Considerations on Using Wind Energy in Illinois; Making the Wind Work for You

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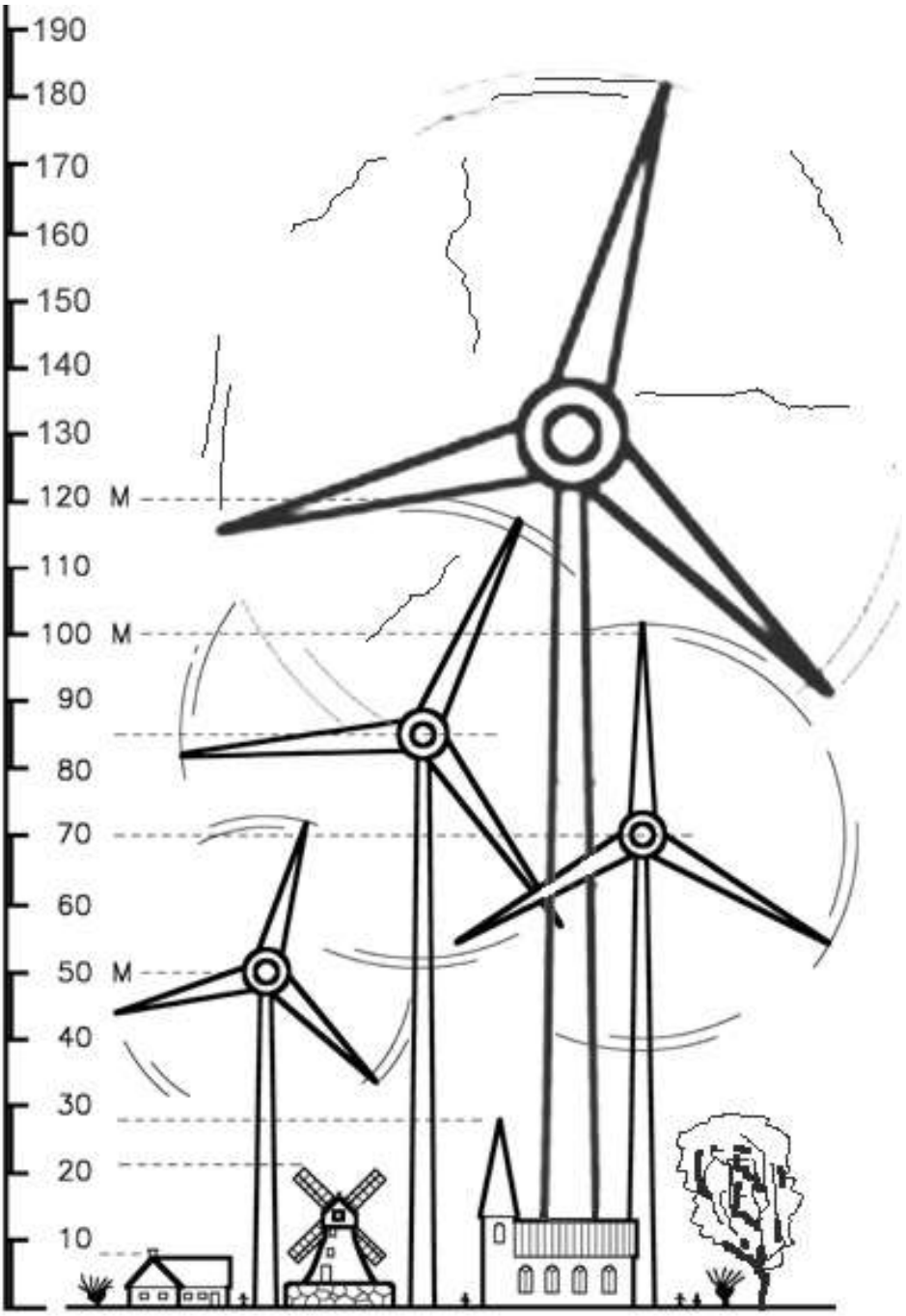


I have been a wind enthusiast for about 30 years. In the early 1980s, my father thought it was a good idea to investigate wind power so we started to learn about, sell and install wind turbines in the Rocky Mountain states – Wyoming and Colorado mostly. I was privileged to work with wind pioneers; Marcellus Jacobs and his son Paul of Jacobs Wind Electric, Karl and Mike Bergey of Bergey Windpower, Bob Sherman and Ned Coffin from Enertech, Skip Allan of the DOE/NREL and a small but growing group of wind power advocates. I helped site and install over 3 dozen turbines of various sizes. Some of these turbines even work today, I am pleased to say.

