State of the Grid

2ND QUARTER 2021

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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.

WELCOME TO OUR Q2 2021 NEWSLETTER!

Summer is in full swing here in the Northern Hemisphere. You'd have to be living under a rock not to notice the change in our weather of late. In fact, it might be more comfortable living under a rock with some of the record-breaking heat we've been experiencing!

With extreme weather comes the impact to our electricity grid, e.g., potential rolling blackouts (California), rationing electricity (China), droughts drying up reservoirs (Brazil), high power prices (Europe).

As things start to heat up and open up post-pandemic, we hope you're staying safe and cool out there.

Dr. Mani Vadari, President

IN THIS ISSUE

INDUSTRY EVENTS

WEBINAR: SSO/SSR Detection, Modeling and Analysis in a Smart Grid

July 15, 2021 11:00 AM EDT

Subsynchronous Oscillations/Resonance (SSO/SSR) is a very important phenomenon in Wind Energy Integration to Smart Grid. This webinar will discuss the modeling, detection and analysis of SSO in the Smart Grid. The application of Time-Frequency Signal Processing and Machine Learning for the study of SSO/SSR phenomenon under flicker and noise. Design of protection for the Wind Turbines as well as the system. It will also help in revision of IEEE Distributed Generation Standard 1547.Click through for more info and to register.

WEBINAR: Modernizing and Preparing the Grid for Decarbonization

July 23, 2021 12:00 PM EDT

The U.S. recently shared its infrastructure plan, as well as a path to achieve 100% carbon-free electricity by 2035. Join the discussion to learn more about: Grid-enhancing Technologies for Transmission grid to enable higher renewable energy integrations; T&D Digital Substations to prepare the grid for decarbonization, digitalization, decentralization; Energy efficiency in Smart Buildings; Cybersecurity and cyber risks mitigation of the modernized grid. Click through for more info and to register.

VIRTUAL CONFERENCE: 2021 IEEE PES Virtual General Meeting

July 25-29, 2021

Registration is open for this now virtual conference, "Managing Energy Business During a Pandemic." Click through for more info and to register.

CALL FOR PARTICIPATION: IEEE PES T&D Conference & Expo

Submission Deadline for Tutorials: August 6, 2021

Submission Deadline for Papers and Panels: August 15, 2021

Don't miss your opportunity to shape the future of energy solutions for years to come at the 2022 IEEE PES T&D Conference and Exposition (April 25-28, 2022). Power and energy professionals worldwide are invited to submit papers, panels, and tutorials on their innovative ideas, research and development, application experience, and expertise. Click through for more info and to register.

PAST EVENT: Prospects for electric vehicles in a green world

May 25, 2021

Dr. Vadari gave the keynote address at the IEEE Smart Grid U.K. Student Branch Virtual Inauguration Event. The event was hosted virtually by IEEE Smart Village and the University of Johannesburg.

MERGERS AND ACQUISITIONS

Birdseye Renewable Energy acquired by Dominion Energy

Birdseye Renewable Energy, a developer of utility-scale solar and storage facilities in the southeastern United States, was acquired by Dominion Energy for $38.05 million. Dominion Energy, a utility provider for 16 states, will use the acquisition to meet its goals to expand the use of renewable energy throughout its service region. Read more here.

TerraScale and iQ International agree to merger

TerraScale, a developer of renewable-energy powered data centers, and iQ International, a battery manufacturer, agreed to a merger. The combined company will focus on enhancing sustainability and security in data center design. Read more here.

NR3 and Montauk Renewables join forces to convert waste into renewable energy

NR3, LLC, which uses zero-emissions processes to convert animal and agriculture waste into forms of environmentally friendly, 100% organic, renewable energy alternatives that can replace the three primary fossil fuels of the global energy infrastructure: oil, gas and coal, was acquired by Montauk Renewables, Inc. Montauk seeks to deploy NR3's technologies to initially focus on harnessing energy from the U.S. swine industry. Read more here.

SparkCognition acquired Ensemble Energy to accelerate the adoption of A.I. within the energy industry

SparkCognition acquired Ensemble Energy, developer of a predictive analytics and asset management platform for the renewable energy industry, for an undisclosed amount. SparkCognition provides artificial intelligence solutions for various industries, including defense, manufacturing, and energy industries. Read more here.

Aria Energy agrees to be acquired by Archaea Energy for $680M

Aria Energy reached a definitive agreement to be acquired by Archaea Energy for $680 million. The business combination with Archaea and Aria, one of the largest companies in the North American landfill gas (LFG) sector, will create the leading U.S. RNG platform. The combined company, which will be called Archaea Energy, will be dedicated to reducing carbon emissions through landfill gas conversion, CO2 sequestration, and green hydrogen. Read more here.

Sunnova to acquire SunStreet, a solar platform for homebuilders

Sunnova Energy International Inc., a U.S. residential solar and storage service provider, and Len X, LLC , a technology-focused subsidiary of Lennar Corporation, one of the nation's leading homebuilders, announced today they have entered into a definitive agreement under which Sunnova will acquire Lennar's residential solar platform ("SunStreet"). In addition to Sunnova's acquisition of SunStreet, Sunnova will become Lennar's exclusive residential solar and storage service provider for new home communities with solar across the country. Read more here.

Pineapple Energy and CSI merge to focus on the residential DER market and VPPs

Communications Systems, Inc., an IoT intelligent edge products and services company, announced that it entered into a definitive merger agreement with privately-held Pineapple Energy, LLC , a growing U.S. operator and consolidator of residential solar, battery storage, and grid services solutions. Upon closing, CSI will do business as Pineapple Energy, with a business model focused on the rapidly growing home solar industry. Read more here.

