The Michigan Wind Prospecting Tool
• MSU’s signature program founded in 2006 to provide leadership for research, outreach and community engagement in land use and strategic growth.
• Connects faculty prowess to pressing issues in sustainable growth.
• Unique land grant framework for addressing policy issues through partnership with stakeholders.
• Targets critical policy issues needing science-based information and analysis and develops solutions.
Land Policy

Institute

HPRP

Michigan Higher Education Land Policy Consortium

MiHELP

REPP

Citizen Planner

NewPATH

PAL

People and Land

LEP

OC Planning and Zoning Center
Why Michigan?

- Michigan exports $3 billion dollars annually for electricity production.
- If this was retained and invested in Michigan we would it could spur tremendous growth.

(Individual fuel costs calculated by multiplying the MPSC regional fuel mix by the PSC energy import estimate of $3 billion).
Regional Position

Proximity to Eastern markets offers great competitive advantage
Why Michigan?

- 35% average annual growth in system sales world-wide.
- Midwest market for turbines enough to spur manufacturers, e.g.:
  - Average 2007 US turbine capacity 1.6 MW.
  - 8,000 to 10,000 turbines needed in Michigan.
  - Value of $12b to $15b.
- Given Michigan’s economic challenges, this is a pivotal moment for policy and business climate changes to attract feasible wind energy industrial growth.
Why Michigan?

- Michigan has 99%+ gap in realized capacity, perhaps highest in the nation.
  - This gap suggests huge opportunity for business growth.
- Relocation companies report strong location interest in Michigan by wind suppliers while few other industries are interested.
- Michigan can compete on the world stage!
  - Good wind and good sites.
  - Developer interest.
  - Community interest.
  - Excess manufacturing capacity.
• Michigan needs to standout on a world stage.
• Developers face location choice decisions.
• Filtering information, integrating it, and presenting it in an easily accessible form helps Michigan’s visibility.
• Focusing effort and targeting development reduces the time and effort of prospecting.
Next Steps

Comprehensive Wind Prospecting Tool will help:
- Communities actively recruit wind development
- Incentive-ize Locations
- Regional component and equipment supplier network facilitation
- Assembling rearranged coalitions of landowners
- Educating decision makers and enabling policy

Second Phase Wind Prospecting Tool includes layers on:
- Grid location and condition
- Economic impact analysis
- Blend with industry cluster patterns
- Environmental assessment rubric
- Small scale development information

Prototype Tool includes:
- Atlas to filter, focus and target suitable communities for development.
  - Geophysical
  - Land/Economic
  - Environmental
Overview of WPT

This web based tool can help filter, focus and target information on wind energy development opportunities in Michigan by providing information on three receptivity questions:

• Geophysical Factors.
• Land/Economic Factors.
• Environmental concerns.
• Local Policy.
The Wind Index

• A suitability index was developed to determine the top areas for utility scale wind development, considering the four factors.
• Each factor was represented by indicators at the community level. These indicators were then ranked and scaled to produce an additive index with a maximum value of 1000.
• The higher the score, the more appropriate an area is for utility scale wind development.

<table>
<thead>
<tr>
<th>Data</th>
<th>Proxy For</th>
<th>Possible Index Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Speed Score</td>
<td>Wind of appropriate density for power generation (NREL class 3+)</td>
<td>350</td>
</tr>
<tr>
<td>Agricultural Land Contiguity and Area</td>
<td>The number of towers that can be strung together in a reasonably compact setting on farmland</td>
<td>180</td>
</tr>
<tr>
<td>Forest Land Contiguity and Area</td>
<td>The number of towers that can be strung together in a reasonably compact setting on forest land</td>
<td>130</td>
</tr>
<tr>
<td>Per Acre Value of Agricultural Land &amp; Forest Land</td>
<td>Land Costs</td>
<td>130</td>
</tr>
<tr>
<td>Population Density: 2000</td>
<td>Possible local resistance to wind farm installation</td>
<td>130</td>
</tr>
<tr>
<td>Population Density Change: 1990 - 2000</td>
<td>Pressure for residential and other types of development</td>
<td>80</td>
</tr>
</tbody>
</table>

| Total Possible | 1000 |
(3) Within 240 days (JUNE 2009) after the effective date of this act, issue a proposed report detailing its findings under subsection (2). The board’s proposed report shall include the following:

