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1. RENEWABLE ENERGY:

As rooftop solar surges, states hit brakes

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Published: Monday, December 12, 2011

WAIMALU, Hawaii -- As the midday sun baked his four-bedroom home in the Honolulu foothills, George Hayashi watched two workers, with drills whirring, install 18 gleaming solar panels on his garage.

A retired military man, Hayashi has lived in Waimalu for 35 years. For decades, rooftop solar didn't seem viable, but now, he said with a laugh, "I look forward to my electric meter going backwards." It's a shared experience in his sleepy neighborhood: One house after another is sprouting panels.

"I walk this dog every afternoon," Hayashi said during a visit to his home earlier this year. "And the route I take, I've noticed that more and more. People are installing it."

Hayashi is lucky he has got his panels. When it comes to solar power, Hawaiians are in a race. And for a small but growing number, the competition is already over.

Hawaii generates most of its electricity by burning imported oil, giving it the dubious distinction of the country's highest electricity prices. And over the past two years, as the price of solar panels plummeted, Hawaiians realized they had a budget-minded alternative to oil. As one, they began going solar.

Now, so many Hawaiians have installed rooftop panels that entire neighborhoods -- and soon, entire islands -- have maxed out the amount of rooftop solar power the energy company wants on the electrical grid. Barring expensive studies no one wants to fund, solar development in these areas grounded to a halt. Homeowners' and developers' rush to solar power has run smack into a grid unprepared for their demands.

"There is a manic mania for megawatts where you have developers from far and wide who are champing at the bit to get into the market and install mondo [solar] systems," said Marco Mangelsdorf, a longtime Hawaiian solar developer. One circuit after another is closing, he said, and it is a "frantic race to grab as much open capacity that's available."

Hawaii is not alone in its bottleneck. Funded by generous subsidies, California is heatedly debating the worth of similar limits, and the recent solar boom in New Jersey has seen Atlantic City's electrical company swear off any additional solar power (***Greenwire***, Aug. 25). And as Chinese manufacturers continue to push down solar prices, experts say, many parts of the United States are going to start hitting the same wall.

"It's not just Hawaii. It's a mainland problem," said Benjamin Kroposki, an expert on rooftop solar at the National Renewable Energy Laboratory (NREL).

"They have to address this now," Kroposki added. "They can't wait. Because this is holding up deployment."

The solar rush has been bewildering for this state's dominant utility, Hawaiian Electric. Large solar developers have stormed in, offering to finance rooftop solar at little cost to the customer. At one point early last year, the power company was so threatened by the growth that it proposed a solar ban for several of Hawaii's smaller islands.

It is a challenge without simple solutions or easy villains. There are real technical and safety reasons electrical companies have imposed these solar thresholds, stemming from the centralized model that, since Thomas Edison, has dominated how the world distributes and consumes electricity. No one, it seems, ever suspected that homeowners would seek to generate their own electricity at the levels now seen in Hawaii.

Indeed, while Hawaii's success in adopting solar power should be cheered, its troubles are putting the lie to the notion that once solar electricity is cost competitive with fossil fuels -- grid parity, as the idea is called -- that consumers will rapidly install the technology in a flurry of market-spurred, carbon-reducing glory. Given the realities of electricity production, where risk aversion is sacred, even compulsive, it's not so simple.

"You could have grid parity with 1 percent penetration of the electric market," said Steve Hegedus, a researcher at the University of Delaware's Institute of Energy Conversion. "The two don't go hand in hand. But the assumption is, once you reach grid parity, people will say, 'Why shouldn't I go solar?'"

For a number of Hawaiians, the answer to that question has become: Because you can't.

'Taking their energy future into their own hands'

Hawaii came to its solar conundrum from a consensus. It has to get off burning oil.

Almost 80 percent of Hawaii's electricity is provided by oil combustion, making the islands vulnerable to price shocks. For example, when oil reached $140 a barrel in 2008, Hawaii essentially burned away its economic growth to meet its electricity needs, said Mark Glick, the new chief of the state's energy office.

"Roughly 4 to 5 percent of what our economy turned out went into a black hole," Glick said. "If [prices] get much more pronounced in the future, it could have a really damaging effect on our tourism business."

These shocks have driven Hawaii's electricity prices sky high. Last year, the islands averaged 25 cents a kilowatt-hour; the next highest state, Connecticut, was 8 cents cheaper. This year, as oil prices again sloshed upward, Hawaii's electricity prices have set record after record, reaching 35 cents in Honolulu, the most affordable market, last month. A typical bill now runs $216 a month, according to Hawaiian Electric.

This sustained cost crisis, combined with its near-constant sun and wind, has prompted Hawaii to adopt the nation's toughest renewable energy laws, including a standard that calls for 70 percent of the state's power to derive from either renewable sources or energy efficiency by 2030. Everyone applauded the standards. But then the questions began: How exactly was the state going to do this?