The largest turbine players at that time were the federal contractors - Grumman Aerospace, Alcoa and Hamilton Standard – General Electric tried and declined to pursue it, Siemens was not involved, no one had heard of Vestas, Nordex or Gamesa. Over the past decade that has all changed. Today, there are over 60 major players in the wind turbine business with billions of dollars at stake and tens of thousands of large and small turbines installed across the globe.

This paper will briefly introduce you to the potential of wind power and give you some guidance should you seek to find the wind way.

Does Illinois have good wind?

At 30 meters, the overall winds in Illinois are marginal but as you climb to higher elevations, the winds in Illinois at 80 or 100 meters are rated as good and better. My slide presentation will show more on this. So the answer is – Yes, Illinois has wind.

The U.S. wind energy industry shattered all previous records in 2008 by installing 8,358 megawatts (MW) of new generating capacity (enough to serve over 2 million homes), according to the American Wind Energy Association (AWEA). In all, wind energy generating capacity in the U.S. now stands at 25,170 MW, producing enough electricity to power the equivalent of close to 7 million households and strengthening our national energy supply with a clean, inexhaustible, homegrown source of energy.

Illinois ranks 9th out of the 50 states with installed wind power. There are over 400 turbines in Illinois with an installed nameplate capacity of 915 MW. The National Renewable Energy Laboratory has estimated that Illinois has the potential for over 9,000 MW of wind power and this does not count any offshore or large turbines. When the wind power potential studies were performed, the nameplate capacity of the largest turbines was 2.5 MW. Now turbines in the 5-10MW nameplate capacity are being proposed and so the overall wind power potential will increase as well. I foresee revisions to find about 15,000 MW of potential wind power in Illinois and that is not including offshore.

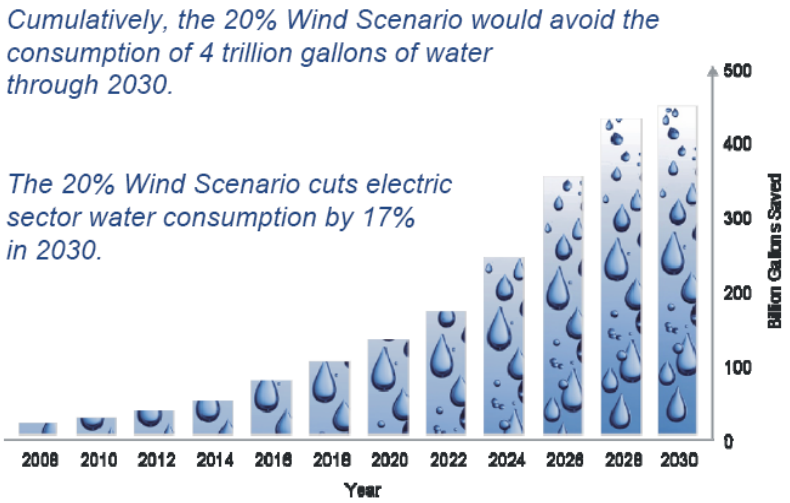
Wind power's recent growth has also accelerated job creation in manufacturing, where the share of domestically manufactured wind turbine components has grown from under 30% in 2005 to about 50% in 2008. Wind turbine and turbine component manufacturers announced, added or expanded 70 new facilities in the past two years, including over 55 in 2008 alone. Those new manufacturing facilities created 13,000 new direct jobs in 2008.
What about my specific site – are the winds okay?

I have had discussions on the decadinal differences of wind speeds on a site, the effect of the El Niño's or La Nina winds, even the potential for differences in wind speeds between two sites only 100 meters apart. All arguments have merit. The first truth, as I call them truths, is that at placing a turbine on a tower over 50 meters in height most everywhere has an adequate wind speed for the turbine to produce sufficient usable energy. You remain the deciding factor whether the amount of energy and the cost make it practical. No one should rule out a site in Illinois unless there are clear obstacles in the prevailing wind direction.

