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THE ISLAND IN THE WIND

A Danish community's victory over carbon emissions.

by Elizabeth Kolbert July 7, 2008

Once people on Samsø started thinking about energy, a local farmer explains, "it became a kind of sport." Photograph by Joachim Ladefoged.

Jørgen Tranberg is a farmer who lives on the Danish island of Samsø. He is a beefy man with a mop of brown hair and an unpredictable sense of humor. When I arrived at his house, one gray morning this spring, he was sitting in his kitchen, smoking a cigarette and watching grainy images on a black-and-white TV. The images turned out to be closed-circuit shots from his barn. One of his cows, he told me, was about to give birth, and he was keeping an eye on her. We talked for a few minutes, and then, laughing, he asked me if I wanted to climb his wind turbine. I was pretty sure I didn’t, but I said yes anyway.

We got into Tranberg’s car and bounced along a rutted dirt road. The turbine loomed up in front of us. When we reached it, Tranberg stubbed out his cigarette and opened a small door in the base of the tower. Inside were eight ladders, each about twenty feet tall, attached one above the other. We started up, and were soon huffing. Above the last ladder, there was a trapdoor, which led to a sort of engine room. We scrambled into it, at which point we were standing on top of the generator. Tranberg pressed a button, and the roof slid open to reveal the gray sky and a patchwork of green and brown fields stretching toward the sea. He pressed another button. The rotors, which he had switched off during our climb, started to turn, at first sluggishly and then much more rapidly. It felt as if we were about to take off. I’d like to say the feeling was exhilarating; in fact, I found it sickening. Tranberg looked at me and started to laugh.

Samsø, which is roughly the size of Nantucket, sits in what’s known as the Kattegat, an arm of the North Sea. The island is bulgy in the south and narrows to a bladelike point in the north, so that on a map it looks a bit like a woman’s torso and a bit like a meat cleaver. It has twenty-two villages that hug the narrow streets; out back are fields where farmers grow potatoes and wheat and strawberries. Thanks to Denmark’s peculiar geography, Samsø is smack in the center of the country and, at the same time, in the middle of nowhere.

For the past decade or so, Samsø has been the site of an unlikely social movement. When it began, in the late nineteen-nineties, the island’s forty-three hundred inhabitants had what might be described as a conventional attitude toward energy: as long as it continued to arrive, they weren’t much interested in it. Most Samsingers heated their houses with oil, which was brought in on tankers. They used electricity imported from the mainland via cable, much of which was generated by burning coal. As a result, each Samsinger put into the atmosphere, on average, nearly eleven tons of carbon dioxide annually.

Then, quite deliberately, the residents of the island set about changing this. They formed energy coöperatives and organized seminars on wind power. They removed their furnaces and replaced them with heat pumps. By 2001, fossil-fuel use on Samsø had been cut in half. By 2003, instead of importing electricity, the island was exporting it, and by 2005 it was producing from renewable sources more energy than it was using.

The residents of Samsø that I spoke to were clearly proud of their accomplishment. All the same, they insisted on their ordinariness. They were, they noted, not wealthy, nor were they especially well educated or idealistic. They weren’t even terribly adventuresome. “We are a conservative farming community” is how one Samsinger put it. “We are only normal people,” Tranberg told me. “We are not some special people.”

This year, the world is expected to burn through some thirty-one billion barrels of oil, six billion tons of coal, and a hundred trillion cubic feet of natural gas. The combustion of these fossil fuels will produce, in aggregate, some four hundred quadrillion B.T.U.s of energy. It will also yield around thirty billion tons of carbon dioxide. Next year, global consumption of fossil fuels is expected to grow by about two per cent, meaning that emissions will rise by more than half a billion tons, and the following year consumption is expected to grow by yet another two per cent.