Government and utility officials -- heavily aided by the U.S. Department of Energy, which sees Hawaii as a test case for the country -- began planning for this transition with a particular focus on large, centralized projects, like massive offshore wind farms financed by the real estate companies descended from the islands' sugar barons.

But while the agencies planned, a revolution was raging below, according to Isaac Moriwake, an attorney for Earthjustice, which is helping solar developers in their talks with the state.

"People [were] taking their energy future into their own hands," Moriwake said.

Businesses and homeowners began installing solar panels in droves, an exponential growth that has continued to this day: Through October, almost 7,700 solar-power systems have been connected to the grid, totaling 55 megawatts -- a drastic increase for a state of 1.3 million people. Put another way, about 15 percent of all the state's construction projects last year stemmed from solar installations, Glick said.

But the surge soon hit a bump.

Following California standards, Hawaii's electricity regulator, the Public Utilities Commission, has set a threshold dictating that, once local power generation reaches 15 percent of the peak electricity typically found on a circuit, Hawaiian Electric can require an expensive study gauging what additional rooftop projects would do to energy reliability. And the utility has not been shy in mandating these reports.

The studies are an open-ended expense, costing thousands of dollars for a large home, and, on average, $45,000 for a commercial installation, said Mark Duda, a solar developer and president of the Hawaii Solar Energy Association (HSEA).

In many instances, this threshold has served as a cap to solar development. Without it, Duda estimates that the number of his commercial customers would have at least doubled.

"Historically, if you had to do the study, people would just say forget it," Duda said.

The story is not so straightforward, however. Hawaiian Electric has at times allowed rooftop solar penetration higher than 15 percent, noted Darren Pai, a company spokesman.

"On many circuits we've taken a look at the specific configuration of the circuit and allowed higher amounts of [solar] integration without doing interconnection studies," Pai said. "We're trying to enable as many [solar] installations as possible without creating more hurdles for our customers."

Still, many communities find themselves near the limit of what can be installed.

Even after regulators raised the study trigger from 10 percent to 15 percent last year, 72 of the islands' more than 700 circuits remain at the threshold. Utility maps laying out the circuits, with the 15 percent regions painted red, make it seem the islands are starting to come down with chickenpox.

The situation is especially dire in Molokai and Lanai, two of Hawaii's smaller islands, according to Mangelsdorf, the solar developer, who works on both islands. "Molokai, for example, within the next six to 12 months will be effectively closed down," he said.

Intense competition for limited space is driving down costs, and some companies, seeking a quick profit, are doing shoddy installation work, he added. Barring an increase in the 15 percent rule, the solar industry is in dire straits.

"We're going to see a winnowing," Mangelsdorf said.

'Rule of thumb'

While they may seem capricious to developers, the solar limits are not arbitrary.

Like most utilities, Hawaiian Electric has deep-seated concerns about maintaining the stability of electricity to all its customers. To understand why, imagine the evening news after a damaging storm. Even before the news anchor mentions how many people died, they will list how many are without power. After even a momentary disruption, utilities will hear a chorus of complaints from their customers, Delaware's Hegedus said.

"Utilities know that," he said, "and so they're extremely compulsive about reliability."

One way this compulsion has manifested itself is the 15 percent rule. At its core, the rule is not solely about rooftop solar. It applies to any electricity a household could connect to the grid, from a gas generator to the modular nuclear reactor your neighbors must be using to power their stereo. Any of these power sources are out of the utility's control, and the electricity they send back into the grid could have mysterious effects.

A tangible example of this unpredictability is voltage, the steady electrical signal -- 120 volts in the United States -- that electronic gadgets are designed to operate on. Move outside a 5 percent range of 120 volts and devices start to fry. The utility, however, only sets voltage at its substations, and the voltage decreases as it strides along a circuit, a walk carefully calculated by the company.

Add rooftop solar into this equation and it gets tricky, NREL's Kroposki said. "They may raise voltage above the nominal limits," he said. "And the utility can't [stop] that."

Reliability concerns are fair, Earthjustice's Moriwake said. But the 15 percent rule is not based in science. It is a rule of thumb, he said, "yet a lot of people take it as gospel."

"It's a conservative assumption of a conservative assumption," he said.

Indeed, the 15 percent rule is a bit of a mongrel, created mostly to allay safety concerns but adapted to reliability rules, Kroposki said. Put simply, it began as a way of preventing utility workers and the public from electrocution.

Regulators had concerns that local electricity generation could create, in a poetic turn of bureaucratise, "unintentional islands," electrical wires that remained live after the power company had shut off its centralized source. Inadvertently fed by local producers, these charged wires, perhaps toppled by a storm, could threaten the public or emergency crews sent to repair the problem.

To stave off the formation of these islands, regulators have sought to have more centralized than local power available on the grid. It's a "rule of thumb" that the minimum amount of electricity on the grid is one-third the peak. Round that third down to 30 percent and divide it in half, for safety's sake, and out springs the 15 percent rule.

