Facility Energy Use Profiling
What, Why, and How

Colorado Industrial Energy Challenge January 12, 2012
Energy Use

- Figuring out where all the energy you buy actually goes
- Assigning energy costs to uses (or wastes)
- Multi step process, getting more accurate and granular as needed

What to target

- Electrical
  - Demand
  - Consumption
  - Cost
- Gas
  - Consumption
  - Cost
- Other Fuels
  - Consumption
  - heating value
  - Cost
- Other Utilities ?
Finding Opportunities

- You can't control or improve what you don't measure
- Prioritize efforts
- Identify best targets – you may get some surprises!
How

- Decide on “lens” for disaggregation - what breakdown makes sense
  - Process
  - Space
  - Equipment

- More than one may appropriate
Equipment/Process
Energy by Space [kWh]

- **Miscellaneous**: 9,756,188 kWh (25%)
- **A**: 10,494,712 kWh (27%)
- **CR 09**: 5,310,930 kWh (13%)
- **CR 01-04**: 4,330,430 kWh (11%)
- **BDSS**: 1,746,629 kWh (4%)
- **CR 06**: 1,437,172 kWh (4%)
- **B Building**: 1,697,053 kWh (4%)
- **C Building**: 1,437,172 kWh (4%)
- **Tech**: 1,746,629 kWh (4%)
- **Admin R&D**: 430,430 kWh (11%)
- **Energy by Space [kWh]**

Space
Admin R&D Energy [kWh] Breakdown

- AHU: 319,903 (33%)
- DX: 301,056 (31%)
- Lighting: 144,862 (15%)
- Pumps: 74,580 (8%)
- Chillers: 74,580 (8%)
- Other: 48,384 (5%)
- Admin R&D Energy: 1,910 (0%)

Detail of energy “services” to a given space
Metering, one-lines and space maps may be good guides
• **First cut**
  ◦ Find and count equipment
  ◦ Estimate loads
    • load factor,
    • efficiency,
    • diversity
  ◦ Establish operating hours
  ◦ Calculate use -- kWh, kW, dth, $
  ◦ Reality check with utility bills

• **Budget 8 - 40 hrs effort**
### Equipment Inventory

**Production HVAC Fans**

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>HP/Tons</th>
<th>LF</th>
<th>Eff</th>
<th>kW</th>
<th>Diversity</th>
<th>Hours</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Packaged Rooftop Units</td>
<td>167</td>
<td>0.5</td>
<td>0.85</td>
<td>73</td>
<td>0.6</td>
<td>8.760</td>
<td>385,178</td>
</tr>
<tr>
<td>ACM Fans</td>
<td>266</td>
<td>0.8</td>
<td>0.9</td>
<td>176</td>
<td>1</td>
<td>8.760</td>
<td>1,545,155</td>
</tr>
<tr>
<td>SSP Baghouse</td>
<td>120</td>
<td>0.8</td>
<td>0.9</td>
<td>80</td>
<td>1</td>
<td>8.760</td>
<td>697,062</td>
</tr>
<tr>
<td>Molding Clean Rooms</td>
<td>265</td>
<td>0.8</td>
<td>0.9</td>
<td>176</td>
<td>1</td>
<td>8.760</td>
<td>1,539,346</td>
</tr>
<tr>
<td>Clean Room 6</td>
<td>60</td>
<td>0.8</td>
<td>0.9</td>
<td>40</td>
<td>1</td>
<td>8.760</td>
<td>348,531</td>
</tr>
<tr>
<td>Humidifiers</td>
<td>60</td>
<td>0.8</td>
<td></td>
<td>242</td>
<td></td>
<td>4,800</td>
<td>929,280</td>
</tr>
</tbody>
</table>

**Office Area HVAC**

<table>
<thead>
<tr>
<th>Zone</th>
<th>HP/Tons</th>
<th>LF</th>
<th>Eff</th>
<th>kW</th>
<th>Diversity</th>
<th>Hours</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin</td>
<td>30</td>
<td>0.75</td>
<td>0.9</td>
<td>19</td>
<td>1</td>
<td>8.760</td>
<td>163,374</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>71</td>
<td>0.75</td>
<td>0.9</td>
<td>44</td>
<td>1</td>
<td>8.760</td>
<td>386,652</td>
</tr>
<tr>
<td>Tech</td>
<td>78</td>
<td>0.75</td>
<td>0.9</td>
<td>48</td>
<td>1</td>
<td>8.760</td>
<td>424,772</td>
</tr>
</tbody>
</table>

