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Eeman Jawad, 19, of Selden, a chemical and molecular engineering student at Stony Brook University, works in a lab at the Advanced Energy Research and Technology Center.

Clean energy revolution

Stony Brook scientists are on the front lines, developing wind, battery and alternative fuel technologies

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Just over a decade after opening, the Advanced Energy Research and Technology Center is hitting its stride, as Long Island and the state prepare for an energy revolution. The Stony Brook University center, which houses advanced re-

search, an incubator for energy startups and a national hub for wind-energy research, is forging a vital role in the state's goal of advancing wind, battery and next-generation fuel technology.

There are a dozen startups in the center working on everything from ammonia-powered vehicles to dustproof solar pan-

els, while world-renowned scientists explore new materials for vehicle and electric utility-scale batteries that are cheaper and last longer. The future of hydrogen as the ultimate replacement for natural gas is also under deep study and testing, as are new materials and placement for wind turbines to produce the most energy.

"For a guy like me who's been in it for many, many years to see the transformation from fossil fuels to renewables is amazing," said Robert Catell, the one-time chief executive of Brooklyn Union Gas who rose to CEO of National Grid USA before becoming chairman of the energy center. But that revolution, he noted, "comes with a

lot of challenges."

Even large-scale energy sources like offshore wind, set to become a key driver of energy for the state, are not always available because of fluctuating wind conditions. Working on next-level battery technology is essential to find fu-

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ture sources of cheaper, more efficient storage to back up the grid when the wind isn't blowing or the sun isn't shining. New York State has a goal of getting more than 9,000 megawatts of power from wind turbines by 2035, enough to power millions of homes, with Long Island eyeing a sizable portion to displace power from local power plants fueled mostly by natural gas.

The National Offshore Wind Research and Development Consortium, centered at Stony Brook, is "doing the research that is necessary to keep the cost of offshore wind down," said Catell, who also chairs the consortium.

