWh}}{80,000 \text{ ft}^2} = 5.9 \text{ kWh/ft}^2/\text{yr} \quad (\text{vs.} \ 5.2 \text{ to} \ 5.5 \text{ cooling + ventilation})
\]
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

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

Example: \( \frac{1,346,000 \text{ kWh}}{80,000 \text{ ft}^2} = 16.8 \text{ kWh/ft}^2/\text{yr} \) (vs. 16.2 to 16.6 cool/heat/vent)
An alternative to baselining energy consumption is using nameplate capacity, efficiency, and weather data to estimate HVAC energy consumption.

- Annual Cooling Load Hours (CLH)
  - Jackson: 533 CLH
  - Houghton Lake: 314 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
\[= 300 \text{ tons} \times 1.3 \text{ kW/ton} \times 533 \text{ hours} \]
\[= 208,000 \text{ kWh (vs. 128,000 @0.8 kW/ton)} \]

- Intensity = \(\frac{208,000 \text{ kWh}}{35,000 \text{ ft}^2}\) = 5.9 kWh/ft\(^2\)/yr (vs 5.2 to 5.5 cooling + ventilation)
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 533 hours = 208,000 kWh
- Proposed = 300 tons x 1.1 kW/ton x 533 hours = 176,000 kWh

Annual energy savings = 32,000 kWh
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 ($) = 32,000 kWh x $0.10/kWh
= $3,200 per year

Demand savings ($) = (0.2 kW/ton) x 300 tons x $10/kW x 8
= $4,800 per year

Total savings ($) = $8,000 per year
Average large office lighting electricity intensity is 4.9 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

Energy consumption (kWh) = Power (kW) x Time (hrs)
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 = Power (kW) x Time (hrs)
= 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 (>4.9)

Electricity intensity (T8) = 3.47 kWh/sqft (<4.9)
Synergistic relationship with HVAC

- Occupancy sensor for lighting can trigger HVAC as well
- Cooling savings counters heating increase from lighting reduction
  - Depends on the type of business
- Tracking of operating hours can determine maintenance needs

Effect of Lighting Reduction on HVAC

Source: Lawrence Berkeley National Laboratory
Lighting Controls

- **Lighting occupancy sensors**
  - 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**
  - Allows you to reduce light output in one step when full illumination is not required

- **Dimmers**
  - Reduces light output for setting mood or for multimedia events

- **Daylight sensors (Photocells)**
  - Dims or turns off lighting when free daylight is available
Another focus for best-in-class office operations is employee personal appliances that circumvent energy-efficiency efforts

- Employee personal appliances can cost up to $135 annually per office!
- Increases sales tax burden on industrial companies.

To limit expenses related to personal appliances, offices...

- Require formal request for personal appliances
- 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></td>
<td></td>
<td><strong>1360</strong></td>
</tr>
</tbody>
</table>
Use Efficient Settings and Equipment

- Offices can save approximately $70 per year per computer just by using sleep mode
  - Use “smart strips” with occupancy sensors for monitors, speakers, radios, fans, and printers.

<table>
<thead>
<tr>
<th>Annual Energy Cost (24 Hours/Day, 7 Days/Week)</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>Total</td>
<td>$93</td>
<td>$26</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”)</td>
<td>$37</td>
<td>$10</td>
</tr>
<tr>
<td>LCD monitor (17”)</td>
<td>$9</td>
<td>$4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$28</strong></td>
<td><strong>$6</strong></td>
</tr>
</tbody>
</table>
Like offices, lighting and HVAC offer the best savings opportunities to retailers:

- Lighting represents almost 50% of total end-use.

Average small retail annual electricity intensity is 13.9 to 14.6 kWh/ft²/yr.
Working to Deliver the Energy You Need, Whenever You Need it; that’s our Promise to You
Hospital Consumption Patterns

- Hospital equipment running 24/7 leads to consistently high energy usage
- Average hospital annual electricity intensity is 24.1 to 25.4 kWh/ft\(^2\)/yr
  - Electricity intensity is more than twice that of offices and retail
- Highest space heating gas intensity at 63.6 kBtu/ft\(^2\)/yr
Hotels & Motels

Working to Deliver the Energy You Need, Whenever You Need it; that’s our Promise to You
Hotel/motel share of consumption is similar to that of hospitals but is half of the intensity.

Average hotel/motel annual electricity intensity is 12.7 to 13.9 kWh/ft²/yr
- Great opportunity for occupancy sensors and CFLs.

