State of the Grid

4TH QUARTER 2019

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WELCOME TO OUR Q4 NEWSLETTER!

Now more than ever, we are all witnesses to the transformative changes in the way electricity is produced, transmitted, managed, transacted and used. It's an exciting time and essential for all of us to understand and evaluate the emerging trends that could transform the grid further.
My hope is that our newsletter highlights some of the trends - like decarbonization, digitalization and decentralization - and provides a bit of intellectual stimulation along the way.

Thank you for reading!
Dr. Mani Vadari, President

AT MODERN GRID SOLUTIONS, SMART GRIDS ARE BUSINESS AS USUAL

Differentiated services to utilities and their vendors focusing on Smart Grid and System Operations. Our team brings deep expertise in all aspects covering technology and management consulting.

IN THIS ISSUE

UMASS Smart Grid Course using Mani's Book as Text

- **Course**: ECE 697/597 SG, Smart Grids
- **Instructor**: Prof. Kishore Nudurupati
- **Enrollment caps**: 20 (grad) + 10 (undergrads)
- **Time**: Mon, Wed at 4:00 - 5:15 pm
- **Prerequisites**: Knowledge of circuit analysis, basic calculus and differential equations, elementary matrix analysis and basic computer programming and desirable to have a knowledge of Power System Analysis

The course addresses developments in Evolving Developments in Grids to Smart Grids, including: Smart Grid Definition, Components, Communication protocols and Infrastructure, Distributed Automation, Smart Meters, Smart Devices, Distributed Energy Resources and integration challenges, Microgrids, Energy storage, Electric transportation, Data Analytics for grid Operations, Restructured Electric Supply.

INDUSTRY ITEMS

Exclusive 30% Discount!

The 2nd edition of Mani Vadari's book, Electric System Operations: Evolution to the Modern Grid is available now. You can save 30%, plus FREE shipping with promo code: **VAD30**. Hurry, offer expires February 29, 2020.

Industry Events

- DistribuTECH 2020, January 28-30 in San Antonio, TX. Both JD Hammerly and Mani Vadari will be onsite. Contact Mani to schedule a meet-up.
- India's Smart Utilities Week, March 3-7 in New Delhi.
- Microgrid Global Innovation Forum, North America, March 10-11 in Chicago. Use discount code **MGS20** for 20% off when registering online.

You May Be Interested in…

Mani Vadari is one of the guest editors of *IEEE Power & Energy Magazine*'s January/February 2020 issue titled, "Advanced Distribution System Applications." This edition includes a broad variety of articles written by personnel from utilities, vendors, university researchers, as well as a perspective from the U.S. Dept of Energy. The editorial from Dr. Vadari sets the framework for the magazine as well as defining a point of view on the future of Distribution Operations and Planning.

MERGERS AND ACQUISITIONS

Acciona acquires 3GW pipeline of U.S. solar projects from Tenaska

Global renewable energy developer Acciona (headquartered in Spain) has signed an agreement with Omaha, Nebraska-based energy developer Tenaska to acquire a portfolio of greenfield solar and energy storage projects in the United States. The development portfolio comprises approximately 3 GW of utility-scale solar and 1 GW of co-located solar and energy storage. The transaction includes 20 solar projects in the PJM Interconnection and Southwest Power Pool (SPP) markets. The portfolio represents a large, diversified solar and storage development pipeline in seven states, including Pennsylvania, Ohio, Kentucky, Illinois, Missouri, Kansas and Oklahoma.

PSEG plans to acquire 25% of 1.1GW ocean wind offshore project

Ørsted and New Jersey utility Public Service Enterprise Group (PSEG) announced they will enter into exclusive negotiations for PSEG to potentially become an equity investor in one of Ørsted's offshore wind projects. Subject to negotiations, PSEG would acquire 25 percent of Ocean Wind. Ocean Wind is a 1,100-MW offshore wind project which will supply more than half a million New Jersey homes with clean power from its location 15 miles off the coast of Atlantic City. Subject to permitting and final investment decisions, Ocean Wind is expected to be commissioned in 2024.

Southern Power acquires 136MW Washington wind project

Southern Power, a U.S. wholesale energy provider and a subsidiary of Southern Company, announced the acquisition of its 12th wind project, the 136-MW Skookumchuck Wind Facility, from Renewable Energy Systems (RES). The project, located in Lewis and Thurston Counties, Washington, is Southern Power's first wind facility in the state. Skookumchuck was developed by RES and is expected to use 38 wind turbines manufactured by Vestas. Construction is underway, and the project is expected to achieve commercial operation in Q1 2020. Once operational, the electricity and associated renewable energy credits generated by the facility will be sold under a 20-year power purchase agreement with Puget Sound Energy, which will use the resource to meet the electricity demand of their Green Direct product customers. Southern Power is the majority owner and has signed an agreement to sell a minority stake in the facility to TransAlta Corporation upon commercial operation.

