

The Greening of Oregon

Oregon Renewable Energy Center is moving Oregon Tech and the State to the head of the class in America's sustainable-power industry

By Frank Jossi

Imagine a world where new technology combines energy from the sun and the earth to heat and cool homes and where fuel cells concoct a brew of oxygen and hydrogen to power cars. With energy prices skyrocketing, the goal of creating an environment with plentiful renewable energy appears less far-fetched and more possible every day.

At Oregon Tech, professors and students are already busy forging just such a future through the Oregon Renewable Energy Center (OREC). They have spent the last three years studying two homes powered by alternative energy and transforming a broken-down 1971 Datsun station wagon into a 9.5 horsepower diesel-electric engine capable of cruising at a cool 50 miles per hour — about the fastest speed the car likely reached in its heyday.

It's all part of OREC's goal to establish renewables as a viable option today and in the future. "We have an opportunity to change our culture through the research we do here," says Bob Rogers, project engineer and professor of mechanical engineering technology at OREC. "We're also working on two homes which make more energy than they use in a year. I feel we're on the ground floor of using new technology that will change the way we live."

From retrofitting the Datsun to monitoring a high-energy-efficient home, the Center offers staff and students a place to test their mettle for solving technological challenges inherent in renewable energy while proposing solutions that can begin to diminish the reliance of the nation and the world on a 20th-century carbon-based fuel economy. It's a place to explore practical applications of renewable energy and to investigate visionary solutions — and have some fun doing it.

OREC, part of Oregon

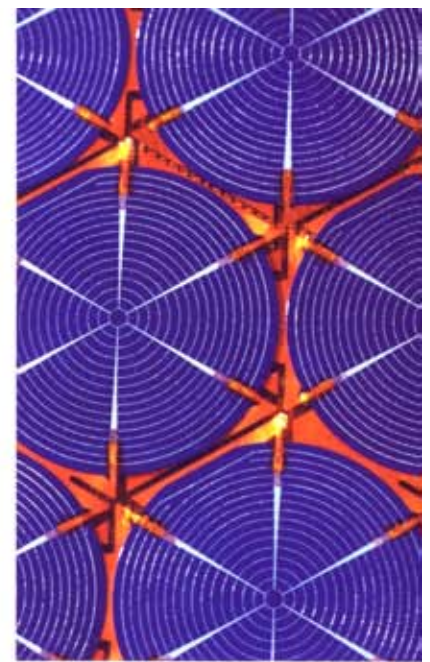
Tech, is going through a time of change. Established three years ago by the Oregon state legislature and funded mainly by a federal grant of \$500,000 and generous contributions from PacifiCorp and JELD-WEN, Inc., the Center has been largely the labor of Rogers and John Yarbrough, a 30-year veteran of Oregon Tech and an electronics engineering technology professor. Yarbrough plans to retire next year to make room for a new director, Rajeeva "Rajiv" Arya (see profile on page 18), who recently joined the staff.

One-Two Punch

OREC also has been instrumental in helping Oregon Tech create the nation's first Bachelor of Science in Renewable Energy Systems (see story on page 20), a degree program aimed at educating students who want to work in the rapidly emerging renewable field as installers, integrators, marketers and researchers. Those students will take courses from the OREC staff while getting involved in various research projects which, if all goes according to plan, will move Oregon into the front ranks of states with strong alternative-energy industries.

"For John Yarbrough and Bob Rogers to do this in Oregon is phenomenal, just phenomenal," says Bob Maynard, founder and president of Grants Pass-based Energy Outfitters, Ltd., one of the nation's largest distributors of photovoltaic cells. "It's exciting and it's good for our industry, which is growing rapidly. Manufacturers looking for the right place to locate their manufacturing facilities will see OREC as one advantage in locating in Oregon."

Maynard points to a



A rooftop 2.5 KW photovoltaic grid-tied array provides solar power for the University Advancement building (formerly the daycare center) at Oregon Tech.

recent study by Olympia-based Climate Solutions, which suggests as many as 12,000 people in the Northwest could be employed in a renewables industry worth \$2.5 billion by 2020. A new state renewable-energy plan increases Oregon's chances of being a national leader, along with continuing research contributions by OREC

and Oregon Tech, he believes. "Manufacturers are looking at Oregon as the right place to locate their manufacturing facilities because there are so many opportunities," he says.

