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State of the Grid

A Service from Modern Grid Academy

Welcome to the second quarter newsletter from Modern Grid Solutions. This is a packed newsletter full of very interesting articles from Cyber Security to Machine Learning. We have two original articles here that will be sure to tickle your interest and attention (1) Energy Storage- first signs of competition to Li-on (2) Discussion on utility regulatory models.

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

Sincerely yours

Mani Vadari, Modern Grid Solutions

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1. MGS news – Hot off the Press

- IEEE certificate course “Smart Grids: Electricity for the Future” started on June 29th with **almost 7000 people registered**. This course based on materials from MGS is offered by IEEE and edX. You can still register for the course at: <https://www.edx.org/course/smart-grids-electricity-future-ieee-smartgrid-x>. Please pass the course and registration information to all the people in your contact lists.
- Dr. Vadari is part of USTDA team focusing on helping Indian cities Ajmer, Allahabad and Vishakhapatnam become smart.

2. Key Highlights

New York PSC adopts new utility-revenue model

The New York PSC issued an order adopting a ratemaking and utility revenue model framework under the Reforming the Energy Vision (REV) process. The order moves New York away from decades of rate-setting decisions that encouraged large, centralized power systems.

The new products will help customers manage their energy use and cut their bills by creating a two-way, "transactive" grid between customers and energy providers. The focus of the decision is to create a modern regulatory model that challenges utilities to take actions to achieve objectives by better aligning utility shareholder financial interest with consumer interest.

The order does not do away with cost-of-service regulation entirely, but supplements it with a combination of market-based-platform earnings and outcome-based-earning opportunities. Utilities will still get paid under cost-of-service for some infrastructure but they will also get earnings from achieving alternatives that cut capital spending and provide a definitive consumer benefit via market-facing platform activities and transitional outcome-based performance measures.

3. New Competition for Li-on Battery

Today renewable energy is one of the fastest growing markets in the industry. The growth of variable generation and the decreasing cost of advanced batteries present numerous opportunities for energy storage systems to be deployed on the distribution grid and behind the meter. Evolving storage opportunities combined with investment of unprecedented amounts of interest into electric storage systems has led to a surge in R&D into new storage technologies. Some of these technologies might well disrupt much accepted and common place technologies.

So, what are some of these energy storage technologies on the horizon?

One technology that has lately been attracting a lot of attention as the next-generation battery and one that has the potential to disrupt the widely accepted lithium-ion is the calcium-ion battery. One of its selling points is that the capacity of the calcium-ion is theoretically twice that of the lithium-ion. The calcium-ion has other advantages over the lithium-ion such as lower cost and greater safety. The lower cost is attributed to greater abundance of calcium than lithium and greater safety due to higher melting point of calcium-ion than lithium-ion. Currently, the calcium-ion faces one major obstacle to its application-the unavailability of a suitable electrode material in which calcium ions can be inserted and extracted reversibly, owing to its relatively larger ionic radius compared to lithium. Research in this area is ongoing.

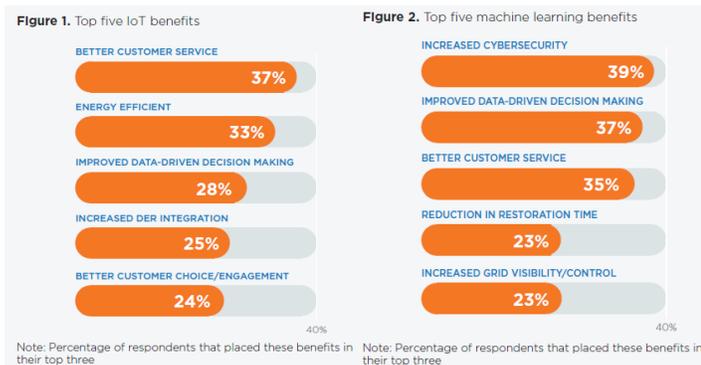
In a similar vein, magnesium-based batteries are out to replace their lithium counterparts. The discovery of a magnesium-friendly electrolyte has led to a more efficient mechanism of using magnesium to power rechargeable batteries. Magnesium batteries have an energy density 8 to 12 times higher than Li-ion batteries and charge-discharge efficiencies that are five times higher. In other words, magnesium-based batteries last a lot longer and pack a lot more power. They are also a lot safer than Li-ions because they don't tend to burst into flames when cracked and exposed to air. Magnesium batteries might soon replace most Li-ion batteries in devices requiring rechargeable batteries.