IPKeys acquires cyber monitoring company N-Dimension

IPKeys Power Partners, a provider of integrated technology solutions for intelligent utilities and smart cities, announced that it has acquired N-Dimension Solutions Inc., the public power sector leader in cyber security monitoring with over 100 utilities served. Ontario based N-Dimension will merge into the IPKeys platform while continuing to serve current customers. The transaction included an equity investment in IPKeys by EnerTech Capital, a venture capital firm focused on energy innovation and technology in areas including Network/Grid Edge, Industry 4.0 and Mobility. The acquisition adds a robust cyber threat detection and remediation capability to IPKeys' existing Cyber Lab as a Service (IPKeys CLaaS™) which provides a broad range of cybersecurity services and solutions to utilities and large municipal and public safety organizations throughout North America. Earlier this year IPKeys Power Partners acquired SigmaFlow to add an automated NERC-CIP compliance capability to their CLaaS offering.

Total Safety acquires Pacific Coast Tool to expand its presence in the power utility segment

Total Safety, a leading provider of integrated safety technologies and services, announced that it has acquired Pacific Coast Tool (Pac Coast) to expand its distribution offerings to power utility customers. Pac Coast is based in Southern California serving utility and industrial customers with supplies, tools and safety products. Pac Coast will operate and be integrated under Total Safety's specialty distribution business unit, which operates under the S&S Supplies and Solutions brand.

Shell to Buy French Offshore Wind Power Developer

Royal Dutch Shell Plc has agreed to buy French offshore wind developer Eolfi SA, continuing its expansion into renewable power.

Shell is boosting spending on low-carbon energy as it faces pressure to address the risks climate change poses to its business. Shell's biggest renewable bets so far have been on acquiring retail customers, through the purchase of a U.K. utility and an electric car charging company. Eolfi has a foothold in one of the most developed markets for floating wind projects, in the shallow waters off France, which could give Shell the experience and expertise it needs to boost investments in the technology.

EDF buys UK electric vehicle charging firm Pivot Power

French state-controlled energy group EDF has agreed to buy Pivot Power, a British start-up company that specializes in battery storage and infrastructure for electric vehicle charging points. Pivot Power is looking at the means to host a battery capable of exporting 50 MW of power and to provide support for hundreds of fast electric vehicle chargers which could be suitable for large retail sites, logistics centers, and bus depots. The takeover of Pivot Power also follows EDF's acquisition in September of U.S. electric vehicle technology company PowerFlex Systems.

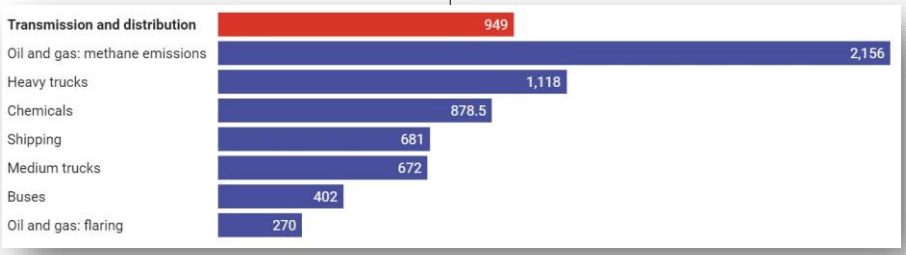
LS Power to acquire EVgo

LS Power, a U.S. power and energy infrastructure owner, announced that it has signed a definitive agreement to acquire EVgo from Vision Ridge Partners. EVgo is the nation's largest and most reliable public fast charging network for electric vehicles and will continue to operate as a stand-alone entity under the LS Power umbrella of companies. The transaction is expected to close in early 2020 and financial terms were not disclosed. Founded in 2010, EVgo is a market leader in developing, building, owning and operating the largest electric vehicle fast charging network in the United States. Its industry-leading footprint of more than 750 sites includes over 1,250 fast chargers and extends across 34 states.

KEY HIGHLIGHTS

More carbon emissions come from lost electricity than the chemical industry

Inefficient global power transmission and distribution infrastructure requires additional electricity generation to compensate for losses. And countries that have large shares of fossil fuel generation and inefficient grid infrastructure, or a combination of the two, are the predominant culprits of what is called "compensatory emissions." These emissions are the result of the extra electricity – often generated from fossil fuels – required to compensate for grid losses. In a recent article, authors calculated that worldwide, compensatory emissions amount to nearly a billion metric tons of carbon dioxide equivalents a year, in the same range as the annual emissions from heavy trucks or the entire chemical industry. In surveying 142 countries' transmission and distribution infrastructures, the authors also determined that approximately 500 million metric tons of carbon dioxide can be cut by improving global grid efficiencies (see image below).



Annual emissions measured in millions of metric tons of carbon dioxide equivalents.
Chart: The Conversation, CC-BY-ND

ComEd customers experienced record-setting reliability this summer

While the summer of 2019 set records for heat and brought severe storms, ComEd customers stayed cool thanks to record-setting reliability during the season, per a Company press release. ComEd has avoided more than 13 million customer interruptions since 2012, due in part to smart grid and system improvements. The avoided outages have resulted in $2.4 billion in estimated savings to society. In addition to keeping energy flowing for residents, strong power reliability continues to help persuade businesses to expand in northern Illinois and Chicago. The GridWise Alliance recently recognized Illinois as the No. 2 state in the nation for its smart grid implementation.

