Citizen's Advisory Committee

Wind Energy

Task Force

April 2, 2010

McHenry County

CONSERVATION DISTRICT

Index

McHenry County Conservation District
Wind Energy Task Force
April 2, 2010

Introduction:

At the October 21, 2009 Citizen's Advisory Committee (CAC) meeting, the District announced the formation of a task force to research wind energy production and use on District property. The task force would be charged with seeking additional factual research specifically about wind energy but would not be asked to provide a consensus or recommendation on any specific wind energy system.

On January 11, 2010, the task force convened for the first time at Brookdale to discuss action steps for the initiative. The task force consists of the following CAC member volunteers:

CAC Members:	MCCD Liaisons:
Tom Paulsen (co-chair)	Martha Carver
Ed Laumbacher (co-chair)	John Kremer
Bill Clow	
Bill Howenstine	
Harold Abramson	

The task force agreed to follow a detailed outline of steps to accomplish its objective. Research topics include:

- current types of wind energy systems, requirements and costs,
- any wind studies and data available on McHenry County,
- any public initiatives related to wind energy and conservation entities,
- environmental studies conducted that include McHenry County or the State of Illinois, and,
- local, county and municipal ordinances that may pertain to wind energy systems.

The task force realizes this is a 'point in time' research effort. Technology, cost efficiencies and product specifications will change as these systems evolve. It is assumed that better product design will occur with evolving wind energy technology and costs will remain within a consistent range. Also, the task force will conduct the research with internet information and contact turbine manufacturers.

None of the task force members has previous wind energy expertise.

Appendix 1 provides a list of website references used for the detail research findings section.

Summary of Wind Energy Research Findings

The Task Force remains firm in its belief in the mission of the District to ensure that all conservation sites and associated wildlife and ecosystems are managed and protected in an ongoing, responsible manner. We support the District in exploring and implementing energy conservation measures provided they conform to the District's mission. From our research findings, we have concluded the following:

1. The U.S. Fish & Wildlife Service has established a protocol for evaluating the feasibility of wind energy from concept to post-construction. Though written for any site, some of which is not applicable to McHenry County, we believe it provides an adequate "road map" for evaluating wind energy use.

2. We were unable to find any published research on actual wind characteristics for McHenry County that was not a result of computer extrapolation of data from adjoining counties and/or, Wisconsin. Most all of McHenry County is classified as Class 2 (marginal wind) which is not conducive to large scale wind turbine use. Plus, the high cost of large turbines ($1.5 - $2 million and ongoing maintenance) makes it imperative to conduct a complete site analysis that can last from 2 – 5 years, depending on the site characteristics. The analysis should include, but not be limited to, measuring average daily wind speeds, topography, soils, location to the national grid and matching equipment to maximize power production.

3. McHenry County does not have a comprehensive wind energy ordinance to date. Local municipal ordinances are being drafted primarily for residential wind energy and have varying permit requirements. Due to long sight lines, cost, and public impact, the McHenry County Board and all local and state governments/agencies should communicate and establish a core ordinance for regulating the installation of commercial wind towers within the county.

4. Due to the high and ongoing cost of large scale wind energy, any purchase or installation of wind turbines must include a financial cost-benefit analysis and explore various funding options that may include:
   a. Leased land sites that currently run $8,000 to $12,000/tower annually;
   b. Public/Private partnerships or grants and;
   c. Sole public (MCCD) ownership.

   Public sentiment and local media need to be assured that any District renewable energy project incorporates efficient use of public funds while still adhering to the District's overall mission.

5. Regardless of size, long term maintenance contracts should be in place.

6. Should MCCD begin electric production, efforts should be made to utilize most of the generated power for MCCD's local site power needs. For example, the Task Force found currently available technology being implemented in Denmark and Hawaii on efficient vehicle battery-recharging stations using wind energy to make electric vehicles more viable for business use.

Detail Research Findings

Types of Wind Turbines and Equipment:

1. *Roof-Top Mini Turbines*

   These types of turbines are mounted at the highest point of the roof of permanent structures. They can produce 200 – 1000 Watts (1000W = 1 kW). They are best for applications in the 250-400W range and are primarily used to supplement residential power needs. They are susceptible to wind turbulence from obstructions close to the structure and vibration damage.

