

You Say You Want a Revolution?

by Wendy Mitman Clarke
photography by Vince Lupo
Article courtesy of Chesapeake Bay Magazine

With its small, efficient motor that can recharge its own power source, a company in Benedict, Md., is presenting boaters with an electric engine alternative unlike any other.

REVOLUTIONS START IN THE UNLIKELIEST PLACES. BENEDICT, Md., for example. It's a little shack of a village along the Patuxent River, about 14 miles upstream from Solomons, home to a couple of river-front watering holes and a company called Solomon Technologies, which is out to change the world. Or at least the boating world.

The company and its CEO, David Tether, are preaching the gospel of electric-powered engines for boats, but with a twist. Solomon Technologies has developed the Electric Wheel, essentially a wind-power/electric hybrid motor that uses a sailboat's free-spinning propeller to recharge its batteries. Unlike other electric motors that drain a battery bank until the next plug-in at the nearest marina, this motor could conceivably take a sailor wherever he or she wants to go without ever having to stop—for fuel, anyway. For displacement powerboaters (trawlers, for example), the distant horizon is not as open and the range is not as unlimited. But they too could take advantage of the motor by installing two, using one to run the boat while the other recharges.



VINCE LUPPO

Not a whole lot bigger than the average desktop computer, the 98-pound, 6-hp motor can replace a 20- to 30-hp engine, and the 160-pound, 10-hp model can replace a 30- to 40-hp engine. Its deceptively simple anatomy is made up of two brushless DC “pancake” motors, ringed with 24 extraordinarily powerful magnets. The motors are connected by an infinitely variable, planetary gear transmission. For boaters, this is sort of an ultimate direct drive system—a motor with all the instant torque of direct drive, but with the variability of a transmission within it.

Put very simply, the Wheel operates as a motor when electricity is used to create a magnetic field within its copper windings. The magnets are repelled and attracted by that field, causing the motor to turn and the shaft to rotate. Recharging is equally simple. When the boat is sailing, the batteries recharge as the free-spinning propeller does the work of turning the shaft and the magnets, pushing them past the copper windings and generating electricity. In powerboat applications—which would require two Electric Wheels—one motor could propel the boat as the other recharged batteries.

When you're standing at the helm of *Seaward*, Tether's venerable 1939, 32-foot, mahogany-on-white oak sailboat, here's what it means: With a flick of the throttle, one 6-hp Electric Wheel can push this 19,000-pound antique to hull

Above: Dave Tether holds a component of the Electric Wheel. Left: The Conser 47 has two Electric Wheels as standard power.

speed within two boatlengths—and can stop it in less than 20 feet when it's thrown into instant, full-torque reverse. Tether can motor in calm weather for about five hours before regenerating (obviously a lighter boat can go longer), and it takes him about three hours of sailing to regenerate one hour of power.

An electric motor's ability to deliver instant high torque at the shaft is not news. Without all the parasitic stuff that bleeds horsepower from a fossil-fuel engine—alternators, compressors, transmissions, water pumps, for example—a lower-horsepower electric motor can deliver more pure power, right at the shaft. And all electric motors share the benefits of nearly silent operation, clean bilges, no need to winterize the engine (Tether even uses his boat's Electric Wheel as a de-icer around the company's pier), no routine maintenance like changing oil or replacing belts, no oil or fuel consumed or spilled into waterways, no fossil-fuel emissions. But combine all this with the Electric Wheel's unique transmission and its ability to recharge its own juice, and you have a motor that is starting to make believers out of boaters and some boatbuilders.

"Its regeneration ability is the real revolution," says John Conser, designer of the Conser 47 catamaran. Now being built by Endeavour Catamaran in Clearwater, Fla., Conser 47s are being offered with two Electric Wheels as standard auxiliary power. Conser says he had researched electric motors for years before he happened upon Tether at the U.S. Sailboat Show in Annapolis last year. "It was a dream come true. It was like, wow, where have you been?"

"It completely changed my whole family's approach to the boat," says David Hadfield of Marina del Rey, Calif., who replaced a 1974, 24-hp gas engine in his Islander 30 with a 6-hp Electric Wheel. "I feel more enabled by technology instead of at the mercy of technology. . . . And every time I go out by the gas dock and know I never have to go there again makes me smile."

