Company Background

- Business in Rogers, MN
- Specializes in polyethylene terephthalate (PET) extrusion
- PET sheets for food package manufacturing
- 14,500,000 kWh, 68 employees
Process Description

Source: Noon-intl.com

Source: Alibaba.com

Source: Millikenchemical.com
Process Description

Silos -> Crystallizers -> Grinders

Dryers

Blenders

Extruders

Winders and Tensioners

Finished Product
Project Overview

- Recommendations help reduce energy and keep company competitive
- Lower energy consumption reduces state generation needs, utility payer costs
- Xcel, Graphet already providing data
- MnTAP opportunities help utilize information
Energy consumption

- 30 million pounds produced per year
- $1,100,000 spent on electricity annually
- Extrusion and drying dominate electrical costs
Recommendation categories

• Lighting
• Heat losses and leaks
• Motors and drives
• Production setting optimization
• Equipment line upgrades
• Miscellaneous upgrades
Lighting

Recommended changes:

• Replace 32W fluorescents with 15W LED lamps
• Motion sensors (part of lighting retrofit)
• Emergency lighting (batteries)
• Exterior lighting
## Lighting savings

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>Waste/energy reduced</th>
<th>Implementation cost (w/ rebates)</th>
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</thead>
<tbody>
<tr>
<td>Lighting retrofit</td>
<td>374,000 kWh</td>
<td>$27,700</td>
<td>$29,900</td>
<td>11 months</td>
<td>Implementing</td>
</tr>
<tr>
<td>Exterior lighting</td>
<td>57,700 kWh</td>
<td>$15,900</td>
<td>$4,620</td>
<td>3.5 yrs</td>
<td>Recommended</td>
</tr>
<tr>
<td>Emergency lighting</td>
<td>N/A</td>
<td>$18,600</td>
<td>N/A</td>
<td>N/A</td>
<td>Implementing</td>
</tr>
</tbody>
</table>
Heat losses and leaks

Recommended changes:
• Fixing heat losses and leaks
• Fixing compressed air and vacuum system leaks
• Reducing heat loss and dust from infrared dryer
Heat losses and leaks continued

Two parts:

• Insulation losses
  Losing heat from conduction
• Mass transfer
  Heating entirely new air from low temp. to process temp.
• Dryers cause most heat loss

Source: Novatec
Heat losses and leaks savings

Payback periods:
- Averages to half a year in payback
- Process air leaks the most costly

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<tbody>
<tr>
<td>Heat losses, leaks</td>
<td>622,000 kWh</td>
<td>$20,000</td>
<td>$49,800</td>
<td>9 months</td>
<td>Implementing</td>
</tr>
<tr>
<td>Compressed air, vacuum leaks</td>
<td>337,000 kWh</td>
<td>$4,000</td>
<td>$27,000</td>
<td>2 months</td>
<td>Implementing</td>
</tr>
<tr>
<td>Infrared dryer heat loss, leaks</td>
<td>178,000 kWh</td>
<td>$2,000</td>
<td>$14,300</td>
<td>2 months</td>
<td>Implementing</td>
</tr>
</tbody>
</table>
More efficient motors and drives

Motors

- Replace extruder DC motors with AC
- Attach VFDs to crystallizers
- Exchange motors for more efficient models
- Address grinding
- Change Line 6 DC to AC

Source: Baldor
Adding more efficient motors and drives

Motors

• At the right size:
  Savings through efficiency upgrades
• Oversized:
  Savings through re-sizing motor or drives
• Variable Frequency Drives (VFD)
  Putting VFD will de facto “re-size”
• Larger motors have lower power factor at lower loads
More efficient motors and drives

