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State of the Grid

A Service from Modern Grid Academy

Welcome to the 4th 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 more than 1400 people. The newsletter presents a wrap-up to the year 2016. It is a packed newsletter full of very interesting articles that I believe you would enjoy.

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

- Subscriptions to “State of the Grid” briefing has now blown past 1400 and is on its way to reaching 1500.
- Dr. Vadari was one of the main presenters at the US-India Smart Technical Workshop held in Delhi on December 8th, 2016.
- MGS now has over 20 experts who 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

Carnegie Wave Energy “Energy Made Clean”

Carnegie Wave Energy (CWE) acquired the leading Australian battery and solar engineering company Energy Made Clean, subject to formal agreements and shareholder approval.

With this acquisition, Carnegie will be the only ASX-listed company with a dedicated renewable energy microgrid project delivery capability. Under this agreement, Carnegie will invest \$2.6 MM cash and \$10.4 MM in shares allowing Carnegie to the lead at designing, developing, financing, constructing, operating and maintaining microgrids, utilizing a world-first combination of wave, solar, wind, energy storage, desalination and diesel in both on/off-grid applications in Australia and other parts of the world.

Accenture Acquires Realworld OO Systems

Accenture acquired Realworld OO Systems B.V., a Netherlands-based company specializing in geographic information system (GIS) solutions. The transaction will expand Accenture’s end-to-end portfolio of smart grid services and accelerate its plans to grow digital consulting services in Europe. By adding GIS services, Accenture will help clients with integrating information and operations technologies. Accenture now can provide Realworld OO Systems an opportunity to immediately expand its business in Europe, while providing employees new technology or industry consulting career paths.

Tecogen to Acquire American DG Energy

Tecogen will acquire all outstanding shares of American DG in a stock-for-stock merger. The transaction will create a vertically integrated clean technology company offering equipment design, manufacturing, installation, financing, and long term maintenance service. This transaction will allow Tecogen to offer a cost-free-installation option to customers without access to financing, sufficient capital on hand, or for those who may not be interested in owning and maintaining the equipment.

3. Key Highlights

Denmark’s 5-Point Strategy to be Global Smart Cities Leader

Denmark has the makings of a leader and a model for other cities through its combination of cooperation, collaboration and communication. The government has recognized the need for a national strategy for smart city solutions to ensure targeted and systematic efforts at all levels. Based on this a 5-point strategy was recommended to set the country on the path to global leadership:

1. Help cities create their own vision so they know which technologies they need and manage their smart city projects in a way that involves all municipal services.
2. Strengthen city collaboration by building on existing networks between municipalities to encourage knowledge sharing and work toward common interests to draw private investment.
3. Clarify standards and regulation to monitor and guide through the necessary technical and legal steps.
4. Ensure that city officials listen to what their citizens have to say about their needs and issues -- and make those concerns are part of the design process.
5. Publish a national smart cities vision to heighten awareness and understanding of the value smart cities offer, as well as a roadmap that also clearly explains targets and expected outcomes.

4. Transformation: Automation – Sensing, analysis & control

Automation is about sensing, control and the algorithms that are necessary to take the data from the sensors, perform some calculations on them and controlling some device in the field.

- **Sensing.** Sensing has seen significant change over the last several years. It has become smaller, more sophisticated, capable of sensing more than one quantity, performing localized calculations faster and even communicating to distant locations using different mechanisms.
- **Moving from sensing to analysis.** Analytics takes a combination of the data received from sensors and the as-operated model to define the state of the network. Analysis is another area that has seen tremendous change using as combination of faster and better processing, better algorithms, and the introduction of distributed analysis very often embedded into the sensors themselves.
- **Last step is from analysis to control:** Controls have moved from being mostly manual (in the distribution network) to becoming more and more automated and having the ability to support extremely complex control schemes many that were only available in transmission until now. Very often, the complexity of distribution level control schemes comes from the need to manage and handle Distributed Energy Resources (DERs) and/or microgrids.

The future is moving towards embedded sensing, analysis and control. The future device will already come with pre-installed sensors, analysis mechanisms, controls and communications mechanisms built into it. The addition of the new functionality will come at very little added cost, can be self-maintaining, remote-upgrading on functionality and can take advantage of the latest technologies of bringing “silicon to the edge of the grid”.

