An Interview with Mick Sagrillo

Harnessing the Wind

By Michael A. Hackleman

(Mick Sagrillo is the founder of *Lake Michigan Wind & Sun*, a company that specializes in helping people repair and install new, used, or rebuilt wind-electric generators. He is the author of numerous articles that have appeared in magazines such as *Home Power*, *Backwoods Home Magazine*, and *Solar Today*, and he is a monthly columnist for the *American Wind Energy Association's Windletter*. He is currently the president of the *Midwest Renewable Energy Association (MREA)*, the organization that hosts the annual *Midwest Renewable Energy Fair (MREF)* in Amherst, Wisconsin. He teaches wind installation workshops at *MREF* and at *Solar Energy International* in Carbondale, Colorado.)

Mick Sagrillo

Mh: Mick, how did you get started in your work with wind energy?

Mick: I read your books, Wind and Windspinners and The Homebuilt Wind Generated Electricity Handbook. It's true. Your books had a big influence on me. At the time, I lived in northern Illinois with my wife, Lynn. It was a windy area, so windmachines were never very far from my mind.

Mh: Was this your first exposure to independent energy?

Mick: No, I actually built a greenhouse on my third story apartment porch in Chicago in 1970. In 1973 I built a number of breadbox-type solar collectors and another greenhouse, this time attached to the house we bought in northern Illinois. The first oil crisis occurred that fall, which was a wake-up call for our dependence on petroleum for electricity and heating. Of course, we were subscribers of several do-it-yourselfer magazines. I have first edition copies of *Lifestyle* and *The Mother Earth News*. These filled my head with ideas. I definitely wanted to be self-sufficient.

Lynn and I moved to northeastern Wisconsin in 1978 and bought a farmhouse on five acres with the intention of homesteading. We gutted the house, then proceeded to rebuild it. We spent most of the first winter in our sleeping bags, and burned 800 gallons of home heating oil just trying to keep the inside temperature of the house above 50°F. While Lynn taught at the university, I stayed at home raising our daughter and building everything from a septic tank to a bathroom and shower. We super-insulated our home and put in a one-acre garden. We grew a ton of vegetables and raised beef, pigs, chickens, and turkeys.

Mh: When did you get your first windmachine?

Mick: In 1979, a friend bought a well-worn 1000-watt Wincharger. Instead of a folding tail, it had a brake drum and a light gearbox with a fiber gear. We began rebuilding the Wincharger, but never finished the project. I still have it but I never put it up. I was still in my research mode, trying to connect with anybody who was working with wind generators. My first important contact was Joe Joddock, a Dakota Wind and Sun (DWS) dealer. He was a member of the Jacobs club, and the DWS was a Jacobs clone made in the late '70s. The Jacobs was a high quality, pre-REA wind-electric machine.

I then met a man who almost killed himself in 1980 trying to hoist a DWS he'd bought to the top of a tower. The gin pole failed and the wind generator came crashing down, bending a leg of the tower. (A gin pole is a device that is bolted to the tower and works like a crane to hoist the windplant to the top.) This taught me the importance of quality hardware for working with these units. My gin pole weighs about 150 pounds. I wound up buying his damaged wind generator and tower, rebuilding them, and installing them on our homestead.

Mh: Let me digress for a moment for our readers. Mick, you eluded to "pre-REA" windmachines. The REA was the Rural Electrification Administration. It came about in 1937, during the Great Depression, and it was a government jobs program with the goal of bringing utility power to the farms in the midwest.

At the turn of the century, the voltage standard was 32V and dc. If you wanted to power electric lights or a radio, you had to be pretty close to the generating station or the line losses would be too great. There was no way to get power to the farms because they were so spread out. So, the farms were left to fend for themselves, using wind generators and/or light plants (standby generators) with batteries for electricity.

Tesla's invention of the AC generator made it possible to move power over long distances with small losses, and eventually it was possible to supply utility-generated power to the farms. This was the REA's mission. This action displaced many of the wind generators these people had been using. It was the availability of these used windmachines that attracted me and I recovered Jacobs and Winchargers on expeditions to the midwest, primarily Wyoming.

