State of the Grid

1ST QUARTER 2022

Certified Minority Business Enterprise MBE

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 Q1 2022 NEWSLETTER!

Our Q1 2022 newsletter looks back on some of the interesting news over the past three months in our industry. We curate these articles based mainly on the context of grid modernization. In addition to a plethora of news related to renewables, EV penetration, etc., we are delighted to report that we have been hearing and seeing an uptick in ESG (Environmental, Social and Governance) content and only expect it to continue on an upward trend.

We welcome this genuine shift in our industry - and others - to recognize issues related to climate change, human rights and social unrest.

Dr. Mani Vadari, President

IN THIS ISSUE

INDUSTRY EVENTS

Q1 Content from Dr. Vadari:

- Dr. Vadari was the guest editor of the **Journal of Modern Power Systems and Clean Energy (MPCE' 2022)** published March 31, 2022. He also contributed a joint paper, "Distribution Control Centers in the US and Europe: Commonalities, Differences, and Lessons."
- Dr. Vadari delivered a keynote at the **cStor Innovation Event** on the topic of "Technologies transforming the utility industry" on March 24, 2022.
- Dr. Vadari delivered a keynote at the India Smart Utility Week on March 2, 2022, called "Evolving architecture of the 21st-century grid with two-way power flows."
- Dr. Vadari delivered a presentation titled "Career transitions – What does the new energy economy bring for us?" as part of a University of Washington course called "Introduction to professional issues."

CONFERENCE: IEEE PES Innovative Smart Grid Technologies

April 25-28, 2022, in New Orleans, LA

Dr. Vadari participated in two sessions:

- Dr. Vadari was part of the plenary session "**Smart gird solutions with customer participation.**" His topic, **"The customer is now the utility!!"**
- He was also a panelist for a session on "**Human-machine teaming and operational considerations for new smart grid technologies.**" Dr. Vadari's topic was **"Operational considerations & need for new power applications."**

CONFERENCE & EXPO: IEEE T&D

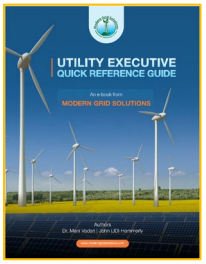
April 25-28, 2022, in New Orleans, LA

Dr. Vadari participated in two sessions:

- He was a panelist for a session on: "**Large-scale distribution test feeder development with emerging operational paradigms.**" Dr. Vadari's topic was "**Emerging operational paradigms and needs for new synthetic test feeders."**
- He participated in a roundtable discussion on "**Management challenges and corporate social responsibility for a sustainable future**."

JUST IN!

Dr. Vadari and John (JD) Hammerly of Modern Grid Solutions have recently published an e-book called, "Utility Quick Reference Guide." Its content covers critically important topics for this audience, enabling executives to navigate our industry's challenges as it transforms to deliver a 21st-century, decarbonized energy system.



Stay tuned for another Modern Grid Solution untitled e-book – a primer on Energy Storage. Look for it in our Q2 newsletter, or follow us on LinkedIn.

MERGERS AND ACQUISITIONS

SE acquires Zeigo to advance energy procurement process

Schneider Electric announced it has acquired start-up climate-tech platform Zeigo to enhance the company's digital capabilities in energy, sustainability, and environmental commodity consulting. The acquisition will complement Schneider Electric's portfolio of clean energy services and solutions and advance the company's digital energy transformation ambitions. Schneider anticipates combining Zeigo's AI capabilities (specifically their machine learning algorithm) with its advisory services to deploy enhanced collaborative intelligence in the energy and environmental commodity procurement process. Read more here.

Mitsui buys stake in Mainstream Renewable Power

Japanese trading and investment group Mitsui has announced the close of a $624.7 million transaction with the global renewable energy company Mainstream Renewable Power, seeing them gain a 27.5% stake in Mainstream. Mitsui joins as a long-term strategic investor in Mainstream, alongside Aker Horizons, which owns 54.4% of Mainstream following the transaction. Read more here.

