R&D

A New Life for a National Clean Technology Workshop

When the Solar Energy Research Institute (SERI) opened its doors in 1977, its future looked as expansive as the Rocky Mountain vistas to the west of its Golden, Colorado, site. The mission of the Department of Energy (DOE)-funded lab—seed and nurture a solar-based industry in the United States—resonated with fresh memories of long lines at gas stations during the energy crisis of the early 1970s. SERI's charge was to make sure the country was producing 20% of its energy from renewable sources such as solar and wind power by the year 2000. "It was ambitious," admits Denis Hayes, SERI director from 1979 to 1981. "But that was the spirit of the place then."

SERI decals are still plastered all over the 300-acre site near South Table Mountain, and SERI's legacy hangs over the laboratory, renamed the National Renewable Energy Laboratory (NREL) in 1991. It's a past that NREL would like to build on, but not entirely repeat. All would agree that SERI did post impressive technical achievements: cheaper and more efficient solar cells, more efficient and practical wind turbines. But it never got a chance to fulfill its mission. Long before the institute could seed the country with new technologies and put the promise of renewable energy to a test, the political climate shifted. Free-market philosophies prevailed, and environmentalism was seen as nothing more than a drag on the market. In the early 1980s, SERI's budget was cut by almost half, and its staff shrank to a core of basic researchers and managers overseeing its extramural funding program.

Now the political winds have changed again. The country may be less concerned with energy independence than it was when SERI was founded, but the current concern with environmental protection has made the facility's consistent devotion to renewable energy look newly attractive. With a new name and a newly expanded budget, the laboratory has the luxury of a second chance to get the United States hooked on environment-friendly technologies—not just by continuing to develop solar cells and wind turbines, but by investigating and developing the potential of all kinds of "renewables," from liquid fuels distilled from corn cobs and grass clippings to industrial ingredients extracted from recycled carpets.

With that range of projects,the lab is extending SERI's record as "one of the finer renewable energy laboratories in the world," says William Glaze, chairman of the department of environmental science and engineering at the University of North Carolina and editor of *Environmental Science & Technology*. And something else hasn't changed: the staff's sense of mission. "We feel we are part of where the world is going," says Edwin Witt, who manages NREL's part of the PVMat (Photovoltaic Manufacturing Technology) program, a multi-year, $100 million collaboration with the DOE and industry to develop ways of manufacturing photovoltaic cells cheaply enough for large-scale use to generate electricity.

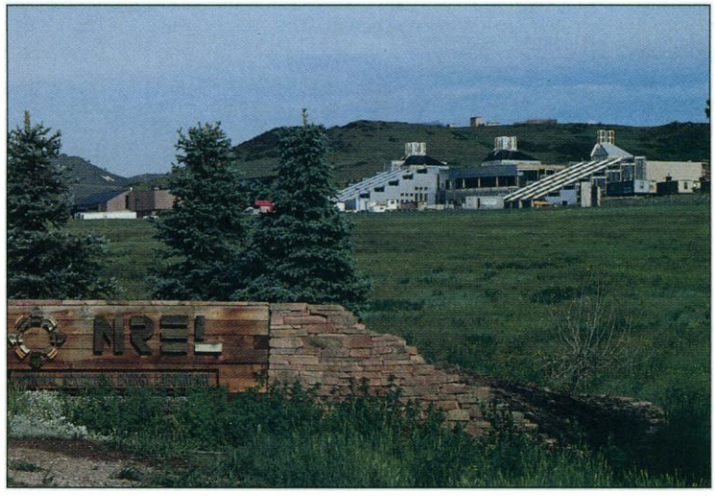
Of course, a sentiment like Witt's does not guarantee success, as SERI veterans know. "We thought we would have worked ourselves out of a job by now," says Tom Surek, who was on SERI's staff when the lab opened and now heads NREL's photovoltaic research program. For a time, the prospects for putting themselves out of business by fulfilling their charter looked good. The institute's budget ballooned from $4 million in 1977 to $124 million in 1980 and its staff soared from 86 to more than 750. Soon, says Hayes, SERI was spending more money on photovoltaic research than the rest of the world combined. Programs in wind energy and alternative sources of liquid fuels also began building momentum. Some research was done in-house, but more than half was done by SERI-funded researchers at universities and companies that, in theory, would develop the means and infrastructure to get the job done.

