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Schneider Electric's Boston One Corporate Campus in Andover, MA has an advanced microgrid that automates and controls generated power and serves as a laboratory for research and development. Lyn Corum's coverage of the Homer Microgrid Conference starts on page 4.



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Dick Flanagan
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World-Gen was invited to report on the world's first solar energy microgrid launched by four partners in Nice, France at a cost of 30 million euros.

Now, four years later, Lyn Corum reports that few microgrid projects are moving forward without significant government support. She attended the two-day HOMER International Microgrid Conference in San Diego, October 8th and 9th, 2018, and you can read her coverage beginning on page 4.

Jim Schretter, President of Beacon Energy and in World-Gen's Class of 2002, sets the stage for 2019. He lists the expected challenges for developers, utilities, corporate customers and suppliers on page 6.

John Chevrette, President of Black & Veatch Management Consulting, surveyed utility professionals. Acceleration in energy storage installations is being led by renewables, microgrid deployments support the growth of storage systems and regulatory factors also contribute to potential growth outlined on page 8.

Marlene Motyka, Class of 2017, reports on DeLoitte's "Global Renewable Energy Trends." She highlights seven key trends and three key enablers helping renewables become equivalent to conventional sources on page 10.

MIT is developing a new type of battery to open up new avenues for tailoring electrochemical carbon dioxide conversion reactions. The concept could replace carbon capture in underground geological disposal on page 12.

E.J. Bernacki explains the 4th round of the Wells Fargo Innovation Incubator (IN2) co-administered by the National Renewable Energy Laboratory. IN2 provides funding, technical assistance and beta testing to startups to improve sustainability in commercial buildings on page 14.

The US Veterans Administration initiated a major program to upgrade emergency backup systems at VA hospitals in hurricane zones. The James A. Haley Veterans Hospital in Tampa, FL completed a \$47 million renovation, and we learn the extent of the upgrades from Stephen McQuaid on page 15.

John Moran writes on page 16 that the price of energy now has a ceiling. The fuel is free in the "Clean Energy Revolution."

Bob Palmer analyzes the engineering of Santa's trip around the world on page 17.

Teresa Ribera writes that Spain is reducing spiraling energy costs from households by suspending the country's 7 percent solar tax. It's shifting towards renewables to be in line with EU2020 directives on page 18.

Damian Brandy from IRENA reports that Egypt could generate over 50 percent of its electricity from renewables by 2030. The Benban Solar Park will churn out 1,650 megawatts of electricity. The country also plans on building the largest wind farm in the Middle East on page 18.

We are pleased to publish the 20th Annual Bueche Directory of Developers on pages 19 and 20.

As we close out 2018, our 30th year of publishing World-Gen, I would like to again acknowledge and thank the advertisers who have made all this possible. They are listed on the back cover.

HAPPY HOLIDAYS,

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MICROGRID MARKETS EXPANDING

BY LYN CORUM, CLASS OF 2012



Resiliency was the word most commonly heard throughout the two-day HOMER International Microgrid Conference in San Diego held on October 8 and 9. Resiliency was most often the reason a community, a utility or a campus seeks to build a microgrid, to protect themselves from power outages and extreme weather, especially in North America. Microgrids outside the US were being built either to bring power to a community or to replace some of the expensive diesel fuel they are dependent on with renewable power.

A report was recently published by the California Energy Commission that profiled 26 microgrids in both the US and internationally. Conclusions reached by the authors, from Navigant Consulting, were that “although the microgrid market is developing rapidly it is still relatively immature and microgrid projects tend to be highly customized. Therefore, these projects often require expensive one-off engineering solutions for emerging technologies (such as advanced energy storage) that in many cases still require government subsidies.” This conclusion was also reached by at least one speaker at the microgrid conference.

Government support is almost always a given to get microgrids built, reported Patrick Morand, a regulatory attorney

with Duane Morris, (see his comments below). The CEC report notes there are a few microgrid projects that are moving forward without significant government support. Summaries of the 26 microgrids are included in the report available on the CEC website, at <https://www.energy.ca.gov/2018publications/CEC-500-2018-022/CEC-500-2018-022.pdf>.

The report, *Microgrid Analysis and Case Study Report*, was written by Peter Asmus, Adam Forni, and Laura Vogel, Navigant Consulting, Inc. 2017.

MICROGRIDS ARE UNIQUE TO SITES

A sprinkling of attendees at the microgrid conference in San Diego came from outside the US, and discussed the microgrid projects they were involved in. Most are solar photovoltaic combined with diesel generation. Projects outside the US usually do not involve energy storage as they do in the states. Here are some microgrids operating or being built in other countries:

Tikuna Energy is developing a pilot project in Chile for a community microgrid. Funding has been obtained for 34 solar PV and battery storage systems, sized at 2 kW per house. No utility power is being used. The company received 400 applications from residents. Tikuna Energy will be studying the performance of the systems for the next year when regulators will be considering regulations.

Alison Mason of SunJuice Solar discussed community microgrids in Puerto Rico. She moved there to develop projects and reports that microgrids will remain isolated from the island’s utility. Barrio Montones Las Piedras, with equipment donated by Tesla, serves 12 homes. The community of Toro Negro, Ciales, having organized for 15 years, built a solar system to serve 28 houses, with equipment paid for by the Puerto Rico Community Foundation and Somos Solar.

Mason reports that the development of San Salvador Caguas in Puerto Rico is a community-driven effort that began two years before Hurricane Maria. Six consumer education workshops were held and 250 households were surveyed. An additional 550 are interested. A concept design exists and financing is being sought.

James Hamilton at the University of Tasmania’s Center for Renewable Energy and Power Systems discussed remote microgrids on three islands: King Island, Flinders Island and Rottnest Island in western Australia.

Hydro Tasmania recently completed the King Island Renewable Energy Integration Project. Designed to provide up to 65% of the island’s energy use, the existing diesel engines provide 2.5 MW peak load and is being augmented by bio-diesel. Two wind turbines provide 1.3 MW, solar systems, 1.2 MW and a battery storage system provides support to the network operating on 100% renewable energy. It stores excess wind power. Two auxiliary diesel engines with a flywheel, to cover short power interruptions, allows 100% renewable energy supply when production is high. The project has reduced fuel costs by 10% according to Hamilton.

Rottnest Island has wind, solar, and diesel power, according to Hamilton. Solar contributes a greater amount of power, wind a small amount. No other details were available.

Emily Chessin, with the Cadmus Group reported there are now utility-owned community solar microgrids in the eastern Caribbean where there is limited progress and growth in customer-sited solar PV, especially with commercial and industrial customers. Electricity costs are high and there is interest in reducing those costs, but there are challenges to making investments. She reported the Turks and Caicos Utility Limited owns a solar PV system which home and business owners can buy into.

Nick Hawley, with BBA Engineering reported on the Old Crow Off-Grid Solar-Diesel Integration project in the Yukon in Alaska. Described in a Government of Yukon press release as a community-driven

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2019 INDUSTRY CHALLENGES

BY JIM SCHRETTER, CLASS OF 2002



President, Beacon Energy LLC

Next year will likely involve substantial energy industry challenges, with the disruptive changes caused by PV solar and storage price declines, and the rise of distributed generation. Winston Churchill said, “A pessimist sees the difficulty in every situation; an optimist sees the opportunity in every difficulty.” That thought sets the stage for the next year in the energy industry, as 2019 offers a number of opportunities for stakeholders to improve their value propositions.

