GIS-based wind farm site selection: Evaluating the case for New York State

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Where to build a 50 MW wind farm?

1. What sites are definitely NOT appropriate or physically impossible?
2. Which sites are most economically feasible?
3. What sites are located in important bird breeding areas?
GIS-based wind farm site selection: evaluating the case for New York State – NEARC GIS conference 2011
Outline

• GIS & Sustainable Energy Research
• Modeling spatial Rate of Return (ROR)
• Architecture of Model
• Results for NYS
• Further Research
GIS-enabled Site Selection for Wind Turbine Farms

- Geographic Information Systems (GIS) provide:
  - Flexibility in user input
  - Fast processing of spatial data
  - Visual, self-explanatory output (map)

- Useful during general site selection, as well as detailed wind farm planning
  - Optimization of local expected profit
  - Insight in environmental impacts (migratory birds, bats, other species)
Exclusion and Optimization

1. Exclusion of sites using buffer areas
2. Ranking of feasible sites using optimization technique:

+ Cost of feeder line
+ Cost of roads
Architecture of GIS

- Input datasets
- Model input interface
- Generated output
- Model explorer

Inputs can be used to interpret results of the exclusion stage.
## Example: New York State

<table>
<thead>
<tr>
<th>State</th>
<th>New York</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Slope</strong></td>
<td>&lt;10%</td>
<td>Baban, S. et al., 2001</td>
</tr>
<tr>
<td><strong>Distance to towns</strong></td>
<td>&gt;0.5km</td>
<td>Baban, S. et al., 2001</td>
</tr>
<tr>
<td><strong>Distance to cities</strong></td>
<td>&gt;2km</td>
<td>Baban, S. et al., 2001</td>
</tr>
<tr>
<td><strong>Distance to Indian reservations</strong></td>
<td>&gt;1km</td>
<td>Own evaluation</td>
</tr>
<tr>
<td><strong>Distance to water bodies</strong></td>
<td>&gt;0.4km</td>
<td>Baban, S. et al., 2001</td>
</tr>
<tr>
<td><strong>Distance to roads</strong></td>
<td>&gt;0.5km</td>
<td>Department of Environmental Management, Rhode Island, 2009</td>
</tr>
</tbody>
</table>

### Do not allow wind farm in the following federal lands:
For example: ‘National Park, ‘Air Force Base’, etc.

<table>
<thead>
<tr>
<th>Forecasted revenue per MWh</th>
<th>$40/MWh</th>
<th>Wiser et al., 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital cost/kW</td>
<td>$1,580/kW</td>
<td>Wiser et al., 2009</td>
</tr>
</tbody>
</table>
North NYS

Buffalo area

State Wind Energy Site Selection

NPV > $0 Potential: 101 GWp (4MW/km²)
Model Verification

- Verify model using:
- Existing wind farms in NYS
  - Maple Ridge
  - Noble Bliss
  - Noble Clinton
  - Noble Altona
  - Dutch Hill Cohocton
  - Noble Chateaugay
  - Noble Wethersfield

<table>
<thead>
<tr>
<th>NPV class</th>
<th># wind farms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (worst)</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>9 (best)</td>
<td>0 (tiny area)</td>
</tr>
</tbody>
</table>
Conclusions

- General site selection possible based on multiple GIS data sources
- Optimization with economic analysis allows accumulation of multiple criteria
- Model results were verified with existing wind farms in NYS
Further Research

- Grid congestion modeling
- Include pricing as data layer
- Environmental Impact Assessment (bats, birds)