Above: South view of our super-insulated, passive solar home in process, with the big Jacobs in the background.

Turbulence: Wind power, zoning, and the 90's

Shawn Otto

Our place is named Breezy for a reason. The wind blows and blows here, which is, well, sort of unique for this small eastern Minnesota community near the banks of the St. Croix River. A lot of people have old rickety, rusty water pumpers that have long ago become relics, nestled in a grove of mature elms, overgrown with ivy, debladed and nude. These things stand as crusty emblems of country life in Minnesota. But they are only emblems. Few folks in our area have wind generators, the newer, sleeker, beefier cousins of these old farm hands, and that's as good a place as any to begin this tale of renewable energy and what to watch out for with your windy dream.

A healthy fever

A little over a year ago, Rebecca and I finally closed on our ideal parcel, 30 rolling, grassy acres abutting ponds and wetlands in May Township, Minnesota, about 35 minutes northeast of the Twin Cities and a stone's throw from Big Marine Lake. We picked a spot with a good south-facing hill to berm into. We designed a superinsulated, passive solar-assisted home with an insulated slab, hydronic heating tied into a masonry

wood heater, and super-efficient appliances. Even before we began building, we would take long, slow walks out in the natural prairie grasses, wading through them, listening to them whisper and spit, and we began to notice that they were almost never still. The wind was almost always blowing. For people who think like we do, the next idea was a simple step in logic—wind power. We didn't realize what a huge leap we had just made, but our feet were already in mid-air, committed.

Innocently, we went boldly forward. It would cost about $3,500 for our electrical cooperative, Anoka Electric, to bring power up our 1/3 mile driveway. This would cost about half as much as a good battery bank. With a utility intertie wind system, we could use the utility as our battery bank and maybe even provide excess power. Minnesota is a net energy billing state, so Anoka would pay us the same 7 cents per kWh they charge. After a good deal of common sense research, we decided that, dollar-for-dollar, buying a used Jacobs 10 kW Machine from Mick Sagrillo at Lake Michigan Wind & Sun was our best value, at about half the cost of new. It was either that or the 10 kW Bergey, which requires much less maintenance. We wanted a payback period in our lifetime, and I didn't mind the idea of climbing the tower and greasing up the bearings twice a year, as a kind of sacrament. In the end, we bought a machine Home Power readers have seen before - it was featured on the cover a few issues back, as the demo at the 1994 Midwest Renewable Energy Fair (MREF) in Amherst, Wisconsin. It's also the first wind tower Karen Perez ever climbed, I heard on good authority.

So far, so good...

So far, everything was a cinch. Dig the holes, pour the footings, stand up the tower, and bolt the generator to the top. The only complexity was a formality—our township had a height ordinance that required a conditional use permit for structures over 35 feet high. No big deal, though, since this was a rural area and there were plenty of water pumpers, barns, and old silos higher than that. Think again!

At our first public hearing, two neighbors showed up who were dead set against our tower. The commissioners' faces became hesitant, their eyes focused inwardly on questions of liability, litigation, and precedent. They became concerned that if they let us go ahead, somehow wind generators would suddenly proliferate, popping up all over the township, as if that were a bad thing, and that some kind of ordinance was needed to control this. The "evil neighbors," as we came to call them, played to these sentiments, painting wind generators as horrible, dangerous, bird killing, noise polluting, aesthetically grotesque, property value detracting attractive nuisances that, besides all that, just plain didn't work. The planning commission balked and tabled the matter pending research and development of an ordinance governing wind generators.

In many rural communities, this kind of scenario would seem somewhat ridiculous. This is America, and you've got the right to do whatever you want to as long as it doesn't infringe on your neighbors' rights to do the same. But in the area where the greatest growth in interest in renewable energy exists—small acreage hobby farming communities near major metropolitan areas—things are getting too constrictive. Neighbors are closer, less trusting, and more likely to seek control over each other's activities. This suggests a need for a whole new set of zoning laws addressing cogenerated and stand-alone renewable energy systems.