Still, I was based in southern California. I think you had it lucky, Mick. Everybody who was doing anything with wind power seemed to be back east.

Mick: I still had to travel long distances to reach any of them. I drove to North Dakota in my VW van to work with Joe Joddock. I spent two weeks with him, rebuilding the DWS I'd bought from the man who nearly killed himself. I learned how to dip and bake armatures and cut down the commutators. I taught him how to work on VWs. It's funny. He was a wind generator rebuilder who went on to work with cars, and I was, among other things, a VW mechanic who went on to work with Jacobs and Winchargers.

Mh: Whom else did you come across?

Mick: I contacted anybody who I could find with a wind generator, such as folks who wrote their stories in magazines like *Wind Power Digest* and *Alternative Sources of Energy (ASE)*. One person I never really had the privilege of meeting was Martin Jopp. Martin wrote a column for *ASE* magazine on how to rewind pre-REA windgenerators.

This was a time of experimentation. In addition to restoring the units to produce power at their original voltages, 32Vdc or 120Vdc, some folks were attempting to beef up the units to work with the Gemini synchronous inverter, the first of today's grid-interfaced units. This seemed like a good way to avoid using batteries in the system. Just plug into the grid and spin the power meter backwards. We did get the Gemini units to work right, but it took quite a bit of work. It was a time of trial and error. I managed to eventually put a Jacobs on my 80-foot octahedron module tower and it still stands there today.

Mh: Were you making a living from windplants at this point?

Mick: I'll answer that by saying it was a good thing that Lynn taught at the university. I had a lot of used windmachines by October of 1980. I needed parts to fix and sell them, so I got a lathe and other equipment and taught myself how to fix or re-manufacture the parts. It's hard to hide a windmachine, so I had people spotting me from the road and contacting me, wanting parts. I turned this into a business, *Mick's Fix-It Shop*.

A lot of manufacturers came into existence during the energy tax-credit time. Wind energy got a big boost, but there was a downside. There were bad designs and a lack of good information. It was hard to find people to service a host of windplant models, and it got worse when the manufacturers disappeared after the tax credits ran out. I earned the reputation of being able to get stuff working. My business grew.

Mh: You founded *Lake Michigan Wind & Sun*. How?

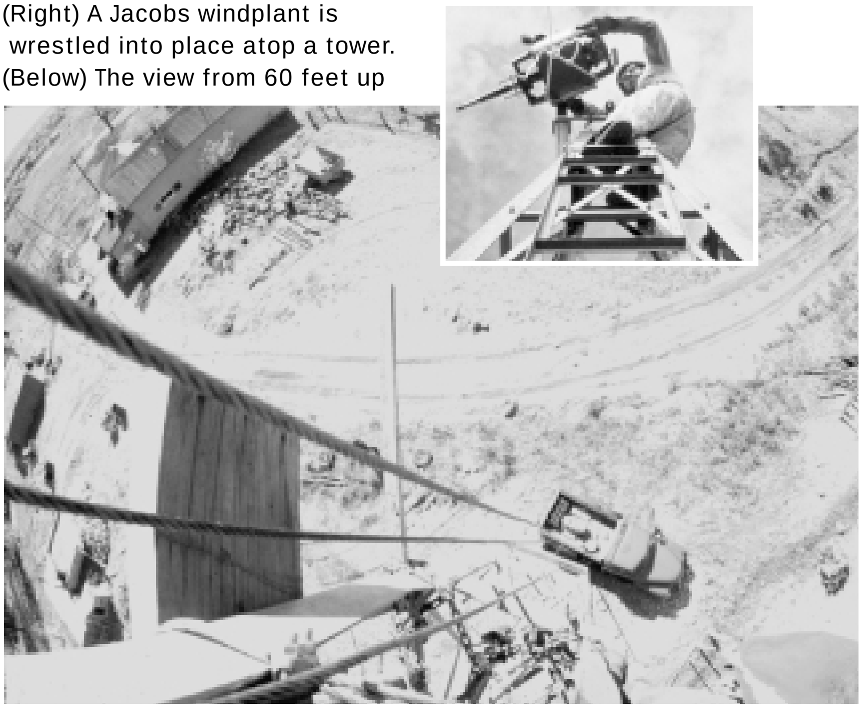
Mick: Martin Jopp died in 1980. Someone near him bought all his tooling for Jacobs parts, plus a lot of inventory. After selling off all of the inventory, he called me. I bought it all from him, and in 1982 my business became *Lake Michigan Wind & Sun.*