When carbon dioxide is released into the air, about a third ends up, in relatively short order, in the oceans. (CO_2 dissolves in water to form a weak acid; this is the cause of the phenomenon known as "ocean acidification.") A quarter is absorbed by terrestrial ecosystems—no one is quite sure exactly how or where—and the rest remains in the atmosphere. If current trends in emissions continue, then sometime within the next four or five decades the chemistry of the oceans will have been altered to such a degree that many marine organisms—including reef-building corals—will be pushed toward extinction. Meanwhile, atmospheric CO_2 levels are projected to reach five hundred and fifty parts per million—twice pre-industrial levels—virtually guaranteeing an eventual global temperature increase of three or more degrees. The consequences of this warming are difficult to predict in detail, but even broad, conservative estimates are terrifying: at least fifteen and possibly as many as thirty per cent of the planet's plant and animal species will be threatened; sea levels will rise by several feet; yields of crops like wheat and corn will decline significantly in a number of areas where they are now grown as staples; regions that depend on glacial runoff or seasonal snowmelt—currently home to more than a billion people—will face severe water shortages; and what now counts as a hundred-year drought will occur in some parts of the world as frequently as once a decade.

Today, with CO_2 levels at three hundred and eighty-five parts per million, the disruptive impacts of climate change are already apparent. The Arctic ice cap, which has shrunk by half since the nineteen-fifties, is melting at an annual rate of twenty-four thousand square miles, meaning that an expanse of ice the size of West Virginia is disappearing each year. Over the past ten years, forests covering a hundred and fifty million acres in the United States and Canada have died from warming-related beetle infestations. It is believed that rising temperatures are contributing to the growing number of international refugees—"Climate change is today one of the main drivers of forced displacement," the United Nations' high commissioner for refugees, António Guterres, said recently—and to armed conflict: some experts see a link between the fighting in Darfur, which has claimed as many as three hundred thousand lives, and changes in rainfall patterns in equatorial Africa.

"If we keep going down this path, the Darfur crisis will be only one crisis among dozens of others," President Nicolas Sarkozy, of France, told a meeting of world leaders in April. The Secretary-General of the United Nations, Ban Ki-moon, has called climate change "the defining challenge of our age."

In the context of this challenge, Samsø's accomplishments could be seen as trivial. Certainly, in numerical terms they don't amount to much: all the island's avoided emissions of the past ten years are overwhelmed by the CO_2 that a single coal-fired power plant will emit in the next three weeks, and China is building new coal-fired plants at the rate of roughly four a month. But it is also in this context that the island's efforts are most significant. Samsø transformed its energy systems in a single decade. Its experience suggests how the carbon problem, as huge as it is, could be dealt with, if we were willing to try.

Samsø set out to reinvent itself thanks to a series of decisions that it had relatively little to do with. The first was made by the Danish Ministry of Environment and Energy in 1997. The ministry, looking for ways to promote innovation, decided to sponsor a renewable-energy contest. In order to enter, a community had to submit a plan showing how it could wean itself off fossil fuels. An engineer who didn't actually live on Samsø thought the island would make a good candidate. In consultation with Samsø's mayor, he drew up a plan and submitted it. When it was announced that Samsø had won, the general reaction among residents was puzzlement. "I had to listen twice before I believed it," one farmer told me.

The brief surge of interest that followed the announcement soon dissipated. Besides its designation as Denmark's "renewable-energy island," Samsø received basically nothing—no prize money or special tax breaks, or even government assistance. One of the few people on the island to think the project was worth pursuing was Søren Hermansen.

Hermansen, who is now forty-nine, is a trim man with close-cropped hair, ruddy cheeks, and dark-blue eyes. He was born on Samsø and, save for a few stints away, to travel and go to university, has lived there his entire life. His father was a farmer who grew, among other things, beets and parsley. Hermansen, too, tried his hand at farming—he took over the family's hundred acres when his father retired—but he discovered he wasn't suited to it. "I like to talk, and vegetables don't respond," he told me. He leased his fields to a neighbor and got a job teaching environmental studies at a local boarding school. Hermansen found the renewable-energy-island concept intriguing. When some federal money was found to fund a single staff position, he became the project's first employee.

For months, which stretched into years, not much happened. "There was this conservative hesitating, waiting for the neighbor to do the move," Hermansen recalled. "I know the community and I know this is what usually happens." Rather than working against the islanders' tendency to look to one another, Hermansen tried to work with it.