2. *Small Free-Standing Turbines*

   These types of turbines are mounted on their own free-standing towers and can be anchored on guy-supported wiring or a strong, single pole. These typically produce output in the range of 1 – 2 kW power and are used for residential or small business power needs. Tower heights for these types, minimally, should be 30 feet higher than any obstacles within 100 feet. The tower requires either a mounting foundation or attachment to a stable structure.

3. *Large Free-Standing Turbines (Commercial Grade)*

   These types of turbines are commercial grade and used for large applications and utility-scale projects. They produce power in the range of 100kW or greater. These turbines can power a small home and are best in rural settings. Permits will most likely need to be obtained along with conformance to local or municipal siting ordinances, ground surveys and site excavation/access roads. They are typically installed with mechanical cranes. The towers can be one-piece (self-supporting) or modular (guy-wire). Rotor lengths can run 16.5 up to 161 feet, with towers as tall as 225-265 feet. A controller is needed to regulate the rotors and cutout in severe winds.

4. *Micro Turbines*

   Technical research on very small turbines that are linked enmasse is being conducted by the wind energy industry. To date, this technology is far from being cost-effective or productive in providing sufficient energy volumes. Future research on micro turbines should be conducted by the District at the appropriate time.

Wind turbines are classified by their size or ‘capacity’ (how much electricity they can produce). They can be connected to the electric grid, but often are just connected to a battery bank instead. Most turbines produce variable DC voltage which is not usable by electrical appliances directly and require use of a ‘rectifier-inverter’ component to convert the DC to AC voltage. Most small-scale turbines are propeller or hydrofoil driven to catch wind from any direction.

A turbine only produces power about 20-30% of the time. To continuously power a site, battery stores or a grid tie-in must be used to supplement a wind energy system. A turbine needs to be about 4 times larger than the daily usage desired. Daily usage can be calculated by adding up 12 months kWh used, dividing by 365 (to get daily use), and further divided by 24 to get hourly use. Most literature appears to support supplementing wind energy with photovoltaic (PV) or other renewable energy sources. The average home uses about 1000 kWh (kilowatt hours) per month.

Location Demands of Wind Turbines:

1. *Does the site have enough wind?*

Wind energy is available 24/7. However, it is never a consistent resource and thus the turbine does not produce power 24/7. Wind maps for McHenry County (Illinois Institute for Rural Affairs (IIRA) and NREL) show the county is only in the ‘marginal’ class for wind (Class 2). Best wind for economic purposes appears to be along the Wisconsin border (northwest corridor of McHenry County) where it approaches a Class 3 rating. Turbines produce best at wind speeds of about 24-36 mph. Wind classes are determined at 10m (30 feet) heights above ground. For McHenry County, a 2007 IIRA study applies:

Height	Avg. Wind Speed
10m (30 ft)	9.6 – 10.41 mph
50m (150 ft)	17.09 – 18.52 mph (west)
50m (150 ft)	18.53 – 19.97 mph (east)
80m (240 ft)	21.42 – 22.85 mph

Also of note, in a marginal wind Class 2 area, it takes longer for a turbine to go from its cut-in speed (minimum wind speed to turn a turbine) to maximum power output. See Appendix 2 for table of wind class specifications from the National Renewable Energy Laboratory (NREL).

2. *Terrain*

Additional height is needed to avoid impacts to wind speed. Current and future proximity to buildings and trees must be considered. The power produced by wind turbines increases exponentially with average wind speed. For example, a site where average wind speed is 13 mph, can yield two times more power than a site averaging 10 mph. Turbines should not be placed in low points in the terrain.

3. State and Municipal Zoning Laws

All wind energy systems must meet and conform to local zoning ordinances. Particularly important are elements of these laws that apply to setback requirements, height restrictions, national wildlife migration corridors and public safety. Parks and recreation areas must consider neighbor opinion on blocked views and noise restrictions. At the present time, local governments are initiating task forces to prepare zoning regulations for wind energy systems (Johnsburg, Lake In The Hills, etc.), while some localities have yet to address wind energy. Counties (e.g. Lake, Henry, DeKalb, etc.) are also setting up ‘special use permitting’ processes for larger wind turbine projects. Large wind turbine projects (greater than 100 kW) can take 2-5 years from project start to end.

