



Certified Minority
Business Enterprise
MBE

State of the Grid

A Service from Modern Grid Academy

Welcome to the 2nd quarter newsletter from Modern Grid Solutions. We have passed a major milestone with this newsletter – it is now going to an organically evolving subscriber list of almost 1700 people. It is a packed newsletter full of very interesting articles that I believe you would enjoy. Please also keep an eye open for the original article on Rate model that should, at the least be eye-opening.

Don't miss the last segment which also includes information on our successes and other activities.

Sincerely yours

Mani Vadari, Modern Grid Solutions

Table of Contents

1. MGS news – Hot off the Press	1
2. Mergers & Acquisitions.....	1
EnerNOC to be Acquired by the Enel Group.....	1
Foresight Group Buys British Battery Storage Project	1
ERMCO Acquires GridBridge.....	1
3. Article: An Alternative Rate Model	1
4. Key Highlights.....	2
Cities Embracing CCA Choice Programs	2
Solar Developers Entering Storage Business.....	2
NY to Allow Battery Power Export to Grid	2
Electric Vehicles – Grid Assets or Liabilities?.....	2
Trends aiding Renewable Energy Dominance.....	2
Significant Growth Likely for Advanced DMS	3
Europe's Battery Gigafactories	3
Hydrogen-Based Storage Experiment.....	3
Key Grid Modernization Actions in Q1 2017.....	3
A Cyberweapon to Disrupt Power Grids	3
Miracle Material – Future of Energy Storage?	3
Preparing for the Utility of the Future	3
5. Smart Grid venture capital (VC) funding	4
6. News from Modern Grid Solutions.....	4

1. MGS news – Hot off the Press

- Subscriptions to “State of the Grid” briefing has now blown past 1750 and is on its way to reaching 1800.
- Dr. Vadari was a panelist at the GE user group held in Bellevue, WA, on June 22nd, 2016.
- Jamaica Public Service (JPS): Dr. Vadari delivered a three-day Grid Modernization course to executives at JPS

MGS's experts (more than 20) are making a difference. Our mantra: if you have a problem, someone in our team has solved it at least 3 times. Call us to find out more.

2. Mergers & Acquisitions

EnerNOC to be Acquired by the Enel Group

EnerNOC, Inc., has entered into an agreement to be acquired by the Enel Group, a multinational power utility and leading integrated electricity and gas operator with a managed capacity of approximately 85 GW and more than 65 million business and household customers worldwide. EnerNOC expects that the acquisition will accelerate the growth of its core businesses and deliver more value to its customers and lead the way towards a more sustainable, distributed energy future.

Foresight Group Buys British Battery Storage Project

Foresight Group has made its first foray into battery energy storage, with a 35 MW project in Britain. Foresight Group will use its Foresight ITS fund for the project in Port of Tyne in northeast England. Foresight expects this acquisition to consolidate its position as a leader in investing in renewable energy generation and flexible grid infrastructure to accommodate increasing penetration of renewables.

ERMCO Acquires GridBridge

ERMCO, a leading manufacturer of distribution transformers and transformer components, entered into a definitive agreement to acquire GridBridge Corporation, a privately held, leading power delivery systems company headquartered in Raleigh, NC. GridBridge's innovative Energy Router Platform combined with ERMCO's long manufacturing expertise make the combined company a potent leader in the rapidly evolving electricity distribution market.

3. Article: An Alternative Rate Model

Future electricity rates may coalesce around either transactive markets or wholesale markets expansion. Transactive energy drives consumer behavior through price signals. Under a transactive model, consumers use less electricity at times of scarcity, represented by higher prices and use more when prices are low. Similarly, Distributed Energy Resources (DER) benefit from transactive markets by self-serving load and increasing electricity exports when prices are high.

Wholesale market downward expansion into retail rates, also driven by the economic value of electricity at specific times and locations, enables alignment of the electricity value chain within regions. Adapting to fluctuating retail rates reflecting scarcity or abundance requires an advanced level of market engagement for either individuals or groups through aggregators.

Although these models represent possible logical and reasonable approaches, both require widespread price granularity and visibility at each meter, feeder, or distribution substation to succeed. In practice, implementation of either approach requires significant infrastructure. Further, these approaches require the end-user or their surrogate to analyze granular, short-term prices and derive a justification for a long-term investment in DER and energy efficiency, simultaneously assuming all the associated risks and uncertainty. Neither of these options may be practical.

What if there were a model that:

- Significantly reduces existing electricity prices.

- Stimulates clean electricity use, such as electric vehicles.
- Stimulates DER and energy efficiency investment without penalizing those who don't or can't invest in DER and efficiency.
- Supports grid justified investment.
- Didn't require the infrastructure or end-customer engagement through either wholesale market expansion or transactive markets.