Then came the Reagan Administration, bringing with it an "enormous hostility" toward solar and renewable energy, Hayes says. Memories of the energy crisis receded, and disreputable solar entrepreneurs, who had peddled bogus products in the 1980s, tarnished the reputation of the entire solar energy research community. SERI was headed for the emergency room. "There were serious balloons floated of a 98% reduction in support for renewable energy," Hayes says. "I was walking around Capitol Hill trying to save as much as I could." SERI pulled through, but it still took a beating. In 1981, its budget was slashed to $65 million, putting several hundred SERI employees on the street.

But a burst of new energy came when George Bush arrived in the White House, pledging greater concern for the environment. Since 1989, NREL's budget has rebounded, reaching $174 million in FY 93. Its staff roster of 850 is sharply up from 476 in 1989, even topping its former peak in 1980. "These are good times," says Duane Sunderman, NREL's present director. Even better times are promised by the Clinton Administration's new budget request for the DOE, which calls for a 30% increase in renewable energy research. Construction on a new $20 million Solar Energy Research Facility next to NREL's existing major laboratory is now well under way and more building is planned.

NREL now hosts more than 60 labs, including a state-of-the-art materials characterization lab where candidate photovoltaic materials from around the country are evaluated, a genetic engineering lab for creating fuel-producing bugs, photovoltaic and wind energy test centers, a high-flux solar furnace capable of concentrating the sun's energy by a factor of 50,000 (for both waste destruction and materials processing), and an on-site pilot plant that produces ethanol from biomass. In keeping with its mission to transform the industrial base, NREL also monitors the economics and environmental effects of energy consumption.

Just as important as what goes on within NREL's walls, Sunderman says, are the activities it funds in academia and industry. The institute has always gone beyond its own laboratories by earmarking much of its R&D budget—often more than half—for outside researchers. The object of these collaborations is not just to advance basic research but also to transfer the resulting



NREL

Building for the future. Ranks of solar collectors top the new Solar Energy Research Facility, under construction at NREL.

technologies to industry—something SERI was doing long before technology transfer became the policy fashion, says Dallas Martin, NREL's technology transfer manager. Since 1991, the pace has picked up with the signing of a dozen Cooperative Research and Development Agreements (CRADAs), which are cost-shared collaborations between government labs and industrial partners.

The first of them may be the closest to commercial viability. Under the agreement, with the New Energy Company (NEC) of Indiana Inc., the second-largest U.S. ethanol producer, NEC expects this year to flick on the switch of a pilot plant that will convert corn into ethanol using NREL-developed improvements on a process called simultaneous saccharification and fermentation (SSF). SSF relies on fungi-derived enzymes called cellulases, which break the corn's cellulose into sugars. The sugars in turn are fermented into ethanol by the biochemical machinery of yeast cells.

Because the improved process can convert previously inaccessible cellulosic fiber in the kernels, it could increase NEC's ethanol yield from its current 2.55 gallons per bushel of corn to about 3.30 gallons per bushel. That should bring the price of ethanol down to $1.27 a gallon, says Charles Wyman, director of NREL's alternative fuels division, another step closer to the 67 cents a gallon that would make it competitive with gasoline. "In 1980, we would have had to sell ethanol for $3.60 per gallon," Wyman says. "We're not far away."

In spite of that kind of progress, the laboratory still hasn't spawned a stand-alone, economically viable industrial infrastructure based on alternative energy, 16 years after its founding. That failure results not from a lack of viable technologies, Sunderman argues, but from the lack of enough funding to build pilot plants that would achieve economies of scale and demonstrate the competitiveness of renewable energy. Adam Heller, a chemist at the University of Texas, Austin, who has visited the lab many times since its founding, agrees. Given NREL's achievements in wind energy and photovoltaics, Heller thinks the appeal of its technologies would be clear if they could be displayed on a larger scale.