PJM announces new CEO

The nation's largest electric grid operator tapped a former senior executive with a power and natural gas competitive supplier to be its next CEO. Manu Asthana, who was the president of Direct Energy Home in North America, will take over the reins of PJM Interconnection on January 1. He replaces Andy Ott, who left PJM at the end of June after more than three years as president and CEO. During Ott's tenure, PJM had challenges associated with its markets at the Federal Energy Regulatory Commission and at some state legislatures that acted on policies stepping into PJM's market functions. PJM oversees the grid and power market that deliver electricity to 65 million customers in 13 states in the Mid-Atlantic and parts of the South and Midwest.

KORE Power to build 10 GWh battery manufacturing plant in the U.S.

In a press release, the company announced that the new one million square foot facility will be used to manufacture and produce the company's Mark 1TM Energy Storage System using state-of-the-art, fully automated battery assembly lines and processes. Once completed, the plant will have 10 GWh of highly scalable manufacturing capacity that will meet the rapidly growing market demand for customized industrial battery solutions. Currently, KORE Power is reviewing specific potential sites in a handful of states within the U.S. as part of its process to select the best location for the construction of its manufacturing plant. KORE Power has narrowed the search down to sites with broad access to labor and logistics hubs. Once established, KORE Power's manufacturing plant will create over 2,000 new jobs in a variety of business segments including production, shipping & logistics, customer service and more, it says.

Solar, wind and battery prices continue to fall

Tracking the Sun (PDF) is an annual report from Berkeley Lab on installed solar panel prices and other trends among grid-connected, distributed solar PV systems in the U.S. Just as the cost of solar and wind energy has dropped in recent years, the price of battery energy storage is also declining—with a 76 percent drop in U.S. prices since 2012 (see image to left). While prices of battery-plus-solar technologies are not yet cheaper than other generation technologies, it is worth considering the present value they may add in mitigating financial losses from grid outages. Installed prices vary widely among states but the U.S. DOE's Solar Energy Technologies Office aims to reduce the cost of PV-generated electricity by about 75 percent between 2010 and 2020, and by an additional 50 percent from the 2020 goal by 2030.

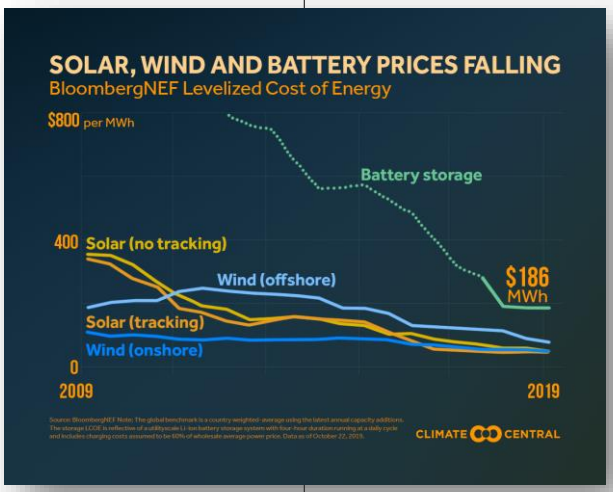


Image source: Climate Central

Germany to close all its nuclear power stations in next two years

Germany will take another step toward completing its withdrawal from nuclear power when EnBW shuts down the Philippsburg 2 power station on New Year's Eve, leaving half a dozen plants still to close over the next two years. The government decided to shut down the 17 reactors in operation at the time of Japan's Fukushima nuclear disaster in 2011, when a tsunami flooded the coastal facility and knocked out its backup generators. Industry association BDEW estimates that nuclear reactors accounted for about 12 percent of German power generation in 2019, down from 30 percent in 2000. Over the same period, the share of power from renewable sources has risen to 40 percent.

Engineers calculate ultimate potential of next-generation solar panels

Double-sided solar cells are already enabling panels to sit vertically on land or rooftops and even horizontally as the canopy of a gas station, but it hasn't been known exactly how much electricity these panels could ultimately generate or the money they could save. A new thermodynamic formula reveals that the bifacial cells making up double-sided panels generate on average 15-20 percent more sunlight to electricity than the monofacial cells of today's one-sided solar panels, taking into consideration different terrain such as grass, sand, concrete and dirt. The formula, developed by two Purdue University physicists, can be used for calculating in minutes the most electricity that bifacial solar cells could generate in a variety of environments, as defined by a thermodynamic limit. In a paper released in the Proceedings of the National Academy of Sciences, Muhammed Alam and coauthor Ryyan Khan likewise demonstrate how the formula can be utilized to calculate the thermodynamic limitations of all solar cells established in the last 50 years. These outcomes can be generalized to technology most likely to be established over the next 20 to 30 years. The hope is that these estimations would assist solar farms to take complete benefit of bifacial cells previously in their usage. Full Purdue article here.