EXPECTED US INDUSTRY CHALLENGES

The Intergovernmental Panel on Climate Change’s (“IPCC”) October 2018 report issued a dire statement based on the assessments of 90 scientists in 40 countries. IPCC said that without “rapid, far-reaching and unprecedented changes in all aspects of society,” the world would exceed a threshold increase in temperatures of 1.5 degrees C by 2030. The report went on to say that the next 10 years are critical and it is likely to require a 45% reduction in CO2 levels from 2010 to stay below 1.5 degrees C in 2030. Above 1.5 degrees C, sea levels may rise by two feet and coral reefs are likely to be eliminated, creating devastating environmental and economic damage.

Worldwide Industry has responded by creating a group of 800+ companies worth \$16.9 Trillion in market value that are instituting specific scientific carbon footprint goals in order to help hit targets and create rapid changes by 2030. Similarly, BP, Total, Statoil, Eni, Pemex, ARAMCO, and others have invested hundreds of millions in support of Oil and Gas Companies for Climate Change (“OGCI”) to provide investments and new technologies to reduce greenhouse gases. Exxon reported a \$1 million policy investment in support of a U.S. carbon tax to help provide new incentives for carbon reductions.

Interestingly, a U.S. carbon tax seems to be getting more attention than ever before.

In the opposite direction, the US White House announced a program during 2018 to permit increased methane emissions for oil and gas producers. It has also lobbied the Federal Energy Regulatory Commission (“FERC”) to provide additional payment support to operate coal plants, since they are becoming increasingly non-competitive.

Aided by tax incentives, the U.S. now has the lowest unemployment levels in 15 years in 2018 and 10-year Treasury bill rates are at a 7-year high. With higher interest rates, the stock market may decline as the federal reserve has also announced its intention to raise interest rates in coming months.

New corporate offtake agreements have surged forward in 2018. The deal tracker provided by the Business Renewables Center affiliated with the Rocky Mountain institute reported YTD-Aug figures of 3.86 GW in 46 deals exceeding 2.89 GW in 2017. Corporate offtake agreements continue to drive demand for new renewables along with state RPS targets, California’s and other states’ renewables and carbon related legislation, and renewable capital costs compared with traditional forms of generation.

In 2019, the solar residential, commercial, and utility scale markets are expected to install approximately 12,000 MW of PV solar according to a Berkeley Labs September 2018 report, citing their research plus SEIA, and GTM.

Offsetting the demand for renewables are continued low prices in the \$3/MMBtu range (Henry Hub) for natural gas, tariff price increases in modules, inverters, steel and aluminum and other trade issues. Some of the new tariffs are in addition to other tariffs and levels of 25% are possible on \$250 billion in Chinese imported goods starting in January 2019, with another \$267 billion under discussion if China retaliates.

Predictably, pricing in power markets is still very competitive. Early in 2018, Xcel Energy reported median bid prices for 2023 PV solar and storage of \$36/MWh and \$21/MWh for wind plus storage which showed developers betting on continued price declines expected in 5 years. Similarly, competition for new gas plants is intense with substantial queue positions reported. New distributed generation resources with or without new storage appear poised for long-term expansion.

SEIA, based on GTM and Wood McKinsey research, states that a 20 MW solar project will be the least cost generating resource in 49 states by 2023.

MARKET CONDITIONS AFFECT VALUE PROPOSITIONS

Developers’ value propositions in 2019 will be affected by the end of the 100% ITC grandfathering for solar projects, likely higher interest rates for financing, difficult-to-predict equipment costs, grid level risks and benefits of new storage and generation on distribution and transmission avoidance costs, and other factors.

Corporate demand for new projects is expected to be strong in 2019 as companies continue to set aggressive sustainability targets. The best developers will have projects in key locations with acceptable queue positions and interconnection costs, having lined up attractive long-term financing, EPC offers and quality equipment less vulnerable to new tariff uncertainties.

Utilities’ value propositions will encom-

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BATTERY STORAGE MARKET

BY JOHN CHEVRETTE



President, Black & Veatch Management Consulting

If you happened to read the third quarter US Energy Storage Monitor, you would have seen that the market jumped 42 percent between Q1 and Q2 this year.

Produced by Wood Mackenzie Power & Renewables in conjunction with the Energy Storage Association, this report also noted that Q2 year-over-year growth in energy storage systems topped 60 percent. No one would call such growth tepid.

Still, analysts expect storage markets to gain even more dramatically in coming years, and research from the 2018 Strategic Directions: Electric Report support these forecasts. Produced by Black & Veatch, this report reflects survey responses from utility professionals. Their answers – combined with market trends – foretell eye-popping acceleration to come in energy storage installations.

FOLLOWING THE SUN

One of the key drivers for strong growth in storage markets is strong growth in renewables.

Remember when industry experts said the grid could only handle 30 percent renewable generation? That view predominated just a few years ago, and it has quickly been proven wrong.

This past April 28, California's power grid reached a remarkable milestone: 73 percent of demand was met by renewable resources that day.

Granted, it only lasted for an hour or so, and it happened during the springtime when three important renewable sources were running full force: wind, solar and hydro. But, it shows that renewables can penetrate power grids far more pervasively than previously thought. They can even play a leading role.

What's more, the cost of renewables has reached parity with fossil-fuel-based generation. This year, Xcel Energy in Colorado received bids from energy developers to supply solar and wind-generated electricity — with battery storage included — at a lower cost than conventional generation. Now, the utility plans to procure some 275 MW of solar-paired storage by 2022.

In the Black & Veatch 2018 Strategic Directions: Electric Report, Black & Veatch renewable energy experts Jeremy Klingel, Jason Abiecunas and Lou Graving had this to say about Xcel's coming storage deployments: "While Colorado's supportive regulatory environment helped make this a reality, the major takeaway is that in 2018, renewable energy at utility scale can not only be price-competitive with fossil fuels, but it can even cost less."

How will utilities deal with ever more renewable generation on the grid? When asked to choose the best options for integrating renewables, 66 percent of utility professionals surveyed for the Black & Veatch report named utility-scale storage as their first choice.

Respondents also were asked what system improvements they recommend to help utilities deal with the variability of renewables. Among the choices were demand management, storage management, real-time monitoring and rapid cutover solutions to meet a sudden drop in output.

The most popular choice was quick response resources, selected by 56 percent

of survey participants, followed closely by load control devices (51 percent) and advanced system control devices (48 percent).

Storage can certainly handle the fluctuating power renewables bring. It also delivers the fast-ramping response needed when generation drops or load profiles follow California's infamous duck curve.

According to the Energy Storage Association, in competitive ancillary markets, flywheel and battery energy storage systems can beat a power turbine's response to a dispatcher's signal and provide a more accurate response as much as ten times faster than a turbine's capabilities.

OPTIMIZING FOSSIL-FUEL-BASED GENERATION

Along with supporting renewables integration, storage can help utilities make the most of fossil-fuel-based generation.

In the 2018 Strategic Directions: Electric Report, my colleague, Alap Shah writes, "Gas turbines have long played a central role in helping supply meet demand, given their ability to quickly flex up or down to demand peaks and dips. But their efficiency is diminished when running under or above optimal load."

Now, some utilities are starting to pair storage with traditional generation. An example Shah points to is the retrofitting of a 50 MW gas turbine with a 10 MW battery energy storage system (BESS). This was done by Southern California Edison (SCE). The result is a system with faster response in both starting and ramping.