Today lithium-ion batteries are the technology-of-choice in the electric car industry. Non-traditional players such as Volkswagen and Tesla are creating an even greater demand through the former's bid to invest \$15 B in a new battery factory, and the latter's plans to build half a million electric vehicles a year by the year 2018. All of these forces will lead to an unprecedented boom in lithium-ion in the near term. Alternatives to the lithium-ion such as the calcium-ion and magnesium-ion might well be much needed game changers.

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Autonomous Grid: Machine Learning and IoT for Utilities

Machine learning and the Internet of Things (IoT) are two of the hottest terms out there today for utilities. Both have the power to create an increasingly autonomous grid that can eventually handle billions of endpoints on utility networks, but the industry may not be maximizing the benefit of these disruptive innovations, nor adequately leveraging the connection between the two of them.



Source: Zpryme

A survey of 200 North American utilities finds that:

- Utilities agree that both IoT and machine learning are critical for their organizations, but they have a better understanding and are more likely to be using IoT than machine learning.
- Over 55% use IoT for metering/meter data management (MDM), and 31% are using machine learning for this area.
- Network security and data privacy are major IoT concerns.
- The top benefits associated with IoT are more likely to be customer-facing, whereas the benefits named for machine learning are more grid-oriented.

With increasing complexity of the grid and the number of real-time decisions that need to be made about it, IoT and machine learning will continue infiltrating utility companies and eventually lead to more self-sufficient, autonomous grids.

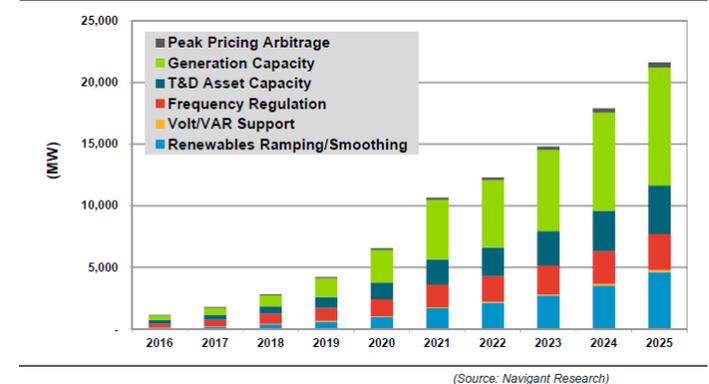
Grid-Scale Energy Storage Expected to Reach 21.6 GW Globally

Utility-scale storage is expected to continue breaking into the mainstream electricity industry. The market is projected to move away from R&D projects and push toward full commercial deployments. Grid operators world-wide are beginning to recognize value from large-scale energy storage systems (ESSs).

According to Navigant Research, global installed energy storage for the grid and ancillary services (ESGAS) power capacity is

expected to grow from 1.1 GW in 2016 to 21.6 GW in 2025. The most important driver of energy storage for ESGAS is the substantial growth in the amount of renewable energy being deployed around the world. Other key drivers include rapidly falling prices of ESSs and the growing need for new electrical infrastructure around the world.

Chart 1.1 Installed ESGAS Power Capacity by Application, World Markets: 2016-2025



PG&E to Phase Out Nuclear Power in CA by 2025

PG&E announced an end to all production of nuclear power in California by 2025. The proposal is intended to support state energy policies to increase investment in energy efficiency, renewables and storage. The proposal would replace power from its nuclear reactor at Diablo Canyon with a portfolio of renewables and energy-efficient storage. PG&E has voluntarily committed to a 55 percent renewable energy target by 2031.

PG&E plans to operate the two units at Diablo Canyon to the end of their current NRC operating licenses, which expire on 2024, and 2025. PG&E does not believe customer rates will increase as a result of the transition, because implementing the proposal is expected to have a lower overall cost than relicensing DCCP and operating it through 2044.

Cybersecurity Investment to Reach \$400 MM

The cybersecurity industry is expected to see a boost in venture capital due to new threats from the Internet of Things (IoT) to smart homes, autonomous cars, and future factories.