See Appendix 1 for links to Winnebago, Lake, DeKalb and Jo Daviess county wind energy codes and ordinances.

4. Towers

Proximity and height of towers supporting wind turbines also present unique considerations. Building attached towers can cause vibration and noise to the site and surrounding areas. There must be sufficient space around the site for tower installation, maintenance and safety. Underground lines to generators or battery stations will be a higher cost if the tower is located further from these key connection points.

Cost of Installation and Life Expectancy:

Cost Elements: Any wind energy project needs to consider the following initial cost components. All costs will vary greatly depending on turbine capacity and site selected.

- Cost of the Turbine
- Installation – Foundation and component location
- Project Management/contingencies
- Road improvements and construction
- Legal and public relations
- Transmission line construction - for grid tie-in (at MCCD cost)
- Permits and site surveys -for the turbine, power line(s) & roads
- Interconnection costs – from turbine to electric box or appliance
- Easements and trails

Recurring costs to consider are:

- Insurance (e.g. fixture replacement, liability)
- Maintenance (e.g. contracted, parts replacement)

Maintenance costs will be dependent on external factors. Small to medium turbines can have maintenance contracted through the manufacturer estimated at 10-15% of original cost contracted annually. The main components of wind energy systems requiring recurring maintenance are the turbine blades (due to damage or wear) and the gearboxes used by the turbine for controlling blade rotation during storms, high winds or extreme wear. Turbines can be susceptible to metal fatigue similar to that which occurs in the airline industry where constant stress on the metal components can weaken the overall unit.

Large turbines present even greater cost variability due to the technology involved and component prices. The Task Force was able to discuss large turbine cost factors with GE, Siemens and Vestas. Based on the information obtained, the following estimated cost components would need to be considered for a single turbine installation. Manufacturer cost quotes were difficult to obtain because advance planning and site studies need to be completed before actual pricing can be determined. These are estimated costs and can vary depending on local conditions.

Component	Estimated Cost Range:
Transformer	$ 15,000 - $20,000
Cabling (above and underground)	$ 25.00 per foot length
Foundations	$ 75,000 - $ 100,000
Road Installation	$ 90 - $100 per foot length
Tower Lighting	$ 10,000
Licensing & Permits	$ 5,000 - $10,000
Interconnection Studies	$ 25,000 - $50,000

From conversations with manufacturers, any project involving a large turbine installation should include a contingency expense at 20% of the overall project cost.

See Appendix 3 for types, sample specifications and cost information obtained from manufacturer and seller websites. Appendix 4 is a pictorial view of Appendix 3 turbines.

Life Expectancy: Most all turbine manufacturers list a time frame of 20-40 years. Exact measures are difficult to determine since many factors play a role in turbine life cycles. The very "mechanical" nature of wind energy presents the potential for multi-component failure. Other factors include weather damage and the degree to which the wind energy system is regularly maintained. Warranties on small to medium turbines average 5 years from date of purchase or installation.

Distribution**:** The task force assumes the District would use wind energy exclusively for its own, local site purposes. It is unknown at this time what the District power requirements from wind energy alternatives is (i.e. kilowatt hours desired). Current large scale utility providers (e.g. ComEd) do have programs available for net-metering and grid tie-in. Net-metering involves sale of unused wind power back to the utility at times of low usage. The cost effectiveness of any grid tie-in will depend on the site selected, power generated and distance from the utility transmission connection point.

Purchase of wind power from utilities is also available, but at a higher premium cost per kilowatt hour. Naperville and St. Charles, Illinois have programs that use this approach. The task force did not see this as an objective of the District and no further research went into this alternative.

Should the District be approached by a large-scale utility provider or land owner co-op to join in a partnership (e.g. provide land leasing, sharing costs), the task force strongly recommends these be evaluated on a 'case-by-case' basis for the impacted site(s) and follow the requirements methodology as outlined in the Summary Findings section.