"The applications for renewable-energy technology in the country are growing dramatically," says Oregon Tech's Provost, David Woodall, who teaches in the new renewable-energy systems program. "You can't pick up a newspaper without finding an article about someone or some institution putting up a photovoltaic panel or installing a heat-water pump." OREC, he contends, is finding a receptive audience of businesses and homeowners interested in reducing energy bills and supporting the cause of renewables because they make sense morally and economically.

What OREC brings to the industry, says Woodall, is the ability to use computing power for testing the design of renewable systems and for using that information to improve their energy production. As he sees it, the one-two punch of having a renewable center accompanied by a B.S. degree program "is a real coup for us. It will be able to help us expand our student body and offer them something positive and unique."

Monitoring Efficiency

The best-known project involving OREC has been the Rose House, an 800-square-foot home built by a retired Portland couple who have been dedicated environmentalists for decades. The couple, Linda Rose and her husband, Eldon Haines, chose to build the house in northeast Portland behind the existing home of Linda's daughter. Rose and Haines received \$27,750 worth of government grants from institutions such as the Energy Trust of Oregon to build the home, spending around \$26 more per square foot than the average home.

The higher building



Students in Professor Yarbrough's Photovoltaic Energy Class take data readings from a solar cell.

constantly monitors the structure at numerous locations, measuring energy consumption and generation, as well as interior and exterior wall temperatures, says Rogers.

The OREC team also monitors a home in Cannon Beach, Ore., employing geothermal energy available through tapping wells hundreds of feet deep and transferring the heat found in water at that level into the home for heating, says Yarbrough. The builders of the home certainly knew who to turn to for advice on geothermal technology, since Oregon Tech has been for 40 years the only campus in the country entirely heated and cooled by deep-water geothermal wells. The University also boasts the 28-year-old Geo-Heat Center, headed up by Professor John Lund.

Despite the novelty of geothermal energy, Yarbrough believes "at least one million homes in the United States and another one million worldwide could be heated this way." Don't expect a geothermal heat kit at Home Depot soon, however. Many of the technologies used in the two model homes are available only from small distributors and can be quite costly, although they arguably pay for themselves over the long haul. Just installing them can be a challenge — one OREC hopes to overcome by training a new cadre of technologists in the renewable energy systems degree program.

Encouraging signs exist of renewables moving from the hobbyist and experimental stage into the mainstream.

Government and private industry remain steadfast in backing zero-energy home construction, says Rogers, going so far as to sponsor a competition among homebuilders and colleges to spur creative approaches to reducing the electric and heat demands of an average American home in various regions of the country.

Rogers likes Oregon Tech's chances for winning the competition in the Northwest region, since the Oregon homes submit-



"The Sparrow," a single-passenger, freeway-licensed vehicle, was donated to OREC.

ted to judges have been built, while other regional competitors have merely offered unbuilt, theoretical zero-energy homes. The winners will participate in an experiment to build 100 to 300 identical zero-energy homes next year, and as many as 30,000 to 40,000 homes "in the near future," says Rogers.

So what's the secret of zero-energy homes? Outside of energy production through tapping the sun and the earth, homeowners install heating and cooling equipment twice as efficient as typical systems, says Rogers. "You reduce the energy load you need and increase your efficiency so you don't use as much energy," he reports. "The economics make sense."

Zero-energy homes do not necessarily use the energy they produce. Instead, they stay connected to the larger energy grid and move power they generate on to it for distribution elsewhere. The eventual goal, says Rogers, is for the homes to produce more energy than they consume. He'd like to see the same goal for Oregon Tech's campus, which Rogers envisions as someday offering residence halls, research structures and classrooms using solar and other energy sources in addition to the geothermal system currently in use.

To this end, OREC installed in Oregon Tech's former daycare center (and now home to University Advancement) a sophisticated system to control heating and cooling through photovoltaic panels, a ground-source heat pump and water-based energy storage. Yarbrough explains water-based energy storage is a relatively little-used application which employs a shallow pond or other water source to heat and cool buildings for pennies on the dollar. The University Advancement building "is a neat building, a zero-net-energy building," he says. "The idea here is to study the behavior of the building and compare it to conventional structures."

