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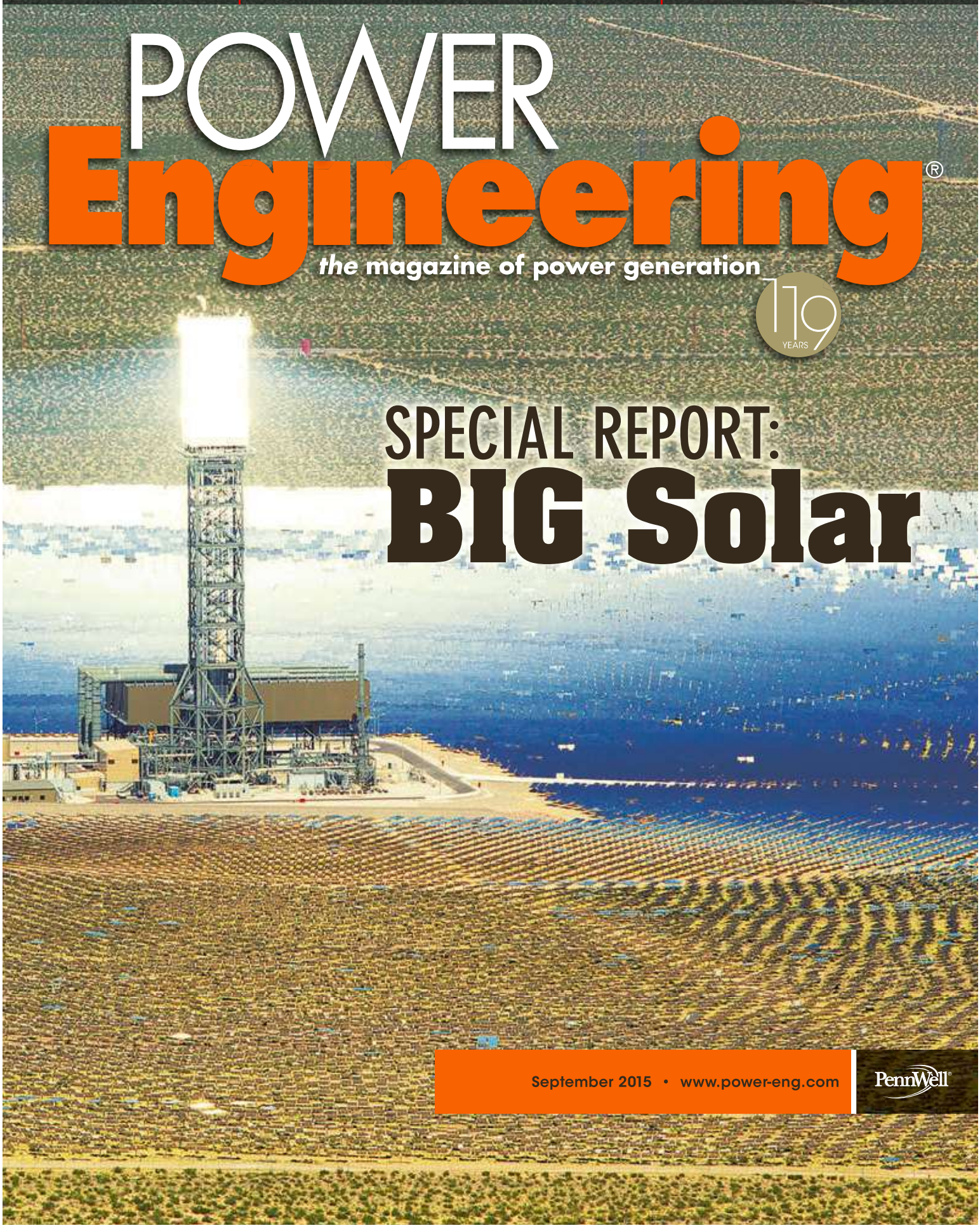

SPECIAL REPORT: BIG Solar

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Large-Scale Solar on the Rise

BY ROBERT SPRINGER

The utility-scale solar energy industry is feeling its oats. The cost of generating electricity from solar power has plummeted in recent years, and experts say it will continue to drop. Utility-scale solar is on par with, if not cheaper than, power produced with fossil fuel in many markets in the U.S., and there are more than 27 GW of solar projects either under construction or in the planning stages.

