A TECHNICAL ANALYSIS OF WIND POWER POTENTIAL IN TOMPKINS COUNTY, NEW YORK

A Professional Report

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Master of Regional Planning

by

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Executive Summary

This report presents a spatial analysis of the potential for large-scale and small-scale wind power in Tompkins County, NY. Using a multi-criteria decision-making model in a GIS, various spatial factors are weighed against each other to select three sites suitable for large-scale wind development. Two of these sites show potential to provide 40MW of installed capacity in the near-term, enough electricity to power approximately 30% of households in the county. Additional capacity may be added in the future if regulatory conditions that prohibit large-scale wind development in certain municipalities change.

A similar analysis is presented for small-scale wind turbines. Approximately 3,800 parcels in Tompkins County could host a small wind turbine, producing enough electricity to provide for 30-95% of annual household electricity demand for the host properties. Of these, 1,500 agricultural parcels show the greatest potential for small wind turbines, as they likely have a high enough load to make the economics favorable and also sufficient land to site a medium-sized turbine. Despite this potential, small-wind will likely remain a small component of the energy landscape due its high cost and the low wind speeds in the County.

The regulatory environment for both scales of wind power is also surveyed. With the passage of the Power New York Act of 2011, the state Power Facilities Siting Board will issue permits for all projects over 25MW installed capacity, while smaller projects will continue to be permitted through the State Environmental Quality Review Act (SEQR). This change in regulation indicates that the state will take a stronger role in siting large facilities, while local governments will retain more authority over siting smaller facilities.

At the local level, zoning and permitting procedures in Tompkins County require revision in order to make wind development at all scales easier for residents and developers.

Towns whose zoning codes do not already provide for wind turbines should mention them, and the County can assist these towns in assessing the different implication of zoning and permitting decisions. On a countywide level, standardizing permitting processes between municipalities would create a more favorable environment for small wind installations.

Lastly, various case studies of community ownership models and local wind projects are presented. Several projects in New York State demonstrate the role that local governments have played in negotiating favorable PILOT agreements and the different remuneration schemes for landowners that host turbines or live near wind farms. In general, landowners receive 1-3% of revenues for each turbine on their property, and some towns have seen up to a 2/3 reduction in property taxes through hosting a wind farm. Several case studies from the Midwest highlight various options for community ownership that could be implemented in Tompkins County. These include in-state, limited offerings of shares in an LLC, a private-public "flip" ownership to take advantage of tax incentives for the first ten years of ownership, and municipal utilities to provide district power.

Overall, wind energy shows a potential to form a part of the County's greenhouse gas reduction strategy. Additional research on cost-competitiveness of wind compared to other technologies, the changing landscape for financial incentives, and the drivers of small-scale turbine purchasing would help inform the County's decision-making process about pursuing wind energy as a priority in the future.

BIOGRAPHICAL SKETCH

Benjamin Koffel is masters' candidate in City and Regional Planning at Cornell University. In 2007 he received his B.A. from Cornell University in Anthropology, with a concentration in Asian American Studies. He worked in the private sector for three years before returning to Cornell to pursue his studies in Planning.

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LIST OF ABBREVIATIONS

AWEA: The American Wind Energy Association

CO2e: Carbon Dioxide Equivalents

CUGIR: Cornell University Geospatial Information Repository

EAF: Environmental Assessment Form

EIS: Environmental Impact Statement

EMC: Environmental Management Council, Tompkins County

MACRS: Modified Accelerated Cost Reduction Schedule

NREL: National Renewable Energy Laboratory

NYSERDA: New York State Energy Research and Development Authority

PPA: Power Purchase Agreement

SEQR: New York State Environmental Quality Review Act

INTRODUCTION

In 2008, recognizing the role of fossil fuels in contributing to climate change and the importance of mitigating the effects of greenhouse gas emissions, the Tompkins County Legislature adopted a new amendment to the County Comprehensive Plan. The "Energy and Greenhouse Gas Emissions Element" commits the county to an 80 percent reduction in CO2e levels by 2050, with an interim goal of 20 percent reduction from 2008 CO2e levels by 2020.[1] In order to achieve these goals, the County published the "Tompkins County 2020 Energy Strategy: Interim Actions Toward Achieving the Community 2050 Greenhouse Gas Emissions Reduction Goal." The Energy Strategy identifies ten new measures to contribute to 23% of the required emissions reductions. One of the ten items is the creation of an "Energy Road Map."

As the 2020 Energy Strategy specifies:

> …a more detailed understanding of the energy demand and supply in the community is key to determine the most effective and efficient means of meeting the community's long-term energy goals. An Energy Road Map would create an integrated approach to assessing the energy demand and supply for the residential and commercial sectors in the entire County today and in the future under the development framework and the objectives established in the County Comprehensive Plan.[2]

This report advances the goal of assessing the energy supply in the County by quantifying the generation potential of wind energy and assessing the regulatory environment for wind development. When taken together with similar studies of other renewable energy

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[1] Tompkins County, New York. "Tompkins County Comprehensive Plan: Energy and Greenhouse Gas Amendment." 2008. http://www.tompkins-co.org/planning/compplan/documents/EGGEElementfromPublisher.pdf

[2] Tompkins County, New York. "Tompkins County 2020 Energy Strategy." 20 August, 2010. http://www.tompkins-co.org/planning/energyclimate/documents/EnergyStrategy20208-20-10_2.pdf

technologies, the information contained herein can be used to form a comprehensive energy strategy to meet the GHG reduction goals of Tompkins County.

This study consists of three parts: A technical analysis of the potential for large-scale and small-scale wind in Tompkins County, an analysis of the state and local regulatory environment and permitting process, and several case studies of wind farms and community ownership structures.

Part 1: Technical Analysis

The report will assess the generation potential within Tompkins County using GIS data available from CUGIR (including an existing wind-speed survey) and the Tompkins County Commercial Wind Farm Atlas as well as supplemental data provided by the County and research staff at Cornell. The GIS analysis will seek to quantify how much electricity can be generated through wind power given existing land uses, zoning and other considerations identified in the Tompkins County Commercial Wind Farm Atlas, and other parameters. The analysis will be conducted on two scales.

Large-Scale

The large-scale technical analysis identifies the top three areas of Tompkins County most suitable for large-scale wind projects (electricity generation for a large employer, municipality, or for power grid delivery). Maps of these areas are presented along with accompanying calculations to estimate annual energy production. The project draws heavily on the siting requirements for large-scale wind turbines specified in the Tompkins County Environmental Management Council's "Model Municipal Ordinance for Utility-Scale Wind Energy Conversions Systems", addressed in the Tompkins County Planning

Department's letter reviewing the Enfield Wind Ordinance in 2008, the Enfield Wind Ordinance, and in the New York State Energy Research & Development Authority (NYSERDA) "Wind Energy – Model Ordinance Options," and parameters from other similar studies in comparable geographies. A summary of assumptions, definitions, findings, and conclusions from the analysis accompanies the maps.

Small-Scale

The small-scale technical analysis identifies which parcels in the county are most suitable for small-scale wind development (electricity generation for consumption by an individual farm, small business or residence) and will provide general estimates on energy production. It should be noted that wind speed data for lower elevations is not as robust as it is for large-scale elevations, many more options exist for turbine selection and power output, and the potential sites for small-scale development are more numerous and more variable than those for large-scale development. Therefore, the analysis of small-scale wind energy potential provides estimates of generation potential, but not site-specific details. Local wind ordinances are reviewed to determine siting requirements for small-scale wind turbines. A summary of assumptions, definitions, findings, and conclusions from the analysis accompanies the maps.

Part 2: Regulatory Analysis

Local, state, and federal regulatory procedures are reviewed to provide an overview of what steps must be taken to install large-scale and small-scale wind turbines. This information can inform individuals and organizations interested in developing wind projects about the steps that must be taken to approve and permit new projects. Zoning and permitting processes for Tompkins County municipalities are surveyed, and recommendations for improvements are made.

Part 3: Large-Scale and Small-Scale Wind Case Studies

Information gleaned during interviews with individuals in Tompkins County who have developed or are developing wind power projects is used to gauge the difficulty of navigating the regulatory environment and to identify potential barriers. Existing wind farms in New York State and the Midwest are presented to highlight options for community ownership and financing, as well as challenges and roadblocks with developing new projects.

PART ONE: TECHNICAL ANALYSIS

Siting considerations

When determining how much energy can be generated by wind power, the primary concern is the number of turbines that can be located in the county in areas with a sufficient average wind speed. The first parameter is largely a spatial one; wind turbines have optimal locations based on existing land uses and natural features. The second parameter also has a spatial component; wind speed is different in each location in the county.

A Geographic Information System (GIS) approach allows all of the relevant spatial parameters to be combined together into a multi-criteria decision-making model. The model can weight each parameter, and establish the most appropriate sites for development.   Later, specific data points for each site, such as average annual wind speed, can be exported and used as inputs in other relevant calculations.

Scale

Large-scale wind turbines are used to generate electricity primarily for sale to the wholesale electricity markets. They generally have capacities of 1MW or higher and function as a power plant, producing electricity and selling it wholesale. Small-scale wind turbines are much smaller, with capacities of 1kW-100kW. Their primary purpose is to provide power to the parcel on which they sit, not to produce revenues from selling electricity.

Large-Scale Wind vs. Community Wind

In this report, "large-scale wind" refers to megawatt-scale turbines, regardless of their ownership structure. Sites that are suitable for large turbines can be owned by an independent power producer and sell their electricity to a utility, or they can be owned under a community ownership structure to provide electricity in a district power system or to a municipal operation. "Community-Wind" in this report refers to an ownership structure, regardless of the size of the turbines involved.

Data

Many sources were used to assemble the data for this analysis and evaluate potential sites. Table 1 below shows each layer used in the analysis, along with its corresponding source. A full list of data, including detailed descriptions of each layer, can be found in the Appendix.

Table 1: Data Layers

Data Layer	Source
Wind Resource at 80m	AWS Truewind, CUGIR
Municipalities	CUGIR
Tax Parcels	CUGIR
Buildings	CUGIR
Land Use	CUGUIR
Elevation	Cornell University, Geddes Lab
Unique Natural Areas	Tompkins County Planning Dept.
Public Open Space	Tompkins County Planning Dept.
Cornell Natural Lands	Tompkins County Planning Dept.
Critical Environmental Areas	Tompkins County Planning Dept.
High Voltage Transmission Lines	Tompkins County Planning Dept.
Airport Approach and Clear Zone	Tompkins County Planning Dept.
Distinctive and Noteworthy Viewsheds	Tompkins County Planning Dept.
Emergency Communication Lines of Sight	Tompkins County Planning Dept.
Important Bird Areas	Audubon Society of New York

Large-Scale Wind Turbine Siting

Background

Utility scale wind turbines – those that generate electricity on a scale that can be sold to a large number of consumers – have significant siting requirements. These siting requirements exist to ensure the safety of people and buildings within the vicinity of turbines, minimize any nuisance to abutting land-owners, and protect other land uses.

Definition of Large-Scale

In 2005, The Tompkins County Environmental Management Council published a "Model Municipal Ordinance for Utility-Scale Wind Energy Conversion Systems." The model ordinance was designed to assist municipalities in the county that expect to host utility-scale wind projects and serve as a guideline for land use considerations. The ordinance defines a utility-scale wind energy conversion system as having at least one of three characteristics:[3]

1. A rated capacity of 500kW or greater
2. 200 feet or greater in height
3. The purpose of such energy generated is for commercial sale

These guidelines are consistent with the installed capacity and height of modern wind turbines used in commercial wind farms. Additional provisions in the Model Ordinance are included in the model parameters outlined in the following section.

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[3] Tompkins County Environmental Management Council. "Model Municipal Ordinance for Utility-Scale Wind Energy Conversion Systems (U-SWECS)." www.tompkins-co.org/emc/docs/windordbackground.doc (14 September, 2005). Retrieved October, 2011. 1.

Previous Survey of Wind Power in Tompkins County

New York State ranks seventh in the nation in terms of installed wind power capacity, with approximately 1,285MW of installed capacity as of 2010.[4] However, in NYSERDA's assessment of wind potential on a county basis, Tompkins County was not deemed to have high enough average annual wind speeds to be considered a prime spot for wind development when compared with other regions of the state.[5] The map on the following page outlines the wind resource profile of the state, and demonstrates that Tompkins County is not among the areas with the highest potential, with most of the county in the lower tercile of wind speeds. However, there may still be areas in the county that would suitable for a wind development.

[4] NYSERDA. Wind Energy Toolkit. 2009. http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. 13.
[5] Ibid, 4

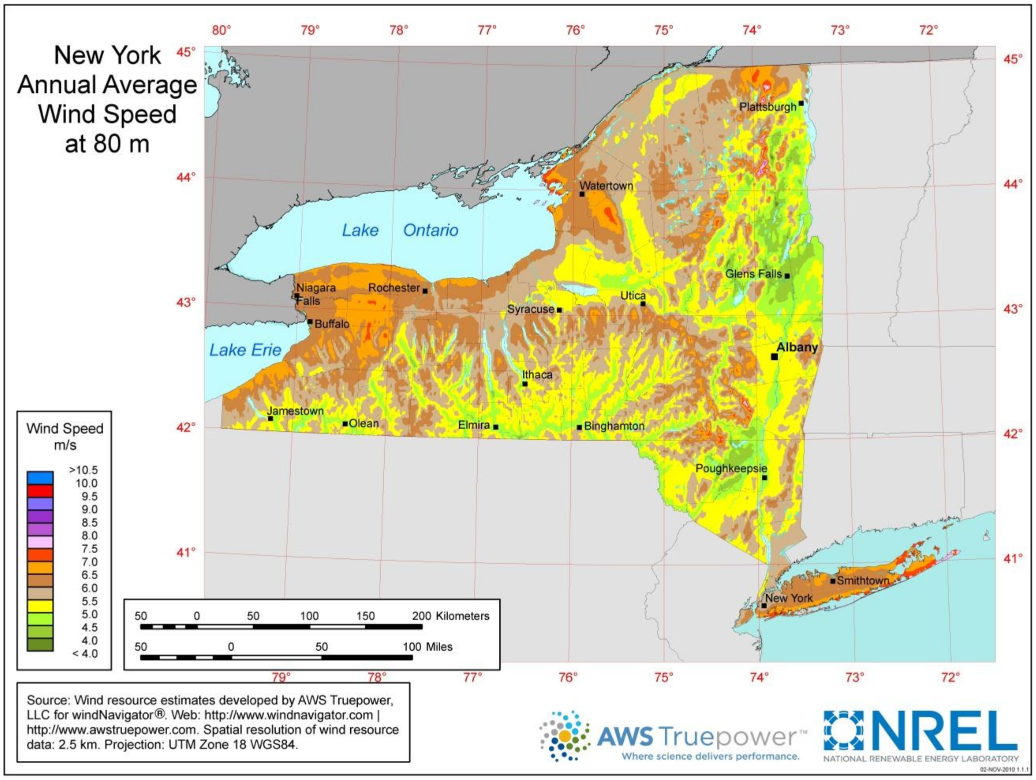

Figure 1: Wind Resource Map of New York State

Source: NREL. "Wind Powering America." (2010). http://www.windpoweringamerica.gov/images/windmaps/ny_80m.jpg

New York State Guidelines for Large-Scale Turbine Siting

In 2009 NYSERDA published the "Wind Energy Toolkit" to assist municipalities and developers in constructing wind power facilities.[6] The toolkit outlines a series of recommendations for selecting sites for large-scale wind power. NYSERDA suggests that five characteristics of a site must be considered when assessing its appropriateness for wind energy generation:

1. Wind Conditions: The site must have average wind speed of 6.5m/s
2. Proximity to Transmission Line: The site should be able to access a high voltage transmission line without significant impacts on nearby land uses
3. Terrain Favorable for Construction: The site must not be built on an excessive slope, and must have soils that can support large structures as well as construction machinery
4. Land Use and Environmental Compatibility: The site should not significantly disrupt other land uses or the natural environment
5. Sufficient land area: The site should have sufficient land area to accommodate turbines and other structures

[6] NYSERDA. Wind Energy Toolkit. (2009). Retrieved from http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. 85.

Methodology and Operationalization of Variables

This section outlines how each relevant variable that may affect a site's suitability was operationalized into a parameter of the model. Assumptions applied when constructing the model are also presented here.

Wind Speed

Small variations in wind speed can have significant impacts on the electrical output of a turbine, due to the fact that the cube of the wind speed is used to calculate the power output from a turbine. A higher wind speed makes a project more financially attractive to a developer, as it indicates that more electricity can be produced. The threshold speed for wind power suitability varies across studies, with some studies using values as low as 5m/s for wind speed (Crill, Gillman et al 2010, Baban and Parry 2001, and Tegou et al 2007). This analysis uses the NYSERDA and NREL-suggested threshold speed of 6.5m/s.[7] In general, the wind conditions in the county are rather low, with a maximum average wind speed of approximately 7.6m/s, according to the AWS Truewind estimates.

Parameter: The table below provides the re-classifications for wind speeds.

Table 2: Wind Speed Re-Classification

Wind Speed	Classification
<6.49m/s	1
6.5m/s – 6.99m/s	5
7.0m/s – 7.49m/s	6
>7.5m/s	7

[7] NYSERDA. Wind Energy Toolkit. 2009. http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. 85.

Note: Wind speed is the only variable that is not scaled from 1-4. Earlier trials of the model with a 1-4 scale and a similar weighting (see following section on weighting) resulted in outputs that created suitable sites with unsuitable wind speeds. Increasing the scale of the wind speed classification ensures that only areas with a sufficient wind speed were classified as suitable.

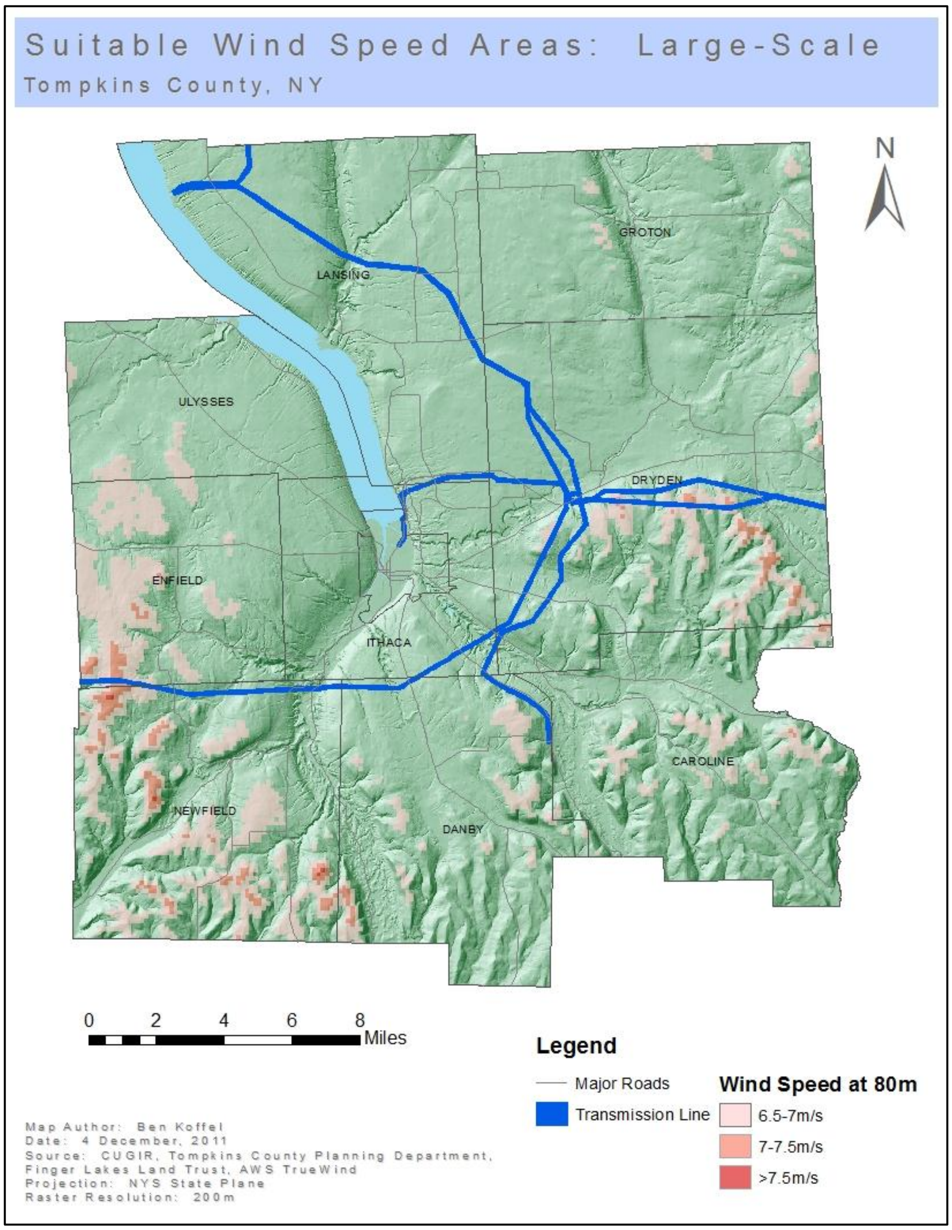

Figure 2: Suitable Wind Speed Areas

Required Setbacks

Large-scale wind turbines are tall structures. A turbine with an 80m hub height can have a blade diameter of up to 50m, bringing the total height to 105m (345 feet). Therefore, the safety of nearby structures, utility connections, and rights of way must be considered.

Section 6.9 of The Tompkins County EMC's Model Wind Ordinance specifies five setback criteria for U-SWECS:[8]

1. Inhabited structures: Each U-SWECS shall be set back from the nearest inhabited structures by 1.25 times its total height at all times.
2. Property lines: Each U-SWECS shall be set back from adjoining property lines by 2 times its total height at all times, unless the applicant receives written consent or a land lease/wind access easement from affected neighbor(s).
3. Public roads: Each U-SWECS shall be set back from the nearest public road a distance of no less than 1.25 times its total height.
4. Communication and electrical lines: Each U-SWECS shall be set back from the nearest existing above-ground public electric power line or telephone line a distance of no less than 2 times its total height.
5. Designated scenic roads/highways: Each U-SWECS shall be set back from a state or locally designated scenic highway or road a distance of no less than 2 times its total height.

In addition to the Tompkins County EMC's Model Wind Ordinance, the Town of Enfield Wind Ordinance specifies the following setbacks for Wind Turbine Generators (WTGs):[9]

[8] Tompkins County Environmental Management Council. "Model Municipal Ordinance for Utility-Scale Wind Energy Conversion Systems (U-SWECS)." www.tompkins-co.org/emc/docs/windordbackground.doc (14 September, 2005). Retrieved October, 2011. 4.

1. Inhabited structures: 450' or 1.1 times the total turbine height, whichever is greater
2. Property lines: 100' or 1.1 times the blade sweep radius, whichever is greater
3. Other WTG: 450' or 1.1 times the total turbine height, whichever is greater
4. Wetlands: 100' from mapped wetlands.

These setback requirements are similar to those suggested by NYSERDA and the AWEA (See the NYSERDA Model Wind Ordinance in the Appendix and the AWEA standards in Part Two of this report).

Turbine Height

With a hub height of 80m (240 ft.) and an estimated blade radius of 50m (135 ft.), a maximum height of approximately 345 ft. for a turbine with an 80m hub height can be expected. This total height is consistent with many turbine models with an 80m hub height.[10]

Assuming a maximum total height of 375 feet, the minimum setbacks range from 438 feet on all sides for criteria 1 and 3 of the EMC's model wind ordinance, to 700 feet for criteria 2, 4, and 5. If the setback criteria from the Enfield Wind Ordinance are applied, these setback distances would somewhat larger, with the 450ft. value being larger than 1.1 times the estimated height of 375 ft.

This analysis follows the setback criteria established in the Tompkins County EMC's Model Wind Ordinance, as this ordinance will likely serve as a guideline for interest municipalities within the County. Under these criteria, a radius of 700ft. is applied to each

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[9] Town of Enfield. "Wind Energy Facilities Local Law." (2009). http://townofenfield.org/content/Laws/View/8. Retrieved October 2011. 7.
[10] See appendix for listing of turbines surveyed for this analysis

turbine, representing the largest setback requirement of the ordinance. Given that few roads cross parcel lines, the 700 ft. buffer from a parcel line would also accommodate the restrictions on public roads and scenic highways.

Setting 700 feet as the radius around a turbine equates to a minimum area of 1,539,380ft^2 in order to meet all of the setback requirements. Dividing this value by 43,560ft^2/acre, parcels must have at minimum a 35-acre circle that does not intersect adjacent properties in order to host a wind turbine. This finding is consistent with the Tompkins County Wind Atlas parameter of 35-acre parcels as the minimum size required to support a U-SWECS project.

This consideration does not include inhabited structures. As the scope of this analysis is the county-scale and not a micro-evaluation of each potential site for development, issues such as specific turbine location on a suitable site were not considered. Additionally, most inhabited structures are built near a parcel line, so as to be close to a road. Therefore, most occupied structures on a site are likely to be at the fringe of the acceptable buffer. Due to the general location of inhabited structures on large parcels in Tompkins County and the ability of turbine siting to be adjusted, buildings are not included in the setback and fall zone analysis.