"One reason to live here can be social relations," he said. "This renewable-energy project could be a new kind of social relation, and we used that." Whenever there was a meeting to discuss a local issue—any local issue—Hermansen attended and made his pitch. He asked Samsingers to think about what it would be like to work together on something they could all be proud of. Occasionally, he brought free beer along to the discussions. Meanwhile, he began trying to enlist the support of the island's opinion leaders. "This is where the hard work starts, convincing the first movers to be active," he said. Eventually, much as Hermansen had hoped, the social dynamic that had stalled the project began to work in its favor. As more people got involved, that prompted others to do so. After a while, enough Samsingers were participating that participation became the norm.

"People on Samsø started thinking about energy," Ingvar Jørgensen, a farmer who heats his house with solar hot water and a straw-burning furnace, told me. "It became a kind of sport."

"It's exciting to be a part of this," Brian Kjær, an electrician who installed a small-scale turbine in his back yard, said. Kjær's turbine, which is seventy-two feet tall, generates more current than his family of three can use, and also more than the power lines leading away from his house can handle, so he uses the excess to heat water, which he stores in a tank that he rigged up in his garage. He told me that one day he would like to use the leftover electricity to produce hydrogen, which could potentially run a fuel-cell car.

"Søren, he has talked again and again, and slowly it's spread to a lot of people," he said.

Since becoming the "renewable energy island," Samsø has increasingly found itself an object of study. Researchers often travel great distances to get there, a fact that is not without its own irony. The day after I arrived, from New York via Copenhagen, a group of professors from the University of Toyama, in Japan, came to look around. They had arranged a tour with Hermansen, and he invited me to tag along. We headed off to meet the group in his electric Citroën, which is painted blue with white puffy clouds on the doors. It was a drizzly day, and when we got to the dock the water was choppy. Hermansen commiserated with the Japanese, who had just disembarked from the swaying ferry; then we all boarded a bus.

Our first stop was a hillside with a panoramic view of the island. Several wind turbines exactly like the one I had climbed with Tranberg were whooshing nearby. In the wet and the gray, they were the only things stirring. Off in the distance, the silent fields gave way to the Kattegat, where another group of turbines could be seen, arranged in a soldierly line in the water.

All told, Samsø has eleven large land-based turbines. (It has about a dozen additional micro-turbines.) This is a lot of turbines for a relatively small number of people, and the ratio is critical to Samsø's success, as is the fact that the wind off the Kattegat blows pretty much continuously; flags on Samsø, I noticed, do not wave—they stick straight out, as in children's drawings. Hermansen told us that the land-based turbines are a hundred and fifty feet tall, with rotors that are eighty feet long. Together, they produce some twenty-six million kilowatt-hours a year, which is just about enough to meet all the island's demands for electricity. (This is true in an arithmetic sense; as a practical matter, Samsø's production of electricity and its needs fluctuate, so that sometimes it is feeding power into the grid and sometimes it is drawing power from it.) The offshore turbines, meanwhile, are even taller—a hundred and ninety-five feet high, with rotors that extend a hundred and twenty feet. A single offshore turbine generates roughly eight million kilowatt-hours of electricity a year, which, at Danish rates of energy use, is enough to satisfy the needs of some two thousand homes. The offshore turbines—there are ten of them—were erected to compensate for Samsø's continuing use of fossil fuels in its cars, trucks, and ferries. Their combined output, of around eighty million kilowatt-hours a year, provides the energy equivalent of all the gasoline and diesel oil consumed on the island, and then some; in aggregate, Samsø generates about ten per cent more power than it consumes.

"When we started, in 1997, nobody expected this to happen," Hermansen told the group. "When we talked to local people, they said, Yes, come on, maybe in your dreams." Each land-based turbine cost the equivalent of eight hundred and fifty thousand dollars. Each offshore turbine cost around three million dollars. Some of Samsø's turbines were erected by a single investor, like Tranberg; others were purchased collectively. At least four hundred and fifty island residents own shares in the onshore turbines, and a roughly equal number own shares in those offshore. Shareholders, who also include many non-residents, receive annual dividend checks based on the prevailing price of electricity and how much their turbine has generated.

