Why Invest in Energy Infrastructure?

• MSU operates its own micro-grid
  • Co-gen heat and electricity: T.B. Simon Plant
  • Significant cost savings vs. buying electricity
  • Historic record of reliability
• Power outages need to be avoided at (almost) all costs; reliability is absolutely important
• Carbon emissions need to be reduced
  • Man-made global warming is real
• Energy efficiency needs to be increased
• Funds are tight, and energy expenses need to be reduced
MSU Energy Transition Plan

- **Timetable**

<table>
<thead>
<tr>
<th>Year</th>
<th>Campus Renewable Energy</th>
<th>Greenhouse Gas Emission Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>15%</td>
<td>30%</td>
</tr>
<tr>
<td>2020</td>
<td>20%</td>
<td>45%</td>
</tr>
<tr>
<td>2025</td>
<td>25%</td>
<td>55%</td>
</tr>
<tr>
<td>2030</td>
<td>40%</td>
<td>65%</td>
</tr>
</tbody>
</table>

- Approved by MSU Board of Trustees, April 2012
GO GREEN

- **GREEN** means environmental sustainability

- **GREEN** also means financial sustainability
  - Only way to make lasting changes in energy portfolio
2010
Kick-off: Energy Transition Plan

2011
Energy Transition Plan Completed (Jan.) & BOT adopted (April)

2012

2013
Anaerobic Digester Completed

2014
RFQ: Renewable Energy Integrator (July 17, 2014) (Sep. 11, 2014)

2015

2016

2017
Array Completion
MSU Dormitory Food System

- 35,000 meals / day
- 500 tons of organic waste per year
MSU Anaerobic Digester

Digestate Storage

Fermenter

Biogas Engine

Feeder
Table 2: MSU South Campus Anaerobic Digester Feedstock

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>TS (%)</th>
<th>Planned (tons)</th>
<th>(%)</th>
<th>2014 (tons)</th>
<th>(%)</th>
<th>2015 (tons)</th>
<th>(%)</th>
<th>2016 (tons)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dairy manure</td>
<td>12</td>
<td>7,000</td>
<td>43</td>
<td>16,000</td>
<td>67</td>
<td>9,525</td>
<td>43</td>
<td>10,554</td>
<td>52</td>
</tr>
<tr>
<td>Fruit &amp; vegetable</td>
<td>11</td>
<td>3,900</td>
<td>24</td>
<td>2,900</td>
<td>12</td>
<td>2,900</td>
<td>13</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Fats, oil &amp; grease</td>
<td>20</td>
<td>5,000</td>
<td>30</td>
<td>4,400</td>
<td>19</td>
<td>3,730</td>
<td>17</td>
<td>4,747</td>
<td>23</td>
</tr>
<tr>
<td>Cafeteria food waste</td>
<td>10</td>
<td>750</td>
<td>3</td>
<td>430</td>
<td>2</td>
<td>440</td>
<td>2</td>
<td>513</td>
<td>3</td>
</tr>
<tr>
<td>Milk process waste</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5,475</td>
<td>25</td>
<td>4,444</td>
<td>22</td>
</tr>
<tr>
<td>Packing material</td>
<td>90</td>
<td></td>
<td></td>
<td>60</td>
<td>-</td>
<td></td>
<td>34</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Glycerin</td>
<td>15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>88</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>16,650</strong></td>
<td></td>
<td><strong>23,730</strong></td>
<td></td>
<td><strong>22,070</strong></td>
<td></td>
<td><strong>20,380</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Bottom Line (per year)**

- ~2,000 garbage truck loads kept out of landfill
- ~3,000 MWh of electricity generated
- ~20,000 tons of organic fertilizer produced
- 5,000 parking spots
- 45 acres
- 40,000 solar panels
- 13.4 MW dc peak power
- 10.5 MW ac peak power
- 15,000 MWh/year of solar energy
18% of MSU peak power demand, 5% of MSU total annual energy.
Largest solar carport array in the USA
LED Night Lighting
PPA allows MSU to purchase power at a fixed price over the next 25 years. 2015 public service commission utility rate $91/MWh, but will increase. (DOE-EIA projection: 2.3%/year; last decade: 3.35%/year)

Projected total net savings ~$10M for MSU over the 25 year PPA period

Green power is now cheaper than brown power!
Summary: Achievements

End of Coal (Mar’16)

Energy Conservation

Waste Reduction

Renewable Power

Bottom Line (end of 2016)
- 10.4 % increase in renewable energy
- 27.7 % reduction in greenhouse gas emissions
- 7 % savings on energy budget, $$ returned to general fund
Greenhouse Gas Emissions

MSU CO₂ Emission Reductions (kilo-tons)

- fuel switch, 256
- remaining, 241
- future RICE, 48
- solar, 16.5
- digester, 20
## Current Issues

### Aging Power Plant
- Boilers 1&2 are more than 50 years old
- High maintenance costs

### Campus Electricity Demand Outpacing Steam Demand
- 38% of produced steam cannot be used for heating / cooling
- Plant efficiency is much lower than ideal co-generation case

### Penalty for On-Peak Purchase Increased by Factor 10
- Buying 40 MW for only 15 minutes in an emergency would result in $1 million demand charge from Consumers Energy

### Water Treatment System in Power Plant is Antiquated
- Costly use of chemicals
- Safety hazards

### Existing Equipment not Nimble Enough
- Selling ~ 0.5 MW during peak time at a loss to avoid demand charge
- Boilers take ~ 10 hours to warm up
• We need your help!
  • Every academic unit and every support unit on campus needs to be aware of sustainability and think about contributing

Contact info:
  bauer@pa.msu.edu
  +1 (517) 432 4762
  http://www.pa.msu.edu/~bauer/