Environmental and Wildlife Concerns:

As wind power (and wind farms) become more common, the need to address potential environmental impacts has increased. Illinois has about 436 documented bird species and is situated on what is called the 'Mississippi Flyway', one of the primary migration paths in the nation. This migration corridor is well-forested, has water supplies and no high elevations or mountains to pass. As a result, migratory wildlife is seen as more susceptible to wind turbine mortality than resident wildlife would be.

Avian and Bat Concerns – For the Lee-DeKalb County Florida Power & Light (FPL) wind farm, a spring and fall survey was conducted to identify potential migratory and habitat displacement impacts. Songbirds, red-winged blackbirds (resident) and grackles (resident) were the most commonly observed species along with red-tailed hawks (resident raptors). Similar to McHenry County, especially the western half, this result was attributed to the location being primarily corn agriculture and cropland with scattered wetlands. No federally-listed endangered species were observed. From a state 'threatened' perspective, northern harrier and sand-hill cranes were observed. The study concluded that potential mortality for migrating species exists on a 'seasonal' basis and that lower power lines presented more a threat to low flying birds (e.g. cranes) than turbines would. Of the songbirds, cowbirds and starlings were most observed with large populations and the study concluded no impacts to those populations. Nocturnal migrants also were not deemed as impacted since they fly at heights above most turbines and recent mortality studies show that less than .01% of those flying through wind farms are killed. The Illinois Department of Natural Resources (IDNR), in their 2007 study, also warned of potential impacts due to turbines located near wetlands (including Lake Michigan shorelines) that can impact arriving/departing bird flocks.

Bats pose a different mortality scenario. Recent media coverage and post-construction studies find that bats are more susceptible to large wind turbine mortality, but not due to external injury flying into turbines. A University of Calgary study (2006-8), found that bats suffered severe injury to their respiratory (lungs) systems as a result of sudden air pressure decreases as they fly close to turbine blades. The decrease in pressure causes the lungs to collapse/burst. Bats are primarily migratory and roost in trees but exact populations are difficult to measure. They are slow to reproduce and so impacts to their populations can be significant.

Displacement of Habitat: Deforestation to accommodate wind turbines reduces land cover and causes habitat fragmentation. The IDNR study found decreased nesting success of forest-nesting species, due especially to increasing populations of parasitizing brown-headed cowbirds in the fragmented habitat, many of which are in decline. Any grasslands, which can be shown to provide habitat for prairie grouse and prairie chickens, are also deemed critical and should not be candidates for locating turbines. The females cease visiting the breeding grounds plus turbines can isolate populations of the birds to prevent genetic interchange. The height of towers has been shown to also impact roosting sites of songbirds and resident wildlife since the sheer verticality of the tower translates to predator perching possibilities and thus are avoided.

Noise: In earlier turbine design, noise was a primary impact to humans and wildlife. Due to technical advances and better material components, noise has been reduced. The State of Illinois regulates noise via the 'Illinois Pollution Control Board (IPCB)' regulations. At a federal level, the EPA has issued guidelines for environmental noise but more as a definition of limits and criteria evaluation. Noise can also be variable due to surrounding conditions such as railroads, highways, agricultural activities and can also be seasonal with winter quieter than spring (and nighttime quieter than daytime) due to reduced activity.

Impacts on residential areas near turbines are controlled by measuring noise levels at property lines and adjusting a proper setback distance to bring noise under the regulating limits. IPCB regulations and local noise ordinances must be complied with before a turbine can be used on a continuous basis. For humans, the effect can not be accurately measured. Headaches, nausea and sleep deprivation are commonly reported.

Flicker: When the sun shines through the rotating turbine blades, it creates a periodic shadow called 'flicker'. It has a strobe effect that can be noticed by humans and wildlife and on sunny days, can be of high intensity. The industry has met this condition by following local ordinances that define the minimum distance a turbine should be from any residential structure (typically 500 feet for land owner, 1000 feet for adjacent property owners). However, the angle of the sun in the sky can still impact a site and if it happens, must be resolved after-the-fact either via local ordinance or mitigating actions. Wildlife tends to avoid residential areas and therefore may be found closer to the turbine location, so flicker and the amount of time flicker occurs at a particular spot may or may not be an issue. Species of birds and mammals which require open grasslands may be most affected by flicker since it indicates the presence of a predator (IDNR Study 2007).