Exploring Possibilities

OREC's staff and students are not just interested in saving energy at home. They have built "the lowest cost fuel-cell-powered vehicle in



OREC students learning parabolic reflector analysis from Dr. Igor Tyukhov.

themselves function properly. The test station will determine whether panels have the correct angle for maximum exposure to sunlight and reveal whether the panels have performed up to the standards set by manufacturers. "We want to use the station to see if manufacturers are backing up their claims," Yarbrough reports.

OREC's new director plans to continue exploration of renewable energy while adding wind power to the equation to determine if Oregon may have some untapped assets there. The new degree program will open future possibilities, Arya says, for training a new generation in the design, manufacture, engineering and implementation of renewable technology, while offering students a chance to explore new materials and components.

OREC will serve as a laboratory for the classes since it boasts state-of-the-art equipment for testing renewables, he notes. The students will work with Rogers, Yarbrough and Arya not just in the classroom, but also in applied research that will bring more attention to Oregon's role as a progenitor of renewable-energy solutions, he says. "Along with Bob Rogers and John Yarbrough, I have high hopes for OREC," Arya asserts. "We believe it could become a regional leader

in renewable-energy research and jumpstart a growing industry in Oregon."

Jossi, a journalist based in St. Paul, Minn., has written for Wired, the Los Angeles Times, the Minneapolis Star-Tribune and the Chicago Times, among other publications. He is former program director of the World Press Institute and has taught journalism as a Fulbright Scholar in Pakistan and Albania.



OREC student Ryan Dela tests a 1.2 KW hydrogen-powered fuel cell.

Power Pioneers

Oregon Tech launches first North American baccalaureate program in renewable-energy systems

With skyrocketing natural gas and oil prices and continued reliance on foreign sources for energy needs, Americans have slowly begun to embrace renewable energy. The federal government and many states have embarked on programs and funded research to boost energy production from wind, solar and geothermal power sources.

Sensing a potential demand for skilled specialists in the area of sustainable energy, Oregon Tech this year becomes the first university in North America to offer a degree in renewable-energy systems. Renewable-energy research and development may have been around for decades, but Oregon Tech is the first to create a separate discipline for students who want to pursue work in that area of engineering, according to the professors who developed the program.

The Bachelor of Science in Renewable Energy Systems begins this winter at Oregon Tech's Portland Metro Center campus in collaboration with Clackamas Community College. Under an agreement between the schools, CCC will teach general-education courses while Oregon Tech provides the renewable-energy component developed by the Oregon Renewable Energy Center (OREC), an applied research institution operated by Oregon Tech. The renewable coursework will be taught at the Wilsonville Training Center.

John Yarbrough, program director of OREC and a primary architect of the new degree program, was surprised to find after more than a year of research just five programs in three countries offering

degrees related to renewable energy. Australia is the international leader, with programs at National University and the University of New South Wales, he says, while Europe has a handful of colleges with like-minded degrees.

Why none in North America? "Cheap electricity," he says with a laugh. "In Germany, it's 50 cents a kilowatt hour, versus 10 to 15 cents here. There are more photovoltaic cells in Germany than the whole United States — and that country is the size of Oregon."

Students taking classes in the renewable-energy systems major will take basic electrical engineering courses so they have strong backgrounds in applications of traditional energy sources, as well as alternative sources such as wind, solar, geothermal and ground-source heat, says Yarbrough. They also will take standard courses in chemistry, physics, mathematics and communications and, naturally, electrical and mechanical engineering, he says.

Students will learn about the design, engineering and manufacture of equipment used to produce renewable energy and about the research required to develop products largely in their junior and senior years, he adds. Among the courses related to renewables offered in the degree are geothermal/ground-source heating systems, energy-system instrumentation, zero-net-energy buildings, renewable-energy transportation and fuel-cell chemistry.