Parameter: Parcels must have at least a 35-acre circle free of property lines to be able to support large-scale wind development.

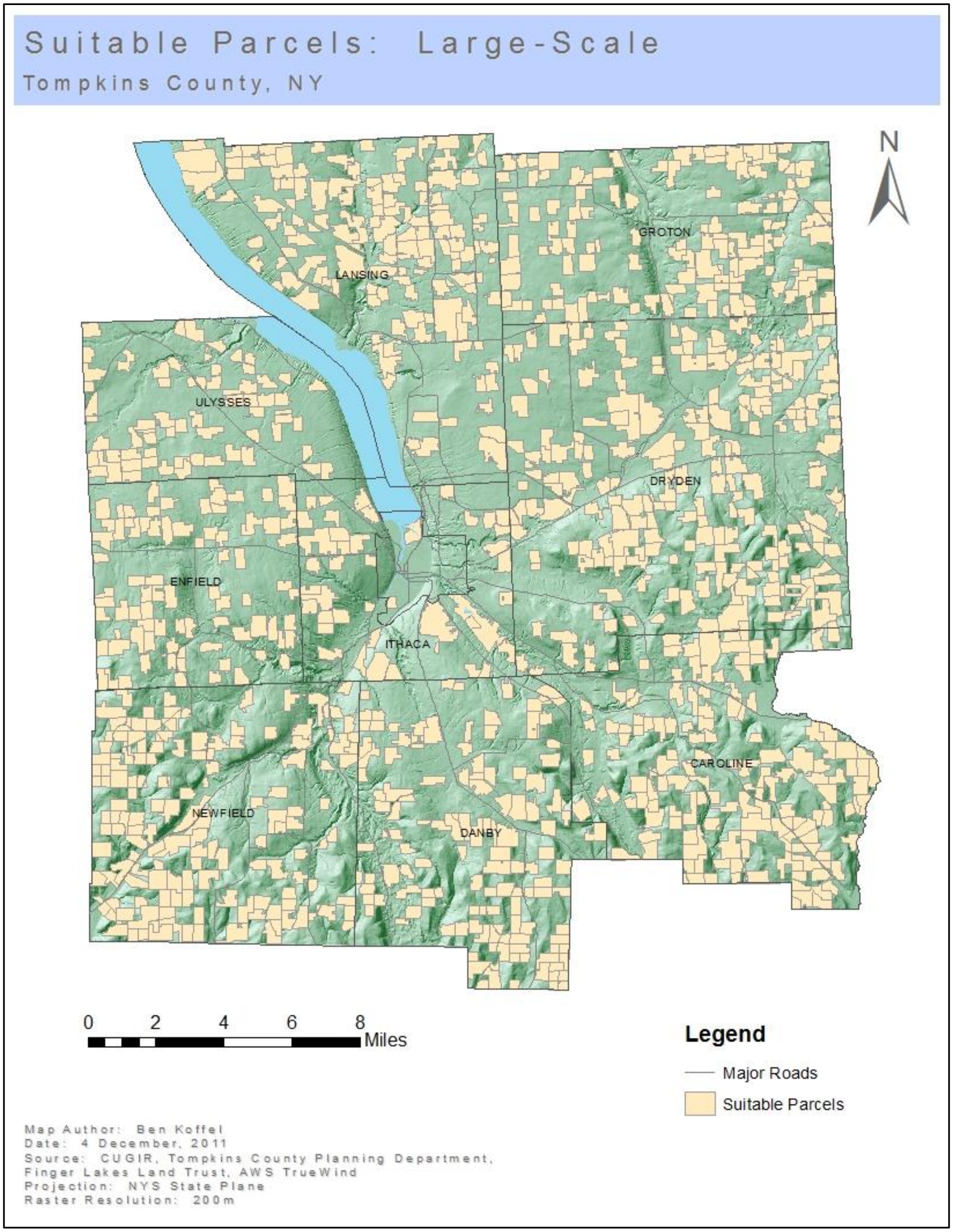

Figure 3: Suitable Parcels: Large-Scale

Land Use

Not all land uses are acceptable or preferable for developing wind power. Various studies use different classification schemes for determining appropriate land use. Baban and Parry (2001) employed a buffer approach for incompatible land uses, with buffers of between 500m and 2,000m for various land use attributes. Their analysis did not rank the suitability of different land uses for wind development, only their constraints. Hansen (2005), Bennui et al (2007), Shamshad and Bawadi (2003), and Tegou (2007) also classified land solely based on proximity to various features, such as roads, dense areas, railroads, and wetlands. Arnette (2010) classified land according to the National Land Cover Data Classifications. Wind farm development was permitted on barren land, forested land, scrub/shrub, pasture, and cropland. In contrast, the Crill et al study (2010) simplified land use classification into seven groups and ranked the suitability for development. Their analysis assigned a value of 10 to pasture and cropland, 9 to grassland, 6 to shrubs and 5 to barren, 3 to forest, and 0 to urban and water.

This analysis uses the model employed by Arnette (2010) and Crill (2010), with modifications to fit the characteristics of Tompkins County. Agricultural land was ranked as the best land use category due to wind turbine's ability to provide additional income to farmers. Barren, brush, and grassland provide minimal wind resistance due to the absence of tall structures. Forestland, although capable of being developed, is not preferable due to the wind interference trees cause.

Parameter: The table on the following page shows the re-classification scheme for land use. Values of "1" are unsuitable and are removed from considering in the weighted analysis.

Table 3: Land Use Reclassification

Land Use Category	Classification
Agriculture	4
Barren or Disturbed	3
Brush	3
Grassland	3
Forest	2
Commercial/Retail	1
Industrial	1
Recreation	1
Public/Institutional	1
Residential	1
Transportation	1
Wetlands	1

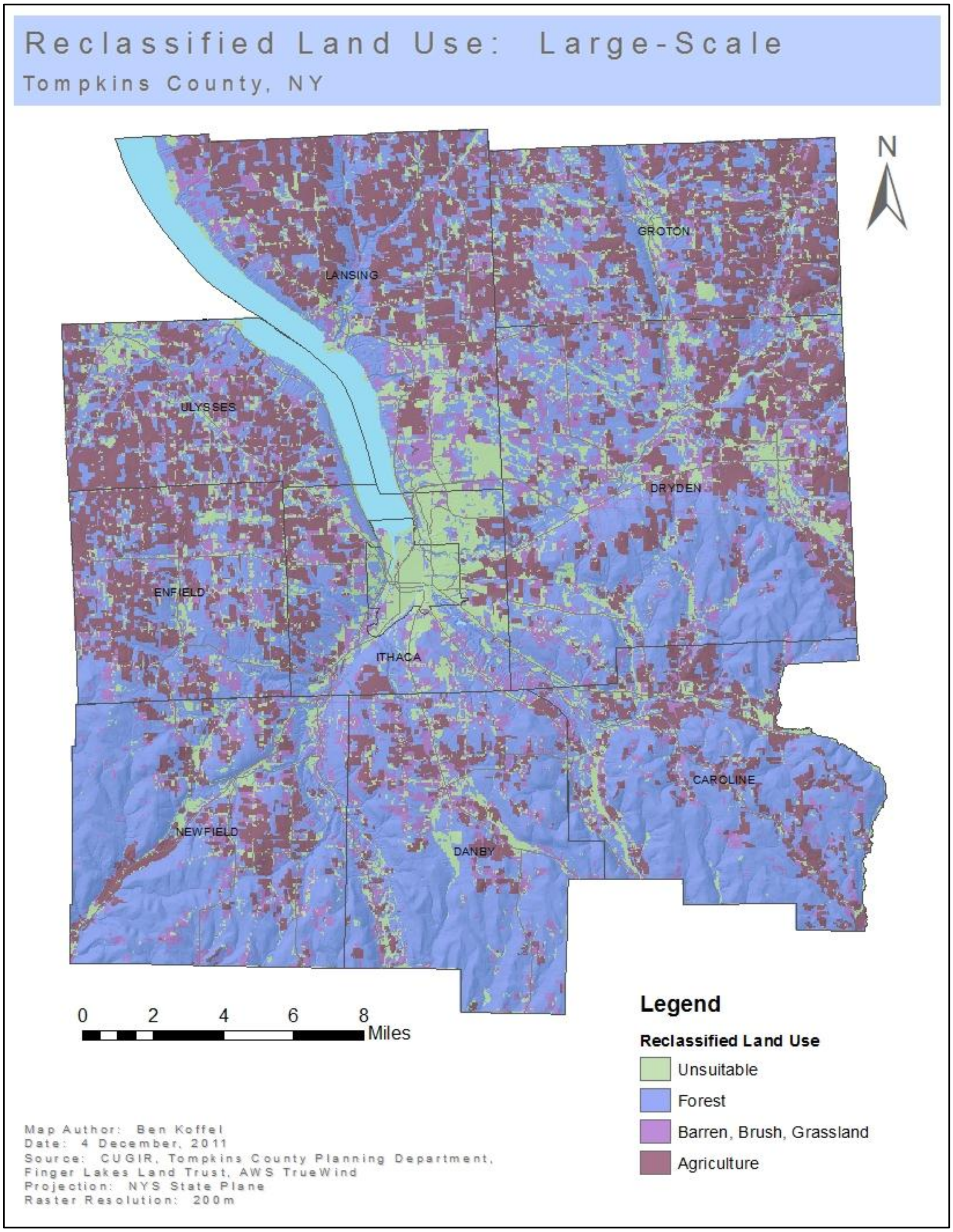

Figure 4: Reclassified Land Use

Protected Areas

Section 6.7 of The Tompkins County Model EMC's specifies: "The facility shall not have a significant adverse effect on endangered or threatened wildlife or plant species or their critical habitats, including either migratory or resident avian and bat populations."[11]

GIS data for avian populations is available via the Audubon Society under the Important Bird Area program (IBA). IBAs are designated as such due to their importance in avian breeding, hosting endangered or threatened species, or their role in monitoring or research. Beyond avian species, the Tompkins County Commercial Wind Farm Atlas includes several other categories of significant ecological land use, which are also included in this analysis. These areas represent protected natural features that are important to the environmental health and character of the county.

- Unique Natural Areas
- Public Open Space (including state parks)
- Critical Environmental Areas

For this analysis, development inside of these areas was prohibited. Although it may be legally possible to develop a wind farm inside of an Important Bird area or some other protected class of land, previous experience in Tompkins County suggests that a project in a protected area would come under significant local scrutiny. Excluding these natural areas from the analysis provides a more realistic outlook on which sites in the County would be of reasonable interest to a developer.

[11] Tompkins County Environmental Management Council. "Model Municipal Ordinance for Utility-Scale Wind Energy Conversion Systems (U-SWECS)." www.tompkins-co.org/emc/docs/windordbackground.doc (14 September, 2005). Retrieved October, 2011. 4.

The provision in the Tompkins County EMC's Model Ordinance of "no significant adverse effect" could be a subject of debate for a potential wind project. Due to the ambiguity in this language and its lack of specificity on what constitutes significant adverse effect, only the protected areas themselves are excluded from the analysis and a buffer zone is not provided.

Parameter: Cells falling within one of these restricted areas receive a value of 0. All other cells receive a value of 1.

Note: At the request of owners of certain data, the protected areas are shown below in aggregated form.

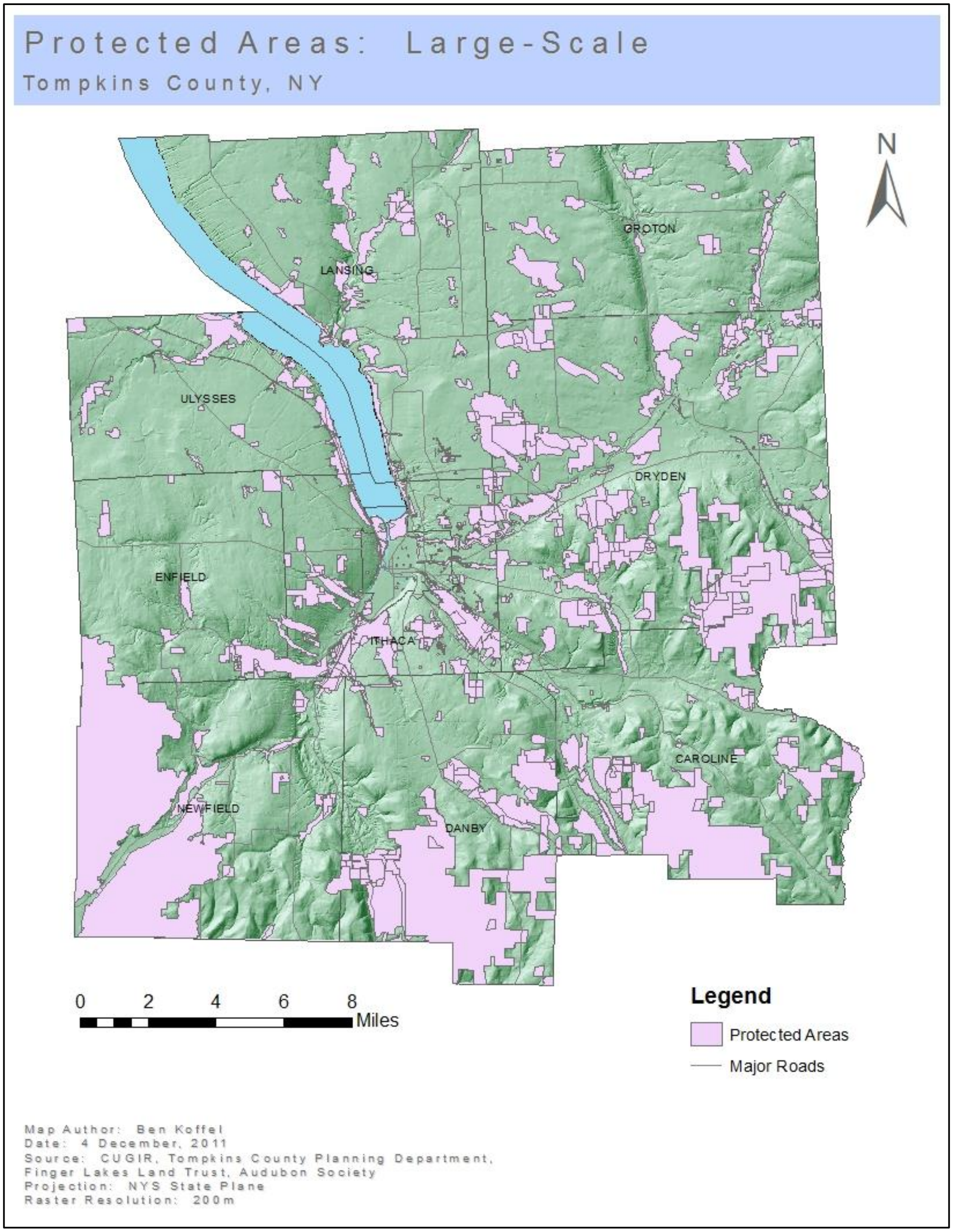

Figure 5: Aggregated Protected Areas

Viewsheds

Section 6.6 of The Tompkins County Model Wind Ordinance specifies: "U-SWECS shall not be allowed in a location that would substantially detract or block the view of a locally designated scenic viewshed."[12]

The Tompkins County Scenic Resources Inventory identifies 25 "distinctive" viewsheds, and 30 "noteworthy" viewsheds, based on their aesthetic value and importance to the character of the county. Although the language of the model ordinance does not specify which classification of viewshed should be applied, for purposes of this study, both the 25 "distinctive" viewsheds and the 30 "noteworthy" viewsheds were applied to the model. Negative visual impact on the surrounding aesthetic is often a reason that communities oppose wind projects, and by including both levels of viewsheds in the analysis it increases the likelihood that sites with potential aesthetic problems will be avoided.

Prior studies have not incorporated rural, scenic viewsheds of significant cultural importance.

Parameter: All cells within a distinctive viewshed receive a value of 0. All other cells receive a value of 1.

[12] Tompkins County Environmental Management Council. "Model Municipal Ordinance for Utility-Scale Wind Energy Conversion Systems (U-SWECS)." www.tompkins-co.org/emc/docs/windordbackground.doc (14 September, 2005). Retrieved October, 2011. 4.

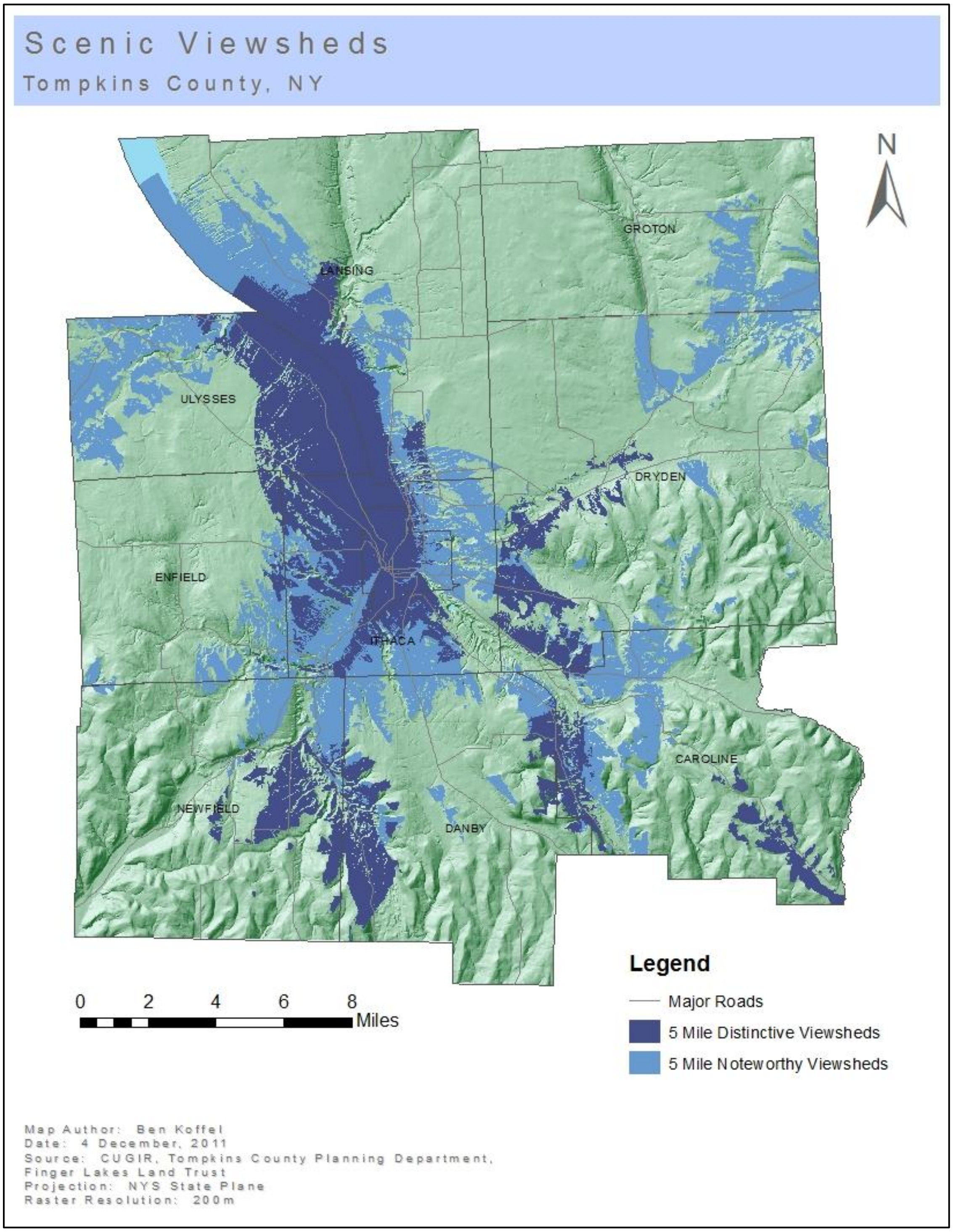

Figure 4: Scenic Viewsheds

Slope

Previous studies use a range of slopes from 10-20% as unacceptable for development. The Crill, Gillman et al study (2010) ranks slopes into five classes from 0-20%, with weighting favoring minimal slope. All other studies that operate on a constraint-only function assign a binary value for those cells that have an acceptable slope. NREL, in their estimates of regional wind power potential, excludes areas with a slope greater than 20%.[13] For this study, a value of 15% was chosen, as this is a generally accepted value above which development is difficult and can become costly.

Parameter: The table below shows the reclassification scheme for slope.

Table 4: Slope Reclassification

Slope	Classification
0-4.99%	4
5-9.99%	3
10-14.99%	2
>15%	1

Proximity to Transmission Line

For a large-scale wind project to sell electricity it must connect to a high voltage transmission line, which can be a large portion of the overall project cost. Therefore it is advantageous to locate close to a high voltage transmission line. All prior studies surveyed used a distance of 10km from a transmission line as the maximum allowable distance for a project.

[13] NREL. http://www.nrel.gov/gis/data_wind.html (2012). Retrieved January 2012.

Parameter: The table below shows the reclassification of transmission line proximity.

Table 5: Transmission Line Proximity

Proximity	Classification
0-2 miles	4
2.1-4 miles	3
4.1-6 miles	2
>6.1 miles	1

Airport Approach

Pursuant to Part 77 of the Federal Aviation Regulations a developer must notify the FAA and obtain permission for any of the following construction activities:[14]

- Any construction or alteration exceeding 200ft. above ground level:
  - Within 20,000ft of a public use or military airport which exceeds a 100:1 (100 feet of horizontal distance for each vertical foot) surface from any point on the runway of each airport with at least one runway more than 3,200 ft.
  - Within 10,000ft of a public use or military airport which exceeds a 50:1 (50 feet of horizontal distance for each vertical foot) surface from any point on the runway of each airport with its longest runway no more than 3,200 ft.

[14] Aviation and Airport Development Law Blog. "Wind Farms Run Into Turbulence with the FAA." http://www.aviationairportdevelopmentlaw.com/2010/01/articles/faa-1/regulatory/wind-farms-run-into-turbulence-with-the-faa/ (25 January, 2010). Retrieved January, 2012.

The runway at the Ithaca-Tompkins County Airport is longer than 3,200ft, and thus a notification would need to be filed with the FAA for any construction within four miles of the airport.

The airport runway approach and clear zone have been included in this analysis, however, many potential developments in the County would still need approval from the FAA.

Parameter: All cells falling inside the Ithaca Airport runway approach zone receive a value of 0, all other cells will receive a value of 1.

Emergency Communication

The Tompkins County Public Safety Communication System is the radio system used by police and medical personal for emergency communications. The system consists of a series of towers and building-mounted radio equipment. The lines of site between towers are important, and large obstructions can interfere with communication.

Most radio and microwave signals travel in a straight line between the sender and the receiver. However, some signals will not travel in a straight line, and if obstructed in their travel from the transmitter to the receiver they will arrive out of synch with the signals that traveled in a straight line, causing interference. Any tall structure may amplify these distortions and lead to suboptimal radio and microwave communication.

The concept of a Fresnel zone helps to explain and predict possible obstruction caused by tall objects such as wind turbines.[15] The first Fresnel zone is the radius around a point (either a transmitter or a receiver) in which obstructions may be likely to cause a problem.

[15] "Wireless – Fresnal Zones and Their Effect." http://www.zytrax.com/tech/wireless/fresnel.htm

It represents a radius of one-half wavelength from the straight-line path between two antennae. The radius of the first Fresnel zone can be calculated as follows[16]:

Fresnel Zones

$$F \qquad \sqrt{\frac{n\lambda d_1 d_2 \; n}{d_{1n} \quad d_{2n}}}$$

In which:

Fn = The radius of Fresnel zone n

N= The Fresnel zone

d_1 = Distance from antenna one (transmitter) to the point of obstruction

d_2 = Distance from antenna two (receiver) to the point of obstruction

λ = Frequency wavelength in gigahertz

[16] Lehpamer, Harvey. "Coexistence of Terrestrial Microwave Point-to-Point Links and Wind Turbines." Microwave Journal, suppl. Barcelona Mobile World Congress. (November, 2011). 14, 16-17.

This equation can be simplified to:

$$rn \quad 8.657\sqrt{\frac{Dn}{fn}}$$

In which:

r = radius of first fresnel zone in meters

D = distance between two towers

f = frequency of transmission

As a general rule, when siting large structures between radio communication towers at least 60% of the first fresnel zone must be clear of obstructions in order to minimize out-of-phase signals.[17]

Radio communication lines of site run through potential large-scale wind sites in Tompkins County. However, the size and location of the first fresnel zones was not included in this analysis due to the site-specific nature of potential obstructions. Depending on the size of the turbine and the specific location of a turbine on a site, radio interference may either be negligible or significant. Many site-specific factors may be at play that would effect the ability of the site to host a development. As this analysis is conducted at a site selection level and not the turbine location level, considerations for the fresnel zones and potential interference were not included in the model.

[17] Lehpamer, Harvey. "Coexistence of Terrestrial Microwave Point-to-Point Links and Wind Turbines." Microwave Journal, suppl. Barcelona Mobile World Congress. (November, 2011). 14, 16-17.