Supposedly, I now had a few of the patterns and tooling Jacobs actually used in their factory. In retrospect, this was a mistake because I could do or was doing most all of this anyway, without needing to buy another person's business. Still, I liked Jakes (Jacobs windplants). They required little or no service. They just went and went. Jacobs windplants had a good reputation with everyone.

Over the years, I've acquired a lot of the tooling and the patterns for the Jacobs windplants and own or have worked on every Jacobs' model. Altogether, I figure I've got about 160 wind machines, of which more than half are from the pre-REA period. I figure I've collected an important piece of history.

The 6V wind plant was the first popular windplant dating back to about 1929. With radios, people on the farm had a door into the outside world. Initially, these ran off car batteries, which could be hauled off to town for recharging periodically. A side-effect of the automotive industry was the general store where these 6

(Right) A Jacobs windplant is wrestled into place atop a tower. (Below) The view from 60 feet up



volt batteries could be recharged. Farmers quickly realized that a 6V windplant would also charge the batteries to power their radios and lights and more.

Mh: People are surprised when I tell them that the voltage standard on farms well into the 1940s was 32Vdc. Or that relatively small pre-REA windplants would power lights, motors, appliances, and tools throughout the farm.

Mick: I believe that the reason more people don't know about the history of electricity in the pre-REA period is the shame associated with the Depression. Still, many manufacturers today use time-tested elements found in these old windplants.

Generating electricity from the wind took a step up from 6V when equipment and technology were borrowed from the 32V systems used by the railroad and tug boats. Here, the availability of 32V motors, tools, and lightbulbs inspired the production of the 32V windplants. For the same power and wire size, a 32Vdc, system has only about 1/10th the line losses of a 6Vdc system.

Reviewing this history reinforced the notion in me that the objective and reward was in the electricity generated by the windplant, not just selling the equipment. I've seen people invest all their money in a 4,000-watt windplant and then stick it on a 42-foot tower where it is unable to deliver its power. Unfortunately, people install towers with a height they're comfortable in climbing. Or they try to save money by skimping on the tower. These are big mistakes. Siting the wind system correctly is paramount to good performance.

Mh: Did you become a dealer?

Mick: At the time, manufacturers didn't want a dealer who sold competing manufacturers' windplants. I was interested in all windplants, so I was denied dealerships. I was more a repairer and installer than a dealer, although I sold numerous rebuilt and remanufactured wind systems. I had plenty of work. I figured it was because I had something good to offer. My brother thinks it was because I worked too cheaply. Eventually, however, I realized I could no longer be a one-man shop. I built up the business to where there were five employees.

Mh: What is the minimum aaw that is needed to generate electricity from the wind successfully?

Mick: A 10 mph aaw (average annual windspeed) is often given as the minimum standard. It makes me shudder to hear it. It's way too high.

Some dealers unfamiliar with wind systems will suggest the installation of a wind-monitoring system for a year as a good way to evaluate the wind's potential. I don't agree. We don't use a monitoring system for assessing the potential of generating electricity from water power or solar power. Why do it for wind? Wind energy is complementary with solar energy through the year. Summer solar, winter wind. In my experience, a 7 mph aaw is enough for a hybrid system where solar-electric modules handle the summer power. The windplant is able to harvest winter weather.

Mh: Of course, you live in the midwest, which is a windy area. What about other areas? Can you give me any rules of thumb?

Mick: Unless someone lives in the extreme southeastern portion of the USA, they've probably got useable wind. Sites located in deep valleys or in groves of 200-foot tall trees will be problematic, of course. Rules of thumb? Buy the tallest tower you can afford. The minimum height? The base of the windplant's rotor, or spinning blades, should be at least 30 feet above any obstacles within 500 feet of houses, terrain or trees for the life of the system. Remember, trees grow. No matter how much you water them, towers don't grow. So install today's tower for tomorrow's tree height. Of course, when you're 75 years old, you probably won't feel like climbing the tower. Today, it is straightforward to rig things so that the tower is easily lowered, the windplant serviced, and the tower raised again.