Yet, there are a few clouds darkening the utility-scale solar market. The darkest being the possible sun setting of federal investment tax credits (ITC) at the end of 2016.

Solar has about 1 percent of the power generation market in the U.S., but the industry is scoring some historic firsts. Georgetown, Texas, about 50 miles north of Austin, recently announced that it will use solar and wind power to become one of a handful of U.S. cities running on 100 percent renewable energy.

The solar power will come from a 150 MW project in West Texas, according to John Lamontagne, senior director of corporate communications at SunEdison. What's interesting about the announcement is why the city chose SunEdison: price.

"They did it because we were the lowest cost option for local ratepayers," Lamontagne says. "In other words, solar energy (along with wind power) were the cheapest ways to power that town."

PROJECT PROFILE

There are two main ways to generate solar power: photovoltaic cells or concentrated solar power (CSP). CSP uses mirrors to focus solar energy to create heat, which can then power a traditional steam turbine. Photovoltaic cells use an electronic process to convert sunlight into electricity.

The Ivanpah Solar Electric Generating System uses solar thermal technology to produce energy. Unlike traditional solar farms, more than 300,000 computer-controlled mirrors track the sun and reflect it towards boilers that sit atop immense towers. Steam is created when the concentrated light hits the boilers. The steam is piped to a turbine where it creates electricity.

Ivanpah, which has been live since January 1, 2014, has three units with a total generating capacity of 377 MW. Units 1 and 3 provide power for Pacific Gas & Electric while unit 2 sends electricity to Southern California Edison. The plant has a 30-year license to operate on public land in California's Mojave Desert, 45 minutes southwest of Las Vegas. About 65 full-time operations and maintenance employees work at the plant.

Ivanpah, a partnership between BrightSource Energy, Google and NRG called Solar Partners, was built by Bechtel. NRG Energy Services handles the plant's operations and maintenance.

The plant reaches full load during sunny days, says Mitchell Samuelian, vice president of operations and maintenance for NRG Renew and the former general manager of Ivanpah. "On sunny days we've made over 103 percent of our estimated energy that we were supposed to reach in the year," he says.

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The Ivanpah Solar Electric Generating System uses mirrors to direct concentrated solar power at a boiler, which produces steam to power a turbine and produce clean electricity for Northern and Southern California. Photo Courtesy: Ivanpah Solar Electric Generating System

The challenge is how to produce the most electricity during partly cloudy weather. The goal, explains David Knox, senior director, wholesale and new business communications at NRG, is to "collect as much solar energy as you can to start it up as quickly as you can, and then to continue that throughout the day, whether it be high noon or early evening and optimizing that throughout the entire day."

This is technically very challenging to do, according to Samuelian, "Because you've got clouds moving in and out and you've got a steam plant with thermal inertia and the parts and pieces move around," he says.

In the early morning, virtually all of the mirrors are aimed at the tower, but as the day goes on some go into a standby position so the tower doesn't overheat. The process is regulated by infrared cameras, Samuelian says. "They monitor the boilers surface with infrared cameras, and they balance turbine load with the amount of solar they're putting in and with how much sunlight's in the sky," he says.

The boiler has three sections – super heat, reheat and evaporator – and multiple mirrors heat a different section of the boiler. Supercomputers balance the energy on the three spots and give aiming signals to each unit every 10 seconds, according to Samuelian.

"I think that people don't understand

the complexity associated with that. I mean these are actually run by big supercomputers that control the system," says Samuelian.

The plant uses recycled water, and is using much less than originally thought, at about 40 percent of the 100 acre feet allotment for all three units, according to Samuelian. Using air-cooled condensers helps, as does having "a closed loop cooling system that ejects the heat to the air rather than evaporating water. There's a golf course next to us out in the desert, and I think we use the amount of water equal to two holes on the golf course," Samuelian says.