The location of the lines of sight between towers are included in the maps presented here, and are worthy of consideration after a particular site has been selected for development in order to determine the proper turbine siting.

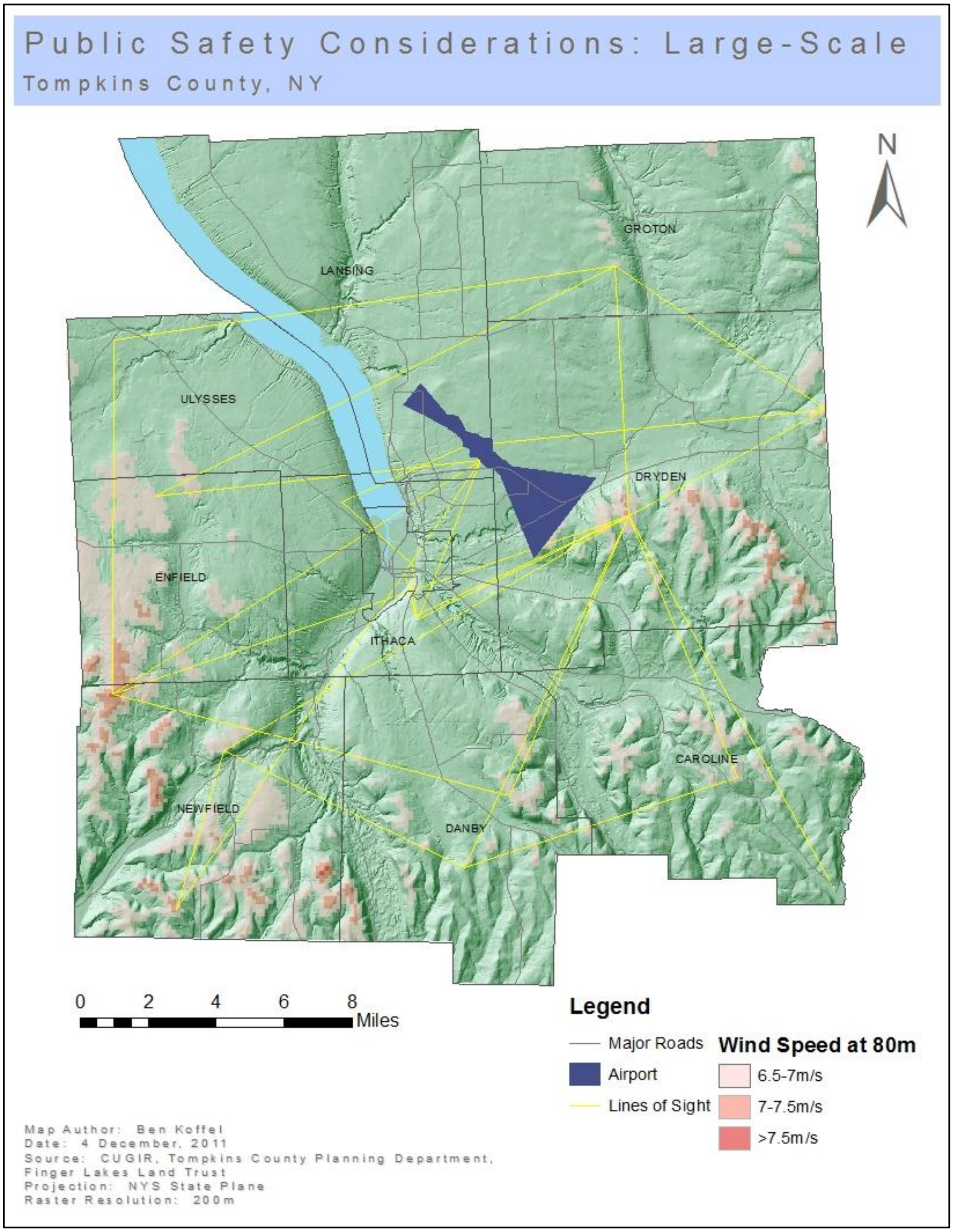

Figure 5: Public Safety Considerations

Model Weighting

All four factors with a range of variables are weighted equally in the weighted analysis. Wind speed receives priority, though, because it's scale ranges from 1-7, as opposed to 1-4 for the other variables.

Parameter: The table below shows the model weighting for the analysis

Table 6: Model Weighting

Parameter	Weight
Wind Speed	25%
Proximity to Transmission Line	25%
Slope	25%
Land Use	25%

Application: ArcGIS 10 was used for this analysis. All features layers were converted to raster data sets with a cell size of 200m; the cell size of the raster layer for the AWS Truewind data. All of the prohibited areas were combined into one layer, and then assigned a value of "0" for a dummy variable. These cells were then erased from the municipality layer, and then through the use of the raster calculator, these cells were extracted from the final analysis to ensure that all the prohibited areas were taken out of the analysis. Model Builder was used to construct the suitability model for the analysis. A graphical description of this model appears in the Appendix.

After the appropriate weighting was applied to the model, a conditional analysis was used to select out only those sites that were in the top two categories; those that were ranked either a "4" or "5" by the weighted analysis.

The constraint of parcel size could not be factored into the model at the beginning. Therefore, the suitable sites layer was joined with the layer for the appropriate parcel sizes, selecting only those parcels that contain at least 50% suitable land.

Figure 6 shows the most suitable sites for large-scale wind development.

Figure 7 shows these sites joined to their respective parcels.

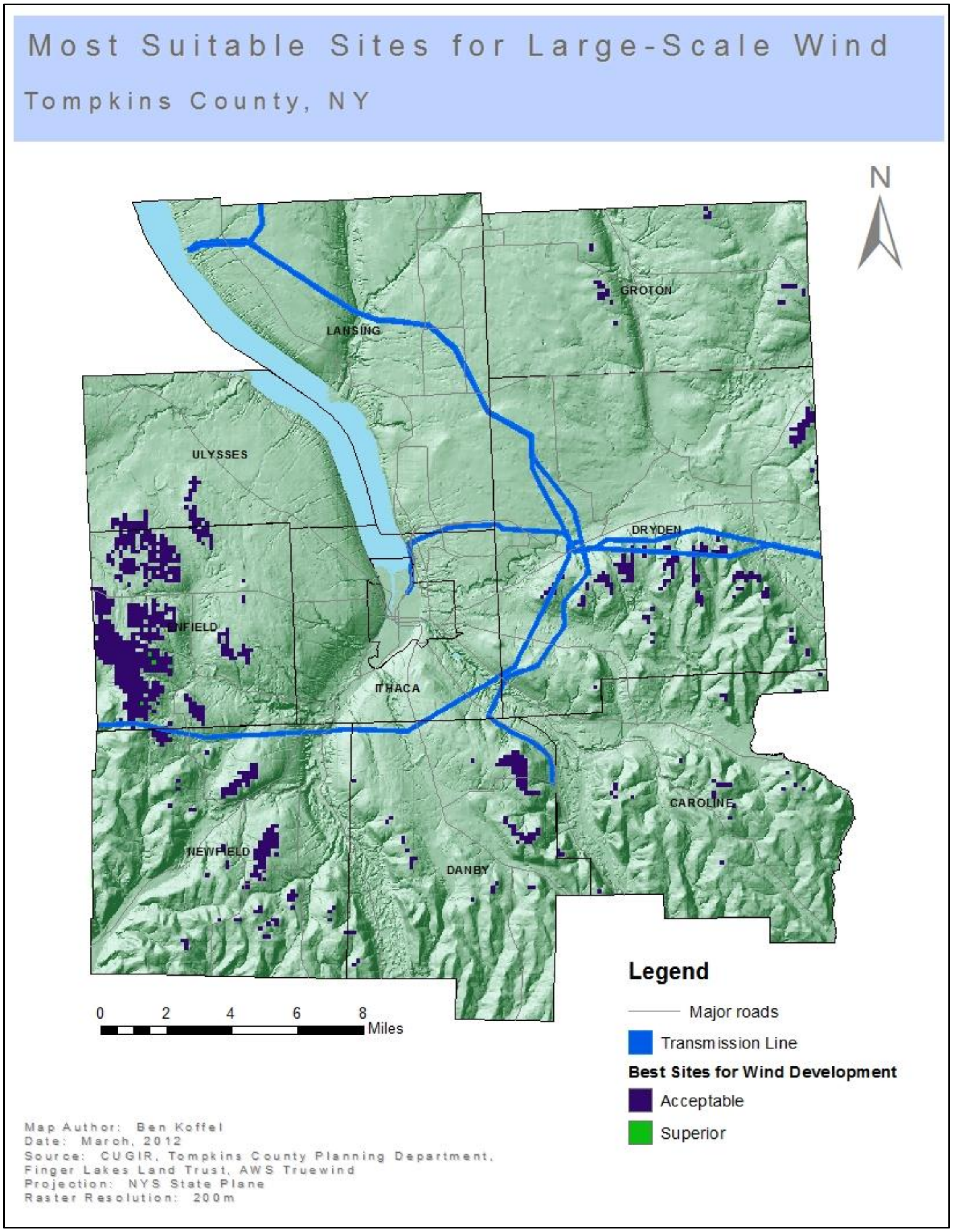

Figure 6: Most Suitable Sites for Large-Scale Wind

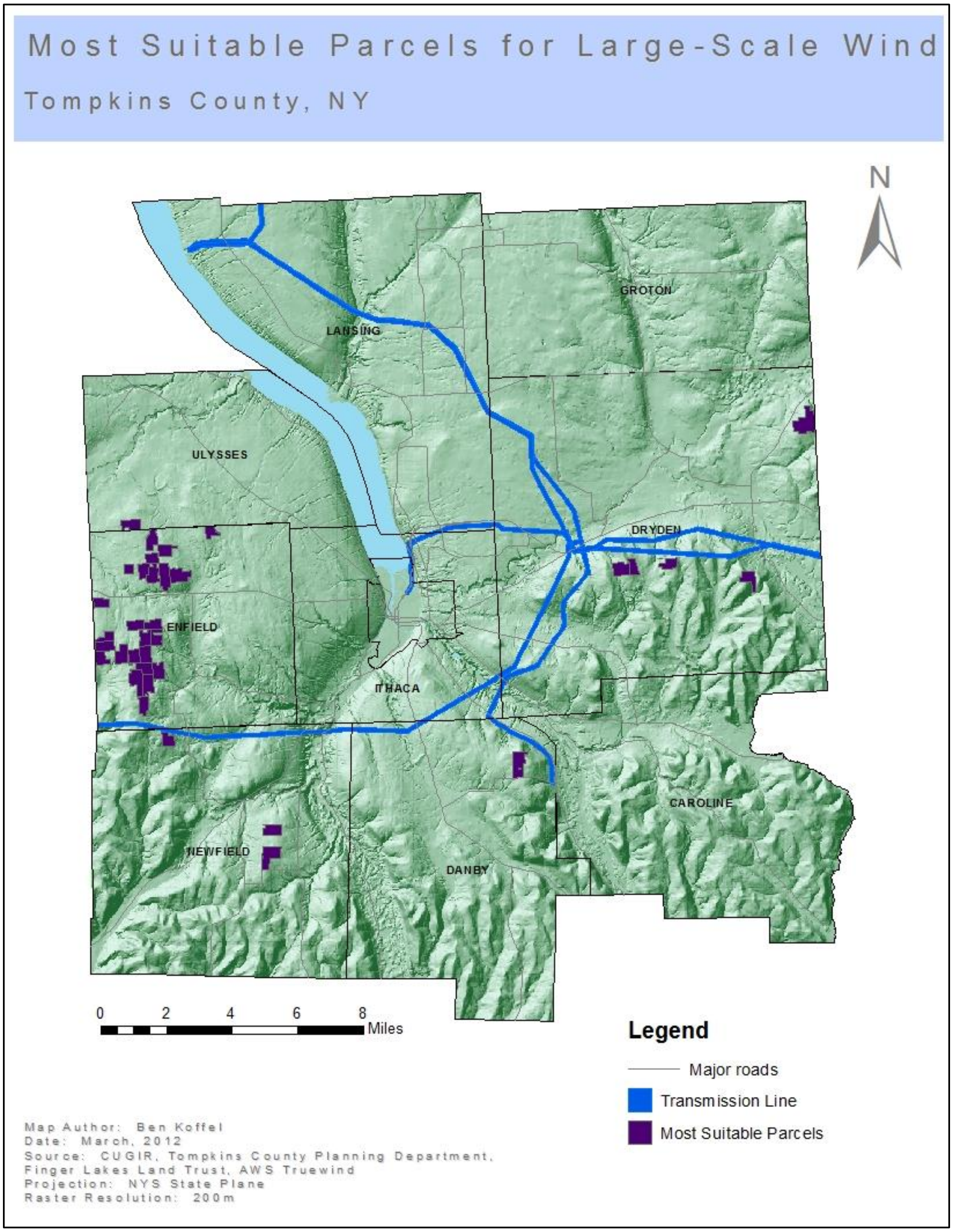

Figure 7: Most Suitable Sites, Represented as Parcels

Energy Production

With the knowledge of which sites are most suitable, an estimate of the amount of electricity to be produced by a turbine can be made.

The expected energy output from a single turbine is a function of four parameters, represented in the equation below.[18]

Energy Production

$$Pn \quad \frac{1n}{2n} * Cp * \; \rho * A * v^{3n}$$

In which:

P_r = Power in watts,

Cp = The power coefficient of the turbine. This represents the efficiency of the mechanical components of the turbine. Modern turbines generally have a power coefficient of .42-.5.[19]

ρ = The air density, measured in kg/m^3. For this analysis, the standard atmospheric air density of 1.25 kg/m^3 is used.[20]

A = The area of the turbine blade sweep, measured in m^2

V^3 = The wind speed cubed, measured in meters per second

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[18] Professor Sidney Leibovich, Cornell University. Personal correspondence, January 2012.
[19] Ibid.
[20] Ibid.

Turbine Selection

For the purpose of this analysis several turbine models were assessed, a list of which can be found in the appendix. For this analysis, the Vestas V100 1.8MW turbine is used as the model turbine for the energy calculations. The Vestas V100 is designed to operate in low wind conditions with a lower cut-in speed than many other turbines of comparable size, and its blade sweep area is also larger than many comparable turbines. This translates to more power produced from the low wind speeds prevalent in the County. Table 7 shows the technical information for the Vestas V100 1.8MW.

Table 7: Technical Information for Vestas V100 1.8MW Turbine[21]

Turbine	Hub Height	Rotor Diameter	Sweep Area	Cut-in speed	Rated speed	Cut-out speed
Vestas V100 1.8MW	80m	100m	7,850m^2	3.0m/s	12m/s	20m/s

Wind turbines do not produce the same amount of power continuously throughout the year, as their power output depends on the wind speed at a given moment in time. Therefore, the annual power output of a wind turbine is a function of the capacity factor of the wind turbine, which, in turn is a function of the average wind speed and its variation. A wind turbine begins to generate electricity at a cut-in speed. Below this wind speed, the turbine will not produce any electricity. Once the cut-in speed is achieved, the wind turbine continues to generate more electricity as the wind speed increases until it reaches its rated speed. Once it reaches the rated speed, it generates the same amount of electricity regardless of increases in wind speed, until it reaches its cut-out speed. The cut-out speed

[21] Vestas. http://nozebra.ipapercms.dk/Vestas/Communication/Productbrochure/2MWMk7/ (2011)

is the speed at which the turbine stops rotating in order to prevent damage, breakage, or other accidents. Figure 8 below outlines this concept.

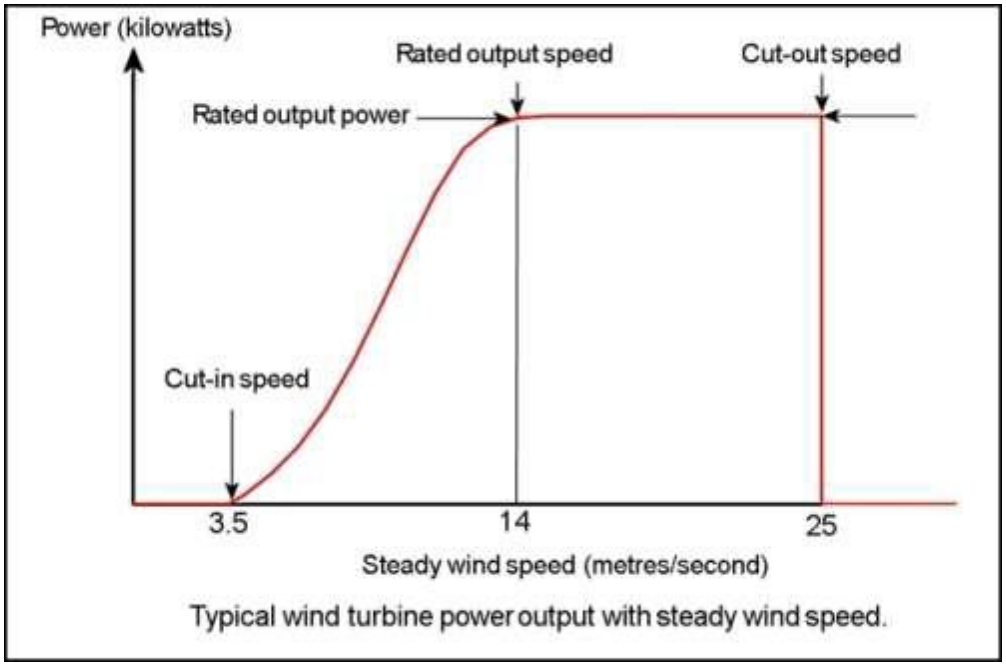

Figure 8: Relationship of Wind Speed to Power Output

Source: NYSERDA. Wind Energy Toolkit. (2009). Retrieved from http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. 12.[22]

When the cut-in speed, rated speed, and cut-out speed for a site are known, the power curve can be interpreted to produce a capacity factor for the turbine using a Weibull probability distribution, which predicts the amount of time that the wind will be blowing at a given speed. The Weibull Distribution relies on two parameters, *k*, a shape parameter, and *c*, a scale parameter. Both of these values can be found using the mean wind speed and standard deviation. The formulas for determining *k* and *c* are presented in the following equations.[23] [24]

[22] NYSERDA. Wind Energy Toolkit. (2009). Retrieved from http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. 12.
[23] Professor Sidney Leibovich, Cornell University. Personal correspondence, January 2012.

K Parameter

$$kn \left(\frac{\sigma_{U}n}{\overline{U}n}\right)n^{1.086}$$

In which:

U = Mean wind speed

σ_U = Standard deviation of wind speed

The AWS Truewind data only provides the estimated annual mean wind speed for the entire year, and not the standard deviation. Therefore, standard deviation was estimated based on existing meteorological data from existing locations in Tompkins County. Two sources of data were used to estimate the standard deviation, the Ithaca Airport and the meteorological tower at Ithaca College. At the airport, between December 1st, 2010, and December 21st, 2011, at an elevation of 10m the mean wind speed at the airport was 3.3m/s, with a standard deviation of 2.42m/s, or 72%.[25] At the Ithaca College meteorological tower, between August 2008 and March 2009, the average wind speed at 50m was 5.01m/s, with a standard deviation of 2.23m/s., or 45%.[26] The College extrapolated these results to a height of 80m to assess the feasibility of erecting a turbine, and estimated the mean wind speed was estimated to be 6.14m/s, with a standard deviation of 2.69m/s, or 43%.

[24] Note: The calculations of *k* and *c* values were completed by Prof. Leibovich, based on these formulae, and were completed using values provided by the GIS analysis.
[25] Northeast Regional Climate Center. Personal Correspondence, December, 2011.
[26] "Ithaca College Wind Power Project." (2009). Retrieved from http://faculty.ithaca.edu/bclark/icwindpowerproject/

Given the relevant data at a comparable elevation at Ithaca College, this analysis uses a standard deviation of 43%.

C Parameter

$$cn \quad \frac{\cup n}{\Gamma n 1 n \ \frac{1n}{k})n}$$

In which:

K = The k value from the previous equation

Γ = The gamma function, a generalization of the factorial

Once the *k* and *c* values are known, the distribution of power over time and the capacity factor of the turbine can be estimated using a Weibull Distribution.

Weibull Distribution

$$CFn \quad \frac{e\left\{-\left(\frac{u \quad ut}{n \quad cn}\right)\right\} - en\left\{-\left(\frac{u}{cn}\right)\right\}n}{\frac{u}{c}) \quad -n\frac{u_{cut}}{cn})} - e\{-n\frac{u \quad ut \quad ou}{c})$$

In which:

e = The mathematical constant, approximately 2.718

$u_{cut\text{-}in}$= The cut-in speed for the turbine, 3.0m/s

u_r = The rated speed for the turbine, 12.0m/s

$u_{cut\text{-}out}$ = The cut-out speed for the turbine, 20.0m/s

A Weibull distribution forms the capacity factor for the turbine. This capacity factor can be combined with the P_r, the instantaneous power output, to calculate the estimated electrical output of a turbine over the course of a year. The equation below demonstrates this relationship.

Annual Electricity Output (Watts)

$$En \quad CF * Pn \; 8760 \text{ hours})n$$

In which:

E = Energy produced per year, in Watts

CF = The capacity factor of the turbine

P_r = The instantaneous power output of the turbine

Lastly, an estimate was made as to the number of turbines that could be placed on a site. Turbine spacing on an individual wind farm is heavily dependent on the local conditions, land available, the site topography, and the direction of the wind. Figure 9 shows the wind rose for the Ithaca airport.

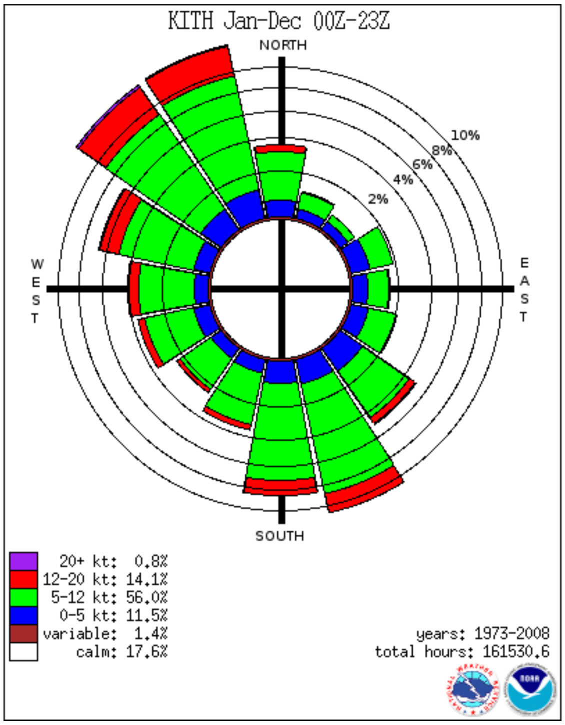

Figure 9: Ithaca Airport Wind Rose

Source: National Weather Service Forecast Office, Binghamton, NY. http://www.erh.noaa.gov/bgm/aviation/windroses/windrose.shtml

As the wind rose demonstrates, the wind in the County is not unidirectional but rather omnidirectional. It blows from primarily the northwest and the southeast. In an omnidirectional environment, turbines are generally placed 5-7 rotor diameters apart from each other.[27] In other environments, they may be placed more closely together. It is difficult to fully model the turbine spacing on a given site without having specific information about the available land, on-site wind conditions, and the turbine manufacturer's suitability study of the site to determine the effects of wind conditions and

[27] NYSERDA. Wind Energy Toolkit. (2009). Retrieved from http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. 92.

turbine wake on a turbine.[28] According to the NYSERDA guidelines, the Vestas V100 would require 500m-700m of space between each turbine.

To account for this parameter, each turbine would need to be 500m away from another turbine. This implies a buffer of approximately 60 acres, which is, in fact, much larger than the parcel setback buffer. This analysis uses a value of 50 acres per turbine, in order to include reasonable expectation of turbine siting given the wind conditions, and also to allow for variability and unknowns of site conditions. In reality, if a developer were to find a suitable site for development, the individual turbine choices and siting considerations would be made so as to maximize the number of turbines on the site.

For each parcel with a suitable area for wind development in one of the site groupings, this analysis divides the acreage by 50 to estimate the number of turbines the site could host.

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[28] Ibid

Results

There are three potential sites that may be suitably attractive to the developer of a large-scale wind energy project in Tompkins County. The three sites are outlined in the maps and tables below.