PowerVerde merges with 374Water to eliminate PFAS

PowerVerde Inc., a Florida-based energy systems developer, and 374Water Inc., a North Carolina-based cleantech company, announced the completion of their merger. The merger will accelerate the delivery of a waste and water resource recovery system that will enable municipal, industrial waste, and wastewater management organizations to address the growing risk of 'forever chemicals' PFAS (Per- and polyfluoroalkyl substances) contamination, while also recovering precious natural resources. PowerVerde Inc. is committed to creating eco-friendly power solutions and is primarily engaged in the development, commercialization, and marketing of electric generating power systems. Read more here.

Total acquires stake in Hysetco in support of hydrogen mobility

Total announces the acquisition of a 20% stake in Hysetco, a French company dedicated to the development of hydrogen mobility in cities. Hysetco owns the largest fleet of hydrogen taxis in the world, launched in 2015 and operated in the Île-de-France region under the Hype brand, as well as hydrogen stations. Hysetco currently owns around 700 taxis in Paris, with still a majority of diesel vehicles that will transition gradually to become exclusively comprised of hydrogen vehicles by 2024. The hydrogen taxis are fueled by a dedicated network of hydrogen stations operated by Hysetco. This network is expected to expand in the coming years to support the growth of hydrogen vehicle fleets. Total will make its network of service-stations available to Hysetco to contribute to the growth of this network of hydrogen stations. Read more here.

Total rebrands to capitalize on renewables

Total has rebranded TotalEnergies as it focuses more on renewables and clean energy. With its 20% stake in Hysetco (above) and its agreement with WPD to acquire a 23% interest in Yunlin Holding GmbH, the owner of Yunlin offshore wind farm located off the coast of Taiwan, TotalEnergies is trying to reinvent itself as a green company as public concerns grow over climate change. Read more here.

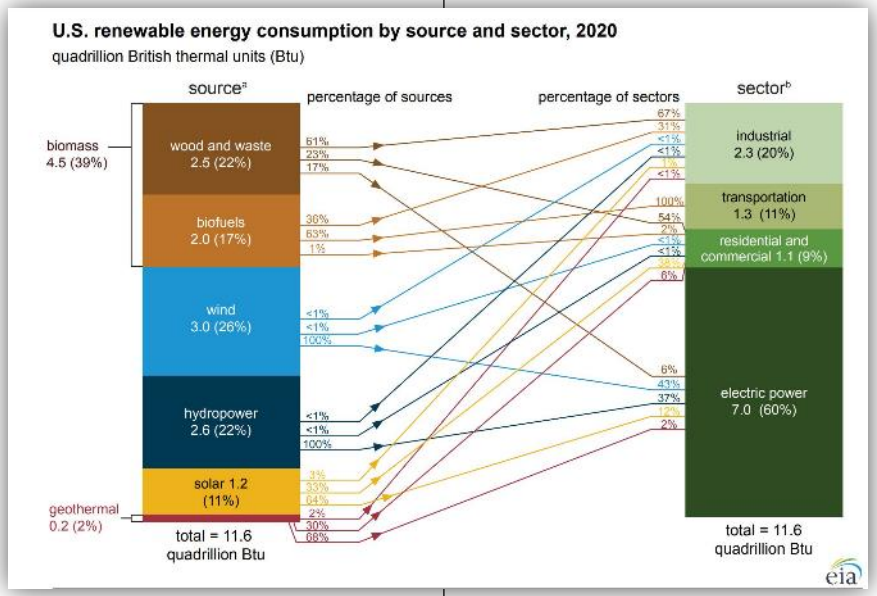
Drax and Mitsubishi to deliver the largest carbon capture project

Drax Group and Mitsubishi Heavy Industries Engineering have agreed to a long-term contract that will see Drax license and use Mitsubishi's (MHI) unique carbon capture solvent, KS-21TM, to capture CO2 at its power station near Selby, North Yorkshire. Drax has already converted the power station to use sustainable biomass instead of coal, reducing its emissions by more than 85%. By deploying Biomass Energy and Carbon Capture and Storage (BECCS) technology, Drax aims to be carbon negative by 2030. The first BECCS unit at Drax could be operational as soon as 2027, capturing and storing at least 8 million tonnes of CO2 a year by 2030. Read more here.

KEY HIGHLIGHTS

Bill Gates and Warren Buffett are building a $1 billion next-generation nuclear reactor in Wyoming

Billionaire Bill Gates' advanced nuclear reactor company TerraPower LLC and PacifiCorp have selected Wyoming to launch the first Natrium reactor project on a retiring coal plant site. TerraPower, founded by Gates about 15 years ago, and power company PacifiCorp, owned by Warren Buffet's Berkshire Hathaway, said the exact site of the Natrium reactor demonstration plant is expected to be announced by the end of the year. Small advanced reactors, which run on different fuels than traditional reactors, are regarded by some as a critical carbon-free technology than can supplement intermittent power sources like wind and solar as states strive to cut emissions that cause climate change. The project features a 345-megawatt sodium-cooled fast reactor with molten salt-based energy storage that could boost the system's power output to 500 MW during peak power demand. TerraPower said last year that the plants would cost about $1 billion. Late last year the U.S. Department of Energy awarded TerraPower $80 million in initial funding to demonstrate Natrium technology, and the department has committed additional funding in coming years subject to congressional appropriations. Read more here.



World's biggest wind and solar hydrogen hub planned for south-west Australia

An international consortium plans to build the world's biggest renewable energy hub along the south coast of Western Australia. The Western Green Energy Hub (WGEH) would stretch across 15,000 square kilometers and could produce up to 50 gigawatts of energy. If it was created, the hub would produce 3.5 million tons of zero-carbon green hydrogen, or 20 million tons of green ammonia each year, for both domestic consumption and export. Read more here.

