State of the Smart Grid Briefing

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We are very excited to release our eighth quarterly newsletter. We have three articles again. Article 1 is from EPRI on customer preferences for a smarter grid. Article 2 is on smart inverters and their disruptive capabilities. Article 3 is about the criticality of rates to the health of distribution companies and mechanisms for utilities to recover their fixed costs from customers who install solar.

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. Key Highlights

Top 10 Energy Storage Vendors

As battery prices for stationary storage continue to decrease, more scrutiny is being applied to other areas in the value chain like energy storage systems integration. Navigant Research recently identified the top 10 energy storage system integrators it believes are differentiating themselves based on technical capabilities, business models and/or financing. The vendors assessed were consistent across both strategy and execution and rated highly on vision; go-to-market strategy; partners; production strategy; technology; geographic reach; sales, marketing and distribution; product performance, quality and reliability; product portfolio; pricing; and staying power. The top 10 vendors are:

AES Energy Storage, NEC Energy Solutions, RES Americas, LG CNS, Younicos, Green Charge Networks, Sharp, Greensmith Energy Management Systems, ZBB Energy, and S&C Electric.

Debate over Ending State RPS

Many states are now debating the RPS - Some are even questioning the need for one if they have already achieved their renewable energy goal. For e.g., Texas Senate voted to eliminate their RPS in April. The Texas RPS began in 1999 with a goal of 2,000 MW of renewable energy, and increased to 10,000 MW, to be met by 2025. But Texas passed that goal far ahead of schedule, and now has nearly 13,000 MW of renewable energy operational in the state.

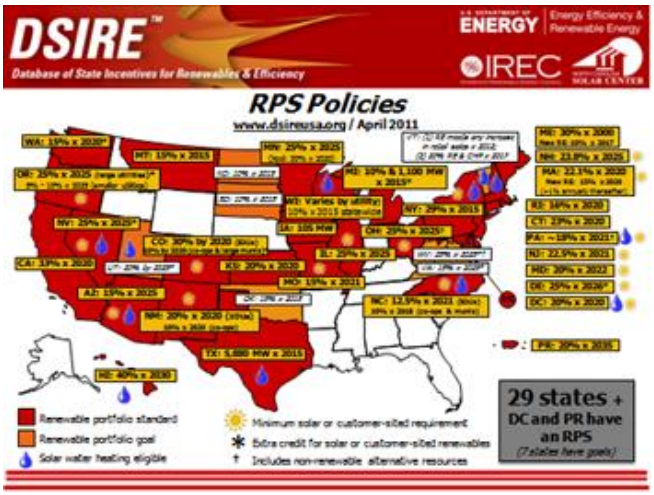

Figure: RPS Policies (Source: U.S. DOE)

Pro-RPS lobbyists, believe the law has brought a myriad of value to the state, and repealing it will put renewable contracts into question especially when there is no problem with the RPS and the way it is working. The opposing argument is that the industry needs to be flexible and adaptable to any evolution that happens.

2. Customer preferences for pricing in a smarter grid

What are customer preferences for pricing in a smarter grid? Discrete Choice Experimentation key to residential insights

Residential electricity customers typically pay the same rate all day every day for electricity. These customers pay the same price for valuable, on-peak electricity, as the less-expensive, off-peak electricity. Utilities are considering offering customers variations in rate structures, such as time-of-use pricing, to reduce on-peak electricity use. But how will utilities know how to design electricity service plans that customers will choose? Whatever the choice, knowing the preference is key to optimizing the residential load as the grid of the future takes shape.

To help answer this question, the Electric Power Research Institute (EPRI) researched approaches for determining stated preferences for hypothetical offerings and determined that a method called discrete choice experimentation (DCE) would be effective. Using DCE, customers are asked a series of questions presenting tradeoffs among attributes, similar to how food manufacturers test new varieties of food, such as Nacho Cheese Doritos.

To test the DCE approach, EPRI embarked on research with several utilities to develop experiments for selected electricity service plans (time-of-use and fixed bill, compared to the status quo flat rate) and tested them in utility territories. Surveys were developed with a well-tested informational piece to describe the different options. More than 1000 surveys were then administered with an average response rate of 38 percent. The results were used to develop choice models, and then market size and share models. The results are statistically significant and can be used to identify likely participants and how to market to them. We anticipate the results will be used by utilities to plan new offerings with confidence in the participation by their customers.