Research is Power

Reasoning that our problem was not unique, we contacted several professionals in the wind energy business. Universally, we felt exasperated with what were,

indeed, increasingly common circumstances. Unfortunately, examples of ordinances or even anecdotal stories of how these problems were solved was lacking. We did run into one couple from Wisconsin at MREF'94 who had a zoning horror story that lasted three years, ending with a permit granted with severe restrictions. As our process progressed, it began to look like this could happen to us, also. One of the board members commented at the third meeting that by the time they got done adding conditions, the only place we would be able to erect our generator would be in a cave.

The "evil neighbors" were grumpily traipsing forward every month with new angles and new research on how wind machines would be a bad thing, or how they should be required to be placed only in the geographic center of lots at least forty acres in size (wonder how they arrived at that number?), or how they should be nowhere near wetlands because of the birds, or how they sounded like helicopters, or how they should be required to have trees planted around them to screen them from view. Our approach was to present both sides of the facts clearly, to out-research our "evil neighbors" (which was easy with *Home Power* and *Wind Power for Home and Business*, by Paul Gipe), and to remind the townspeople and board members of the values we held that made this so important to us. Slowly, reason began to prevail and the board grew irritated with the constant and transparent tirade conducted by our "evil neighbors." Slowly, our amassed research began to influence the formation of the ordinance. Slowly, an important precedent in favor of renewable energy was codified into law in our community. Slowly, good triumphed, and eventually, we were granted a permit to erect our tower.

Looking back on the experience, it is easy to understand the quick exasperation of wind energy dealers with some zoning laws. Many don't account for a wind tower's unique circumstances. On the other hand, the concerns of town and county commissioners about precedent and liability, with little or no body of law to fall back on, are understandable in today's litigious society. Standards are needed to encourage wind energy's safe and effective development within a community. They should act as a guide for wary town boards and city councils who feel they are flying in the dark, have little exposure to the idea of wind generation, and lack informed sources.

Those standards are slowly developing, in the form of local ordinances. To promote reasonable laws, renewable energy advocates need to help educate others in this process. In our case, we were heavily involved in the research and drafting of the eventual ordinance. Had we an example early on, our process could have been greatly foreshortened. We are enclosing a sample ordinance (see sidebar and editor's note) that may be codified in township, city, or county law. It will provide a practical format for fostering the safe and reasonable use of wind energy in our communities.

Here are some common concerns your community board is likely to have about wind energy.

Tower height

Tower height is a key factor in wind generator performance. The rotor arcs have to be at least thirty feet above any objects within 300 feet, including trees, to avoid power-robbing turbulence. *Home Power* has printed several very educational articles by Mick Sagrillo on the physics behind this rule. In short, wind generators come with three relatively standard tower heights: 80 feet, 100 feet, and 120 feet. To simplify, the higher the tower the faster and more powerful the wind, because it's not getting chopped up by terrain, trees, and buildings. Ours is an 80 foot tower, which is a sufficient height for our high, open hill. Most locations require 100 to 120 feet for economic performance. Most people cannot visually perceive the difference between 80 and 120 feet without some reference.

Tower location

The tower should be located within the normal setbacks for structures on your parcel. Towers are typically engineered to standards far superior to homes and tall buildings and can withstand severe winds - in excess of 100 mph - with no damage. Statistically, trees are far more likely to fall and your roof more likely to blow off. This is what you have insurance for. Your municipality, however, will likely still err on the conservative side, requiring the tower to be located at least its own height away from all lot lines. This is called the "fall zone" of the tower.

Tower safety and access

There are competing arguments on the issue of safety. One side says: somebody might climb it and fall off ("attractive nuisance") so you should fence it to deter that. There are eight arguments against this idea. One, the fence is as much if not more of an attractive nuisance as the tower. Two, if somebody decides to climb an 80 foot tower, a six foot fence isn't going to stop them. This is our position, which made sense to our township and county boards.

Three, in our case, the tower is located several hundred feet away from the road. A person would have to trespass pretty heavily just to find the base of the tower. Four, even if someone *did* find the base, the bottom twelve feet of rungs will be removed, making

Top Left: Tower base showing base junction box and required signage

Bottom Left: Some massive footings - 6 yards of concrete piers reinforced with 1" rebar each tied into a 2' x 5' x 5' pad buried at eight feet. The angle iron bases are held in place by this wood template while the concrete sets.