GridWise Alliance calls for $50 billion to modernize U.S. power grid

The GridWise Alliance has renewed a call for significant investments to be made in the U.S.'s transmission and distribution systems. In a letter to the U.S. Congressional leaders member organizations of the industry Alliance and the members of its Grid Infrastructure Advisory Council have called for at least $50 billion to improve the resilience, security and flexibility of the national grid. The 2-page request offers recommendations on how investments in the nation's electric system will make the grid more resilient, secure, and flexible. Collectively, the signatories on the letter represent $4 trillion of market capital, employ 1.6 million people in the United States, and represent 825,000 union workers. Read more here.

New solar plant named after Hydro Quebec's first female engineer

For the first time in Hydro-Québec's history, solar power is now supplying the company's grid. Gabrielle-Bodis generating station, located in La Prairie, and Robert-A.-Boyd generating station in Varennes were recently inaugurated. The generating stations have a combined installed capacity of 9.5 MW and will be able to generate close to 16 GWh of solar power annually—equivalent to the consumption of 1,000 residential customers. These facilities will help Hydro-Québec determine whether solar power is a good fit for H.Q.'s generating fleet, its transmission grid and the Québec climate. "I am very proud that the generating station in La Prairie pays tribute to Gabrielle Bodis," stated Sophie Brochu, President and CEO of Hydro-Québec. "She was the very first woman to earn an engineering degree from Polytechnique Montréal and she worked for Hydro-Québec for over 35 years. It is also the first Hydro-Québec facility named after a woman." Read more here.

The U.S. consumed a record amount of renewable energy in 2020

In 2020, consumption of renewable energy in the United States grew for the fifth year in a row, reaching a record high of 11.6 quadrillion British thermal units (Btu), or 12% of total U.S. energy consumption. Renewable energy was the only source of U.S. energy consumption that increased in 2020 from 2019; fossil fuel and nuclear consumption declined. Our U.S. renewable energy consumption by source and sector chart (left) shows how much renewable energy by source each sector consumes. Read more here.

Northwestern Energy joins the Western Energy Imbalance Market

The Western Energy Imbalance Market (EIM), operated by the California Independent System Operator (ISO), has expanded its footprint to Montana with the addition of NorthWestern Energy. NorthWestern Energy's participation caps off a year of significant growth for the real-time energy market, with eight utilities joining already this year. The Western EIM now serves consumers in 10 states, including portions of Arizona, California, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, Wyoming, and Montana. By 2023, 22 active Western EIM participants will represent more than 83% of the load in the Western Interconnection. Read more here.

Singapore's first large-scale solar floating farm opens at Tengeh Reservoir

Singapore, home to the world's largest offshore floating PV farm and the world's largest FPV testbed is now home to an operational 60 MW PV array on the Tengeh Reervoir. Sembcorp Floating Solar Singapore, a unit of Sembcorp Industries, began construction on the system back in June 2020. On July 14, Singapore unveiled one of the world's biggest floating solar power farms. Covering an area the size of 45 football fields, the project comprises 122,000 panels on the Tengeh Reservoir. It is part of Singapore's efforts to quadruple its solar energy production by 2025. The farm will produce enough electricity to run the country's five water treatment plants.. Read more here. And watch a comprehensive video about the project here.

World's largest offshore wind farm reaches major milestone

World's largest offshore wind developer Ørsted said it had installed its 1000th offshore wind turbine in U.K. waters. "As part of the Hornsea Two offshore wind farm installation, the 16th turbine to be erected at site symbolizes the world leader in offshore wind's millennial milestone," Ørsted said in a statement. The company, based in Denmark, has been building offshore wind farms in the U.K. since 2004 when it secured its first project, Barrow offshore wind farm. According to Ørsted, Hornsea Two, where the 1000th turbine milestone was achieved, will, with its 165 turbines, become the world's largest offshore wind farm once completed in 2022. Located some 89 kilometers northeast of Grimsby, Hornsea Two comprises 165 wind turbines, an offshore substation, and a reactive compensation station. Read more here.

Image Source: Ørsted

Con Edison spends $1.5 billion on grid modernization

Con Edison has completed projects throughout New York City and Westchester County to maintain its industry-leading reliability while continuing to lead the state's shift toward renewables and other clean technologies. The company invested $1.5 billion on new cable, transformers, network protectors, switches and other components that make its electric-delivery system robust. Meanwhile, the company continues to lead New York State's transition to a low-carbon, clean energy future. Con Edison is adding energy storage to its system and investing in transmission to bring renewable energy to customers. The company is helping customers save with energy efficiency programs, connect solar panels and adopt electric vehicles. Read more here.

First hydrogen powered houses in the U.K.

U.K. energy company Northern Gas Networks is partnering with smart meter company MeteRSit to install some hydrogen meters in the country's first houses to be powered entirely by hydrogen. The intelligent meters, which MeteRSit is developing as part of the U.K. Department for Business, Energy & Industrial Strategy (BEIS)'s Hy4Heat project, will be installed at Northern Gas Network (NGN)'s site at Low Thornley in northern England. Read more here and here.

Italy's Dolomiti Energia secures funding for grid modernization

Italian energy company Dolomiti Energia has secured €100 million ($121 million) in European Investment Bank (EIB) funding to modernize its electricity and water distribution infrastructure. The aim is to achieve water and energy sustainability and transition goals set by both the Italian government and the European Commission. The utility will be installing second-generation smart meters and smart streetlights to digitize its grid network, a development that will help improve consumer energy efficiency and the management of the electricity distribution system. Upgrades to the energy network will have a direct positive impact on approximately 335,000 consumers whilst upgrades to the water infrastructure will benefit 78,000 households in north-eastern Italy. Read more here.