The site and mature tree height determines the minimum tower height. For example, if your windplant has a 12-foot rotor, and you've got 50-foot trees, then your minimum tower height is 50 feet, plus 30 feet clearance, plus 6 feet for distance between the blade tip and the windplant itself. That's 86 feet. Allowing for tree growth, this site should use a minimum of a 100-foot tower.

Mh: As we both know, there is a nice benefit in extra tower height. The power in the wind goes up with the cube of the windspeed. Thus a small change in windspeed can result in a big jump in windplant power generation. For a given windspeed on the ground, the windspeed increases the further you go above the ground. For example, consider the availability of power for a windplant on a 36-foot tower versus a 96-foot tower. The output nearly doubles on the taller tower.

Mick: Exactly! Two wind generators at 36 feet would produce the same amount of electricity as the same model of wind generator at 96 feet. Except for micro turbines and wind generators with rotors smaller than five feet in diameter, taller towers are always the most cost-effective option.

That's why I said, "a minimum of a 100-foot tower." A 120-foot tower with a specific size of windplant usually proves to be more economical and yield more electricity than that provided by a bigger wattage of windplant located 20 feet lower.

Mh: What standards exist in the wind energy industry today to help people fit a windplant to their site?

Mick: That's a problem. There are few standards. Whatever standards do exist tend not to clarify the issues. I wouldn't call it misinformation, but it is arguably incomplete. Windplants are rated all over the place. The customer must understand the difference between power ratings (wattage output) and the windspeed at which this rated power is reached. To the manufacturers' credit, most do provide a number which represents the probable energy production per month or year at different values of aaw. Still, these rely on the readings of the local climatological station, and the aaw values of the closest climatological stations describe your region, not your site.

Mh: It's revealing to calculate the power in an 18-mph wind versus a 25-mph wind. A windplant that generates 2,500 watts at 25 mph of windspeed will only produce roughly 750 watts at 18 mph. I always loved it that the Jacobs reached its power rating in an 18-mph wind.

Mick: The best criteria is the rotor diameter. A windplant harvests as much energy as the area its rotor sweeps. It's no different than a solar collector. One solar collector produces this much energy, two of them produce twice as much. Small changes in blade diameter can quickly double the swept area of a windplant.

Compare two windplants. One is an 1800-watt Jacobs with a 14-foot diameter rotor. The other is a 1500-watt commercially-available machine with a 10-foot rotor. The area of a circle is equal to the square of its radius multiplied by pi. So, the Jacobs has a swept area of roughly 150 ft^2 while the second windplant's rotor sweeps 75 ft^2. The wattage ratings suggest the two machines are comparable, but both in theory and practice, the Jacobs will outperform its competitor by at least a factor of two in average windspeeds. Why? It's got twice the swept area. A 40% increase in rotor diameter yielded a 100% increase in energy harvested from the wind. And since it fails in this example to stand on its own, wattage as a measuring stick is flawed.

Mh: And look what happens when rotor size drops lower. A windplant rotor with a 6-foot diameter (3-foot blades) sweeps only 28 ft^2 of wind. When will this windplant produce the rated power that your wattage per dollar evaluation revealed was a great deal? The answer is: at a much higher windspeed. This information is not clearly presented in product literature. Small rotor and lightweight windplants touting big wattages must be more closely examined.

Mick: The bottom line is: which of the these three windplants would you rather install at a marginal windsite? The windplant must be able to produce significant power at the windspeeds the site is likely to experience. Generally, small amounts of power generated the majority of time are of greater value than large amounts occasionally.

Mh: In essence, the ideal windplant for a low wind area is one which dips into the lower windspeeds for its power. This means a bigger rotor. Since solar-electric modules were rare and expensive at the time I started in wind energy, my initial focus was a wind-only system where you used a big-wattage, big-rotor machine to capture the rich energy of storm winds. My experiences have altered that view. A hybrid system designed to capture the energy of solar and wind and water as they're available through the year makes more sense.