<u>The Land</u>: There is no 'one size fits all' approach to evaluating risks associated with wind turbine installation and impacts on a site and surrounding land. Each site has a unique environment. Installation of a wind turbine has the potential for:

- Loss of natural resources and public trust to preserve land
- Change in natural drainage conditions
- Soil erosion around turbine sites and access roads
- Altering sediment conditions
- Loss of prime farmland
- Tribal or cultural objections to use of the land

The US Fish & Wildlife Service, through its "Wind Turbine Guidelines Advisory Committee", is developing guidelines (currently under review for public comment) for the Department of the Interior that define an iterative process for evaluating the risks and impacts to wildlife of wind energy projects. These "Best Management Practices "(BMP) for site selection and mitigating the impacts to the land include but is not limited to:

- Minimize the area that may be impacted by construction activities
- Use data (state & federal) of sensitive resources
- Use native species for restoration
- Establish buffer zones to protect sensitive habitats
- Follow Clean Water Act and Rivers and Harbors Act for storm water and erosion control
- Limit the number and length of access roads

The US Fish & Wildlife Advisory Committee is recommending a five-tiered approach for the guidelines which allow for decision-making at the completion of each tier. The process builds up information that a developer and wildlife agency can evaluate together. The five tiers are:

1. Preliminary evaluation or screening of potential sites
2. Site Characterization
3. Field studies to document site wildlife conditions and predict project impacts
4. Post-construction fatality studies
5. Other post-construction studies

In 2004-5, the Vermont Agency of Natural Resources (ANR) developed a comprehensive policy on wind energy and other renewable energy development on ANR lands. Extensive public comment and feedback was incorporated into a single policy covering both large and small scale renewable energy projects. See Appendix 1 for the applicable references to how ANR approached input for the policy.

APPENDIX 1

Website Research References:

US Dept. of Energy - www1.eere.energy.gov/windandhydro/

2007 Illinois Dept of Natural Resources Study - www.dnr.state.il.us/

Vermont Agency of Natural Resources (ANR) – Policy & Public Involvement
www.adamantaccord.com/docs/ProcessFactSheet.pdf
www.vermontwindpolicy.org/finalpol.pdf/
www.vermontwindpolicy.org/pubdeccom.pdf/

American Wind Energy Association - www.awea.org/

National Renewable Energy Laboratory (NREL) - www.nrel.gov/wind

National Wind Coordinating Committee (NWCC) - www.nationalwind.org

Denmark Re-charging stations powered by wind energy -www.betterplace.com

Wind Energy Warehouse Resellers – www.WindEnergyWarehouse.com/

Illinois Institute for Rural Affairs (IIRA) – www.illinoiswind.org/

DeKalb County Board – FPL Wind Farm Exhibits H, I – Turbine Impacts
www.dekalbcounty.org/Planning/windfarm.html

University of Calgary Study – Impacts on Bats - www.ucalgary.ca/news

US Fish and Wildlife – Wind Turbine Guidelines Advisory Committee
www.fws.gov

German Wind Industry Association – Standard technical specs for Large Turbines
www.wind.energie.de/hom

City of Naperville – Agreement to purchase wind energy
www.naperville.il.us/dynamic_content.aspx?id=16508

Sample County Ordinances on Wind Energy:
Jo Daviess - www.sterlingcodifiers.com/codebook/index.php?book_id=655
Lake -
temp.lakecountyil.gov/Planning/PlanningandSupportServices/Documents/WETF_Model_Wind_Energy_Ordinance.pdf
Winnebago - www.co.winnebago.il.us/deptNews_detail.asp?deptID=1082&newsID=274

Dekalb - www.dekalbcounty.org/Ords_Policies/pdf/09/Nov.pdf

APPENDIX 2

Classes of wind power density at 10 m and 50 m[a].