Pros and cons of using floating solar panels on hydro reservoirs

In a recent two-part article series featured on *CleanTechnica*, author Michael Barnard covers the advantages and disadvantages of floating solar on pumped hydro including evaporation control, panel efficiency, reuse of transmission connections, volatile water levels, shadowed reservoirs, water movement, and relative cost. The combination of these factors suggests that floating solar is limited in terms of the number of pumped hydro sites it would be suitable for. In general, it comes down to a hot, arid climate where the evaporation control and improved efficiency are stronger positives and sites where a broader turkey's nest reservoir is suitable. While solar on hydro is not an open and shut case generally, it's an interesting option in certain areas.

DTE Energy establishes renewable arm

In early November, U.S. energy company DTE Energy based in Detroit, MI, announced leadership changes designed to accelerate renewable energy investments. Following prior commitments to triple its renewable energy capacity over the next decade and reach net zero carbon emissions by 2050, DTE Energy considers its renewable energy future important and demanding enough to set up a renewables arm that will be responsible for all aspects of its clean power business.

U.S. wind power reaches milestone 100 gigawatts

There are now more than 100 gigawatts (GW) of wind farms operating across the U.S., enough to power 32 million American homes, marking a major milestone in the transition to a cleaner electricity supply. The 100 GW milestone was first reported in the American Wind Energy Association's (AWEA) U.S. Wind Industry Third Quarter 2019 Market Report. More than half of the wind capacity has been installed in the past seven years with Texas having the most of any state at nearly 27 GW. The next closest state is Iowa with nearly 9 GW of wind energy capacity. Wind energy producers are expected to add over 14 GW of capacity next year. If that happens, the U.S. will have about 122 GW of wind capacity by the end of 2020 according to the DoE.

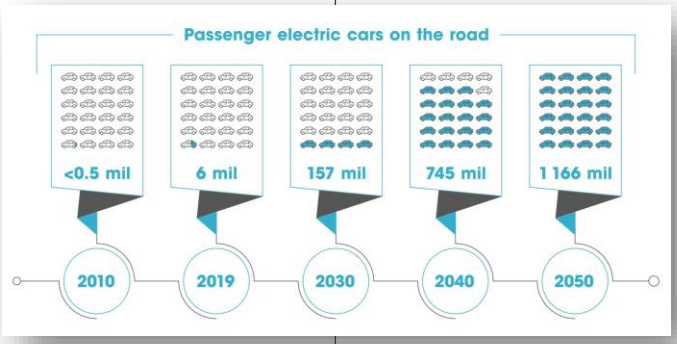
Reservations for Ford's First Edition Mustang Mach-E are full

The No. 2 U.S. automaker unveiled the electric Mustang crossover on Nov. 17, and began taking reservations with a refundable deposit of $500. Ford did not provide details on how many reservations it took, but has said global production in the first 12 months after its launch is limited to 50,000 vehicles. More than 80 percent of U.S. customers are reserving Mach-E with an extended range battery, while about 55 percent opted for an all-wheel drive, Ford said. More than 25 percent of the reservations are from California, with nearly 30 percent of U.S. customers choosing Mach-E GT, the company said.

IRENA's Enabling Technologies: Innovation Landscape report released

The International Renewable Energy Agency (IRENA) released its Enabling Technologies: Innovation Landscape report (PDF) in September. The full report includes comprehensive briefs on six enabling technologies which IRENA says will likely play critical roles in the utility of the future. The six technologies are:

1. Utility-scale batteries, also known as front-of-the-meter batteries;
2. Behind-the-meter (BTM) batteries;
3. Electric vehicle (EV) smart charging;
4. Internet of Things (IoT);
5. Artificial intelligence (AI) and big data; and
6. Blockchain.



Growth in EV deployment between 2010 and 2050 in Paris Agreement-aligned scenario. Image source: IRENA 2019b

There are many insights throughout this report. One interesting visual illustrates that if most of the passenger vehicles sold from 2040 onwards were electric, more than 1 billion EVs could be on the road by 2050 (see image to left). IRENA analysis indicates that future EV battery capacity may dwarf stationary battery capacity. In 2050, around 14 terawatt-hours (TWh) of EV batteries would be available to provide grid services, compared to 9 TWh of stationary batteries.

FEATURED ARTICLE

The Modern Grid's Role in Climate Mitigation and Adaptation

By Dr. Lawrence Jones, VP International Programs at EEI

There are increasing calls for urgent actions to address the accelerating pace of change to our climate and its cascading impacts around the world. Global temperature rise, warming oceans, shrinking ice sheets, glacier retreats, sea level rise, and extreme events[1] are just some of the undeniable indicators that climate change is upon us. Unless actions are taken, consequences will be devastating for current and future generations. Unlike other challenges whose impacts can be constrained to an isolated part of the world, directly or indirectly, no country or region of the planet is 100 percent insulated from the myriad of negative impacts from climate change. Consequently, all actions, big or small, that help us mitigate or adapt are indeed welcome.

