Tompkins County Energy Plan

EAS 4010/5010 Combined Final Presentation
December 3rd, 2010
Professor Cathles
Presented by:
Tanya Cabrito, Christopher Carter, Hannah Jurkowicz, George Stutz,
Russell Zhao, Carl Greiner
Introduction

Current Energy Picture:
Tompkins Population: 100,135
Ithaca: 29,952

NYSEG Milliken Station:
350MWe
Coal fired
85-95% of electric demand for Tompkins County
Remainder from Nuclear and other sources
Current Usage

- Electricity is \(~1/3\) of energy uses but \(~2/3\) of energy expenditures.
- Gain in cost saving can be made in electric.
- Large emission reduction can be made in electric.
- Does not involve moving vehicles that currently require gaseous fuels.
Energy Plan

Electric energy generation alternatives to coal:
Solar, wind, natural gas, and nuclear.

Evaluated based on seven criteria:

1. Capital Input
2. Electric Cost
3. Land Use
4. Renewable?
5. Social/Political Feasibility
6. Externalities (waste, emissions, goodwill, etc.)
7. Suitability
## Solar

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable</td>
<td>High capital cost</td>
</tr>
<tr>
<td>Socially/politically positive</td>
<td>High electric cost</td>
</tr>
<tr>
<td>Job creation</td>
<td>Large area, exclusive land use</td>
</tr>
<tr>
<td>No emissions</td>
<td>Poor solar resource</td>
</tr>
<tr>
<td>Government incentives offset</td>
<td>High operations expense; low efficiency</td>
</tr>
<tr>
<td>some cost (federal funding)</td>
<td>Negative visual impact</td>
</tr>
</tbody>
</table>
## Wind

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable</td>
<td>Land requirements</td>
</tr>
<tr>
<td>Job creation</td>
<td>Negative visual impact</td>
</tr>
<tr>
<td>No emissions</td>
<td>Shadow flicker</td>
</tr>
<tr>
<td>Government incentives (state level, limited)</td>
<td>Noise (within 1000 ft.)</td>
</tr>
</tbody>
</table>

Social/political mixed

- Impact on birds found not significant
## Natural Gas

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>High capital cost offset by production revenue</td>
<td>Not renewable</td>
</tr>
<tr>
<td>Low price transmission to community</td>
<td>Negative visual impact</td>
</tr>
<tr>
<td>Low electric cost</td>
<td>Socially/politically contentious</td>
</tr>
<tr>
<td>Available resource supply</td>
<td></td>
</tr>
<tr>
<td>Efficient land use</td>
<td></td>
</tr>
<tr>
<td>Less emissions than coal, higher than renewables and nuclear</td>
<td></td>
</tr>
</tbody>
</table>

- Revenue subject market fluctuations
# Nuclear

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low electric cost</td>
<td>High capital cost</td>
</tr>
<tr>
<td>Small land requirements</td>
<td>Socially/politically difficult</td>
</tr>
<tr>
<td>Large, indefinite resource supply</td>
<td>Waste storage</td>
</tr>
<tr>
<td>No emissions</td>
<td>Thermal pollution</td>
</tr>
<tr>
<td></td>
<td>Lack of experience- most promising technology untested</td>
</tr>
</tbody>
</table>
## Land and Water Use Summary

<table>
<thead>
<tr>
<th>Power Type</th>
<th>Area [ha] needed</th>
<th>Area Occupied per MW [ha/MW]</th>
<th>Power density [W/m²]</th>
<th>Water Use [gal/MWh]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milliken</td>
<td>37.5 (3)</td>
<td>.107</td>
<td>933</td>
<td>775</td>
</tr>
<tr>
<td>Nuclear</td>
<td>35.7 (4)</td>
<td>.0309</td>
<td>3080</td>
<td>825</td>
</tr>
<tr>
<td>Marcellus</td>
<td>21,900</td>
<td>0.032</td>
<td>1.6</td>
<td>615 (2)</td>
</tr>
<tr>
<td>Wind</td>
<td>27,300</td>
<td>0.3</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>2,450</td>
<td>7</td>
<td>14.3</td>
<td></td>
</tr>
</tbody>
</table>

1. Water use is for an electric plant only
2. Marcellus requires additional 1-5 million gallons/well
3. Does not include area of coal mines
4. Does not include area of mines for nuclear fuel
$/kWh and Economics

Power Generation Viability

Break even sales price, ¢/kWh vs. Investment cost per kW for various power generation technologies:
- Solar photovoltaic
- Solar thermoelectric
- Wind
- Gas
- CHP
- Coal
- Micro hydro
- Nuclear

Investment cost per kW ranges from $0 to $4,500, and break even sales price ranges from 0.00 to 40.00¢/kWh.
Proposed Model

• **Total output:** Electric power demand of 350 MW (current output of Milliken Station)

• **Short-term:** A mix of wind and natural gas; recreational solar
  • Retrofit coal plant to burn gas
  • Use wind to meet RPS and other mandates (25%)
  • Mix = 75% natural gas, 25% wind