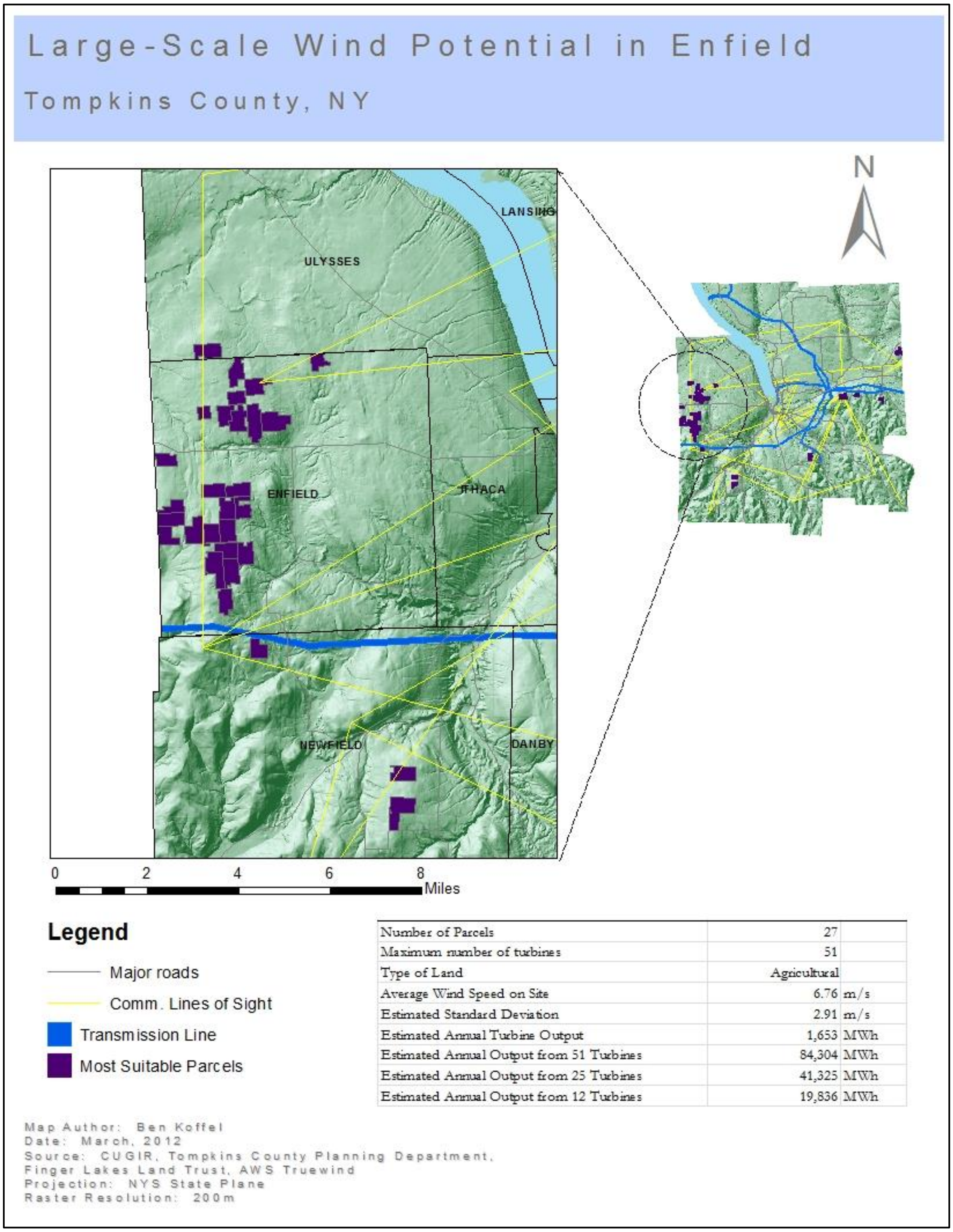
Enfield

The Enfield site encompasses 27 parcels and is estimated to be able to host up to 51 turbines. Its average wind speed is estimated to be 6.76m/s at 80m, with a standard deviation of 2.91m/s.

The southern portion of this site is currently under development by Black Oak Wind.

Table 8: Enfield Site Information

Enfield Site Information		
Number of Parcels	27	
Maximum number of turbines	51	
Type of Land	Agricultural	
Average Wind Speed on Site	6.76	m/s
Estimated Standard Deviation (43% model)	2.91	m/s
Estimated Turbine Output	1,653	MWh
Estimated Annual Output from 51 turbines	84,304	MWh
Estimated Annual Output from 25 turbines	41,325	MWh
Estimated Annual Output from 12 turbines	19,836	MWh
k parameter	2.46	
c parameter	7.52	
Cut in speed	3	m/s
Rated Speed	12	m/s
Cut out speed	20	m/s
Rotor sweep area	7,850	m^3
Capacity Factor based on Weibull Distribution	0.281	



Number of Parcels	27	
Maximum number of turbines	51	
Type of Land	Agricultural	
Average Wind Speed on Site	6.76	m/s
Estimated Standard Deviation	2.91	m/s
Estimated Annual Turbine Output	1,653	MWh
Estimated Annual Output from 51 Turbines	84,304	MWh
Estimated Annual Output from 25 Turbines	41,325	MWh
Estimated Annual Output from 12 Turbines	19,836	MWh

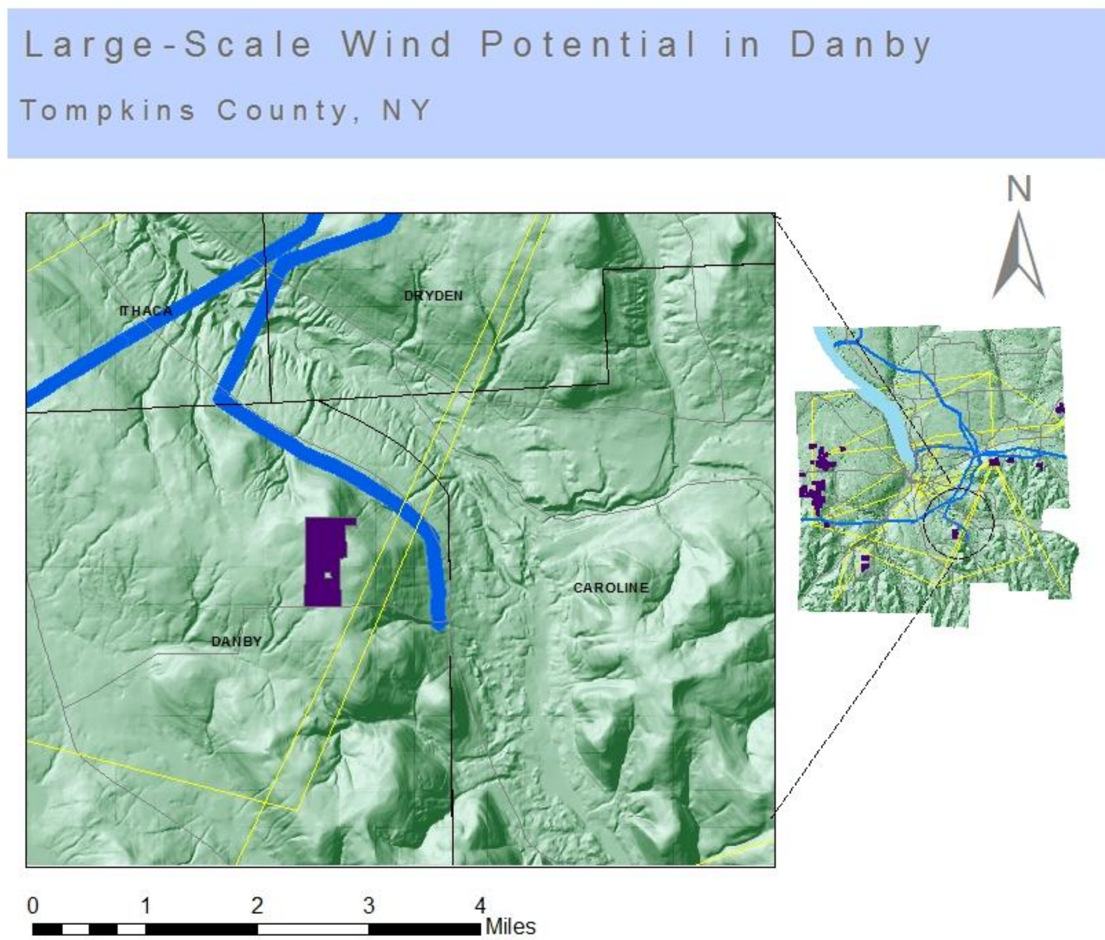
Figure 10: Enfield

Danby

The Danby site is located near Route 79. Located on one parcel, it is estimated to be able to host three turbines. Its average wind speed is estimated to be 6.64m/s, with a standard deviation of 2.86m/s. Presently, no commercial development of this site is in progress.

Table 9: Danby Site Information

Danby Site Information		
Number of Parcels	1	
Estimated number of turbines	3	
Type of Land	Vacant, Agricultural	
Average Wind Speed on Site	6.64	m/s
Estimated Standard Deviation	2.86	m/s
Estimated Annual Turbine Output	1,531	MWh
Estimated Output from 3 Turbines	4,593	MWh
k parameter	2.49	
c parameter	7.48	
Cut in speed	3	m/s
Rated Speed	12	m/s
Cut out speed	20	m/s
Rotor sweep area	7,850	m^3
Capacity Factor based on Weibull Distribution	0.275	



Legend

Major roads

Comm. Lines of Sight

Transmission Line

Most Suitable Parcels

Number of Parcels	1	
Estimated number of turbines	3	
Type of Land	Vacant, Agricultural	
Average Wind Speed on Site	6.64	m/s
Estimated Standard Deviation	2.86	m/s
Estimated Annual Turbine Output	1,531	MWh
Estimated Output from 3 Turbines	4,593	MWh

Map Author: Ben Koffel
Date: March, 2012
Source: CUGIR, Tompkins County Planning Department, Finger Lakes Land Trust, AWS Truewind
Projection: NYS State Plane
Raster Resolution: 200m

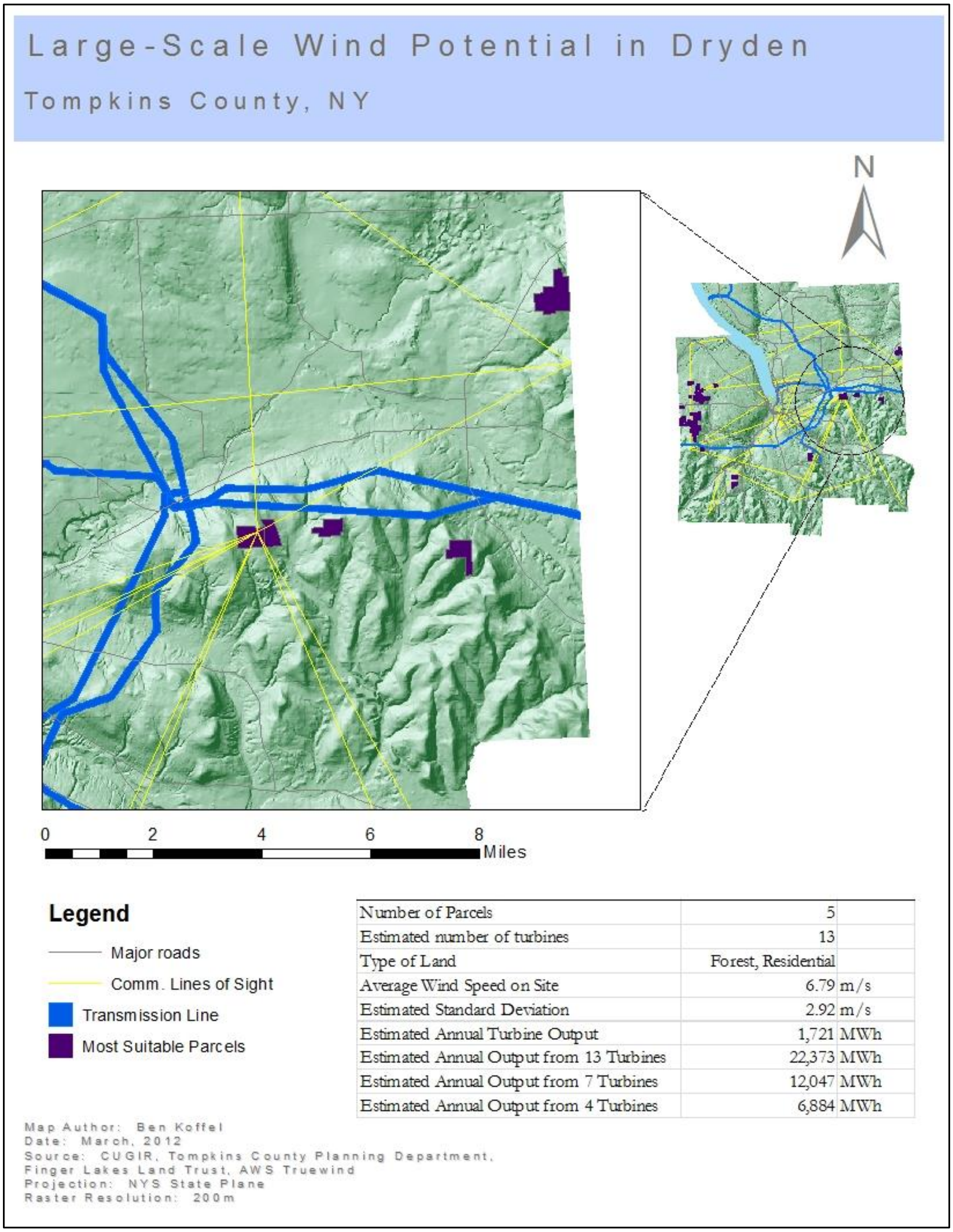
Figure 11: Danby

Dryden

The Dryden site is located near Mt. Pleasant. It is spread out across 5 parcels and is estimated to be able to host 13 turbines. The average wind speed is estimated to be 6.79m/s, with a standard deviation of 2.9m/s. In 2005, Cornell University conducted a pre-feasibility study for wind development on this site, but decided not to pursue the project.

Table 10: Dryden Site Information

Dryden Site Information		
Number of Parcels	5	
Estimated number of turbines	13	
Type of Land	Forest, Residential	
Average Wind Speed on Site	6.79	m/s
Estimated Standard Deviation	2.92	m/s
Estimated Annual Turbine Output	1,721	MWh
Estimated Annual Output from 13 Turbines	22,373	MWh
Estimated Annual Output from 7 Turbines	12,047	MWh
Estimated Annual Output from 4 Turbines	6,884	MWh
k parameter	2.5	
c parameter	7.65	
Cut in speed	3	m/s
Rated Speed	12	m/s
Cut out speed	20	m/s
Rotor sweep area	7,850	m^3
Capacity Factor based on Weibull Distribution	0.289	



Number of Parcels	5	
Estimated number of turbines	13	
Type of Land	Forest, Residential	
Average Wind Speed on Site	6.79	m/s
Estimated Standard Deviation	2.92	m/s
Estimated Annual Turbine Output	1,721	MWh
Estimated Annual Output from 13 Turbines	22,373	MWh
Estimated Annual Output from 7 Turbines	12,047	MWh
Estimated Annual Output from 4 Turbines	6,884	MWh

Figure 12: Dryden

Discussion and Recommendations

The spatial analysis reveals three potential sites for large-scale wind development, with a technical potential of up to 120MW of installed capacity, producing 111,250MWh/year. However, most of this potential will go unrealized due to regulatory and financial constraints. A realistic assessment of the potential for large-scale wind power in Tompkins County is approximately 40MW of installed capacity, for an annual production of roughly 36,000MWh/year. The three sites are reviewed below, along with the revised assessment of the potential for large-scale wind.

Enfield

The site in Enfield is currently under development and is slated to come online in 2013 (the site is discussed in greater detail in Part Three of this report). Black Oak Wind, LLC, is in the permitting phase of developing a 30-35MW project on Connecticut Hill, directly in the path of the electrical transmission line. Although the land north of Connecticut Hill shows potential to host an additional 50-60MW of installed capacity, these parcels are further away from the transmission line and the interconnection costs would be significantly higher. The Black Oak Project will likely be constructed in the coming years, however as of now there are no additional plans for developing Enfield's wind resource. For the time being, Black Oak's estimate of 30-35MW installed capacity is a reasonable estimate of generation potential in Enfield.

Dryden

The Dryden site shows potential for 23MW installed capacity, but no projects will be developed for the foreseeable future due to the Dryden Renewable Energy Facilities Local

Law.[29] Passed in 2006, the law puts a cap of 10kW installed capacity on any wind turbine within Dryden, eliminating the potential for large-scale projects. Although the suitability analysis shows potential for up to 13 turbines on five parcels, the five parcels are not adjacent to each other. Six-to-seven turbines spread out across three parcels is a more reasonable estimate, with 11MW installed capacity a better assessment of Dryden's potential, were development to be permitted.

Danby

The site in Danby enjoys high wind speeds and an optimal location in the path of a transmission line. Due to the site's small size it may not be attractive to a traditional wind developer, but it could still be a strong location for a new district energy system, community-owned project, or as the location of a future use with large enough on-site demand to make the economics of self-power attractive. With approximately 5MW installed capacity, the site shows potential for specialized applications not related to wholesale electricity sales.

County Expectations

Given these considerations, a revised expectation of large-scale wind energy can be prepared. In the short term, the potential installed capacity in the County, between Enfield and Danby, is 30-40MW, which could be increased to 51MW if large-scale wind development were permitted in Dryden. In the future, if more projects in Enfield were to come online, this would likely increase to 70-80MW. A reasonable near-term expectation of wind power potential is approximately 40MW of installed capacity between Enfield and

[29] Town of Dryden, New York. "Renewable Energy Facilities Law of the Town of Dryden, New York." 2006. http://dryden.ny.us/Local_Law_Postings/lle2006.pdf

Danby. With the expected annual outputs of turbines at both of these sites, this equates to approximately 36,000 MWH/year.[30]

In relative terms, the average housing unit in Tompkins County uses 7.405 MWh/year.[31] With this figure, large-scale wind has the potential to meet the annual electrical consumption of approximately 4,900 households per year, or 13% of the county.[32]

However, in assessing the installed capacity of the projects in Tompkins County against other projects in New York, the number of houses served may be larger. A survey of three wind farms in New York — Maple Ridge, First Wind Cohocton, and Fenner Wind Farm — shows the relationship between their installed capacity and the number of households they claim to serve. These data are displayed in Table 11.

Table 11: Installed Capacity and Number of Homes Served

Wind Farm	Installed Capacity (MW)	Homes served	MW/Homes
First Wind Cohocton[33]	125	50,000	.0025
Maple Ridge[34]	231	64,000	.0036
Fenner Wind Farm[35]	30	7,800	.0038

From these three projects, the average ratio of installed capacity to homes served is .0033. When this ratio is applied to the potential installations in Tompkins County, the number of households served increases to approximately 12,100, or 31% of the County.

30 (Expected turbine output for Danby * 3 turbines) + (Anticipated 35MW capacity for Enfield/1.8MW per turbine * expected turbine output for Enfield)
31 Tompkins County Planning Department, personal correspondence, February 2012. Value based on total electricity usage by the residential sector in 2008 (293,371MWh) divided by the number of households (39,616)
32 US Census Bureau. "Profile of General Population and Housing Characteristics: 2010. Tompkins County." http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_10_DP_DPDP1&prodType=table
33 First Wind Cohocton. http://www.cohoctonwind.com/cohocton/about.cfm
34 Maple Ridge Wind Farm. http://www.horizonwind.com/projects/whatwevedone/mapleridge/
35 Community Energy Inc. http://www.communityenergyinc.com/wind-farms/wind-farm-story-fenner/

These data may not be entirely reliable, however, as the wind farms do not display their methodology and largely present these data for public relations purposes. However, the numbers are based on operational data rather than projected values, and they likely incorporate seasonal variations in electrical use and production as well. Thus, their figures may more accurately reflect the realities of power generation in the state.

When taking the two estimates together, large-scale wind may be able to provide electrical power for 5,000 to 12,000 households, representing between 13% and 31% of the county. Taking the median value, for decision-making purposes the county can reasonably expect that large-scale wind could power approximately one-fifth of county households.

The greatest role the County Planning Department can play in realizing this potential is to assist municipalities in writing appropriate zoning code and creating efficient permitting processes. Part Two will discuss strategies for supporting local governments in this task.

Small-Scale Wind Turbine Siting

Background

Small-scale wind is an option for individual landowners interested in generating their own power, offsetting their carbon footprint, or taking their property off the grid. Additionally, small turbines are often eligible for net metering, in which electricity that they produce beyond what is consumed onsite may be sold or distributed to other parties.

The goal of the GIS analysis for small-scale wind is to identify which parcels are of suitable size, in a suitable location, and with suitable conditions to host a small wind turbine. Therefore, sites are not ranked or selected as the most suitable, but rather suitable parcels are classified based on their wind speed in order to quantify total generation potential in the county.

Local Definition and Siting Considerations

Within Tompkins County, the Town of Ithaca is most robust in its zoning code regarding small-wind turbines.

The Code of the Town of Ithaca state:

"Small wind energy facilities are permitted in all zoning districts in the Town as accessory structures providing power primarily to structures on the same lot, and as principal structures providing power primarily to structures on an adjacent lot, with any excess power net-metered to the public utility system if the facility is grid-connected…"[36]

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[36] Town of Ithaca, New York. "Code of the Town of Ithaca, New York." § 270-219.4. Small wind energy facilities. http://www.town.ithaca.ny.us/local-laws-codes

Within the Town of Ithaca there are several requirements for siting small-scale wind facilities:[37]

1. Small-scale wind facilities may not be installed within 500ft of public parkland, natural area (an area designated as a Critical Environmental Area, a Unique Natural area, or other similar designation), nature preserve, or the high-water line of Cayuga Lake.
2. The facility may not exceed a total height of 145ft, as measured from the base of the facility to the highest point of any part of the equipment.
3. The fall zone of the facility shall be measured from the center of the base of the tower, and shall extend for the height of the facility plus ten feet. The entire fall zone must be on the owner's property, or the owner must obtain an easement from abutting property owners. The fall zone must not include any of the following:
    a. Public roads
    b. Overhead transmission lines
    c. Above-ground fuel storage and pumping facilities
    d. Human occupied buildings (unoccupied buildings must have a setback of 15 ft. from the center of the base of the tower)
4. The lowest point of any moving part of a ground-mounted facility must not extend below 30ft above the ground. For building-mounted systems, the lowest point of any moving part must be 15 feet above grade and above any human occupied structures, such as balconies or gardens.
5. The decibel level of devices operating between 0 and 25 mph must not exceed 55db(A), as measured at the abutting property line.
6. For lots of two acres or more, one wind energy tower is permitted as a matter of right, and owners may apply for a permit to construct an additional tower.
7. The setback for the wind facility must follow all applicable setback requirements for the zone it is in. However, the setback from a property line must be at least 50ft.

Other municipalities have similar setback provisions, with maximum heights ranging from 120 ft. to 145 ft., and setbacks ranging from 100 ft. from a property line to 1.5 times the total height of the turbine.

Note: More information and recommendations on local wind ordinances can be found in the NYSERDA Model Wind Ordinance on p. 115 in the Appendix, and the AWEA's recommendations for a model wind ordinance on p. 88 in Part Two.

[37] Town of Ithaca, New York. "Code of the Town of Ithaca, New York." § 270-219.4. Small wind energy facilities. http://www.town.ithaca.ny.us/local-laws-codes

Methodology and Operationalization of Variables

Required Setback and Parcel Size

Using the maximum allowable height of a turbine, a conservative estimate of minimum parcel size was created. Assuming that the property setback of 50ft can incorporate the fall zone setback of 10ft, and assuming a maximum turbine height of 145ft, the following setback requirements are true:

145ft (turbine height) + 40ft (property line setback) + 10ft (fall zone) = 195ft radius

This translates to an area of 119,459 ft^2, or 2.75 acres.

Based on turbine sizes and ratings, though, a 145ft tall turbine assembly is the maximum range of small-scale wind turbines. It is likely that a turbine of this height which have a rotor sufficiently large to generate 50-100kW when operating at peak performance. An average home, however, may not require this much electricity. A smaller turbine, with a capacity of 10kW-50kW, may have setback requirements as follows:

110ft (turbine height) + 40ft (property line setback) + 10ft (fall zone) = 160ft radius.

This translates to an area of 80,424ft^2, or 1.8 acres.

For this assessment, a value of 2 acres was used. This provides enough space for a turbine with a capacity between 1kW and 50kW, based on common hub heights and rotor diameters of turbines in this range. Individual turbine choice is a function of the site geometry, wind conditions, and the parcel owner's preferences and available financing. A value of 2 acres is a reasonable estimate of turbine fall zone for many home-scale models.

On small parcels, the inability to meet building setbacks may influence the size of a turbine, or the decision as to whether to erect a turbine or not. For this reason, inhabited structures were considered when selecting appropriate parcels.

Parameter: Only parcels with a 2-acre circle clear of human occupied structures and abutting parcels are suitable to host a small wind turbine.

Wind Speed

Small-scale wind turbines can generate electricity at lower wind speeds than large-scale wind turbines; many of the turbines surveyed during research have cut-in speeds of between 2.5m/s and 3.5m/s. AWS Truewind data is not available in aggregate form for elevations below 70m. Therefore, wind speed was converted from 80m to 30m. The actual hub height of a turbine on a particular site will vary, however 30m was chosen as the hub height because it falls within the range of turbines that a property owner may choose, and wind speed is higher at higher elevations. An individual interested in purchasing a turbine would likely want to place it in the windiest place possible.

This analysis uses the Wind Power Law Profile to convert the wind speed at 80m to the wind speed at 30m.[38] The equation below highlights this transition.

[38] Manwell, J.F., and J.G McGowan and A.L. Rogers. "Wind Energy Explained: Theory, Design, and Application." 2002: John Wiley and Sons, West Sussex, England. P. 44-45.