Energy grids across the world are becoming increasingly vulnerable and are at risk due to extreme weather events that are attributed to climate variation. The reliability and resilience of these systems can be weakened as design parameters and operational limits are exceeded. Built for past decades and under a different operational paradigm, current and new energy grids are now being designed subject to new constraints, using new architectures and technologies. This new design paradigm is enabling modernization of the grid and smarter energy infrastructure along the energy value chain.

The energy industry is already is responding to the urgent climate clarion call with actions that take advantage of its smarter energy infrastructure to ultimately increase the use of cleaner energy. Globally, electric companies' total renewable energy generation capacity integrated into the energy supply mix reached 2,351 GW at the end of last year – around a third of total installed electricity capacity.[2] Many electric companies have stated their targets and timeline for reaching net-zero carbon emissions.[3] In the United States, between 2010 and the first quarter of 2019, power companies announced the retirement of more than 500 coal-fired power units, totaling about 102 gigawatts (GW) of generating capacity. Plant owners intend to retire another 17 GW of coal-fired capacity by 2025, according to the U.S. Energy Information Administration's (EIA).[4]

Many electric companies are investing in grid modernization by engaging in vulnerability assessments and creating resiliency plans that take into account potential extreme weather events. A range of resilience measures may be available either to reduce the probability of damage or disruption (e.g., hardening and relocating assets) or to reduce the business consequences of any damage or disruption (e.g., recoverability and risk transfer/insurance).

Perhaps some of the most valuable smarter technologies for a modern grid are predictive analytics and tools for asset management to increase system reliability and resilience. Smart condition monitoring devices can be integrated via communications protocols to bring real-time condition data into the control room for analysis. Applications exist to consolidate all asset-related data (e.g. manual records, inspection reports, data from the EMS itself) to produce advanced strategies – not only to help define optimum maintenance schedules, but also to provide early warning signals and avoid potentially harmful situations. With better control of asset behavior, network reliability analysis and situational awareness of the grid can be operated in a more consistent manner, closer to the true limits of the assets. Advanced predictive tools also can help to identify the risks of wild fires and other extreme weather events. In addition, technologies based on artificial intelligence, robotics, virtual reality, and augmented reality can be used to improve the speed and quality or system restoration after extreme events.

In the long term, modernization of the energy grid through the deployment of smarter technology and increased use of advanced materials (e.g., nanotechnology, superconductors, graphite, etc.) will result in smaller and more efficient grid equipment, which in turn will accelerate the pace to achieving substantial carbon emissions reduction and net-zero emissions goals. The energy grid's capability to contribute to climate adaptation also may be heightened by wireless sensor networks that enable better sensing of the physical grid as well as the surrounding environment.

Ultimately, for smart energy infrastructure to aid climate adaptation, the regulatory framework which governs the operation of energy networks must adapt to the new conditions. Policy makers around the world are becoming more aware of this and some are implementing new policies to promote climate adaptation enabled by modernizing the grid. Furthermore, the electricity industry worldwide must continue to engage with a broad array of stakeholders and talk about the need for and value of greater and cleaner electrification to the world.

Dr. Lawrence Jones, *Vice President, International Programs at Edison Electric Institute*

[1] https://climate.nasa.gov/evidence/

[2] https://www.irena.org/newsroom/pressreleases/2019/Apr/Renewable-Energy-Now-Accounts-for-a-Third-of-Global-Power-Capacity

[3] https://insideclimatenews.org/content/chart-utilities-emissions-cutting-plans

[4] https://www.eia.gov/todayinenergy/detail.php?id=40212

FEATURED ARTICLE

IoT: The Electric Grid's Final Frontier

By Sridhar Chandrashekar, Jake Varghese and Mani Vadari

As the grid evolves, the biggest changes are happening at the edge. People are installing roof solar panels, buying electric vehicles (EVs), installing home and building automation. These new categories of smart devices require a robust software backbone to help monitor and control the devices. For a utility, all of this is leading to an increased amount of uncertainty in basic things such as generation (from solar panels), load (smart homes and buildings, EVs). These grid edge technologies belong to a broad genre under the moniker of the internet of things (IoT). They generate massive volumes of data often inaccessible by the people responsible for monitoring and operating the grid, thereby leaving them bereft of critical operational insights.

IoT Refresher

IoT is a global system of devices, sensors, actuators, and controllers, interconnected and operating over computer networks and accessible over the internet.

IoT is the central nervous system of the connected world ushering in unprecedented visibility and awareness into the operational behavior, health of all systems in this connected workflow. IoT enables rapid, ongoing data-driven intelligent decision-making that is transforming all industries and segments. IDC predicts an installed base of 212 billion connected things by 2020. GlobalData forecasts spending on IoT technologies will reach US$318 billion by 2023.

A successful IoT strategy starts with targeted proofs of concept that rapidly demonstrate value allowing for investment to scale quickly. An IoT platform that seamlessly scales from proof-of-concept to enterprise-grade workloads is a key success indicator.