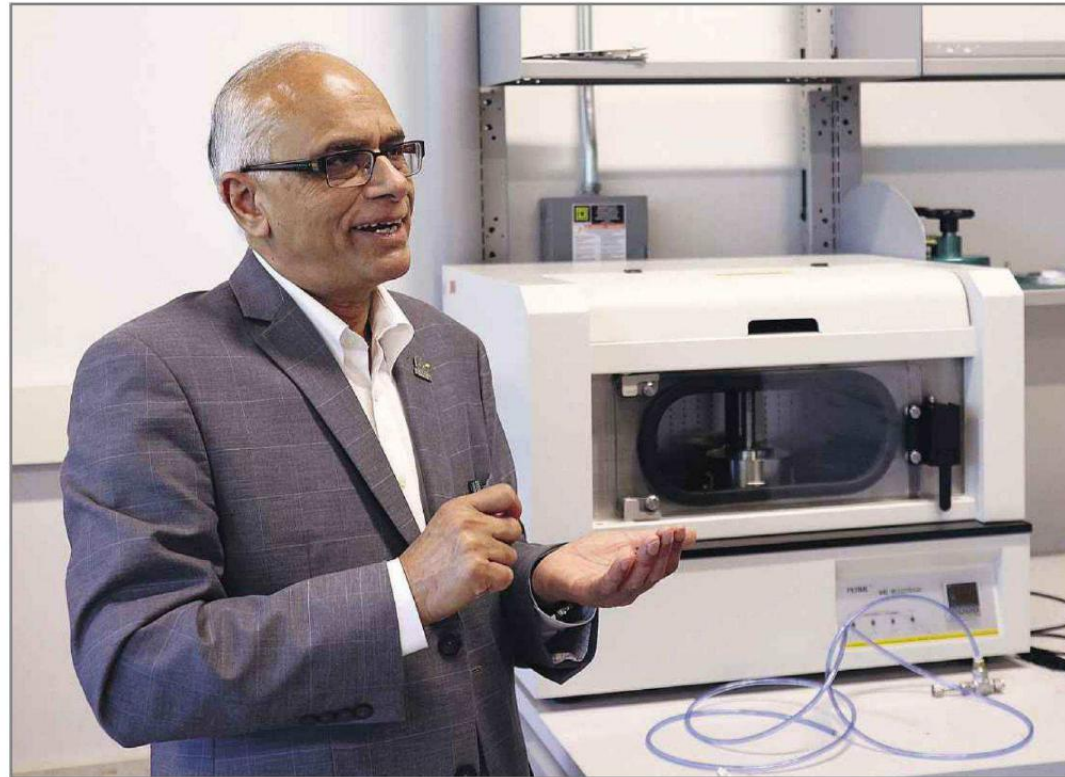
Which way the wind blows

Research to date has looked at the components of wind turbines, including construction of the turbines, improving turbine foundation design, looking at the patterns of wind and strategically locating turbines to take advantage of prevailing winds, and the impact of hurricanes on the structures, Catell said. Researchers have also looked at how best to transmit power from the turbine arrays to local energy grids.

"One of the things we need to figure out is the future funding of the consortium," said Catell, noting the original \$40 million has funded more than 30 research projects. "We're essentially out of research funds, so the U.S. Department of Energy has to decide if they want to continue to fund this consortium."

Several major areas of research at the center are working with outside partners to fund specific research that is expected to be commercialized. The center's Advanced Power Sources Laboratory has been working since 2018 with Mercedes-Benz on next-level battery research.

Esther Takeuchi, distinguished professor in material science and chemical engineering and chemistry, said most of the work these days involves finding ways to make Mercedes-Benz electric vehicles



Chemical engineering professor Devinder Mahajan directs the Institute of Gas Innovation and Technology.



Amogy, a startup that developed a process for deriving hydrogen from ammonia, worked with Unique Technical Services, another startup at the center, to create this ammonia-powered tractor.

safer and longer-lasting, while allowing cars to charge even faster than today's superfast chargers (which recharge batteries in an hour or less). There's also much interest in advancing large utility-scale batteries to help in the transformation of the electric grid.

"On Long Island in particular we're talking about large amounts of offshore wind as

well as the expansion of solar power," Takeuchi said. "We all know that those are intermittent. So storage becomes critical to be able to use those renewable sources of energy effectively," including storing large surplus amounts of that energy away when it's widely available to feed the grid when the sources turn scarce.

More fundamentally, the re-

search is exploring other mineral sources for batteries given the "several downsides" of today's main battery material, lithium, Takeuchi said.

Assault on battery hazards

Today's big lithium batteries are "highly flammable. So with a big battery if something goes wrong, then it's pretty catastrophic. There's usually a sig-

nificant fire," she said.

"What we're pursuing are batteries that are much safer and in contrast we're using water as the solvent inside the batteries, whereas lithium-ion batteries all use some kind of flammable solvent," she said. Safer batteries mean not only safer large storage units used by electric utilities, but those used in cars and even portable electronics, which also have been implicated in hazards.

The other major component of battery research is cost and source. "We're exploring materials that are inexpensive, that are readily available, are mineable in the U.S. so we'll have domestic supplies of these materials, so as these batteries get big they can be safe, they can be low-cost and can be deployed at whatever size is appropriate," Takeuchi said.

Federal and New York State government both have vested interests in the types of advanced energy research the center is focused on. The recent passage of the federal Inflation Reduction Act, along with the state's aggressive climate goals built into the state Climate Leadership and Community Protection Act, make the center a prime candidate for new research funding, officials said.

"There's going to be an infusion of funding here that is going to help us develop technologies further," said Richard Reeder, vice president for research and operations manager for the university's Research Foundation. "The important thing here is to be able to bring the cost down and that is going to make these technologies affordable."

Reeder said he sees a "real opportunity to transform the way in which we create energy," a change that brings with it "a lot of technical challenges. That's where I think Stony Brook and the Energy Center play a significant role."

From lab to market

David Hamilton, director of programs and economic development for the energy center and its Clean Energy Business Incubator Program, said companies that are developing prod-



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In the center's Advanced Combustion Lab, researchers are looking for ways to make traditional combustion engines more efficient.

ucts at the center are achieving breakthroughs, and some are moving on to wider commercialization.

One called Thermolift has seen such success with its highly efficient thermal heat pump, which uses natural gas to heat and cool homes and buildings, that it's moving out of the center in September and moving to Michigan as it works toward full commercialization next year. The heat pump makes cost-efficient heat even in the coldest environments.