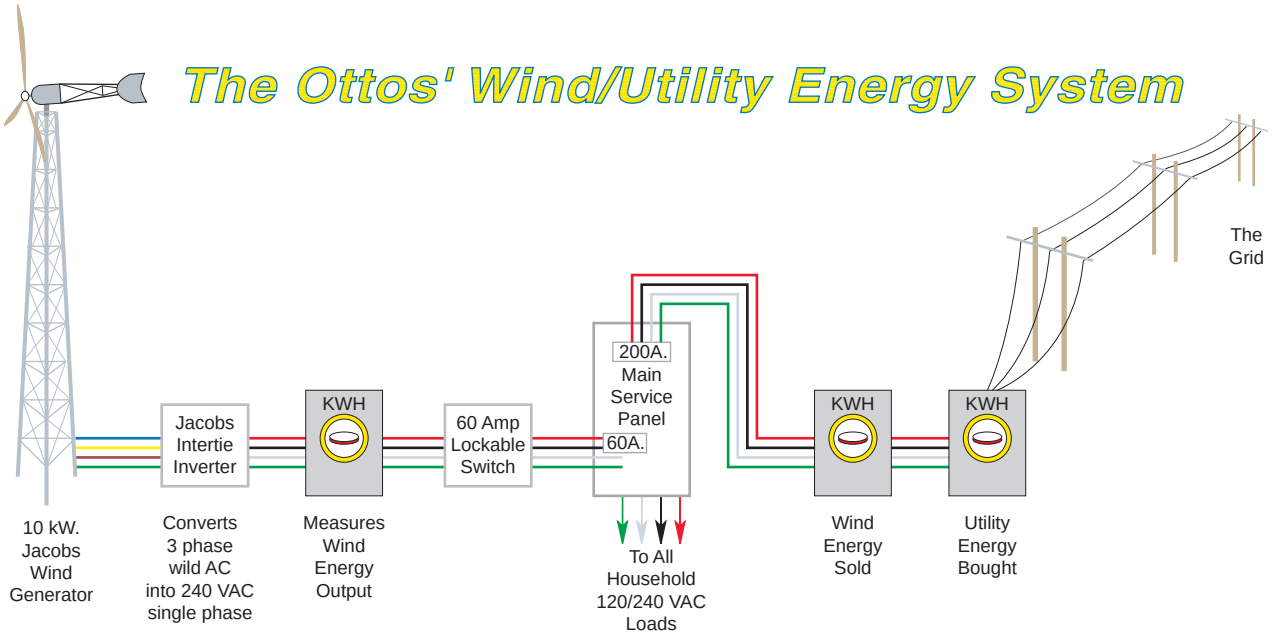
Above: One of the three tower footings up close.

the tower difficult to climb. Five, the tower will be posted with a sign stating: "Danger: High Voltage!", which will be a far stronger deterrent to most people than a fence. Deterrence is what we are discussing here. Six, a locked fence, aside from being a maintenance and aesthetic nuisance, is in itself a safety hazard during an emergency. What happens when the brake should be pulled on the generator but can't because the gate is locked and nobody is home? Or the key can't be found? Seven, the utility may want access to the base of the tower to manually shut down the system in a power outage, in addition to using the safety disconnect. And, eight, grass is preferred to a fence in the event that a worker (or trespasser) should fall from the tower.

Other issues of safety include proper tower and footing design. Our tower is manufactured by Rohn, one of the largest tower makers in the country. It is specifically engineered for the Jacobs wind generator. It is also designed to withstand direct 100 mph winds. The footings are also designed by Rohn and must be made to their spec. The whole works is to be inspected by the building inspector. This is typical procedure for all manufactured towers.

High winds

Operation for our "Jake" peaks and remains constant in wind speeds over 25-27 mph. At wind speeds higher than 40 mph, each rotor blade automatically begins to twist on its axis, feathering itself out of the wind and so reducing speed, power, and torque. As wind speed climbs even higher, up around seventy-five miles per hour, the manual recommends shutting the system down using the manual brake. Wind generators of this



design have withstood hurricanes. All major wind generators today have some form of automatic governing system like this, with very, very secure track records. Wind generators are designed to survive without constant supervision at remote relay stations, where a breakdown causes severe problems.