SCE also entered a power purchase agreement (PPA) with AES Corporation for 1,284 MW of combined cycle capacity with 100 MW of BESS capability. The combined cycle plant is slated to come online in 2020, and the BESS will follow in 2021. Because the BESS facilitates greater performance from the combined cycle plant, it allowed for lower PPA pricing.

Other companies that have announced storage plus conventional generation include NextEra Energy and Southern Company, Shah notes in his section of the Black & Veatch report. "New scenarios are

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GLOBAL RENEWABLE TRENDS

BY MARLENE MOTYKA, CLASS OF 2017



NEW YORK, NY - Renewable energy sources, notably solar and wind, are reaching price and performance parity on and off the grid, finds a new Deloitte Global report, *Global Renewable Energy Trends*.

According to the report, three key enablers—price and performance parity, grid integration and technology — allow solar and wind power to compete with conventional sources on price, while matching their performance. As technologies such as blockchain, artificial intelligence (AI), and 3-D printing continue to advance the deployment of renewables, prices will likely continue to fall, and accessibility will improve.

Demand for renewable energy sources has grown tremendously in recent years. Governments, communities, emerging markets, and corporations increasingly understand that renewables are sustainable and affordable, and they want them included in current and future procurement plans.

Longstanding obstacles to greater deployment of renewables have receded as a result of three key enablers:

REACHING PRICE AND PERFORMANCE PARITY

The unsubsidized cost of solar and

wind power has become comparable or cheaper than traditional sources in much of the world. New storage options are now making renewables more dispatchable — once an advantage of conventional sources.

COST-EFFECTIVE AND RELIABLE GRID INTEGRATION

Once seen as an obstacle, wind and solar power are now viewed as a solution to grid balancing. They have demonstrated an ability to strengthen grid resilience and reliability and provide essential grid services. Smart inverters and advanced controls have enabled wind and solar to provide grid reliability services related to frequency, voltage, and ramping as well or better than other generation sources. When combined with smarter inverters, wind and solar can ramp up much faster than conventional plants, help stabilize the grid even after the sun sets and the wind stops, and, for Solar PV, show much higher response accuracy than any other source.

THE IMPACT OF TECHNOLOGY

Technology is accelerating the deployment of renewables: automation and advanced manufacturing are improving the production and operation of renewables by reducing the costs and time of implementing renewable energy systems; AI can fine tune weather forecasting, optimizing the use of renewable resources; blockchain can enable energy attribute certificate (EAC) markets to help resolve trust and bureaucratic hurdles; and advanced materials are transforming the materials of solar panels and wind turbines.

Already among the cheapest energy sources globally, solar and wind have not even run the full course of their enabling trends yet. As costs continue to fall and accessibility increases, the demand for renewables is growing rapidly, driven by the following stakeholders:

SMART RENEWABLE CITIES

Most of the world’s population now lives in growing cities, some of which have taken a proactive “smart” approach to managing their infrastructure with connected sensor technology and data analytics. The focus of more advanced smart cities is to enhance quality of life, competitiveness and sustainability. Solar and wind are at the intersection of these goals because they contribute to depollution, decarbonization and resilience while enabling clean electric mobility, economic empowerment, and business growth.

COMMUNITY ENERGY

Building on the original trend toward “community solar”, the addition of storage and management systems give communities more flexibility when implementing renewables. On-grid communities can now be powered independently from the grid, and in off-grid areas, community-owned partnerships enable electrification and reinvestment of profits.

EMERGING MARKETS

The cumulative capacity of emerging markets to develop renewable energy is on the verge of surpassing that of the developed world, as emerging markets have helped bring down the cost of renewables and are innovating in ways that benefit the developed world.

CORPORATE INVOLVEMENT

Corporations are procuring renewables in new ways, with many large corporations pursuing Power Purchase Agreements (PPAs) and smaller corporations turning to aggregation. Furthermore, currently two-thirds of Fortune 100 companies have set renewable energy targets and are leading

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NEW BATTERY DEVELOPED

BY DAVID L. CHANDLER, MIT

CAMBRIDGE, MA -- A new type of battery developed by researchers at MIT could be made partly from carbon dioxide captured from power plants. Rather than attempting to convert carbon dioxide to specialized chemicals using metal catalysts, which is currently highly challenging, this battery could continuously convert carbon dioxide into a solid mineral carbonate as it discharges.

While still based on early-stage research and far from commercial deployment, the new battery formulation could open up new avenues for tailoring electrochemical carbon dioxide conversion reactions, which may ultimately help reduce the emission of the greenhouse gas to the atmosphere.

The battery is made from lithium metal, carbon, and an electrolyte that the researchers designed. The findings are described today in the journal *Joule*, in a paper by assistant professor of mechanical engineering Betar Gallant, doctoral student Aliza Khurram, and postdoc Mingfu He.

Currently, power plants equipped with carbon capture systems generally use up to 30 percent of the electricity they generate just to power the capture, release, and storage of carbon dioxide. Anything that can reduce the cost of that capture process, or that can result in an end product that has value, could significantly change the economics of such systems, the researchers say.

However, “carbon dioxide is not very reactive,” Gallant explains, so “trying to find new reaction pathways is important.” Generally, the only way to get carbon dioxide to exhibit significant activity under electrochemical conditions is with large energy inputs in the form of high voltages, which can be an expensive and inefficient process. Ideally, the gas would undergo reactions that produce something worthwhile, such as a useful chemical or a fuel. However, efforts at electro-

chemical conversion, usually conducted in water, remain hindered by high energy inputs and poor selectivity of the chemicals produced.

Gallant and her co-workers, whose expertise has to do with nonaqueous (not water-based) electrochemical reactions such as those that underlie lithium-based batteries, looked into whether carbon-dioxide-capture chemistry could be put to use to make carbon-dioxide-loaded electrolytes — one of the three essential parts of a battery — where the captured gas could then be used during the discharge of the battery to provide a power output.

This approach is different from releasing the carbon dioxide back to the gas phase for long-term storage, as is now used in carbon capture and sequestration, or CCS. That field generally looks at ways of capturing carbon dioxide from a power plant through a chemical absorption process and then either storing it in underground formations or chemically altering it into a fuel or a chemical feedstock.

Instead, this team developed a new approach that could potentially be used right in the power plant waste stream to make material for one of the main components of a battery.

While interest has grown recently in the development of lithium-carbon-dioxide batteries, which use the gas as a reactant during discharge, the low reactivity of carbon dioxide has typically required the use of metal catalysts. Not only are these expensive, but their function remains poorly understood, and reactions are difficult to control.

By incorporating the gas in a liquid state, however, Gallant and her co-workers found a way to achieve electrochemical carbon dioxide conversion using only a carbon electrode. The key is to preactivate the carbon dioxide by incorporating it into an amine solution.

“What we’ve shown for the first time is that this technique activates the carbon

dioxide for more facile electrochemistry,” Gallant says. “These two chemistries — aqueous amines and nonaqueous battery electrolytes — are not normally used together, but we found that their combination imparts new and interesting behaviors that can increase the discharge voltage and allow for sustained conversion of carbon dioxide.”

They showed through a series of experiments that this approach does work, and can produce a lithium-carbon dioxide battery with voltage and capacity that are competitive with that of state-of-the-art lithium-gas batteries. Moreover, the amine acts as a molecular promoter that is not consumed in the reaction.