"If I'm reduced to being a customer, then if I like something I buy it, and if I don't like it I don't buy it," Hermansen said. "But I don't care about the production. We care about the production, because we own the wind turbines. Every time they turn around, it means money in the bank. And, being part of it, we also feel responsible." Thanks to a policy put in place by Denmark's government in the late nineteen-nineties, utilities are required to offer ten-year fixed-rate contracts for wind power that they can sell to customers elsewhere. Under the terms of these contracts, a turbine should—barring mishap—repay a shareholder's initial investment in about eight years.

From the hillside, we headed to the town of Ballen. There we stopped at a red shed-shaped building made out of corrugated metal. Inside, enormous bales of straw were stacked against the walls. Hermansen explained that the building was a district heating plant that had been designed to run on biomass. The bales, each representing the equivalent of fifty gallons of oil, would be fed into a furnace, where water would be heated to a hundred and fifty-eight degrees. This hot water would then be piped underground to two hundred and sixty houses in Ballen and in the neighboring town of Brundby. In this way, the energy of the straw burned at the plant would be transferred to the homes, where it could be used to provide heat and hot water.

Samsø has two other district heating plants that burn straw—one in Tranebjerg, the other in Onsbjerg—and also a district plant, in Nordby, that burns wood chips. When we visited the Nordby plant, later that afternoon, it was filled with what looked like mulch. (The place smelled like a potting shed.) Out back was a field covered in rows of solar panels, which provide additional hot water when the sun is shining. Between the rows, sheep with long black faces were munching on the grass. The Japanese researchers pulled out their cameras as the sheep snuffled toward them, expectantly.

Of course, burning straw or wood, like burning fossil fuels, produces CO_2. The key distinction is that while fossil fuels release carbon that otherwise would have remained sequestered, biomass releases carbon that would have entered the atmosphere anyway, through decomposition. As long as biomass regrows, the CO_2 released in its combustion should be reabsorbed, meaning that the cycle is—or at least can be—carbon neutral. The wood chips used in the Nordby plant come from fallen trees that previously would have been left to rot. The straw for the Ballen-Brundby plant comes mainly from wheat stalks that would previously have been burned in the fields. Together, the biomass heating plants prevent the release of some twenty-seven hundred tons of carbon dioxide a year.

In addition to biomass, Samsø is experimenting on a modest scale with biofuels: a handful of farmers have converted their cars and tractors to run on canola oil. We stopped to visit one such farmer, who grows his own seeds, presses his own oil, and feeds the leftover mash to his cows. The farmer couldn't be located, so Hermansen started up the press himself. He stuck a finger under the spout, then popped it into his mouth. "The oil is very good," he announced. "You can use it in your car, and you can use it on your salad."

After the tour, I went back with Hermansen to his office, in a building known as the Energiakademi. The academy, which looks like a Bauhaus interpretation of a barn, is covered with photovoltaic cells and insulated with shredded newspapers. It is supposed to serve as a sort of interpretive center, though when I visited, the place was so new that the rooms were mostly empty. Some high-school students were kneeling on the floor, trying to put together a miniature turbine.

I asked Hermansen whether there were any projects that hadn't worked out. He listed several, including a plan to use natural gas produced from cow manure and an experiment with electric cars that failed when one of the demonstration vehicles spent most of the year in the shop. The biggest disappointment, though, had to do with consumption.

"We made several programs for energy savings," he told me. "But people are acting—what do you call it?—irresponsibly. They behave like monkeys." For example, families that insulated their homes better also tended to heat more rooms, "so we ended up with zero." Essentially, he said, energy use on the island has remained constant for the past decade.

I asked why he thought the renewable-energy-island effort had got as far as it did. He said he wasn't sure, because different people had had different motives for participating. "From the very egoistic to the more over-all perspective, I think we had all kinds of reasons."

Finally, I asked what he thought other communities might take from Samsø's experience.

"We always hear that we should think globally and act locally," he said. "I understand what that means—I think we as a nation should be part of the global consciousness. But each individual cannot be part of that. So 'Think locally, act locally' is the key message for us."

"There's this wish for showcases," he added. "When we are selected to be the showcase for Denmark, I feel ashamed that Denmark doesn't produce anything bigger than that. But I feel proud because we are the showcase. So I did my job, and my colleagues did their job, and so did the people of Samsø."