Central to this alternative is a connection charge, which replaces a utility's KWH revenue, reduces electricity prices, fosters a "wires" business model, and elevates the impact of current and future negative wholesale prices. Households with less income would pay a lower or no connection charge. Further, DER produced electricity would be "bartered" to the utility when available and resupplied to the producer, KWH for KWH, when needed.

The connection charge supports a combination of centralized generation (where appropriate), storage, and the wires. Utilities can finance grid-scale storage, which could be centralized or community located but remains a utility asset and would not need to be part of DER investment unless it is a vehicle to grid.

Lower KWH prices increase clean electricity demand, fostering rapid electric vehicle adoption without the reliance on subsidies and fossil penalties. Lastly, overall economic growth improves when electricity prices are low.

Residential DER investments can expect replacement of any KWHs produced and lower prices for any KWHs required.

Lastly, a "barter" rate:

- Has no need for highly granular or locational prices.
- Avoids transaction costs from becoming a significant part of a transaction's value.
- Uses the monthly bill as a "true-up" between DER owner and the utility.
- Preserves the simple relationship between supplier and consumers.

Public utilities may innovative rates more quickly than investor owned utilities, which will require regulatory occurrence.

*John (JD) Hammerly
CEO, The Glarus Group
jd.hammerly@theglarusgroup.com*

4. Key Highlights

Cities Embracing CCA Choice Programs

California's Community choice aggregation (CCA) is growing in popularity. By mid-2020s, CPUC estimates up to 85% of retail load to be supplied through CCAs, rooftop solar and others. These changes are attributed to interplay of aggressive environmental and clean energy goals with deregulated electricity market.

Since Marin Clean Energy formed the first CCA in 2010, the trend has been accelerating. The program now serves more than quarter million customers, and LA County is moving forward with a CCA that could eventually serve a million customers.

The San Jose City Council voted unanimously to form the largest CCA program in California, ensuring residents will have more supply options than simply taking service from Pacific Gas & Electric. This requires San Jose Clean Energy to provide at least one option with 10% more renewable energy than PG&E's power mix, as well as a 100% greenhouse gas-free option. It is projected

that if all consumers chose this option, San Jose could see greenhouse gas emissions reductions from 10% to 18%.

Solar Developers Entering Storage Business

The solar industry is actively pairing energy storage with solar generation. Eight of the top 10 solar developers have incorporated storage into their business strategy, and have deployed storage either alongside PV or are pursuing hybrid installations. In addition, an increasing number of solar-plus-storage projects have been cropping up around the country, as Li-on prices drop lower and customers get more comfortable with storage technology. Specifically, for large developers, storage makes the solar product more appealing to a utility by giving the power plant flexibility and mitigating its effects on grid operations.

NY to Allow Battery Power Export to Grid

NY PSC has granted permission to Consolidated Edison (ConEd) to allow battery storage systems to export electricity to the grid, located at specific commercial locations, under a program to lower electricity demand in growing areas of Brooklyn and Queens.

Under Brooklyn/Queens Demand Management program, ConEd has awarded contracts for 22 MW of demand response resources that will go live this summer. The program, known as the Brooklyn-Queens Neighborhood Program, is a high-profile example of a non-wires alternative program demonstration project under New York's REV initiative. Under the program, customers can use installed battery storage systems to export power to the grid to respond to ConEd's calls to reduce peak load conditions.

Electric Vehicles – Grid Assets or Liabilities?

A recent SMUD report on EV charging forecasts that EV-related overloads could necessitate replacing 17%, or 12,000, of its transformers at an average cost of \$7,400 each. Projecting to U.S. grid scale, the 580,000 EVs on the road today represent 1 TWh of consumption, but by 2040, that could grow to 551 TWh.

Managed charging is a key opportunity that can result in benefits to utility customers, grid, and private charging providers, while also allowing integration of more renewables. Managed charging also called V1G, clarifies its role as a precursor to vehicle-to-grid (V2G) dispatch. Emerging V1G capabilities allow a utility to turn its charging load up, down, or off to balance grid conditions.