How it works

The generator is in most cases a large ac alternator, which spins when wind turns the three rotor blades. In our case, each blade is eleven feet long. Together, the blades and hub have a diameter of 23 feet. For residential sized generators, this varies down to about eight feet and up to about twenty-six feet. As the wind machine spins, it generates electricity, the amount of power goes up and down depending on wind speed. This "wild" electricity is then run through a power conditioner, usually a synchronous inverter, which cleans up the signal and changes it into line quality electricity. Our inverter is hooked into the main breaker panel through a 60 Amp breaker. When the wind is blowing, we consume much of the power the wind generator is producing, reducing the power we draw off the utility grid. When we are not using all of it, the excess of generated electricity is pushed through a second meter (measures backflowing current) and back out to the utility's lines where the utility sells it to someone else. This wiring is governed by the National Electric Code, and is inspected by *both* the electrical inspector and the utility *before* hookup. We actually entered into a cogeneration contract with the utility.

Above: Our detent meters. Service meter on right measures inflowing power. Wind Generator meter on left measures outflowing power.

Birds

Several years ago, one wind farm in the Altamont Pass in California became known for bird kills—raptors, in particular, flying into the rotors or the lines coming from the generators, when strung above ground. This has raised the untrue criticism and unfounded concern that wind generators are especially dangerous to birds. Donald Aitkin, of the Union of Concerned Scientists, presented a study at MREF'93 (Amherst, Wisconsin) which shows that even in the Altamont Pass, the rate of kill is one bird per wind generator every 20 to 40 years, extremely low. The Minnesota Audubon Council of the National Audubon Society recently passed a resolution based on a report prepared by an independent consultant regarding the Buffalo Ridge area of Minnesota, and proposed commercial wind farms be sited in that area. The Council urged avian mortality

studies be done before siting of any large scale wind farm. However, the report went on to affirm that "avian mortality attributed to transmission lines, communications towers and other man-made structures was significantly greater than mortality reported to date for wind power installations." It also revealed that "studies of single wind turbines during the 70's and 80's concluded that there was little to no impact on birds (Howell, et al, 1991)." In fact, birds are not stupid, and are statistically (and logically) far more likely to die hitting a high voltage power line, flying into a picture window or being hit by a car. Statistically, far more birds are killed by the environmental consequences of conventional power sources than by wind generators. For instance, Donald Aitkin points out that it would take the Altamont Pass wind farms about a thousand years to kill as many birds as the Exxon Valdez spill did in just two weeks.

ElectroMagnetic Interference (EMI)

EMI is another non-issue. The rotors of wind generators are typically made of basswood, sitka spruce, or fiberglass so they will bend and flex with wind gusts. Metal blades, found on large commercial wind generators, could cause an electromagnetic reflection. However, wood and fiberglass are electromagnetically transparent and cannot.

Noise

Our ordinance requires that we meet all standards set by the Pollution Control Agency regarding noise pollution. In fact, PCA workers I've talked to know this is not even an issue. Paul Gipe, in what is far and away the single most comprehensive resource manual on wind power, *Wind Power for Home and Business*, cites sound pressure levels in decibels for various noises. Wind in trees is rated at 55 decibels while our wind generator is rated at 50. Wind generators operate only in wind, when buildings and trees are making noise as well. While audible, the sound is neither loud nor obnoxious. One must compare this to other sounds we have come to regard as a necessary part of modern life: cars, airplanes, lawn mowers, etc., all far louder.

The barely-audible noise of a wind generator on a windy day is a small reminder of responsible and clean use of our natural resources. It takes burning about two pounds of coal to produce just one kiloWatt-hour of electricity. The average American house uses about 600 kiloWatt-hours a month—about 14,000 pounds of coal burnt every year. That's a lot of acid rain. Most folks will opt for the whisper in the wind any day.