It's always bothered me that the power curves on windplant product literature are so small. I wish they'd use tables. For example, it's difficult to figure out what wattage any windmachine will generate in an 18 mph wind. I've had a windplant representative tell me customers are just confused by such information. I don't agree. If I had tables that showed the power production in 15, 18, 21, and 24 mph winds of every windplant available today, I would quickly be able to eliminate a whole host of windplants from further consideration for most sites. I believe manufacturers don't want to have it be that clear cut.

I like your rotor comparison. Looking at the windplants of the pre-REA period, the large-diameter rotors like those found in the Jacobs and Winchargers were the ones that proved successful.

Mick: In a hybrid solar/wind system, there usually isn't sufficient capacity in the batteries to absorb energy from storm winds. Or the timing is bad, with the wind arriving after the batteries have been charged by the sun all day. Whenever this occurs in a system, I suggest dumping this electricity into room heating or water heating. It's perfect. Every watt I generate with electricity is just that much wood I don't have to cut and haul.

Mh: On the west coast, we call this process "load diversion." The battery is a load, too. So, when it nears being full, switch on a secondary load such as a floor heater or immersion element. The simple and reliable method of doing this activates a relay to power up a load whenever a pre-selected voltage is reached. This switches on the load which runs directly off the battery bank for a few minutes. When the voltage drops below a pre-selected lower voltage (only a few volts different), the windplant's output should quickly replenish the slight drain on the batteries. This cycle is repeated for as long as the windplant's output exceeds the battery's ability to absorb it.

Generally, I've found that you don't want to power loads directly from the windplant. This is trickier than it seems and is only used in areas that experience strong winds of ample duration. Surplus energy isn't always of a quality such that it is useful or worth going after.

Mick, the wind power formula is useful for understanding the effect of variables like swept area, windspeed, air density, and windturbine efficiency on power generation. It predicts what's available. The windplant's design also contains variables. Will you talk about these?

Mick: You mean like airfoil efficiency and power curves for generators and alternators? Airfoil efficiency changes with windspeed, as does alternator or generator efficiency. Each windplant designer balances these factors in different ways and this results in the wind generator's power curve.

It's a mistake for people to buy the windplant first. There are three questions that precede this event. One, how much resource is available at the site? Two, where will the tower be sited? And, third, how tall must the tower be to place the windplant above the turbulence produced by obstacles. Then, ask: What kind of windplant will work best here?

Mh: The trend in windplant design seems to be toward small rotors and PM (permanent magnet) alternators. In your experience, what's driving this transition?

Mick: Alternators are lighter than generators, eliminate brushes, and cost less to produce. A whole Bergey 1500 windplant might weigh 168 pounds. There is at least 100 pounds of copper in the armature and field coils of a Jacobs windplant of the same wattage. Of course, a lot of copper and complex windings in an armature costs money. The newer brushless alternators eliminate the parasitic load of field current by using magnets to generate high-density flux.

I think these benefits work for the manufacturer more than the customer. Yes, the brushes in a generator must be replaced every few years, but I think it's important to inspect your windplant occasionally, too. Bolts loosen up, adjustments change. If anyone expects to install a windplant for a homesite and forget about it, they shouldn't use wind energy. Periodic inspection is the cheapest way to operate a windplant. You can catch problems before they become problems.

There *are* windplants that will work unattended on remote mountain sites. However, they compromise the windspeed power curve in favor of reliability and being maintenance-free. There is no one size that fits all applications and aaw values.

Mh: I've seen advertising that shows a picture of one house with 3-4 small windplants along the roofline. I wonder if these folks have tried living in a house with this setup. I have. It gets old fast. Let's see. A vibrating device and a boxlike structure ...

Mick: ... is just a guitar. Yeah, a sounding box. Most annoying. Rotor blades are getting thinner, too. They are light and strong and designed to produce power at high rpm. But high-speed blades tend to be noisy. Sometimes, very noisy!

Mh: An alarming tendency with the smaller windplant designs is their liberal wattage ratings.