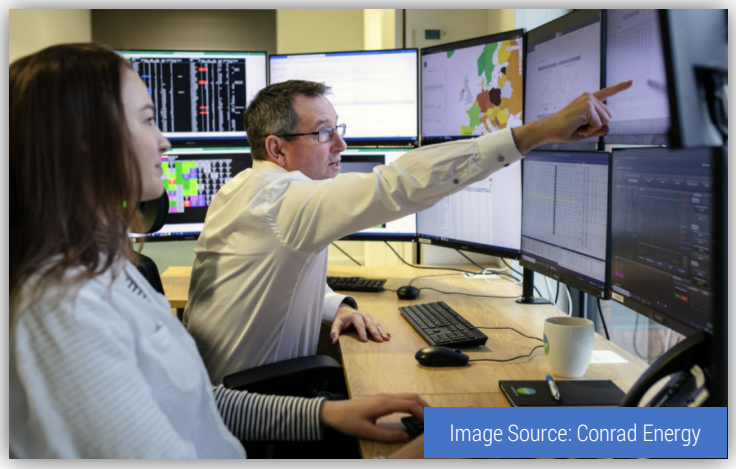


Image Source: Conrad Energy

Tantalus acquires Congruitive

Tantalus, a smart grid technology vendor based in British Columbia, announced their acquisition of Congruitive to accelerate the digitization of the electric grid. The acquisition is purported to help utilities prepare for the impact of EVs and DERs. Congruitive has a software platform (C.IQ) that enables the interoperability of a wide range of devices through an emerging IEEE standard. By deploying C.IQ, a utility's smart grid deployment can operate as one intelligent, interoperable system, with the necessary scalability and flexibility as more EVs and DERs are deployed at the edge of the grid. Congruitive is currently selling its C.IQ software to investor-owned utilities ("IOUs"), smart meter vendors and renewable power integrators. Read more here.

HydrogenOne buys minority stake in Bramble Energy

HydrogenOne Capital Growth (HydrogenOne) has bought a £10mn minority equity stake in Bramble Energy as part of their Series B funding round. With this purchase, HydrogenOne receives a board seat at Bramble. Bramble has pioneered a printed circuit board ('PCB') fuel cell solution - PCBFCÔ, which manufactures low-cost, scalable and recyclable fuel cell modules, and can be made at any PCB factory worldwide. Hydrogen fuel cells are used to convert clean hydrogen into electricity and water, resulting in a power source that is free from greenhouse gas emissions. Bramble intends to deploy its fuel cell technology by ramping up the global distribution of its portable power units in partnership with BOC (a Linde Group company), and further by developing fuel cell stacks for light commercial vehicles. Read more here.

EnergyAustralia and Edify partner on battery storage projects

EnergyAustralia has again partnered with Edify Energy (Edify), a leading developer in renewable energy generation and storage projects, on two new battery storage projects to help safeguard reliable electricity supply for customers in New South Wales. Due for completion during the summer of 2023/24 and developed on traditional lands of Wiradjuri Country, the Darlington Point and Riverina Battery Energy Storage Systems have the potential to power more than 46,0001 homes for two hours of peak demand before being recharged. Construction will commence later this year on the lithium-ion battery projects, which will bring flexible, dispatchable capacity to the NSW market and complement the significant volume of renewable generation in the region. Read more here.

Conrad Energy buys SCADA software company TGG Solutions

Independent power producer (IPP) Conrad Energy has acquired flexible power software provider TGG Solutions. Conrad Energy – a portfolio company of I Squared Capital which itself focuses on flexible generation, with over 600MW of generation across 45 sites in operation – currently uses TGG's software solutions to manage its power assets. TGG's flagship product iON is used as its main Supervisory Control and Data Acquisition (SCADA) system, which connects Conrad Energy's commercial desk to the sites that it manages, communicating in real-time with the assets. This will now be combined with the IPP's own in-house algorithmic trading and asset management capabilities. Read more here.

InstaVolt to be acquired by EQT Infrastructure

EQT Infrastructure has agreed to acquire InstaVolt, the UK's fastest-growing independent rapid electric vehicle charging operator, from Zouk Capital. InstaVolt operates rapid charging infrastructure through its nationwide network of approximately 700 charge points. EQT Infrastructure is committed to invest significantly to accelerate InstaVolt's expansion of charge points across the UK, and support the mission to roll out 10,000 rapid EV chargers by 2032. Read more here.

BP to invest £1bn in UK EV charging infrastructure

bp announced new plans to invest £1 billion in electric vehicle charging in the UK, supercharging the roll-out of fast, convenient charging across the country. bp pulse, bp's EV charging business, intends to make the investment over the next 10 years helping to meet the UK's fast-growing demand for EV charging and support the country's transition to low carbon transportation for both consumers and fleet vehicles. The company also expects this to support hundreds of new jobs in the UK. The investment will allow bp pulse to deliver more rapid and ultra-fast chargers in key locations, expand fleet products and services, and launch new home charge digital products and services to enhance the customer experience. Read more here.

National Grid sells stake in gas business as it pivots to electricity

National Grid said it would sell a 60% stake in its British gas transmission and metering business to Australia's Macquarie Asset Management and British Columbia Investment Management Corporation as it shifts towards electricity. The deal implies an enterprise value for the unit of about 9.6 billion pounds ($12.7 billion). Macquarie said its investment will ensure the transmission system will play a leading role in delivering the UK's net-zero by 2050 target, by supporting hydrogen's role in the energy mix. Read more here.

KEY HIGHLIGHTS

California's solar market is now a battery market

California has long been the nation's leading market for both battery storage, and solar-plus-storage solutions. But PV Intel's examination of the interconnection queue from California's grid operator shows that in terms of large-scale projects, this transformation is reaching another stage. California is on the cusp of no longer being a solar market where batteries are being added – instead, it is becoming a battery market that (sometimes) includes solar. Read entire article from PV magazine here.