Sunderman is eager to have a larger canvas. In April, he made a pitch to the Senate Subcommittee on Renewable Energy, Energy Efficiency and Competitiveness to recommend up to $275 million over the next 5 years for NREL-led industry-building initiatives in wind energy, biofuels, and photovoltaics. That's chutzpah in a time of national belt-tightening. But this time around, he hopes the government will see the wisdom of steady support. Says Sunderman: "People at NREL are out to solve the world's energy problem for all times."

–Ivan Amato

CONSERVATION

Wetlands Trading Is a Loser's Game, Say Ecologists

In the early 1980s a growing number of conservationists and regulatory officials thought they saw a way to reconcile developers' hunger for land with the need for environmental protection: Use the fledgling science of ecological restoration and creation to replace the lands being devoured by development. Compensatory mitigation, as this approach became known, promised a way to have your K-mart and your wetland, too. You want to build a new mall here, on top of this salt marsh? No problem, the new reasoning went; just create a new marsh on another stretch of coast. Your highway will disrupt the habitat of an endangered bird? No sweat, just move the bird to a new ecosystem built conveniently out of the way.

JULIETTE MURQUIA

Hard to please. A wetlands denizen, the light-footed clapper rail.

Sounds great, but 10 years later, after thousands of mitigation projects, that supposedly scientific fix seems more like smoke and mirrors than a panacea. Many mitigation projects, the vast majority of which have been attempted in wetlands, don't work, or at least don't work well. "Most mitigation stories read like horror stories," says Ken Berg, chief botanist for the California State Office of Land Management. Some restored or created wetlands literally disappear—2 or 3 years after completion, a marsh may be little more than a dry pit used by off-road vehicles. Others persist but bear little resemblance to natural wetlands. Still others are close mimics, with look-alike vegetation, but fail to support the birds or endangered plants they were intended to preserve. All told, says Michael Bean, a lawyer with the Environmental Defense Fund (EDF), wetlands mitigation has been "well short of a smashing success."

Part of the problem, ecologists say, is that developers often don't keep up their end of the bargain: Many of these mitigation projects aren't completed according to the plans filed with government agencies—and many aren't even started, according to a recent study by the Environmental Protection Agency (EPA) scientists. And when the projects do get under way, the practitioners often find themselves humbled by the difficulty of mimicking natural systems. No one knows a sure way to assemble a functioning ecosystem from its components, at least with any reliability, admits Peter White, director of the North Carolina Botanical Garden. In mitigation, he and others agree, a priceless original is all too often bargained away for a cheap counterfeit. "It is not a fair trade," says White.

In the early 1980s, however, mitigation looked like a promising way to resolve a stubborn impasse. Environmental groups and, increasingly, the public were coming to view wetlands not as marginal land to be "improved" but as crucial habitat for plant and animal species (many endangered), a buffer for storm tides, and a natural water purification system. At the same time, developers were finding that many of the most tempting sites for new housing or shopping centers were wetlands that had been overlooked in earlier tides of development.

Restraining the developers was Section 404 of the Clean Water Act, which since the late 1970s has forbidden the filling of wetlands without a permit. The act requires applicants to avoid damaging wetlands if possible, and to minimize or mitigate any unavoidable loss. At first, "mitigation" usually meant minimizing the impacts by modifying the project's design or time of construction.

No net loss. Before long, however, that approach was losing favor. As EDF's Bean recalls, environmentalists realized that even though some wetlands were being protected as others were developed, the overall result was a net loss—and by the early 1980s more than half the wetland area in the contiguous United States was already gone. Developers, meanwhile, chafed at the slow permit process, and the Reagan Administration was eager to help them. In 1981 President Reagan's Task Force on Regulatory Relief targeted Section 404 with the goal of getting the Army Corps of Engineers to issue more permits faster.

The answer seemed to lie in a little-used style of mitigation, according to William Kruczynski, who was at EPA at the time: the restoration or creation of an equivalent wetland either on or off site. Ecologists and conservationists were reporting some success in restoring vanished ecosystems (see box). As developers destroyed some wetlands, it seemed, others could be resurrected by removing dikes or drainage tiles from reclaimed land and letting nature take its course. Or a