Wind Power Class*	10 m (33 ft)		50 m (164 ft)	
	Wind Power Density (W/m^2)	Speed[b] m/s (mph)	Wind Power Density (W/m^2)	Speed[b] m/s (mph)
1	0	0	0	0
1 / 2	100	4.4 (9.8)	200	5.6 (12.5)
2 / 3	150	5.1 (11.5)	300	6.4 (14.3)
3 / 4	200	5.6 (12.5)	400	7.0 (15.7)
4 / 5	250	6.0 (13.4)	500	7.5 (16.8)
5 / 6	300	6.4 (14.3)	600	8.0 (17.9)
6 / 7	400	7.0 (15.7)	800	8.8 (19.7)
7	1000	9.4 (21.1)	2000	11.9 (26.6)

This table was obtained from the National Renewable Energy Laboratory (Wind Energy Resource Atlas of the United States). Website: rredc.nrel.gov/wind/pubs/atlas

APPENDIX 3

Examples Chart

Type	Type:	Rating	Output	Cut-In	Rotor Length	Avg. Cost
Bergey Excel	**Free-Stand**	10 kW at 27 mph	* 24 - 120 VDC * 1480 kWh/mo at 12 mph	5 mph	* 11 feet length * 23 feet diameter	* $23-$29,000 per unit * Tower $10 - $17,200 (140') * 10 yr warranty
ARE 442	**Free-Stand**	10 kW at 25 mph	* 48 VDC * 1820 kWh/mo at 12 mph	6 mph	* 11 feet length * 23 feet diameter	* $40,000 per unit * Towers to $7300 * $50 - $80,000 complete * 5 yr warranty
ARE 110	**Free-Stand**	2.5 kW at 25 mph	* 48 VDC * 410 kWh/mo at 12 mph	6 mph	* 6 foot length * 11.8 feet diameter	* $12,700 per unit * Towers to $7300 * $20 - $35,000 complete * 5 yr warranty
Skystream 3.7	**Free-Stand**	2.4 kW at 29 mph	* 120/240 VAC * 400 kWh/mo at 12 mph	8 mph	* 6 foot length * 12 feet diameter	* $12,500 per unit includes tower * $ 15-$16,000 installed * 5 yr warranty
Supa-Flo Urbanite 1000	**RoofTop**	1 kW at 28 mph	* 120/240 VAC * 150 kWh/mo.	5 mph	* 3.5' high x 3 foot wide * 220 ibs. w/ generator	* $5,500 per unit * Mount adaptors $1500 * 5 yr warranty
GE 1.5MW SLE	**Large**	1.5 MW at 27 mph	* 690 V * 5.5 GW per year	8 mph	* 140 Feet length * 231 feet diameter	* $ 1.5 - $2 million unit includes tower * $500,000 install * $75 - $100,000 annual maintenance
NordTank 150 kW (Vestas)	**Large**	150 kW at 27 mph	400 V	8 mph	* 32 feet length * 66 feet diameter	* Refurbished $ 92,000 includes 80 foot tower * $315,000 new unit * 2 yr / 5yr warranty

* Rating defines vendor wind speed where turbines produce top power.
* Cut-In speed is the minimum wind speed to turn a turbine rotor.
* Cut-Out speed is the maximum wind speed a turbine can handle before damage.

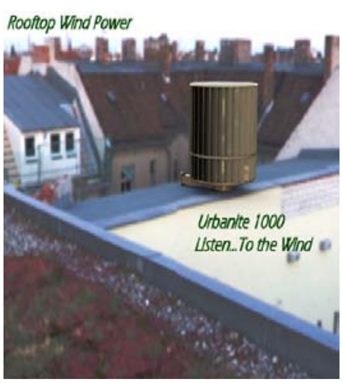
Appendix 4 - Pictorial Reference of Example Turbines


Bergey Excel – 10 kW


ARE 442 – 10 kW


ARE 110 – 3.5 kW


SKYSTREAM 3.7 – 2.4 kW



SUPA-FLO URBANITE 1000 – 1 kW


NORDTANK – 150 kW


GE SLE – 1.5 MW