

THE DANISH ISLAND THAT WENT CARBON NEGATIVE

By Nick Gier

We are a conservative farming community.
We are only normal people, not some special people.
--Jørgen Tranberg, Samsø island farmer

Although its largest and most prominent geographical feature is the peninsula of Jutland, the country of Denmark is primarily a nation of 444 islands, 76 of them inhabited. The capital Copenhagen is located on the largest island Zealand, and the second largest island Funen is the home of Hans Christian Andersen.

These days the Danish island most in the news is Samsø, situated between Jutland and Zealand. Twice the size of Manhattan, the island used to be known mainly for its delicious strawberries and potatoes. In ancient times it was famous for a great battle between warring factions of Swedish Vikings. In the sagas it is where the god Odin learned to cast charms, for which he was teased by Loki because it was a woman's skill.

Today the Samsingers, as the 4,200 people on Samsø call themselves, are the first in the industrialized world to reach a carbon negative state. They used to be totally dependent on petroleum imports and electricity from Jutland's coal-fired plants. Before 1998 each Samsinger was responsible for 11 metric tons of CO₂ released into the atmosphere. Annually each American puts 19 metric tons into the air.

By installing wind turbines, solar panels, and burning biomass in "closed" furnaces, the Samsingers have now reduced their CO₂ emissions by 140 percent. By 2005 they had reached 100 percent and had attained carbon neutrality. The additional 40 percent reduction means that they are now carbon negative: they are exporting more energy than they consume.

It all started with Søren Hermansen, a former farmer and teacher, who is now director of the Samsø Energy Academy and winner of prestigious Göteborg Award for Sustainable Development. In 1997 Hermansen thought that his island had a good chance to win a national competition for "Renewable Energy Island." Engineer Ole Johnsson came over from Jutland and did some wind and sunshine studies, and he and Hermansen sent their proposal off to Copenhagen. They won the competition and the prize was \$90 million in grants from the Danish government over ten years.

The grants were used to insulate houses, buy new windows, replace oil furnaces with heat pumps, install solar panels, and set up nine central heating plants fueled by wood chips and straw from the wheat and rye fields. One bale of straw turns out to be the equivalent of one barrel of oil. The government allowed the Samsingers free reign in deciding how to increase their energy efficiency.

At first most of the Samsingers were resistant to expending all this effort to go green. Especially reluctant were the plumbers, carpenters, and electricians who were used to installing and maintaining fossil fuel-based equipment. After 100 jobs were lost after a pig slaughterhouse closed, Hermansen's promise of new jobs turned the tide. Since 1998 an average of 30 new jobs

a year have come on line, and workers with newly acquired green skills are in great demand not only in Denmark but other European countries as well.

Raising 80 percent of their own capital, the residents eventually installed 11 one-megawatt wind turbines and set up many smaller household turbines. Most of the turbines are cooperatively owned and those shareholders include 1,100 of the 50,000 tourists who visit the island during the summers. Each year the island uses 26 million kilowatt hours, but there is 80 million kilowatt hours left over that is sold to the national grid for \$8 million a year. One enterprising dairy farmer, Jørgen Tranberg, owns his own wind turbine and has half-interest in another. He claims that on a good windy day he not only supplies all of his electrical needs but earns \$2,500 from wind power that he exports.

To off-set the 690,000 gallons of gas and diesel still used in their cars, tractors, and ferries, the Samsingers invested in 10 sea-based 2.3-megawatt wind turbines, which greet visitors as they arrive at the ferry terminal. The green house gases produced in the construction of the turbines have been included in the carbon reduction claims.

The Samsingers are expanding their biogas production to include methane from pig waste, and they are also experimenting with the production of hydrogen, which can be used to run fuel cells. A century ago Danish scientist Paul La Cour used wind power to produce hydrogen for the lights at Askov Folk High School. (Some of the lamps blew up because there was still a little oxygen left in the hydrogen!) La Cour published *The Journal of Wind Electricity* and under his leadership wind power produced 3 percent of Denmark's electricity by 1918. The lure of cheap oil then put an end to this early green development.

Danish scientists, working at a research station once devoted to nuclear energy, are again on the cutting edge of hydrogen production. On the Danish island of Lolland wind mills are producing 50 percent more power than the people consume, so the Lollanders are electrolyzing water to produce hydrogen and oxygen, which is used to speed up the treatment of the island's sewage.

Along with Israel, Denmark is starting to build charging stations for electric vehicles, so these cars will soon be on Danish highways in greater numbers than elsewhere. The Danish government is waiving the 200 percent excise tax on conventional vehicles to encourage Danes to switch to electric transportation. Teaming up with the American company Better Place, Danish utility Dong Energy is laying out \$103 million for 500,000 charging stations and 150 battery swap depots strategically located for longer trips.

One might ask why Better Place is not doing business with U.S. utilities, and the answer is that, except for negotiations with Hawaii and San Francisco, there is neither the political will nor the government support to make innovation such as this happen. The U.S. is also far behind other countries in developing "smart-grid" networks that can shift excess power to where it is needed.

On the Danish island of Bornholm an experiment with "vehicle-to-grid" power storage is now underway for the 40,000 inhabitants. Parked vehicles will serve as storage for the excess wind power produced on the island. When the weather is calm, electricity flows back into the grid making unnecessary the reliance on coal-fired plants. Only 400,000 electric cars used in this

manner would be needed to take up the slack when Denmark's 5,200 turbine rotors are not turning.

Denmark generates on average 20 percent of its electricity from wind, and on a really stormy day, the total power produced from coal and wind well exceeds the needs of this country of 5.5 million people. Dramatic improvement in efficiency and durability of the wind turbines mean more energy and shut downs only in extreme conditions.

When in Denmark for my first sabbatical there in 1978-79, I was following the news about a hippie commune in Tvind that was selling excess electricity from its home-made windmill. With advice from the Danish Technical University and an engineer in Germany, the Tvind hippies solved basic problems with rotor composition that had stumped other engineers. Today Denmark produces the most efficient rotors in the world.

Over 80 percent of Danish wind turbines are owned by cooperatives or individual farmers. Substantial tax credits, now being phased out, were required to get this industry off the ground, but this government support has paid off in spades.

Danish wind technology now accounts for \$7.4 billion of the country's exports, joining dairy, pork, and shipping as a major industry. The road from hippie wind engineering to Vestas, the Danish company that supplies one third of the world's wind turbines, has been a great success story for the synergy of government and individual innovation for which the Nordic countries are famous.

Electricity can be transmitted over long distances much more efficiently as DC current. A DC grid is now in place in Scandinavia, Northern Germany, and the Netherlands. Excess Danish wind power is sent to Norway to pump water back up into reservoirs. AC current cannot be transmitted under water, so there are plans to expand this smart grid across the North Sea to Scotland.

The Samsingers, the Lollanders, and Bornholmers, mostly conservative farmers, say that they are just ordinary people. Their challenge is that if they can become carbon neutral, then anyone on earth can follow their lead. With sufficient political will and cooperative effort every nation could kick its petroleum habit and planet earth could be saved from ecological disaster.

Nick Gier taught philosophy at the University of Idaho for 31 years. Read his column on wind power and other green topics at www.home.roadrunner.com/~nickgier/green.htm.