Is Electric Utility Ownership of CHP Good for Ratepayers and the Environment?

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FVB Energy Inc.

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Agenda

• Drivers
• Case study: Duke University
• CHP role in the dispatch order
• Calculating GHG reductions
• Economic impact on ratepayers
• Why not use renewable energy instead?
• Resiliency benefits
Drivers

- Policy-makers
- Electric utilities
- Thermal hosts
- Environmental advocacy groups
Case study: Duke University

• Duke Energy and Duke University have planned a 20 MW natural gas turbine CHP facility located at the University
• Financed, owned and operated by Duke Energy as a rate base generating asset
• Opposition from student and outside advocacy groups
CHP role in the power grid dispatch order

CHP must compete with marginal costs of grid generating capacity

- Peaking: 8%
- Intermediate: 34%
- Baseload: 58%

Global Presence
Local Solutions
CHP role in the power grid dispatch order

Variable costs ($/MWh)

- Nuclear
- Fossil Steam
- Gas turbine
- Other Grid Resources
- CHP

- Net fuel cost
- Thermal sales
- Other O&M

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Calculating GHG reductions

• What are the lifecycle GHG impacts of natural gas, including not only combustion but also the extraction, processing, transportation and delivery of the fuel?

Calculating GHG reductions

- Best estimate values of natural gas life cycle GHG impacts from Weber and Clavin analysis (lbs CO2e/million Btu HHV):

<table>
<thead>
<tr>
<th></th>
<th>Shale Gas</th>
<th>Conventional Gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion</td>
<td>117.0</td>
<td>117.0</td>
</tr>
<tr>
<td>Upstream</td>
<td>30.6</td>
<td>33.5</td>
</tr>
<tr>
<td>Total</td>
<td>147.6</td>
<td>150.5</td>
</tr>
</tbody>
</table>

Calculating GHG reductions

What are the GHG emissions of separate heat and power?

• GHG emissions at the CHP plant

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<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Heat rate (Btu/kWh)</td>
<td>10,265</td>
</tr>
<tr>
<td>Thermal output (Btu/kWh)</td>
<td>4,255</td>
</tr>
<tr>
<td>Avoided boiler fuel (Btu/kWh)</td>
<td>(5,319)</td>
</tr>
<tr>
<td>Net natural gas consumption (Btu/kWh)</td>
<td>4,946</td>
</tr>
<tr>
<td>GHG emissions rate (lbs CO2e/MMBtu)</td>
<td>150.5</td>
</tr>
<tr>
<td>GHG emissions (lbs/kWh)</td>
<td>0.74</td>
</tr>
</tbody>
</table>

• GHG avoided from offset grid power is more complex
  
  ➢ Depends on the type of generation avoided, which varies depending on the dispatch of the CHP plant and GHG emissions of the power plants displaced by CHP
Calculating GHG reductions

Calculating GHG reductions

• *CHP does not displace the “average MWh”!*  
  • Duke University CHP would displace coal and gas  
    – Duke Energy nuclear capacity is about equal to minimum grid load  
    – CHP can’t compete with nuclear, but does compete with coal and natural gas  
• GHG reductions for three scenarios for displaced grid generation:  
  – Weighted Duke Energy capacity mix (coal and gas)  
  – Existing Duke Energy natural gas capacity  
  – New natural gas combined cycle plant
### Calculating GHG reductions

<table>
<thead>
<tr>
<th>CHP GHG emissions (lbs/kWh)</th>
<th>0.74</th>
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</thead>
<tbody>
<tr>
<td><strong>Avoided power grid emissions</strong></td>
<td></td>
</tr>
<tr>
<td>Current Duke Energy capacity mix</td>
<td>(1.87)</td>
</tr>
<tr>
<td>Existing Duke Energy natural gas</td>
<td>(1.20)</td>
</tr>
<tr>
<td>New natural gas combined cycle</td>
<td>(0.99)</td>
</tr>
<tr>
<td><strong>Net GHG emissions impact of CHP</strong></td>
<td></td>
</tr>
<tr>
<td>Current Duke Energy capacity mix</td>
<td>(1.13)</td>
</tr>
<tr>
<td>Existing Duke Energy natural gas</td>
<td>(0.46)</td>
</tr>
<tr>
<td>New natural gas combined cycle</td>
<td>(0.25)</td>
</tr>
<tr>
<td><strong>% Reduction</strong></td>
<td></td>
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<tr>
<td>60%</td>
<td></td>
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<tr>
<td>38%</td>
<td></td>
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<tr>
<td>25%</td>
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</table>
Economic impact on ratepayers

- Highly case-specific
- Duke case:
  - 20.3 MW gas turbine CHP with a high capacity factor
  - In utility service area requiring additional power generation capacity
Economic impact on ratepayers

- Well-sized gas turbine CHP competes well with other options for new grid capacity
Why not use renewable energy instead?

- Renewable power can play an important role in campus and grid power mix
- Intermittent renewables are not a substitute for baseloaded CHP
- Battery storage is advancing but is still not cost-effective in making solar an effectively reliable source
- Solar is space-intensive
Resiliency benefits of CHP

- *Wilma, Katrina, Ike, Gustave, Irene, Sandy.........who’s next?*
- On-campus CHP is inherently more resilient to disruption from natural disasters or other events that interrupt energy supply from complex and interconnected grids
- CHP systems can be designed to operate in island mode during a grid outage
- CHP and district energy systems have demonstrated that they can keep the power on and continue to keep people warm in the winter and cool in the summer even when the power grid is down
Thanks for your attention!

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