PG&E and Ford collaborate on bi-directional EV charging tech

Pacific Gas and Electric Company (PG&E) and Ford Motor Company announced a collaboration exploring how Ford's new F-150 Lightning electric vehicle (EV)—the first commercially available light-duty truck with bidirectional charging technology—can interact with the electric grid and provide electric reliability benefits to PG&E customers. One in five EVs in the country are on the road in PG&E's service area of Northern and Central California, where customers are often early adopters of new clean energy technologies. PG&E and Ford will test the F-150 Lightning and its Intelligent Backup Power bidirectional charging capabilities in providing backup power for customers' homes in PG&E's service area. Intelligent Backup Power, making its debut on the F-150 Lightning, gives customers the ability to use bidirectional power technology from their all-electric truck to provide up to 10 days of power to their homes during an outage, depending on home energy usage. The first installations of Ford's Intelligent Backup Power are beginning in spring 2022, supported by Sunrun as Ford's preferred installation partner. Read PG&E's press release here.

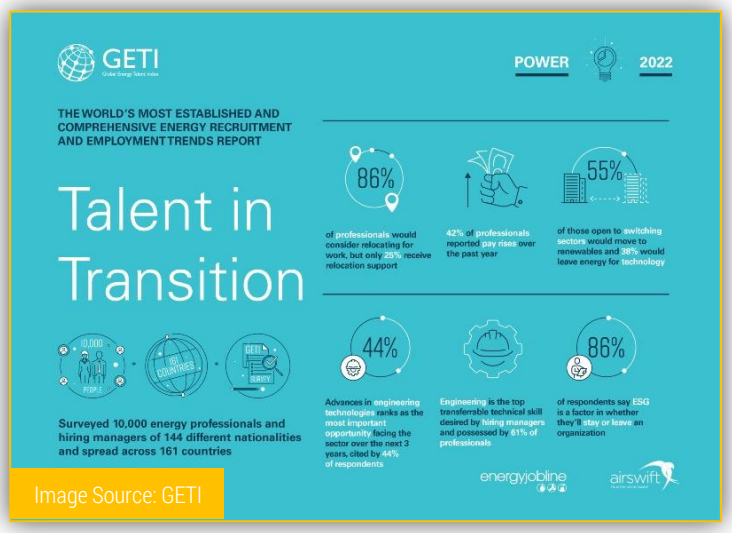


Image Source: GETI

Gates' TerraPower develping and building small nucelar reactors

As climate change pushes states in the U.S. to dramatically cut their use of fossil fuels, many are coming to the conclusion that solar, wind and other renewable power sources might not be enough to keep the lights on. Nuclear power is emerging as an answer to fill the gap as states transition away from coal, oil and natural gas to reduce greenhouse gas emissions and stave off the worst effects of a warming planet. The renewed interest in nuclear comes as companies, including one started by Microsoft founder Bill Gates called TerraPower, are developing smaller, cheaper reactors that could supplement the power grid in communities across the U.S. Nuclear power comes with its own set of potential problems, especially radioactive waste that can remain dangerous for thousands of years. But supporters say the risks can be minimized and that the energy source will be essential to stabilize power supplies as the world tries to move away from carbon dioxide-emitting fossil fuels. Read the entire article from the AP here.

Wind and solar are reducing generation from natural gas, EIA says

One big shift in the U.S. energy mix over the last decade has been the rapid expansion of renewable energy resources, especially solar and wind. The amount of solar power generating capacity operated by the U.S. electric power sector at the end of 2021 was 20 times more than it was at the end of 2011; wind power capacity was more than twice what it was 10 years ago. Those trends are reflected in the latest projections by the U.S. Energy Information Administration (EIA). In its Short-Term Energy Outlook, EIA forecasts that most of the growth in U.S. electricity generation in 2022 and 2023 will come from new renewable energy sources. EIA estimates that the U.S. had 63 GW of solar capacity at the end of last year. It forecasts that installed capacity base will grow by about 21 GW in 2022 and by another 25 GW in 2023. The country had 135 GW of wind capacity at the end of 2021, EIA said. It projected that 7 GW of wind generating capacity will be added in 2022 and another 4 GW in 2023.. Read the entire article from Power Engineering magazine here.

War for green talent could undermine clean electricity growth, report shows

The sixth annual Global Energy Talent Index (GETI), the world's most established and comprehensive energy recruitment and employment trends report, has found that failure to clean up power grids mean many power companies face losing out to renewable rivals in a cross-sector war for green energy jobs. The report by Airswift, the global workforce solutions provider for the STEM industries, and Energy Jobline, a job site for the energy and engineering industries, found that 86 percent of power workers would consider leaving for another energy industry in 3 years. ESG concerns are the second biggest driver behind potential resignations and renewables are the first choice for a switch due to their pivotal role in the energy transition. Read more here.

Michigan Governor Releases Plan Draft for Carbon Neutrality

Michigan will build clean energy infrastructure and invest in green programs over the next 30 years with the goal of becoming carbon neutral by 2050 to confront climate change, a draft of a state plan says. Gov. Gretchen Whitmer committed Michigan to the 2050 goal in 2020 and formed the Council on Climate Solutions in the Michigan Department of Environment, Great Lakes, and Energy — or EGLE — to create and oversee the implementation of the MI Healthy Climate Plan. Read more here.