Eiffel Tower illuminated with renewable hydrogen

Renewable hydrogen-powered the lights and laser show at the Eiffel Tower in Paris for the first time in May. This green energy demonstration was a component of the "Paris de l'hydrogène" event organized by Energy Observer (check out some of E.O.'s other innovations here) who also supplied the hydrogen electricity equipment for the event.The hydrogen used to power the event was supplied by Air Liquide to showcase the potential role of hydrogen in France's green recovery, as well as raising awareness of the energy transition in general. Read more here.

AES Ohio smart grid receives PUCO approval

The Public Utility Commission of Ohio has granted U.S. utility AES Ohio approval to implement phase 1 of its $249 million smart grid program. The smart grid project forms part of the utility's digital transformation and will help ensure the development of a modern, robust and efficient grid network with fewer customer outages. AES Ohio will spend up to $267 million over the next four years on smart meters and self-healing grid technologies capable of responding in real time to service outages and more. Read more here.

Largest off-grid solar-battery system for the mining industry

Suntrace and BayWa r.e., together with B2Gold, have completed commissioning of the world's largest off-grid solar-battery hybrid system for the mining industry, at the Fekola gold mine in Mali, West Africa. The Fekola gold mine operates 24-hours a day. During the daytime, the new 30 M.W. solar plant allows three out of six heavy fuel oil generators to be shut down; the energy production of the residual three generators could also be significantly reduced. The 15.4 MWh battery storage compensates energy generation fluctuations and assures a reliable operation, which allows up to 75% of the electricity demand of the gold mine to be covered by renewable energy during the daytime. Read more here.

ERCOT releases roadmap to improving grid reliability

ERCOT's newly appointed interim President and CEO Brad Jones delivered a 60-item roadmap to Texas Governor Greg Abbott, members of the Texas Legislature and the Public utility Commission. The roadmap is a comprehensive plan that addresses operational improvements to the Texas power grid, including important legislative changes, objectives outlined in the Governor's letter issued July 6 and other reforms. In developing the Roadmap, Jones and the ERCOT team worked with the PUC, customers, former regulators, retired industry executives, environmental advocates and market participants to ensure all areas for improvement were considered and included. Read the roadmap here.

Duke Energy plans to triple renewable energy production this decade

By the end of this decade, renewables will make up a large portion of the company's generation mix as Duke Energy looks to triple the amount of renewable energy it produces from company power plants and dramatically reduce carbon emissions. This information, along with large amounts of other data, is spelled out in Duke Energy's 15th Sustainability Report, the company's annual disclosure on environment, social and governance (ESG) issues. Read more here.

FEATURED ARTICLE

Storage Primer
Third of a five-part series
By John (J.D.) Hammerly, CEO, The Glarus Group

The third article in our five-part series takes us beyond the halfway point. The first two articles delivered a storage overview and explained dominant battery storage chemistries. The first article in December '20 identified Li-NMC batteries as the dominant solution for stationary storage because the storage market is driven by mobile electronification. Three months later, the second article, still accurate, identified alternative battery chemistries (Li-LFP, Li-Ti, and others) had moved from the labs to production. As the storage journey continues, we will explore storage solutions that may successfully compete with lithium storage technologies.

Storage differentiation

The success of a storage technology requires differentiation. Cost differentiation comprises multiple factors such as buy-cost, install-cost, cost to operate, and longevity (e.g., charge/recharge cycle count), but success factors beyond cost, such as storage duration and roundtrip efficiency, may matter more. Given that electricity is cheap most of the time, roundtrip storage efficiency becomes less important, but storage duration is key. Today, there are two storage time domains: short-term and long-term. Short-term has a goal of 16-hour storage, currently 4 hours, to capture daytime renewables to get through the night. Long-term, currently uncommon, would be greater than 16 hours. I anticipate long-term storage to bifurcate into mid-term, eventually (e.g., a week), and long-term (e.g., more than a week).

Electricity can be stored in chemical, kinetic, thermal, and electronic "batteries." The major considerations for stationary storage are duration and cost. Energy density is less important, although it drives the physical size, and roundtrip efficiency is subject to energy cost.

Chemical storage

Chemical storage includes not only lithium-ion batteries but also flow batteries. The first vanadium redox flow batteries recently entered production, and more are planned or under construction. Flow battery deployment expansion results from their lower cost and longer storage duration compared to lithium-based batteries. Their fundamental design, in which a fluid is pumped across a charge/discharge membrane, limits the charge and discharge speed making them less attractive for power applications but superior for energy storage. Further, flow battery capacity expansion only requires tank enlargement, making installations scalable. The introduction of less toxic, low-cost fluids such as iron/saltwater further improves their viability.

Hydrogen is another promising chemical storage solution stored physically as either a gas or a liquid. Hydrogen is produced either through water electrolysis or natural gas reformation. The stored hydrogen can be blended with or replace natural gas in existing generation (burned) or converted directly to electricity via a fuel cell. Stored hydrogen offers nearly unlimited storage duration with an energy density over 130 times that of a lithium-based solid battery. Further, it can replace natural gas in non-generation applications such as HVAC, water heating, and cooking. Hydrogen's cost and the roundtrip efficiency remain challenging, but innovations are improving both rapidly. Lastly, hydrogen appears to be a force because it brings high energy density, straightforward conversion from water (salt or fresh) or natural gas, long-duration storage, and flexibility in converting it back to electricity via a fuel cell or boiler.

Further, Zinc-Air batteries possess greater energy density than Li-NMC. Zinc-Air battery components cost substantially less due to Zinc's abundance. Once produced at scale, Zinc-Air batteries will be a major competitor for stationary energy storage applications.

Thermal storage

Once limited to HVAC applications, thermal energy storage is emerging as a low-cost solution addressing mid-term (<week) electricity storage. An inexpensive substance like sand, heated with electricity and stored in a well-insulated space, produces heated air or steam converted to electricity by a turbine. This emerging technology shows promise because of cost, reliability, and simplicity. It has already moved from pilot to product because the solution uses all proven components.

