



State of the Grid

4TH QUARTER 2018

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WELCOME TO OUR Q4 NEWSLETTER!

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.*



At MGS, we're all geared up for another exciting and eventful year. But first, a look back on Q4 2018.

The last few months have seen an uptick in more state governments, corporations and utilities getting increasingly serious about not only reducing emissions but also simplifying tools, processes and supply chains to benefit all stakeholders.

Happy reading and Happy New Year!

Dr. Mani Vadari
President



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MGS NEWS

HOT OFF THE PRESS!

Dr. Vadari's book, *The Smart Grid Redefined: Transformation of the Electric Utility* is being translated into Chinese and a Chinese edition is coming out soon.

Upcoming Events

- DistribuTECH 2019, February 5-7 at Ernest N. Morial Convention Center in New Orleans, LA
- IEEE Innovative Smart Grid Technologies (ISGT) North America 2019, February 17-20 at Grand Hyatt Washington in Washington DC. Dr. Vadari is a panelist on Day 2 Plenary Session, "Technology Solutions for the Evolving Energy Industry."
- Western Energy Institute Operations Conference, April 23-26 in Vancouver, BC.

You May be Interested in... *Paris to Pittsburgh*

[Paris to Pittsburgh](#) is a documentary set against the national debate over the country's energy future. It aired on National Geographic on December 12 and showcases the difficult impacts of climate change across the US. In the wake of the Trump Administration's announcement that they would pull out of the Paris Climate Accord, cities across the U.S. announced that they would still align with it and continue to work to reduce carbon emissions on their own. Paris To Pittsburgh highlights the efforts by local communities, from Los Angeles to Pittsburgh, and features the people who are actively taking steps to participate in the sustainable energy sector.



MERGERS AND ACQUISITIONS

\$218 Billion raised by Battery Storage, Smart Grid and Energy Efficiency companies in 2018

Mercom's Q4 and Annual 2018 Funding and M&A [Report](#) found that in 2018, a combined \$2.8 billion was raised by Battery Storage, Smart Grid, and Energy Efficiency companies, an increase from the \$1.5 billion raised in 2017. Specifically, Smart Grid companies raised \$530 million in VC funding in 29 deals in 2018, a 26 percent increase compared to 2017. Total corporate funding, including debt and public market financing, came to \$1.8 billion in 33 deals, compared to \$1.2 billion in 50 deals in 2017.

GE spins off industrial IoT company and sells its stake in ServiceMax

In December, GE announced it will spin off GE Digital into a \$1.2 billion independent industrial IoT company and sell a majority stake of ServiceMax to a private equity firm. The company has already announced plans to spin off its healthcare and railroad locomotive divisions and sell two IoT-related businesses, connected lighting division Current and automation division Intelligent Platforms. All this is underway as the company faces shareholder pressure to reduce its large amount of debt. While becoming a standalone company, GE Digital will remain under the whole ownership of GE. It's also been reported that Steven Martin, former Chief Digital Office of GE Power, has been named as acting CEO of the spinoff.

Con Ed buys solar-powered assets from Sempra Energy

Sempra Energy announced in mid-December that it has completed the sale of its U.S. operating solar assets, solar and battery storage development projects, as well as its ownership interest in one wind facility, to Consolidated Edison, Inc. for approximately \$1.6 billion in cash, subject to customary post-closing adjustments. Sempra reports it expects to use the sale proceeds to significantly expand its regulated Texas utility platform through Oncor Electric Delivery Company LLC's pending acquisition of InfraREIT, Inc. and to pay down debt. This buy strengthens Consolidated Edison's position in the renewable energy market and will likely generate synergies due to proximity of plant locations. The transaction represents approximately 980 megawatts AC of installed capacity.

NextEra Energy Partners announces it will buy diverse renewable assets portfolio

NextEra Energy Partners, LP recently announced that it has entered into an agreement with a subsidiary of NextEra Energy Resources, LLC to acquire a geographically diverse portfolio of 11 wind and solar projects, collectively consisting of approximately 1,388 megawatts. In conjunction with the acquisition, NextEra Energy Partners also has entered into a \$750 million convertible equity portfolio financing with a fund managed by BlackRock Global Energy & Power Infrastructure. "The acquisition of these high-quality, contracted renewable energy assets demonstrates the continued execution of our plan to expand NextEra Energy Partners' portfolio for the benefit of our unitholders," stated Jim Robo, chairman and chief executive officer.