High water heating gas load.
Food Stores

Working to Deliver the Energy You Need, Whenever You Need it; that’s our Promise to You
• Grocery stores’ electric intensity is 3X higher than that of large office buildings due to refrigeration requirements

• Average food store annual electricity intensity is 51.2 to 52.9 kWh/ft²/yr
  ▪ Refrigeration represents half of total end-use intensity
  ▪ Highest lighting intensity at 10.6 kWh/ft²/yr

Working to Deliver the Energy You Need, Whenever You Need it; that’s our Promise to You
Freezer energy consumption is three times that of a cooler

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

<table>
<thead>
<tr>
<th>Freezer Avg. kWh/Month</th>
<th>Size</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>6x6, 6x8, 8x8</td>
<td>2280</td>
<td></td>
</tr>
<tr>
<td>8x10, 8x12, 10x10</td>
<td>3480</td>
<td></td>
</tr>
<tr>
<td>10x12</td>
<td>4100</td>
<td></td>
</tr>
</tbody>
</table>

Source: U.S. Cooler
Knowing amps and volts also allows you to estimate kWh

Energy consumption = Amps x Volts x PF x Hours/1000
= 75A x 240V x 0.8 x 480 Hours/1000
= 6910 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></td>
<td><strong>75A</strong></td>
</tr>
</tbody>
</table>
• Best energy-saving options for refrigeration offer less than two-year payback

<table>
<thead>
<tr>
<th>Technology</th>
<th>Electricity Savings (%)</th>
<th>Cost Premium ($)</th>
<th>Annual Savings ($) at $.0782/kWh</th>
<th>Payback (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-Efficiency Compressors</td>
<td>12%</td>
<td>$16</td>
<td>$40</td>
<td>0.4</td>
</tr>
<tr>
<td>Non-Electric Anti-sweat</td>
<td>20%</td>
<td>$93</td>
<td>$67</td>
<td>1.4</td>
</tr>
<tr>
<td>Condenser Fan ECM Motor</td>
<td>3.3%</td>
<td>$22</td>
<td>$11</td>
<td>2.0</td>
</tr>
<tr>
<td>Evaporator Fan ECM Motor</td>
<td>7%</td>
<td>$48</td>
<td>$23</td>
<td>2.1</td>
</tr>
<tr>
<td>ECM/Variable Speed Compressor</td>
<td>16%</td>
<td>$150</td>
<td>$54</td>
<td>2.8</td>
</tr>
<tr>
<td>Thicker Insulation</td>
<td>2%</td>
<td>$100</td>
<td>$8</td>
<td>13</td>
</tr>
</tbody>
</table>

Note: Savings not additive due to interactions between measures. ECM = electrically commutated motor. Source: ADL 1996

Source: DOE, Energy Savings Potential for Commercial Refrigeration Equipment
Freezer Best Applications

- Best energy-saving options for freezers offer less than two-year payback

### Reach-In Freezer Energy Savings (Relative to Base Model)

<table>
<thead>
<tr>
<th>Technology</th>
<th>Electricity Savings (%)</th>
<th>Cost Premium ($)</th>
<th>Annual Savings ($) (at $.0782/kWh)</th>
<th>Payback (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-Efficiency Compressors</td>
<td>16%</td>
<td>$24</td>
<td>$65</td>
<td>0.4</td>
</tr>
<tr>
<td>Non-Electric Anti-sweat</td>
<td>14%</td>
<td>$67</td>
<td>$58</td>
<td>1.2</td>
</tr>
<tr>
<td>ECM/Variable Speed Compressor</td>
<td>19%</td>
<td>$160</td>
<td>$77</td>
<td>2.1</td>
</tr>
<tr>
<td>Condenser Fan ECM Motor</td>
<td>2.7%</td>
<td>$24</td>
<td>$11</td>
<td>2.2</td>
</tr>
<tr>
<td>Evaporator Fan ECM Motor</td>
<td>2.3%</td>
<td>$24</td>
<td>$9</td>
<td>2.6</td>
</tr>
<tr>
<td>Hot Gas Defrost</td>
<td>6.3%</td>
<td>$83</td>
<td>$26</td>
<td>3.2</td>
</tr>
<tr>
<td>Thicker Insulation</td>
<td>3.8%</td>
<td>$84</td>
<td>$15</td>
<td>5.5</td>
</tr>
<tr>
<td>Liquid-Suction Heat Exchanger</td>
<td>3.4%</td>
<td>$75</td>
<td>$14</td>
<td>5.5</td>
</tr>
</tbody>
</table>

Note: Savings not additive due to interactions between measures. ECM = electrically commutated motor. Source: ADL 1996

Source: DOE, Energy Savings Potential for Commercial Refrigeration Equipment
Restaurants

Working to Deliver the Energy You Need, Whenever You Need it; that’s our Promise to You
• Cooking/refrigeration, lighting, and cooling are typically responsible for the majority of restaurant energy usage