**Lighting**

- 560,000 Square Feet * 1.25 watts per square foot = 700 kW* 5,718 kWh 4,002,600

**Process Cooling**

<table>
<thead>
<tr>
<th>Type</th>
<th>Tons</th>
<th>LF</th>
<th>kW/ton</th>
<th>kW</th>
<th>Hours</th>
<th>kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACM</td>
<td>60</td>
<td>0.55</td>
<td>1.3</td>
<td>43</td>
<td>7,000</td>
<td>300,300</td>
</tr>
<tr>
<td>Molding Clean Room</td>
<td>80</td>
<td>0.55</td>
<td>1.1</td>
<td>48</td>
<td>8,760</td>
<td>423,984</td>
</tr>
</tbody>
</table>

**Temperature Dependent Cooling - from Utility Bill data**

- Monthly Baseline kWh = 2,200,000
- Annual Baseline kWh = 26,400,000 kWh
- Total Annual kWh = 31,196,000
- Temperature sensitive cooling = 31,196,000 - 26,400,000 = 1500 kWh

**Plant Misc Load**

- 560,000 Square Feet * 0.43 watts per square foot = 238 kW* 5,718 kWh 1,360,884

**Compressed Air**

- see compressed air worksheet

**Process Equipment**

- 75 large process machines 12.8 kW each 960 7,500 7,200,000

### Total

- See compressed air worksheet

### Total kWh

- 30,547,108 kWh
End use estimate
Getting deeper

- More accurate, more precise, more granular
  - Interval data
  - Spot measurements
  - Data logging
  - Sub metering

- Measured loads, efficiency
- Measured schedules
- Develop equipment load profiles
- Budget 1-3% of total utility spend (or end use cost)
Interval data (used to quantify cooling loads)
Using interval data
### Test & Pump

<table>
<thead>
<tr>
<th></th>
<th>$/year</th>
<th>Calc kWh/day</th>
<th>Demand [kW]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Generator</td>
<td>$27,527</td>
<td>730.40</td>
<td>59.60</td>
</tr>
<tr>
<td>Pump Room / Generator</td>
<td>$244,450</td>
<td>1987.44</td>
<td>82.81</td>
</tr>
<tr>
<td>Oil Pumps</td>
<td>$15,956</td>
<td>796.60</td>
<td>34.26</td>
</tr>
<tr>
<td>Pump Room</td>
<td>$18,880</td>
<td>1003.20</td>
<td>41.80</td>
</tr>
<tr>
<td>Test Room</td>
<td>$33,040</td>
<td>1756.60</td>
<td>73.15</td>
</tr>
<tr>
<td>Oven</td>
<td>$76,929</td>
<td>2183.66</td>
<td>148.80</td>
</tr>
<tr>
<td>Seasoning Tank</td>
<td>$17,627</td>
<td>800.43</td>
<td>41.31</td>
</tr>
<tr>
<td>Refrigerated Cabinet</td>
<td>$2,361</td>
<td>76.80</td>
<td>3.20</td>
</tr>
<tr>
<td>Gantry</td>
<td>$47,784.18</td>
<td>470.496</td>
<td>19.604</td>
</tr>
</tbody>
</table>

### Test & Pump [Cost, $/year]

- RF Generator: 50%
- Pump Room / Generator: 10%
- Test Room: 8%
- Oil Pumps: 4%
- Gantry: 3%
- Seasoning Tank: 3%
- Refrigerated Cabinet: 2%
- Oven: 1%

### Test & Pump [kWh/day]

- RF Generator: 8%
- Pump Room / Generator: 5%
- Oil Pumps: 4%
- Test Room: 3%
- Gantry: 1%
- Seasoning Tank: 0%
- Refrigerated Cabinet: 0%
- Oven: 0%

### Test & Pump [Demand, kW]

- RF Generator: 13%
- Pump Room / Generator: 9%
- Oil Pumps: 7%
- Test Room: 7%
- Gantry: 4%
- Seasoning Tank: 1%
- Refrigerated Cabinet: 1%
- Oven: 1%
I35 Furnace Electrical Profile

**Usage**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Power</td>
<td>81.5 kW</td>
</tr>
<tr>
<td>Average Power</td>
<td>3.4 kW</td>
</tr>
<tr>
<td>Load Factor</td>
<td>0.04</td>
</tr>
<tr>
<td>Yearly Energy</td>
<td>29,715 kWh</td>
</tr>
</tbody>
</table>

**Environment**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly CO2 Emitted</td>
<td>63,025 lbs</td>
</tr>
</tbody>
</table>

**Cost**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Yearly Demand</td>
<td>$12,687</td>
</tr>
<tr>
<td>Yearly Energy</td>
<td>$806</td>
</tr>
<tr>
<td>Total Electric</td>
<td>$13,493</td>
</tr>
<tr>
<td>Blended Rate</td>
<td>$0.45/kWh</td>
</tr>
</tbody>
</table>

**I35 Furnace Electric Cost Breakdown**

- Yearly Energy, $806, 6%
- Yearly Demand, $12,687, 94%
• Questions

• Contact
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