Emerging storage technologies

Many emerging technologies offer promise, such as electronic (SMES) and kinetic (flywheel, compressed gas, falling weights), many in test, and some in pilots. They have not yet found a niche to propel them to ubiquitous deployment. Each must find differentiation and a niche to gain a foothold. Perhaps a low-cost, long-term technology with adequate roundtrip efficiency becomes the dominant reserve supplier, just as Li-NMC successfully supplies regulation

Next in the series

Next in this five-part series, the author will examine the necessary scale and practical applications of stationary storage in a transformed electrical landscape. The final article will provide insight into the future, identifying possible opportunities and threats.

FEATURED ARTICLE

Australia leans in on synthetic inertia for grid stability

By Roger Riley, Managing Director Asia Pacific, PSC

PSC's Roger Riley explains the inertia dilemma in balancing modern electricity grids and how Australia has utilized its asynchronous generation and storage to find cost-effective grid stability solutions.

Inertia – the resistance of an object to a change in its motion – in the power grid helps limit frequency variations in the case of sudden load or generation changes. Traditionally, this inertia (or stored energy) has been provided by the rotating mass of synchronous generators and has been essential to stabilizing power grids.

With the onset of high penetration of asynchronous renewable generation from inverter-based/grid-forming technologies like solar which has no synchronous rotating mass, energy providers like AEMO[1] and others are looking to other solutions to provide the frequency response of 'grid following' fossil-fueled units.

Enter 'synthetic inertia'

Synthetic inertia is the ability of a generator to sense and respond to system frequency changes. It's produced by asynchronous generators as a way to bear the burden of their own frequency dynamics.

A typical response to grid instability due to inverter-based generation has been to impose constraints on wind and solar farms or install synchronous condensers which are essentially unpowered motors linked to the grid to provide voltage stability via rotating mass. It is old technology being used in a new way but it's an expensive add-on proposition. Now, however, emerging technologies are demonstrating they can provide many of the services previously thought only possible through spinning machines, ironically due to the absence of rotating mass.

Renewable generation + storage = synthetic inertia

When the Callide C power station in Queensland exploded in May 2021 causing cascading, state-wide issues, the region's electricity grid was under pressure. The subsequent frequency issues were able to be immediately addressed by South Australia's big battery, Tesla's Hornsdale Power Reserve. The battery was able to slow down the rate of frequency changes due to the explosion, acting as a "virtual machine" and providing a crucial grid service normally provided by spinning machines.

Another example is ElectraNet's ESCRI-SA large-scale battery at Dalrymple substation. This battery allows the transmission grid operator to provide grid stability and prevent outages in case of disruptions to the power grid.

Storage solutions like these and others are being used in Australia and beyond for the express purpose of providing reserve capacity and ancillary grid services to have generation available for immediate dispatch if frequency drops. The upside is that these utility scale batteries don't need to be synchronized and generating and can provide immediate inertial response in milliseconds of a trip. Further to this, they also provide revenue-generating services as opposed to installing costly synchronous condensers.

There are 16 large-scale batteries under construction in Australia as of December 2020[2] indicating the important role battery storage is expected to play in the future energy landscape. The role of battery storage is further highlighted by the large pipeline of battery storage projects going through feasibility and the connection application process. These include stand-alone battery energy storage systems as well as augmenting existing renewable generation projects with a battery storage component.

[1] AEMO is currently developing an Advanced Inverter White Paper to increase understanding of the application of grid-forming inverters, including the provision of synthetic inertia. This is currently planned for release by July 2021.

[2] https://assets.cleanenergycouncil.org.au/documents/resources/reports/clean-energy-australia/clean-energy-australia-report-2021.pdf

FEATURED ARTICLE

The benefits of joint training among neighboring utilities

By Aida Mosier, COO, PowerData Corporation

The grid has been evolving rapidly in the last decade, with changes such as increasing distributed energy sources (DER), increasing renewable energy, and transmission-distribution systems changing into a new two-way relationship. Operators remain the first line of defense to keep the electric grid reliable and stable. NERC requires different certifications for the job an operator will perform and mandates restoration training by Reliability Coordinators (R.C.s) to all its members to verify that each black start resource can meet its restoration plan and emergency operations requirements.

2021 has proven to be a challenging year for everyone, including utilities. Heavy lockdowns due to the COVID-19 pandemic forced all nonessential personnel to work from home, putting a damper on training practices as the modality of virtual training became standard.

The industry faces several challenges besides the pandemic:

- A retiring workforce who has experienced events scenarios that some new operators might never see
- Increasing frequency of extreme weather events
- Incursion of distributed energy resources (DER) into both transmission and distribution
- Significant penetration of renewable resources
- Increasing danger from cyber threats

In the past two decades, some of the major blackouts in North America have involved operator error and failure to plan. Operator training becomes more critical to transfer knowledge and test extreme scenarios not only within a utility but in a joint effort with neighbors to bring more awareness of the actions and the repercussions on the areas of influence.

This Spring, R.C. West held training for its entire footprint encompassing 25 Balancing Authorities. The focused training allowed utilities to interact while testing black start plans in a very realistic and controlled environment, practice three-way communication, see the effect of their actions on neighboring utilities, and opening a window into the multiple roles played during normal and emergency operations.

Participants applied principles they had not yet used in the real-time system and gained familiarity with their procedures, complementing the experience with the observations done during the restoration practice.

Furthermore, the training contained Emergency Operations allowing dispatchers to learn remedial actions, intricacies of the Western Interconnection splitting to preserve reliability, islanding conditions, paralleling and tying lines with their neighbors when trying to restore.

The ability to openly explore and explain the cause of a blackout and still move forward are lessons learned that each dispatcher will take with them and be able to recognize later. During the exercises, the operators were forced to respond to system changes and evaluate their actions promptly. This collaboration facilitates the knowledge transfer between seasoned dispatchers and new ones, helping bridge the experience gap.