The key was developing the right electrolyte system, Khurram explains. In this initial proof-of-concept study, they decided to use a nonaqueous electrolyte because it would limit the available reaction pathways and therefore make it easier to characterize the reaction and determine its viability. The amine material they chose is currently used for CCS applications, but had not previously been applied to batteries.

This early system has not yet been optimized and will require further development, the researchers say. For one thing, the cycle life of the battery is limited to 10 charge-discharge cycles, so more research is needed to improve rechargeability and prevent degradation of the cell components. “Lithium-carbon dioxide batteries are years away” as a viable product, Gallant says, as this research covers just one of several needed advances to make them practical.

But the concept offers great potential, according to Gallant. Carbon capture is widely considered essential to meeting worldwide goals for reducing greenhouse gas emissions, but there are not yet proven, long-term ways of disposing of or using all the resulting carbon dioxide. Underground geological disposal is still the leading contender, but this approach remains somewhat unproven and may be limited in how much it can accommodate. It also requires extra energy for drilling and pumping.

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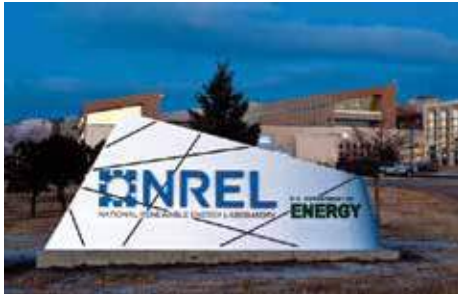
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IN² CLEAN-TECH STARTUPS

BY E.J. BERNACKI



DENVER, CO - The Wells Fargo Innovation Incubator (IN2), a technology incubator and platform funded by the Wells Fargo Foundation and co-administered by the National Renewable Energy Laboratory, has selected the fourth round of clean-tech and energy efficiency startup companies to join the program.

The five startups join 20 other early-stage companies that have received support to address energy challenges in commercial buildings, which currently account for more than 40 percent of energy usage in the U.S.

Each of the five early-stage companies will receive up to \$250,000 in non-dilutive funding to test, validate and advance their technologies with a network of experts at the National Renewable Energy Laboratory's research facility in Golden, CO. After validation in the lab, participating companies may have the opportunity to beta test on a Wells Fargo property or with a strategic program partner.

Portfolio companies selected for IN2's fourth round are developing technologies designed to advance energy efficiency in commercial buildings. They are:

75F (Burnsville, Minn.). Easy-to-setup HVAC controls system with the potential to cut install time and costs by up to 80 percent, compared to traditional controls systems.

Ladybug Tools (Baltimore). Computer applications that support the design process for sustainable buildings and net-zero districts seeking to employ cutting-edge energy technologies.

Next Energy Technologies, Inc. (Santa Barbara, Calif.). Low-cost, printable, transparent energy-harvesting coatings that are seamlessly integrated into windows to provide onsite renewable power.

UbiQD, Inc. (Los Alamos, N.M.). Nanomaterials for energy harvesting that provide a simple, scalable, low-cost and aesthetically pleasing approach to solar windows.

Yotta (Austin, Texas). Modular energy storage integrated with solar, designed to reduce cost and expand development of energy storage and grid resiliency on commercial buildings.

"This initiative began four years ago to help cutting-edge, clean-technology startups refine and further develop their technology to speed the path to market and improve sustainability in commercial buildings," said Ramsay Huntley, Clean Technology and Innovation Philanthropy program officer for Wells Fargo. "Our \$30 million program has invited 25 startups to participate, and those companies have gone on to collectively raise more than \$100 million in external follow-on funding, making the Wells Fargo Innovation Incubator one of the premier launchpads for advancing clean technologies in the U.S."

Launched in 2014, the IN2 facilitates the commercialization and adoption of clean energy technologies. With resources from Wells Fargo and the National Renewable Energy Laboratory, IN2 provides funding, technical assistance and real-world beta testing opportunities that help companies uniquely understand their customers. Founded initially to address energy challenges in commercial buildings, the program recently expanded its focus to include the interconnection of food, energy and water.

"We are excited to welcome these five innovative companies and look forward to helping them tackle sustainability and energy efficiency challenges and speed their path to market," said Trish Cozart, IN2 program manager at the National Renewable

Energy Laboratory. "Companies participating in previous rounds are already demonstrating their technologies in real-world applications, receiving follow-on funding and being acquired by successful corporations. This sustained success demonstrates the value of our program and enhances our ability to attract the highest quality applicants and companies moving forward."

As an invitation-only program, IN2 finds and selects companies through its Channel Partners, a curated network of incubators, accelerators and universities across the U.S. that refer startups to the program. Once referred, companies participate in a highly competitive application and selection process to determine which will be invited into the next round of participants.

For a complete list of IN2 portfolio companies and Channel Partners, visit in2ecosystem.com.

ABOUT THE WELLS FARGO INNOVATION INCUBATOR

IN2 is a \$30 million clean-technology incubator and platform funded by the Wells Fargo Foundation. Co-administered by and housed at the National Renewable Energy Laboratory (NREL) in Golden, Colorado, IN2's mission is to speed the path to market for early-stage, clean-technology entrepreneurs. Companies selected for participation in the program receive up to \$250,000 in non-dilutive funding from Wells Fargo, technical support and validation from experts at NREL and the Danforth Plant Science Center's facilities, and the opportunity to beta test at a Wells Fargo facility or with a strategic program partner. Launched in 2014 with an initial focus on supporting scalable solutions to reduce the energy impact of commercial buildings, IN2 is expanding its focus in 2018 to support innovation in sectors such as transportation, food systems, energy storage and others with the ultimate goal of fostering smart and connected communities of the future. For more information, visit in2ecosystem.com.

POWERING FLORIDA VA HOSPITAL

BY STEPHEN MCQUAID

In the aftermath of Hurricane Katrina, which hit New Orleans in 2005, the U.S. Veterans Administration (VA) initiated a major program to upgrade emergency/backup power systems at VA hospitals in hurricane zones. James A. Haley Veterans' Hospital, located in Tampa, Florida, completed a major power plant renovation as part of the national upgrade. The \$47 million renovation to the power plant includes a backup system capable of covering all electrical loads for 120 hours (without refueling) in an event of an outage. Included in the upgrade was a supervisory control and data acquisition (SCADA) system from Russelectric.

Haley Hospital awarded the bid for the SCADA system to Russelectric, based in Hingham, Massachusetts, which provided power control switchgear, transfer switches, and SCADA for the emergency backup system.

VA UPGRADES EMERGENCY SYSTEM IN RESPONSE TO HURRICANE KATRINA

James A. Haley Veterans' Hospital, a teaching hospital affiliated with the adjacent University of South Florida College of Medicine, provides a full range of patient services with state-of-the-art technology and research. Haley is the busiest of four national VA polytrauma facilities. It has 415 beds, plus another 118 beds in an onsite long-term care and rehabilitation facility. The system also includes four outpatient clinics serving a four-county area.

As part of the national emergency/backup power system upgrade, Haley Hospital completed a major power plant renovation. One of the key project goals was to ensure continuous air conditioning as well as operation of life-safety and other critical equipment. <image008.png>

The hospital's former backup power system included nine on-site generators, but could still only cover life-safety loads (45 percent of the total load) in the event of

a utility outage. According to Haley's electrical shop supervisor Bill Hagen, the old system resulted in major headaches, especially its dynamic matrix control. "We had nothing but problems with it," he recalls. "We never got it to work in parallel. It couldn't even generate a monthly testing report."