• **Long-term:** As natural gas is depleted, phase out for nuclear; continue research on renewable sources
  • Expand or contract wind production based on incentives and mandates
  • Add in other renewables (expanded solar, biofuels, geothermal, etc.) as technology becomes feasible
Cost Analysis for Short-Term Plan

Natural gas: 75% of 350 MW = 262.5 MW needed

- Overnight cost: $930 / kW
  - Assuming 40 yr. lifespan: $930 / (365 days * 40 yrs. * 24 hrs.) = $0.002654 / kWh
- Fixed operating and maintenance: $0.001256 / kWh
- Fuel (highly variable): $4.20 / MMBTU (60% conversion efficiency)

Source: http://www.nrel.gov/analysis/tech_costs.html
Cost Analysis for Short-Term Plan

Wind: 25% of 350 = 87.5 MW needed

• 175 Turbines needed
  • Assuming 500 kW / turbine at 6 m/s avg. wind speed
• Overnight cost: $1631 / kW
  • Assuming 25 yr. lifespan: 1631/(365 days*25 yrs.*24 hrs.)
    = $0.007447 / kWh
• Fixed operating and maintenance: $0.003653 / kWh
• No fuel cost

Source: http://www.nrel.gov/analysis/tech_costs.html
Geographic Analysis

- Natural Gas Production is limited to areas of feasible extraction from the Marcellus Shale, min. 2000ft. depth

Color Contours – Organic rich thickness
Black contours burial depth
Geographic Analysis

Extraction is also limited by thermal maturity

Marcellus Thermal Maturity

Not all Marcellus is in the Gas Window – Only the area east of the 1.1 Ro line – Very high maturity values in southeast
Geographic Analysis

Ideal extraction areas are in Steuben, Schuyler and Broome Counties, particularly around Binghamton.
Wind resources best in the northern areas. Optimal natural gas and wind locations differ.
Geographic Analysis

Solar resources best in the southwest. Northeast has relatively poor solar intensity.
Project Timeline

• Timeline for 175 turbine installation (assuming starting in 2011). Total expected installation time – 2 years with an average lifespan of 25 years
  • First phase: 140 turbines, 70 MW. Construction begins May 2011 production in January 2012.
  • Phase 2: 35 turbines, 17.5 MW, construction in Spring 2012, production in late 2013.
• Natural Gas Timeline – Total expected time 2-2.5 years, well lifespan approximately 70 – 80 years.
  • Each Well requires Four-Five Weeks of 24/7 Drilling
• Nuclear Installation – Even though nuclear technology has significantly progressed to include inherent fail safe mechanisms, application highly dependant on sociopolitical views due to Three Mile Island and Chernobyl.
Project Timeline

• Nuclear Installation – Highly dependant on sociopolitical views due to Three Mile Island and Chernobyl.

*Overall, do you strongly favor, somewhat favor, somewhat oppose, or strongly oppose the use of nuclear energy as one of the ways to provide electricity for the U.S.?*

![Graph showing support for nuclear energy from 1994 to 2010.](http://www.gallup.com/poll/126827/support-nuclear-power-climbs-new-high.aspx)


• Nuclear Plant Installation – Approximately 60 months for an AP1000 reactor with a lifespan of about 60 years.

Social/Political Analysis

• Marcellus Shale – estimated value of USD $1.5 Trillion, Depending on Commodities Market. Frac’ing for profit seems inevitable.
  • Water Use
  • Seismic risk
• Wind technology – Opposition to wind farms exists but is the minority: local stakeholders with specific issues about safety, aesthetics, property line setback distance, etc.
• Nuclear power is socio-politically contentious and economically demanding capital costs.
  • Many misconceptions - technology has advanced significantly to include built in fail-safe mechanisms. Risk of radiation exposure and deaths are less than that of coal.
  • Due to the low application of nuclear, little field data available.
Conclusion

**Short-term:** Some mix of wind and natural gas; recreational solar
  - Retrofit coal plant to burn gas
  - Use wind to meet RPS and other mandates (25%)
  - Mix = 75% natural gas, 25% wind

**Long-term:** As natural gas is depleted, phase out for nuclear; continue research on renewable sources
  - Expand or contract wind production based on incentives and mandates
  - Add in other renewables (expanded solar, biofuels, geothermal, etc.) as technology becomes feasible
The Westinghouse AP1000™
Thank you

Questions?
Tompkins County Energy Plan 2010 Notes

#4 Tompkins county is in a stable position to rationally evaluate options for future energy generation opportunities.

#9 “Cooling Power Plant,” [Online]. Available at: http://www.world-nuclear.org/info/cooling_power_plants_inf121.html

#12 1.666 BTU / s = 1.7583 kWe

(1.666 BTU/s*3600s/hr)

6000 BTU = 6330 kWh

.006 MMBTU * 4.20 = $0.0252 / 6330 kWh

= $3.98E-6 / kWh

Or $3762 / hr for our plant