Hitachi to buy ABB's power grid business for \$6.4 Billion

Hitachi Ltd.'s takeover of ABB Ltd.'s power grid division for about \$6.4 billion would be the Japanese conglomerate's biggest-ever deal as it shifts focus from nuclear plants to the higher-growth market for electricity networks. Hitachi agreed to acquire 80.1 percent of a business with an enterprise value including net debt of \$11 billion. ABB will keep the remaining stake and plans to return as much as \$7.8 billion to investors through a buyback or other measures. Its sale will leave the Swiss engineering giant more concentrated on robotics and automation.

Washington State regulator denies bid to reconsider Hydro One-Avista deal

Washington state regulators have denied a request from Hydro One and Avista Corp. to reconsider the rejection of the Ontario utility's planned multibillion-dollar takeover of the American company. The Washington Utilities and Transportation Commission says it will take no action on the request, which was made after regulators found the \$6.7-billion planned merger would not adequately protect Avista customers from political and financial risk. In December, Hydro One and Avista said in their request for reconsideration that the commission erred in reaching its decision because it "misapprehended" the political risks Ontario's ownership stake in Hydro One posed. In early January, the Idaho Public Utilities Commission also denied the proposed takeover, finding that the companies had failed to demonstrate that the transaction met the public interest and no-harm tests set out in the state law.

GIP secures financing to acquire stake in what will be the world's largest offshore wind farm

In September, Ørsted completed divestiture of 50% of the 1,218MW offshore wind farm Hornsea 1 to Global Infrastructure Partners (GIP). Hornsea 1 is under construction

and will be the world's largest offshore wind farm when commissioned in 2020. GIP also holds 50% stake in Orsted's German offshore wind farms, Gode Wind 1 and Borkum Riffgrund 2. Located in the North Sea 120km from the UK east coast, the Hornsea 1 offshore wind farm will consist of 174 wind turbines supplied by Siemens Gamesa. The wind farm, which is expected to be fully commissioned in 2020, will produce enough electricity to power more than one million UK homes, while offsetting 1.7 million tons of CO2 from entering the atmosphere. Headquartered in Denmark, Ørsted develops, constructs and operates offshore wind farms, bioenergy plants and innovative waste-to-energy solutions and provides smart energy products to its customers.





KEY HIGHLIGHTS

US electricity interruptions spike to 8 hours in 2017

The US Energy Information Administration [reported](#) that in 2017, Americans experienced electricity interruptions totaling almost eight hours, which is double the number of hours in 2016. The spike was caused by natural disasters such as hurricanes and winter storms. Puerto Rico experienced the longest US blackout due to Hurricane Maria, but that data was not included in this report. Since the storm, regulators on the island have introduced a clean energy bill that would put PR on the path to getting 100% of its electricity from renewable energy by 2050.

MIT researchers conceptualize “Sun in a Box” renewable storage system

MIT researchers have proposed a concept for a renewable storage system that would store solar and wind energy in the form of white-hot liquid silicon stored in heavily insulated tanks. It then converts the light from the glowing metal back into electricity when it's needed. The researchers estimate that such a system would be vastly more affordable than lithium-ion batteries, which have been proposed as a viable, though expensive, method to store renewable energy. They also estimate that the system would cost about half as much as pumped hydroelectric storage—the cheapest form of grid-scale energy storage to date. The system is called TEGS-MPV for Thermal Energy Grid Storage-Multi-Junction Photovoltaics. It has also affectionately been coined, “Sun in a Box” because ‘it’s basically an extremely intense light source that’s all contained in a box that traps the heat.’ And, it’s much easier to remember!

Google’s designed a giant flying wind generator

California-based company Makani, a division of GoogleX, is testing a wind turbine that looks more like a glider airplane than a wind generator. Called the M600 after the 600 kW of electricity produced by its movement, it has mass of about 10% that of a conventional wind turbine with similar output thanks to the carbon fiber materials it’s primarily made from. The lighter, portable design could help bring wind energy to areas devastated by natural disasters and places where coastal waters are too deep for other wind systems to sit on the seabed.