Aesthetics

The wind generator is generally painted a color to blend in with the sky. The common lattice type tower becomes invisible from a distance of a few thousand feet. The three blades of the rotor whipping around in the breeze is an intriguing and almost hypnotic sight to most people, like a campfire. It is less visually massive than a house or barn, since it is narrow and see-through. It is a colossal weather vane, reporting at a glance both wind speed and direction, drawing nearby residents into a more intimate relationship with the sky and its nuances of weather. But a wind generator's purpose isn't aesthetic; it's utilitarian. It does a very important job: it produces pollution-free electricity so that natural beauty may be preserved. Those who still object must remember two truths. One, we do not own our view of others' property. Two, far uglier than a wind tower is the specter of greenhouse gasses, coal smoke, acid rain, and mercury in our lakes. It's easy to ignore if it's not right next door, visible to the eye.

Above: Bolting the tower sections together.

A word about the utility

Most utilities these days are coming around to the idea of wind power, especially the rural electric cooperatives. Most utilities now have direct experience. Many rural and semi-rural cooperatives have at least one or two systems on line. At Anoka, Russ Wagner is the Energy Use Specialist. His job is to promote energy efficiency through a variety of programs. He also handles the cogeneration contracts. His help and support were extraordinary. Asking your utility if they have an energy use specialist is the best place to start. But do your homework up front. While utility approval for us was easy, *your* utility may be inexperienced with cogeneration and it could take *months*.

The Early Bird

One last word—don't wait. Lobby your area to get a similar code on the books now, at the town, city, and/or

county level... don't let your "evil neighbors" get there ahead of you. And P.S.—it is all worth it, no matter the cost, watching those blades go around, knowing you are really being good to the earth. This is how things change—one conscious family at a time. Last night was windy up at Breezy. We shipped 135 kiloWatt-hours back to Anoka Electric. Just last week we got our first check from them, for $21.45. It was like winning the lottery. Some battles are still, after all, well fought.

The max system output we've recorded is 15.42 kW on a super windy day, although it's rated at 10 kW at 25 mph. The cost per Watt therefore is $.74 or $1.11, depending on rated or actual peak power production. I've excluded the cost of an analog anemometer from NRG systems at $125 since it *is* optional.

(Sample) Ordinance Regulating Wind Energy Conversion Systems (WECS)

Whereas this (Town, City, County) recognizes the inherent benefits of WECS to the environment and the township as a whole, and

Whereas (Town, etc.) is desirous of encouraging the positive use of wind power,

Now, therefore, the (Board) hereby ordains as follows:

Section 1. ADOPTION. Ordinance No_____ is hereby adopted and known as Wind Energy Conversion Systems (WECS).

Section 2. PURPOSE. The purpose of this ordinance is to establish standards and procedures by which the installation and operation of WECS shall be governed within the (Town, etc).

Section 3. APPLICATION. WECS may be allowed as a conditional use within any Zoning District, subject to the regulations and requirements of this ordinance, provided the property upon which the system is located is to be at least one acre in size.

Section 4. DECLARATION OF CONDITIONS. The Planning Commission may recommend and the (Board) may impose such conditions on the granting of a WECS conditional use permit as may be necessary to carry out the purpose of this ordinance.

Section 5. SITE PLAN DRAWING. All applications for a WECS conditional use permit shall be accompanied by a detailed site plan drawn to scale and dimension, showing the following:

A. Lot lines and dimensions.

B. Location and height of all buildings, structures, above ground utilities, and trees on the lot, including the proposed WECS and guy wires and anchors, if any.

C. Existing and proposed setbacks of all structures on the lot.

Section 6. CODE COMPLIANCE. Standard drawings of the structural components of the WECS and tower system, including base and footings, shall be provided along with engineering data and calculations demonstrating compliance with applicable provisions of the State Building Code. Drawings shall be certified by a Registered Structural Engineer. WECS electrical equipment and connections shall be designed and installed in compliance with the National Electrical Code. Building and Electrical permits shall be taken out by the applicant before construction.

Section 7. DESIGN STANDARDS.