Global approaches to diversity, equity and inclusion: Case studies from electric companies

The Edison Electric Institute (EEI) has released the publication "Global Approaches to Diversity, Equity, and Inclusion: Case Studies from Electric Companies." Globally, electric companies are ramping up their DE&I efforts and driving change in the energy sector. Electric companies are creating and implementing holistic approaches to DE&I, recognizing the value that diversity can bring to their workforce, customers, and stakeholders, including how different perspectives can increase innovation for the clean energy transition. In this casebook, ten international electric companies share their approaches to DE&I and how they are leading in the DE&I space through an exploration of their overall strategies, initiatives to connect with the local communities they serve, and actions to create inclusive workplaces. Read the full casebook here (PDF).

Renewable hydrogen costs expected to plummet by 2030

Energy Transition Investment Trends, a new report from BloombergNEF, predicts that 2022 will be a boom year for the green hydrogen sector, as increasing focus on industrial decarbonization and falling technology costs underpin surging investment in new renewable hydrogen production capacity. The report outlines several bold predictions for the coming year for the green hydrogen industry, including a massive acceleration of electrolyzer installations and a growing number of dedicated hydrogen companies undertaking public listings. "Although expensive today, green hydrogen costs are expected to plummet 75 percent by 2030, as the price of electrolyzers rapidly declines. Chinese companies already sell electrolyzers at one-quarter the price of their western peers," BloombergNEF says.

Largest Nordic data center to provide flexibility to the grid

Fortum and Telia have signed a collaboration agreement to connect the Helsinki Data Center (HDC) to the electricity market. Through the collaboration, HDC's Uninterrupted Power Supply (UPS) systems manufactured by ABB will take part in balancing production and consumption fluctuations in the electricity market.The number of data centers in the Nordic countries is expected to increase significantly in the upcoming years, so it is important that the data centers operate as eco-consciously as possible and have the ability to be active participants in the energy system. Read Fortum's press release here.

Army plans microgrids, EV fleets in first climate strategy

The Army plans to install a microgrid on all of its installations by 2035 and have a fleet of all-electric vehicles by 2050, among other efforts outlined in a climate strategy released Tuesday. The strategy, the first such plan for the service, is meant to guide the Army in how it responds to climate threats that affect soldier readiness, warfighting and installations. It also directs how the U.S. military's largest branch can reduce its own climate impacts through less fossil fuel use, among other efforts. Read the U.S. Army Climate Strategy report here (PDF).

Biden administration promises $5b over five years for EV charging

The U.S. Departments of Transportation and Energy today announced nearly $5 billion that will be made available under the new National Electric Vehicle Infrastructure (NEVI) Formula Program established by President Biden's Bipartisan Infrastructure Law, to build out a national electric vehicle charging network, an important step towards making electric vehicle (EV) charging accessible to all Americans. The program will provide nearly $5 billion over five years to help states create a network of EV charging stations along designated Alternative Fuel Corridors, particularly along the Interstate Highway System. The total amount available to states in Fiscal Year 2022 under the NEVI Formula Program is $615 million. States must submit an EV Infrastructure Deployment Plan before they can access these funds. A second, competitive grant program designed to further increase EV charging access in locations throughout the country, including in rural and underserved communities, will be announced later this year. Read press release here.

Construction starts on New York's first offshore wind farm

South Fork Wind, a 50-50 joint venture between Ørsted and Eversource, has approved the final investment decision (FID) for the project that will be New York's first offshore wind farm. This final investment solidifies the companies' commitment to the 132 MW offshore wind farm. The FID also marked the start of the construction phase of the project. To be located 56 kilometres (35 miles) east of Montauk Point, New York, and some 30 kilometres (19 miles) southeast of Block Island, South Fork is set to become fully operational at the end of 2023. The offshore wind farm will comprise twelve 11 MW Siemens Games turbines and will generate enough clean, renewable energy to power 70,000 homes, according to Ørsted and Eversource.

EU invests over $1b in energy infrastructure

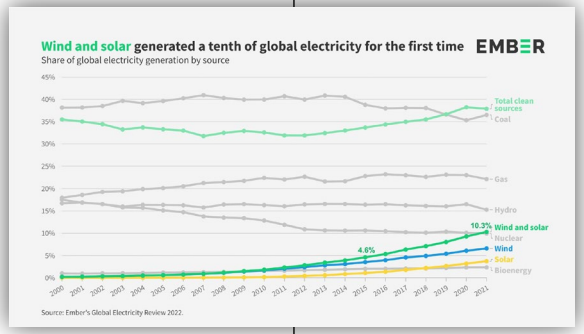
EU countries have agreed on a Commission proposal to invest €1.037 billion (US$ 1.18 billion) in five cross-border infrastructure projects under the Connecting Europe Facility (CEF) for trans-European energy networks. CEF will provide financial support to 4 projects for construction and 1 study. The largest amount of funding will go to the EuroAsia interconnector project (€ 657 million or US$ 746 million) to support the first electricity interconnection between Cyprus and the European grid. Read more about the other projects in this T&D World article here.