Motors

• Ideal motor load around 75-80%

Source: Toshiba Lighting Systems

Source: Physics Stack Exchange
Motor and drive savings

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<tr>
<td>Replace extruder DC motors with AC</td>
<td>763,000 kWh</td>
<td>$21,300</td>
<td>$61,000</td>
<td>4 months</td>
<td>Recommended</td>
</tr>
<tr>
<td>Attach VFDs to crystallizers</td>
<td>898,000 kWh</td>
<td>$18,700</td>
<td>$71,800</td>
<td>3 months</td>
<td>Implementing</td>
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<tr>
<td>Convert motors to higher efficiency</td>
<td>181,000 kWh</td>
<td>$48,600</td>
<td>$14,500</td>
<td>3.4 yrs</td>
<td>Recommended</td>
</tr>
<tr>
<td>Address grinding</td>
<td>71,200 kWh</td>
<td>$2,070</td>
<td>$17,100</td>
<td>2 months</td>
<td>Recommended</td>
</tr>
<tr>
<td>Convert line 6 DC to AC motors</td>
<td>173,000 kWh</td>
<td>$4,200</td>
<td>$13,800</td>
<td>4 months</td>
<td>Recommended</td>
</tr>
</tbody>
</table>
Production setting optimization

Recommended changes:

- Lengthening regeneration cycle of dryer beds
- Changing crystallization process
Production savings

Paybacks:
- Instantaneous paybacks
- Requires making process changes to produced material
- Process changes risk altering material properties

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<tbody>
<tr>
<td>Lengthen dryer regen cycles</td>
<td>219,000 kWh</td>
<td>$</td>
<td>$17,600</td>
<td>Instant</td>
<td>Recommended</td>
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<tr>
<td>Changing crystallizing process</td>
<td>262,000 kWh</td>
<td>$</td>
<td>$21,600</td>
<td>Instant</td>
<td>Recommended</td>
</tr>
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</table>
Equipment line upgrades

**Recommended changes:**

- Using compounders to create pellets from raw materials
  Alternatively, combine PET with additives
- High vacuum twin screw extrusion (HVTSE)

Source: PTi Extruders
Equipment line savings

Compounding:

• Waiting on specific quotes for compounding costs
• Compounding can save $9,000,000 potentially for PET
• Self-compounding eliminates mark-up
  Material costs dominate, not energy
Equipment line savings

High vacuum twin screw extrusion (HVTSE):

- HVTSE can reduce energy costs by 30-40% by eliminating need for drying and crystallization
- HVTSE saves $405,000 annually (5,000,000 kWh), but costs $2,500,000 per line installation ($10,000,00 total)
  
  Improved throughput, material variety
Miscellaneous

**Recommended changes:**

- Curtailment
- Improving dust collection and ventilation
Miscellaneous

Paybacks:
- Other opportunities are instantaneous
- Many do not save energy, but address finances

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</thead>
<tbody>
<tr>
<td>Curtailment</td>
<td>N/A</td>
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<td>$ 62,600</td>
<td>Instant</td>
<td>Recommended</td>
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<tr>
<td>Improving dust collection</td>
<td>N/A</td>
<td>$</td>
<td>N/A</td>
<td>N/A</td>
<td>Implementing</td>
</tr>
</tbody>
</table>
## Conclusions

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<tr>
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<tr>
<td>Lighting</td>
<td>432,000 kWh</td>
<td>$62,200</td>
<td>$34,500</td>
<td>1.8 yrs</td>
<td>Implementing</td>
</tr>
<tr>
<td>Heat losses and leaks</td>
<td>1,140,000 kWh</td>
<td>$26,000</td>
<td>$91,000</td>
<td>4 months</td>
<td>Implementing</td>
</tr>
<tr>
<td>Efficient motors and drives</td>
<td>2,090,000 kWh</td>
<td>$94,000</td>
<td>$178,000</td>
<td>7 months</td>
<td>Implementing</td>
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<tr>
<td>Changing production settings</td>
<td>481,000 kWh</td>
<td>$ -</td>
<td>$39,200</td>
<td>Instant</td>
<td>Recommended</td>
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<tr>
<td>Miscellaneous upgrades</td>
<td>N/A</td>
<td>$ -</td>
<td>$62,600</td>
<td>Instant</td>
<td>Implementing</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>4,143,000 kWh</strong></td>
<td><strong>$182,200</strong></td>
<td><strong>$405,300</strong></td>
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<td></td>
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</tbody>
</table>
Personal Benefits

- Learned how to quantify opportunities into tangible paybacks
- Developed skills to pull information together from different sources
- Discovered the general processes in the background that drive energy consumption
- Practiced time management
Questions?