Why is using wind power of interest to us today?

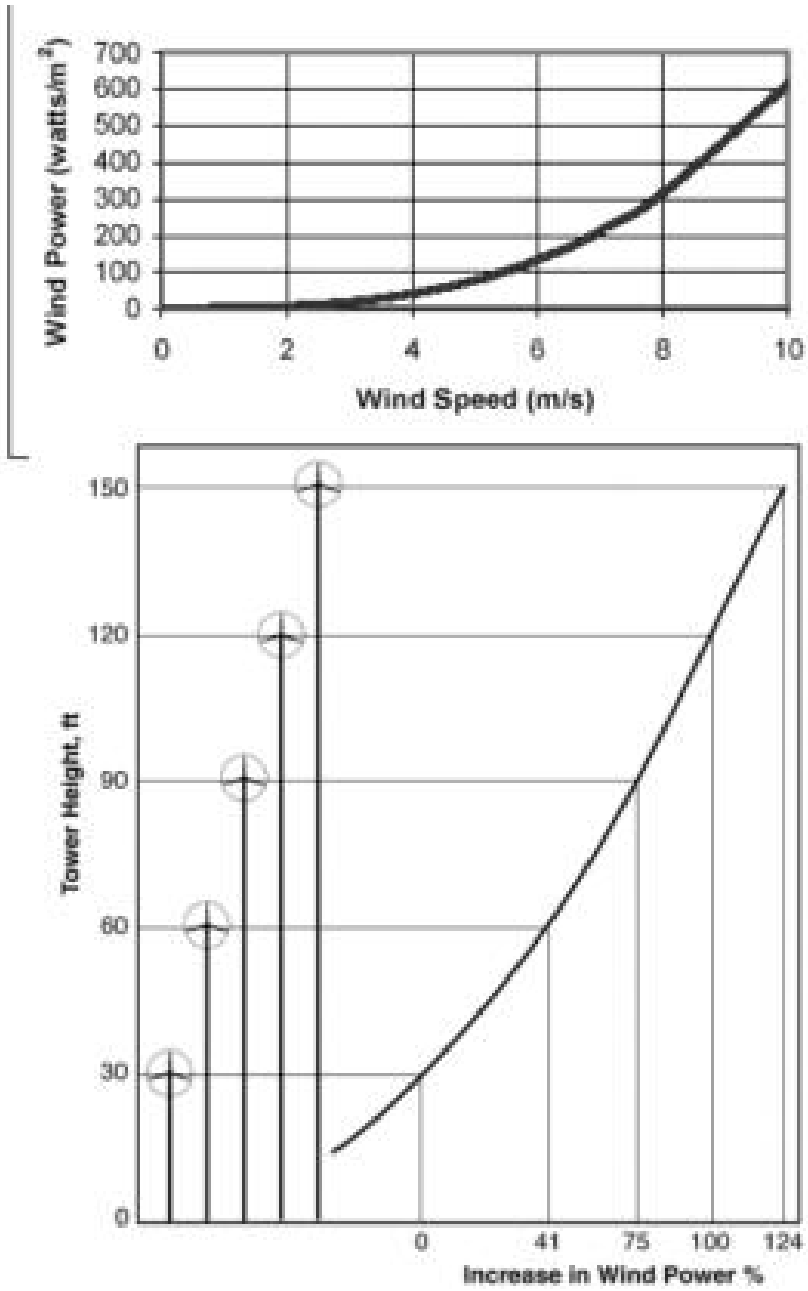
Wind power saves on greenhouse gas emissions. The studies show that using renewables offsets the use of fossil fuels. My presentation will provide some numbers.

Also, using wind power save water – other than the cots of the fossil fuels involved with electricity generation, water is the second largest component. Mostly due to the water used in cooling towers and with the steam turbines. If we can use wind power instead, we can save roughly 30,000 gallons for each MW of electricity produced. Those 400 turbines are saving up to 10 billion gallons of water each year. The graph below shows the potential if we produced 30% of our electricity from wind power.