True value comes from changes in the business model through the provision of improved processes and people changes. For automation to deliver value both the utility’s front, mid, and back offices need to be transformed.

Automation is the first step to making the grid smart (Smart meters/AMI were an initial step in this direction) and the release in value comes from the utility, the customer, the regulator and all others along the value chain only when they also transform themselves.

*Dr. Mani Vadari, President and Founder, Modern Grid Solutions
mani.vadari@moderngridsolutions.com*

Previously published by Intel Energy Insights - viewable in full at “[Utility Transformation: Automation – All about sensing, analysis and control](#)”

CEC to Grant \$26 MM for Solar and Storage Projects

The California Energy Commission (CEC) intends to award up to \$26 MM for advanced technologies and solutions supporting increased viability, capability, adoption or grid integration of distributed solar resources.

The solicitation intends to advance deployment/grid integration of distributed solar resources through use of energy storage, smart inverters, and advanced forecasting/modeling techniques. The solicitation will fund applied research and development, and

technology demonstration and deployment projects. The projects must fall within one of the following project groups to be eligible:

- **Group 1:** Pilot demonstration of advanced solar + Storage technologies for community-scale applications;
- **Group 2:** Pilot demonstration of advanced solar + storage technologies for building-scale applications;
- **Group 3:** Enhanced modeling tools to maximize solar + storage benefits;
- **Group 4:** Advanced smart inverter capabilities to support high-penetration solar;
- **Group 5:** Holistic forecasting to support high-penetration solar grid operations; and
- **Group 6:** Deployment to facilitate storage interconnection to enable Integration energy from high-penetration distributed PV..

5. Transformation: DER - Supply from the edge of the Grid

DERs are all about providing energy into the grid closer to where the customers are. So, what does this mean?

- **What types of generation are called DERs?** However, between NY and CA, a standardized list is emerging which includes Solar (PV, CSP), Fuel cell, Wind, Thermal, Hydro, Biogas, Cogeneration, Combustion generators. They also include various forms of storage and demand response.
- **Size, number and location:** There are many of them and they are small. They are also moving away from needing to use the transmission system and are located directly on the distribution system closer to the consumption.
- **Not all of them are from renewable sources:** Not all DERs get their energy from renewable sources. Some of these are not even sources of energy in the traditional sense – Energy storage and demand response are examples of these.

What does this mean to the Utility?

- **2-way power flow:** The distribution system worldwide is designed to be radial in nature. This paradigm is impacted by DERs that are generating closer to the consumption impacting everything in the grid from design of the infrastructure, infrastructure protection, people work procedures and safety, all the way to grid operations, system planning, commercial operations and beyond.
- **New technical and business configurations:** Microgrids can be defined as a group of interconnected loads and DERs with a clear set of electrical boundaries and can act as a single entity both physically and from a control perspective. These entities can also result in the reduction of the load from a utility (reduced revenues) and entities fully within a utility environment but controlling themselves.
- **New players entering the marketplace:** The advent of DERs is also bringing in new players such as DSO (or DSPs as defined in the NY REV), aggregators, and others.
- **New business models:** Companies such as Edison Energy, Con Edison Solutions, are going outside their traditional rate-base but delivering unregulated services to their (and other) customers.

Utilities will need to transform. While the present pace of the movement towards a distributed world is slow, the pace is slowly moving up exponentially as it accelerates and at some tipping point in the future, the course will change irreversibly.

Dr. Mani Vadari, President and Founder, Modern Grid Solutions

mani.vadari@moderngridsolutions.com

Previously published by Intel Energy Insights - viewable in full at "Utility Transformation: Distributed Energy – Supply from the edge of the Grid"

Boston tries Public-Private Partnership for a Smarter City

Boston issued a RFI that sets out the city's positions on the topic, what it hopes to accomplish and how the public can help. An excerpt from the RFI explains, "this next step starts with you! We want to create a thriving, 21st century city for all, and we can only get there with partners. These sorts of collaborations will enable us to explore how to best turn data, design and tech into public value."