Another challenge is the sheer size of the plant. A coal-fired plant of similar size would have a much smaller footprint, Samuelian says. Ivanpah's three units cover about 3,000 acres and is about five miles end to end. "So if I've got someone working in the solar field on one end of the plant and I need them to go look at something else on the other end of the plant, there's restrictions on what speed you can drive onsite, for wildlife considerations, and creating dust, and so, the speed limits like 10 miles an hour," says Samuelian. It takes about half an hour to go from one end of the plant to the other.

FOLLOWING THE PHOTONS: SOLAR IS MORE THAN PANELS

Solar panels get the lion's share of the publicity, but they'd just be large, shiny mirrors without the ability to take the electricity the solar panels produce from the panel to the grid. ABB, a global provider of power and automation technologies, manufactures and installs the equipment that allows utilities to get solar energy onto the grid.

ABB's products take over once the solar panels have converted the energy from photons into DC power, says Bob Stojanovic, ABB's director of solar power for North America. "What ABB makes is everything from the connectors that connect the cabling to the devices," he says.

Groups of solar panels (or "strings") run in a series and in parallel until they get the maximum voltage they're designed for, and the electricity is taken to a combiner box, which is a group of fuses and switches that take the input from the strings and combine it into a single output, according to Stojanovic. "And that typically runs back to another larger combiner box, which is typically a bunch of breakers or large fuses that take the rest of these strings and combine it into one big DC input into an inverter," he says.

ABB provides concentrated solar power and thermal automation solutions for solar farms around the world, including this customized application with eSolar's Sierra SunTower facility in Southern California. Photo Courtesy: ABB

The DC power needs to be converted to AC to reduce losses and because that's what the North American grid supports.

Stojanovic says they typically get somewhere around 300 to 690 volts of AC out of the inverter, and "then it goes through what's called an inverter step-up transformer" or padmount transformer, he says. The transformer typically boosts the voltage up to 34.5 KV.

Although there are small losses during the conversion process, the final boost to 34.5 KV will decrease the loss as the power is sent to the substation, according to Stojanovic. "Inside the substation you'll typically string, depending on the plant design, somewhere between, five to eight converters together on the same circuit, and you'll bring it back to a main breaker, a feeder breaker which will then feed it into the main power transformer," he says.

ABB manufactures turnkey substations and almost all of the equipment that's in the substations, Stojanovic says, "Everything from the reclosers to the tank breakers to the power transformers, the current transformers, and the instrument transformers where you measure power and voltage."

Stojanovic says that ABB has no

desire to enter the solar panel market, although the company looked into it a few years ago, as they realized it was not a core competency. "What we manufacture is power and automation equipment. That's really where we can add value," he says.

WHAT HAPPENS IN 2017?

There are a myriad of predictions for what would happen to the U.S. solar industry if the federal investment tax credit were to decrease from the current 30 percent to 10 percent in 2017. The predictions range from an extreme disruption of the industry to a 12 to 18 month hiccup in the industry's rapid growth of the past few years.

"I think right now people are proceeding with cautious optimism," says Katherine Gensler, director of government affairs for the Solar Energy Industries Association (SEIA). "This is in contrast to say the last five or six years, where there was sort of a booming industry and a growing industry."