Trends aiding Renewable Energy Dominance

According to consulting company, Oliver Wyman, renewables will become the dominant energy source by 2050. It has identified four mega-trends that will reshape the global energy industry:

- Coal-fired power and nuclear will no longer be viable sources of power in OECD countries by 2050.
- The speed of adoption of renewable generation and distributed energy resources (DER) will result in a mostly decentralized and highly democratized energy system by 2040.
- The engine for developing technologies to power the energy revolution will reside in Asia and to a lesser extent in the US.
- The energy transition will change the economics of oil and gas industry, leading to emergence of 4 distinct business models.
 - Low-cost, high-volume producers
 - Onshore unconventional operators
 - Integrated asset-owning service companies
 - Finance-backed operators

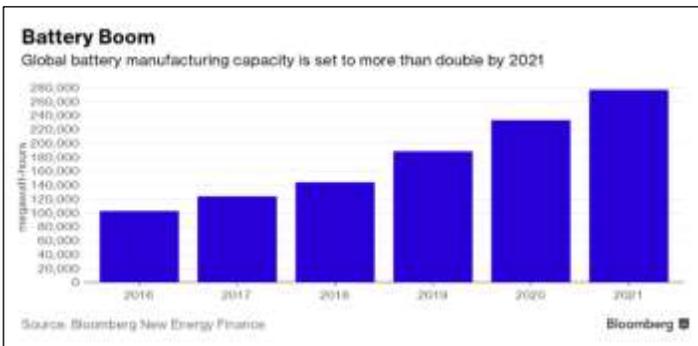
Significant Growth Likely for Advanced DMS

A recent study by Newton-Evans Research Company finds that only 9% of North American utility respondents reported having an ADMS as of the first quarter of 2017. Twenty percent of North American respondents indicated they will have an ADMS by the end of 2019, and another 17% indicated plans for implementing an ADMS sometime after 2019. Overall, 46% of the North American sample either currently has or plans to have an ADMS.

Real-time Network Visibility is the DMS application most used by the North American survey sample. Thirty-three percent of responding utilities currently use this application, while 25% plan to have it later on. Nineteen percent indicated that they currently use FLISR, and 37% plan on having FLISR as part of their DMS or ADMS.

Europe's Battery Gigafactories

Battery-making giga-factories are coming to Europe. Germany is building a 500 MM € (\$ 543 MM) plant to assemble Li-on storage units for Daimler AG. This highlights a push by both major automakers and power companies into energy storage. The technology is crucial to drive the next generation of green vehicles and to hold electricity from wind and solar farms. With two dominant industries moving in the same direction, the cost of batteries is expected to plunge.



Global battery-making capacity is set to more than double by 2021, reaching 278 GWh, up from about 103 GWh. Europe's market share is expected to almost double over that time from 2.5 percent.

Source: bloomberg.com

Hydrogen-Based Storage Experiment

On Semakau, an island near Singapore, Engie SA is experimenting with renewable power storage. Engie is helping build a small, self-contained power grid to demonstrate usefulness of hydrogen gas in converting intermittent power from solar panels and wind turbines into stored fuel to generate electricity days or even months later.

Batteries serve storage needs for intraday, or few hours, but if energy produced is to be stored for use much later of the order of days or months, then hydrogen could be a potential solution. But, hydrogen storage costs would have to come down dramatically. Hydrogen-based energy storage system costs about 10 times more than a diesel back-up generator with similar power output.

Key Grid Modernization Actions in Q1 2017

According to a report by N.C. Clean Energy Technology Center (NCCETC), most states are currently taking steps to modernize the electric grid, all the way from conducting studies to deploying new technology. Its key findings include:

- 36 state or utility proposals in 19 states to implement demand response programs or deploy advanced metering infrastructure, smart grid technologies, microgrids or energy storage were pending or decided.
- 16 states considered or enacted changes to policies related to grid modernization, including energy storage targets and clean peak standards.
- 16 states plus the District of Columbia took action to study or investigate grid modernization, energy storage, demand response or rate reform.
- 13 states acted related to utility business model or rate reform.
- 12 states considered changes to utility planning processes or state rules enabling market access.
- 11 states considered adopting new incentives or making changes to existing incentives for energy storage and other advanced grid technologies. *Source: nccleantech.ncsu.edu*

A Cyberweapon to Disrupt Power Grids

According to U.S. researchers, hackers allied with the Russian government have devised a cyberweapon that has the potential to be the most disruptive against electric systems.

The malware, dubbed CrashOverride, has a "wiper" component that erases the software on the computer system that controls the circuit breakers, forcing the grid operator to revert to manual operations - driving to the substation to restore power.

It is known to have disrupted Ukraine's energy system in December. In that incident, the hackers briefly shut down one-fifth of the electric power generated in Kiev.

It is believed that with modifications, the malware could be deployed against U.S. electric transmission and distribution systems with devastating effect.

Miracle Material – Future of Energy Storage?