Grid-scale energy storage tech start-up gets \$26 million investment

Malta, a Boston-based start-up, raised \$26 million toward building its first full-scale 10 MW pilot plant that can provide power for up to 10 hours. Malta is building a grid-scale energy storage technology that stores electricity from renewable energy sources as heat inside large tanks of high temperature molten salt and as cold in large tanks of chilled liquid. The system can discharge electricity back to the grid when energy demand is high - effectively “time shifting” energy from when it’s produced to when it’s most needed. Malta expect the cost of building a heat-pump system could be as low as \$12.7/kWh. That’s compared to lithium-ion battery packs which cost on average \$176/kWh, or approx. \$10/kWh for pumped hydro storage.

New York Governor Cuomo commits to 100% clean energy

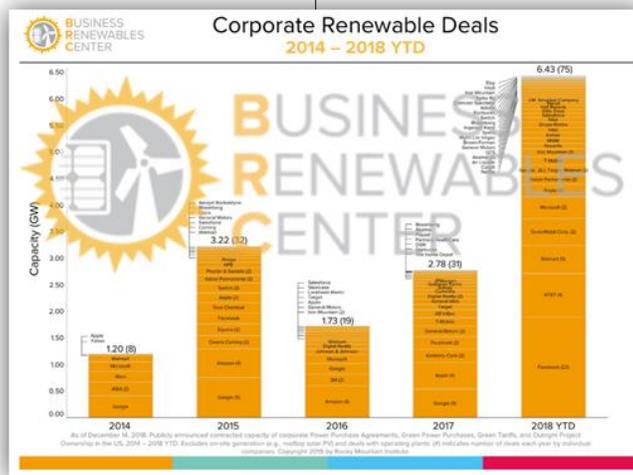
New York Gov. Andrew Cuomo announced in December that by 2040 the state would get all of its electricity from carbon-free sources. The announcement dubbed this latest commitment the “Green New Deal” and follows Gov. Cuomo’s previous increase of New York’s energy storage target to 3 GW by 2030. The move positions New York as the fourth state with a 100% clean electricity or clean energy goal, following California, Hawaii and New Jersey. New York currently has over 9,000 solar jobs and 1500 MW of solar installed, the 10th most among the US.

CO utilities commit over half of all electricity sold in the state to come from zero-carbon resources by 2030

A growing number of electric utilities across the nation individually have announced ambitious targets for carbon reductions in line with science-based goals and the international commitments made under the Paris Agreement. Nowhere is this more evident than in Colorado. After discovering earlier this year that continuing to run two coal plants would cost its customers an extra \$200 million compared to retiring and replacing them with renewables and batteries, Xcel Energy became the first major, multi-state US utility to commit to 100 percent carbon-free electricity by 2050. Colorado Springs Utilities announced a plan to provide over 20 percent of its energy from solar projects by 2024. The board of Platte River Power Authority voted unanimously to adopt a goal of 100 percent carbon-free electricity by 2030. And Holy Cross Energy adopted a goal of 70 percent renewable energy by 2030. These new goals from diverse Colorado utilities ensure that over half of all electricity sold in the state will come from zero-carbon resources by 2030, leapfrogging the 30 percent standard set by the legislature.

More electric utilities getting serious about replacing coal-fired generation with cleaner resources

Electric utilities are starting to recognize and act on the emerging cost-effectiveness of low-carbon resources compared to legacy coal technologies. PacifiCorp, a large utility serving customers in six Western states, released a study in early December showing that 13 out of its 22 existing coal-fired generating units were more costly to keep running than to replace with new, cleaner resources. Consumers Energy in Michigan filed a plan in June with its regulator to retire all of its coal-fired generators by 2040, replacing them entirely with renewable resources and energy efficiency investments. And the Northern Indiana Public Service Company, in the heart of coal country, announced in November it could save its customers \$4 billion by retiring all of its coal plants ahead of schedule and replacing them with wind, solar and batteries.



Corporate America’s taking action with record-breaking numbers of renewable energy projects

While there is certainly plenty of progress left to be made by US utilities in terms of setting and taking action against climate-aligned goals, corporate America is more than picking up the slack. In 2018, corporations signed deals to buy nearly 5,000 megawatts of new renewable energy projects, beating records set in previous years. The Business Renewables Center actively tracks new corporate

renewable energy contracts as they are announced. The [chart to the left](#) shows their analysis of all the public transactions during the past five years.