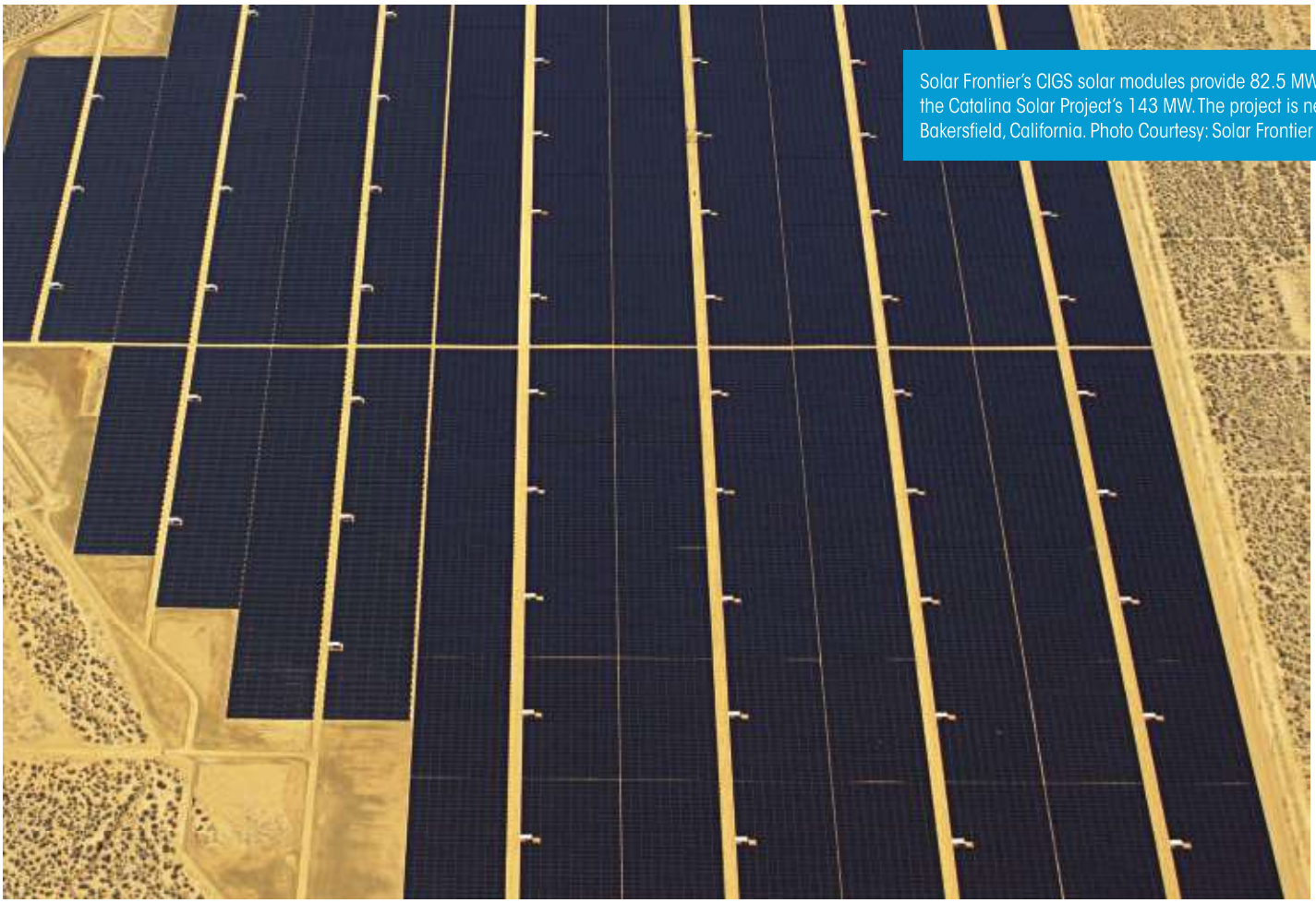
Gensler adds that the eight year ITC extension that the industry received in 2008 allowed the industry to grow and especially helped larger utility-scale projects that had long lead times.

Charles Pimentel, Solar Frontier's chief operating officer, is not optimistic that congress will extend the ITC in its current form, although he is "confident that congress will provide some kind of interim solution, whether it be a complete extension, or whether it be some kind of safe harbor, or some kind of grandfathering in of projects completed by the end of 2016," he says.

He doesn't foresee long term damage to the industry if the ITC is allowed to expire. "Will the industry cease to exist? No, definitely not. It has become very competitive to the point where I think it would certainly cause a considerable slowdown in the industry, but I'm confident that the industry can absorb it if it's forced to," he says. "It will certainly spur a high level of consolidation in the industry and only the very strong and very efficient will survive the expiration of the ITC. "

David Feldman, senior financial analyst at the National Renewable Energy Laboratory, notes that the personal homeowner credit completely goes away, so the distributed market could be harder hit than the utility-scale one.

