Roadmap to Carbon Neutrality
Implementing Change in Higher Education

Nina Axelson
VP Sustainability and Outreach
Ever-Green Energy
www.ever-greeneenergy.com
Question

If we know we need to reduce carbon AND so many institutions are committed to reductions, why aren’t more campuses on their way to carbon neutrality?
Common Challenges

- Deferred Maintenance
- Constrained Access to Capital
- Carbon-Intensive Grid
- Lack of Leadership Buy-In
- Inconsistent Building Design and Operation Specifications
Common Pressures

- Student Expectations
- Changing Campus Programming
- Climate Resiliency
- Electrification
- Competing Demands for Investment
What if they just needed a little help to move forward?
Roadmap to Carbon Neutrality

“We created this pilot program to help campus leaders move past the planning phase of carbon neutrality goals and into implementation. If we want to see transformation, we must help our partners move their projects to construction and operation. The right plan is key.”

- Ken Smith, CEO and President
Shaping the Pilot: Submission Process & Screening

• Committed to carbon neutrality – throughout the organization

• Hurdles that could realistically be overcome by this process

• Committed to providing a partner to coordinate data collection and a cross-functional stakeholder group, representing students, faculty, facilities, and financial management of the institution.
Campus A: private, rural university

- 3640 undergraduate students
- ~1,300,000 gross square feet
- In October 2015, signed onto the Climate Commitment
- Charter signatory of the original American College & University Presidents' Climate Commitment in 2007
Campus A : Operations Profile

- Annual electric usage 11,590,000 kilowatt hours
- Annual gas consumption 749,000 CCFs
- Previous energy efficiency efforts have focused on lighting retrofits and educational programming
Campus A: Historic and Projected Gas Usage

Natural Gas Projections from
FY2005 Average Building Efficiencies and
Institutional Growth Rate 1990-2005

- Natural Gas Demand (MMBtu)
- Cost
- Demand

- $0
- $100,000
- $200,000
- $300,000
- $400,000
- $500,000
- $600,000
- $700,000
- $800,000
- $900,000
- $1,000,000

- 2002
- 2004
- 2006
- 2008
- 2010
- 2012
- 2014
- 2016
- 2018
- 2020
Campus A: Historic and Projected Electric Usage

Electricity Projections from FY2005 Average Building Efficiencies and Institutional Growth Rate 1990-2005

Electric Demand (kWh)


Demand
Cost

$0 $500,000 $1,000,000 $1,500,000 $2,000,000 $2,500,000
Campus B: private, urban university

• 84 acres
• 3,191,000 Gross Square Feet
• 10,000 undergraduate and graduate students
• Eight schools and colleges, offering 150+ majors and minors
• Three campuses – Main campus is the focal point for carbon reductions
Campus B: Operations Profile

Utility Consumption for 2018
- Electrical 26,588,058 kWh
- Natural gas – 1,597,1439 Therms
- Fuel Oil – 60,751 Gallons
- Heating Degree Days – 6,283
- Cooling Degree Days - 905
Campus B: Comparison of 2007 and 2016 Source Emissions