Clean energy gains steam through Midwest

A new [report](#) from the Natural Resources Defense Council documents the impact of clean energy on the rural Midwest using employment data and case studies of the benefits of solar, wind, and energy efficiency projects. In 2017, Midwestern wind and solar energy capacity grew to 31 gigawatts, 24 of which are located in rural places, and support about 158,000 jobs throughout the region. Rural electric cooperatives have been increasing solar programs with more than 190 co-ops now offering community solar in 31 states. The clean energy movement is supported on a federal level by the USDA's [Rural Energy for America Program](#) which gives farmers credit for investments in things like solar, biomass, geothermal and small hydro.

In related news, Organic Valley, America's largest cooperative of organic farmers announced a first-of-its-kind community partnership that will enable Organic Valley to become the largest food company in the world to source 100 percent of its electricity from renewable sources. This partnership will initiate over 12 megawatts (MW) of solar installations in Wisconsin. The electricity created by this partnership will not only enable Organic Valley to cover 100 percent of its electric energy needs from renewable sources by 2019, but also increase overall solar energy use in Wisconsin by 15 percent.

Apple's Supplier Clean Energy Program

As part of Apple's commitment to address climate change and increase the use of renewable energy within its supply chain, Apple has set a goal to generate and source more than four gigawatts of new clean energy in Apple's global supply chain by 2020. This goal represents one-third of the electricity Apple currently uses to make their products. The Supplier Clean Energy Program has 3.7 gigawatts of clean energy commitments. Once operational, these commitments will avoid over 5.2 million metric tons of CO2 emissions, the equivalent of taking over a million cars off the road each year.

Trade tariffs likely to have less than a 1 percent impact on 2018 solar procurement

According to a recent [report released by Wood Mackenzie Power & Renewables](#) and the Solar Energy Industries Association, utility solar PV installations fell nearly 50% in the US from the second to third quarter of 2018. Despite delays or cancellations of \$2.5 billion in large solar projects earlier this summer, the tariffs will likely end up having less than a 1% impact on 2018 procurement. In addition, panel prices have fallen faster than expected because China pulled back its subsidies for the renewable power source in June, creating an oversupply of modules in the global market that has eroded the impact of the tariff. Utilities are eager to start new solar projects because of the federal solar tax credit that will begin phasing out in 2020. Next year will be the most impacted by the tariffs, Wood Mackenzie said. Developers will begin projects next year to claim the highest level of tax credit but delay buying modules until 2020 because the tariff drops by five percent each year.

Unintended consequences of a good economy

In the energy sector, U.S. power consumption increased "meaningfully" in 2018, even amid a steady decrease of coal-generation capacity, said Rhodium Group, an independent economic research firm, which produced the recent report, "[Preliminary US Emissions Estimates for 2018.](#)" Natural gas not only replaced most of the lost coal generation but also fed the vast majority of the load growth last year. In fact, natural gas-fired generation increased by 166 billion kWh during the first ten months of the year. That's three times the decline in coal generation and four times the combined growth of wind and solar. The result: Power sector emissions rose by 34 million metric tons in 2018, compared to a decline of 78 million metric tons in 2017, said Rhodium.

Top global utility-scale energy storage system integrators identified in new Navigant research

According to a new report from Navigant Research, Fluence, Nidec ASI, Tesla and RES are the leading players in the increasingly competitive utility-scale energy storage market. These leaders are changing how energy storage is viewed in the industry and are working to open new markets. The report, [Navigant Research Leaderboard: Utility-Scale Energy Storage Systems Integrators](#), compares the strategy and execution of 12 leading ESSIs focused on the utility-scale market. Companies are rated on 12 criteria, including vision, go-to-market strategy, partners, production strategy, technology, geographic reach, sales/marketing/distribution, product performance, product quality and reliability, product portfolio, pricing, and staying power.

Five ways AI can revolutionize the energy industry

In a recent article published by *Energy Central* in its *Digital Utility Professionals Group*, author Jacob Dillon lays out five ways in which Artificial Intelligence can revolutionize the energy industry. First, there would be a reduction of mistakes. For example, if an AI program was monitoring the grid, it would pinpoint any problem faster than a human. Second, AI would also help reduce the carbon footprint by doing what humans currently cannot due to advanced machine learning. Next, the author poses that independent power grids of the future will be run solely by AI with humans checking the workflow and that splitting big plants into smaller ones will improve energy efficiency, prevent blackouts and provide customers with better power. Fourth, AI will also allow us to anticipate problems by learning and analyzing existing patterns which will ultimately save time and money. Finally, AI can help us discover new energy sources in the future by accelerating the process of scientific improvement. Is there anything AI can't do?