Several WECC - Western Electricity Coordinating Council utilities are also recognizing the benefits to joint training and are working together to prepare for gas curtailment events, IROLs (Interconnection Reliability Operating Limits), public safety public shutoffs and remedial actions that they have not seen but expect to experience at some point.

As more utilities and R.C.s integrate virtual, joint exercises to their training procedures, operators and all parties involved gain more situation awareness into the interconnect ability and dependability of each other in the grid. The idea of bringing distribution operators to these exercises starts being a possibility as distribution becomes more dynamic and affects transmission, especially in smaller entities where operators serve both transmission and distribution desks.

FEATURED ARTICLE

Puget Sound Energy continues to innovate in the Pacific Northwest

By Kincheiu Wei, Dana Kaul and Karen Koch of Puget Sound Energy

Washington state's 100% clean energy policy and goal has driven, and will continue to drive, the proliferation of renewable distributed energy sources (DER) recognized as the top candidates for replacing fossil-based energy sources in our current energy portfolio. The most currently mature DER technologies, such as photovoltaics and battery energy storage, have been popular amongst earlier stage demonstration projects. While PV+storage has formed several successful microgrids across the industry, their inherent technical limitations render prolonged outage support impossible in areas where seasonal weather impacts on P.V. generation is significant, such as in the Pacific Northwest (PNW). During the winter months (Jan. – Mar.) when the PNW typically experiences low sunlight coinciding with harsh weather conditions, PV+Storage microgrids have difficulty in providing backup power beyond 24 consecutive hours. This presents opportunities for alternatively fueled backup generations to improve resilience for critical loads and community resources – particularly, those that serve vulnerable populations during prolonged, adverse events.

The "P.V. + storage" microgrid that PSE is planning to build in collaboration with the Tenino High School (THS) in the Clean Energy Fun (CEF) 3 program presents an opportunity for PSE and its partners to continue to innovate and demonstrate how rising technologies can advance the integration and energy source options of renewable energy for utility customers.

While the new microgrid to be installed in CEF 3's scope will offer great potential for energy independence most of the year, detailed feasibility studies show that the P.V.'s energy created during the winter months and the characteristics of Lithium-ion batteries are not the optimal solution to meet the THS studied emergency shelter load requirements. A fuel-based backup generator is a natural solution to close the resiliency gap throughout the school year and during winter storm season when the potential for prolonged outages is greater. This also aligns with the City of Tenino's vision to enhance community services by utilizing the THS as an emergency shelter. PSE is applying for the CEF 4 with the goal of analyzing the commercial and financial feasibility of clean fuel-based backup generator supplementing the THS microgrid collaboratively with the Department of Commerce, City of Tenino, and the THS.

According to the Electric Power Research Institute (ERPI)'s study on "Low Carbon Backup Generators," hydrogen fuel cell and spark ignition engine powered by 100% hydrogen or renewable natural gas plus 15% hydrogen mix are viable candidates for this project in that

1) their low or zero-carbon emission and/or renewable characteristics align with the State's clean energy goal,
2) they are non-conventional DERs and their commercial applications are scarce,
3) the integration of these technologies in addition to PV+storage adds a new dimension of challenge to DER optimization planning and operations, and to microgrid/distribution control systems,
4) they widen PSE's customer energy choice by enabling PSE to offer low or zero carbon renewable gas service as an alternative to 100% electrification in achieving the clean energy goal, and
5) they will help to be catalyst for local producers of clean hydrogen or renewable natural gas to promote a "local energy ecosystem" when opportunities present themselves.

Overall, it will broaden the engagement of grid modernization beyond the typical participants in the previous rounds of the CEF program, as vendors of new forms of technology, energy source providers, and PSE's Gas Division will be joining this effort.

PSE is currently in the process of engaging the City of Tenino to see if there is synergy between this expanded scope and the City's energy and community service goals. This includes engaging with a wastewater treatment plant near THS to review its methane production capacity and availability for RNG supply, which could be part of the preliminary or future design considerations.

As this is a new product for both PSE and its customers, successful implementation of this project will provide a test bed to

1) demonstrate the current industry technology on hydrogen fuel cell and hydrogen/RNG generators,
2) to determine the modifications required, and
3) to address issues with hydrogen and RNG handling, creation, storage, sourcing, transportation, system reliability, safety protocol, and other regulations and economics.

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FEATURED ARTICLE

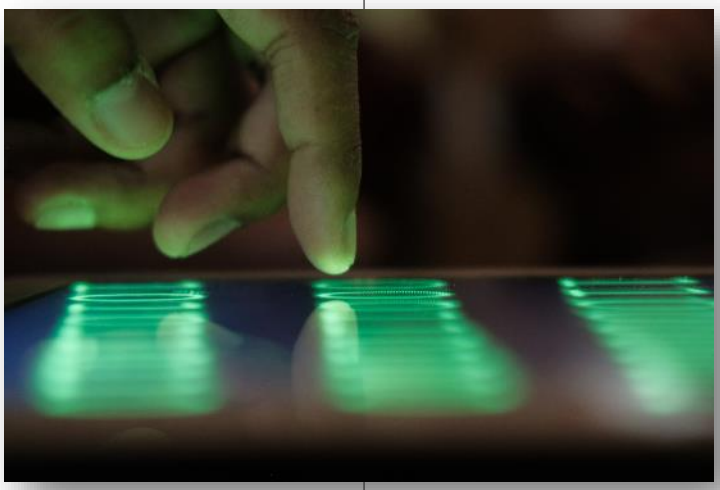
Securing America's electricity grid: Inaction is not an option

By John (J.D.) Hammerly, CEO, The Glarus Group

Grid operations are more vulnerable to cyberattacks than ever before

America's electric, gas, water, and transportation infrastructure operations rely on telemetry from geographically dispersed assets to monitor and control their reliable operation. While most cybersecurity efforts focus on securing I.T. assets to protect America's economy and society, operational technology (O.T.) communications have been overlooked for decades. O.T. operations anticipate natural (e.g., storms) or humanmade (e.g., cyber) disasters and are designed to survive some communications loss. Additionally, O.T.'s complexity (obscurity) and communication isolation (air gap) made O.T. operations secure – until now. Today, O.T. relies heavily on I.T. products, routable protocols, and IoT sources, all of which substantially increase security vulnerability.