Northwestern Energy announces net-zero by 2050 commitment

NorthWestern Energy announced its goal to reach net zero carbon emissions by 2050 while continuing its commitment to reliable, affordable, environmentally sustainable energy service, capable of meeting the needs of all customers and communities. With a foundation that now includes: a company-wide electric generation portfolio that provided approximately 56% of its customers' energy from carbon-free resources in 2021; investments in its natural gas system to reduce methane and carbon emissions; investments in a more efficient, reliable and flexible energy grid; and energy efficiency efforts to reduce customer demand, the company believes net-zero by 2050 is an achievable target. Read NWE's press release here.

Wind and solar energy generate 10% of global electricity

Wind and solar generated over a tenth (10.3%) of global electricity for the first time in 2021, rising from 9.3% in 2020, and twice the share compared to 2015 when the Paris Climate Agreement was signed (4.6%), according to a new report from Ember. It found 50 countries reached the 10% landmark in 2021, up from 43 in 2020 and 36 in 2019. Combined, clean electricity sources generated 38% of the world's electricity in 2021, more than coal (36%).



Denmark, Luxembourg and Uruguay led the electricity-from-renewables charge, at 52%, 43% and 47% respectively, while Netherlands, Australia and Vietnam have shifted over 8% of their total electricity demand from fossil fuels to wind and solar in the last two years. Vietnam has seen astonishing growth in solar as it increased its generation by 17TWh in a single year (Phan Rang, Ninh Thuan province, in central Vietnam pictured). Read Ember's full report here (PDF).

U.K. government creates new Future System Operator to oversee energy system

The U.K. government has committed to delivering a new public body to strengthen the resilience of Great Britain's energy system. The Future System Operator (FSO), to be launched once legislation is passed and timelines have been discussed with key parties, will look at the Great Britain's energy system as a whole, integrating existing networks with emerging technologies such as hydrogen. The FSO will be a new public body founded on the existing capabilities of the Electricity System Operator (ESO), and, where appropriate, National Grid Gas (NGG). It will work with energy suppliers and networks to balance the UK's electricity systems and ensure continued energy resilience and security of supply for households and businesses. It will also provide strategic oversight of the UK gas system by taking on longer-term planning in respect of gas (but not real-time operation, which will remain with NGG). Read more here.

FEATURED ARTICLE

Electricity Storage: In constant change

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

This is a bonus article to the five-part energy storage series summarizing amazing progress and changes in the stationary storage marketplace. In 18 months since this series started, promising technologies have emerged while some have faded.

Short-term storage

The most dramatic change has been the "industrialization" of short-term storage. Today, short-term lithium-based battery solutions can be purchased and deployed as products. Further, the leading vendors offer chemistry-agnostic products that embrace the three dominant chemistries, Li-NMC, Li-LFP, and LI-LTO, allowing alignment of the storage solution to the owner's specific requirements.

Cost and footprint reductions

In parallel with this flexibility, the cost for storage solutions continue to decline rapidly, not driven by battery components reductions but through standardization, productization, and market volume. Also, emerging grid-scale storage packaging reduces land-use requirements, with some suppliers allowing multi-level storage deployments. As physical space requirements are reduced, energy storage can replace fuel-based auxiliary generation. Today's auxiliary generation requires fuel – diesel or natural gas but does not bring the flexibility of storage-based resiliency. Storage-based resiliency resources contribute daily for peak-shifting, demand charge reduction, or improving power quality. Fuel-based auxiliary generation will be supplanted by energy storage as the required footprint for batteries shrinks.

Disappointing flow

While the lithium-based battery solutions have matured, other promising technologies haven't achieved similar success. Flow batteries remain predominantly at the pilot stage, failing to reach off-the-shelf product status. Existing pilots have been plagued with reliability and availability challenges, limiting their value. Further, other technologies have transitioned from the laboratory to pilot projects and threaten flow batteries' advantages of scalability, flexibility, and lower cost than lithium-based batteries.

Duration possibilities

Today's storage marketplace has become compartmentalized by storage duration, short (< 8 hrs.), medium (8-72 hrs.), and long (>72 hrs.). Of course, lithium-based batteries retain energy for long periods, but their cost compared to other storage technologies makes them most competitive for short-duration storage and power applications, such as ancillary services like regulation. Further short-duration storage presents an attractive solution to charging with solar energy during the day and discharging during the evening peak. Daily energy charge/discharge cycles and power capabilities provide layered benefit streams to mitigate the higher cost of lithium batteries.

The future of long-term storage will be shaped by pilots recently announced by several major utilities for iron/air, thermal (TES), and kinetic (KES). A new storage technology manipulates the state of carbon dioxide between a gas and liquid but never releases the CO2 into the atmosphere. Like other kinetic and thermal long-duration storage solutions, this technology does not require an inverter and produces inertia providing stability in the face of constantly fluctuating demand. Again, each long-duration technology has its duration "sweet spot," but most offer a range of duration flexibility, some from minutes to months making them highly attractive. In three years, the competing long-term storage technologies will narrow, leaving a few that bring reliability, flexibility, longevity, and very low-cost per kWh stored.