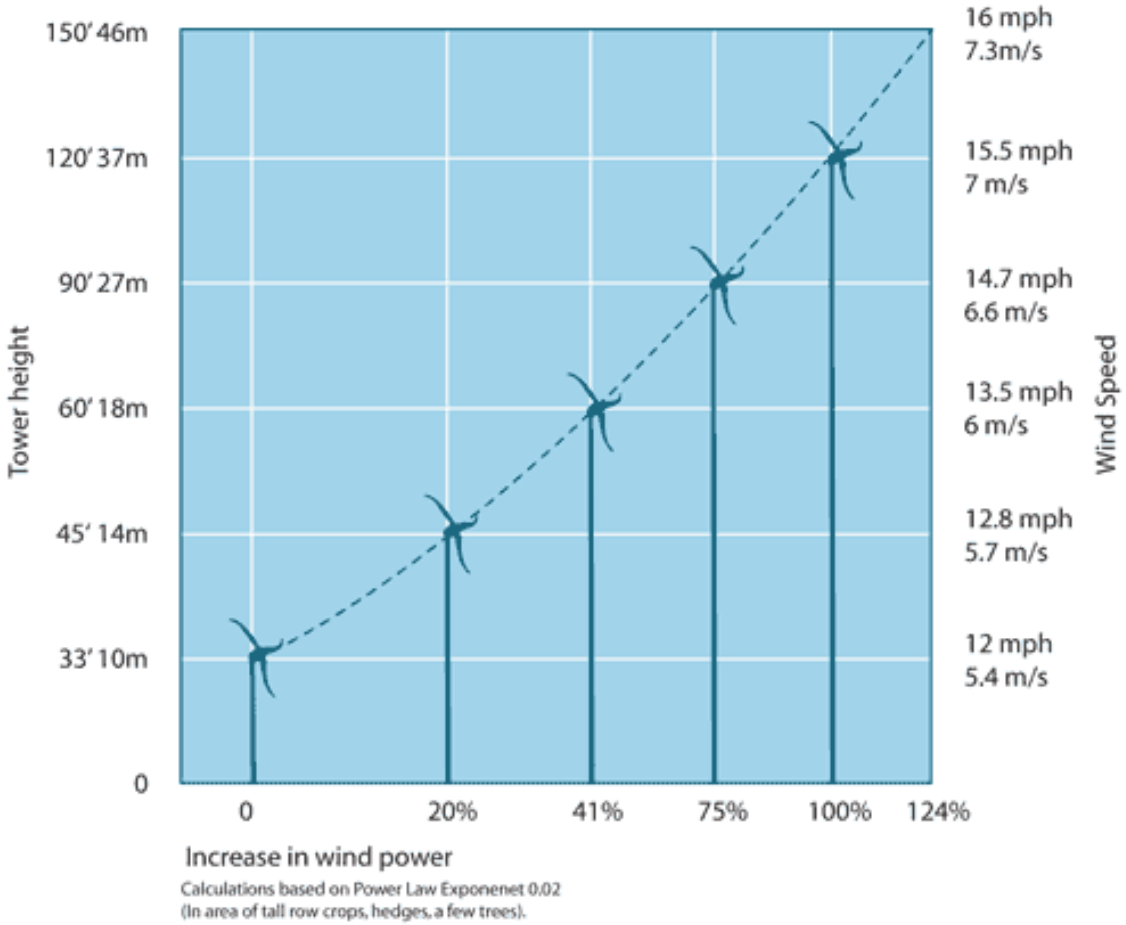


So the **first wind truth – wind power works most anywhere – not everywhere**.

Please do not get carried away with the differences between winds at 10-meters, 50 meters or 80 meters. Remember the **second truth - higher is always better**. Never let anyone tell you different. Never install a turbine of any size on any tower less than 30 meters. If you do, call it an experiment or a demonstration unit. This low site will cause you more aggravation than it is worth – I speak from experience. Mounting a small turbine to your sailboat is a good idea, that's the only give here. The table below illustrates the potential increase in useful power by going higher.