One company that has drawn attention recently is Amogy, which has developed a process for deriving hydrogen from ammonia, one of the most prevalent chemicals in the world, for use in the transportation sector. It recently worked with another center company, Unique Technical Services, to convert ammonia in real time to power a fuel-cell based tractor on the university grounds.

"It's a match made in heaven," said UTS engineering manager Michael Kuhl, adding his company, which has a sister division that retrofits standard

Advanced Energy Research and Technology Center

Location: Research & Development Park at Stony Brook University

Completed: 2010

Size: 49,000 square feet

Building: LEED Platinum certified, using advanced energy-saving technologies including solar tubes for lighting, chilled beams, solar hot-water heater and cool-roof design

Includes: Incubator for energy startups, gas innovation institute, advanced combustion lab, battery-storage lab, energy-efficiency lab and the National Offshore Wind Research and Development Consortium

Funding: Comes from public and private entities such as the U.S. Department of Energy and National Grid

trucks into electric vehicles, worked on the EV technology for the tractor. Ammonia-based fuel-cell EVs, he said, would have longer range than typical battery-based electric vehicles.

Another company, Terra-ment, is developing a gravity-based battery storage system that creates energy by dropping specially equipped weights down a mile-long tunnel. The weights are then electronically pulled back up during off-peak hours when elec-

tricity is cheaper.

Super Clean Glass uses NASA-developed technology in a clear layer that's placed over solar-panel glass to make it self-cleaning, deriving up to 20% more efficiency from the panels, which in certain locations can become covered in dust and sand.

Hot and cold

FriRoMar is working on a process to wrap specially developed "walls" around mostly

urban buildings to make them more energy-efficient, while VoltAir Power uses solar panels, heat pumps and an innovative water-thermal system to create highly efficient heating and cooling systems for buildings.

One company, GenH, makes a portable hydroelectric energy producer that can work on smaller waterways than traditionally larger hydroelectric dams.

The center this year returns to Manhattan to hold its annual conference, the first time it's been held there since 2018. It draws up to 200 speakers and more than 2,000 attendees, from government, academia and industry. It will be held at the Marriott Marquis Sept. 7-9.

But not all the work at the center is purely forward-looking technology. One of the largest spaces at the center is an Advanced Combustion Lab looking at ways to make traditional combustion engines for cars, trucks and other vehicles more efficient, including through the use of advanced fuels.

And one major component of the center is the Institute of Gas Innovation and Technology, funded by grants from National Grid and Con Edison, among others. A main part of that research involves studying the most effective ways to store and transport hydrogen gas, but for use in specially retrofitted power plants, and for use in fuel cells (which create energy through an electrochemical process that avoids combustion).

The shape of water

Experiments underway in the lab are using an electrolyzer that essentially splits water molecules into their oxygen and hydrogen components, then uses the hydrogen to test the effectiveness of a range of materials to store and transport it. Hydrogen is a significantly cleaner fuel, and the electrolyzers can be powered using renewable energy from wind or solar arrays, meeting zero-carbon goals. But hydrogen presents challenges in storage because its smaller molecules make it more difficult to contain and transport, said Devinder Mahajan, director of the institute and the Low Carbon Energy Laboratory.

The mission: to transition from fossil fuels to non-fossil, non-carbon sources of energy, and primarily hydrogen, which is currently too costly to use as fuel. Funding for his projects has come from the National Science Foundation, the Department of Energy and private industry, but Mahajan sees opportunities for much more — upward of \$20 million next year as the state and federal government deepen their interest in hydrogen as a transition fuel from natural gas.

Mahajan and other officials said amid all the transformational work, teaching the next generation of energy engineers and researchers is central to the mission. The gas institute currently has 27 graduate and undergraduate students working in its labs, and their work could help determine which new energy systems dominate in the future.

"It's kind of the Wild West right now in terms of energy, which is a really exciting place to be," said Jon Longtin, interim dean of the College of Engineering and Applied Sciences. "It will be interesting to see ultimately what bubbles to the top. But at this point there's a lot of opportunities to explore."