Around the same time that Samsø was designated Denmark's renewable-energy island, a group of Swiss scientists who were working on similar issues performed a thought experiment. The scientists, all of whom were affiliated with the Swiss Federal Institute of Technology, asked themselves what level of energy use would be sustainable, not just for an island or a small European nation but for the entire world. The answer they came up with—two thousand watts per person—furnished the name for a new project: the 2,000-Watt Society.

"What it's important, I think, to know is that the 2,000-Watt Society is not a program of hard life," the director of the project, Roland Stulz, told me when I went to speak to him at his office, in the Zurich suburb of Dübendorf. "It is not what we call *Gürtel enger schnallen*"—belt tightening—"it's not starving, it's not having less comfort or fun. It's a creative approach to the future."

Stulz, who is sixty-three, is a softspoken man with dark wavy hair and a salt-and-pepper mustache. He was trained as an architect and later became interested in energy-efficient building. In 2001, when he took over the 2,000-Watt Society, his mandate was to push it into the realm of the practical. (His work is funded in part by the Swiss Federal Institute of Technology, which has campuses in Zurich and Lausanne, and in part by private donations.) He began holding meetings that brought researchers together with government officials from cities like Zurich and Basel.

"I divided them into groups," Stulz recalled. "And I told them, At four o'clock each group must come and tell the whole session what project they will do in the future, and who will lead the projects. And they said, Oh, it's not possible. But at four o'clock everybody came with a project. And that's how we started." The cantons of Geneva and Basel-Stadt and the city of Zurich subsequently endorsed the aims of the 2,000-Watt Society, as did the Swiss Federal Department of the Environment, Transport, Energy, and Communications. "At first glance, the objective of a two-thousand-watt society appears unrealistic," Moritz Leuenberger, the head of the federal department, has said. "But the necessary technology already exists."

One afternoon, Stulz took me to visit the headquarters of an aquatic-research center known as EAWAG, which was designed to meet the 2,000-Watt Society's energy-efficiency goals. (EAWAG is an acronym for a German name so complicated that even German speakers can't remember it.) We drove over in his Volvo, which runs on compressed natural gas produced in part from rotting vegetables. When I first caught sight of the place, I thought it was covered with banners; these turned out to be tinted-glass panels. Inside, hanging from a set of chains in a large atrium, was what I took to be a sculpture of a bug. This turned out to be a model of a water molecule, enlarged some ten billion times.

Among the many unusual features of the EAWAG Center is a lack of usual features. The building, which opened in 2006, has no furnace; it is so tightly insulated that, on most days, the warmth thrown off by the office equipment and the two hundred people who work inside is enough to keep it comfortable. Additional heat is provided by the sun—in winter, the outside panels tilt to allow in the maximum amount of light—and by air sucked in from underground. The building also has no conventional air-conditioners: in summer, the panels tilt to provide shade, and if the building gets hot during the day, at night the windows at the top of the atrium open, and the warm air rushes out. It supplies about a third of its own electricity with photovoltaic panels installed on the roof, and gets its hot water from solar collectors. Its bathrooms are equipped with specially designed "no mix" toilets that separate out urine, which contains potentially useful phosphorus and nitrogen. ("Exploiting common waste as a resource is a mark of sustainable civilization," a booklet on the building observes.)

"It's not a miracle, such a building," Stulz told me when we went to have a cup of coffee in the center's cheerfully modernist cafeteria. "It's just putting smart elements together in a smart way." Outside, it was rainy and forty-three degrees; inside the temperature was a pleasant seventy.

One way to think about the 2,000-Watt Society is in terms of light bulbs. Let's say you turn on twenty lamps, each with a hundred-watt bulb. Together, the lamps will draw two thousand watts of power. Left on for a day, they will consume forty-eight kilowatt-hours of energy; left on for a year, they will consume seventeen thousand five hundred and twenty kilowatt-hours. A person living a two-thousand-watt life would consume in all his activities—working, eating, travelling—the same amount of energy as those twenty bulbs, or seventeen thousand five hundred and twenty kilowatt-hours annually.