So what did we find? Our research infers that 20 to 30 percent of residential utility customers have stated preferences for time-of-use rates over a flat rate (the status quo). The results are intended to bring confidence to utilities and stakeholders who may be reluctant to present changes to residential customers.

Providing customers with diverse choices is essential to optimizing the performance of electricity markets. Customers benefit from choosing the plan that best fits their circumstances --- and, as a result, they use electricity more effectively, and pay less for the services electricity provides. We're looking forward to this next round of research where we will address customer technologies and learn even more about how tomorrow's grid will be relevant to today's customer.

By Ellen Petrill
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INL/NREL Team up on Smart Grid Simulation

DOE's National Labs NREL and INL have partnered to demonstrate the capability to connect power grid simulations between two laboratories. The experiment's Real-Time Digital Simulators (RTDS) allowed software and hardware to talk to each other in real time. This new capability allows them to interconnect a wide variety of equipment and software simulations to support grid modernization objectives. The technology could have significant impact for utilities by providing testable and deployable solutions to address cascading and interdependent dynamic and transient grid events.

SolarCity's Home Energy Management push

SolarCity has partnered with Nest to bring Nest Thermostats to the next 10,000 customers who have solar panels installed through SolarCity. The partnership between Nest and SolarCity solidifies the Google/SolarCity relationship, which has included numerous projects in recent months. Google recently committed $300 million to SolarCity's new residential solar project. This partnership highlights the potential of merging smart technologies such as solar, electric vehicles (EV), and smart home devices which includes appliances, lighting, security systems, and others. While some utilities look at it as a welcome trend, others look at it as a potential threat.

3. Mergers & Acquisitions

British Gas Buys AlertMe

British Gas stepped up its push into the smart home market with its acquisition of UK-based AlertMe. The deal is worth £65 million ($100 million) and cements the previous partnership between the two companies, in which AlertMe provided the software platform for British Gas' Hive smart thermostat system. British Gas now boasts more than 150,000 customers for its Hive system. With the UK government mandating the roll out of smart meters over the next six years, companies in the smart homes sector are increasingly confident demand for more sophisticated building controls will soar.

Silver Spring Acquires Escondido's Detectent

Silver Spring Networks (SSN) has agreed to acquire Detectent, a company that provides analytic software to utilities, for $12 million in cash.

According to SSN and Detectent, coupling their operational improvements and enhanced customer engagement creates a growing opportunity to unlock billions of dollars in value. Detectent's technology helps utilities improve the operational efficiencies of the power grids they manage, analyze customer billing accuracy, energy efficiency, and energy theft.

4. Smart Inverter –answer to integrating DERs

As utility grids see more and more Distributed Energy Resources (DERs), there is a greater need for dynamic control. The intermittency of these DERs is very difficult for a utility to deal with. This is where the inverter comes in. For utilities and grid operators, the capabilities of the inverter are vital to reliably integrating solar and other renewables onto the grid. Current inverter performances fall short and disconnect at first sign of grid disturbance. However, advancements in inverter technologies have given rise to a new type - the smart inverter.

So, what is a Smart Inverter? At a fundamental level, the inverter converts DC input to AC output, which, for a grid-tied system, enables the supply of real power to the grid. Other standard functions include power transfer optimization, voltage conversion, grid synchronization, disconnection, anti-islanding protection, and storage interfacing. These capabilities ensure that power is efficiently supplied to the grid while also providing key safety features. Functions beyond this scope are what qualify an inverter as "smart." These include reactive power control, voltage, frequency ride-through, advanced two-way control capabilities, storage integration and data streaming.

California utilities are already pushing for all new PV sites to use smart inverters. DOE and EPRI have a number of smart inverter demo projects in the works - collaborating with utilities such as National Grid, DTE Energy, Xcel Energy, etc.

Smart inverters are here to stay, and evolving. A new level of product differentiation is occurring in inverter space that goes well beyond traditional measurements like efficiency, kW rating and cost. These new inverters are enabling levels of PV penetration that simply would not otherwise be possible. These advanced features will enable the next phase of growth in the global distributed renewables industry.