So far, Electric Wheels have been installed in 18 boats, among them a 48-foot Cherubini in England, a 46-foot cruising catamaran in Maine and a Hunter 33 and a Cal 29 on the Bay. This summer Tether plans to install two newly developed 12-hp Wheels in his Marine Trader 40 to begin refining the motor in powerboat applications. Depending on the boat's size and weight, owners report they have between four

and 10 hours of motoring time, and that it takes about three hours of sailing to regenerate one hour of motoring time. Most installations use a 144-volt system, with 10 to 12, 12-volt batteries—Group 27, 31 or 4D batteries are typical. And most are using absorbed glass mat batteries, which are fully sealed and can be installed just about anywhere on board.

"They weren't just selling me a product, they were selling an idea," says Hadfield, who was the first boater in the country to install an Electric Wheel in his boat. "The idea is not only a way of looking at things slightly differently. The future is being addressed."

In the 1980s, Tether worked at the Patuxent River Naval Surface Warfare Center developing systems that collect and analyze the electromagnetic signatures emitted by various aircraft. He managed the project to build the world's largest nuclear detonation simulator (to see how atmospheric detonations and the electromagnetic pulses that result would affect aircraft). Suffice to say, his wasn't an ordinary career.

But he didn't particularly like being a civilian contractor to the government, and in the late 1980s he joined up with an inventor named Jonathan Edwards from Leonardtown, Md., with whom he co-invented the concept of the Electric Wheel. Originally designed with automotive applications in mind, the Electric Wheel idea was pretty simple: Put a vehicle's engine in its wheels rather than under the hood, make it electric and eliminate the conventional engine, transmission and drive train.

In 1994, Kevin Smith of NASA's Mid-Atlantic Technology Applications Center got wind of the idea and made a deal: NASA would have the rights to use the Electric Wheel concept in space, and in return Solomon Technologies would benefit from the research and development that emerged. Ultimately, NASA used the motor-in-the-wheel concept in its Mars rover, though that motor was far simpler, without the transmission and gearing Tether has developed in the Electric Wheel, Smith says.

Tether wasn't making many inroads convincing the automotive industry to buy the Electric Wheel concept, so he started thinking about other markets. He'd been on boats since he was a Navy brat growing up, and he had fallen in

love with the Patuxent River and the Chesapeake Bay, so it was probably inevitable that he began to modify and perfect Electric Wheel for the marine market. And to do that, he pulled out the 22-hp diesel in his aged classic boat, installed an Electric Wheel and started motoring back and forth in front of his home on the Patuxent.

To understand the mindset of Electric Wheel converts, say Hadfield, Conser and others, you first must remember that in sailboats, at least, engines are called *auxiliary* power for a reason. Most sailors need engines only for maneuvering around docks, motoring for short distances or generating electricity for other onboard uses. Why put up with a noisy, smelly, heavy, polluting, fossil-fuel engine for such minimal use, they ask.

John Spence, partners with Teddy Turner Jr. in Charleston Boatworks in Charleston, S.C., agrees. "We were initially going to put a diesel in, but it makes little sense to have a diesel motor just for generating electricity," says Spence, who's refurbishing Turner's Condor 40. He has repowered the Annapolis-built trimaran, removing its twin 15-hp outboards and installing a single Electric Wheel, 10 Group 20 batteries (the minimum Solomon Technologies would permit them, Spence says) and a Fischer Panda 4-kilowatt generator. Spence and Turner are using a feathering, three-bladed Max-Prop. When they race, they can feather the prop, minimizing drag. When they want to recharge while cruising, they open the prop and let it spin.

The motor recharges through its extraordinarily powerful neodymium iron boron magnets. "In the past, the magnets would have had to be about fifty times the size they are," says Tether. "These new magnets popped on the scene about ten years ago and all of a sudden they were powerful enough to work on a small scale." As a motor, the Wheel is about 94 percent efficient, and as a generator it's 80 percent efficient, Tether says. An electronic controller allows the Electric Wheel to switch from being a motor to a generator instantaneously. If you're motor-sailing, the Wheel can generate power as you sail down a wave and the prop spins more quickly, then instantly become a motor as you power up a wave.