Utilities collaborate to develop an Open Distributed System Platform

Avista, Duke Energy, APS and Entergy are starting an industry-led collaboration to build an open-source operating system for the electric grid. They've coined it OpenDSP, which stands for Open Distributed System Platform. It's intended for use by utilities of all sizes and open to development by any interested vendors. The DoE is a key stakeholder, but the platform is being defined by utilities with input from a committee. The first beta is expected in Q3 2019 and a second complete beta by Q1 2020. Avista and Duke Energy will both be working on apps to deliver with the new platform and an open-source foundation will be set up to manage the code going forward.



FEATURED ARTICLES



Balancing the Duck Curve with a Blockchain Distributed Energy Exchange

For utilities and consumers, load balancing can be a challenge - or an opportunity. On March 31st, 2018, California wholesale electricity prices fluctuated from \$15 - \$60/MWh. Solar overproduction during the day caused negative prices 21 times from March through May, and the high cost of ramping at night caused a 171% increase in peak costs - a pattern known as the duck curve. In response, the energy economy is turning to storage and time-of-use pricing. Consumers with battery storage in this market can store low and sell high, potentially paying off a battery in 3 - 6 years.

Due to legal mandates and the increasing affordability of home energy systems, solar is going to see further gains as a share of the generation base, worsening the duck curve. To counteract this there are a growing number of incentives for home and grid level storage, necessitating a singular software platform for both consumers and utilities to track and coordinate the use of distributed energy resources (DERs), from grid level operations down to individual customers, to balance the load. Current software solutions are often efforts of single manufacturers or utilities, thus lacking the flexibility and scalability of a universal, device and network agnostic application. Utilizing a Distributed Energy Exchange (DEE) utilities and customers could trade energy using real-time pricing, and track their transfer, production, consumption and storage data on a web-based application. Managing DERs on an exchange would allow grid operators to use electric vehicles, and residential and commercial batteries as dispatchable assets for a virtual power plant, providing a flexible tool for grid management, demand response and load balancing activities.

While most applications update to a centralized database, blockchain acts as a distributed ledger that records every energy measurement and transfer for all involved parties. This technology provides the scalability, data security, and access controls needed to support microgrids, utilities, customers and industrial prosumers on a single database. Blockchain-based smart contracts are programmable, multi-layered terms for automating the buying and selling of energy, giving customers control over their assets while making them available to utilities. Addressing the issue of wasted energy by the Proof of Work and Proof of Stake consensus mechanisms, The Proof of Energy provides trusted authentication quickly and efficiently. Using a blockchain based DEE, a distributed, transactive production and storage network would provide a non-wires alternative to expensive grid upgrades, turning the challenges of renewable energy into opportunities.

[Patrick Phelps](#), Founder & CEO WHYgrene Inc.



The Race to a 200 kWh Car Battery

Last August, the CEO of Bentley, Adrian Hallmark, was interviewed about the prospect of an all-electric Bentley after the launch of their Hybrid SUV, Bentayga earlier that year. Bentley plans to have hybrid versions of every model by 2025 and they are analyzing the adding an all-electric version, but are constrained currently by battery density which limits the range and performance ultra-luxury vehicle owners expect. Bentleys and their cousin, Rolls Royce produce cars and SUVs that weigh in at close to three tons with top speeds north or 150 mph. Opening bids for these vehicles begin at about \$200k and can exceed \$400k for some models with added customization. While ultra-luxury cars are a niche market, Hallmark stated that 37% of Bentley owners considered purchase of EVs and an electric Bentley would increase sales.

Currently the Tesla is the only car in production with 100 kWh battery, available in Model S and X. Equipped with a 100 kWh battery in these models range is over 300 miles with a top speed around 150 mph and weigh between 2.5 and 3 tons. Luxury car makers such as Audi, BMW, Mercedes, Volvo, Jaguar all have plans to market large EVs by 2025, and most other auto manufactures will offer EVs in many models by then.

Missing from this list is the light truck (pickups) segment, which outsells cars in the US by a two to one margin. Light trucks are also the fastest growing segment in the US. Between 2009 and 2018, light truck sales more than doubled, from 4.9 million to 11.7 million, while car sales increase from 5.4 million to 5.6 million. The light truck market includes vehicles which weigh between 2 tons and 4 tons, but can carry up to a battery draining 4 tons of cargo. In addition, these trucks often tow trailers, which depending on the model, can exceed 10 tons.