He also thinks it's time for the ITC to go away entirely, albeit gradually. "The best thing that I think that could happen is that they just agree to somehow put some sort of orderly ramp-down in place rather than just a hard cliff; but I



Solar Frontier's CIGS solar modules provide 82.5 MW of the Catalina Solar Project's 143 MW. The project is near Bakersfield, California. Photo Courtesy: Solar Frontier

think whoever's in office, it's going to take congress as well as the president to decide what the policy is going forward. But all energy is policy, so it's not just solar," he says.

NET METERING: A DEBATE IN MANY STATES

Net metering, or the process of selling excess electricity generated on-site back to a utility at retail power rates, is an issue that utilities and solar-using rate payers are passionate about. The rate at which customers are paid for energy sold back to a utility impacts its bottom line and the cost effectiveness of a rooftop solar installation, experts say.

Pimentel says that while net metering does impact a utilities bottom line, it won't destroy their business model as rooftop solar is such a tiny percentage of the energy generated in North America.

"If a homeowner is typically paying the utility $250 every month and all of a sudden the utility is only getting $15 a month, that impacts their revenue," he says. However, if a utility has 2 million customers and only 5,000 use solar "it's not going to destroy the utility. It will affect their revenue and their economics, but it's certainly not going to destroy them," he says.

It makes sense for customers to be paid the retail rate, according to Feldman, as utilities don't have to pay for pay transmission charges, the facilities are collocated and there are other benefits which make distributed solar worth a higher value price.

The solar industry itself is of two minds about net metering. In California, the SEIA and the Alliance for Solar Choice have asked the public utilities commission to leave things as they are, while Pacific Gas & Electric and Southern California Edison want payments lowered to new net metered installations.

FUTURE OF SOLAR IN N.A.

While experts agree that solar has a place at or near the head of the table of renewable energy options for North America, the industry has some substantive challenges in addition to the possible expiration of the ITC at the end of 2016.

ABB's Stojanovic is an "optimist" when it comes to technological innovations that will continue to drive down equipment costs and increase efficiencies in the next few years. "They've basically proven everybody wrong over the last five years by blowing away whatever cost curves they thought they

had in line," he says.

Solar's biggest challenge going forward is making energy that's affordable in the daytime also affordable at night, Stojanovic said. "I don't think cost for solar is the issue anymore," he says.

Interconnection continues to be an issue, according to Feldman. Putting the right amount of solar technology in the right location at the right cost is a challenge. He says that a utility industry that has placed a high premium on reliability (a good thing) might be acting too conservatively when it comes to solar. In addition to reliability, flexibility and storage are important factors for utilities to consider, Feldman says.

Samuelian thinks era of the mega-solar projects is over, as the low price of oil and natural gas is "really kind of driving the energy market in general," he says. Knox sees the home solar market as "an incredible growth market," he says. "We just really see a huge potential for the home solar market, not instead of but in addition to the utility-scale market."

Many different technologies – including wind, storage, diesel generators and solar – could converge to help create a self-sustaining micro grid, Samuelian says.

The number of states that have aggressive solar and renewables programs has grown exponentially, Pimentel says, with North Carolina being the poster child for this group. "Two years ago, nothing was going on in North Carolina, and now North Carolina will do gigawatts next year," he says. Georgia is also getting into solar in a big way, according to Pimentel.

New markets will be important for the industry, Feldman says, as states start to satisfy their Renewable Portfolio Standards (RPS). If Arizona, for example, hits its RPS, utility-scale solar might not make sense there as the demand will have evaporated. On the other hand, states like California and Hawaii have very aggressive RPS', which could balance out the demand. Solar is also competing against wind, Feldman notes.

Gensler says that there is "still some trajectory" left in the market through 2016, but large utility-scale solar plants are not being planned for post 2016 until the ITC debate is resolved. "There's a lot more uncertainty about the near-term future, but then once we get through the uncertainty, the industry is strong and will continue to grow," she says. pe