In contrast, the new backup system covers all electrical loads for 120 hours without refueling. It handles every load for 9 buildings, 15 trailers that make up an on-campus clinic, and a parking garage – with just 7 generators. Each of the new 13,200-VAC Caterpillar diesel generators produces 2,200 kilowatts (kW) of power.

Another improvement is the hospital's renovated fuel system. The former system had a capacity of 22,000 gallons, and the storage tanks were spread out over several locations. The new tank farm has four 12,000-gallon tanks. With another 6,000-gallon tank under each generator, the system now has a total capacity of 90,000 gallons.

NEW SCADA SYSTEM

The system includes a state-of-the-art SCADA system, which features software and screen displays customized by Russelectric for the hospital's site-specific needs. It provides interactive monitoring, real-time and historical trending, distributed networking, alarm management, and comprehensive reports around the clock for every detail of the entire power system, not just for the backup components.

In addition to monitoring power quality, the SCADA system includes continuous monitoring of fuel consumption by each generator and the level of fuel in every tank. With SCADA, an operator can easily monitor and control a facility's entire power system using full-color "point and click" interactive computer-screen displays at the system console.

For example, the operator can access and change the system's PLC setpoints,

display any of the analog or digital readouts on switchgear front panels, run a system test, or view the alarm history. A dynamic one-line diagram display uses color to indicate the status of the entire power system, including the positions of all power switching devices. Operating parameters are displayed and updated in real time; flashing lights on the switchgear annunciator panel also flash on the SCADA screen. Event logging, alarm locking, and help screens are standard.

The SCADA is so sensitive that it detects and explains even the slightest anomaly, including those in the utility feeds," says Byron Taylor, the hospital's lead power plant operator. "A number of times we've called Tampa Electric Company (TECO) because we saw something happening, and they had no idea they even had a problem yet! The stuff the system does is phenomenal. It gives us more data than we ever need for an average day, but it's tremendous that we have it when we do need it."

REQUIRED SYSTEM TESTING

To meet state and federal regulations, backup generators must be tested every month. Thanks to the new system's capability for closed-transition transfer, the tests no longer require power interruptions that interfere with hospital loads.

The system allows operators to carry out the tests in two different ways. They can parallel the output of all seven generators to the utility feed, or they can test one generator at a time, up to its full output, using a special 2-megawatt (MW) load bank that has an independent control panel. Testing can be initiated manually or through SCADA.

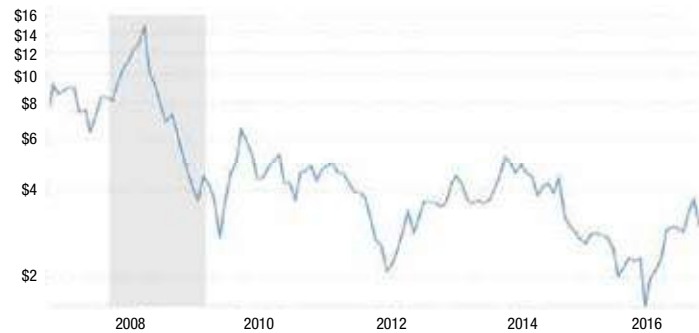
"It's so much easier now," says Hagen. "We'll never again have to pay a testing firm to come out and test an engine to make sure it meets all the requirements." Unlike most hospitals, Haley has the luxury of four utility feeds. On a normal day, it draws from two of these (primary) feeds. This means that, except for testing, Haley does not have to start its generators until it loses three or more utility feeds.

(continued page 22)

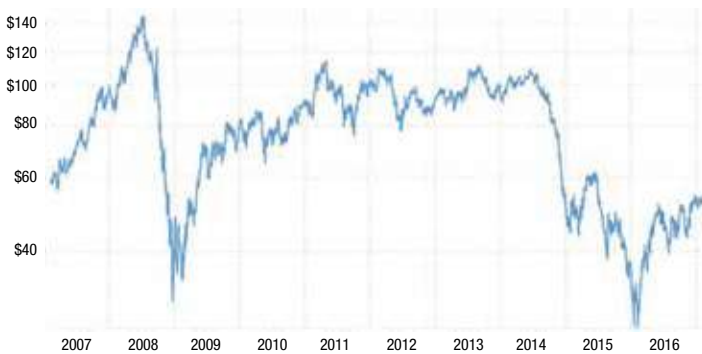
RENEWABLES SLAY INFLATION

BY JOHN MORAN

Have Renewable Energy and fracking put the inflation genie in the bottle for the foreseeable future? There is an argument to be made that structural changes in the energy market brought about by the precipitous cost declines in wind, solar and natural gas have put an upper ceiling on the price of oil. Since energy and oil are embedded in the cost of almost everything it would follow that the risk of inflation rising due to energy prices, as we saw in the 1970's, is no longer probable. The marginal cost of electricity is being set by the price of natural gas. Due to the proliferation of fracking in the United States, and now spreading throughout the world, the price of natural gas has plummeted:



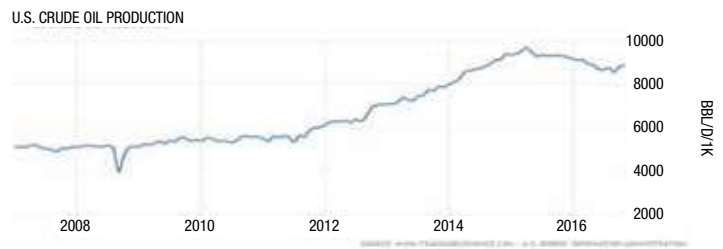
The price of oil has also dropped significantly and has been trading between \$40 and \$60/barrel for the last two years:



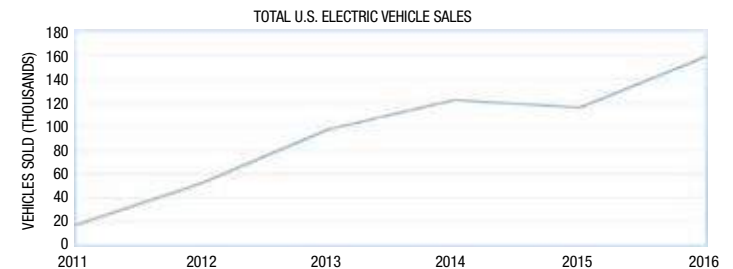
The Oil Markets have been fundamentally changed by the resurgence of US Oil Production associated with fracking. The United States has become the swing producer for oil and is no longer at the mercy of OPEC. Furthermore, Oil production in the United States associated with fracking, as opposed to traditional drilling, is much easier to “turn on and off” as prices change. The slump in prices below \$30 in 2015 caused some of the wells to be “out of the money” so they were simply capped and turned off.