Power Profile Law

$$\frac{U_{1n}}{U_{2n}} \qquad \frac{Z_1}{Z_{2n}})^{\propto n}$$

In which:

U_1 = Wind speed at height 1, in m/s

U_2 = Wind speed at height 2, in m/s

Z_1 = Height 1, in m

Z_2 = Height 2, in m

α = Power law exponent, 1/7, or .143

The power law exponent is a parameter that helps to adjust for differing wind speeds at different elevations. Under normal conditions it is approximated to 1/7, or .143. It is possible to adjust the power law exponent given the surface roughness conditions of a piece of land, however the AWS Truewind model already incorporates the surface roughness of terrain into its calculations.

Investing in a small-wind turbine is an expensive undertaking for most property owners. By setting an appropriate wind speed threshold, the model provides a more realistic prediction of which parcels in the county may be likely to develop small-scale wind. A higher wind speed effectively lowers the cost of the project by generating more electricity over time.

NYSERDA suggests that a small-scale wind system may only be feasible if the minimum speed is 10mph, or approximately 4.4m/s. [39] However, Renovus Energy, a local installer of wind turbines, suggests a minimum average speed of 5.0m/s, with a recommended wind speed of at least 5.5m/s.[40] This analysis uses a cutoff wind speed of 5.25m/s.

Parameter: Only cells with a wind speed above 5.25m/s are selected for this analysis. The remaining cells are grouped by equal intervals into five categories of mean wind speed, and all cells falling within a given range are assigned a new value. Next, the standard deviations for each new value are calculated using the same methodology as the large-scale section. These cells are joined to the suitable parcels and aggregated based on mode, so that each suitable parcel is assigned one wind speed value. Table 12 shows the new classification scheme.

Table 12: Wind Speed Classifications for Small Wind

Mean Range	New Value	Standard Deviation
5.25-5.52m/s	5.30m/s	2.44
5.53-5.80m/s	5.60m/s	2.58
5.81-6.07m/s	5.90m/s	2.71
6.08-6.34m/s	6.20m/s	2.85
6.35-6.63n/s	6.50m/s	2.99

View

As there are no provisions in any of the municipal regulations on small wind turbines for scenic viewsheds, the model does not incorporate viewsheds as a parameter.

[39] NYSERDA. Wind Energy Toolkit. 2009. http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. P. 6.
[40] Renovus Energy. http://renovusenergy.com/wind.html. 2011.

Land Use

In contrast to utility-scale wind power, small-scale wind power can exist on many types of land use due to the smaller fall zone and the fact that it provides electricity for a specific building or function. Therefore, this analysis uses the property class designation of the parcels to evaluate land instead of the land use layer. The parcel designation is important because the possibilities for net metering differ between parcel types, as Table 13 demonstrates.

Table 13: Net-Metering Limits[41]

Property Type	Maximum Installed Capacity
Residential	25kW
Agricultural	500kW
Non-residential, non-agricultural	2,000kW

Parameter: The parcels are classified based on their associated land use, with suitable parcels limited to Agricultural, Residential, Commercial/Industrial, and Public parcels.

Protected Areas

Given the information in the Ithaca Small Wind Zoning Ordinance, the same protected areas constraint from the utility-scale analysis applies to the small-scale wind analysis. The following areas are protected from small-wind development.

[41] Database of State Incentives for Renewable Energy. "New York – Net-Metering." 2012. http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=NY05R&RE=1&EE=1

- Unique Natural Areas
- Public Open Space (including state parks)
- Cornell natural lands
- Critical Environmental Areas
- Important Bird Areas
- Airport approach and clear zone

It may be possible to develop a project given that most small wind structure will be less than 200 ft. in total height. However, the Mt. Pleasant project in Dryden received significant opposition from the recreational pilots association based out of the Tompkins County airport. This experience suggests that any development near the airport may be difficult. Therefore, the airport clear zone and approach were included as protected areas.

Parameter: The protected areas are removed from consideration.

Slope

The same slope considerations from the large-scale study apply to this study; development on areas with a slope greater than 15% is prohibited.

Parameter: All areas with a slope greater than 15% were removed from the analysis.

Results

The following maps highlight suitable parcels for small-scale wind and their associated average estimated wind speeds.

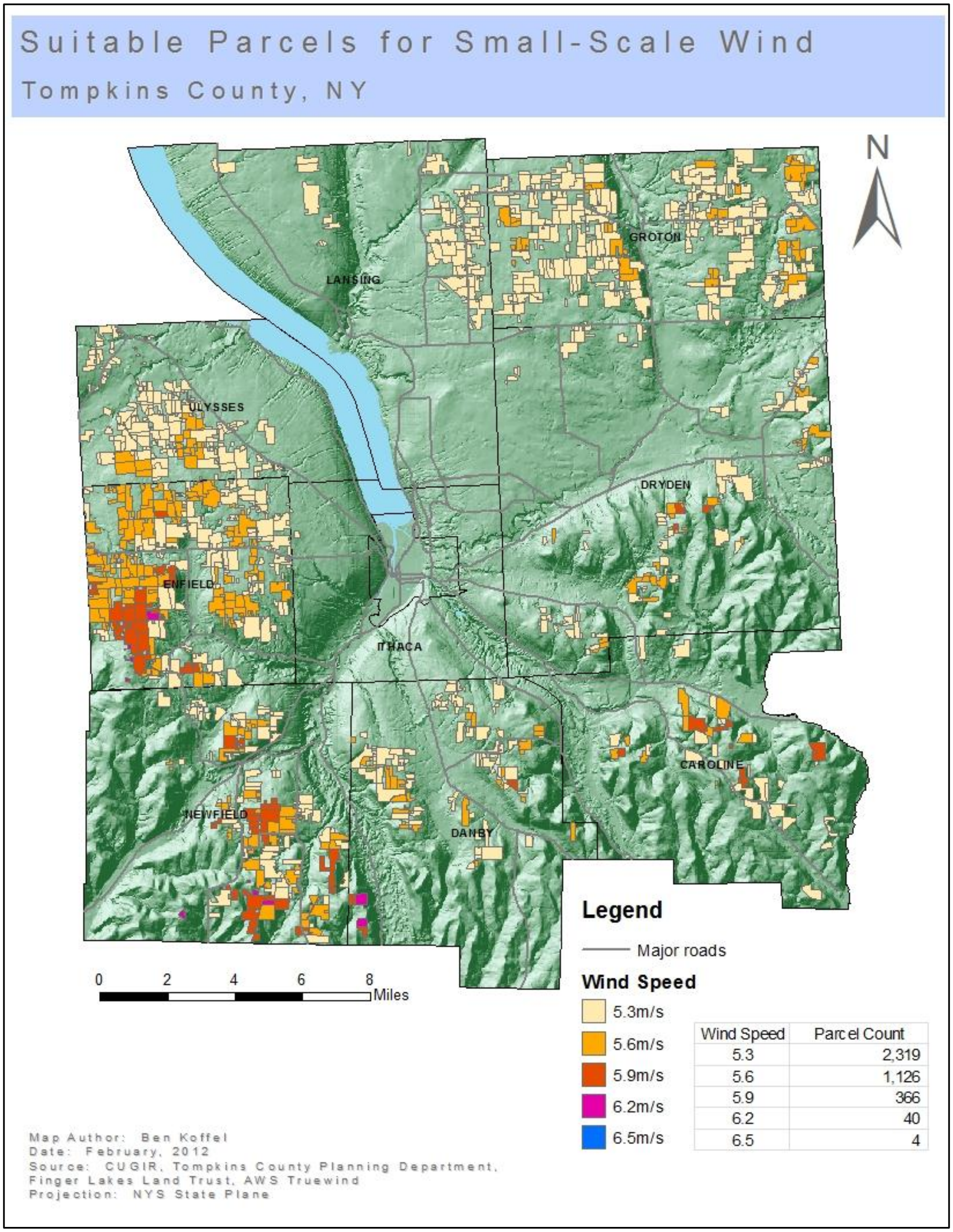

Figure 13: Suitable Parcels for Small-Scale Wind

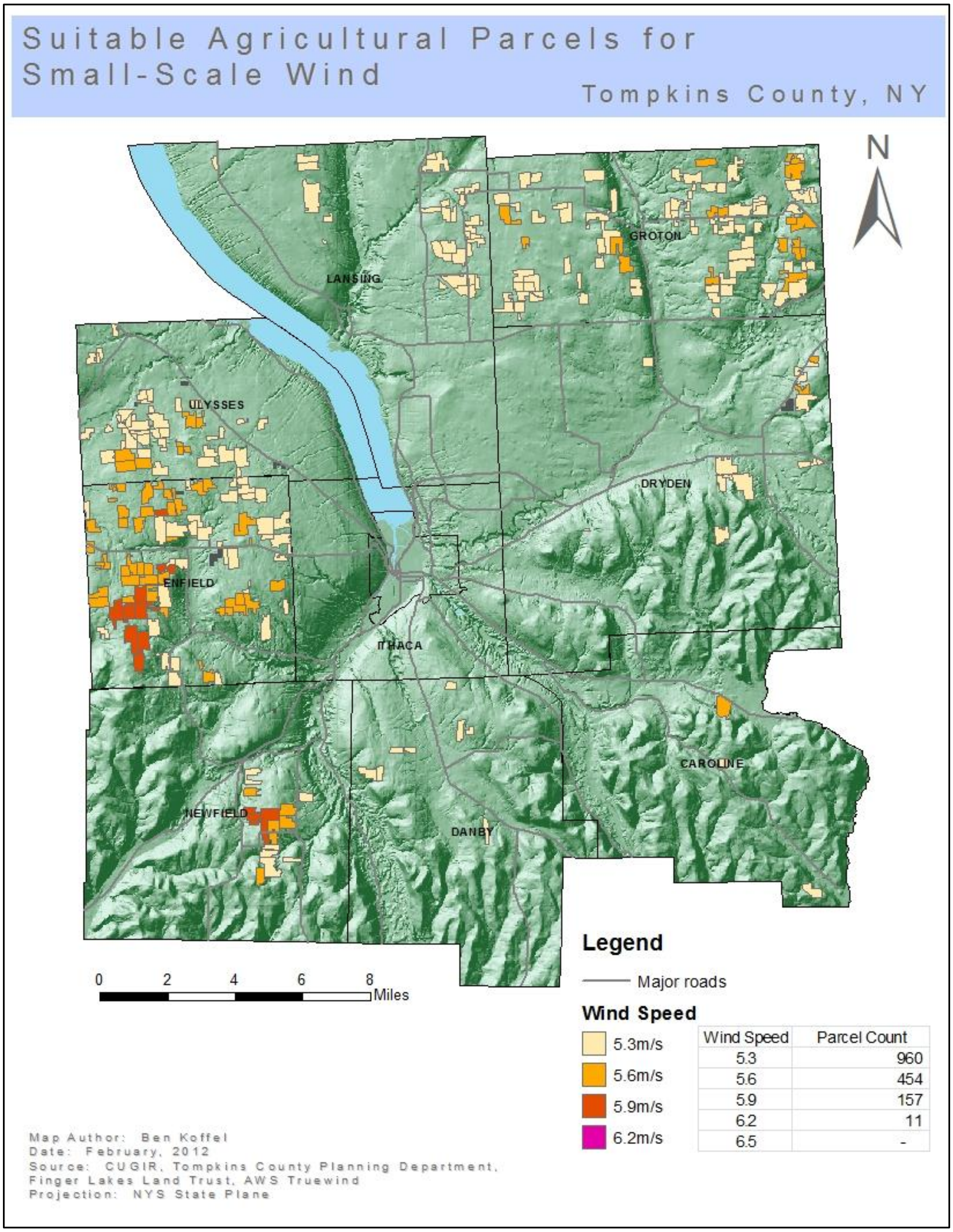

Figure 14: Suitable Agricultural Parcels for Small-Scale Wind

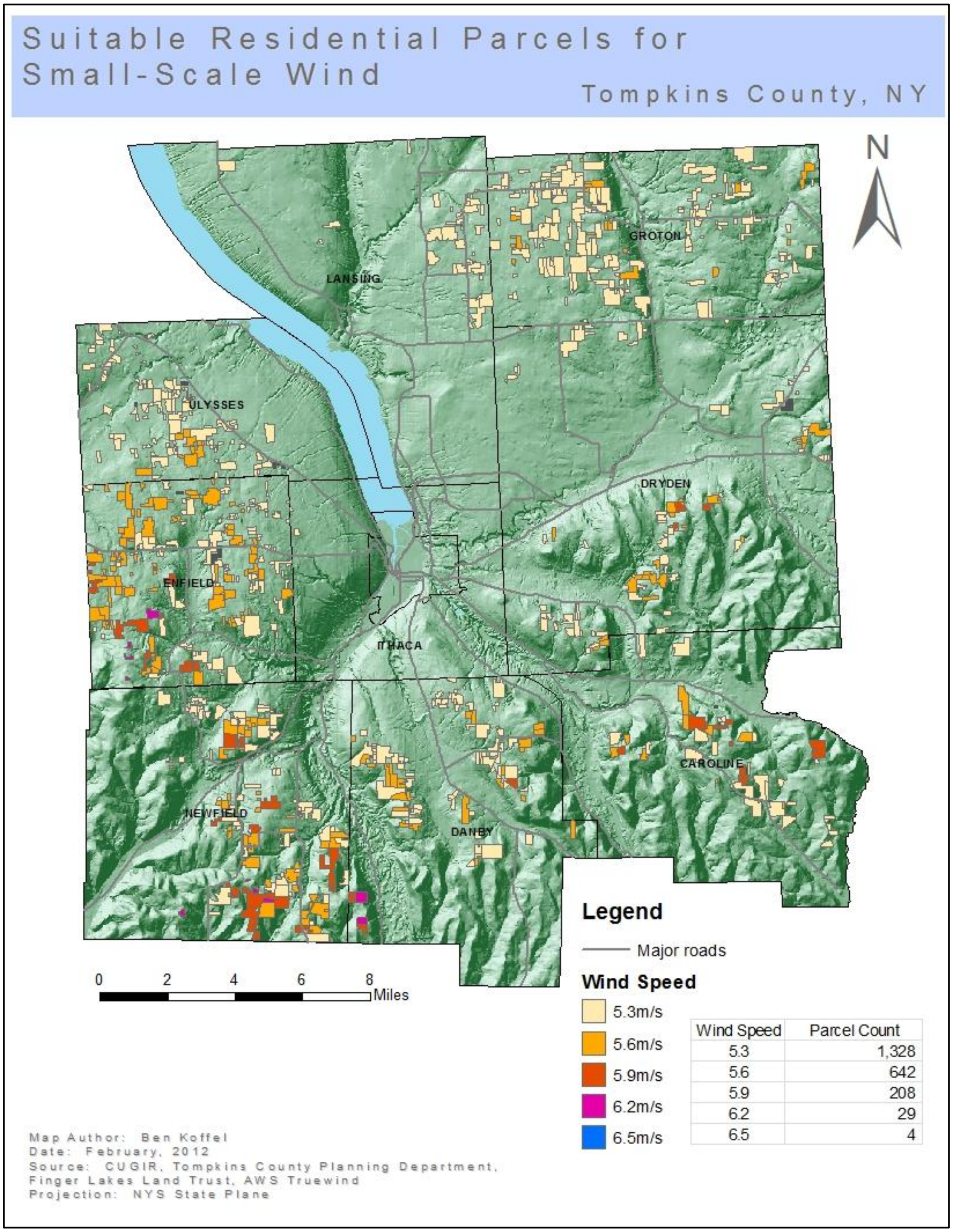

Figure 15: Suitable Residential Parcels for Small-Scale Wind

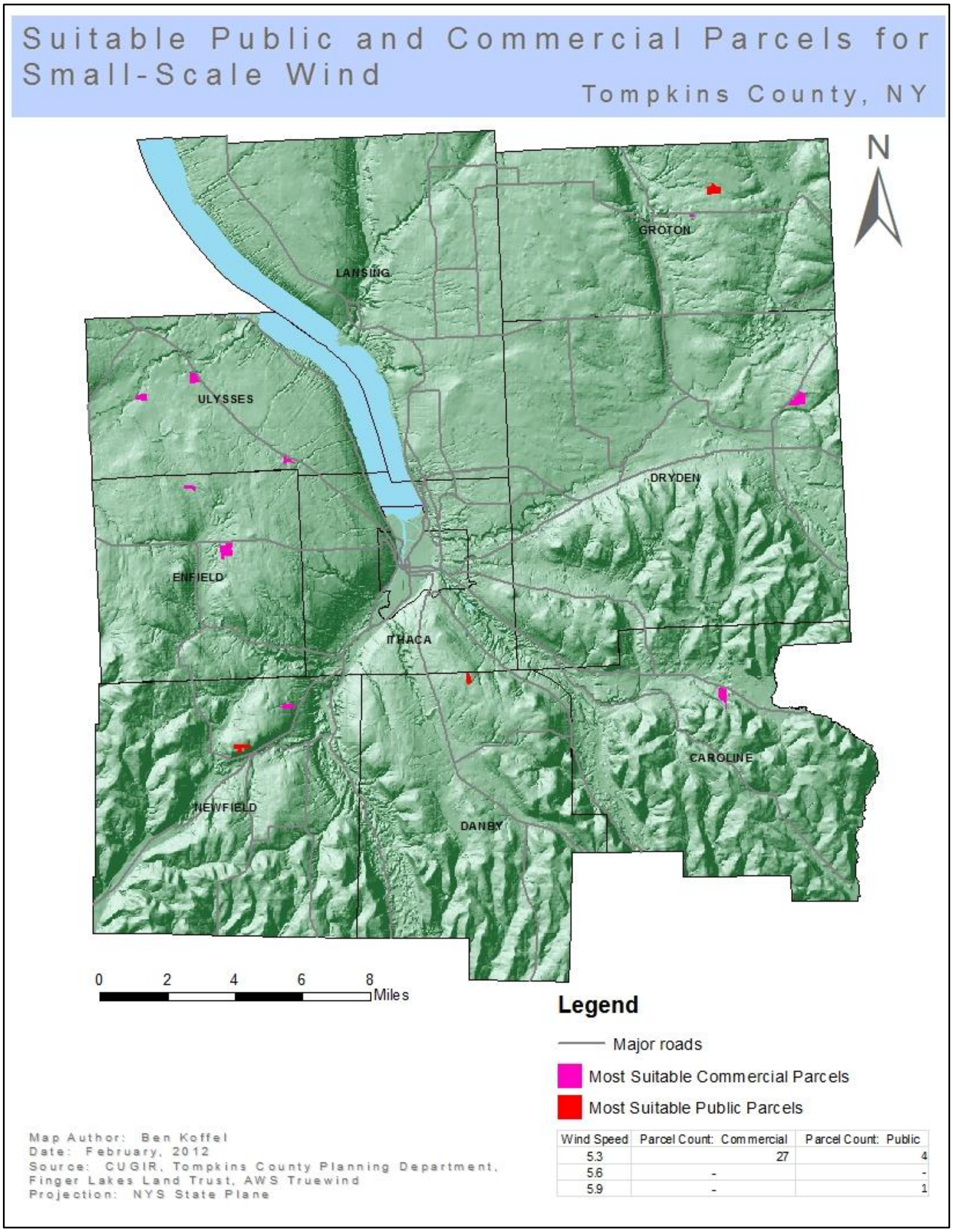

Figure 16: Suitable Commercial and Public Parcels for Small-Scale Wind

Energy Production

A number of home-scale turbines were surveyed for this analysis (see Appendix for table of turbines surveyed), and the Bergey Excel 10 was chosen as the model turbine. A homeowner's decision-making process for choosing a specific turbine is dependent on their own preferences for renewable energy, maintenance, and most importantly, how they plan to finance their project. The choice to use a 10kW turbine in the model assumes that if a homeowner is interested in producing power from wind, he or she will want to produce as much power as possible. Table 14 shows the projected power generation in Tompkins County from small-scale wind.

Table 14: County-Wide Small-Scale Electrical Generation Potential

Wind Speed	Residential Parcels	Agricultura l Parcels	Annual Output (kWh)	Countywide Output (kWh)	% of annual household demand (residential only)
5.3m/s	1,328	960	2,357	5,392,816	32%
5.6m/s	642	454	3,192	3,498,432	44%
5.9m/s	208	157	4,214	1,538,110	58%
6.2m/s	29	11	5,490	219,600	75%
6.5m/s	4	-	7,055	28,220	96%
Total	**2,211**	**1,582**		**10,677MWh/year**	

Discussion

The small-scale analysis shows that approximately 3,800 parcels in Tompkins County show potential to host a small wind turbine. For the 2,211 residential parcels, 60% could meet up to 32% of their electrical needs through wind, 29% could meet up to 44%, and 11% could meet 58-96% of their annual demand. It is difficult to estimate the percentage of demand that could be met on agricultural parcels without parcel-level data on electricity demand, as farms vary widely in size and operations. Despite this technical potential, the realistic outlook for small wind in Tompkins County is much more conservative for several reasons.

First, a small wind system is a significant investment for homeowners. As a rule of thumb, homeowners can expect to spend $3,000-$6,000 per kilowatt of capacity, meaning a 10kW turbine used in this analysis would cost $30,000-$60,000.[42] [43] The cost can be reduced through state and federal incentive programs, or through purchasing a small turbine. Regardless, a wind turbine is an expensive addition to most homes, and it is reasonable to assume that most residential properties in the county that could erect a turbine will not do so for financial reasons.

Second, very few small wind turbines have been installed to date. Although no complete list exists the table below shows all projects within Tompkins County that received funding through NYSERDA.

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[42] Windustry.org. "How Much Do Wind Turbines Cost?" http://www.windustry.org/how-much-do-wind-turbines-cost

[43] NYSERDA. Wind Energy Toolkit. 2009. http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. P. 149.

Table 15: NYSERDA-funded small wind installations in Tompkins County

Turbine/Model	Tower height (ft.)	kW	Installed
Fortis/Montana	120	2.5	2/8/07
Bergey/Excel-S	100	10	8/4/04
Southwest Whisper 200	80	1	9/6/06
Bergey/Excel-S	80	10	7/11/05
Fortis/Montana	120	2.5	2/1/07

There may be more turbines in the County, however it is reasonable to assume that turbine owners would take advantage of all financial incentives available and would have applied for funding from NYSERDA for their turbine.

Third, as will be discussed in Part Two of this report, the regulatory environment for small wind lags behind the technical potential. Many municipalities in the county do not mention wind turbines in their zoning code, making permitting and development difficult for a homeowner and potentially more expensive in monetary terms and in time spent navigating the permitting process.

The greatest potential for small-scale wind in the county may lie in agricultural parcels. Farms generally use more electricity than homes, particularly dairy farms that operate milking barns. Farms sit on large parcels that would allow for a larger turbine to be sited, and can take advantage of more financial incentives, including USDA support and net metering potential up to 2MW. Taken together, these factors indicate that the 1,582 suitable agricultural parcels could take advantage of favorable economics and physical conditions to offset a larger portion of their electricity demand than residential properties.

Local Perspective: Renovus Energy

Renovus Energy is an Ithaca-based installer of small renewable energy systems, chiefly wind and solar arrays. In his ten years installing energy systems, Art Weaver, founder of Renovus, has found that a small wind turbine is rarely a wise investment for a homeowner.[44]

First, the wind resource in the County is not very strong, and low average wind speeds mean a long payback period and low rate of return for a turbine owner. Second, over the past ten years turbine costs have remained relatively stable, whereas the cost of solar panels has dropped significantly. In Tompkins County, a solar array is generally half the cost of a wind turbine, making the choice between the two technologies an easy one for most homeowners. Third, wind turbines are mechanical devices with many moving parts; they require regular maintenance and break over time. Art has not installed any turbines in the past four years because he has seen so many small wind turbines fail due to the poor quality of turbines available in the market. In contrast, a solar PV array has no moving parts, requires little maintenance, and is much less likely to break. Fourth, Renovus frequently encounters local governments that don't understand the technology, don't have an established permitting process, and are hesitant to allow a new use within the town. Art has seen many customers' excitement and interest wane after repeated trips to Town Hall were met with confusion and frustration, until eventually they abandoned the projects.

Art's experience suggests that for half the cost of a wind turbine, a homeowner can purchase a solar system that is more reliable, requires less maintenance, and is easier to

[44] Weaver, Art, Founder, Renovus Energy. Personal Correspondence, February 2012.

permit than a small wind turbine. Only in the windiest areas of the county would a small wind turbine be able to compete on a cost-basis with a solar array.

Potential for Medium-Scale Wind

Although this analysis focuses on turbines in the 10kW range and those in the 1-2MW range, there are also turbines in the "medium-scale" range with installed capacities of 250kW-1,000kW. These turbines fill a gap between large turbines designed to produce electricity for a utility, and small turbines that are appropriate for supplementing home electricity consumption. The equation on p. 35 demonstrates that as the blade sweep area and the wind speed increase, the power generation increases. Therefore, as a property owner considers scaling up their wind turbine, the energy they generate increases significantly, as does the cost.