David Woodall, provost and vice president of academic affairs, sees the degree as an interdisciplinary effort to teach students



Geothermal energy is generated by tapping into hot steam that lies beneath the earth's surface. There are 69 geothermal power plants at 18 different sites now operating in the U.S. Geothermal plants emit little air pollution and provide more than 2,700 megawatts of power — the equivalent of three large coal-fired or nuclear power plants and enough to provide electricity to 3.5 million homes. "Each year the United States saves 22 million tons of carbon dioxide, six million tons of carbon, 41.5 million barrels of oil and 200,000 tons of sulfur dioxide," says John Lund, director of Oregon Tech's Geo-Heat Center. Geothermal resources come in five forms: hydrothermal fluids, hot dry rock, geopressured brines, magma and ambient ground heat. Of these five, only hydrothermal fluids have been developed commercially for power generation. The state and temperature of water in a reservoir determines what type of power plant can be built. To learn more about geothermal power, visit the Geothermal Resource Council (www.geothermal.org), Geo-Heat Center (geoheat.oit.edu), Geothermal Education Center (geothermal.marin.org) or U.S. Department of Energy (www.eere.doe.gov/geothermal).



ROGERS

how to merge the skills of mechanical and electrical engineering with computing. Renewable systems require an understanding of everything from the amount of energy a photovoltaic cell can produce on a sunny day to the monitoring equipment that can be deployed to create more energy-efficient houses.

Rajiv Arya, the new director of OREC, sees the degree as a logical extension of electrical engineering. Twenty years ago, computer science remained part of the electrical engineering curriculum until colleges and universities began creating a separate department for it with the rise of the computer revolution. Says Arya: "I see a day when renewable engineering will be separating out from mechanical and electrical engineering and becoming a new academic discipline."

The lack of baccalaureate degrees in renewable energy should mean plenty of applicants for the program, says Woodall, and will give Oregon Tech a point of distinction in the Northwest. Since the program officially begins this spring, he figures a handful of current undergraduates will select renewables as their major and become the first class to graduate in two years. Oregon Tech plans to grow the program from 20 to 30 students over the first year, he predicts, while attracting applicants through relationships with high schools and community colleges.

Bob Rogers, a profes-



Hydropower plants use river flows to spin turbines to create electricity, without emitting air pollution. Judging the way a hydroelectric dam impacts a river is important in determining whether it qualifies as a "renewable" source of power. High-impact hydro projects cause concern because dams can change natural river flows, degrade water quality and block fish migration. The size of the dam is not the only criteria for judging high vs. low impact. Mitigation measures such as fish ladders that protect spawning, and location, are considerations. Pictured here is McNary Lock and Dam on the Columbia River, which produces 8.7 billion KWH of hydroelectric power annually. Construction, by the U.S. Corps of Engineers, was begun in 1947 — the year Oregon Tech was founded. For more information, check out www.lowimpacthydro.org.



WOODALL

sor at OREC, hopes the program will inspire other leading engineering institutions such as MIT, Stanford and the University of Washington

to copy Oregon Tech's program. Moreover, he wants to share data Oregon Tech collects from renewable projects through a website, and encourage greater collaboration among schools interested in the discipline.

Oregon has a growing renewable-energy industry and OREC has identified several businesses that may hire graduates in the future. Bob Maynard, founder and president of Energy Outfitters, Ltd. in Grants Pass, says the state "is on the radar nationally of the renewable-energy industry" and the degree program will only help further the cause.

"We're excited about what they're doing over there at Oregon Tech," proclaims Maynard, who owns one of the largest distributors of photovoltaic panels in the country.

"From an industry perspective, education in the renewables field has been non-existent for several years, and of the few programs there are, most have barely scratched the surface. To have a four-year degree program is a phenomenal educational opportunity for students."
— Frank Jossi



Klondike Windfarm, located in Sherman County near Wasco, Ore., is one of several sources of renewable energy being tapped by PacifiCorp. Electricity is generated when the wind spins turbines (windmills) mounted on tall towers. Wind, the fastest-growing renewable-energy resource in the world, is pollution free. Estimates indicate that wind-power technology, if fully developed, could supply about 20 percent of the electricity in the United States. Wind farms can increase the tax base of rural counties where they are located. Ranchers and farmers who own land with wind farms can receive a long-term source of income, in addition to generating construction jobs and administrative positions. For more information about wind energy on the web, go to American Wind Energy Association at www.awea.org or the Renewable Northwest Project at www.rnp.org.