<table>
<thead>
<tr>
<th>Legislation</th>
<th>WPT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) A list of regions in the state with the highest level of wind energy harvest potential.</td>
<td>Top 12 areas</td>
<td>The top 12 areas can be refined based on planned updates to the tool and other pertinent information.</td>
</tr>
<tr>
<td>(b) A description of the estimated maximum and minimum wind generating capacity in megawatts that can be installed in each identified region of this state.</td>
<td>Estimates of 5%, 10%, 15%, 20%, and full build-out capacity of wind turbine power production.</td>
<td></td>
</tr>
<tr>
<td>(c) An estimate of the annual maximum and minimum energy production potential for each identified region of this state.</td>
<td>Maximum at 50m</td>
<td>Can be done with wins monthly distribution data from AWS Truewind in cooperation with the state energy office.</td>
</tr>
<tr>
<td>(d) An estimate of the maximum wind generation capacity already in service in each identified region of this state.</td>
<td></td>
<td>Can be tracked with the MPSC</td>
</tr>
</tbody>
</table>
WIND ENERGY RESOURCE ZONES and the Land Policy Institute Wind Prospecting Tool Coordination

(3) In preparing its order, the commission shall evaluate projected costs and benefits in terms of the long-term production capacity and long-term needs for transmission. The order shall ensure that the designation of a wind zone does not represent an unreasonable threat to the public convenience, health, and safety and that any adverse impacts on private property values are minimal. In determining the location of a wind zone, the commission shall consider all of the following factors pursuant to the findings of the board:

<table>
<thead>
<tr>
<th>Legislation</th>
<th>WPT</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Average annual wind velocity levels in the region.</td>
<td>50m wind density area within each township and each of the top 12 areas. The WPT update will incorporate 70m wind speed.</td>
<td>The top 12 areas selected by the WPT are an intersection of agricultural land, forest land, and wind potentially suitable for utility scale production based on the 50m wind density, and various other factors in the tool.</td>
</tr>
<tr>
<td>(b) Availability of land in the region that may be utilized by wind energy conversion systems.</td>
<td>Acres of agricultural and forest land.</td>
<td>Can be tracked in cooperation with MPSC and mapped</td>
</tr>
<tr>
<td>(c) Existing wind energy conversion systems in the region.</td>
<td></td>
<td>Modeling calculation that will be inserted into the WPT framework.</td>
</tr>
<tr>
<td>(d) Potential for megawatt output of combined wind systems in the region.</td>
<td></td>
<td>With the planned revision to the tool distance to transmission, transmission capacity, and right of way analysis for transmission could be useful here. An update of the local ordinance survey performed in 2007 will be</td>
</tr>
<tr>
<td>(e) Other necessary and appropriate factors as to which findings are required by the commission.</td>
<td>Agricultural and forestland contiguity, land value per acre of agricultural and forest land, and local zoning can be useful here.</td>
<td></td>
</tr>
</tbody>
</table>
The Index Components

Wind Score

• Class three or better wind as modeled by NREL is generally considered to be the threshold for utility scale wind development.

• The wind score is a result of filtering the NREL original 50m wind density data to produce a map of only class three to seven wind resources in Michigan.

• Area in each class was scaled and added to produce the final wind resource score for a community.

• NREL wind Density map at 50m. for each class of wind.
The Index Components

Area of Agriculture with Wind

• Agricultural land has proven to be one of the most important land types for the installation of wind turbines.
• The installation of wind turbines on agricultural land allows a farmer to continue farming the land because of the minimal footprint of each tower, and the income generated for the farmer by the leases is far greater than the minimal loss in capacity to produce crops where the turbines are installed.
• Another added benefit of installing wind turbines on agricultural land is that it preserves the agricultural land for future food production.
• The more area of agricultural land within a community, the greater the amount of towers that can be installed within that community. In addition, the ability to assemble coalitions of landowners interested in hosting turbines is increased.
The Index Components

Contiguity of Agricultural Land with Wind

- The cost of an installation and the ease of interconnection are partially decided by the compactness of the entire wind farm.
- Some communities have large areas of agriculture that is scattered throughout the landscape while others have agriculture that is densely packed.
- Contiguity is a measure derived from the discipline of landscape ecology that is a direct measure of how connected or separated agriculture is in the area in question.
- Scores are determined within each community using the Fragstats analysis environment.
The Index Components

Area of forest with wind
- Forest area with wind is important to wind energy development, while possibly less desirable than agricultural land for wind development due to siting concerns.
- The NREL map models the effect for land cover so some of the forested area of Michigan have high wind resources.
- As with agriculture, the more area of forest within a community, the more potential towers a wind developer can concentrate in an area.