Basically, if you double the height of your tower, you gain 1/3 the power potential from the wind. What? By doubling the tower height, the wind speed increases about 10% and the power increases about 35% (the $1/7^{th}$ power rule). There is a realistic aspect to this because you may not be able to install such a tall tower on your potential site and so your project may not come to fruition. Please do not install a turbine on a smaller, say 30 meters or less, just do not do it. Regardless how attractive it is, it will not work out. I have experience here.



Energy Efficiency first!

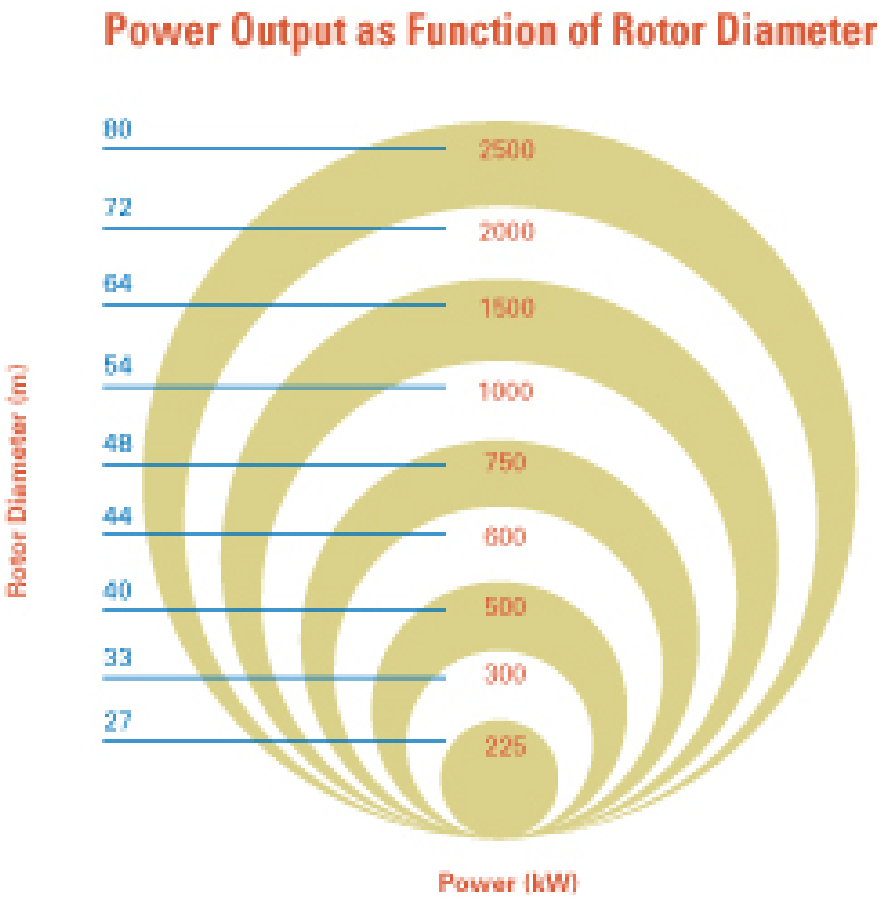
Energy efficiency does work and is the easiest and fastest way to reduce your power consumption and costs. I am assuming that you have considered and implemented energy efficiency and are still in need of additional power. So the **third truth - energy efficiency pays for itself** faster and better than any new fangled gadget or technology. Look at Amory Lovin's Rocky Mountain Institute website (www.rmi.org) – what Amory offers you as free information and guidance will pay many more dividends than most other measures. If you have become or are becoming more energy efficient and you still need power, please consider the installation of a wind turbine.

The **fourth truth - bigger is always better**. The wind turbine produces power by capturing some of the winds that pass through the propellers. So the more swept area you have to capture the wind, the more power you will produce. A man named Betz came up with a physical law that states you can only capture about 59% of the wind passing through an area. Right there, wind turbines are limited to being 59% efficient. But that is okay since any other generator loses about 40% of its power just getting to you in transmission losses. So wind is already on an equal playing field for efficiency.

