Fueling the Future

Exploring innovative energy research at NH's colleges and universities.

BY CINDY KIBBE

The Granite State's universities and colleges have invested heavily in renewable energy research—both brainpower and money—which could lead to dramatic changes in the way we heat our homes, power our businesses and drive our cars.

That research also attracts significant outside investment: the College of Engineering and Physical Sciences at the University of NH in Durham garnered more than $17 million in awards and grants in Fiscal Year 2012; Dartmouth College's Thayer School of Engineering took in more than $165 million, including endowments, in FY 2012; and Keene State College's sciences and social sciences departments received awards and grants of nearly $522,000 that same year. Those awards and grants include energy projects.

Biofuel

One of the major focuses of research is biofuels. Much of the biofuel development is centered on ethanol, which is often derived from food crops like corn. However, while a cleaner source of fuel, ethanol presents its own challenges as a fuel source. Some critics say when crops are diverted from the food supply to produce fuel, food prices can skyrocket. The landmass required to grow enough for both uses is also significant.

That's why the search is on for alternative sources for biofuels. At UNH, Ihab Farag and his team—through a $240,000, two-year grant from the U.S. Department of Energy—are extracting oil from algae to create biodiesel. But they haven't stopped there. "We are also studying algae growth in plastic bags that would float on the surface of sea water to reduce the land footprint," says Farag. "Thus our research aim is to reduce the fresh water, land and energy requirements [needed] to produce algae biodiesel while biologically absorbing CO2." Drivers could see algae-based fuel at the pump soon. "I believe algae biodiesel will take about five years to happen," he says.

Keene State College (KSC), along with partners Dartmouth College and the University of Vermont, is studying the effect of biodiesel on humans and the environment. KSC received nearly $1 million through two multi-year grants from the Centers of Biomedical Research Excellence and the federal government to support the study. Researchers found local landfill workers operating biodiesel-powered bulldozers experienced a 60 percent decrease in exposure to airborne fine particles. "We believe the engines burn hotter and therefore release less particulate emissions as well as there being less carbon in the fuel," says Melinda Treadwell, KSC provost, vice president of Academic Affairs and the head of the initial research team along with Nora Traviss. The findings are particularly interesting because the biodiesel was made from waste animal tallow (animal fat), not plant-based oils. Essentially it demonstrates that what is essentially trash can be converted into a cleaner burning fuel source.

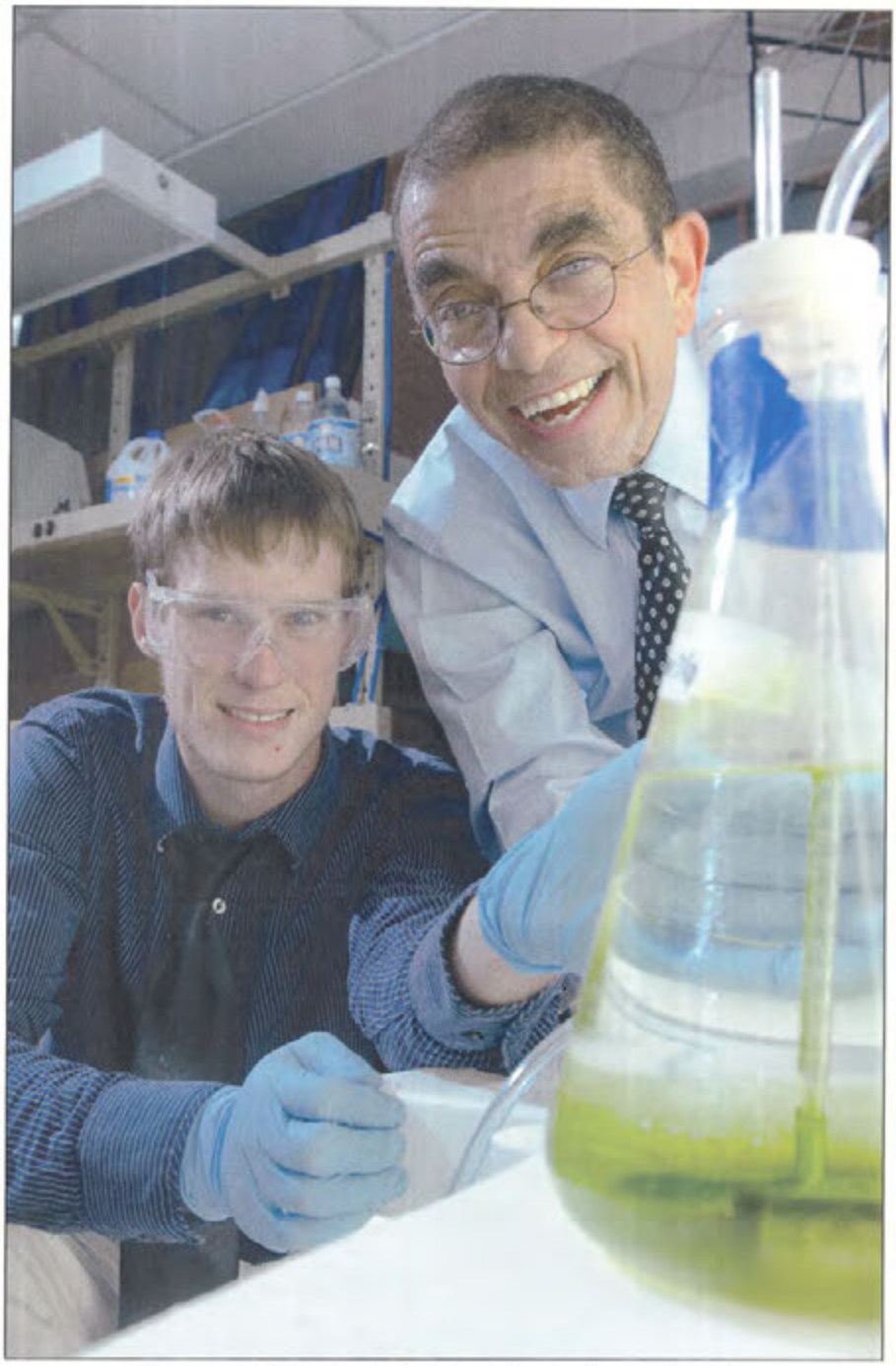
KSC continues to research other components in biodiesel emissions, and hopes to open a regional testing lab this summer, says Treadwell.