Most of the people in the world today consume far less than this. The average Bangladeshi, for example, uses only about twenty-six hundred kilowatt-hours a year—this figure includes all forms of energy, from electricity to transportation fuel—which is the equivalent of using roughly three hundred watts continuously. The average Indian uses about eighty-seven hundred kilowatt-hours a year, making India a one-thousand-watt society, while the average Chinese uses about thirteen thousand kilowatt-hours a year, making China a fifteen-hundred-watt society.

Those of us who live in the industrialized world, by contrast, consume far more than two thousand watts. Switzerland, for instance, is a five-thousand-watt society. Most other Western European countries are six-thousand-watt societies; the United States and Canada run at twelve thousand watts. One of the founding principles of the 2,000-Watt Society is that this disparity is in itself unsustainable. "It's a basic matter of fairness" is how Stulz put it to me. But increasing energy use in developing countries to match that of industrialized nations would be unacceptable on ecological grounds. Were per-capita demand in the developing world to reach current European levels, global energy consumption would more than double, and were it to rise to the American level, global energy consumption would more than triple. The 2,000-Watt Society gives industrialized countries a target for cutting energy use at the same time that it sets a limit for growth in developing nations.

The last time Switzerland was a two-thousand-watt society was in the early nineteen-sixties. By the end of that decade, energy use had reached three thousand watts, and by the mid-seventies it was up to four thousand watts. This rapid rise could be said to follow from technological advances—the spread of automobiles, the advent of jet travel, the proliferation of appliances and electronic devices—or it could be seen as just the reverse: a failure to apply technology where it is needed. A few years ago, a group of Swiss scientists published a white paper—or, to use the Swiss term, a "white book"—on the feasibility of a 2,000-Watt Society. Relying on widely agreed-upon figures, the scientists estimated that two-thirds of all the primary energy consumed in the world today is wasted, mostly in the form of heat that nobody wants or uses. ("Primary energy" is the energy contained in, say, a lump of coal; "useful energy" is the light emitted by a bulb once that coal has been burned to produce steam, the steam has been used to run a turbine, and the resulting electricity has been transmitted over the grid to heat the bulb's filament.) This same paper concluded that, with currently available technologies, buildings could be made eighty per cent more efficient, cars fifty per cent more efficient, and motors twenty-five per cent more efficient.

In Switzerland, I visited several other buildings that, like the EAWAG Center, had been specifically designed to maximize efficiency. One was an upscale apartment building in Basel. The apartments have eighteen-inch-thick walls filled with insulation, triple-paned windows coated with a special reflective film, and a heat-recovery system that captures eighty per cent of the energy normally lost through ventilation. Instead of a boiler, it has a geothermal heat pump, which essentially sucks energy out of the groundwater. In the summer, the same system is used for cooling. (In compliance with Swiss building codes, the building also contains a bomb shelter.)

"The construction industry is very traditional," Franco Fregnan, an engineer who showed me around the apartments, said. "If you bring an innovation to them, you usually have to wait another generation until it arrives into a building. And we are trying to change that, step by step."

"It usually makes sense to become more intelligent in any human activity," Stulz told me. "As the former Saudi Arabian oil minister Sheikh Yamani once said, the Stone Age didn't end because there were no more stones. It ended because people became more intelligent. "

What would it take to lead a two-thousand-watt life? When I posed this question to Stulz, he gave me another research paper, which offers case studies of six fictionalized households. The Jeannerets are an imaginary family of four who live in Glattbrugg, a town north of Zurich. They own an energy-efficient house, travel by electric bike or train, and occasionally rent a car—they belong to a car-sharing service—to do their grocery shopping. The Moeris, fictional farmers who live northeast of Bern, generate their own electricity with natural gas produced from cow manure; and Alain, Michel, Angela, and Marlène, fictional students living in Geneva, share all their appliances, use the tram, and like to go hiking in the French Alps during school breaks. "There is no formula for how to achieve a two-thousand-watt society," the paper declares. "Three things are needed: societal decisions. . . technical innovation, and the resolve of every individual to act in an energy-conscious way."