Taking Betz to the next step introduces the fifth truth. Betz's Law shows that if you double the rotor diameter, you obtain four times the potential power. Yes, that is right, double the diameter, and get 4 times the power. So if you are considering a 20 meter rotor diameter

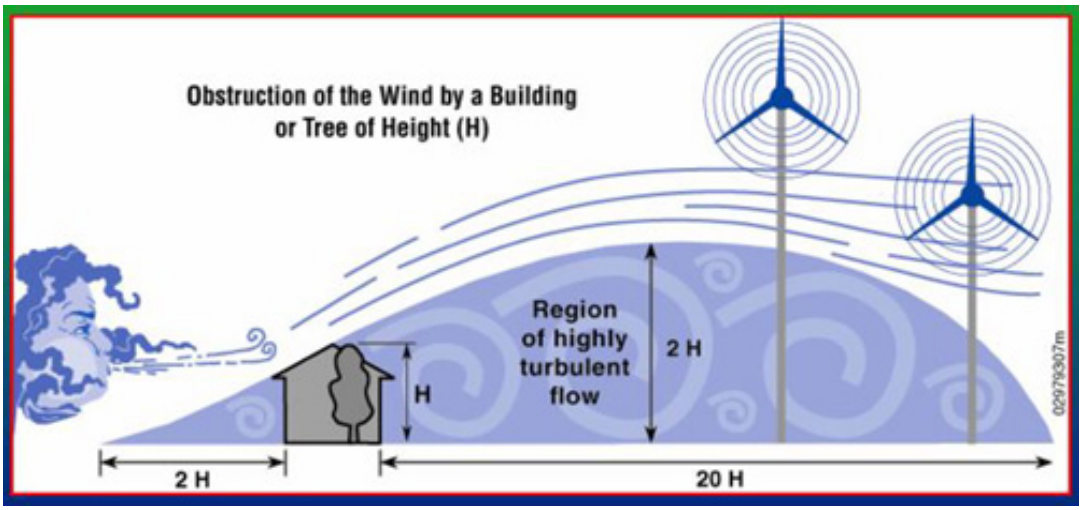
machine versus a 40 or 50 meter turbine, you get substantially more power by going with the larger rotor diameter – all else considered. It would be great if you could go from 20 to 40 meters but there is a cost factor to consider. Also if you double the wind speed, you get eight times the power output – this is called the Law of the Cube. The increased power output of the turbine may offset the additional costs.

So the **fifth truth – the larger the rotor diameter the more power.**



Now that you have a site picked out and determined a rotor diameter for the turbine. The next step is to ensure that you have no obstructions in the prevailing wind direction. What? Simply, do not install a turbine in a forest or in the middle of a group of buildings.
Turbulence will wreck most machines and can drastically cut their life expectancy. How do I know if I have an obstruction? Look around your site and identify any object taller than you within twenty rotor diameters of your proposed site. Again, the more distance away the better you are. In Illinois and most of the Midwest – do not forget crops. You would be amazed at the loss of production caused by those 3-4 meter tall corn crops on a 30-meter tower and turbine. Also, why just consider the prevailing wind direction? If the wind blows from the northwest, why would you look at the southern exposure? Yes, there are sites with good all round winds, but those are rare in Illinois and most of the world.

Therefore, the **sixth truth - avoid obstructions** from the prevailing wind direction for at least twenty (20) times the height of the obstruction. But that means I cannot place my turbine in a crowded residential neighborhood or downtown? Yes, that is correct. Forgetting the potential zoning and neighbor issues, it just does not make sense to do it. Believe me, I speak from experience. A 1.5- 2.5 MW turbine may sound like a diesel truck idling outside when the wind is mild, so a good rule-of-thumb is to place the turbine at least 400-500 meters away from homes, schools or occupied buildings. Remember when the wind is not blowing, the turbine produces little to no noise and when the wind is howling, you will barely hear the turbine. Please do not consider placing a turbine on a building that was not designed to take the extra stress and load.



How large of a turbine should I consider? How much can you afford? A simple napkin calculation is offered – add up all you spend on electricity per year and come up with the total for the next ten years and that is your beginning budget. All of those tax credits and grants should be gravy to the project. If you need to figure your project to the last penny, wind may not be for you. Why, but you are a wind enthusiast? You should be promoting wind? Yes, I am both but one bad wind project can sour an entire region. But if you had not heard, there are over 400 turbines in Illinois with hundreds more planned so wind works.