Solomon Technologies recommends boatowners upgrade to the largest diameter prop they can, to

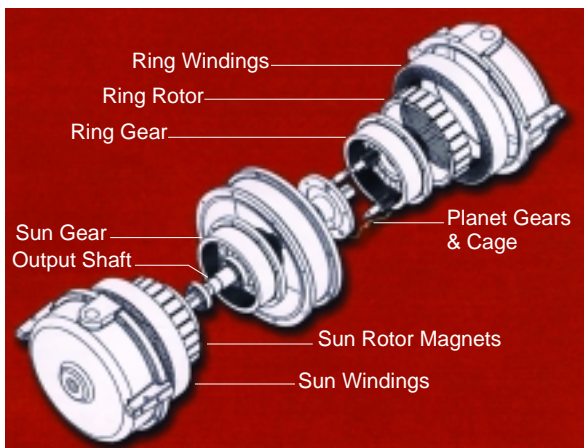
boost recharging ability and take advantage of the motor's powerful torque. And that's a problem for some sailors and boat-builders, who don't like the idea of a big prop dragging under the boat. On the Bay in particular, where light air and short, choppy waves are the norm, the added drag is clearly a potential downside.

But John Conser, who builds a 13,000-pound (read extremely lightweight), 47-foot, high-performance cruising catamaran, says it's not an issue with him—in part because his boat is mostly sailing where trade winds blow. “The only time I'm concerned about drag is in very light air, but it's not going to stop the boat. It'll always sail. And with our setup [an Electric Wheel in each hull] we can actually have one engine running and powering the boat and the other regenerating.”

Battery weight is also an issue—one Group 31 absorbed glass mat battery weighs 70 pounds, and you'll need at least 10 of them. One Group 27 absorbed glass mat battery weighs 63 pounds. Conversely, a typical 30-foot sailboat would have about 145 pounds of fuel in a full tank and about 300 pounds of engine.

Fischer Panda recently signed on with Solomon Technologies to partner in Electric Wheel installations. You don't need a generator to use Electric Wheel; it's simply up to the operator to keep an eye on the “e-meter,” which displays battery capacity in volts, amps in use, amps used and hours remaining in the battery bank.

A generator makes the whole system a complete no-brainer. Bud Virts, Maryland's recently retired Secretary of Agriculture and an investor in Solomon Technologies, has converted his Hunter 33, installing a 10-hp Electric Wheel with a 4-kilowatt Fischer Panda. With the generator mounted on a bracket over the Wheel, both fit easily into the existing engine space. Ten Group 31 batteries are beneath the cabin settees, and Virts is also adding an inverter which will give him 3,000 watts of AC power for his refrigeration system and microwave. The system is set up so that



once Virts turns the key, the generator automatically comes on if battery power is low and automatically turns off once the batteries are recharged.

Hadfield, on the other hand, has opted for no generator on his Islander 30. His engine was “noisy, smelled bad, vibrated—all very common things for engines.” He'd already ordered a diesel replacement—had it sitting in a box—when he saw an article on Solomon Technologies. He sold the diesel and installed a 6-hp Electric Wheel, with 10 Group 27 batteries. “That gives me between six and eight hours of motoring without recharging,” Hadfield says.

He upgraded his prop from a 12-inch to a 16-inch, fixed three-blade. With his batteries evenly distributed beneath the cabin settees and the Wheel in the original engine compartment, Hadfield says his boat weighs about 140 pounds less. He can go to hull speed (6.4 knots) within about three boatlengths, and he's only using about 40 percent of the amperage he has available—he could crank it up some more, but the Wheel's full potential is limited by inefficient hull design, Tether says. Like Tether's *Seaward*, Hadfield's boat generates about one hour of motoring power for every three hours of sailing.

So the next obvious question is cost. A 6-hp Electric Wheel (including the e-meter and electronic controller) is \$6,500, and the 10-hp Wheel is \$10,000. Say you'll need 10 Group 31 absorbed glass mat batteries at \$220 each (Group 27s are about \$190 each). Remember that batteries have variable life spans depending on how you use them—most should be good for about five years, but after that you're looking at



VINCE LUPO

Left: An exploded view of the Electric Wheel. Above: Bud Virts's Hunter 33 with Electric Wheel and generator installation.

another hefty investment in batteries.

Some sailors will want to stop there; they won't need anymore. If you want a shore-power charger, that's another \$1,200, and the Fischer Panda generators start at about \$4,000. If you go with a larger prop and a bigger shaft to handle it, you're looking at at least \$1,500, and probably more. Solomon Technologies staff have been installing all the motors for free (the company is beginning to look for authorized dealers), but in the future installation generally should cost about \$2,000 (that doesn't include removing the old engine). The Wheel is warranted for five years.

Like any revolution, this one has its challenges. The issues of weight, drag and cost may deter some boaters from considering the Electric Wheel. But it also has some momentum. “I feel very proud to be on the forefront of this thing,” Conser says, “and to show people it will work.” ■