Very broadly speaking, the average Swiss today uses energy as follows: fifteen hundred watts per day for living and office space (this includes heat and hot water), eleven hundred watts for food and consumer items (the energy that it takes to produce and transport goods is referred to as "embodied" or "gray" energy), six hundred watts for electricity, five hundred watts for automobile travel, two hundred and fifty watts for air travel, and a hundred and fifty watts for public transportation. Each person's share of Switzerland's public infrastructure, which includes facilities like water- and sewagetreatment plants, comes to nine hundred watts. Reducing these five thousand watts to two thousand would seem to require a significant reduction in every realm. Assuming that infrastructure-related consumption could be cut to five hundred watts, a person who continued to use fifteen hundred watts for living and office space would have nothing left for food, electricity, and transportation. Similarly, a person who continued to travel and use electricity at current rates would consume two thousand watts without having anywhere to live or work, or anything to eat.

While I was in Switzerland, I kept looking for people who actually led two-thousand-watt lives.

“I’m pretty close, except for this stupid air travel,” Gerhard Schmitt, the vice-president for planning and logistics at the Zurich campus of the Swiss Federal Institute of Technology, told me. “I go once to Shanghai and it’s gone.” (A round-trip flight between Zurich and Shanghai is the equivalent of using something like eight hundred watts continuously for a year.)

“Let’s skip that question,” Stulz said when I put it to him. While he lives in an energy-efficient apartment, he, too, travels a great deal; when I visited, he had just returned from a conference in New Delhi, a round trip that used roughly the equivalent of six hundred watts for the year.

The one person I spoke to who did seem to be leading a two-thousand-watt life, or something very near to it, was an engineer named Robert Uetz. Uetz works in the same building as Stulz, and when we returned from visiting the EAWAG Center he was still in his office, even though it was after six. Stulz encouraged me to go talk to him.

“We don’t experience it as a restriction,” Uetz told me of his two-thousand-watt life style. “On the contrary. I don’t feel that we’re giving up anything.” Uetz and his wife, a dentist, live with their two children in the city of Winterthur, near Zurich. About ten years ago, they bought a two-thousand-square-foot house in a newly built energy-efficient development. The house is heated with a geothermal heat pump—“It’s crazy to heat a house with fossil fuels,” Uetz said—and has a solar hot-water system. Uetz added photovoltaic panels to the roof to produce electricity; in the winter the panels produce somewhat less power than the house uses—it’s equipped with the most energy-efficient lights and appliances the family could find—and in the summer they produce somewhat more, so that over the course of the year the house’s electricity use nets out to zero.

“The most important decision was that we wouldn’t have a car,” Uetz told me. “That was a conscious decision. We looked for a house where we didn’t need a car.” Driving a lot—even in what, by today’s standards at least, counts as an energy-efficient vehicle—also makes it difficult to live within two thousand watts. A person who drives a Toyota Prius ten thousand miles a year consumes roughly two hundred and twenty-five gallons of gasoline. This is equivalent to consuming around eight thousand kilowatt-hours, or to using nearly a thousand watts on a continuous basis. (For a family of four, the same gasoline consumption would come to almost two hundred and fifty watts per person.)

“It’s a matter of what you’re used to, but I find taking the train a lot more pleasant than driving,” Uetz went on. “On the train I can work and relax. If I took a car, I’d have to worry about parking and traffic, rain, snow, and a certain number of people who can’t drive but are on the road anyway.” When Uetz and his family go on vacation, they travel by rail. “The only thing I’d say that is sort of a restriction is the flying,” he said. “Because, obviously, with the train where you can go is limited. We can’t go to China, or if we did it would take a week.”

"I don't make a religion out of it," he added. "I wouldn't do it if I didn't feel good about it—it's how I like to live."

By the 2,000-Watt Society's own reckoning, cutting consumption is just half—or, perhaps more accurately, a quarter—of what needs to be done. The project's ultimate goal is a world where people consume no more than two thousand watts apiece and where fifteen hundred of those watts come from carbon-free sources. In such a world, everyone would use energy sparingly, like Robert Uetz, and generate it renewably, like Jørgen Tranberg. In such a world, filled with windmills and net-zero houses, carbon emissions would fall sharply, and the concentration of CO_2 in the atmosphere would slowly level off. But how realistic is such a scenario?