Final Areas
Area of Forest Land With Suitable 50m Wind Density
- 0 - 1
- 2 - 3
- 4 - 6
- 7 - 11
- 12 - 20
- 21 - 40
- 41 - 65

Miles
Contiguity of Forest Land with Wind

- As with agricultural landscapes, the cost of an installation and the ease of interconnection are partially decided by the compactness of the entire wind farm.
- Scores are determined within each community using the Fragstats analysis environment.
The Index Components

Open Space (Agriculture and Forest) Land Value

- Land value is a fundamental metric in determining lease rates, local taxes, and also serves as an indicator measure of other development pressures.
- As the value of open landscapes increases, the cost of wind installations also increases; therefore, low land values score high on the index.
- Ag value as defined by the state tax commission also includes forest land value.

Final Areas
Value of Open Space
- 83.3 - 103.9
- 104.0 - 117.3
- 117.4 - 121.6
- 121.7 - 123.9
- 124.0 - 126.1
- 126.2 - 128.5
- 128.6 - 130.0
The Index Components

Population Density: 2000

- Population density in this index is used to measure the potential for local resistance in a community to wind development.
- The greater the population density within a community, the more likely there are going to be individuals with concerns about issues such as view shed impingement, ice throw, flicker fusion, and bird strikes.
- In communities with low population density, there is less chance of creating these issues.
The Index Components


• Population Density change measures a community’s potential for other types of development pressures such as residential development or commercial which may be more financially rewarding than wind leases.

• This metric is used to capture willingness on the part of land holders to enter into long term leases vs. the potential payoff from a sale to other types of development.

• Communities with low population growth are given high index scores; all negative values were given a value of 100.
The Index Components

Zoning Score

- One of the key factors in determining the suitability for wind energy development is local zoning laws applicable to wind turbine and energy development within a community.

- A review of the zoning language in Michigan applicable to wind power development was conducted, and the level of barrier presented by zoning was assessed ranked and scaled.

- Unfortunately, zoning scores have the only potentially negative values as there are no communities that have passed enabling ordinances that reduce barriers for wind development.

- Positive score are possible.

- Also communities with no language pertaining to wind were assigned a zoning score of zero.
# Initial Results

## Top Ten Communities Wind Index Scores

<table>
<thead>
<tr>
<th>NAME</th>
<th>Agricultural Area Score</th>
<th>Agricultural Contiguity Score</th>
<th>Forest Area Score</th>
<th>Forest Contiguity Score</th>
<th>Open Space Value Score</th>
<th>Open Space Contiguity Score</th>
<th>Population Density Score</th>
<th>Population Density Change Score</th>
<th>Wind Resource Score</th>
<th>Zoning Score (subtracted)</th>
<th>Wind Index Score</th>
<th>Wind Index With Zoning subtracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Village of Douglas</td>
<td>7</td>
<td>44</td>
<td>46</td>
<td>32</td>
<td>130</td>
<td>124</td>
<td>85</td>
<td>375</td>
<td>0</td>
<td>830</td>
<td>830</td>
<td></td>
</tr>
<tr>
<td>Oostana Twp</td>
<td>19</td>
<td>41</td>
<td>38</td>
<td>113</td>
<td>134</td>
<td>83</td>
<td>373</td>
<td>0</td>
<td>799</td>
<td>799</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand Haven Twp</td>
<td>5</td>
<td>41</td>
<td>28</td>
<td>125</td>
<td>124</td>
<td>83</td>
<td>234</td>
<td>0</td>
<td>699</td>
<td>699</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lulu Twp</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>122</td>
<td>122</td>
<td>78</td>
<td>287</td>
<td>0</td>
<td>650</td>
<td>650</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alton Twp</td>
<td>83</td>
<td>27</td>
<td>2</td>
<td>118</td>
<td>124</td>
<td>83</td>
<td>178</td>
<td>0</td>
<td>642</td>
<td>642</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alpena Twp</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>124</td>
<td>123</td>
<td>83</td>
<td>287</td>
<td>0</td>
<td>635</td>
<td>635</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt. Haven Twp</td>
<td>83</td>
<td>31</td>
<td>0</td>
<td>117</td>
<td>123</td>
<td>83</td>
<td>287</td>
<td>41</td>
<td>676</td>
<td>635</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alton Twp</td>
<td>1</td>
<td>46</td>
<td>4</td>
<td>120</td>
<td>123</td>
<td>83</td>
<td>247</td>
<td>28</td>
<td>655</td>
<td>623</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grant Twp</td>
<td>0</td>
<td>46</td>
<td>35</td>
<td>125</td>
<td>130</td>
<td>83</td>
<td>178</td>
<td>0</td>
<td>650</td>
<td>623</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Bottom Ten Communities Wind Index Scores