Through the RFI the city is looking to form public-private partnerships to accomplish its overall goals:

- Increase digital access and equity
- Improve mobility and flow of people through the city
- Develop accessible and useful public spaces
- Deliver exceptional city services
- Expand constituent engagement
- Spark business growth and build a platform for learning

Generating Cost of Solar Declines Over Other Renewables

Annual in-depth studies by Lazard compare energy costs from renewable and storage technologies. Analysis shows continued decline in cost of solar generation, but lesser declines from other renewables. Storage technologies cost reductions show wide variations depending on type of application and technology:

LCOE (Levelized Cost of Energy) 10.0

- Median levelized cost of energy from utility-scale PV technologies is down 11% from last year, and residential rooftop PV technology is down about 26%.
- Cost of generating energy from other renewables such as onshore wind, geothermal, & biomass, declined minimally, reflecting both maturing of technology & lower investment.

LCOS (Levelized Cost of Storage) 2.0

- Median cost of li-on decreased by 12% (peaker replacement), 24% (transmission investment deferral) and 11% (residential) over last year, partially attributable to declining capital costs.
- "Behind-meter" merchant energy storage, sited at factories, universities & hospitals, show great promise. But, economic viability depends on local market structure and incentives.
- Industry expects continued high demand for storage resulting in enhanced manufacturing scale and ensuing cost declines.

Although alternative energy is increasingly cost-competitive and storage technology holds promise, they alone cannot meet baseload generation needs of a developed economy for the foreseeable future. The optimal solution is to use a diversified fleet of traditional and alternative energy sources.

Six "Smarter Energy Grids" Projects Get Funding in UK

UK's Ofgem is driving innovation improvements across electricity & gas sector. This year, Ofgem is funding £44.6 MM for 6 projects (4 electric and 2 gas). The winning projects involve:

- Probing role of hydrogen in gas networks by blending 10-20% hydrogen with natural gas on Keele University's gas network.

- Using cloud-based software to allow communities to make more efficient use of locally-connected renewable energy.
- Using new types of circuit breakers to ease network faults helping smaller generators connect in areas such as London.
- Testing whether small scale distribution-connected generators can provide services traditionally offered by larger generators.
- Trialing new equipment to regulate frequency and voltage on the grid in response to variable output from wind farms.
- Developing a new billing system to adapt to the next generation of gas sources on the networks.

Diamond-Age of Power Generation as Nuclear Batteries Developed

University of Bristol scientists have used nuclear waste to generate electricity. They have grown an artificial diamond that, when placed in a radioactive field, generates a small electrical current. The team demonstrated a prototype 'diamond battery' using Nickel-63 as the radiation source and are working to improve the efficiency by utilizing carbon-14, a radioactive version of carbon. Applications include low-power electrical devices where long life of the energy source is needed, such as pacemakers, satellites, high-altitude drones, and spacecraft.

Could Performance-based Incentives be Key to a Modernized Grid

Utility regulators in some U.S. states are considering adoption of performance-based rates to replace the traditional cost of service model. Under this model, utility's revenues are not based on total costs of providing service, but rather on a broad economic measure such as the Consumer Price Index in conjunction with a set of specific performance metrics related to the utility's operations.

Performance-based rates provides a utility with a strong incentive to control costs. Performance-based rates would fundamentally change the rate-setting process from a singular focus on cost recovery to one focused on financial and operational incentives.

Some states, such as Connecticut, Illinois and Maryland, have established performance-based reliability requirements. The requirements incorporate incentives for meeting reliability standards and penalties for falling short.

Are we ready for a Smart State?

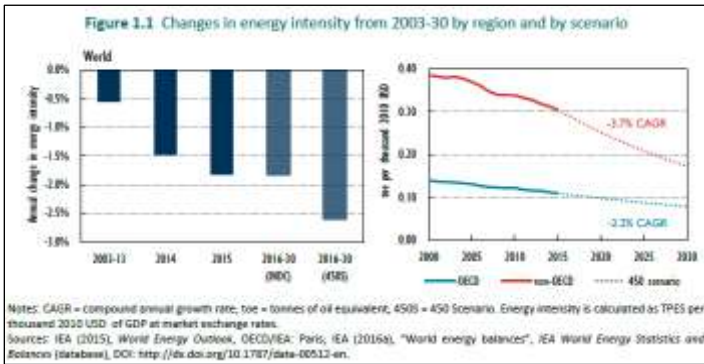
A smart state converges on a shared approach of sharing infrastructure and costs - using information and communications technology (ICT) to enhance livability, workability and sustainability in its cities, towns, rural areas and state agencies.