Solar

Researchers at Dartmouth College in Hanover are making solar panel components lighter, more efficient and cheaper. Jason Stauth and his team are studying advanced microconverter devices to route energy around portions of panels that are in shade or are dusty, which would normally impede the flow of current. "Solar cells are like batteries in a flashlight," says Stauth. "When one dies, the whole thing stops." Losses like this on a utility scale could cripple power grids, he says. Stauth is also boosting panel efficiency by harvesting the little energy collected by underperforming solar cells.

Although his research is currently unfunded, Stauth says microconverters "will be the industry standard" in 10 years, reaching utility-scale in perhaps a decade. Charles Sullivan, Stauth's colleague, is developing models to decrease the energy lost by the magnetic components inside microinverters (devices that turn DC power into AC power). Not only are microinverter-linked solar panels less complicated to install due to the AC wiring, they also work independently of each other. "Each panel can be optimized and the others are unaffected," says Sullivan, whose research was supported by a $223,000 grant from the National Science Foundation. Solar panels with microinverters are available, but those with next-generation magnetics won't be on the market for several years.

At UNH, researchers have teamed with Conductive Compounds Inc. of Hudson to investigate using silver nanoparticle coatings to improve the conductivity of solar panels. (Silver nanoparticle coatings are finer and more efficient than the coatings currently used.) The research is being funded through a $450,000, three-year grant, received last August from the National Science Foundation. Nanoparticles are difficult to manufacture, so some estimate it will still be five or more years before these types of solar panels are available commercially.



UNH PHOTOGRAPHIC SERVICES / LISA HUGHNT

University of NH's Dr. Ihab Farag, right, and a member of his team work on a biodiesel project.

Wind Power

While not without controversy about its environmental impacts, wind farms are making inroads as a power source. Turbines, however, wobble when wind hits individual blades differently. This causes uneven and inefficient loads, and ultimately structural problems. Brenden Epps of Dartmouth is developing computer models of "smart" turbine blades for offshore wind farms. Someday, such turbines could monitor themselves and react to unsafe wind loads, improving efficiency and reducing repair costs. While these turbines are years away from the market, Epps says he hopes to make test-scale prototypes soon.

A team of students at UNH is exploring wind power on a smaller scale, but with some practical applications. They want to harness wind blowing through bridge underpasses to power turbines generating electricity for bridge lighting, signs and other systems.

Several countries are already using large bridge turbines, but the electricity often feeds back to the power grid. The devices the UNH group is considering are smaller and would work independent of the grid. In April 2012, the Environmental Protection Agency awarded the UNH students $15,000 to fund the first phase of their research.

Hydro Energy

Hydrokinetic power is the energy created by waves, tides and currents when they

naturally push turbines or motors placed in the water. Unlike with biofuel, "you don't have to invest energy" to create hydrokinetic power, points out UNH's Martin Wosnik. He and colleague Ken Baldwin, director of UNH's Center for Ocean Engineering, develop tests for private hydropower companies. The "extreme ocean environment," with wildly varying wave heights and winds, and high installation costs, limit the widespread adoption of hydrokinetic power, says Baldwin. "Simply deploying test devices in the ocean involves specialized charter boats and crews costing thousands of dollars," he says.

Last summer, the scientists received $210,000 of a $1 million Department of Energy grant awarded to FloDesign of Wilbraham, Mass., to test the company's hydrokinetic turbine in open water. FloDesign's turbine is commercially available, but UNH's research will further refine it.

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A research team from UNH conducts a wind turbine experiment in the Flow Physics Facility. Pictured from left are Professor Jean Benoit, students Jonathan Travers, Nate DuFresne, Pat Vincenti, Andrew Gherardi, and Professor Martin Wosnik.

Fuel Cells

A UNH team is working on making fuel cells cheaper and more efficient, which could eventually lead to a fuel cells becoming a ubiquitous power source for cars.

Fuel cells create electricity from chemical reactions like conventional batteries; however, they use hydrogen and oxygen instead of metallic ions. Unlike batteries though, they produce electricity continuously as long as there is hydrogen available, and leave just water as a byproduct.

Fuel cells using ethanol or methanol to generate hydrogen are safer than those using hydrogen gas, and can be created sustainably. The problem is their slow and expensive oxidation process. UNH's Xiaowei Teng and his team are developing a new class of catalysts for ethanol-based fuel cells to make this process cheaper and more efficient. The National Science Foundation awarded the UNH team two grants last summer totaling nearly $1 million. Although the technology shows promise, experts say it could be a decade or more before fuel cell-powered cars are seen on the road. ■