To request a brochure on the new major, call the Admissions Office toll-free at 1-800-422-2017.

Sun Worshiper

Former solar-energy executive and consultant chosen to lead OREC



More than 25 years ago, Rajeewa “Rajiv” Arya attended an international conference on solar energy at the suggestion of a professor at Indian Institute of Technology in Kanpur, where he was a master’s candidate in material science. Awakened by what he learned and intrigued by the possibility of being part of a new energy movement, Arya began pursuing what has become a lifelong passion for researching solar-energy technologies.

His devotion soon led to a Ph.D. in electrical engineering from Brown University and then to Amoco Solarex, where he spent 20 years moving up the corporate ranks of a company once known as the largest producer of solar products in the United States. Two years ago, Arya abandoned the corporate life to settle into a more independent role as a solar-

energy consultant — until he saw an advertisement for a new director for Oregon Tech’s Oregon Renewable Energy Center (OREC).

Arya eagerly sought the position at the three-year-old Center on the Klamath Falls campus and was offered it last year, taking over from Interim Director and Provost David Woodall. “I like building things, and this is an opportunity to build a program that is very small today into something larger,” Arya explains. “That’s what I enjoy doing, I love

building technical organizations. We have a state-wide charter and we expect to someday have a positive effect on the entire state.”

John Yarbrough, an Oregon Tech electronics engineering technology professor who works as one of two primary researchers at the Center, says

“I like building things, and this is an opportunity to build a program that is very small today into something larger.”

Rajiv Arya

Arya should be a perfect match for OREC. "What we needed was an individual who had experience in the private sector, and Rajiv for 20 years had managed large groups of people and large budgets," says Yarbrough. "He's had an excellent education and he's a very collegial and congenial person. He gave us a great presentation of the current renewable-energy market and pointed out the many contacts he's made. Rajiv's also got an entrepreneurial spirit, which you don't always find in a higher-education leader."

Arya jumped at the opportunity to get in on the ground floor of a new energy center.

Born in England to a chemist-turned-journalist and a schoolteacher, the 51-year-old engineer likes to call himself

eration of products. BP Solarex was much more focused on product manufacturing and marketing, not on development of new products."

After BP Solar shut down its thin-film operations and the North American technology center that Arya headed, he ventured out on his own, becoming a thin-film technology consultant to ICP Solar, National Renewables Energy Laboratory, Hewlett-Packard, Dow Corning and others. Beyond the workplace, he stays active in the renewables industry by serving as a board member for several national solar-energy and engineering associations.

Outside of getting to know Oregon Tech's faculty and staff, he's now heading his own basic research project as a



"Indo-British." When still a child, his family returned to India to live in Calcutta, where Arya spent his formative years. An outstanding student, Arya received a B.S. with honors from Ranchi College in Jharkhand, India, and master's degrees from the Indian Institute of Technology and Jadavpur University in Calcutta.

At Amoco Solarex, he started as a senior project scientist and moved into several positions before becoming executive director of the thin-film technology division, where he managed a \$2.2-million budget and a staff of 26 people. Among the achievements Arya most "cherishes" was a difficult reorganization of his department from research and development to applied research in a manufacturing plant environment. Some researchers left the company, while others managed to reorient themselves to a new set of priorities.

After BP merged with Amoco in the late 1990s, the new company's direction gradually changed. "BP didn't believe in developing technology and research, they cut back on both," he says. "Amoco believed in building the next gen-

one-man team looking for a house in Portland and keeping an eye out for jobs for his wife, Uma, a home-health-care administrator. Arya's also happy to be soon living in a new part of the country after three decades out East and pleased to be close to his son, Rajat, a software engineer at Microsoft in Seattle.

"We've lived on the East Coast for 25 years, so we're looking forward to living in another part of the country," he says. "I'm also looking forward to helping Oregon become the hub of renewables in the United States. It's not the hub now, but one of our jobs is to make it one. In the Northwest these things are just beginning and it's our job to do something substantial so we're recognized as a leader in the country in renewable-energy applications." —*Frank Jossi*