Before I left Switzerland to fly back to New York (a trip equivalent to using roughly two hundred and fifty watts continuously for a year), I went to speak to the president of the research council of the Swiss National Science Foundation, Dieter Imboden. Imboden, who is sixty-four, is a compact man with an oval face and silvery hair. He received his training in theoretical solid-state physics, later became interested in environmental physics, and for several years chaired the Swiss Federal Institute of Technology's environmental-sciences department. In the late nineties, he served as the director of the 2,000-Watt Society. He said that as a scientist he could see no technical barriers to creating a two-thousand-watt world.

"We are putting our mental energy into the wrong basket," he told me. "Nothing has to be reinvented—for an engineer it's not even a challenge."

"The problems of the twenty-first century are a different kind of problem," he went on. "And I think our society will be measured according to the solution of this new kind of problem, which cannot be solved with the same recipe as the flight to the moon, or the Manhattan Project. It's a qualitative difference—a paradigm change in the role of science for our society."

He continued, "The difficult thing is what I call 'constructed Switzerland.' You in America could call it 'constructed United States'—the buildings and how they are built, but also where they are built and, even more important, the roads, the railroads, the lines for energy, for wastewater, and so on. It's not economically feasible to replace everything in one instant." But since infrastructure should in any case be replaced at the rate of roughly two per cent a year, if the project is approached incrementally, it's a different task. Then, Imboden said, "it suddenly *is* feasible."

As of yet, no one has undertaken a rigorous analysis of the economics of a transition to two thousand watts. Researchers have tended, rather, to focus on the price of stabilizing carbon-dioxide levels in the atmosphere at a given concentration—either, say, five hundred and fifty parts per million, which is double pre-industrial levels, or four hundred and fifty parts, which, many climate scientists say, is the very highest level advisable. Perhaps the most often cited economic study is the Stern Review, commissioned by the British government and named for its lead author, Sir Nicholas Stern, formerly the chief economist for the World Bank. The Stern Review, published in October, 2006, concluded that greenhouse-gas levels could be stabilized below double pre-industrial concentrations at a cost to global G.D.P. of around one per cent a year. (The Stern Review considered not just CO_2 but other greenhouse gases, like methane and nitrous oxide, as well.) An analysis released last year by the Swedish utility Vattenfall, with research assistance from the American consulting firm McKinsey & Company, reached a similar conclusion: it determined that many measures to reduce carbon emissions, like improving building insulation, would save money, while others, like installing wind turbines, would carry a price. The Vattenfall report estimates that “if all low-cost opportunities are addressed,” CO_2 levels could be stabilized at four hundred and fifty parts per million with an annual expenditure of six-tenths of one per cent of global G.D.P.

Though one per cent of the global economy is clearly a lot of money, in the grand scheme of things it’s also clearly manageable. It is about a ninth of what’s currently spent on health care, a seventh of what’s spent on oil, and half of what’s spent on defense. (More than forty per cent of all the world’s military expenditures are made by the United States.) Perhaps most pertinent, it’s a far smaller figure than the cost of inaction. The Stern Review projects that if current emissions trends are allowed to continue, the eventual damage from climate change will “be equivalent to losing at least 5% of global GDP each year, now and forever,” and that “if a wider range of risks and impacts is taken into account” that figure could “rise to 20% of GDP or more.”

Twenty years ago, NASA’s chief climate scientist, James Hansen, testified on Capitol Hill about the dangers of global warming. Just a few days ago, Hansen returned to the Hill to testify again. “Now, as then, frank assessment of scientific data yields conclusions that are shocking to the body politic,” he said. “Now, as then, I can assert that these conclusions have a certainty exceeding ninety-nine per cent. The difference is that now we have used up all slack in the schedule.” Hansen went on to warn that there would be no practical way to prevent “disastrous” climate change unless the next President and Congress act quickly to curb emissions. Few parts of the U.S. may be as windy as Samsø, or as well organized as Switzerland, but just about everywhere there are possibilities for generating energy more inventively and using it more intelligently. Realizing these possibilities will require a great deal of effort. We may well decide not to make this effort. Such a choice to put off change, however, will merely drive us toward it. ♦

PHOTOGRAPH: VII


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