As an example, Smarter Illinois harnesses digital transformation in a socially inclusive way that strengthens business opportunities and the state's brand. Key goals of its smart state initiative include improving the overall efficiency, effectiveness and accessibility of government services; creating an attractive climate for businesses and entrepreneurs. Its key action areas include:

- Applying sensors and connectivity to buildings & streetlights
- Enhancing mobile citizen engagement and delivery of government services
- Developing a procurement platform to obtain better pricing through volume discounts and streamline city/state purchasing
- Generating more benefits from existing assets
- Using a digital portal to create business-friendly state
- Applying smart cities standards

- Reviewing policy and regulations to remove barriers to implementing smart technologies

Growing Investor Confidence in Energy Efficiency Markets



The IEA estimates that global investment in energy efficiency was USD 221 billion in 2015, an increase of 6% from 2014. Investment in efficiency was two-thirds greater than investment in conventional power generation in 2015. Energy efficiency services are now a sizeable, distinct market sector. In 2015, energy service companies (ESCOs), whose primary business model is delivering energy efficiency solutions, had a total turnover of USD 24 billion.

Mergers and acquisitions of energy efficiency services firms have also been increasing, with utilities, technology providers and equipment manufacturers all stepping into the market. The low energy demand outlook in IEA countries has prompted several

traditional energy utilities to adopt the provision of energy services to expand their revenues.

Finance for dedicated energy efficiency products and services is also expanding. Since their launch in 2012, the value of "green" bonds have grown to over USD 40 billion in 2015, of which over USD 8 billion is dedicated to energy efficiency. Other financial products are also starting to develop.

6. Smart Grid venture capital (VC) funding

Top 5 VC Funded Companies in Q3 2016

Company	\$M	Investors
Ecobee	35	Amazon Alexa Fund, Thomvest, Relay Ventures
Skeleton Technologies	14.5	FirstFloor Capital, UP Invest, Harju Elekter
Sense	14	Shell Technology Ventures, Energy Impact Partners, Capricorn Investment Group, etc.
Cadenza Innovation	5.2	Golden Seeds, Connecticut Innovations, Scale Investors, Eric Redman, Mark Torrance
Site 1001	5	JE Dunn Construction Company, Flyover Capital, Tifec, Ward Ventures

Source: Mercom Capital Group, Inc

Smart Grid, Battery Storage and Efficiency companies raised \$102 MM in venture capital funding (including private equity and corporate venture capital) in Q3 2016. Of this, VC funding for Smart Grid companies came to \$11 MM in 7 deals in 3rdQtr2016.

7. News from Modern Grid Solutions

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.

Training news - Courses based on materials from MGS and offered by IEEE and edX.

- Module 1 of the IEEE certificate course titled "**Smart Grids: Electricity for the Future**" was extremely successful with over 8300 registrants from across 167 countries. 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.
- Module 2 of the IEEE certificate course titled "**Distributed Energy – Smart Grid Resources for the Future**" is now live and has over 4000 registrants. You can register for this course at: "<https://www.edx.org/course/distributed-energy-smart-grid-resources-ieee-smartgrid02-x>". Please pass the course and registration information to people in your contact lists.
- Stay tuned for Module 3.

Events and News – Dr. Vadari in the news

- "[Utility Transformation: Distributed Energy – Supply from the edge of the Grid](#)", an Intel Blog Series, Article #4, is listed in Grid Insights, a series sponsored by Intel at Grid Insights by Intel, October 11th, 2016.
- "[Utility Transformation: Automation – All about sensing, analysis and control](#)", an Intel Blog Series, Article #3, is listed in Grid Insights, a series sponsored by Intel at Grid Insights by Intel, September 8th, 2016.

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.