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IXYS Acquires RadioPulse

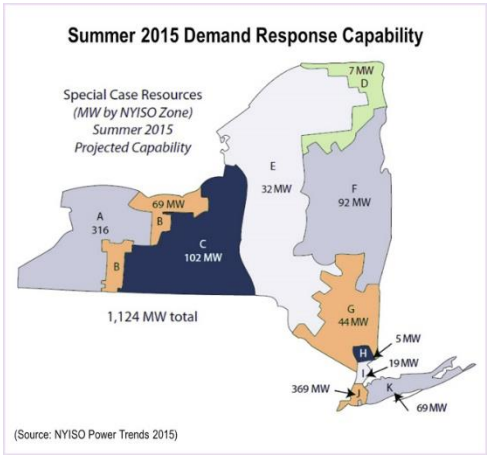
South Korean Firm IXYS signed a definitive agreement to acquire RadioPulse. IXYS, develops, manufactures and sells wireless network technology solutions based on the ZigBee protocol. RadioPulse's energy-friendly solutions are designed to enable a broad range of power-sensitive applications in the industrial,

medical, consumer, Smart Grid and IoT markets. The combined products set will allow IXYS to expand system solutions for customers globally.

Electrovaya Acquires Evonik Litarion

Electrovaya has completed the acquisition of Evonik Litarion GmbH and licensing of SEPARION, intellectual property, a unique ceramic composite separator, from Evonik. The transaction includes automated production plants for lithium ion electrodes and ceramic composite separators, with a rated capacity of 0.5 Gigawatt hours (GWh) of electrodes and 10 million m2 of ceramic separators along with all associated intellectual property. This is a transformational acquisition for Electrovaya as it instantly brings best-in-class manufacturing, and capacity to meet exciting growth prospects for the company's energy storage and other products. Products from the plant will now be expanded to broader and higher margin markets including grid-scale energy storage, aerospace, micro-grids and marine industries.

REV Advances in NY



The New York State PSC approved new rules through which electric utilities will offer customers financial payments to reduce the amount of electricity used during periods of high demand or system stress such as hot summer days. These programs will give consumers more options and control over energy bills, while also increasing utilities' ability to manage demand on their systems. These changes are core components of Governor Andrew M. Cuomo's reforming the Energy Vision (REV), a comprehensive strategy to build a clean, resilient, and affordable energy system for all New Yorkers.

The implementation of dynamic load management programs by all major electric utilities in the State represents a major step forward toward meeting New York's energy, capacity, and reliability goals in a cost effective and environmentally friendly way. Furthermore, as envisioned in the REV initiative, such programs will eventually become commonplace parts of the utility business model in New York as load management is incorporated into everyday operations and planning and the utilities transition from serving static loads to dynamically managing a platform that provides ratepayers with the greatest benefits at the lowest cost, while also maximizing consumer options.

5. Rates, Distribution companies and Solar

If utilities do nothing, they will see a reduction in revenues from the customers who have installed solar on their rooftops. This is a problem because there are some fixed costs for a utility necessary to support the infrastructure that has been put in place – these need to be recovered. When customers with solar on their rooftops pay less to their utility, the component of fixed costs that these customers had been paying must then be covered by others – who in turn will see their overall costs go up.

Now, this is a problem – what is the solution? Decouple

One plausible solution is to decouple rates into (at least) two components: (1) connection charge and (2) consumption charge.

- **Connection Charge:** The customer could pay a connection charge to stay connected to the grid. Components include:
  - Distribution connection charge: Customer's cost of staying connected to the utility distribution system.
  - Solar connection charge: Some utilities are looking at a nominal charge to connect solar to the grid.
  - Grid disconnect charge: Even if a customer wants to completely disconnect from the grid, they may need to pay for a portion of the distribution grid infrastructure.
- **Consumption Charge:** This is the energy charge paid by the customer for the energy consumed. This is component that would go down if the customer consumes less.

  To reimburse the customer when they send energy back into the grid, there is generally a different rate for that.

What is holding us back?

This is not a technical discussion – more of a regulatory discussion. Some states are encouraging their customers to install more distributed renewables on the grid and want to make it easier for them and reduce the burden on them. Once one or more states define the right path to covering utility fixed costs, we believe that the issue will get resolved.

Dr. Mani Vadari
Founder and President Modern Grid Solutions
Excerpts from article in Solar Rates

6. Smart Grid venture capital funding

VC funding in Q1 2015 was about $185 million in 15 deals, translating to a 200^{+}% increase over Q4 2014. There were 37 total VC investors including one accelerator who participated in VC funding rounds. Within Smart Grid, Smart Grid Communications Technology companies received the most funding.