A high performing IoT Platform includes:

- Device authentication and connectivity
- Intelligent edge processing
- Hyperscale cloud services
- Responsive user interface
- Predictive, preventative analytics and actionable insights
- Automated end-to-end monitoring, fault detection and remediation
- Integrations with existing enterprise applications
- Rapid Application Development

Use Case: Nano/Microgrids

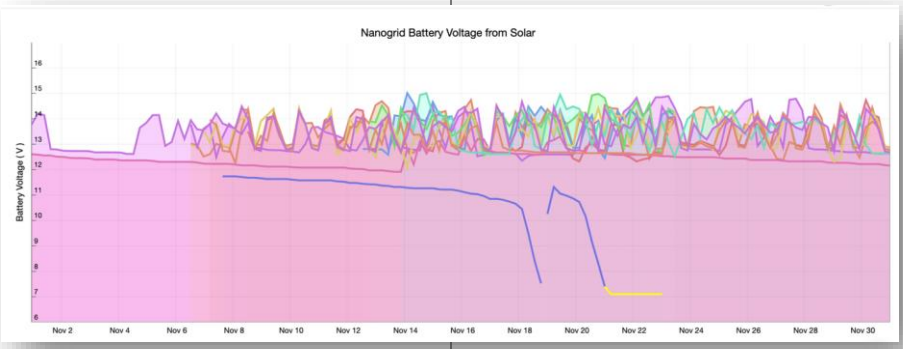
A microgrid is a localized group of electricity sources and loads normally operating connected to and synchronous with the traditional distribution grid (macrogrid) but can also disconnect and function autonomously as geographical or economic conditions dictate. A nanogrid is smaller; its scope involving powering most components in a house.

A typical nanogrid includes:

- Energy sources such as solar panels or diesel generators
- Batteries to store energy
- A charge controller to regulate voltage and current generated by the solar panel
- Charging outlets to power appliances such as lights, cellphones, and refrigerators
- Keeping energy production humming and effective requires 24x7 monitoring of overall system health and, if remote, the landscape and distances makes physical access to the system by licensed technicians impractical.

A cloud-based, automated, real-time remote operations management system continuously monitors the system and proactively detects situations that could compromise system efficacy. It conducts automated root cause analysis and sends automated alerts with relevant operational logs to engineers who review the data, troubleshoot situations remotely, and determine if a system has deviated from normal behavior.

The figure below shows multiple pieces of real-time information plotted over various time horizons. Notice the blue line dipping precipitously portending an impending failure scenario. Engineers can remotely define precise instructions for local technicians arming them with specific details needed to solve the problem.



In return, the end user's service experience is seemingly uninterrupted availability of their nanogrid.

Conclusion: Journey into the Final Frontier

With maturing technologies, enterprise and consumer expectations regarding IoT are rapidly evolving and becoming mainstream. Energy service and other providers need to determine mechanisms to leverage insights generated from always-connected systems.

Consumers are increasingly becoming sophisticated and leveraging network connected, distributed energy resources (DERs) to not only address their energy needs independently but also become energy producers.

IoT and IoT-enabled platforms are making a difference in developing and underdeveloped economies by bringing remote monitoring and analytics capabilities to support electrification which in turn raises the economic productivity of those historically disenfranchised communities. All of this sets us up well in the fight against climate change where optimization of energy usage leads to reduction in CO2 levels. Technologies exist today to support these capabilities and add significant flexibility in data management and interfacing with other enterprise systems.

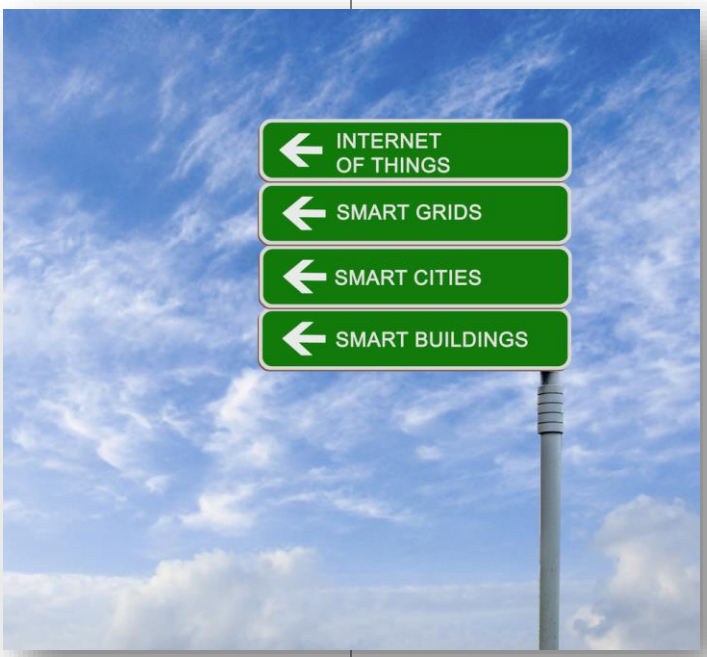
The full version of this article is available T&D World's online publication. Please check it out for the additional commentary, visual aids and use cases included in the unabridged version.