While the price was low the industry figured out how to drive production up, costs down and brought the breakeven price for these wells lower and lower. Now that the price has risen back over \$50 a barrel, the spigots are being turned back on. A lot of these

unconventional oil plays are now profitable at well below \$40/bbl. The United States is becoming Energy Independent:

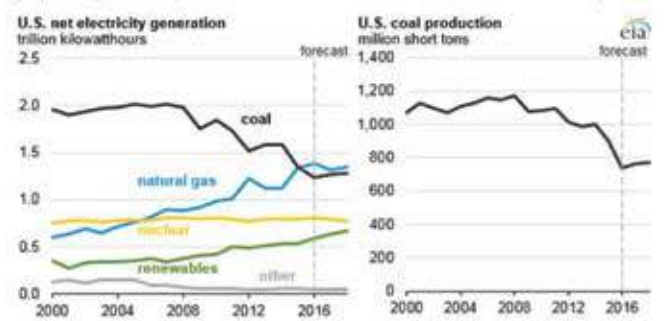


As Domestic Supply has increased dramatically over the last 5 years, demand for oil as a ground transportation fuel is set to plateau if not decrease. Corporate Average Fuel Economy Standards (CAFE) are set to rise from 27 miles per gallon in 2011 to over 50 miles per gallon in 2025. So even if the price of oil doubles by 2025, the price consumers paying at the pump per mile driven will remain essentially the same. Increasing supply, flattening to decreasing demand and the emergence of electric cars all point to limits to how far the price of oil can increase. While internal combustion engines gain in efficiency, Electric Vehicles have started to take off. Sales in the US jumped 37% in 2016 to 159,139 vehicles:

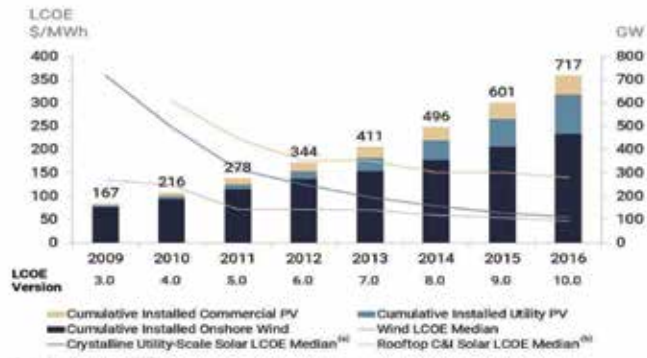


Of course air travel continues to increase and we will rely on oil for the foreseeable future but the increases in fuel efficiency standards, the electrification of transportation, the blending of 10% ethanol into most gasoline sold in the United States, the sharing economy (think Uber and Zipcar) leading to less car ownership by Millennials, and the imminent arrival of autonomous vehicles all point to a weakening of demand for oil in the United States. All of these factors should put a damper on price increases for oil.

The price of electricity in the United States adjusted for inflation has fallen 4% since 2007 and the proportion generated by Renewables and Natural Gas continues to increase at Coal's expense:



The price of solar installed has dropped from over \$8/watt in 2006 to \$1/watt in 2017. The cost of wind turbines has dropped from \$1.34/MW to \$1.12/MW over the last five years. According to Investment Bank Lazard's December 2016 Levelized Cost of Energy Analysis, the levelized cost of electricity from wind and solar are now among the cheapest available of any generation type:



In good resource locations Power Purchase Agreements for Solar and Wind are well under \$40/mwh. This is truly a game changer. Renewables have now put a cap on the price of energy. If oil were to increase in price dramatically, the market would move even faster to the electrification of transportation. If you were suddenly paying

\$5/gallon for gas the value proposition of an electric car that you can charge with cheap solar panels on your house becomes very compelling. If the price of natural gas spikes, utilities, homeowners and corporations will move to solar and wind at an even faster pace.

The price of energy, which is embedded in our food, our clothing, our manufacturing, our transportation, the list goes on, now has a ceiling. Why? Because the fuel is free. This is a turning point in the history of humanity. Large portions of the human population cannot breathe clean air due to the burning of coal (see Beijing and New Dehli). They don't need to suffer any longer, the answers are here, they are cheaper and the societal health impacts alone will be enormous. Did I mention it will also solve our Climate Change problems and allow billions of people in the 3rd world access to cheap, affordable power while employing millions? This will allow our brothers and sisters in the 3rd world access to knowledge and unlock human potential that has been waiting to be unleashed but was constrained by the lottery of where they happened to be born. The Intermittency of Renewables will be solved with battery prices that are dropping faster than the price of Solar and Wind. There is a lot to be concerned about in today's world, but it is also an extremely exciting time to be alive.

ENGINEERS SUIT UP

BY BOB PALMER

AROUND THE WORLD WITH SANTA CLAUS

There are approximately two billion children (persons under 18) in the world. However, since Santa does not visit children of Muslim, Hindu, Jewish or Buddhist (maybe in Japan) religions, this reduces the workload for Christmas night to 15% of the total, or 378 million (according to the population reference bureau).

At an average (census) rate of 3.5 children per household, which comes to 108 million homes, presuming there is at least 1 good child in each, Santa has about 31 hours of Christmas to work with, thanks to the different time zones and the rotation of the earth, assuming east to west (which seems logical). This works out to 967.7 visits per second. This is to say that for each Christian household with a good child, Santa has around 1/1000th of a second to park the sleigh, hop out, jump down the chimney, fill the stocking, distribute the remaining presents under the tree, eat

whatever snacks have been left for him, get back up the chimney, jump into the sleigh and get on the next house.

Assuming that each of these 108 million stops is evenly distributed around the earth (which, of course, we know to be false, but will accept for the purposes of our calculations), we are now talking about 0.78 miles per household; a total trip of 75.5 million miles, not counting bathroom stops or breaks. This means Santa's sleigh is moving at 650 miles per second, or 3,000 times the speed of sound.

The payload of the sleigh adds another interesting element. Assuming that each child gets nothing more than a medium sized LEGO set (two pounds), the sleigh is carrying over 500 thousand tons, not counting Santa himself. On land a conventional reindeer can pull no more than 300 pounds. Even granting that the "flying" reindeer can pull 10 times the normal amount, the job can't be done with eight or even nine of them. Santa would need 360,000 of them. This increases the payload, not counting the weight of the sleigh, another 54,000 tons, or roughly seven times the weight of the Queen Elizabeth (the ship, not the monarch). A mass of nearly 600,000 tons travel-

ling at 650 miles per second creates enormous air resistance.

This would heat up the reindeer in the same fashion as a spacecraft reentering the earth's atmosphere. The lead pair of reindeer would absorb 14.3 quintillion joules of energy per second each. In short, they would burst into flames almost instantaneously, exposing the reindeer behind them and creating deafening sonic booms in their wake. The entire reindeer team would be vaporized within 4.26 thousandths of a second, or right about the time Santa reached the fifth house on his trip.

Not that it matters, however, since Santa, as a result of accelerating from a dead stop to 650 miles/second in .001 seconds, would be subjected to acceleration forces of 17,000 g's. A 250 pound Santa which seems ludicrously slim considering all the high calorie snacks he must have consumed over the years would be pinned to the back of the sleigh by 4,315,015 pounds of force.

So is there really a Santa Claus?

Merry Christmas and Happy New Year!

EGYPT'S RENEWABLE OUTLOOK

BY DAMIAN BRANDY, IRENA

CAIRO, EGYPT - Egypt has the potential to generate up to 53 per cent of its electricity from renewable sources by 2030, according to a new report by the International Renewable Energy Agency (IRENA). The Renewable Energy Outlook: Egypt report finds that pursuing higher shares of renewable energy could reduce the country's energy bill by up to USD 900 million annually in 2030.

Renewables could cost-effectively provide up to a quarter of Egypt's total final energy supply in 2030. Achieving the higher targets would, however, require investment in renewables to grow from USD 2.5 billion per year based on today's policies to USD 6.5 billion per year. Under current plans, Egypt aims to source 20 per cent of its electricity from renewables by 2022, rising to 42 per cent by 2035. Total installed capacity of renewables in the country today amounts to 3.7 gigawatts (GW).