Mick: I know of one manufacturer who increased the wattage rating of a particular windplant by simply increasing the windspeed rating at which it would produce this power. This tactic helps the manufacturer who does it, but it doesn't help the end user who's looking at dollars per watt. How many kWh of electricity your windplant produces *must* be the measuring stick.

At *Lake Michigan Wind & Sun*, a big part of my work was evaluating wind sites. Some I could do at a distance. I was often sent a topographic map, a video, and pictures. Once I know the height and direction of trees, hills, houses, and other obstacles and the shape of the terrain, I can make the needed calculations and finish the evaluation. Here, the mathematics of wind energy is reduced to the aaw and tower height. In turn, these suggest the type and size of windplant, and the tower height. I'd tell people they could return the system if it didn't produce as much as I estimated. I never had one system returned.

Mh: Every windplant must protect itself against overspeed. A rotor spinning too fast can fail, with centrifugal forces tearing it apart. A generator that produces in excess of its upper current rating can overheat and fail mechanically or electrically. High windspeeds are usually the culprit, but a full battery bank or even a blown fuse can result in overspeed at modest windspeeds. There are a number of ways to govern a windplant. Which method do you prefer?

Mick: The most elegant way is pitch-change governing, like that used on the Jacobs. This protects against both rotor and generator overspeed at modest or high windspeeds. Some windplants use the offset method of governing. If the rotor shaft is offset with respect to the axis about which the windplant rotates on the tower, the windplant will face sideways in higher winds. This is a method that is time-tested with water-pumping windmachines. Pitching the rotor up and back also works.

In addition to automatic governing, I like some kind of manual shutdown mechanism, too. With the Jacobs, a winch at the base of the tower lets you crank the rotor into the wind from its side-facing position. That way, if the cable breaks, the windplant's rotor automatically turns out of the wind.

Mh: I've always liked that feature in the Jacobs. The Wincharger design did it the other way. You'd crank the rotor out of the wind. Unfortunately, if the cable broke while you were trying to shut it down, the windplant's rotor would be left in the operating position.

The scariest governing mechanism I've seen was the one used on earlier and smaller Winchargers: the airbrake. It consisted of two arced sheets of metal on an arm which rotated in front of the propeller. At a specific rpm, they would begin to change their pitch, plowing through the air and slowing the entire rotor assembly. Using the airbrake would be like pushing down on the brake in your car without having removed your other foot from the accelerator. It was noisy, too. Worse, it would repeat a cycle of slow and quiet, speed up and govern. We adopted the practice of shutting down this windplant in high winds. We got more sleep at night.

Mick: Some windplant designs today have no manual shutdown mode, relying on electronic loading or passive governing, which relies on blade stall or a centrifugal-induced flattening of the blade pitch. This bothers me. Electronics can break down. Passive governing may prevent overspeed but it doesn't stop the rotor from spinning fast. Whatever method or combination of methods of governing are used, it must be fail-safe.

(Above) A remanufactured Jacobs is installed during an MREA workshop.

(Left) A Jake clone is coaxed onto a tower stub in an SEI workshop.

(All photos by Mick Sagrillo unless otherwise noted.)

Mh: Will you explain why windplants have different numbers of blades on them?

Mick: Two-blade rotors are subjected to gyroscopic forces when they hunt the wind or run in turbulence. When the blades are vertical (straight up and down), there is no resistance to the windplant's rotation about the tower. When the blades are horizontal, one blade pushes into the wind while the other moves downwind. Combined with the forces imposed by gyroscopic action, in rotation each blade actually flexes in response—null, upwind, null, downwind—for each revolution. Now go to a thousand times one revolution (1,000 rpm). It makes a noticeable chatter as the windplant yaws.

Gyroscopic vibration wears bearings and parts quickly, and loosens bolts. It's the primary reason that many windplants have three blades. Three-blade geometry, as with four-blade and five-blade rotors, balances out the forces and effectively neutralizes the gyroscopic vibration endemic to two-blade machines.

Mh: I've made my share of mistakes in working with wind energy systems. What was an early mistake you made in this work?