A. Height. The maximum permitted height shall be 135 feet. In determining the height of a WECS, total system height shall be used as measured from the tower base to the highest extended rotor tip. 1. A Ratio of 1 foot to 1 foot setback shall be maintained between the system height and the nearest property line ("fall zone"). 2. The tower must meet all FAA regulations.

B. Setbacks. No part of a WECS, including guy wires or anchors, shall be located within a required front, side, or rear yard setback. WECS shall not be located within 30 feet of an above ground utility line, except the service drop for the property in question.

C. Rotor Size. Rotor diameters shall not exceed 26 feet.

D. Rotor Safety. The WECS shall be equipped with both an automatic and a manual braking device capable of slowing or stopping WECS operation in high winds and during maintenance.

E. Tower Access. To prevent unauthorized climbing, WECS towers must have all rungs removed within 12 feet of the ground.

F. Signs. WECS shall have 1 sign not to exceed 2 square feet, stating "Danger - High Voltage".

G. Electromagnetic Interference. WECS shall be designed and constructed so as not to cause radio and television interference.

H. Noise Emissions. Noise emanating from the WECS shall be in compliance with the State Pollution Control Standards.

I. Utility Interconnection. No WECS shall be interconnected with an electrical utility without the utility's prior knowledge and consent and a written agreement with the utility.

Section 8. INSPECTION. The (Town, City, County) hereby reserves the right to annual inspection of the WECS. If a WECS is not maintained in a safe and operable condition, the owner shall take expeditious action to correct the situation.

Section 9. ABANDONMENT. Any WECS not operational for a period of 6 consecutive months may be cited for repairs. If repairs are not made within a further 180 days, the WECS shall be deemed abandoned and shall be dismantled and removed at the expense of the property owner.

Section 10. INSURANCE. The WECS owner shall carry in full force and effect property liability (homeowner's policy listing the wind generator as an appurtenant structure) insurance in the amount of $500,000, and shall upon request provide proof of same to the (Town, City, County).

Section 11. VIOLATION. Violation of any of the provisions of this ordinance or of the provisions of the conditional use permit it contemplates shall be cause for revocation of the conditional use permit.

Section 12. EFFECT. This ordinance shall be in full force and effect from after its publication as required by law.

Editor's Note: I would not recommend that others offer the use of this ordinance, as it is written, as a model for their situations. The ordinance, written specifically for Shawn Otto's installation, is by far the most restrictive and burdensome that I have ever run across. Certain items, like limiting the rotor diameter to 26 feet and requiring duplicative braking devices, are actually specific features of Shawn's particular wind generator. Other items, like the redundant approval by a structural engineer or limiting the maximum tower height to 135 feet, seem arbitrary and pointless. The requirement for $500,000 liability insurance applies a burden that not even the utility required. I am not quite sure why Shawn's county or township felt it necessary to be so overbearing, unless there was some major butt covering going on. Add to this two conditional use permits at $450 each! These are the types of requirements one might expect in a rapidly developing area or a subdivision with covenants where the obviously intended purpose is to keep certain structures from even being built. It is a credit to Shawn that he persisted with his local government agencies until he was successful. Mick Sagrillo

Shawn & Becky Otto's System Cost

Used Jacobs 10kW with tower	$8,000	72%
Footings	$983	9%
Wire	$485	4%
Township conditional use permit	$450	4%
County conditional use permit	$450	4%
Excavation	$250	2%
Crane service	$245	2%
Wiring sundries	$185	2%
PVC conduit	$63	1%
Total	$11,111	

Above: The all volunteer tower assembly crew enjoys lunch in the dining room.

Access

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Shawn Otto is a poet, writer and entrepreneur. He and his wife Becky own and operate Fresh Paint Inc, a commercial painting contractor, which they established 10 years ago. They also own several historic commercial properties which they have restored. Shawn is trying to demonstrate with Breezy that environmentally low impact homes don't have to be impractical, overly expensive, or unattractive.

Rebecca Otto resigned as President of Fresh Paint to acquire a Master of Education because she felt teaching was a calling she had to answer. She now teaches to her Life Science students at Highview Middle School a comprehensive unit on environmental science that includes renewable energy, recycling, conservation, and field trips to Breezy.

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