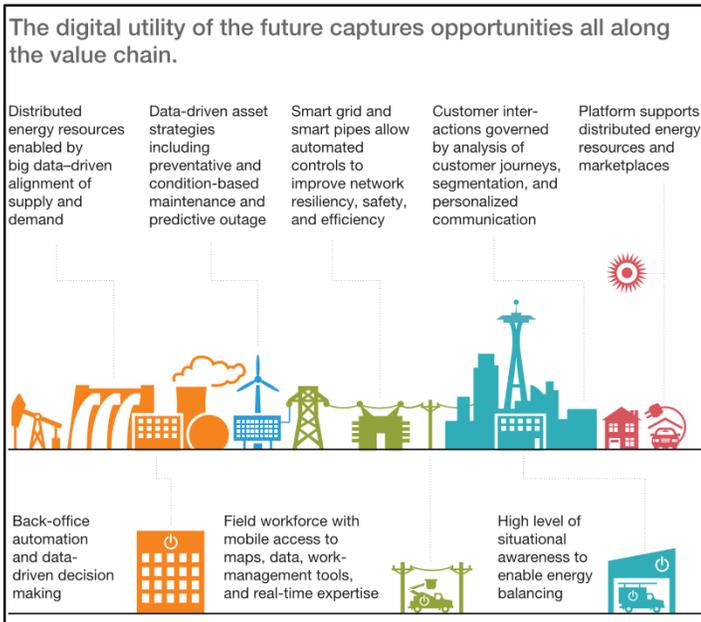
Investment in cybersecurity rose by 78 % in 2015 to \$228 MM and Lux Research expects it to reach \$400 MM in 2016, in part because of the rapid adoption of IoT devices.

Connected consumer and business products have begun flooding the market, but security has been mostly an afterthought. Security for IoT systems is critical, especially in situations where an entire grid of devices could be turned offline. Security services are cropping up all across the globe to tackle the issues raised from IoT and a growing reliance on computers handling product management and logistics.

Digital Utility: Opportunities & Challenges

The digital revolution is coming to the power industry. Renewables, distributed generation, and smart grids demand new capabilities and are triggering new business models and regulatory frameworks. Data collection and exchange are growing exponentially, creating digital threats but also valuable opportunities.

To thrive amid these challenges, the utility of the future will be fully digital facing a digital transformation of their organization and business. The potential opportunity is worth many times the attending cost and risk. Digital-forward sectors such as retail and financial services have already demonstrated that the value in digitization is greater than anyone predicted. For utilities, transformations can yield productivity improvements, revenue gains, better network reliability and safety, enhanced customer acquisition and retention, and entry into new business areas.



Source: McKinsey&Company

4. Next Gen Utility Regulatory Models

Three key elements need to be considered.

Regulatory Models: The United States has possibly the most complex regulatory model. We have a complex set of interactions between federal, state and other jurisdictions, supported by a lack of energy policy at any level. As a result, every state functions differently and under a different set of rules.

Business Models: Since PUHCA, the utility business model has been mostly unchanged with the exception of FERC orders 888 and 889 which resulted in the separation of wholesale generation from the rest of the utility.

Our industry: For the longest period of time our industry has been focused on delivering reliable power to the customer. This mandate has almost been sacrosanct in that it has been the core mantra that has virtually driven every decision made by utilities.

The first set of questions we need to ask ourselves is that

- Is there a lesson to be learnt from the telecom industry? It is widely believed that while the breakup of Ma Bell in the mid-80s led to several major innovations including cellular technologies, the wide dispersion of the internet, Voice-over IP and the Smartphone. Are there similar opportunities that await the next generation electric utility and if so, what would that look like?
- The electric utility has survived for over 100 years - does it need to survive another 100?

- Is there an alternative to today's T&D approach to delivering power – and if so (1) what would it look like and (2) when would it become a reality?

The second major question that still needs to be asked is

Do we still need an entity that has the job of ensuring ongoing key goals of serving the public with economic rates, operational excellence, high standards for safety, and service reliability, are still met?

I believe that the answer to this is a YES at least in the near and mid-term. In the long-term, this responsibility could be provided by any number of entities – some still fully connected to the grid, some using the grid as a backup option and some completely disconnected.

However, the movement away from utilities is also not a foregone conclusion – as the current provider, they will have the best opportunity to continue their present strong position but they will also need to transform themselves into the most optimal and flexible provider of services focused on the customer instead of the infrastructure buildout.

So what?

As can be seen in this blog, there are more questions than answers. Given the pace of change, one cannot predict where this future will lead us – but one thing is certain.

- Today's utility will need to change.
- Today's regulatory regime will need to change

If these changes do not happen – we will have an extended period of chaos before the legislative arm may need to jump in and enforce something that may make the situation worse.

