Lesson 2
Principles of Energy Management

QEM 570
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Learning Objectives

After this presentation you will be able to:
- List the four basic principles of energy management
- Explain how the four basic principles of energy management relate to commercial operations
- Determine the fraction of energy consumed in various process
- List codes and standards relevant to energy management
Four Basic Principles of Energy Management

1.) Control cost of energy function or service not BTU's of energy

Examples

- Boiler
  - Fuel
  - Steam
  - Losses
  - Water
  - Improve efficiency
  - Reduce waste

- Motor
  - Electricity
  - Shaft power
  - Losses

From: US Energy Information Administration
http://www.eia.gov/emeu/mecs/special_topics/energy_use_manufacturing/energyuse98_02/energy_cons.html#euem

Cost of Energy

Figure 1. Increase in Average Nominal Price per Unit of Fuel from 1988 to 2007

<table>
<thead>
<tr>
<th>Fuel</th>
<th>1988 (Price per unit)</th>
<th>1994 (Price per unit)</th>
<th>2007 (Price per unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>$4.40</td>
<td>$6.75</td>
<td>$10.43</td>
</tr>
<tr>
<td>Electricity</td>
<td>(80.75 per kWh)</td>
<td>(90.62 per kWh)</td>
<td>(107.41 per kWh)</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>$1.09</td>
<td>$1.09</td>
<td>$1.09</td>
</tr>
</tbody>
</table>

% increase

Sources: Energy Information Administration. Manufacturing Energy Consumption Survey – Table 7.2
(1) Includes energy services by manufacturers included in multipliers (tuiles, aluminum, steel, etc.).
(2) http://www.eia.gov/emeu/mecs/special_topics/energy_use_manufacturing/energyuse98_02/energy_cons.html#euem

From: US Energy Information Administration
http://www.eia.gov/emeu/mecs/special_topics/energy_use_manufacturing/energyuse98_02/energy_cons.html#euem
### Industrial Energy Function by Expenditure and BTUs

<table>
<thead>
<tr>
<th>Function</th>
<th>Dollar Expenditure (billions)</th>
<th>Percent Expenditure</th>
<th>Percent of Total BTUs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine Drive</td>
<td>19</td>
<td>35%</td>
<td>12%</td>
</tr>
<tr>
<td>Feedstocks</td>
<td>16</td>
<td>29%</td>
<td>35%</td>
</tr>
<tr>
<td>Process Steam</td>
<td>7</td>
<td>13%</td>
<td>23%</td>
</tr>
<tr>
<td>Direct Heat</td>
<td>4</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Indirect Heat</td>
<td>4</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>Electrolysis</td>
<td>4</td>
<td>7%</td>
<td>3%</td>
</tr>
<tr>
<td>Space Conditioning and Lightning</td>
<td>1</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>55</strong></td>
<td><strong>100%</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>


### Four Basic Principles of Energy Management

2.) Control cost of energy function as a part of product cost not part of overhead.
How to control energy cost as a part of product cost

- a.) Determine energy function impact on product cost
- b.) Determine theoretical minimum energy for product
- c.) Compare actual energy cost to theoretical minimum
  Reduce variance by:
  1.) applying control system
  2.) control fuel or electricity costs
  3.) modify processes

3.) Meter and control only major energy functions

Use Praeto Principle: 20% of functions produce 80% of cost

Use sub-metering to quantify consumption

<table>
<thead>
<tr>
<th>Total kWh in</th>
<th>M</th>
<th>SM</th>
<th>SM</th>
<th>SM</th>
</tr>
</thead>
<tbody>
<tr>
<td>ovens</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>presses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>compressors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Four Basic Principles of Energy Management

4.) Major effort of energy management program should be installing/developing controls and achieving results

Requires that energy management be part of corporate structure
Requires budget of capital and personnel
Requires cooperation of all organizational stakeholders
  operations
  maintenance
  management

Energy Codes and Standards

Codes
Enforceable document specifying how buildings must be constructed.

Standards
How buildings **SHOULD** be constructed.

Codes derived from standards, vary by state and city
Some more strict than others
Energy Codes and Standards

Example Standard

American Society of Heating, Refrigerating and Air-conditioning Engineers. (ASHRE)

Standard 90.1 - Efficient design for new buildings
Standard 90.2 - Efficient design for new residential buildings

End

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