<table>
<thead>
<tr>
<th>NAME</th>
<th>Agricultural Area Score</th>
<th>Agricultural Contiguity Score</th>
<th>Forest Area Score</th>
<th>Forest Contiguity Score</th>
<th>Open Space Value Score</th>
<th>Open Space Contiguity Score</th>
<th>Population Density Score</th>
<th>Population Density Change Score</th>
<th>Wind Resource Score</th>
<th>Zoning Score (subtracted)</th>
<th>Wind Index Score</th>
<th>Wind Index With Zoning subtracted</th>
</tr>
</thead>
<tbody>
<tr>
<td>St. Joseph</td>
<td>0.0</td>
<td>38.4</td>
<td>2.0</td>
<td>21.9</td>
<td>0.0</td>
<td>47.1</td>
<td>83.3</td>
<td>0</td>
<td>198.8</td>
<td>198.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grand Haven</td>
<td>0.0</td>
<td>52.5</td>
<td>0.2</td>
<td>18.3</td>
<td>0.0</td>
<td>51.9</td>
<td>83.3</td>
<td>32</td>
<td>238.3</td>
<td>194.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Muskegon</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>69.6</td>
<td>83.3</td>
<td>42</td>
<td>194.5</td>
<td>194.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palisades Park</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>69.6</td>
<td>83.3</td>
<td>42</td>
<td>194.5</td>
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<td></td>
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<td>47.1</td>
<td>83.3</td>
<td>0</td>
<td>198.8</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Grand Haven</td>
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<td>0.2</td>
<td>18.3</td>
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<td>32</td>
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<td>69.6</td>
<td>83.3</td>
<td>42</td>
<td>194.5</td>
<td>194.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palisades Park</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>69.6</td>
<td>83.3</td>
<td>42</td>
<td>194.5</td>
<td>194.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Note:** The table includes the following data:
- **Initial Results**
- **Top Ten Communities Wind Index Scores**
  - **Agricultural Area Score**
  - **Agricultural Contiguity Score**
  - **Forest Area Score**
  - **Forest Contiguity Score**
  - **Open Space Value Score**
  - **Open Space Contiguity Score**
  - **Population Density Score**
  - **Population Density Change Score**
  - **Wind Resource Score**
  - **Zoning Score (subtracted)**
  - **Wind Index Score**
  - **Wind Index With Zoning subtracted**

- **Bottom Ten Communities Wind Index Scores**
  - **Agricultural Area Score**
  - **Agricultural Contiguity Score**
  - **Forest Area Score**
  - **Forest Contiguity Score**
  - **Open Space Value Score**
  - **Open Space Contiguity Score**
  - **Population Density Score**
  - **Population Density Change Score**
  - **Wind Resource Score**
  - **Zoning Score (subtracted)**
  - **Wind Index Score**
  - **Wind Index With Zoning subtracted**

---
Initial Results - With and Without Zoning Restrictiveness
The highest scoring communities in Michigan (index scores of 500 or better) were then selected and aggregated into the top 12 wind utility scale wind development areas in the state.

It is important to note that the grid and transmission issues have not been addressed yet so some of these areas will possibly be later determined to be impractical.

The final community score with and without zoning are shown to the left, the final areas best suited to utility scale development in Michigan are shown below.
Development Scenario Results

• The top 12 areas in the state were then further examined to determine the possible number of towers they can accommodate as well as estimating power output, lease values, and maintenance and upkeep job as well as construction creation.

• Wind turbines are generally spaced no closer than five times their rotor diameter. Using this rule, 450m spacing was determined to be a reasonably conservative estimate of tower density as it represents a 90m rotor diameter, and the largest turbines commissioned for installation in Michigan have an 80m rotor diameter.

• The power possible was calculated by assuming a 1.65 megawatt turbine (the size slated for recent a recent Michigan development) at 28% efficiency.

• Job creation was estimated by a literature review which indicates approximately .08 FTE maintenance and upkeep jobs are created per megawatt installed and 1.23 construction jobs per megawatt in large installations.