Recent government initiatives are a step in the right direction



On April 21, 2021, the Biden Administration announced a 100-day plan for Power Grid Cybersecurity, which called attention to this vulnerability. This 100-day plan, in concert with the Federal Energy Regulatory Commission's (FERC) December 17, 2020, Notice of Proposed Rulemaking (NOPR), established an incentive-based framework for utilities making voluntarily cybersecurity enhancement investments beyond mandatory Critical Infrastructure Protection (CIP) Reliability Standards subject to tariff relief. In addition, the forthcoming Department of Homeland Security's (DHS's) "60-day sprint initiative" targets industrial control systems, signifying a new and promising trend for government support for critical infrastructure.

The grid is especially challenging to secure

Historically, O.T. telemetry employed highly optimized protocols to reduce message size, enabling deployment over low-speed, often point-to-point, serial communications paths. However, today, "smart" O.T. assets imply embedded intelligence and communications via high-speed O.T. networks carrying increased operational data and new data, such as asset health. On top of that, Advanced Meter Infrastructure (AMI) and behind-the-meter (BTM) devices threaten a thousand-fold data increase across O.T. networks.

This device and data explosion exposes O.T. to increased cyber risk; however, the difficulty in securing O.T. is enhanced because historically, only about 3% of O.T. assets are replenished, replaced, or upgraded each year. Additionally, telemetry upgrades require extensive testing to ensure data accuracy and communications reliability. Therefore, today's O.T. networks connect an infrastructure of assets of widely differing ages; some installed decades before cybersecurity concerns arose.

The next steps require widespread retrofitting

Although the consequences of inaction expose our vital infrastructure to intrusion, which threatens public safety and the economy, securing our electrical infrastructure requires extensive retrofitting of existing O.T. environments with solutions that:

- Protect against existing and emerging threats (e.g., quantum-based hacking)
- Deploy easily and transparently without modifying existing assets, regardless of age
- Support public, private, wired, or wireless network architectures
- Introduce negligible network latency and communications delays
- Minimize the cost of ownership by reducing overhead and prioritizing alerts
- Keep OT security ahead of threat evolution

Given the peril of inaction, our next steps must be to actively secure: telemetry from field devices to those system(s) monitoring and controlling them; protection and control communications; metering, both internal (substation & tie lines) and consumer; and external interfaces to third-party DER (storage, D.R., renewables, and microgrids).

So, where do we start?

Some initial steps ensure the sender of the communication is who they claim to be through immutable authentication. We must also install firewalls in the field and in front of the system(s), monitoring and controlling field assets to provide certainty of source and content. And we must profile senders, identifying deviations from historical behavior by creating immediate alerts, notifying a monitoring agency or operator.
Our recent experience indicates vigilance is critical and bad actors, whether state-sponsored or with criminal intent, should be regarded as existential threats. Again, paraphrasing FBI Director Christopher Wray, there are a lot of parallels, there is a lot of importance, and a lot of focus by the FBI on disruption and prevention; cybersecurity represents today's equivalent to the 9/11 terrorist attack.

WHAT's on MANI's MIND?

We all know the statistics when it comes to GHG emissions. In the U.S., transportation is the worst offender. Transportation accounts for approximately 30% of total U.S. energy needs and generates the largest share of the country's greenhouse gas emissions. Electricity production generates the second-largest share of greenhouse gas emissions. Approximately 62 percent of our electricity comes from burning fossil fuels, mostly coal and natural gas. Finding solutions to decrease GHG in both areas got me thinking about the electrification of fleet vehicles.

Companies like Amazon, DHL, UPS, and Lyft have put in place sustainability goals to address climate change. As one of the levers in their sustainability strategies, they are starting to deploy E.V.s to decarbonize their business operations. Some elements working in their favor are the continuous improvements in E.V. technologies that produce lower costs, greater range, and faster charging, further enabling the use of E.V.s in the commercial sector. Of course, there are other considerations of which I've listed some at the top of my mind here.

1. As companies like those mentioned above seek to reduce their transportation costs and lower emissions, they are looking for pathways to renewable generation for consistent, green electrification of their fleets. This is an opportunity for utilities to work with regulators and such companies to continue the trend of servicing E.V. loads with clean energy resources, not building new generation from fossil fuel-based sources, which would defeat the purpose.

2. Unlike individual consumer E.V.s, fleet customers have very different charging and use patterns, some of which are listed below.
   - **School buses:** They are used for a couple of hours in the morning, a couple of hours in the afternoon and that's it. Their routes are exceptionally well known and predictable.
   - **City commuter buses**: They generally tend to have standardized routers, which means that they only go on certain roads and stop at certain locations for specific periods of time.
   - **Delivery Light Commercial Vehicles (LCVs):** These are the most unpredictable of the fleet vehicles.

   The important note here is that all of these can be fully charged at night at the depot.

3. Vehicle-to-grid (V2G): Fleet vehicles are the best option for V2G. They are mobile, can park in a specified location and send power back to the grid. Because of their standardized and predictable patterns, the company knows the amount of charge needed for them on any day, at any time to predict how much power they can deliver back to the grid.