Medium-scale wind turbines show potential to fill a special niche within the county for farms or other institutions that have large on-site demand, large available land, and can take advantage of enough incentive programs to make the financing attractive. Clearly, turbine size and cost are directly related, but the combination of increased electrical production from a larger turbine and the availability of incentive programs for farms may provide a sufficient balance of cost and performance for medium-scale wind turbines. Spatially, areas that are appropriate for small-scale wind would only be more attractive for medium-scale, and the ability to finance a project is the key determinant for the appropriateness of medium-scale wind on agricultural parcels.

PART TWO: REGULATORY ENVIRONMENT

The regulatory structure for wind turbines is governed primarily at two levels – the state and local level. For large-scale wind installations, the state is generally the most involved level of government through the Power Facilities Siting Act, also known as Article X, or the State Environmental Quality Review Act, SEQR. For small-scale turbines, the primary government entity is the municipality, who may create their own regulations for height restrictions, zoning, and special use permits.

State Level

The regulations on large-scale energy development in New York State are presently changing. The SEQR process is being replaced for all facilities over 25MW installed capacity. These large facilities will be required to pursue approval through the Article X of the Public Service Law. Facilities with an installed capacity of less than 25MW will still be permitted under the SEQR process.[45] Article X centralizes the authority for site approval of large projects with the state, whereas the SEQR process grants more authority to local governments.

Article X

The Power NY Act of 2011, signed by Governor Cuomo in August 2011, reinstates Article X of the Public Service Law, which previously expired in 2003. Under Article X, any project with an installed capacity of 25MW or more must submit an application for

[45] Morris, Jackson. The Pace University Energy & Climate Center. Personal correspondence, February 2012.

approval to a seven-member state siting board.[46] Previously, only sites with an installed capacity of 80MW or above were required to submit applications to the board.

The board consists of the following individuals:[47]

- Chair of the Department of Public Services
- Commissioner of Environmental Conservation
- Commissioner of Health
- Commissioner of NYSERDA
- Commissioner of Economic Development
- Two ad hoc members, who must reside within the host municipality

Each applicant must submit a "Pre-application preliminary scoping statement," including a brief discussion of the project's potential environmental health and safety impacts, emissions analysis (not applicable to wind farms), a demographic analysis of the host community, reasonable alternative locations to the selected site, measures to be taken to minimize environmental impact, a list of additional studies to be conducted, and required permits.[48] The applicant must also submit a fee of $350/MW, not to exceed $200,000, to defray the expenses incurred by the host municipality in hiring expert witnesses and consultants to assess the impacts of the project.[49] During the pre-application process, the

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[46] Blair, Adam. "Understanding Article X of the Power NY Act of 2011." Community and Regional Development Intitute (CaRDI), Cornell University. September, 2011. http://www.cals.cornell.edu/cals/devsoc/outreach/cardi/programs/land-use/loader.cfm?csModule=security/getfile&PageID=1024193

[47] Senate-Assembly of the State of New York. "Power NY Act of 2011." S. 5844, A. 8510, regular sess. http://assembly.state.ny.us/leg/?sh=printbill&bn=A08510&term=2011

[48] Blair, Adam. "Understanding Article X of the Power NY Act of 2011." Community and Regional Development Intitute (CaRDI), Cornell University. September, 2011. http://www.cals.cornell.edu/cals/devsoc/outreach/cardi/programs/land-use/loader.cfm?csModule=security/getfile&PageID=1024193

[49] Senate-Assembly of the State of New York. "Power NY Act of 2011."

sponsor is required to share the scoping statement with local officials, and provide a newspaper announcement in the local community to encourage transparency and local participation in the review process.

Within 60 days of filing a scoping statement, the board must convene to determine if the scoping statement is complete. After the scoping statement has been filed, the applicant is required to complete a full application and provide additional studies expounding on the scoping statement. Additionally, the developer must provide a fee of $1,000/MW, not to exceed $400,000, for local communities to hire consultants and expert witnesses.

Upon receiving an application, the board has 60 days to determine if it is complete, and must conduct a public hearing within a "reasonable time thereafter."[50] The board must come to a decision within one year of the submission, and their decision must address the following:[51]

- If a facility is a "beneficial addition to or substitution for" generation capacity
- Construction or operation are in public interest
- Adverse environmental effects will be minimized
- Impacts on Environmental Justice communities will be avoided, offset, or minimized "using verifiable measures"

S. 5844, A. 8510, regular sess. http://assembly.state.ny.us/leg/?sh=printbill&bn=A08510&term=2011

[50] Blair, Adam. "Understanding Article X of the Power NY Act of 2011." Community and Regional Development Intitute (CaRDI), Cornell University. September, 2011. http://www.cals.cornell.edu/cals/devsoc/outreach/cardi/programs/land-use/loader.cfm?csModule=security/getfile&PageID=1024193

[51] McGowan, Peter. New York State Department of Public Service. "Article X." Presentation at ACE NY Conference, 26 October, 2011. http://www3.dps.ny.gov/W/PSCWeb.nsf/ca7cd46b41e6d01f0525685800545955/64c8a03c408086eb85257687006f3abe/$FILE/Final%20Article%2010%20Presentation-10-26-11.pdf

- Compliance with state laws and regulations and compliance with, or override of unreasonably restrictive, local laws and regulations.

This last item indicates that local laws regulating turbine size, setback, or other siting provisions may be overturned by the board if they are deemed too restrictive or if preempted by state regulations.

SEQR Process

(The NYSERDA Wind Development Handbook provides a comprehensive review of the SEQR process as it relates to large-wind facilities, which has been summarized here.[52])

The SEQR process is designed to provide a coordinated environmental review, and grants state agencies the opportunity to request modifications to the project if substantive information suggests that it will lead to environmental harm. Additionally, the SEQR process requires agencies to consider alternatives to the proposed development in the review process. These alternatives can include such actions as reducing or relocating turbines, and must include a scenario for no action — the non-development of the project.

Within the process, there are two types of agencies — involved agencies and interested agencies.

Involved Agencies are state agencies that have the jurisdiction to approve, fund, or undertake an action relating to the proposed development. Involved agencies generally have the authority to issue specific permits, forms, or approvals in the process.

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[52] NYSERDA. Wind Energy Toolkit. 2009. http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. P. 122-128.

Interested Agencies are state agencies that can express concerns in the process but do not have jurisdiction. Interested agencies generally lack the authority to issue a specific approval, however they may be interested in the project given specific areas of expertise or concern.

Application Process

First, the potential development must be classified as either a Type I, Type II, or Unlisted action.

- Type I: Those actions that are likely to require the preparation of an Environmental Impact Statement (EIS). These include any project that physically alters more than 10 acres of land, or measures over 100 ft. in height. Most wind farms are Type I actions.
- Type II: Those actions that are not as likely to require an EIS.
- Unlisted: Those actions which are neither Class I or Class II

If an action is designated a Type I action, the project sponsor must complete a Full Environmental Assessment Form (EAF). This document will serve as the basis for a coordinated environmental review by all the involved state agencies. The municipal government generally serves as the lead agency for the review process, and will determine if an action requires an Environmental Impact Statement (EIS).

If an EIS is required, either the project sponsor or the lead agency will prepare the EIS. Once the EIS is completed, it must be open for a public comment period of a minimum of 30 days, during which time a public hearing may be scheduled. A final EIS must be submitted no later than 60 days after the draft EIS is filed, or 45 days after a public hearing, whichever occurs latest.

After the final EIS has been submitted, involved agencies will have a minimum period of 10 calendar days before issuing a findings statement. The findings statement expresses the involved agencies' decision on the action, and the findings statement and the decision must always be presented at the same time.

The findings must:

1. Consider the relevant environmental impacts, facts and conclusions disclosed in the final EIS;
2. Weigh and balance relevant environmental impacts with social, economic and other considerations;
3. Provide a rationale for the agency's decision;
4. Certify that the requirements of this Part have been met;
5. Certify that consistent with social, economic and other essential considerations from among the reasonable alternatives available, the action is one that avoids or minimizes adverse environmental impacts to the maximum extent practicable, and that adverse environmental impacts will be avoided or minimized to the maximum extent practicable by incorporating as conditions to the decision those mitigative measures that were identified as practicable.

The lead agency may charge a fee to recover the costs associated with preparing the EIS. For a non-residential construction process such as a wind farm, this fee may not exceed .5% of the total project cost.

Sample Agency Involvement

The following summarizes the sample involvement of state agencies in a large-scale wind power project.

NYS Department of Environmental Conservation (DEC)

The NYS DEC may become involved in project approval if land that will be affected by the project falls into its jurisdiction under the federal Clean Air and Clean Water Acts. Issues related to streams or wetlands represent one of the most common ways in which the NYSDEC could become involved. The DEC does not issue a specific permit for wind projects, but permits may be required for specific actions taken in the construction of the wind project.

NYS Department of Agriculture and Markets (Ag & Markets)

The Department of Agriculture and Markets may be involved to ensure that local wind development does not significantly infringe on the agricultural productivity of area.

New York State Office of Parks, Recreation, and Historic Preservation

If there are visual impacts on historic structures or locations, the Office of Parks, Recreation, and Historic Preservation may require notification.

US Fish & Wildlife Service

If a proposed project site includes or is adjacent to sensitive plant or wildlife habitat, the USF&WS can perform a threatened and endangered species review.

Army Corps of Engineers

The Army Corps of Engineers (COE) may become involved in a project, if any portion of the project (e.g., access road, distribution line) crosses a water body subject to COE jurisdiction such as streams flowing into navigable waters.

Federal Aviation Administration (FAA)

The FAA requires lighting on any structure taller than 200 feet. Additionally, projects within 20,000 feet of airports or military facilities require additional review.

NYS Public Service Commission

The Public Service Commission oversees issues related to grid interconnection and transmission (see following section on interconnection)

Comparing Article X and SEQR

Article X centralizes decision-making authority for a large energy project with the state and simplifies the permitting process for large energy facilities. Under the existing SEQR process there is no central agency responsible for facility siting, a varying number of state agencies may be involved in the review process, and the developer must commit significant attention and energy to navigate the permitting process. Local wind developers have stated that the SEQR is a time-consuming process, and it is difficult to make sense of in the absence of one state agency that can provide the final word on questions or interpretation of regulations. Additionally, the process can differ for each project, depending on which agencies take an interest.

Although it streamlines the application process, Article X removes some of the control from the municipality hosting the project. Under SEQR, the municipality would generally act as the lead agency in preparing the EIS, and later would have final authority in granting the building permit and site plan approval. Under Article X, provided that the developer's site plan falls under accepted DEC regulations, the municipality will not have grounds to deny a building permit. In particular, the siting board has the authority to override local ordinances or laws it deems too restrictive. While Article X provides opportunities for local participation and provisions to fund independent analysis, it also removes the decision-making authority of the local government. To date, no wind projects have been developed under Article X, as the regulations will not be finalized until August 2012, with proposed DPS regulations submitted for public review in the spring of 2012.[53]

Grid Interconnection

The same grid interconnection procedure applies, regardless of whether a project is permitted through SEQR or Article X.

The New York Independent System Operator (NYISO) requires that the wind farm developer follow several steps and requirements in order to connect to the grid. This process has been summarized from the NYSERDA Wind Energy Toolkit.[54]

- For each Point of Interconnection (POI) to be studied, the developer must submit a request for interconnection, a $10,000 deposit, a demonstration of site control or

[53] Morris, Jackson. Pace University Energy & Climate Center. Personal correspondence, February 2012.
[54] NYSERDA. Wind Energy Toolkit. 2009. http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. P. 126-127.

a $10,000 deposit in lieu of site control, and at least a minimum set of technical data.

- Upon receipt of a valid interconnection request, NYISO will assign the project a queue position and initiate the Interconnection Study process.
- NYISO will tender a Feasibility Study Agreement, which must be executed and returned to NYISO with a $10,000 study deposit. After the completion of the Feasibility Study, NYISO will provide the customer with a report including a good faith estimate of (i) system upgrades required to effect full transfer of the new generation (ii) cost responsibility for necessary system upgrades, and (iii) time to construct.
- Along with the Feasibility Study Report, the developer will receive a System Reliability Impact Study (SRIS) Agreement, to be executed and delivered to NYISO, including demonstration of site control and a $50,000 deposit. The SRIS will study the effects of the proposed project to the reliability of the New York Transmission system. After the completion of the SRIS, NYISO will provide the customer with a report including a (i) good faith estimate of non-binding upgrade costs, (ii) good faith estimate of a non-binding upgrade timeline, and (iii) a list of required upgrade facilities.
- Along with the SRIS Report, the developer will receive an Interconnection Facilities Study Agreement. For this study, the project will be placed into a cluster called a class year for the study. The developer will execute and deliver the Facilities Study Agreement to NYISO, including demonstration of site control and a deposit equaling the greater of $100,000 or the facilities portion of the estimated monthly study cost. The clustered approach to the Interconnection Facilities Study will

include all class year projects in one combined study. Along with the estimated cost, a good faith schedule for upgrades will be established, which will contain major milestones to facilitate the tracking of the progress of each Large Facility interconnection project.

- After the Facilities Study has been completed, the developer will have the option to enter into an Optional Interconnection Study, which will utilize further data to support the previous studies. Upon the completion of the Optional Interconnection Study and/or the Facilities Study, a Large Generator Interconnection Application (LGIA) will be tendered by NYISO. The LGIA will be signed by the developer and filed with FERC along with a non-refundable $250,000 security to the Transmission Owner to begin construction of the necessary facility upgrades. The facility will have no more than 3 years to become commissioned after the signing of the LGIA.

Local Level

The greatest control that a local community can exercise over wind power development is through its zoning, land use provisions, and permitting procedures. By creating regulations that address wind turbines and provide an efficient and easily understandable permitting process, municipalities can encourage more development of both small and large-wind in their jurisdictions, and restrict certain types of development to specified districts.

Survey of Tompkins County Municipalities

Local zoning ordinances in Tompkins County vary greatly in their treatment of wind turbines. Some municipalities make no mention of them and others specify permitting procedures, appropriate zoning district, and installed capacity limitations.

Town of Caroline

No provisions for wind turbines could be found, however the Comprehensive Plan for the town identifies renewable energy technologies as an area of interest for the town. Additionally, Caroline does not have any zoning laws.[55]

Town of Danby

No provisions for wind turbines could be found.[56]

Town of Dryden

In 2006, the Town passed the "Renewable Energy Facilities Law of The Town of Dryden," which prohibits the development of any wind energy conversion system (WECS) other than a small WECS, defined as a system intended to reduce on-site. A Small-WECS over 50ft in total height may only be constructed by a Special Use Permit, and is considered an accessory use in all zoning districts. An owner must submit a completed application to the town board, and a public hearing must be scheduled within 62 days of receipt of the application. A completed application includes parcel and turbine information, as well as a short EAF and a visual study addendum. The maximum allowable height is 140 ft. and the

[55] Town of Caroline, New York. "Town of Caroline Comprehensive Plan." 2006. http://carolinetown.powweb.com/wp-content/uploads/2007/11/comprehensive-plan-2006.pdf
[56] Town of Danby, New York. "Zoning Ordinance, Town of Danby, New York." May, 2005. http://town.danby.ny.us/Documents/ZoningOrdinance.pdf

maximum allowed installed capacity is 10kW.[57] Note that this effectively prohibits large-scale wind development in Dryden.

Town of Enfield

According to the Enfield Wind Ordinance, a Wind Energy Permit is required in order to construct any wind turbine, regardless of size, or any meteorological tower.[58] The only exception to this rule is for turbines that are exclusively used in an agricultural zone. For turbines larger than 100kW a Wind Energy Permit Application must include a description of the project, site plans, turbine information, decommissioning plan, landscaping plan, Part 1 of a Full Environmental Assessment Form (EAF) with visual impact addendum, and a construction schedule. For a turbine under 100kW, the Wind Energy Permit application must include turbine information, a visual analysis, evidence that the utility provider has been informed of the electrical interconnection, electrical diagrams, and evidence that the primary use of the turbine will be for reducing on-site electric demand.

For both permits, the fee schedule appears below:

1. WTG Wind Energy Permit: $250 per WTG.

2. Wind Measurement Towers Wind Energy Permit: $200 per tower.

3. Small WTG Wind Energy Permit: $150 per WTG.

4. Wind Measurement Tower Wind Energy Permit renewals: $50 per WTG.

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[57] Town of Dryden, New York. "Renewable Energy Facilities Law of the Town of Dryden, New York." 2006. http://dryden.ny.us/Local_Law_Postings/lle2006.pdf
[58] Town of Enfield. "Wind Energy Facilities Local Law.: 14 January, 2009. http://townofenfield.org/content/Laws/View/8:field=documents;/content/Documents/File/184.pdf

Additionally, the town may charge the project owner any fees associated with the inspection by an expert. The town reserves the right to negotiate a PILOT with the owner of a turbine.

As Enfield does not have zoning, there are no specifications on the allowable locations of wind turbines.

Town of Ithaca

Within the Town of Ithaca, small wind facilities are permitted as a matter of right as an accessory structure providing power to its host parcel or as a principal structure providing power to an adjacent lot. Small wind facilities are permitted in all zones. The maximum height is 145 ft., with no maximum installed capacity limit. Turbines must operate within a specified decibel range.[59]

Town of Groton

The use of a "Non-Commercial Wind Powered Generator" is permitted on all property provided that it is less than 10kW installed capacity and has a maximum height of 120 ft. The property owner must submit a site plan with a visual assessment, and the turbine must have a property line setback of 1.5 times its total height.[60]

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[59] Town of Ithaca, New York. "Code of the Town of Ithaca, New York." § 270-219.4. Small wind energy facilities. http://www.town.ithaca.ny.us/local-laws-codes

[60] Town of Groton, New York. "Town of Groton Land Use and Development Code." 2011. Section 367: Non-Commercial Wind Powered Generator. http://townofgrotonny.org/Code/Code.pdf

Town of Lansing

Wind turbines are not permitted in areas zoned for medium density residential, and all commercial districts. Within the zones in which it is allowed it requires a special considerations and a special use permit.[61]

Town of Newfield

No provisions for wind turbines could be found. Additionally, Newfield does not have any zoning laws.[62]

Town of Ulysses

No provisions for wind turbines could be found.[63]

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[61] Town of Lansing, New York. "Lansing Land Use Ordinance." 18 May, 2005. Section 503. http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=0CCMQFjAA&url=http%3A%2F%2Fwww.lansingtown.com%2Findex.php%2Fcodes-and-planning-documents%3Fdownload%3D33%3Acurrent-land-use-ordinance&ei=TJowT5TMPKHi0QH46aDUBw&usg=AFQjCNHSipZXs530Kic8DI6x6nZn7f9AGg
[62] Town of Newfield, New York. http://townofnewfieldny.com/planning.html
[63] Town of Ulysses, New York. "Town of Ulysses Zoning Law." 28 November, 2007. http://ulysses.ny.us/pdf/zoning-law-2007.pdf

Best Practices in Local Zoning and Wind Permitting

Permitting and Zoning Options

Municipalities use different methods to classify wind turbines. The list below discusses the various approaches, and offers some pros and cons for each strategy.[64] [65]

- *Permitted Use:* Permitted uses are allowable where specified by zoning. The key advantage is that no special application process is needed, nor is a public hearing. However, for municipalities that are extremely concerned with negative impacts of wind turbines, a permitted use does not afford many opportunities for review.
- *Special Use/Conditional Permit:* Special use permits can be useful when the municipality must determine on a case-by-case basis if a wind development is suitable for a given zone. Although they give more control to the municipality in regulating land use, the potential cost and time associated with acquiring a permit may discourage development.
- *Site Plan Review:* The site plan review generally accompanies a special use permit, and provides an additional measure of insurance that the project is conducted in an environmentally sound manner. A site plan review may not be necessary for wind turbines up to a certain capacity or height or in certain zones, but could be beneficial for districts with environmental or historic significance.
- *Accessory Use:* This is most common in agricultural, commercial, or industrial areas, in which small wind complements the site's intended use by providing electricity.

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[64] American Wind Energy Association. "In The Public Interest: How and Why to Permit Small Wind Systems." September, 2008. http://www.awea.org/learnabout/smallwind/upload/InThePublicInterest.pdf
[65] NYSERDA. Wind Energy Toolkit. 2009. http://www.nyserda.ny.gov/en/Page-Sections/Renewables/Large-Wind/Wind-Energy-Toolkit.aspx?sc_database=web. P. 114.

- *Use Variance:* Use variances can be granted for small turbines that aren't generally permitted in a particular zone (such as a historic district), but should not be relied upon as the chief zoning consideration for wind turbines, as the review process would be lengthy.
- *Overlay Zone:* A renewable energy overlay zone can be used to increase the speed and ease of permitting. However, the overlay zone should not go against the use of the original zone.

Model Wind Ordinances

The American Wind Energy Association (AWEA), a trade association for wind energy, recommends several considerations for creating a local wind ordinance: [66]

- Setback: Should be sufficient to remove harm from neighbor's property in the event of a tower collapse. Generally, the setback is equal to the tower height plus a blade length. However, setback rules may be more relaxed for wind turbines that are part of the same wind farm spanning multiple parcels.
- Aesthetic: The aesthetic impact is largely a function of the turbine's height. Limiting development to areas outside of significant historic or natural resources can mitigate the potential impact.
- Sound: Zoning should reflect the prevailing sound level of the area, as well as occasions where no one is likely to be located near a wind turbine. Doubling the distance from a tower decreases sound output by a factor of four.

[66] American Wind Energy Association. "In The Public Interest: How and Why to Permit Small Wind Systems." September, 2008. http://www.awea.org/learnabout/smallwind/upload/InThePublicInterest.pdf

- Insurance: Wind systems should be added to an existing policy as an uninhabited structure and not be required to have a separate policy.
- Abandonment: Small systems should be required to be taken down if not used for a period of time, but should not be subject to a security bond.
- Potential Structural or Electrical Failure: Electrical drawings and specifications from the turbine manufacturer should be acceptable as documentation of structural and electrical soundness.
- Soils: Soil studies are unnecessary for most turbines under 20kW

While it is important for communities to develop their own zoning regulations that suit the opinions of their residents, the AWEA points out that conservative zoning can make systems more difficult to install by effectively reducing their financial performance. Higher wind speeds are only accessible at higher elevations, and enacting low maximum height restrictions reduces the electricity that a turbine can generate as well as the financial returns for the owner.

NYSERDA also recommends a model wind ordinance (contained in the Appendix on p. 115) that incorporates many of the AWEA's suggestion.

Local Incentives for Wind Power

Most financial incentives for renewable energy are offered at the state level, and few local governments are in a position to offer production incentives or rebates directly to property owners. However, there are a number of incentives that a municipality can offer that decrease the cost of development by making permitting easier. Municipalities can:

- Create regulations in advance of public inquiries
- Treat small turbines as improvements to individual property
- Promote consistency in fees across municipalities. This reduces complications for installers and developers.
- Base electrical code compliance on a common set of standards
- Reduce or waive permit fees on wind installations, when special use permits are involved
- Fast track review periods
- Award density bonuses for developments that reduce or generate 50% of energy demand on-site
- Award points in performance-based review and green building programs
- Consolidate the permitting process to as few agencies as possible
- Educate permitting staff about small wind systems

Additionally, in New York, property owners may receive a tax exemption equal in value to the incremental increase in assessed property value resulting from a renewable energy system. The exemption lasts for 15 years, and equipment must be installed before January 1^{st}, 2015. [67]

Recommendations for Tompkins County

The largest role that the County can play in supporting wind development is to assist municipalities in writing thoughtful zoning codes and permitting procedures for small wind turbines. The technical analysis suggests that all municipalities contain some parcels that are suitable for small wind development. However, the survey of local codes reveals that four towns (Caroline, Danby, Newfield, and Ulysses) make no mention of wind turbines in their zoning code. The remaining towns differ in their approach, with Dryden and Groton restricting installed capacity significantly, and Ithaca, Enfield, and Lansing, outlining permitting procedures, setback restrictions, and acceptable zoning districts. This analysis reveals several steps the County could take to improve wind ordinances:

1. **Outline implications of zoning choices:** Municipalities may not have a strong understanding of the different options for small wind zoning and permitting. By producing reports, guidelines, or workshops that present the implications of different permitting schemes, towns will have a greater awareness of their regulatory options and how they may affect development.
2. **Suggest that height restrictions replace capacity restrictions:** Turbine designs change and improve over time, and in 10-20 years new technologies may supplant existing ones. If municipalities are concerned with the size of the turbine blade sweep area, the height of the turbine, or the noise it produces, these issues can be

[67] New York State Department of Taxation and Finance. "Application for Tax Exemption of Solar or Wind Energy Systems or Farm Waste Energy Systems."
http://www.tax.ny.gov/pdf/current_forms/orpts/rp487_fill_in.pdf

individually addressed in zoning ordinances. However, in 20 years a 20kW turbine may be the same size as today's 10kW turbines, and the environmental and social impacts may be indiscernible. Therefore, by removing restrictions on capacity and focusing on physical features, municipalities can create zoning codes that can adapt to new technologies.