It was an engineer's estimate. "Utilities assumed they wouldn't see high penetrations of distributed generation," Kroposki said. "So this rule wouldn't really affect people."

There are reasons to suspect the 15 percent rule is too conservative. Minimum electricity use during the day, when solar is relevant, is much higher than at night. New solar panels automatically cut off from the grid when centralized power goes down, preventing islands. And there are numerous examples of circuits operating well beyond 15 percent penetration, Kroposki said.

With the rule now under siege by annoyed businesses and consumers, regulators have scrambled to better define how the threshold should apply to solar panels. DOE has launched multiple studies into "high penetration" solar, using Hawaii as its guinea pig, and next month Kroposki's peers at NREL will release a study likely to recommend an increase in the 15 percent threshold.

When states will act on such recommendations, however, is another story.

Proving ground

In Hawaii, renewables are now a source of suspicion and debate. And, yes, some hope.

They are far removed from the blue-sky optimism of keynotes and pitches, instead lingering in the gritty, technical disputes that influence how investments are made for decades to come. Industries are made in these trenches -- there is perhaps no better sign of renewable energy's arrival as a serious competitor to fossil fuels.

Seeking to heal the divisions between the utility and developers, Hawaii's Public Utilities Commission brought the two together in an advisory group this year. At the panel's first meeting, the commission's chief, Hermina Morita, had tough words for both sides. The state will seek to accelerate rooftop solar, she warned, but not at a cost to reliability.

"We cannot keep piling on new renewable projects until the system breaks down," she said, "or until your projects are all online but losing money due to regular curtailments. ... Poor grid reliability will hurt our economy just as much as high power costs."

Hawaii is especially vulnerable to disruptions thanks to its isolation. Each island has its own electrical grid and cannot shunt excess power from one area to another, a common trick on the mainland. This fragility underlies all the commission's decisions and also played a role in luring federal support, according to Duda, the solar association president.

"If you can do [renewables] here, you can do them anywhere," he said.

That fragility has prompted some grand schemes. Hawaii is hosting several smart grid projects, including a $37 million demonstration **project** on Maui. Most prominently, it is planning an expensive undersea cable

that would link the islands' grids, enabling offshore wind farms and the spread of steady geothermal power from the Big Island. Construction could begin within two years.

Long before the undersea cable is ready, however, Hawaii will need to accommodate much more solar and wind power, said Glick, the state's energy chief.

"We have to address these issues by default," he said. "Right now."

At times, it has not looked hopeful. Solar developers regularly accused Hawaiian Electric of slow-walking its acceptance of rooftop solar, seeing distributed power generation as a challenge to its centralized business model. In the utility's ideal world, it would substitute biofuels for oil in its power stations, or at the least it would build large wind and solar farms that it could easily manage, Earthjustice's Moriwake said.

"What's become very clear," he said, "if it wasn't pretty transparent from the beginning, was that the utility, as part of this clean energy movement, wanted to maintain control of their [power] generation, and especially their legacy plants."

Duda is more conciliatory. Hawaiian Electric has an understandable self-interest that may bias it against rooftop solar, he said. After all, how could it be good for the utility?

"There really isn't a business model that they've embraced that isn't primarily about owning things, including generation," he said. There's a lesson here: Regulators in other states, he said, need to find a business model that will prompt utilities to embrace rooftop solar. Or, he added, they can "drag the utility kicking and screaming along."

Hawaiian Electric has never seen itself as opposed to solar, added Pai, its spokesman.

"[Solar] is an important part of the solution to Hawaii's energy problems," Pai said. "There is no 'either-or,' there is no silver bullet. It's not a matter of playing one solution off against the other. If you look at the projections done by others on the amount of available resource for [solar], wind and other resources, it's clear we can do them all."

Despite these suspicions, the groups have made progress. Late last month, Hawaii's regulators approved a deal that will relax its solar study triggers. While the 15 percent threshold remains, the utility agreed to allow circuits reaching the trigger to first use a quick, free "supplemental review," which will allow small rooftop projects to proceed if the local generation does not exceed half of the daytime minimum supply.

In effect, the deal should allow a number of circuits to surpass the 15 percent impasse without raising the threshold. It is a standard that places like California may soon also adopt.

"This is kind of a preview of coming attractions," Moriwake said.

Like the threshold increase from 10 to 15 percent last year, the deal is another peace treaty in a long-running campaign. Given the difficult circumstances, Hawaiian Electric is "doing the best they can," said Mangelsdorf, the solar developer. Still, he added, there's little doubt that the entire 15 percent threshold will need to go up. The imperative to add rooftop solar is not going away, he said. It will only grow.

Back in Waimalu, the retired soldier, George Hayashi, can explain exactly why.

Hayashi has seen the promos for wind farms and burning waste for energy, he said. The technologies look amazing, but he doubts any of their savings will go into his pocket.

"Wow, that's cool," he said. "But I'm not seeing it. It's going to Hawaiian Electric."