Mick: I learned not to believe everything I read. In your book, The Homebuilt Wind Generated Electricity Handbook, you suggested using a cable sling and pulley as one means of tilting up tall towers. I tried it on a 100-foot tower I was installing in our pasture. There was too much friction for the pulley to easily slip along the sling. When we got the tower to about a 45° angle, the pulley slipped on the sling and the resulting jerk caused the tower to buckle and fail.

Mh: You reminded me that you asked me about this years ago. Actually, I *did* try the pulley-and-sling technique after I wrote the book and it didn't work but I attributed this to the rigging I used rather than the technique itself. Whoops.

Mick: Nobody got hurt. We repaired the damage, tilted up 70 feet of the tower, and used a crane to mount the last 30-foot section of tower, followed by the windplant. This incident actually got me thinking more about tilt-up towers. When you rig a tower to be raised, it's also rigged to be lowered. In our solution, the gin pole became part of the installation. And we used pulleys to gain mechanical advantage and lower the tension in the raising cable. The tower can be raised or lowered using a truck or tractor, or even a winch.

Mh: I first saw this type of rigging up at the *Home Power* offices back in 1996. A nosecone flew off a Whisper windplant owned by Richard and Karen Perez. Their 64-foot pole tower was lowered in a matter of minutes. On went the new nosecone and, just as easily, the windplant and tower were raised back up. No big deal. A nice setup. I personally like climbing towers—it gives a new perspective on things—but I've been unable to coax some people up even a small tower. Asking them to actually work at the top of the tower is out of the question.

Mick: People are surprised that it takes 3-4 days to rig and raise a tower, and only a few hours to install the windplant itself. Actually, it was Richard Perez who encouraged me to design a tilt-up kit for towers so that people could raise and lower their own towers. After some design and development, my company released several hardware kits for pipe towers for different heights (up to 126 feet) and rotor diameters (up to 14 feet).

Mh: I have to admit that pipe towers are economical. I didn't use them at all initially. They're difficult or dangerous to climb. With a raise/lower rigging, this is not an issue. You lower the tower, service the windplant, and put it back up. I used to tell people that windplants were an order of magnitude more complex than solar panels. Tower raising is big stuff to most people. I know. I was enlisted to raise a bunch of them. I like the element of safety the raise/lower rigging provides. It makes wind energy more accessible. Also, the tower is most vulnerable during a lowering, particularly when it gets near the ground and the cable tension is highest. So, its nice to know that everything is rigged exactly as it was when it was *first* tested as a system—when the tower was raised. What size of pipe are the kits based on?

Mick: Two sizes. One is tubing, which is like big EMT (electrical metallic tubing) used in the electrical trade. It's 11-gauge, so it's got a thick

wall. For large windplants or taller towers, I use 5-inch schedule 40 pipe, which is well casing. We encourage the customer to buy either type of pipe locally to save on shipping costs. The kits vary from basic to complete. Most include the pipe couplers, guy wires, attachments, turnbuckles, pulleys, and other rigging.

Mh: I understand that you've sold *Lake Michigan Wind & Sun*?

Mick: Yes. John Hippensteel is a mechanical engineer who joined the company about a year before I sold it to him in March of '97. I'm not good at managing a company and keeping everybody busy. He still manufactures and sells the tilt-up towers and kits.

Mh: What's the tallest tower you've raised? And what rule of thumb do you use for siting the guy anchors away from the tower?

Mick: A 126-foot tower is the tallest I've raised. For the towers I designed, I use the 40% rule for anchor siting. Other towers may use a different guy radius. The guy anchors are positioned away from the tower a distance equal to 40% of the tower height. For example, that's 40 feet for a 100-foot tower and 20 feet for a 50-foot tower. There are four anchors, positioned equally about a circle. During raising or lowering the tower, there are two side guy wires, the raise cable, and the cable that opposes it. Most of the hardware that is used to raise the tower is also used to hold it safely vertical.

Mh: In your experience, what element of weather—thunderstorm, lightning, icing, or imbalance—is the biggest threat to a windplant?

Mick: Thunderstorms can be quite violent. I recommend shutting the windplant down during a big storm or high winds. Sure, there's energy there but it's so rough on the windplant, particularly the lightweight machines. I belong to the heavy metal club. I like a windplant with some weight to it. They seem to fare better in storms over the years.