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Previously published by T&D World and is viewable in full at <http://tdworld.com/smart-grid/nexgen-regulatory-models?page=3>

5. Mergers & Acquisitions

GE Acquires Daintree Networks

Current, powered by GE acquired Daintree Networks, an Industrial Internet provider of building controls solutions for commercial facilities. The acquisition will enable Current to expand its building automation platform and its energy-as-a-service offering to small- and medium-size facilities through the deployment of Daintree's open, standards-based wireless control systems. The combined offering will be the industry's first next-generation, scalable cloud-based energy management and facilities optimization platform for every building type and size.

Oracle Buys Opower

Oracle acquired Opower, for approximately \$532 MM. Opower's big data platform stores and analyzes over 600 billion meter reads from 60 million utility end customers, enabling utilities to proactively meet regulatory requirements, decrease the cost to serve, and improve customer satisfaction. Together, Oracle and Opower will become the largest provider of mission-critical cloud services.

Centrica acquires ENER-G Cogen

Centrica plc has acquired ENER-G Cogen International Limited, a supplier and operator of combined heat and power (CHP)

solutions, from ENER-G Holdings PLC for £145 MM. ENER-G Cogen has over 500MW under contract with a growing customer book. The business will form part of Centrica’s new international Distributed Energy & Power business and complements Centrica’s existing capability in installing and managing distributed systems for customers in both the UK and US.

4 Countries to Invest \$8.1 B in Smart Grid Infrastructure

Pakistan, Sri Lanka, Bangladesh and Nepal will invest \$8.1B in smart grid infrastructure to modernize power sectors. These countries will make significant investments in smart grid infrastructure over the next decade to modernize their grids, particularly in the metering segment. The investment is projected to total \$8.1 B over the period 2016-2026 with additional investment in prepaid metering. There are already large-scale plans to address these challenges, including a \$177 MM AMI investment plan in Pakistan and a target to deploy prepaid meters to all residential customers in Bangladesh.

Both local and international vendors are active in projects throughout the region. Vendors such as EDMI/Osaki, GE, Itron, Landis+Gyr, Secure Meters, and others are all involved.

6. Smart Grid venture capital (VC) funding

Venture capital (VC) funding for Smart Grid companies increased 2-fold in Q1 2016 with \$110 MM in 14 deals, compared to \$56 million in 12 deals in Q4 2015. 22 investors participated in VC funding rounds, with Communication companies raising the most.

Top 5 VC Funded Smart Grid Companies in Q1 2016

Company	\$M	Investors
mPrest	20	GE Ventures, OurCrowd
Powerhive	20	Prelude Ventures, Caterpillar Ventures, Total Energy Ventures, etc.
Smart Wires	20	Undisclosed
Telensa	18	Environmental Technologies Fund, Silicon Valley Bank
Evatran	10	Zhejiang VIE Science and Technology Company

Source: Mercom Capital Group, llc

7. News from Modern Grid Solutions

DOE Grid Modernization Laboratory Consortium (GMLC) – Awards

Modern Grid Solutions is a named partner in “Development of an Open-Source Platform for Advanced Distribution Management Systems” along with PNNL and NREL as primes and other partners including Washington State University and Incremental Systems.

MGS team grows its team of experts

MGS has assembled over 20 key industry leaders in its portfolio of experts, each with between 25-40 years of experience in their respective fields ranging from T&D Operations, Big data analytics, Grid Modernization, Utility regulatory and economics, Generation operations, Energy Efficiency and Demand Response and T&D Planning and Construction. Please ask us as to how we can help you.

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. It is now being used at several universities as course materials. SUNY Buffalo, UW-Wisconsin, LeHigh, Pennsylvania State University, Drexel and Stony Brook.

Training news

- IEEE certificate course “**Smart Grids: Electricity for the Future**” started on June 29th with over 5000 people registered. This course based on materials from MGS is offered by IEEE and edX. You can still register for the course at: “<https://www.edx.org/course/smart-grids-electricity-future-ieee-smartgrid-x>”. Please pass the course and registration information to all the people in your contact lists.

Events and News

- “Smart Grid Redefined”, by Dr. Vadari is now ready for viewing by the public. Check it out. This article redefines the Smart Grid as it has changed over time and looks to the future.
- Dr. Vadari is now a regular contributor to the IdeaXchange blogs managed by Transmission & Distribution World. His latest article is “Next Generation Regulatory Models”. Check it out.
- Dr. Vadari is now a regular contributor to the Intel energy series blog also. His latest article is “Utility of the Future – An Intel Blog Series by Dr. Mani Vadari”. Check it out.

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.