• Average restaurant annual electricity intensity is 41.1 to 42.6 kWh/ft²/yr
  - End-use intensity is three times higher than large office building
  - Cooking, lighting and refrigeration each represent 25% of total end-use intensity

• Cooking is largest gas load
Manufacturing

Working to Deliver the Energy You Need, Whenever You Need it; that’s our Promise to You
Motors represent largest end use for most manufacturing segments

- Chemicals (228 kWh/sqft)
- Paper Mills (113)
- Plastic Products (69.15)
- Pharmaceutical (63.40)
- Computer & Electronics (57.67)
- Wood Products (47.16)
- Transportation Equipment (45.46)
- Beverage (42.20)
- Apparel (32.28)
- Machinery Manufacturing (29.77)
Manufacturing Consumption Patterns

- Process heating represents the largest gas end use for manufacturing segments:
  - Petroleum (10,950 kBtu/sqft)
  - Chemicals (2,432)
  - Primary Metals (1,184)
  - Paper Mills (845)
  - Pharmaceutical (355)
  - Beverage (250)
  - Transportation Equipment (177)
  - Plastic Products (164)
  - Fabricated Metal Products (160)
  - Apparel (144)
  - Wood Products (125)
  - Machinery Manufacturing (97)
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**
- Normal Production 50%
- Leaks 25%
- Wrong application 20%
- Excessive Pressure 5%

Working to Deliver the Energy You Need, Whenever You Need it; that’s our Promise to You
With a VFD, decreasing speed (rpm) by 50% decreases power (HP) by 87%!
Estimating VFD energy savings

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

Full load energy consumption = 41.4 kW x 16 hr
= 662 kWh

VFD energy consumption = 352 kWh

Savings = 310 kWh

<table>
<thead>
<tr>
<th>VT/VH Power vs Speed</th>
<th>Speed</th>
<th>Power</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>90%</td>
<td>73%</td>
</tr>
<tr>
<td></td>
<td>80%</td>
<td>51%</td>
</tr>
<tr>
<td></td>
<td>70%</td>
<td>34%</td>
</tr>
<tr>
<td></td>
<td>60%</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>50%</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>40%</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td>30%</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>20%</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>10%</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>50 HP VFD Pwr vs Speed @Hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>100%</td>
</tr>
<tr>
<td>75%</td>
</tr>
<tr>
<td>67%</td>
</tr>
<tr>
<td>50%</td>
</tr>
<tr>
<td>Totals</td>
</tr>
</tbody>
</table>
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
- Zero or slightly positive pressure air balance in building
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
• 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
• 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
• 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
• **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
• **Hot Water Operations**
  - Hot water heater(s) and pipes are insulated
  - Thermostat temperature set to 110°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
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
- Drinking fountains on timers to turn off after-hours
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
• **Kitchen Operations**

- New equipment is ENERGY STAR rated
- Plug loads (coffee pots) are identified and controlled
- Preheat is only done before actual cooking
- Pots are all covered
- Potatoes and chicken are pre-cooked in a steamer before frying
Kitchen Operations (continued)

- Sensors are used to turn down heat when food is not present
- Flat-ribbon, low-watt-density heating elements replace calrods
- Contact between the thermostat tip and griddle plate is solid
- TRIAC solid-state relays replace thermo-mechanical thermostat controls
• **Kitchen Ventilation**

- Temperature and optical sensors used with VFD motors to control hood exhaust
- Makeup air velocity near the canopy or hood is limited to 75 fpm
- Partial or full side panels/skirts added to hoods
- Hoods pull the air (not push)
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
Manufacturing Customers

• 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
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
• 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
Manufacturing Customers

- **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
Helpful Resources

• Facility Assessment Wizard

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Energy Efficiency Recommendations

- Consider equipment capability to idle at low heat or to shut down for periods of time when the product flow will be stopped.

- Annual inspection and cleaning of a boiler by a qualified technician is essential. More on this topic.
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
  - EnerSys Analytics - [Energy Profile Tool](#)
  - InterEnergy Software - [Building Energy Analyzer Pro](#)
  - DOE [Industrial Facilities Scorecard](#)
  - DOE [Integrated Tool Suite]/Quick Energy Profiler
  - ENERGY STAR - [Portfolio Manager](#)
Specialty Programs

- New Construction
- Agriculture
- Industrial Continuous Improvement
- Multiple Measure Bonus Program
- Buy Michigan
- Building Operator Certification
- Smart Buildings
- Compressed Air

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QUESTIONS?

Resources For You

- Sign up for our FREE Solution Center eNewsletter
  - Ask an Expert
  - Tools, calculators and energy-saving tips
  - All available at....
- Call us at 800-805-0490