3. **Organize travel to installed wind turbines:** With the low number of installed projects in the County, it's likely that many town board members have never seen an operating wind turbine. By providing support to municipal leaders for travel outside of the county to see small-scale turbines and meet with owners and municipal leaders, the County could help towns understand the technology and write more meaningful code.
4. **Urge municipalities to standardize permitting:** A landowner will always erect a turbine with the assistance of a local vendor or developer. If vendors must navigate a different permitting process each time they develop a project, the process takes more time, and these costs may be passed on to homeowners. Zoning codes, setback rules, and height restrictions may vary from town to town, but a common permitting process make it easier for energy installers to work with homeowners to develop projects.
5. **Educate farmers on opportunities for small wind:** The technical analysis reveals that many farms show potential to offset their electricity consumption with wind power. Given their large electricity demand and favorable physical conditions, farms should be the primary audience for countywide efforts to promote small wind development. In particular, farms might benefit most from turbines in the medium-size range, from 50kW-500kW.

Part Three: Case Studies

Case studies of several projects illustrate the opportunities and challenges presented by wind power development. As Tompkins County investigates the potential of wind power for the future, these case studies help to answer three research questions:

1) What is the history of wind power development in Tompkins County?
2) How have other wind projects in New York State navigated the development process and what is the relationship between host communities and project developers?
3) What options have project developers and local governments used to encourage local ownership of wind projects and revenue sharing amongst landowners?

A survey of wind power in Tompkins County reveals a high level of public engagement and interest in wind projects — on both sides of the issue. Cornell University's brief experience with wind power shows the early public engagement can derail a project, as the site was in an optimal location but suffered from severe backlash from the local community. In contrast, Enfield Energy is committed to local ownership and involvement, and once a pro-wind town board came into office the project benefitted from significant local support.

In New York, local governments have taken a lead role in the permitting and planning processes through SEQR, however this relationship is likely to change once Article X takes effect. The financial arrangements between project developers and landowners are largely a private concern, with individual owners negotiating their own land-lease agreements. However, municipalities have worked with developers to write attractive PILOT agreements to pay for municipal fleet upgrades, improvements to historic structures, and other local projects. With few opportunities for large-scale wind in Tompkins County, it is unlikely that many of the issues or solutions in these case studies will prove relevant.

Lastly, several case studies from the Midwest highlight non-traditional ownership structures that provide financial benefits to local institutions and local residents. These financing models include public-private "flips," in-state limited offerings of an LLC, and municipal light and power districts. These strategies may be appropriate across different scales of development in Tompkins County, and can educate local governments and residents about approaches for sharing revenues among landowners and investors.

New York State

Black Oak Wind Farm

The only large-scale wind project currently under development in Tompkins County is the Black Oak Wind Farm in Enfield.[68] In the early 2000s, a local landowner and real estate developer put up a small wind turbine on his property in Enfield. Seeing how expensive a larger turbine would have been, the owner purchased land nearby that already had a high voltage transmission line running through the site and formed Enfield Energy. In 2006, ownership of the project transferred from Enfield Energy to the Black Oak Wind, LLC. Black Oak estimates that the site will have an installed capacity of 30-35MW.

One of the first challenges for Enfield Energy and Black Oak was compliance with the previous Enfield Wind Ordinance. During the mid 2000s, the town board in Enfield passed an ordinance to prohibit the development any large-scale wind power projects.

[68] Wells, Marguerite, Project Manager of Enfield Energy. Personal Correspondence, November 2011.

Then, that town board was removed from office and a new, pro-wind board was elected. In 2009, this board passed the Wind Energy Facilities Local Law, which permitted large and small-scale wind development and specified the permitting procedures, setbacks, and environmental studies that must accompany development. With this new regulation in place, development could begin.

Once Article X takes effect, Black Oak could decide to permit itself through the new process. However, Black Oak had already begun the SEQR process when Article X was passed and will be grandfathered in, and given that the project is locally owned and has the backing of the town, it is advantageous to keep more local control. Black Oak acknowledged that many large-scale wind developments in the state struggle because the developers are outsiders coming in to a community that may be hostile towards a large wind development. For these types of developers, Article X, which centralizes decision-making power at the state level, would be preferable to the SEQR process.

The Town of Enfield is the lead agency on the SEQR process. The development team at Black Oak has found the SEQR process somewhat murky and difficult to navigate. The steps to follow in the process are not well laid out, and there is no central agency at the state level that coordinates the process or serves as a clearinghouse of information. The agencies likely to participate in the SEQR process include the DEC, the FAA and the FCC, the Historic Preservation Office, and possibly the Fish and Wildlife Department and the Army Corps of Engineers. The Corps of Engineers may become involved in the project if they deem that a body of water on the site is a tributary to a navigable body of water. In this case, a minor stream, even a seasonal one, may be deemed a tributary to Cayuga Lake, and thus could trigger the involvement of the Corps of Engineers. The development team has hired a firm out of Syracuse to write the EIS and navigate the SEQR process, however the Black Oak project manager is still involved in the SEQR process on a daily basis.

In December of 2009 the EAF was submitted, and in the summer of 2010 it was deemed a Type 1 Action, one requiring a full EIS. However, an EIS is an amorphous document that may or may not contain a number of specific studies. The Town of Enfield, which is very much in favor of the project, still wants to ensure that they conduct their due diligence and do not approve the project without any scrutiny. The town hired, at the developer's expense, a lawyer and consultant specializing in wind farms, and in September 2010 compiled a list of required studies. Black Oak expects to deliver the completed EIS in the winter of 2012. Once the EIS is completed and filed, the Town will have the authority to grant Black Oak a building permit for the site. Concurrently, Enfield Energy conducted three interconnection studies with NYISO, and sent preliminary turbine locations to the FAA.

A critical challenge in the development process is negotiating the Power Purchase Agreement (PPA). Local Utilities presently are not interested in signing PPAs, the rationale for which is not known to the developers. Black Oak's approach has been to negotiate PPAs directly with large institutional partners in the area, such as universities, hospitals, and other facilities with large annual demand, as well as power wholesalers. Additionally, at the present it is very difficult to price electricity and to prove the price at which they will be able to sell electricity in the future.

Since beginning the project, community ownership has been an important tenant. Several times large developers from outside the community offered to buy the project, and Black Oak has turned them down. The present site encompasses five different landowners' properties. For each turbine, all properties within that effected radius will receive compensation. Currently the compensation will be around 3% of gross revenues for the project split among leaseholders (those landowners with turbines on their property), and 1% split among neighboring parcels. The company has partnered with South Dakota Wind Partners, and is exploring financing options for community ownership.

In terms of financial incentives, Black Oak will not begin construction in time to take advantage of the Federal Governments 1603 grant program, which refunds construction costs for new renewable energy facilities that begin construction between 2009 and 2011.[69] For the South Dakota Wind Partners, this grant was significant, covering approximately 25% of the cost of the project. The federal production tax credit (PTC), set to expire at the end of 2012, is not as attractive, but without it the project may not succeed.

Cornell – Mt. Pleasant Wind Project

In 2003 Cornell University began exploring the possibility of erecting wind turbines on its land in Dryden, near Mt. Pleasant.[70] The university began a pre-feasibility study of the site, spearheaded by the Utilities and Energy Management Office, now the Energy and Sustainability Office. Cornell chose the Mt. Pleasant site because it was on university property and the power could be used behind the meter without being sold to a utility.

The Cornell project would have erected eight 1.5MW turbines on the ridge at Mt. Pleasant. After the University had completed the pre-feasibility study to assess the wind resource at

[69] United States Treasury Department. "1603 Program: Payments for Specified Energy Property In Lieu of Taxes." http://www.treasury.gov/initiatives/recovery/Pages/1603.aspx
[70] Joyce, Lanny, Director of Energy Management, Cornell University. Personal correspondence, November 2011.

the site, they presented the project to the community at a public meeting in Varna, and opposition emerged. The charter flying community, which flies out of the Ithaca-Tompkins County Airport, felt that the proposed turbines would interfere with landings, although the site was well outside of instrument range. The site was near an AM radio tower, which raised some concern as well. Bird and bat migrations were another issue the community wanted to investigate, and avian studies would have cost an additional $100,000-$200,000. Abutting property owners were also concerned about property values, noise, and shadow flicker. Lastly, Cornell runs a plant-breeding lab on the site, and scientists were concerned that conditions on the site that enabled certain experiments to be run might be adversely affected. Individually, each of these problems was manageable, but when taken together they seemed insurmountable.

Ultimately, in 2005 Cornell discontinued the project partly because of the anticipated development challenges, but chiefly because the University decided to construct a Combined Heat and Power Plant, which provides all of the electrical demand on-campus between April and October. Additionally, because Cornell is a non-profit, certain state and federal incentives do not apply, such as the PTC and MACRS depreciation schedule.

Ithaca College Wind Project

In 2007, Ithaca College signed the American College and University President's Climate Action Plan, which is a voluntary commitment to reduce carbon emissions.[71] As a component of this plan, the university, under the director of Prof. Beth Joseph, began a feasibility study to examine erecting 1-2 wind turbines on the college campus. Initially, the

[71] Prof. Beth Ellen Cark Joseph, Dept. of Physics, Ithaca College. Personal Correspondence, February 2012.

College received a P3 grant from the EPA, which is given to universities for student design projects that deal with issues of sustainability. With the grant money, Ithaca College explored installing a 10kW turbine on their campus. The University CFO reviewed the proposal and asked the team to consider a larger turbine, which led to a feasibility study of installing a large-scale turbine on campus.

Ithaca College installed a meteorological tower from August 2008 to March 2009. The meteorological tower required a short form EIS statement, a height variance, and a temporary building permit. AWS Truewind estimated that a turbine placed on the site could generate about 3,800MWH/year. The board of trustees funded the feasibility study, with a matching $25,000 grant from NYSERDA.

The feasibility study is completed and has been presented to the College leadership. Presently, the project will be considered for development between 2016 and 2025. As part of its GHG reduction goals, the College is first looking at reducing its consumption and offsetting electricity costs. In the future, if the campus were to use less electricity, a wind turbine would then generate a greater percentage of power for the site.

Steuben County, New York

Steuben County, southwest of Ithaca, is home to three large-scale wind farms that have been constructed in the past decade, with several additional proposed projects in various stages of development.[72]

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[72] Dlugos, Amy. Planning Department, Steuben County, New York. Personal correspondence, December 2011.

When wind developers began assessing potential sites around 2005, few municipalities in the county had any regulations around meteorological towers or turbines. Communities worked to adopt regulations for property setbacks and noise at the same time as developers were trying to erect towers and turbines, and the initial period was difficult. One community in particular has struggled to balance their desire for stringent property line setbacks with the standards set out in the state permitting process. A developer was pursuing development in the town under the impression that the SEQR approved setbacks would be in place, however the town is currently trying to pass more stringent setback requirements of 2.5 times the total turbine height. Once Article X takes effect, the Power Facilities Siting Board could deem these setback standards too restrictive and override them. For the time being, the developer can choose to conduct the state permitting process through the SEQR process, in which the host municipality would likely serve as the lead agency and would have final say over the building permit approval, or they can wait for Article X to take effect and permit directly through the authority of the state board.

At the county government level, the county planning department fields many calls from towns looking for guidance on model wind ordinances and setback requirements. The county has little regulatory authority, except for municipal law 239M, which states that the county can review site proposals that are within 500ft of a county road or a municipal boundary. In general, though, the county planning department works in an advisory capacity.

The county office that has been most involved with wind projects is Industrial Development Authority (IDA). The IDA has helped towns negotiate PILOT agreements with project developers. They use a general formula for how revenues should be distributed, based on the assessed value of the property and the project; however, some towns have been able to negotiate better PILOT agreements than others. In Cohocton, property taxes in the town decreased by 2/3, and the town also received money from First Wind to update their truck fleet and make repairs on several historic buildings. However, other agreements were not as lucrative. In addition to payments to the town, the developers of the three projects in the county pay lease fees and royalties to landowners with turbines, although they do not provide compensation to abutting landowners.

A general theme that emerged during the public review process for the wind farms is a conflict of ideology between two different groups of residents. The first are long-term residents of the county who farm, come from farming families, or are otherwise accustomed to viewing their land as an asset that can be used to earn a livelihood. These individuals see wind turbines as an improvement that increases the value of the land. In contrast, there are many newcomers to the area who have retired to Steuben County or purchased second homes there. To these individuals, land is a vehicle for recreation and aesthetic enjoyment. They view the wind turbines as a nuisance that decreases the value of the land.

Maple Ridge Wind Farm, Lewis County, NY

In 2000, a group of three developers submitted an application to develop a large wind farm on Tug Hill, in the towns of Martinsburg, Harrisburg, and Lowville.[73] [74] The first phase was

[73] The Tug Hill Commission. "Harnessing the Wind on Tug Hill." July 2010. http://www.tughill.org/wp-content/uploads/2011/10/HarnessingTheWind2010.pdf

completed in 2004, and the second in 2006, for a total of 300MW installed capacity. Presently, the project is owned by Iberdrola USA, the American subsidiary of the Spanish renewables company. The wind farms produce 900,000MWh/year, enough electricity to supply approximately 90,000 homes.

Compared to other projects in New York State, the development on Maple Ridge was non-controversial. The turbines are located on parcels that are operating or abandoned dairy farms, and the landowners welcomed the extra income, which amounts to $6,000-$8,000/year per turbine. The approximately 50 landowners negotiated lease agreements with the developer independently, and the agreement generally includes a royalty of 2-3% of the gross revenues from each turbine. Additionally, landowners that did not lease a turbine on their property but were nonetheless affected due to their proximity to turbines also receive compensation from the project owner. Many landowners see the turbines as the enabling factor in maintaining their farms or securing their retirement.

Prior to construction, the Tug Hill Commission organized trips to visit with local officials and residents at existing large wind farms in Madison County, New York, and in Vermont. These trips enabled residents to see firsthand what impacts would be like during construction and operation, discuss turbines with landowners, and come to a better understanding of the positive and negative effects of large-scale wind.

The project spans three towns, and separate PILOTS were made with four towns, three school districts, and the county, with the County attorney taking a lead role in helping to negotiate the PILOT agreements for each town. The agreements initially granted $9 million per year, but were later reduced to a specified fallback amount after Empire Zone

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[74] Malinowksi, Katie. Associate Director of Natural Resources, The Tug Hill Commission. Personal Correspondence, February 2012.

benefits for renewable energy expired. In addition to the PILOTS, the developer provided funds for repairs to historic structures, and installed signal repeaters on several towers to increase high-speed internet access in the area.

Off-Grid Home, Danby NY

In 2004 Guillermo Metz installed a 1kW Bergey turbine at his home in Danby, NY. For Guillermo, the choice to install a wind turbine was a result of his family's decision to build a house off the grid. Originally, the family worked with Renovus Energy of Ithaca to assess the solar potential at their home, but when Renovus visited the site they found that the house had a better wind resource. Guillermo encountered very little resistance to his turbine during the permitting process, with the town only requiring a height variance for the 100ft turbine. Initially, some neighbors were concerned that the turbine would scare horses.

The turbine has operated well over the past five years and has even survived two lightning strikes without burning out. His turbine works in tandem with a 600W solar array to provide about 1.5kW of electricity. Normally this would not be enough to power a home, but Guillermo and his family have incorporated many energy efficiency measures into their home, and they also use a propane refrigerator, which decreases electricity demand. Although Renovus suggested a Bergey turbine in 2004, since then they have experience issues with the control systems, which has led them to discontinue recommending these specific turbines. Guillermo believes that these early issues with control systems are part of the reason that small-scale wind has been slow to take off in Tompkins County.

In addition to owning a turbine, Guillermo is the director of Green Building and Renewable Energy for Cornell Cooperative Extension of Tompkins County. In his work he does not field many calls from residents interested in small wind, and his turbine was only the second to be installed in the County.

The Midwest

Winona County, MN

In 2005, Winona County Economic Development Authority (EDA) began studying benefits of public investment in wind energy, and received a $200,000 grant from the Minnesota Department of Commerce to build a 2MW turbine.[75] The EDA determined that between the MDC grant and other investments from private partners, a turbine project with an investment of $3M could return $6M over 20 years. The County discovered that it was eligible for $3.2M in Clean Renewable Energy Bonds (CREBs), which can be put toward the construction cost and then paid off through sales of electricity. However, the Director of the EDA researched the bonds and discovered that the County did not have the legal authority to own a turbine or pay investors with proceeds from energy sales. As the EDA pursued changes to state legislation to allow for this arrangement, they also learned that most developments that had used CREBs had also depended on tax benefits, such as MACRS depreciation or a PTC, for up to 60% of their revenues. As a public agency, the County was ineligible for tax benefits.

[75]The Minnesota Project. "Lessons and Concepts for Advancing Community Wind." December, 2009. http://www.mnproject.org/pdf/TMP_Advancing-Community-Wind_Dec09.pdf p. 7-9

In the spring of 2007 the County board met to discuss the project, and one county commissioner felt the project should be privately run and financed, which would have disqualified Winona County for the grant from the Department of Commerce. Additionally, this commissioner felt that the wind resource study data was outdated. To remedy this shortcoming the county erected a meteorological tower, but after a year of operation they discovered that their anemometers were defective and had not been collecting data. As the project progressed through more public meetings, a group of citizens, "Sustain Winona," came together to support the project. However, in the summer of 2007 a large flood hit the area, halting progress.

When work resumed in 2008, the county abandoned its original energy development company, Winergie, and entered a "Minnesota Flip" ownership structure with developer Juhl Energy. In a "Minnesota Flip," for the first ten years of operation private investors own 99% of the project and the county owns 1%. After ten years, the ownership structure flips, and the County owns 90% of the project while investors own 10%. Winona County still had to pursue a statutory change to allow them to form an LLC with the ability to sell electricity, and in 2009 the state legislature approved the change.

When it came time to move forward with construction, the County found that it was difficult to purchase a single wind turbine from a manufacturer. Their order was placed in the back of the queue behind larger, more lucrative orders. Nonetheless, in 2011 Juhl Energy completed the project and the 1.5MW turbine came online.

Willmar, MN

The city of Willmar, Minnesota, is served by its own municipal utility and was interested in a community wind project to power local homes and businesses.[76] The project began as a private initiative in 2005, when a local energy consulting firm proposed constructing a turbine and entering a PPA with the utility. The city believed that an investor-owned project would increase the cost of energy to residents, and instead contracted the developer to construct a turbine that would be managed by the utility. Under this structure, once construction and development costs were paid, all revenues from the project flow back to consumers as cost savings.

In May 2006 the utility contracted the original developer to conduct a feasibility study. One of the biggest challenges the project faced was in siting turbines. The wind resource in Willmar was not particularly high, and because the turbine would serve the municipal utility it needed to be located within the utility's service area. The utility decided to locate the turbine adjacent to the city's high school, which provided an educational opportunity for students and teachers as well. Similar to Winona, the city found it difficult to purchase only two wind turbines, and manufacturers were reluctant to enter a public bidding process for such a small order. The contractor, Folkedahl energy, entered an agreement with another wind developer who decided to become an official turbine vendor for DeWind, a turbine manufacturer. This eliminated the need for a bid bond and helped to speed the process.

In October 2008 the public bidding process began, and in August of 2009 the two 2-MW turbines were installed. Each turbine cost $3.3M, with an installation cost of over $1m

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[76] The Minnesota Project. "Lessons and Concepts for Advancing Community Wind." December, 2009. http://www.mnproject.org/pdf/TMP_Advancing-Community-Wind_Dec09.pdf p. 10-12

each. The expected cost of power is approximately $.05/kWh, and collectively they provide about 3% of the city's electricity.[77] In addition to the electricity the turbines offset 236,000 tons of CO_2, and the city expects to see a decrease in electricity costs in the long term.

Note: There are two municipal utilities with the County — Cornell University, and the Village of Groton.

Eldora-New Providence Community School District, Iowa[78]

> Eldora-New Providence Community School District in the central Iowa town of Eldora installed a 750 kW wind turbine in October 2002 after years of talks, negotiations, setbacks and planning with the school board and IES Utilities. The school district borrowed a total of $800,000 to finance the project—including the cost of the turbine, consultant and attorney fees, interconnection fees, and an extended 5-year warranty—and expects to pay off the loans in ten years. Part of the financing came through a $250,000 no-interest loan from the Iowa Energy Bank, an energy management program run by the Iowa Department of Natural Resources Energy Bureau. The remaining $550,000 was borrowed from the local Hardin County Savings Bank. The turbine is large enough to offset the school district's entire electricity bill under a net metering arrangement. Excess power is sold back to IES at a generous 3.8 cents/kwh. The Eldora wind turbine is not receiving REPI payments.

MinWind Projects, Luverne, MN

The MinWind projects are a popular example of a locally-owned energy project financed through a vehicle that limits ownership to in-state residents, and provides conditions to ensure that ownership is distributed among many investors and not dominated by one large individual or entity.

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[77] Willmar Municipal Utility. "Wind Turbine FAQ." http://wmu.willmar.mn.us/main/index.php?option=com_content&view=article&id=114&Itemid=237

[78] The Environmental Law and Policy Center. "Community Wind Financing: A Handbook by the Environmental Law and Policy Center." 2004. http://www.elpc.org/documents/WindHandbook2004.pdf P. 3

The MinWind projects are an example of farmer-owned wind developments that champion the idea of local ownership and financing of energy projects. By 2000, several wind farms were already operating near Luverne, and a group of farmers was interested in finding additional sources of revenue and providing economic benefits for local communities. In order to take advantage of tax benefits for wind energy, the farmers formed two LLCs and issues shares at $5,000 each for roughly 40% of each project's total cost, $1.6M each.[79] Shares were restricted to in-state residents, and 85% of the shares were reserved for farmers or residents of rural communities, with a stipulation that a maximum of 15% of a project may be owned by one investor.[80] There are also provisions for shares to be transferable among family members. In total, 66 investors purchased shares in the two companies within 12 days of the offering.[81] The two companies cooperate closely, but are governed by separate boards. Each company hired outside consultants and construction firms to complete the permiting and development phases, and in 2002 each group installed two 950kW turbines. One of the largest challenges was negotiating a PPA. MinWind found that rural electric cooperatives were challenging to work with, due to high interconnection costs and existing long-term PPAs with their current suppliers.[82] Eventually, the companies signed a PPA with Alliant Energy, a large Midwest utility.

Once online, the two projects generated significant demand for opportunities to invest in locally-owned renewable energy projects, and planning for additional MinWind projects began shortly thereafter. MinWind III-IX are similar projects constructed on the same

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79 The Environmental Law and Policy Center. "Community Wind Financing: A Handbook by the Environmental Law and Policy Center." 2004. http://www.elpc.org/documents/WindHandbook2004.pdf P. 5

80 Windustry.org. "Minwind III-IX, Luverne, MN: Community Wind Project." http://www.windustry.org/minwind-iii-ix-luverne-mn-community-wind-project

81 Clean Energy Resource Teams. "Case Study: MinWind I and II." July 2003. http://www.cleanenergyresourceteams.org/files/CS-Minwind.pdf

82 Ibid

model, with each project governed by a separate LLC. Each of the subsequent projects also took advantage of USDA Farm Bill Section 9006 grant funding, which provided $178,201 in grant funding towards engineering, equipment, and construction.[83] In contrast to many other wind projects, the boards of each MinWind project decided not to rely on the PTC for financial viability, which gave the project more stability, as the financing structure would not change after the PTCs expire in ten years.

[83] Windustry.org. "Minwind III-IX, Luverne, MN: Community Wind Project." http://www.windustry.org/minwind-iii-ix-luverne-mn-community-wind-project

CONCLUSIONS AND SUGGESTED RESEARCH

Although the County is not a prime location for large-scale wind, there are several sites that show potential. The technical analysis presented here estimates that large-scale wind may be able to power up to 30% of households in Tompkins County in the near-term, with potential for additional capacity in the future. The greatest challenges for large-scale wind are strict regulatory rules in some municipalities that prohibit utility-scale turbines, and project finance. The case studies presented here highlight some approaches that other wind developments in the Midwest have used to overcome the financing challenge, and there is no reason why these ownership systems cannot be deployed in Tompkins County as well. The case studies of large-scale wind developments in New York demonstrate the difficulty in navigating the SEQR process, however this landscape will change drastically once Article X takes effect. Municipalities will have less control over large-scale developments, which could decrease permiting times and regulatory hurdles, but may also inhibit local government's efforts to regulate land use.

Small-scale wind shows potential for offsetting electrical consumption of 3,800 parcels in the County. Although many of these parcels will choose not to install turbines for economic reasons, agricultural parcels in particular may be well served by small wind turbines. They generally have higher electricity demand than residential units, large spaces on which to site a turbine, and can take advantage of more favorable incentives and rebate programs. The county should work to engage farmers and explore options for supporting wind development in agricultural areas. Additionally, the best way for the County to promote small wind is to help municipalities draft zoning ordinances and permitting processes that make it easy for homeowners to install a wind turbine. By educating municipalities about the implications of different permitting options and working to standardize procedures across the County, the wind installation process will become easier for residents and installers.

Several additional areas of research would complement this analysis and provide the County with a more robust perspective on the potential for wind power to meet its greenhouse gas reduction goals.