The race to dominate medium duration storage promises to be most interesting as the short-duration storage technologies costs fall and the long duration storage solutions mature, each pursuing the center of the storage duration domain. For North America, low-cost, medium-duration storage offers attractive mitigation to solar and wind intermittency driven by a few days of overcast and still air. Arguably mid-term duration storage becomes key to providing reliable electricity supply at competitive prices as decarbonization proceeds.

Hydrogen and energy storage

And then there is hydrogen. Whether hydrogen is produced by water electrolysis or hydrocarbon pyrolysis, hydrogen can participate in four distinct dimensions if produced at a competitive cost. Hydrogen becomes the obvious replacement for natural gas and propane, assuming technology can improve the distribution network to contain the smaller molecule. Also, hydrogen and captured CO2 combined to produce eFuels. Much of our existing transportation and heating infrastructure, including CCG generators, could be preserved with adaptations in both dimensions.

Hydrogen, as an energy storage medium, offers two additional dimensions. First, as a transportation fuel. Compressed hydrogen's energy density is 130+ times higher than a lithium battery, making it attractive for larger vehicles where the energy demand makes batteries less practical. Also, hydrogen provides highly flexible stationary energy storage. Fuel cells convert hydrogen into emission-less electricity using a well-understood and reliable technology in both dimensions. The future of hydrogen hangs on two critical issues, cost, and availability. Both represent challenges, but significant progress has been made in the last two years, offering promise.

Location, location, location

The specific nature of a utility's service territory and region will dictate its energy storage solutions. Some will have ready access to less intermittent, renewable energy, only needing short- and medium-duration storage while they wait for the sun to shine and the wind to blow. Others, less fortunate, face using transmission to import and long-duration batteries to store carbon-free electricity to ensure reliable delivery to their customers. Regardless, utility-scale storage will be an essential component of the coming energy landscape.

A year from now brings additional rapid evolution and technology maturation as the marketplace votes with its investments. It will be a fun ride.

FEATURED ARTICLE

Keeping up with the pace of change

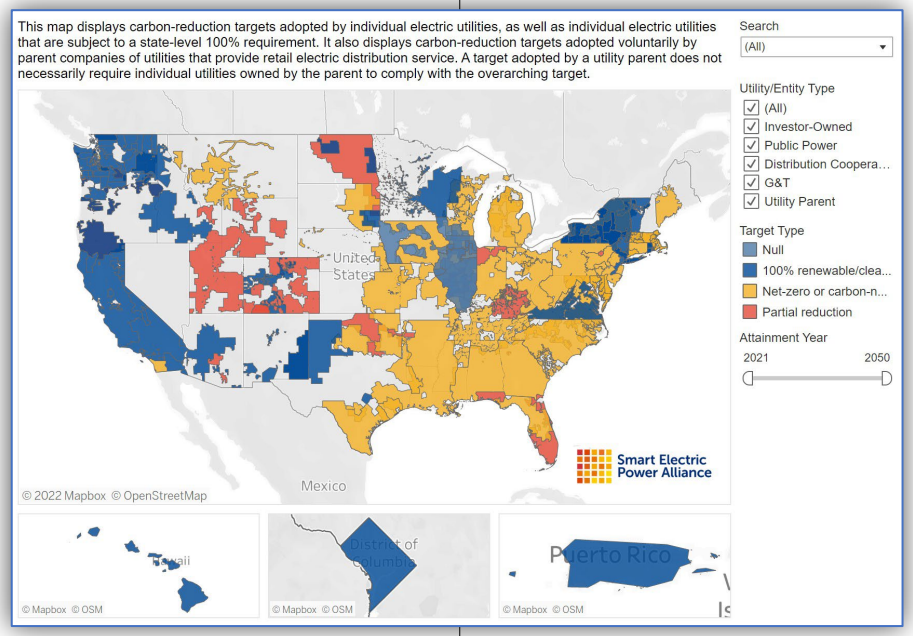
By Kevin Cheung, PSC North America Managing Director

Investing and adapting to achieve net-zero

Today, the impetus for electricity to become more carbon-neutral is growing at a rapid pace. This has uncovered new challenges on both the supply side, and with consumers. Residential consumers are increasingly moving toward more earth-friendly infrastructure, with their homes, their cars, and the way (and with whom) they do business. Commercial consumers on the other hand, are rethinking the traditional "business as usual" model. More and more, corporations are moving toward new strategies that demonstrate insight and leadership and meet growing shareholder and customer expectations around net-zero strategies.

For utilities, the stakes are higher. Currently, many are working to proactively manage shifts in infrastructure, customer expectations, increases in connection requests, net-zero mandates, growing complexity, and resiliency in the face of severe weather events and other consequences of global warming. In developing renewables, the biggest barrier for utilities has been interconnection delays. Data from the Lawrence Berkeley National Laboratory indicates that at the end of 2020, approximately 670 GW of renewables and 200 GW of storage were waiting to interconnect to the bulk transmission system. On average, interconnection wait times can take more than three years.