FEATURED ARTICLE

Electric Utility Distribution Planning at a Crossroads

By Robert Young, Managing Director Economists.com LLC

In many US states, electric utilities are transforming the planning process for the distribution grid. Drivers of the transformation are varied. In some states, significant and growing levels of distributed energy resources (DER), such as residential and commercial rooftop solar, electric vehicles and batteries, result in intermittent, two-way power flows on grids designed for one-way power flows. Drivers in other states include changes in state law to achieve 100 percent clean energy by specific future dates, policies to reduce the states' carbon footprint and policies to develop smart grids and distribution markets. All of these state grid transformation efforts will require a radical change in the way distribution grids are planned, operated and controlled.



With high levels of DER and EV penetration, distribution grids will need to be redesigned to handle significant and intermittent two-way power flows and incorporate a wide range of new distribution automation and control technology. They will also need to be able to monitor and manage varying loads, power flows and the customer – down to the individual device level, such as EV charging and return of energy from battery storage.

Current utility distribution planning does not receive significant regulatory oversight - except for reliability, safety, capital spending and O&M expense - nor is there much public involvement as is the case for generation and transmission planning. New state grid planning efforts include significant regulatory oversight with many states merging distribution planning into the Integrated Resource Planning (IRP) process and requiring utilities to develop active public involvement processes for the new distribution grid planning process.

This new distribution planning process is overlaid on an electric grid which is aging rapidly and requires significant investment to replace old equipment and maintain or improve reliability. A 2015 report from the U.S. Department of Energy concluded 70 percent of power transformers are 25 years of age or older, 60 percent of circuit breakers are 30 years or older and 70 percent of transmission lines are 25 years or older.[1] In the same report, the EIA stated, "Managing a grid with increasing amounts of customer-sited variable generation increases wear and tear on the distribution equipment required to maintain voltage and frequency within acceptable limits and to manage excessive heating of transformers during reverse power flow."[2]

The key question for these new distribution planning processes is not the design or details of the plan, but how will utilities and state commissions incorporate the increased investment into retail rates. Between 2012 and 2017, distribution investment increased 5.9 percent annually, to $26.5 billion.[3]

Grid modernization efforts will push utility distribution spending growth even higher putting pressure on utilities and state commissions to justify the increased costs of grid modernization.

The PUCs in New Mexico and Massachusetts rejected rate increases for AMI proposals because the costs were greater the benefits to the customers. Utilities and state commissions will need to expand the definition of benefits beyond the simple utility payback analysis traditionally used to justify utility investments.

Because many distribution grid modernization efforts are part of a state law or policy to address climate change, the economic analysis to justify grid modernization will need to include benefits including the economic impact of increased employment and investment, carbon reduction and other external benefits.

Robert Young, Managing Director of Economists.com LLC

[1] https://www.eia.gov/todayinenergy/detail.php?id=36675
[2] Id.
[3] https://www.scottmadden.com/wp-content/uploads/2018/10/ScottMadden_Energy_Industry_Update_V18_I2_2018_1024.pdf#page=5

WHAT's on MANI's MIND?

Do you own an electric vehicle yet? If not yet, you may in the future and certainly your children will. By 2040, Bloomberg New Energy Finance (BNEF) predicts that 57 percent of all passenger vehicle sales and over 30 percent of the global passenger vehicle fleet will be electric. Consumers know that EVs can reduce emissions and even save money since on average, it costs about half as much to drive an electric vehicle compared to paying for regular gasoline. Transportation electrification offers too many benefits not to take seriously.

Electric utilities are considering the impact of this trend on the grid. With the increase in EVs, BNEF forecasts global electricity consumption from EV charging will reach 1,800 TWh by 2040. And if one considers that 14 kWh and 22 kWh EV batteries result in 4.25 and 8 hours to recharge, then a plug-in car adds from a third more to twice the full load of a house to the grid. Another way to look at it is that one EV can store as many as three days' worth of a typical home's energy use. In this way EVs can be likened to grid assets, because, in effect, EVs are mobile storage units. Using vehicle-to-grid (V2G) technology, which allows vehicle batteries to store surplus energy from intermittent renewable resources like solar and wind, EV owners could power their homes with energy stored in car batteries or sell it back to utilities, balancing fluctuations in energy demand. Using real-time rates, utilities could encourage EV owners to charge up during the day, when there is excess (and therefore cheap) solar energy and sell back to the grid during times of high demand.

The impact of load growth on peak demand are a critical issue for utilities. EVs represent the most significant new electric load opportunity for utilities since the rise of air conditioning in the 1950s, according to Smart Electric Power Alliance. The increasing EV load could deliver great value to utilities and their customers if it's shifted away from high-priced peak demand periods. This could increase electricity sales without adding stress to the grid, and at the same time lowering drivers' charging costs.

On the other hand, some utilities risk being overrun by new peak demand unless they invest in communications systems and planning needed to properly manage and deliver transportations electrification's full value.