- **Cost competitiveness:** Assessing the cost per kWh of large-scale and small-scale wind against other competing renewable technologies is critical to making an informed decisions about the relative value of wind power. In determining costs, transportation of wind turbines, grid interconnection, and permiting all must be included, as these represent significant portions of total project cost.
- **State and federal incentives:** The landscape for renewable energy incentives is changing rapidly. The Production Tax Credit is set to expire at the end of 2012, and the Treasury Department's 1603 Grant Program will soon expire as well. At present it is unclear what the federal incentives will look like, and they may change significantly following the 2012 presidential election.
- **Drivers of small turbine purchasing:** Of the 3,800 parcels in the county that could support a small wind turbine, most will choose not to purchase a wind turbine. With a better understanding of the decision making criteria that farms and homeowners use when making energy choices, a more accurate estimate could be made of the potential for small-scale wind.

APPENDIX

Exhibit 1: Data Layers for GIS Analysis

Layer	Description	Source
Wind Resource at 80m	An estimate of mean annual wind speed at 80m, provided by AWS Truewind using the MesoMap atmospheric simulation model	CUGIR
Municipalities	Municipalities in Tompkins County	CUGIR
Tax Parcels	Tax Parcels in Tompkins County (2010)	CUGIR
Buildings	Tompkins County Building Outlines (2006)	CUGIR
Land Use	Land Use and Land Cover for Tompkins County (2009), based on 2007 digital orthophotos and classified using the 1968 Land Use and Natural Resource Inventory (LUNR) schema	CUGIR
Elevation	Elevation in Tompkins County	Cornell University, Geddes Lab
Unique Natural Areas	Defined by the Tompkins County Environmental Management Council as areas with "outstanding environmental qualities" deserving of special protection	Tompkins County Planning Department
Public Open Space	All local and state parks within Tompkins County	Tompkins County Planning Department
Cornell Natural Lands	Natural and open space managed by Cornell University	Tompkins County Planning Department
Critical Environmental Areas	Areas which have a significant connection to one or more of the following criteria: a benefit or threat to human health; a natural setting (e.g., fish and wildlife habitat, forest and vegetation, open space and areas of important aesthetic or scenic quality);	Tompkins County Planning Department

	agricultural, social, cultural, historic, archaeological, recreational, or educational values; or an inherent ecological, geological or hydrological sensitivity to change that may be adversely affected by any change.	
Important Bird Areas	Areas which are critical to bird species habitat or breeding	The Audubon Society of New York
Electrical Transmission Lines	High voltage transmission lines which run through Tompkins County	Tompkins County Planning Department
Airport, Airport Approach, Airport Clear Zone	Areas around the Tompkins County Airport inside of which large-scale turbines would interfere with aircraft operation or safety	Tompkins County Planning Department
Distinctive and Noteworthy Viewsheds	Important viewsheds in Tompkins County as identified in the 2010 Tompkins County Scenic Resources Inventory	Tompkins County Planning Department
Emergency Communication Lines of Sight	Direct lines of sight between the Tompkins County Emergency Management radio and cell towers	Tompkins County Planning Department

Exhibit 2: Large-Scale Turbines Surveyed for Analysis

Turbine	Hub Height (m)	Sweep Area (m^2)	Cut-in speed (m/s)	Rated speed (m/s)
Vestas V82 1.65MW	~80m	5,281	3.5	13
Vestas V90 2.0	80m	6,362	4.0	12
Vestas V100 1.8MW	80m	7,850	3.	12
GE 2.5MW	85m		3.0	12
GE 1.5MW	80m		~4.0	~12
Gamesa G58-850kW	74m	2,642		
Games G90-2.0MW	78m	6,362		
Siemens SWT-2.3-101	80m	8,000	4.0	12

Exhibit 3: Small-Scale Turbines Surveyed for Analysis

Note: For small-scale turbines, hub heights are variable depending on site conditions

Turbine	Sweep Area	Cut-in speed (m/s)	Rated Speed (m/s)
Bergey Excel 1	4.9	2.5	11
Bergey Excel 5	30.2	2	11
Bergey Excel 10	38.5	2.5	12
Eoltec 6KW	24.6	3	12
Kestrel 800	4.15	2.5	11
Kestrel 1000	7	2.5	11
Kestrel 3000	12.5	2.5	11
Whisper 100	3.5	3.4	12.5
Whisper 200	5.7	3.1	11.6
Skystream 3.7	10.9	3.5	13
WTIC 31-20	70	3.4	11.6

Exhibit 4: NYSERDA options for Model Wind Ordinance[84]

Wind Energy Model Ordinance Options

The following is a mix/match menu of options for creating a local wind energy ordinance.

Because no two towns are alike, included are a variety of choices for addressing the many issues involved in a review of a proposed wind energy facility. The standards below are drawn primarily from adopted wind energy ordinances in New York State and around the country.

They are grouped under general headings that address different aspects of a wind energy ordinance. Typically, a few issues are addressed under each heading. Where there are multiple ways to address the same essential issue, we have provided "or" language to point out the choices. "And" language is used to identify review standards that are linked and should be used together. In some cases, just one sample standard on a particular issue is offered.

While some standards, particularly most of those that address safety concerns and setbacks, are basic and need to be included in any wind energy ordinance, other standards should be considered optional and considered for inclusion based on the particular circumstances, objectives and desires of each town or municipality.

Purpose

Any new wind ordinance standards should be accompanied by a purpose statement that explains the intent of the new provisions. Examples of possible purpose statements are as follows:

The purpose of this district is to foster the development of the Town's wind power resources while preserving farmlands and adjoining settlements as compatible adjoining uses.

Or

It is the purpose of these amendments to provide a wind power overlay district and certain regulations regarding setbacks and other requirements relative to wind power facilities.

Or

The purpose of the ordinance is to provide a regulatory scheme for the construction and operation of Wind Energy Facilities in the Town, subject to reasonable restrictions, which will preserve the public health and safety.

[84] NYSERDA. "Wind Energy Model Ordinance Options." October, 2005. http://www.gflrpc.org/programareas/wind/LL/NYSERDA_windenergymodelordinance.pdf

Findings

A brief statement of findings provides a rationale for the purpose of the ordinance. The following is a sample findings statement:

The Town finds that wind energy is an abundant, renewable and nonpolluting energy resource and that its conversion to electricity will reduce our dependence on nonrenewable energy resources and decrease the air and water pollution that results from the use of conventional energy sources. Wind energy systems also enhance the reliability and power quality of the power grid, reduce peak power demands and help diversify the state's energy supply portfolio.

Definitions

Wind energy facilities should be specifically defined in municipal zoning ordinances to ensure that the language of the ordinance legally applies to them. While some existing broad definitions for uses such as 'public or semi-public utilities,' 'industrial uses' or even 'accessory uses' might be argued to include some types of wind energy facilities, they are not likely to apply to the full range of wind energy facilities, including small to large applications. A specific definition of wind energy facilities also provides Towns with a basis for the adoption of approval and siting standards that are specific to this use. The following are examples of definitions for this use.

Wind Energy Facility: An energy facility that consists of one or more wind turbines or other such devices and their related or supporting facilities that produce electric power from wind and are a) connected to a common switching station or b) constructed, maintained or operated as a contiguous group of devices.

Or

Wind Power Generating Facility: Facilities at which wind is converted to another form of energy and distributed to a customer or customers.

Or

Wind Energy Facility: An electricity-generating facility consisting of one or more wind turbines under common ownership or operating control that includes substations, MET towers, cables/wires and other building accessories to such facility, whose main purpose is to supply electricity to off-site customer(s).

Information to be Submitted

Some of the following information may already be required to be submitted as part of a special use permit or site plan review. However, there may be a need to require the submission of some additional information, depending on the ordinance standards that towns adopt. The following are types of information that towns could request:

The applicant and landowner's name and contact information.

The tax map numbers, existing use and acreage of the site parcel.

A survey map at an appropriate scale showing the proposed location of the wind energy facility (including access roads) as it relates to the boundaries of the parcel, adjacent ownerships and existing residences/schools, churches, hospitals, or libraries to a distance of 2,000 feet (or other measure).

A survey map at an appropriate scale showing any federal, state, county or local parks, recognized historic or heritage sites, state-identified wetlands or important bird areas as identified in federal, state, county, local or New York Audubon's GIS databases or other generally-available documentation.

Standard drawings of the wind turbine structure, including the tower, base and footings, drawings of access roads, and including an engineering analysis and certification of the tower, showing compliance with the applicable building code.

Data pertaining to the tower's safety and stability, including safety results from test facilities.

Proposal for landscaping and screening.

A completed Environmental Assessment Form.

A project visibility map, based on a digital elevation model, showing the impact of topography upon visibility of the project from other locations, to a radius of three miles from the center of the project. The scale used shall depict the three mile radius as no smaller than 2.7 inches, and the base map used shall be a published topographic map showing man-made features, such as roads and buildings.

No fewer than four, and no more than the number of proposed individual wind turbines, plus three color photos, no smaller than 3" by 5", taken from locations within a three-mile radius from the site and to be selected by the Planning Board, and computer-enhanced to simulate the appearance of the as-built site facilities as they would appear from these locations.

Approval Standards

The standards chosen must be integrated into whatever local review process is used by the town. The standards that follow may be used in addition to existing special use permit and site plan review standards, if the town feels they are applicable, or the following may be used to create a stand-alone set of review standards that substitute for any existing review standards.

Typical site plan review standards for a wind energy facility would be those that assure proper design and site layout. This would cover most safety, setback and siting and installation issues. Typical special use permit issues for wind energy facilities are those that assure compatibility of the use with and minimal adverse impacts on neighboring properties. This would cover nuisance and most environmental and visual *issues. A town that uses both the site plan review process and the special use permit will be in the best position to fully consider all aspects of proposed wind energy facilities.*

A town that wishes to allow small wind energy facilities through an outright permitting or accessory use process with minimal review may still use some of the following standards, provided that compliance can be readily determined by the town's code enforcement office.

Safety

The minimum distance between the ground and any part of the rotor blade system shall be thirty (30) feet.

To limit climbing access, a fence six feet high with a locking portal shall be placed around the facility's tower base or the tower climbing apparatus shall be limited to no lower than 12 feet from the ground, or the facility's tower may be mounted on a rooftop.

Or

Wind turbine towers shall not be climbable up to 15 feet above ground level.

And

All access doors to wind turbine towers and electrical equipment shall be lockable.

And

Appropriate warning signage shall be placed on wind turbine towers, electrical equipment and wind energy facility entrances.

Towers shall be equipped with air traffic warning lights and shall have prominent markings on the rotor blade tips of an international orange color where the total height of the tower exceeds 175 feet.

Or

Use the minimum lighting necessary for safety and security purposes and use techniques to prevent casting glare from the site, except as otherwise required by the FAA or other applicable authority.

Or

Wind energy facilities shall not be artificially lighted, except to the extent required by the FAA or other applicable authority.

All wind turbines shall have an automatic braking, governing or feathering system to prevent uncontrolled rotation, overspeeding and excessive pressure on the tower structure, rotor blades and turbine components.

Prior to issuance of a building permit, the applicant shall provide the town proof of a level of insurance to be determined by the Town Board in consultation with the Town's insurer, to cover damage or injury that might result from the failure of a tower or towers or any other part or parts of the generation and transmission facility.

Any wind energy system found to be unsafe by the local enforcement officer shall be repaired by the owner to meet federal, state and local safety standards or removed within six months. If any wind energy system is not operated for a continuous period of 12 months, the Town will notify the landowner by registered mail and provide 45 days for a response. In such a response, the landowner shall set forth reasons for the operational difficulty and provide a reasonable timetable for corrective action. If the Town deems the timetable for corrective action as unreasonable, they must notify the landowner and such landowner shall remove the turbine within 120 days of receipt of notice from the Town.

Siting and Installation

Use existing roads to provide access to the facility site, or if new roads are needed, minimize the amount of land used for new roads and locate them so as to minimize adverse environmental impacts.

Combine transmission lines and points of connection to local distribution lines.

Connect the facility to existing substations, or if new substations are needed, minimize the number of new substations.

All wiring between wind turbines and the wind energy facility substation shall be

underground.

Or

Electrical controls and control wiring and power lines shall be wireless or underground except where wind farm collector wiring is brought together for connection to the transmission or distribution network, adjacent to that network.

The wind power generation facility, if interconnected to a utility system, shall meet the requirements for interconnection and operation as set forth in the electric utility's then current service regulations applicable to wind power generation facilities.

Any construction involving agricultural land should be done according to the NYS Department of Agriculture and Market "Guidelines for Agricultural Mitigation for Wind Power Projects" (which can be found at: www.agmkt.state.ny.us, "construction projects affecting farmland.")

Setbacks

The minimum setback distance between each wind turbine tower and all surrounding property lines, overhead utility or transmission lines, other wind turbine towers, electrical substations, meteorological towers, public roads and dwellings shall be equal to no less than 1.5 times the sum of proposed structure height plus the rotor radius.

Or

Each wind turbine shall be set back from the nearest residence, school, hospital, church or public library a distance no less than the greater of (a) two (2) times its total height or (b) one thousand (1,000) feet.

Or

All wind power generating facilities shall be located at least 50 feet plus the height of the structure from roads and side and rear lot lines.

Or

Setbacks for wind power generating facilities shall be 100 feet plus the height of the structure from lot lines and 1,500 feet from existing residential structures.

Or

The wind energy system shall be set back a distance equal to one hundred ten (110) percent of the height of the tower plus the blade length from all adjacent property lines and a distance equal to one hundred and fifty (150) percent of the tower height plus blade length from any dwelling inhabited by humans on neighboring property.

Or

Each wind turbine shall be set back from the nearest property line a distance no less than 1.1 times its total height, unless appropriate easements are secured from adjacent property owners.

And

Each wind turbine shall be set back from the nearest public road a distance no less than 1.1 times its total height, determined at the nearest boundary of the underlying right-of-way for such public road.

And

Each wind turbine shall be set back from the nearest above-ground public electric power line or telephone line a distance no less than 1.1 times its total height, determined from the existing power line or telephone line.

Nuisance

Individual wind turbine towers shall be located so that the level of noise produced by wind turbine operation shall not exceed 55 dBA, measured at the site property line.

Or

Audible noise due to wind energy facility operations shall not exceed fifty (50) dBA for any period of time, when measured at any residence, school, hospital, church or public library existing on the date of approval of the wind energy facility.

The applicant shall minimize or mitigate any interference with electromagnetic communications, such as radio, telephone or television signals caused by any wind energy facility.

Or

No individual tower facility shall be installed in any location along the major axis of an existing microwave communications link where its operation is likely to produce electromagnetic interference in the link's operation.

And

No individual tower facility shall be installed in any location where its proximity with fixed broadcast, retransmission or reception antenna for radio, television or wireless phone or other personal communications systems would produce electromagnetic interference with signal transmission or reception.

Environmental and Visual

Brand names or advertising associated with any installation shall not be visible from any public access.

Or

Wind turbines shall not be used for displaying any advertising except for reasonable identification of the manufacturer or operator of the wind energy facility.

Colors and surface treatment of the installation shall minimize visual disruption.

Or

Wind turbines shall be painted a non-reflective, non-obtrusive color.

Or

The design of the buildings and related structures shall, to the extent reasonably possible, use materials, colors, textures, screening and landscaping that will blend the facility into the natural setting and existing environment.

Appropriate landscaping shall be provided to screen accessory structures from roads and adjacent residences.

Where wind characteristics permit, wind towers shall be set back from the tops of visually prominent ridgelines to minimize the visual contrast from any public access.

And/or

Towers shall be designed and located to minimize adverse visual impacts from neighboring residential areas, to the greatest extent feasible.

And/or

The tower shall not significantly impair a scenic vista or scenic corridor as identified in the Town's comprehensive plan or other published source.

Or

No individual tower facility shall be installed at any location that would substantially detract from or block the view of the major portion of a recognized scenic vista, as viewed from any public road right-of-way or publicly-accessible parkland or open space within the Town.

Avoid, to the extent practicable, the creation of artificial habitat for raptors or raptor prey, such as a) electrical equipment boxes on or near the ground that can provide shelter and warmth, b) horizontal perching opportunities on the towers or related structures or c) soil where weeds can accumulate.

Wind turbines shall be set back at least 2,500 feet from Important Bird Areas as identified by New York Audubon and at least 1,500 feet from State-identified wetlands. These distances may be adjusted to be greater or lesser at the discretion of the reviewing body, based on topography, land cover, land uses and other factors that influence the flight patterns of resident birds.

Exhibit 4: Additional Community Wind Financing Options[85]

Private Placements: An unlimited amount of money can be raised through a private placement that does not have to be registered with state or federal securities offices. An Offering Memorandum or Prospectus is needed. A private placement cannot attract more than 35 "non-accredited" investors in any 12-month period; however, there is no limit to the number of accredited investors (e.g., high net worth individuals). In addition, there cannot be advertising or a general solicitation for investors.

SCOR Offerings: SCOR ("small corporate offering registration," part of SEC Regulation D) offerings are in-state offerings that are limited to $1 million, but have no limit on the number of investors. Again, the offering cannot be advertised. Registration costs and requirements are relatively low; however, the $1 million cap limits the applicability of SCOR offerings to single-turbine projects.

ULOE Offerings: The "Uniform Limited Offering Exemption" allows for an offering of up to $5 million provided that all investors are in-state and that there are no more than 35 non-accredited investors.

Regulation A Offerings: Regulation A offerings have no size or investor limits but have more extensive and expensive registration requirements and are limited to intra-state investors.

[85] The Environmental Law and Policy Center. "Community Wind Financing: A Handbook by the Environmental Law and Policy Center." 2004. http://www.elpc.org/documents/WindHandbook2004.pdf. P. 5

Exhibit 8: Large-Scale Siting Model

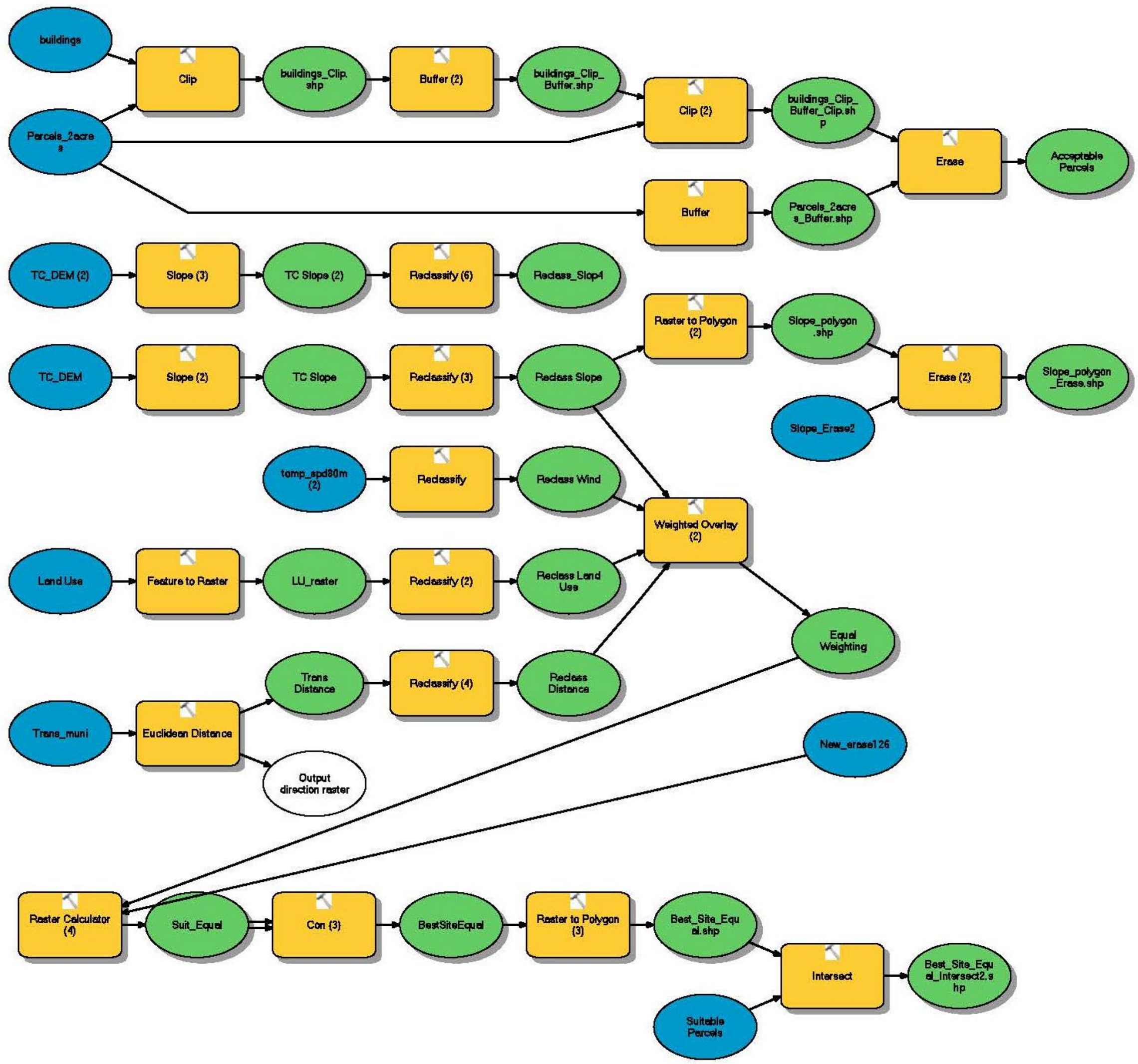
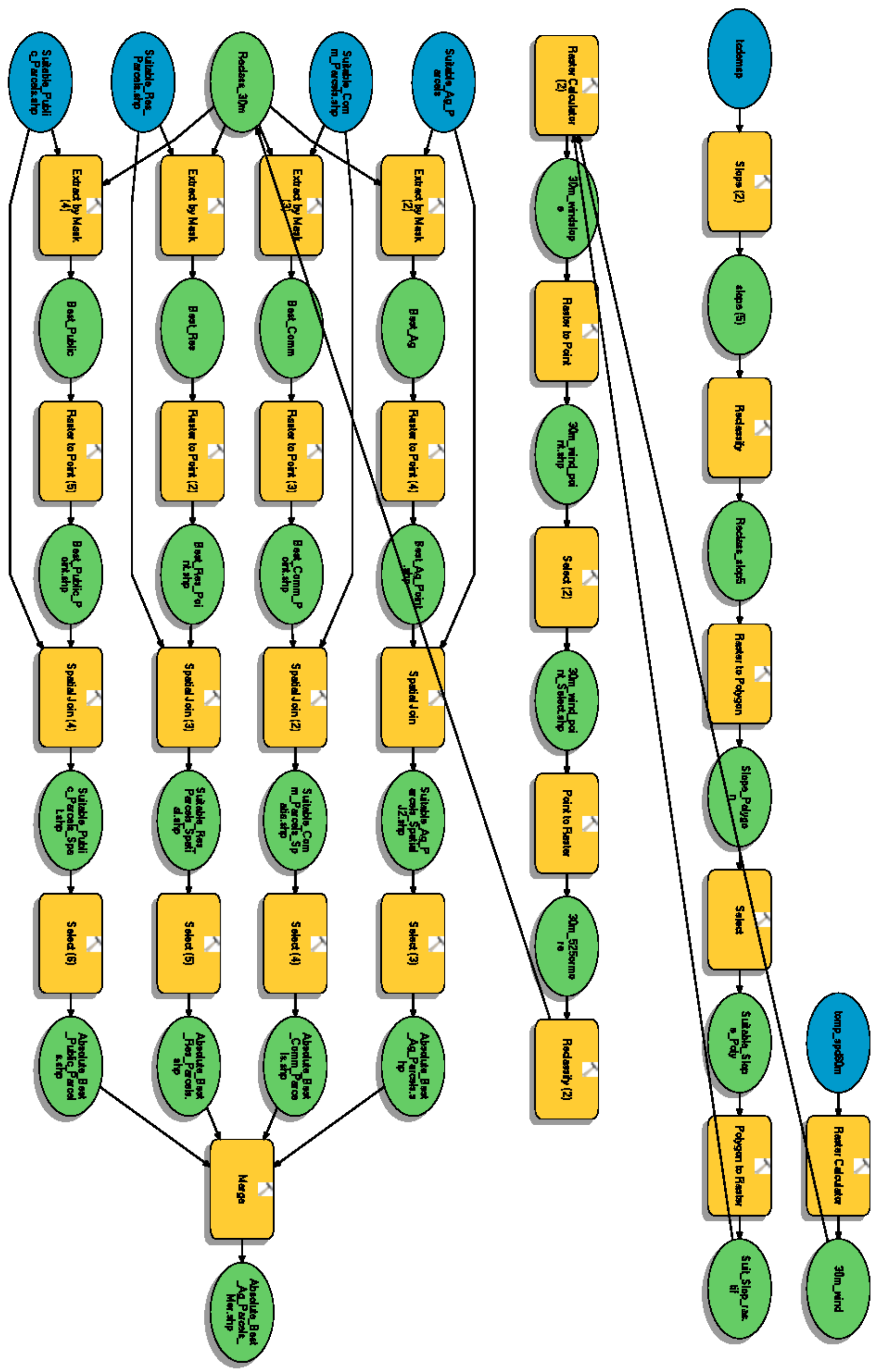


Exhibit 9: Small-Scale Siting Model



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