From both a customer and industry standpoint, are we collectively doing enough to adapt to meet current demand? Have we done what needs to be done to be agile and easily adapt in the future?



Commitment to the future

In April of 2021, the White House has called for 80% carbon-free electricity by 2030, and more and more utilities in North America are making commitments to achieving net-zero emissions by 2050. The first to commit was Minnesota's Xcel Energy in 2018, and over the next three years, others began to follow suit, including large utility groups like Dominion Energy, Duke Energy, and Southern Company.

The Utility Carbon Reduction Tracker from the Smart Electric Power Alliance – shown below – offers a dynamic geographic look at utilities' path to a carbon-free system.

The road ahead

So are we on track to get to net-zero by 2050? Lawrence Berkeley National Laboratory has reported that between 2005 and 2020, annual carbon dioxide (CO_2) emissions from the power supply in the United States dropped to 1,450 million metric tons (MMT)— 50% below earlier projections. But according to a 2020 study by Princeton University's Andlinger Center for Energy + the Environment, building a net-zero America will require an immediate acceleration of commitment to strategic and infrastructure initiatives. This would include a minimum of $2.5 trillion of capital investment into energy supply, industry, buildings, and vehicles by 2030.

It is critical for governments to take the lead in planning and to incentivize through unprecedented investments to help utilities smoothly rapidly transition to more clean electricity. The US government's Build Back Better Framework represents the country's ambitious effort to address climate change, offering consumer rebates and tax credits for solar installations and EVs, and investment in clean-energy infrastructure and technologies.

Helping power a more sustainable world

At PSC, we help utilities position themselves to meet the goal of NZE through insight and expertise that supports transformation toward net-zero. Contact PSC for more information.

FEATURED ARTICLE

Virtualization and Containerization - Infrastructure as a Service (IaaS, aka Cloud)

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

Introduction

Our society relies heavily on applications in the "Cloud." The Cloud is significantly more than using somebody else's data center. Cloud/IaaS deployment benefits are many, but the central ones are cost reduction, scalability, deployment speed, and flexibility. The "If we build it, they will come" coupled with an "only pay for what you use" revenue model enabled Amazon Web Services, Microsoft Azure, and Google Cloud to crush computing costs by deploying massive data centers linked with ultrahigh-speed communications. Cloud/IaaS enables applications to consume as much or as few computing resources to deliver the required results based on the current workload. Applications can access nearly limitless computing resources if allowed, but to do so requires "virtualization."

Relevance to the utility industry and implementations

Utilities are moving to both on-premises and hyper-scale Cloud to reduce cost. Hyperscale Clouds significantly reduce costs over utility-owned data centers because of their massive scale. Further, even utility-owned, on-premises Cloud enables improved computing resource utilization. Both on-premises and hyper-scale Cloud increase deployment flexibility. The container eliminates any environmental dependences reducing ongoing application maintenance to only the application's functionality.

Initially, a few Public Utilities moved batch applications to the Cloud. Today, every utility is moving applications such as finance, HR, work management, asset management, and customer systems, such as CIS and CRM, to the Cloud. Further, engineering applications find Cloud deployment attractive because computational resources scale to meet the problem's needs.

Today, thought-leading utilities deploy operational applications, such as GIS, forecasting, generation scheduling, and even OMS, to the Cloud. Still, real-time applications, such as SCADA, remain in their traditional environments because of utility security concerns and NERC CIPs compliance requirements.

Containers and their significance

Containers emerged to make software portable and easily deployed on the Cloud. The container "wraps" applications by providing Application Programming Interfaces (APIs) to the resources the application requires. An application's external resource and service requests must be converted to use the container's API; once done, testing for functionality and performance ensures the application can then be deployed on hyper-scale or on-premises Cloud. Container APIs allow portability and ease of development. A container can be moved from development to test or production with no or relatively few configuration changes.

In essence, an application "runs" within the container. The container provides all the services the application requires and isolates the application from the current external environment, including the hardware and network. In this way, the application becomes environment independent so that application instances can be deployed wherever and in the desired number to address user demand. Application dependencies are considered when an application instance is deployed to enable interdependent applications to have their containers reside on the same physical servers and local network to improve performance.

Kubernetes

Kubernetes (K8s) is a container orchestrator using docker formatted containers and employs building blocks or "primitives" that enable the deployment, maintenance, and scaling of applications based on CPU or memory. Kubernetes are loosely coupled and extensible, capable of supporting different workloads. The internal components, extensions, and containers running on Kubernetes rely on Kubernetes APIs. The platform exerts control over compute and storage resources by defining resources as Objects and managing them as such.

Kubernetes follows the primary/replica architecture. The components of Kubernetes can be divided into those that manage an individual node and those in the control plane. Kubelet (the primary 'node agent' that runs on each node) is responsible for the node's running state, ensuring all containers on the node are healthy. Kubelet starts, stops, and organizes containers into pods as directed by the control plane. Kubelet monitors the pod's state, and if not in the desired state, the pod is re-deployed to the same node. Node status is relayed via heartbeat messages the primary. Once the primary detects a node failure, the Replication Controller observes this state change and launches pods on other healthy nodes.