2007 Source Emissions

2016 Source Emissions
## Campus B: Greenhouse Gas Emissions FY 2008-2016

<table>
<thead>
<tr>
<th>Year</th>
<th>Stationary Source Emissions (tonnes CO₂)</th>
<th>Purchased Electricity Emissions (tonnes CO₂)</th>
<th>Total University Emissions (tonnes CO₂)</th>
<th>Total University Emissions with Renewable Energy Offsets (tonnes CO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>10,488</td>
<td>29,731</td>
<td>66,415</td>
<td>58,919</td>
</tr>
<tr>
<td>2009</td>
<td>9,506</td>
<td>29,107</td>
<td>65,802</td>
<td>58,399</td>
</tr>
<tr>
<td>2010</td>
<td>9,115</td>
<td>26,533</td>
<td>64,978</td>
<td>57,976</td>
</tr>
<tr>
<td>2011</td>
<td>11,236</td>
<td>28,433</td>
<td>67,474</td>
<td>56,248</td>
</tr>
<tr>
<td>2012</td>
<td>8,165</td>
<td>28,024</td>
<td>59,852</td>
<td>47,176</td>
</tr>
<tr>
<td>2013</td>
<td>10,234</td>
<td>23,310</td>
<td>57,872</td>
<td>32,557</td>
</tr>
<tr>
<td>2014</td>
<td>12,161</td>
<td>21,788</td>
<td>57,657</td>
<td>33,580</td>
</tr>
<tr>
<td>2015</td>
<td>10,180</td>
<td>25,936</td>
<td>59,918</td>
<td>41,249</td>
</tr>
<tr>
<td>2016</td>
<td>8,421</td>
<td>24,636</td>
<td>49,594</td>
<td>NA</td>
</tr>
</tbody>
</table>
Campus B: Recent GHG Reductions
Campus B: Initial Findings

- Campus has been focused on efficiency efforts to optimize overall savings, as well as carbon savings.
- Reduced carbon by nearly 20% since 2007 (baseline tracking year)
- Microgrogrid under development 2016
- Electric utility will achieve 80% carbon-free threshold by 2030 and 100% carbon-free electricity by 2050
- Additional combustion strategies are limited to RNG

Rhombus Energy provided two UPC-30/60 kW bi-directional inverters to the project. They come equipped with two 30-kW DC input ports and one 60-kW AC output port.
Campus B: Initial Findings Cont.

• Offsets are a lower priority strategy for the campus, but could include gas/thermal offsets
• Steam conversion is a low priority, limiting additional low-temperature strategies in near-term
• Significant Scope 3 carbon challenges related to travel and commuting that the leadership would like to address
Campus C: public, rural university

- Carbon neutrality commitment - 2020
- 1600 students
- 165 acres
- 993,000 Gross Square Feet
- One of the first public colleges to generate on-site renewable power from wind and corn stover (biomass gasification)
- Integration of solar thermal and PV
Campus C: Operations Profile

• Steam Produced – 113,000 MMBtu (Peak 21.8 MMBtu/hr)
• Gas Consumed – 124,000 Therms
• Electricity Consumed – 8,627 MWhr (Peak 1.7 MW)
• Cooling
  - No individual cooling metering
  - Campus has three chillers:
    • Chiller 1 (Electric): 400 actual tons max @ 232 kW
    • Chiller 2 (Electric): 600 actual tons max @ 346 kW
    • Chiller 3 (Steam): 617 tons
  - Campus demands around 550-600 tons of cooling on average on a typical summer day
Campus C: Operations Profile Cont.

- Roughly 70% renewable electricity
  - 60% of campus electricity from 2 wind turbines
  - Utility is 30% renewable
  - 240 kW of solar PV
- Campus electrical demand ranges from 1000 – 1650 kW
- Peak steam demand is 23,000#/hr
Campus C: Path Forward

- Steam to low-temperature hot water system transformation – 140 degree supply
- Three primary renewable source opportunities:
  - Heat capture from a local ethanol plant
  - Extended biomass program to include local woody biomass and additional agricultural residues (tree waste and ag waste)
  - Geothermal
Sources and Technologies Examined

- Geoexchange
- Hot Water Distribution
- Biofuel
- Waste Heat Recovery
- Sources and Technologies Examined
Common Opportunities

- Thermal, Thermal, Thermal
- Additional onsite renewable electricity
- Additional REC purchasing
- RNG or Renewable Thermal Credits
- Greater investment in building efficiency and design standards
Common Lessons

- All teams need to buy-in
- No silver bullets
- Ok to go slow first to eventually get further, faster
- Still lots of low-hanging fruit
- Stakeholder education
- Data is Not Readily Available or Always Current
What’s Next?
Questions?
Thank You

Nina Axelson
Ever-Green Energy
Nina.Axelson@ever-greenenergy.com