US truck owners recently started ICEing (internal combustion engines) Tesla supercharger stations, which involves blocking the EV chargers with their trucks. While this practice is rare and more likely a derivative of the US culture wars, one could argue that the lack of EVs in the light truck class in the near future could be an underlying cause of ICEing, as gas or diesel mileage of the upper end of large trucks is poor.

All-electric ultra-luxury cars and light trucks will require batteries in the 200 kWh range to provide owners with the performance and range they expect in their vehicles. The race is on!

[Robert Young](#), Managing Director, Economists.com
Principal, Modern Grid Solutions



MEET THE EXPERTS

Mr. Hammerly has been an electricity industry innovator and leader for almost three decades. His focus has been to improve the design, economics, reliability, and society's perception of the electricity industry. His expertise spans generation, transmission, distribution, and end-use energy consumption. He was instrumental in founding the GridWise Alliance, Northwest Center for Electric Power Transmission, and regularly represents the industry at various Federal, State, and Local political and regulatory forums including testifying before Congress on multiple issues such as security and grid reliability.

Mr. Hammerly brings a unique ability to combine the commercial, technical, and political dynamics into a strategy, strategy into tactics and lead an organization through implementation and on-going support. He has headed large multi-national, small entrepreneurial organizations and not-for-profits in the energy and technology space. In so doing, he led the development of the worldwide deregulated market, distribution automation, and end-use energy solutions. He has been instrumental in developing business strategies to suppliers and utilities to embrace

emerging technology. Where appropriate, he has facilitated the acquisition of technology and technology companies.

He has worked with both investor-owned and public utilities, large energy consumers, industry suppliers, and governments entities by providing solutions to their emerging problems focused on creating, moving, and delivering electricity efficiently and economically. He led teams in developing new technologies, designed and implemented innovative business models, advocated for new policies and forged alliances and mergers for key industry leaders. Throughout his career, Mr. Hammerly had been on the frontier of changes in technology, business, and processes necessary to keep the industry delivering reliable electricity.



John (JD) Hammerly



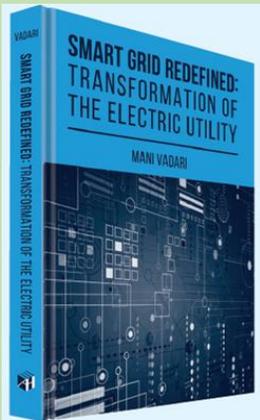
NEWS FROM MODERN GRID SOLUTIONS

Ongoing Projects at Modern Grid Solutions

Our current work with clients includes:

- 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.
- Major Canadian utility Restoration processes update and improve

- Defining a Smart Grid Roadmap for a major Northwest Municipal utility
- Assisting an international Transmission company with their North American expansion and worldwide technology roadmap
- Assisting with an EMS integration effort



ARTECH HOUSE PRACTICAL BOOKS FOR ENGINEERING PROFESSIONALS

Smart Grid Redefined: Transformation of the Electric Utility Mani Vadari

- Guides professionals in the evolution of the Smart Grid and offers insight into distribution automation, storage, and microgrid;
- Highlights the journey to a transformed electric utility, provides solid examples, and includes real-world case studies;
- Presents new energy storage solutions and electric value chain disruptors;
- Learn how to overcome challenges related to integrating supply and demand diversity;
- Discusses how new technologies impact the day-to-day operations of a utility and how these technologies can transform the normal functioning of the utility;
- Provides discussions about how a transformed utility can be a springboard to a smart city;
- Demonstrates how to apply the strategies of technologies in this resource to guide them to success in the field;
- Defines the roadmap to the utility of the future and provides a vision for how utilities can thrive in their new environment.

MGS team grows its team of experts

MGS has built a portfolio of experts with 25-40 years of experience in fields ranging from Grid Modernization, T&D Operations, Generation operations, Utility regulatory & economics, Energy Efficiency and Demand Response and T&D Planning. Check us out!

Electric System Operations: Evolving to the Modern Grid

Dr. Vadari's book "[Electric System Operations – Evolving to the Modern Grid](#)" continues to receive rave reviews from readers. Buy them soon at a leading retailer.

Smart Grid Redefined: Transformation of the Electric Utility 3.0

The book has been released and is now available in all leading bookstores and an online store near you. A Chinese edition will be available soon.



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