For more information check out Smart Grid Redefined: Transformation of the Electric Utility by Mani Vadari.

MEET THE EXPERTS

Robert Young is a nationally recognized expert in economic, rate-making and financial analysis for the energy industry. As the Managing Director of Economists.com LLC, Robert provides his deep expertise as it pertains to the economics of infrastructure in regulated industries.

His impressive career spans over 40 years in a wide variety of issues concerning energy utilities. After attaining Bachelor's and Master's degrees in Economics from Southern Illinois University, Robert spent several years working directly for electric utilities as a rate analyst in the Pacific Northwest. His domain knowledge and industry perspective have since been applied as a consultant for numerous industrial and large commercial entities.

Robert Young

Robert's particular expertise is rooted in analyzing electric utility rate and financial issues for a wide variety of electric utilities, large industrial and high-tech companies. As the energy industry modernizes, Robert has parlayed his talents by analyzing various conventional and DER resources to lower electricity costs and help meet corporate sustainability goals.

Beyond his consulting practice and work with MGS, Robert is the former Vice Chair of the Board of Directors and a member of the Executive Committee to the Western Energy Institute, a trade association serving the electric and natural gas industries throughout the Western U.S. and Canada. Robert also has a strong sense of civic duty and sits on the boards of several community organizations, offering his business acumen and skills as needed.

MORE ABOUT MODERN GRID SOLUTIONS

Modern Grid Solutions

Modern Grid Solutions (MGS) is a cost-effective, global, supplier of deep expertise and board-experienced domestic resources. Our team members have been industry colleagues for over 25 years. Our approach focuses on delivering actionable guidance, direction and value, based on the depth of our team's expertise in North America, and around the world.

MGS has assembled a team of leading experts all having between 25 – 45 years of experience delivering complex, innovative technology, business, regulatory and finance solutions to electric utilities, corporate clients and policymakers. Our experts bring expansive breadth and tremendous depth in engineering, technology, economics, operations, and commercial areas directly applicable to utilities, suppliers, regulators and policymakers.

BUSINESS EXPERTISE AREAS	TECHNICAL EXPERTISE AREAS
For Utilities and Policy Makers • Strategy, tactics, and process redesign • Business, technical and enterprise architecture • Transmission and distribution roadmaps • Grid modernization plans • Project and program management • Strategic change management • RPS Support	**For Utilities and Policy Makers** • T&D system operations – EMS, DMS, OMS • Generation operations • Energy markets – design and deployment • Energy and REC tracking system • T&D Automation and smart grid solutions • GIS and asset management solutions • Generation planning and renewables integration • Big data management and analytics • Solution and vendor selection
For Suppliers and Corporate Clients • Business model design and analysis • Electricity market entry and go-to-market • Market analysis, volumes, and trends • Competitive landscape analysis • Alliances, divestitures, and acquisitions • M&A, Project finance, structured products	**For Suppliers and Corporate Clients** • Solutions design and implementation • Portfolio review and analysis • Adjacency analysis and technology management • Energy, REC and emissions trading

Ongoing Projects

- Assisting a major Northwest utility with transforming their planning capabilities to address the influx of Distributed Energy Renewables, Non-Wires Alternative solutions and to address the newly signed Washington State Clean Energy Act (SB 5116) to transition the state's electricity supply to 100 percent carbon-neutral by 2030, and 100 percent carbon-free by 2045.
- Assisting the Pacific Northwest National Laboratory on a DOE project - development of an OpenADMS application development platform (GridAPPS-D).
- Assisting with a major multi-OpCo distribution operations transformation – Control center consolidation, ADMS specification and procurement, and operations standardization.
- Assisting a major multi-Opco utility with identifying improvements to their Outage Customer Experience – People, Process and Technology.
- Assisting a major multi-Opco utility with defining a strategy for dispatching the DERs in their footprint by focusing on – People, Process and Technology aspects of the full implementation.
- Assisting multiple startup companies in the areas of IoT, Blockchain, and Voltage regulator.

Electric System Operations – Evolving to the Modern Grid, Second Edition

Dr. Vadari's book "**Electric System Operations – Evolving to the Modern Grid, Second Edition**" is available now. The key chapters covering EMS, OMS, ADMS, and DERMS now include industry case studies to move the discussion from theoretical to evidentiary with real-world, relatable content.

Save 30%, plus FREE shipping with promo code: VAD30.
Order now at Artech House. Hurry, offer expires 2/29/20.

Smart Grid Redefined: Transformation of the Electric Utility 3.0

The book has been released and is now available in all leading bookstores and online. The Chinese edition is out now and available in China.

This book is also being used as a text book for a UMass course given by Prof. Kishore Nudurupati on Smart Grids for undergraduate and graduate students. (ECE 687/597 SG, Smart Grids)

ABOUT THIS NEWSLETTER

This quarterly newsletter is a production of Modern Grid Academy under the auspices of Modern Grid Solutions.
Please send all comments and inquiries to info@moderngridsolutions.com.