The effect of lightning on a wind system is largely mitigated by grounding the tower and using lightning arrestors at various points. Actually, there's more of a lightning problem with wind systems that are line-tied to the grid. Power poles and wires take a lot more hits than a single tower, and a surge can backtrack and hurt the power equipment.

Blade icing generally occurs when the wind dies. Icing spoils the rotor's airfoil, so the windplant simply won't start until the ice melts and drops off.

Mh: One protection I like to see in a wind-electric system is a way to detect any unusual vibration. What if a piece of the blade or a bolt flies off? Unattended, a small imbalance can shake the windplant and tower until something else breaks. I've bolted a vibration sensor to a tower to sound an alarm. In one setup, I rigged a circuit to operate the winch and shut down the windplant if strong vibration was detected.

I don't want to put you on the spot but I'd like your opinion. What's the best windmachine available today for producing electricity?

Mick: I've repaired wind equipment from over 75 manufacturers over the years. What I've chosen to work with is the old Jacobs. It's a heavy-duty beast, plus it's got a good rotor size and generates its power at low windspeeds. Bergey is another good design with a reputation for high reliability. The small Whispers are great. Frankly, I'd like to see more imported

(Left and below) A 10kW Bergey is raised on a 120-foot tower which is rigged to safely lower it, too. (L to R) David Nixon, Steve Bell, Bob Peterson, and Mick Sagrillo pause before raising tower and windplant.

Windplants, towers, & hardware

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22700 NE Mtn Top Rd., Newburg, OR 97132 **Phone:** (503) 538-8292 **Fax:** (503) 538-8782 **E-mail:** rwpreus @yahoo.com Remanufactures Jacobs windplants and parts for Jacobs and other windplants up to 65kW, new and used.

Bergey Windpower Co.
2001 Priestly Ave, Norman, OK 73069 **Phone:** (405) 364-4212 **Fax:** (405) 364-2078 **Website:** bergey.com Supplies BWC and Excel windplants, tilt-up, guyed, and free-standing towers

Southwest Windpower, Inc.
P.O. Box 2190, Flagstaff, AZ 86003 **Phone:** (502) 779-9463 **Fax:** (502) 779-1485 Manufactures Windseeker and Whisper windplants and microturbine tilit-up tower kits.

Wind Turbine Industries, Corp
16801 Industrial Cir. SE, Prior Lake, MN 55372. **Phone:** (952) 447-6064 **Fax:** (952) 447-6050. **E-mail:** WTIC@windturbine.net **Website:** windturbine.net Manufactures heavy-duty freestanding towers and Jacobs 29-20 (20kW) windplants.

Lake Michigan Wind & Sun
1015 County Rd. U, Sturgeon Bay, WI 54235. **Phone:** (920) 743-0456 **Fax:** (920) 743-0466
E-mail: lmwands@itol.com **Website:** windandsun.com Manufactures tilt-up towers and kits and tower-top adaptors, and supplies guyed lattice and freestanding towers and used windplants.

windplants. There are some solid designs emerging from other countries. I think they just need dealers in the U.S.

Mh: What do you think of grid interties? And how do you integrate a windplant with solar-electric modules and a standby generator?

Mick: It's senseless to install a large-wattage machine and use a grid connection that's not net-metered. Net-metering means you are paid per generated watt by the utility at the same rate you buy it. Where net metering isn't available, this buyback idea is less attractive.

For off-grid systems, I favor the hybrid solar/wind system. I start with the load. What do you want to power? An honest appraisal here helps to size the battery bank. Then, I add in the wind and the solar. And some kind of load diversion, i.e., heating of some sort, to handle surplus electricity.

Mh: Now that you've sold your company, what are you doing? And what are your future plans?

Mick: I teach workshops, for both the *MREA* and *SEI* (*Solar Energy International*) in Carbondale, Colorado. I occasionally do a workshop for other renewable energy organizations and consulting firms. I'm even doing some workshops overseas. I like teaching 15-20 people at a time, where the focus of the workshop is a wind generator and tower installation. The students turn around and multiply this effort. I like the technology transfer and how it empowers people to do it for themselves, or make a career of it.

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