4. Charge as you go: Hyundai and Prius are among auto makers that have options for charging your consumer E.V. while driving via embedded solar panels on the car's roof. For after-market solar options, companies like Merlin Solar offer stickable solar that can be applied atop buses or LCVs (as well as residential E.V.s), allowing them to charge on the go as well.

5. Charge from the road: Many commuter buses tend to go to specific "park and ride" locations and starting points on their routes. Therefore, they are excellent locations to set up charging points. In "park and ride" locations, the charging can be embedded into the road so that charging can be induction-based.

This is a quick list of considerations that can be read as a list of opportunities to decrease GHG via commercial E.V.s. However, as is the case with all major change, there are hurdles to be addressed too. As we are at the beginning of the transportation transformation, the list of challenges is not trivial, but is being addressed.

At the end of the day, commercial fleets need to keep up with market demands. That means that E.V. charge times must be minimized and predictable, and reliability must be consistent with conventional ICE (fossil fuel-powered) vehicles. The future for fleet electrification is bright. We can increase grid utilization and help balance supply and demand while also connecting renewable resources to the grid.

MEET THE TEAM


Elyse Hammerly

I was born and raised in Issaquah, Washington. Throughout my K-12 years, I was involved in Girl Scouts. I later worked for Girl Scouts, first supervising volunteers, then managing projects on both the business side and the I.T. side, doing process improvement and software implementation. I also played on the high school golf team and still enjoy putt putt.

I left Washington State for college at the University of Colorado in Boulder, where I graduated with degrees in Classical History and Humanities with an emphasis in Communications. While there, I joined Tri-Delta sorority, worked for the university as a tour guide, and interned at Alstom. I returned to the Seattle area after college because I love the Pacific Northwest. I worked at Pediatric Associates as I.T. support and then moved over to Microsoft as a business administrator in the finance department facilitating internal communications. After my time at Girl Scouts, I moved into corporate event management at Opus and worked on Microsoft-specific projects around the world.

Recently, my husband, my 18-month-old daughter, and I, along with our cat Squeaky moved to the Spokane area and are looking for land to build our dream home. We enjoy exploring and have been on several camping trips and love the variety of farmers markets available in the area. I started with MGS in March, and I am working on two interesting projects. I thoroughly enjoy the challenges each project brings.

MORE ABOUT MODERN GRID SOLUTIONS

Modern Grid Solutions

Modern Grid Solutions (MGS) is a cost-effective, global, supplier of deep expertise and board-experienced domestic resources. Our team members have been industry colleagues for over 25 years. Our approach focuses on delivering actionable guidance, direction, and value based on the depth of our team's expertise in North America and worldwide.

MGS has assembled a team of leading experts all having between 25 – 45 years of experience delivering complex, innovative technology, business, regulatory and finance solutions to electric utilities, corporate clients and policymakers. Our experts bring expansive breadth and tremendous depth in engineering, technology, economics, operations, and commercial areas directly applicable to utilities, suppliers, regulators and policymakers.

BUSINESS EXPERTISE AREAS	TECHNICAL EXPERTISE AREAS
For Utilities and Policy Makers • Strategy, tactics, and process redesign • Business, technical and enterprise architecture • Transmission and distribution roadmaps • Grid modernization plans • Project and program management • Strategic change management • RPS Support **For Suppliers and Corporate Clients** • Business model design and analysis • Electricity market entry and go-to-market • Market analysis, volumes, and trends • Competitive landscape analysis • Alliances, divestitures, and acquisitions • M&A, Project finance, structured products	**For Utilities and Policy Makers** • T&D system operations – EMS, DMS, OMS • Generation operations • Energy markets – design and deployment • Energy and REC tracking system • T&D Automation and smart grid solutions • GIS and asset management solutions • Generation planning and renewables integration • Big data management and analytics • Solution and vendor selection **For Suppliers and Corporate Clients** • Solutions design and implementation • Portfolio review and analysis • Adjacency analysis and technology management • Energy, REC and emissions trading

Ongoing Projects

- Assisting a major Northwest utility with transforming their planning capabilities to address the influx of Distributed Energy Renewables, Non-Wires Alternative solutions and to address the newly signed Washington State Clean Energy Act (SB 5116) to transition the state's electricity supply to 100 percent carbon-neutral by 2030, and 100 percent carbon-free by 2045.
- 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.
- Assisting a major multi-jurisdictional utility with defining a strategy for dispatching the DERs in their footprint by focusing on – People, Process and Technology aspects of the full implementation.
- Assisting a major multi-jurisdictional utility with assessing their ADMS implementation and helping define their long-range planning efforts.
- Assisting multiple startup companies in the areas of IoT, Blockchain, and Voltage regulator.

Electric System Operations – Evolving to the Modern Grid, Second Edition

Dr. Vadari's book "Electric System Operations – Evolving to the Modern Grid, Second Edition" is available now. The key chapters covering EMS, OMS, ADMS, and DERMS now include industry case studies to move the discussion from theoretical to evidentiary with real-world, relatable content. This book has been used in a semester-long course at Shri Vishnu Engineering College for Women in Bhimavaram and at BV Raju Institute of Technology in Narsapur, taught be Dr. Anil Jampala, Dr. NDR Sarma and Dr. Mani Vadar, author.

Smart Grid Redefined: Transformation of the Electric Utility 3.0

The book has been released and is now available in all leading bookstores and online. The Chinese edition is out now and available in China. This book is also being used as a textbook for a UMass course given by Prof. Kishore Nudurupati on Smart Grids for undergraduate and graduate students. (ECE 687/597 SG, Smart Grids)

Recorded Webinar: "To DER or not to DER – is that a valid question?"

Hosted by K.X. and CGI, this roundtable of industry experts including Dr. Vadari explored the recent FERC 2222 ruling and the next steps affecting the North American Energy Markets.

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.