"This analysis offers the Egyptian energy sector a roadmap, building on current ambitions and plans, to enhance our position as an energy hub connecting Europe, Asia and Africa," said H.E. Dr. Mohamed Shaker, Egyptian Minister of Electricity and Renewable Energy. "Job creation, economic development and the growth of local manufacturing capabilities are at the heart of our renewables program, and with the support of IRENA we can pursue our plans to grow the country's installed capacity base through smart policies, and the latest renewable technologies."

Egypt can draw on an abundance of renewable energy resources to achieve higher shares of hydropower, wind, solar and biomass. To capitalize on this, the report suggests that national policy makers may benefit from periodically re-evaluating the long-term energy strategy to reflect rapid advances in renewable energy tech-

nology and falling renewable power generation costs.

"Remarkable cost reductions in renewable energy in recent years are encouraging governments all over the world to rethink energy strategies so as to better reflect the new economics of renewables," said Mr. Adnan Z. Amin, IRENA Director-General. "Egypt's renewable energy potential is vast and the Government has now moved decisively to accelerate its deployment. The Benban solar complex with its impressive scale reflects this new momentum."

"Building on these achievements, Egypt has the opportunity to further raise its ambition which entails substantially increased investments," continued Mr. Amin. "Attracting these investments requires stable policy frameworks and a streamlined regulatory environment that provides clarity and certainty for investors. Investments in renewable energy not only help to meet rising energy demand but they can also contribute to fostering economic growth, creating employment and developing local manufacturing."

(continued page 22)

SUN TAX SCRAPPED

BY TERESA RIBERA,

SPAIN'S MINISTER OF ECOLOGICAL TRANSITION

The recently elected Spanish government is set to suspend the country's controversial 7% solar tax, as moves towards renewables.

The 'sun tax' is one of the most controversial laws in Spain and was implemented by the previous government of Mariano Rajoy in 2012. It has drawn criticism because it charges Spanish homes fitted with solar panels with an additional tax of 7% to remain connected to Spain's electricity grid should the solar panels not produce enough energy. The average family home with three solar panels will have to pay around EUR 70 each month to remain con-

nected to the grid whether or not they use the electricity it generates.

Spain started its shift towards renewable energy sources in-line with an European Union directive that requires all member states to produce 20% of their energy from renewables by 2020.

"As the energy landscape of Europe alters, and climate change becoming an even more pressing topic, it is extremely positive to see Spain joining Poland and other countries in Europe in taking the right steps to move towards renewable energy," said Sun Investment Group CEO, Deividas Varabauskas. "SIG is also assess-

ing Spain as a potential market, so we are very interested in seeing how their positive shift towards renewable energy goes. We already have experience in Spain in structuring and developing a solar PV projects portfolio for 40 MW with local PPA utility company, so we are eager to start new projects in this market."

Spain's new commitment to renewable sources was also outlined by a recent EUR 450m finance package issued by the European Investment Bank, which will fund Spanish solar and onshore wind projects. Similar to Poland, which is also making the transition to solar energy, these newly funded Spanish renewable projects are expected to help the country meet its 2020 EU renewable energy targets. These plants will also substitute almost 5GW of its coal-fired capacities, which are set to be closed that year.

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MICROGRID MARKETS EXPANDING CONTINUED FROM PAGE 4

en grassroots project, the 940-kW solar system is designed to cover the current peak demand of 450 kW, currently supplied by diesel generation at 60 cents/kWh. The goal is to get off diesel, since the fuel has to be flown in. Residents experience 24 hours of sunlight during summer months and none in the winter months.

There is no process for selling power as an independent power producer in the Yukon, so an agreement to sell power to the local utility, ATCO Electric Yukon, was necessary. A 25-year contract was a key component, with a guaranteed price and market certainty, established ownership and operational requirements of system components.

The solar system design is suitable for minus 67 degrees Fahrenheit. A single axis tracker and bifacial panels failed to provide enough sunlight so back-to-back panels with east/west tracking were designed. The microgrid also includes batteries, diesel engines and a controller. Because the panels would be built on permafrost, insulation boards were laid down on the permafrost since the top three feet become slush in the summer months.

The project will be completed in May 2019 for a total capital cost of \$6 million. The Government of Yukon announced in August 2018 a \$500,000 investment in the system. The Canadian government contributed over \$2.6 million. Loans will cover additional costs. Approximately 40,000 gallons/year of diesel will be offset and revenues of \$400,000/year are expected.

Huang Lu, director of energy storage systems at Canadian Energy, described the microgrids being developed for industrial agriculture in Canada which are providing alternatives to the transmission grid. In the case study Lu presented, the 500-kW solar PV array plus a centralized battery storage capacity of 770 kWh and diesel generator backup are providing resilient and redundant off-grid power and are minimizing global greenhouse emissions generation.

Lu said each agricultural of three barns has its own storage supplied by the central energy storage system. Power is distributed through the storage system to each barn as well.

MICROGRIDS NEED GOVERNMENT HELP

Patrick Morand, a regulatory attorney with Duane Morris LLP, asked the question, who should pay for microgrids? Individual US states have different regulatory structures for community microgrids that interface with utilities and these structures may impact their financing. A little more than half of state utilities remain monopoly institutions. Less than half of them have retail competition. Morand added that a regulatory framework for microgrids hasn't been invented yet.

Alabama Power's Smart Neighborhood Project serves 62 new high efficiency homes tied to new microgrids and the local distribution grid.

In Illinois Commonwealth Edison's new Bronzville Project will serve ten community facilities, police headquarters, health clinics, schools and public works. The US Department of Energy chipped in \$5 million toward the \$25-million cost, and Com Ed rate-based the remaining costs with the approval of the Illinois Public Utilities Commission. Com Ed will not own the generation. The utility bid out the project and has agreed to develop more projects with others.

Baltimore Gas & Electric is building public purpose microgrids, but the Maryland Public Service Commission told them they could not rate-base the projects.

Morand concluded that significant contributions from state and federal agencies along with in-place policies are needed for microgrids to get built. States have rejected projects without significant contributions from state and federal agencies. He said he did not find a microgrid that was entirely owned by a community.

MICROGRIDS AS A SERVICE

Jim Dodenhoff of IPERC discussed "Microgrids as a Service" or MAAS, as a way of overcoming microgrid deployment hurdles. It is a new trend in project ownership which has shifted from 92% of microgrids owned by end users to 44% in 2017.

Third parties now own 46% of microgrids, he said, with utilities owning 4% of the microgrids being built.

A MAAS module incentivizes operations and maintenance optimization. A third party covers all ancillary services costs and sales of the power and builds the project.

All elements of the power purchase agreement are provided by the investor who also provides the funding.

MAAS providers are driven to retaining institutional memory. Contracts can include O&M performance metrics with a financial kickers and penalties if the project fails.

This illustrates how the market is becoming more complex, Dodenhoff told the audience, and energy storage is becoming a standard element of that market.

Meanwhile, investors are becoming more comfortable with microgrids being built "on someone else's nickel" Dodenhoff said. Risk is transferred to MAAS and the host can focus on his or her core business. Resiliency is foundational to microgrids. It can solve some reliability problems but not all of them.

The MAAS owner has motivation to stick around and follow the life of the microgrid since a new technology cannot operate if the supplier goes away for a year, says Dodenhoff.

Dodenhoff said he is encouraged by the reoccurrence of a more holistic approach and to managing load first with energy efficiency initiatives.