• To present reasonable estimates of impacts, several scenarios were calculated using 5%, 10%, 15%, and 20% of the wind resource area. The results of this analysis are shown in the table below.
## Development Scenario Results

<table>
<thead>
<tr>
<th>Area NAME</th>
<th>Towers possible if 15% of the resource area is used</th>
<th>Power production possible if 15% of the resource area is used</th>
<th>Potential land lease value if 15% of the resource area is used</th>
<th>Potential maintenance and upkeep jobs created if 15% of the resource area is used</th>
<th>Potential construction jobs created if 15% of the resource area is used</th>
<th>Towers possible if 20% of the resource area is used</th>
<th>Power production possible if 20% of the resource area is used</th>
<th>Potential land lease value if 20% of the resource area is used</th>
<th>Potential maintenance and upkeep jobs created if 20% of the resource area is used</th>
<th>Potential construction jobs created if 20% of the resource area is used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern P*</td>
<td>183</td>
<td>94.7</td>
<td>$395,558</td>
<td>24</td>
<td>372</td>
<td>240</td>
<td>535.1</td>
<td>$470,200</td>
<td>32</td>
<td>486</td>
</tr>
<tr>
<td>Honeeroux</td>
<td>256</td>
<td>115.9</td>
<td>$166,714</td>
<td>34</td>
<td>516</td>
<td>328</td>
<td>771.1</td>
<td>$607,600</td>
<td>44</td>
<td>677</td>
</tr>
<tr>
<td>Leelanau</td>
<td>197</td>
<td>81.1</td>
<td>$394,424</td>
<td>26</td>
<td>400</td>
<td>258</td>
<td>595.1</td>
<td>$515,600</td>
<td>34</td>
<td>523</td>
</tr>
<tr>
<td>Mason County</td>
<td>71</td>
<td>32.7</td>
<td>$141,329</td>
<td>9</td>
<td>143</td>
<td>92</td>
<td>213.4</td>
<td>$194,800</td>
<td>12</td>
<td>188</td>
</tr>
<tr>
<td>Presque Isle</td>
<td>24</td>
<td>11.2</td>
<td>$48,348</td>
<td>3</td>
<td>48</td>
<td>32</td>
<td>73.0</td>
<td>$53,200</td>
<td>4</td>
<td>64</td>
</tr>
<tr>
<td>Siles</td>
<td>147</td>
<td>67.7</td>
<td>$203,148</td>
<td>19</td>
<td>267</td>
<td>192</td>
<td>462.6</td>
<td>$365,300</td>
<td>25</td>
<td>389</td>
</tr>
<tr>
<td>Thumb 1</td>
<td>273</td>
<td>125.2</td>
<td>$446,210</td>
<td>36</td>
<td>554</td>
<td>357</td>
<td>824.7</td>
<td>$714,000</td>
<td>47</td>
<td>725</td>
</tr>
<tr>
<td>Thumb 2</td>
<td>319</td>
<td>147.6</td>
<td>$293,928</td>
<td>42</td>
<td>648</td>
<td>418</td>
<td>954.7</td>
<td>$325,300</td>
<td>55</td>
<td>586</td>
</tr>
<tr>
<td>Thumb 3</td>
<td>273</td>
<td>125.2</td>
<td>$446,210</td>
<td>36</td>
<td>554</td>
<td>357</td>
<td>824.7</td>
<td>$714,000</td>
<td>47</td>
<td>725</td>
</tr>
<tr>
<td>Traverse Bay</td>
<td>130</td>
<td>69.3</td>
<td>$203,148</td>
<td>19</td>
<td>267</td>
<td>192</td>
<td>462.6</td>
<td>$365,300</td>
<td>25</td>
<td>389</td>
</tr>
<tr>
<td>UP Ribbon</td>
<td>108</td>
<td>49.7</td>
<td>$219,118</td>
<td>14</td>
<td>218</td>
<td>141</td>
<td>324.8</td>
<td>$281,200</td>
<td>19</td>
<td>265</td>
</tr>
<tr>
<td>UP Ribbon 2</td>
<td>42</td>
<td>19.5</td>
<td>$84,450</td>
<td>6</td>
<td>90</td>
<td>55</td>
<td>127.5</td>
<td>$150,400</td>
<td>7</td>
<td>112</td>
</tr>
</tbody>
</table>
Additional Information/Value added to the Map Server

- Beyond the factors already addressed, there are a host of environmental and landscape issues that affect wind power sighting and development such as:
  - areas of critical habitat for threatened and endangered species
  - conservation land
  - Wetlands
  - Lakes
  - steep slopes.
- With the help of project partners, this information was included in the tool as well. These areas were not subtracted from the total area available for development because they serve as indicators that as part of comprehensive site assessment are areas of concern.