Top 5 VC Funded Smart Grid Companies in Q1 2015

Company	$M	Investors
SIGFOX	115	Telefonica, SK Telecom, NTT DOCOMO Ventures, and others
Tempered Networks	15	Ignition Partners, IDG Ventures
Blue Pillar	14	EnerTech Capital, Allos Ventures, and others
Enbala Power Networks	11	GE Ventures, Edison Energy, Export Development Canada, and others
Trove Predictive Data Science	8.4	Avista, Itron, CUBRC

Source: Mercom Capital Group, llc

Exciting New Technologies to Watch Out for

A glimpse of some exciting technologies out in the market:

- **Cutting edge solar attic fan:** Solar Royal's newest model, the SR1800, is up to 50% less expensive, superior ease of installation, easier-to-maintain two-piece design, with greater aesthetic appeal, and proprietary, patent-pending attributes.

- **Scalable low-maintenance energy storage**: UtiliCell's EnergyVAULT™ is an energy storage solution scalable from kW to MW applications. It includes a control system, Lithium-Ion Battery Modules and a battery management system. The power conversion system offers power quality and a real-time control software interfaces to the electrical network, thereby controlling the stored power, and optimizing the charge or discharge of the batteries according to electrical grid needs.
- **Generating electricity directly from waste heat:** MicroPower's chip is a new solid-state semiconductor and no moving parts, which converts heat directly into electricity three times more efficiently than previously possible. It's design is based on a combination of solid-state thermoelectric and thermionic principles. Operating between 200˚C and 600˚C, MicroPower's semiconductor technology has demonstrated conversion efficiencies approaching 40% of ideal Carnot Cycle conversion efficiencies with absolute efficiencies of 18% – in other words, thermionic efficiency at a significantly lower temperature range in which many waste heat applications were simply not previously thought viable.

Smart Cities: Global Outlook and Forecasts 2014 - 2019

Smart Cities are a focal point for growth in several key ICT areas including: Connected Devices, Broadband Wireless, Cloud Computing and others. Smart City developments are causing many technologies and solutions to integrate with convergence across energy, water, sanitation, and other essential services.

Systems and resources are intertwined as mobility, communications, monitoring/control, performance management, predictability and forecasting all merge together. This convergence is being realized first in a few leading industries such as home entertainment and automobiles. It is forecasted that growth in certain related solutions and services areas will realize growth of 67% CAGR from 2014 through 2019.

7. News from Modern Grid Solutions

Electric System Operations – Evolving to the Modern Grid

Certified Minority Business Enterprise MBE

Dr. Vadari's book "**Electric System Operations – Evolving to the Modern Grid**" receiving rave reviews from readers. Buy them soon at any leading retailer. It is now being used at several universities as course materials

- SUNY Buffalo – Regular course – combined undergraduate and graduate course
- University of Wisconsin-Madison. Summer course
- Lehigh University, Pennsylvania
- Pennsylvania State University – to be used in the graduate program in Smart Grid
- Drexel University – Active consideration by Charles D. Close School as the foundation for a course in energy entrepreneurship.
- Other universities are actively looking at it for future courses.

Training news

- MGS has now signed a training deal with IEEE – to deliver a certificate course in Smart Grid through the EdX mechanism.
- Under the Smart Cities Council banner, Dr. Vadari delivered a Smart Cities Readiness Workshop in Dubai 26-27 April. The workshop was sponsored by the Dubai Real Estate Institute.
- Under the Smart Cities Council banner, Dr. Vadari will deliver a Smart Cities Readiness workshop as a part of the Smart Cities Week in Washington DC 14-16 September.
- Under the Smart Cities Council banner, Dr. Vadari will join Jesse Berst in delivering a Smart Cities Readiness workshop as a part of the International City/County Management Association (ICMA) annual conference in Seattle, WA.

Events and News

- Under the banner of Smart Cities Council, Dr. Vadari will present the keynote at the Mauritius Smart Cities 2015 on October 14-15 in Balaclava, Mauritius.
- Dr. Vadari is now a regular contributor to the IdeaXchange blogs managed by Transmission & Distribution World. Check out the latest one at the T&D World site.
- Dr. Vadari is now a regular contributor to the Intel energy series blog also. Check out the latest one at the Intel site.

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