So the **seventh truth – your turbine budget should equal your ten-year power budget**.

That's right; calculate what you will be spending for your electricity needs for the next ten years. This is the budget estimate for your wind turbine project (or any portion thereof). My facility uses about 1,000,000 kWhrs per year at a cost of $110,000 so I should reasonably expect to purchase and install a wind power system for roughly $1,500,000 if I allow for minor inflation and cost increases. If you can install the system for less that's great. If you are being asked to pay more, please reflect on the costs to ensure that they are reasonable. Most modern turbines larger than 1 MW (50 meter rotor diameter) have a life expectancy of greater than 20 years. Some turbines that were placed in California in the later 1980's have been refurbished and are on their second life. There is a growing market in refurbishing older turbines and in repowering smaller turbines with large turbines, so there should always be a strong second-hand market for hardy turbines.

Net metering with your utility will help and that is what Illinois has (up to 2MW). You can joint venture with another utility, municipality or school district to acquire a larger turbine and share the produced power. So if your neighbor has a windier site, consider going together on a larger turbine. There are economies of scale with the larger turbines.

Below is a table that simply provides an estimate of annual power production from different size turbines at varying winds and height. This table can be used as a rule-of –thumb to determine the approximate turbine size needed to produce a desired amount of energy. For example, if you needed to produce 4 million kilowatt-hours per year (4.0 MkWh/yr) you could use a 70 m turbine in a Class 4 wind area at 80 meter tower height or a 90 meter turbine at less than a Class 3 wind site or a 50 meter turbine at greater than a Class 5 site (a very rare site). Please err on the conservative side and go larger diameter on a taller tower-remember the wind truths.

		Rotor Diameter (m)		
Wind Class	Tower (m)	50m	70m	90m
3	50	2.0	3.5	6.0
4	80	2.5	5.0	8.0
5	100	3.0	6.0	10.0
		MkWh/yr		

Table 1 Estimated Annual Turbine Production

Summary

Let's review - I am hopeful that in my short speech, I will have shown you dozens of turbines – some of the turbines shown are located in Illinois or surrounding states. All of the turbines are operating, producing power under all kinds of wind speeds, in all kinds of terrain and weather.

I hope that you have learned that wind power is a viable energy resource in Illinois.

I have passed on to you several truths that should be considered unless you knowingly decide to ignore them. Believe me, some projects do proceed full tilt because the owner wants to make a statement, wants to help the planet, is making a choice to pursue their energy freedom, to promote a renewable resource, to show that you care about the future and our planet or for any number of valid exciting reasons.

If you are one of the lucky few who decide to go the wind way – you will have fun along the way.

The Wind Truths
So here are the truths again

1. Wind power works most anywhere.
2. Higher is better, start at 30 meters and climb
3. Energy Efficiency dollars are well spent
4. Bigger is always better, don't look at KW size, compare rotor diameter
5. The larger the rotor diameter or the more wind - the more power potential
6. Avoid obstructions, stay clear - twenty times the height of the obstruction
7. Use the next ten-year's energy costs as your beginning budget.

Web Resources
Here are good websites that offer some good advice and counsel – maybe better than I have done here today:

http://www.awea.org
http://www.the-mrea.org/smallwind.php
http://www.wind-works.org/
http://www.20percentwind.org/
http://www.wind.ilstu.edu/
http://www.nawindpower.com
http://www.glrea.org/
http://www.rmi.org
http://glc.org/energy/wind/
http://www.thewindwaycom/ (yes, this is my site – give it a look)
http://www.windpoweringamerica.gov/
http://www.windustry.org/communitywind
http://www.illinoiswind.org/

Dates to Remember
Now for some important dates for wind power in the Midwest in 2009:

March 3-4	Michigan Wind Conference	Detroit, MI
May 5-7	American Wind Energy exhibit and conference	Chicago, Illinois
May 8	Wind Powering America State Summit	Chicago, Illinois
June 16-17	Midwest Renewable Energy Small Wind Conference	Steven's Point, WI
July 15-16	Advancing Wind Power in Illinois	Bloomington, Illinois
	Great Lakes Wind Collaborative Annual	Milwaukee, WI

If you need to get in touch with me, please do so

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