2019 INDUSTRY CHALLENGES CONTINUED FROM PAGE 6

pass quality RFPs to identify the best new resources and at locations that will be attractive to their system costs. In some cases, utilities may even reduce their T&D costs and new or replacement build costs. Many utilities will focus on the last mile and controlling the customer interface.

New regulatory compacts for utilities will take time to nurture and develop. The best utilities will work with regulators to design important incentives for new distribution assets that help avoid unnecessary costs and encourage new resources that are the most competitive.

Corporate customers will likely work with multiple suppliers to obtain the best renewable supplies at cost-effective pricing at or below long-term avoided costs. Many buyers seek to improve resiliency, lower energy costs, and reduce their carbon footprint. New technologies have driven down costs and corporate customers are expected to continue to be relentless in their drive for lower cost energy.

The best corporates, utilities and developers will work together for the good of local communities and jobs.

Suppliers will seek to differentiate themselves on the bases of the best products at the best price. Availability of product and avoidance of tariff disincentives will also be factors. The cost declines expected by the industry will be a challenge to all suppliers.

The overall opportunity is to create winning value propositions in this challenging environment. Leading companies recognize and respond to challenges and usually find a way to be optimistic about their chances of success. When put in context, Churchill faced a greater challenge than we do today.

NEW BATTERY DEVELOPED CONTINUED FROM PAGE 12

The researchers are also investigating the possibility of developing a continuous-operation version of the process, which would use a steady stream of carbon dioxide under pressure with the amine material, rather than a preloaded supply the material, thus allowing it to deliver a steady power output as long as the battery is supplied with carbon dioxide. Ultimately, they hope to make this into an integrated system that will carry out both the capture of carbon dioxide from a power plant's emissions stream, and its conversion into an electrochemical material that could then be used in batteries. "It's one way to sequester it as a useful product," Gallant says.

EGYPT'S RENEWABLE OUTLOOK CONTINUED FROM PAGE 18

ABOUT THE INTERNATIONAL RENEWABLE ENERGY AGENCY (IRENA)

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international co-operation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. With 159 Members (158 States and the European Union) and 24 additional countries in the accession process and actively engaged, IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy.

POWERING FLORIDA VA HOSPITAL CONTINUED FROM PAGE 15

With advance notice from the utility that an outage is likely, Haley's power plant personnel can now parallel the utility feeds with their own generators, then switch to on-site power seamlessly with a closed-transition transfer. If there is an unexpected outage (and during automatic transfer switch testing), there will be a 1 to 10 second "blip", depending on the load. For life-safety and other critical loads, the blip is only 1-3 seconds. Blips for other loads are adjustable; most are set for 8-10 seconds.

ADDITIONAL CAPABILITIES

The new power system provides many more capabilities than the previous system.

"We've had some storms come through, and it has been really nice because we do not have to worry," says Taylor. "One time, we saw the storms coming and TECO asked us to drop off the grid. We fired up our generators, and we operated on our own power for 17 hours, while TECO concentrated on restoring power to its residential customers. That sort of thing has happened several other times for shorter periods, and there has never been a problem." Hagen particularly appreciates the quality of the power from the backup system. "We get more blips from TECO than we do from our system," he notes. "It is exceptionally smooth."

MEETING HOSPITAL'S FUTURE NEEDS

The fact that the system is designed to allow for modifications as the hospital continues to grow is a huge benefit. Concludes Taylor, "With this new power system, we have seen what is possible. It provides us with the information we need to analyze our power usage and consider new possibilities – opportunities we never would have considered before."

BATTERY STORAGE MARKET CONTINUED FROM PAGE 8

emerging that pair storage with conventional gas turbine generation to deliver a more rapid response, milder ramp rates, fewer starts and stops and emissions reductions.”

SHORING UP RESILIENCY AND POWER QUALITY

Here’s another trend supporting the growth of storage systems: the growth of microgrid deployments. Several factors contribute to this. Among them, you’ll find reduced costs. Peter Asmus, a Navigant Research analyst who has been tracking microgrids for nine years, recently told the Microgrid Knowledge news site that, “overall costs for microgrids have declined by 25-30 percent since 2014.” These declines, he said, were “focused on solar, wind and battery storage technologies.”

In addition, microgrids have become a component of resiliency planning in several states, including New York and New Jersey, after they kept lights burning in a few sites surrounded by blackouts during Hurricane Sandy in 2012. Not surprisingly, 62 percent of utility staffers who responded to Black & Veatch’s 2018 Strategic Directions: Electric Report survey either have built a microgrid, are developing a microgrid or have included microgrids on their technology roadmap.

Asked what they felt were major benefits of microgrids, 56 percent of survey respondents picked “improved reliability and resiliency for critical customers,” while 53 percent picked “Improved reliability and resilience for a group of customers (e.g., a feeder or substation).” Integrated distributed generation also was a winner; 39 percent of respondents cited it as a benefit.

RIDING REGULATORY WAVES

Joining renewables and microgrid growth as drivers of the storage market, a number of regulatory factors contribute to potential growth.

In California, a new building code requires that homes constructed after 2019 have built-in solar power. This power can come from installations on individual homes

or shared systems for a collection of homes. “Once all the homes in a newly constructed subdivision or neighborhood are equipped with solar, it makes sense to add microgrid storage that would deliver backup power in case of an outage,” wrote Jason Abiecunas and Wes Denton in a chapter of the 2018 Strategic Directions: Electric Report.

Abiecunas and Denton also point to the Federal Energy Regulatory Commission (FERC) Orders 841 and 845 issued earlier this year. These remove barriers preventing energy storage technologies to enter U.S. power markets. The new rules are designed to “enhance competition and promote greater efficiency in the nation’s wholesale electric markets and will help support the resilience on the bulk power system,” according to FERC.

As Abiecunas and Denton note, “Observers say the new rules will open the floodgates for energy storage companies to compete in wholesale power markets. One research report predicts that energy storage will become competitive with gas-fired peakers in five to 10 years. In certain applications, such as ancillary services or peak shaving, energy storage is competitive with fossil-fueled alternatives now. The FERC decision is expected to spur innovation that should translate into further price declines.”

Given these conditions, the Energy Storage Monitor research team now expects the U.S. storage market to reach \$541 in 2018 and cross the billion-dollar mark in 2019. “Surging deployments will result in a jump in total market size, with the market more than doubling between 2018 and 2019 and then doubling again between 2019 and 2020. The market size will reach \$4.6 billion by 2023,” the Q3 Storage Monitor report says.

Clearly, storage isn’t an emerging technology anymore. Today, energy storage is proven and ready for business.

The Black & Veatch 2018 Strategic Directions: Electric Report is part of a larger, ongoing research initiative in which Black & Veatch regularly surveys industry participants and analyzes responses in a report that consists of multiple chapters

covering various topics. Black & Veatch’s 2018 Strategic Directions: Electric Report explores the progress made by the electric utility industry as it adapts to the changing power-sector landscape.

ABOUT THE AUTHOR

John Chevrette has more than 20 years of industry consulting experience and has worked with domestic and international clients in the electric utility, energy technology, gas pipeline, telecommunications and water industries.

GLOBAL RENEWABLE TRENDS CONTINUED FROM PAGE 10

global corporate procurement, signaling an important commitment from the private sector.

Wide-scale integration of renewable energy sources is no longer a question of if, but when: Countries such as China, the United States, and Germany have already reached price parity for certain renewable sources. With prices continuing to drop, developed countries and emerging markets alike have the ability to integrate renewables into their grid systems to ensure competitive advantage.

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