Graphene, a nanomaterial hailed as a miracle material since it was isolated in 2004 by researchers at The University of Manchester, is the thinnest material known to man - 1 million times thinner than a human hair. It's the world's first 2D material, and it's ultra-light and transparent. It's 200 times stronger than steel, but unlike steel, it's flexible and superconductive - and it could be a game-changer for energy storage.

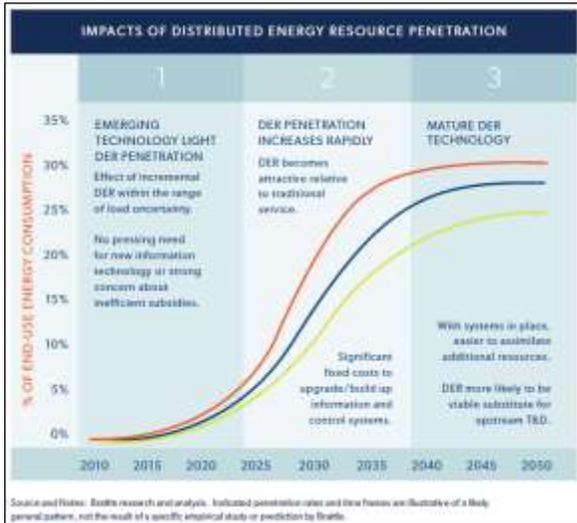
Graphene is made up of a single layer of carbon atoms in a honeycomb-like structure. It is an excellent conductor of electricity, and one of its potential industrial applications is in energy and energy storage. The material is believed to be able to dramatically increase the lifespan of lithium-ion batteries. Graphene capacitors could also provide power while using much less energy than traditional technology, and it could be potentially used in grid applications by storing solar and wind power.

The challenge is to find a way to produce large amounts of high-quality graphene at costs low enough to warrant replacing and upgrading existing technology.

Preparing for the Utility of the Future

The rapid penetration of distributed energy resources (DERs) into the electric utility market has raised concerns that the utility business model that has been applied for the last 100 years will no longer suffice, and will need to evolve in the very near term. Utilities will therefore need to take a hard look at their practices and prepare for this transition. The Brattle Group has the following readiness checklist for the Utility of the Future:

- Develop cost of service (and marginal cost) analyses to better understand geographic and other differences in costs and benefits of integrating DERs.
- Gradually replace “make-whole” lost-revenue recovery mechanisms with more efficient cost recovery and rate designs



- Determine applications where the non-utility market can provide DER-based incentives and where applications are best provided by the utility
- Reformat traditional benefit-cost analyses to incorporate the scope of DER benefits
- Evaluate growth opportunities, particularly in beneficial electrification, such as the electrification of transportation

Source: brattle.com

5. Smart Grid venture capital (VC) funding

VC funding (both private equity and corporate venture capital) for Smart Grid companies increased 3-fold in Q1 2017 with \$164 MM in 14 deals compared to \$46 MM in 6 deals in Q4 2016.

Top VC Funded Companies in Q1 2017

Company	\$ MM	Investors
View -Dynamic Glass	100	TIAA Investments
Chargepoint	82	Daimler, BMW i Ventures, Linse Capital, Rho Capital Partners, Braemar Energy Ventures
Kinestral	65	Undisclosed
Primus Power	32	Success Dragon, Matador Capital, Anglo American Platinum, DBL Partners, etc.
Urjanet	20	Oak HC/FT

Source: Mercom Capital Group, llc

- Add incentives to the traditional rate of return framework as a transition step and to encourage utilities to integrate DERs and platform functionality

6. News from Modern Grid Solutions

New Projects at Modern Grid Solutions

MGS assists a broad range of clients performing a broad range of work. In summary, our current work with clients includes

- Selecting a modeling and simulation tool to support a statewide electricity system planning process that supports accurate representations of distributed energy resources.
- Developing the conceptual design for a grid innovation center in New York to support the REV mandate.
- Assisting the Pacific Northwest National Laboratory on a DOE project - development of an OpenADMS application development platform (GridAPPS-D).
- Assisting with an EMS integration effort
- Assisting with the evaluation of distribution operations
- Assisting with the evaluation of energy trading operations
- Assisting with the evaluation of a utility’s DERMS needs

MGS team grows its team of experts

MGS has built a portfolio of experts with 25-40 yrs 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.

Electric Utility 3.0 – Evolving to the Distributed Grid (Title still to be confirmed)

Please stay tuned for Book #2 from Dr. Vadari. This book to be published by Artech House focuses on different aspects of the Smart Grid that are now becoming mainstream at utilities worldwide are its impacts on how utilities are transforming themselves.

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



At Modern Grid Solutions, *Smart Grids Are Business as Usual*
We deliver 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.