A container resides inside a pod. The container is the lowest micro-service level, which holds the running application, libraries, and dependencies. Containers can be exposed to the world through an external IP address. Kube-proxy implements a network proxy and a load balancer, supporting the service abstraction and other networking operations. It is responsible for routing traffic to the appropriate container based on the IP and port number of the incoming request.

Kubernetes provides a partitioning of the resources it manages into non-overlapping sets called namespaces. Namespaces enable environments with many users spread across multiple teams, projects, or even different development, test, and production environments.

The scheduling unit in Kubernetes is a pod consisting of one or more containers that are guaranteed to be co-located on the same node. Each pod in Kubernetes is assigned a unique IP address within the cluster, allowing applications to use ports without the risk of conflict. Within the pod, all containers can reference each other. The containers can be running in different IP segments as well. However, for a container within one pod to access another container within another pod, it must use the pod IP address.

A pod can define a volume, such as a local disk directory or a network disk, and expose it to the containers in the pod. Pods can be managed manually through the Kubernetes API or management automated through a controller.

Why it's important

Cloud deployment enables greater flexibility, allowing applications to scale to process the current workload easily. Further Cloud deployment simplifies application development, upgrades, and testing. Lastly, the Cloud reduces IT costs and prepares utilities to embrace Software as a Service (SaaS), enabling third parties to provide utility solutions, allowing the utility to pay for what it uses.

WHAT's on MANI's MIND?

What's up with the bru-ha-ha about hydrogen? How did it go from obscurity to the wonder solution of the 2020s? Is it real or is it hype?

It's colorful

These days, we're hearing a lot about hydrogen. It even appears to come in different colors.

- White hydrogen: the byproduct of industrial processes such as chloralkali electrolysis
- Grey hydrogen: produced from natural gas, which emits dioxide
- Brown hydrogen: produced from gasifying fossil fuels such as coal/petcoke, which emits carbon dioxide
- Green hydrogen: produced from the electrolysis of water powered by renewable energy
- Blue hydrogen: produced from reforming natural gas (or other fossil fuels) with carbon capture
- Yellow hydrogen: produced from the electrolysis of water using grid energy
- Purple hydrogen: produced though using nuclear power and heat through combined chemo thermal electrolysis splitting of water
- Pink hydrogen: produced through electrolysis of water by using electricity from a nuclear power plant.
- Red hydrogen: produced through the high-temperature catalytic splitting of water using nuclear power thermal as an energy source.
- Turquoise hydrogen: produced from natural gas using methane pyrolysis with carbon capture
- And, there is one more option (which hasn't been given a color yet) –mining for hydrogen.

It's abundant

It's true that hydrogen is the simplest and most abundant element in the universe, but it needs to be extracted from other elements to be used in gas form. It's used extensively for industrial applications, but less than 1% of global hydrogen is derived from renewable energy. According to GreenTech Media (now Wood Mackenzie), in 2019, around 99 percent of the roughly 130 million tons of hydrogen a year used for industrial processes – mostly oil refining and ammonia production – was made using coal or lignite gasification processes, or steam methane reformation.

It's not exactly efficient - yet

The round-trip efficiency of hydrogen measured by calculating the energy lost by converting electricity to hydrogen and back again to electricity is between 18-46%. The question that needs to be asked is "Why would someone use electricity to make hydrogen and then convert it back to electricity at a 60-80% loss in energy?" True, you can make it more efficient by making hydrogen on-site, but then you have to bear the significant cost of electrolysis plants. In comparison, the typical loss in the U.S. from transferring electricity over wires is just 5%, so you still have 95% left.

It's got green potential

The common argument made is that we should use excess renewable energy to produce hydrogen because, if not, this energy would be lost anyway. There is an inherent fallacy in this argument which is all about excess renewable energy. What is this about? Why are we having excess renewable energy?

My thought is that if the excess renewable is temporary in nature, then it will not be worth it to set up a hydrogen plant to use this excess energy for hydrogen production. If the excess is long-lasting or permanent, would someone not try to create a business need to take advantage of it – someone with a better use of the energy than the 18-46% round-trip conversion that is being promised by hydrogen?

It's part of the solution

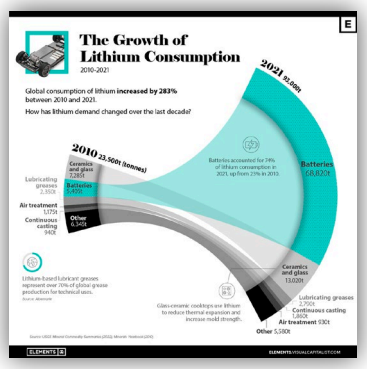
The point of my musings is not about whether hydrogen is the answer to decarbonization or not. I believe, hydrogen should and must have a place in our decarbonized future. However, to be a solid contender, we need to figure out how to produce hydrogen more efficiently since the present mechanisms of producing hydrogen will not sustain. We need newer mechanisms to produce hydrogen which would significantly increase the round-trip efficiency to greater than 70-80%. And we also need mechanisms to store and transport hydrogen so that it is available when and where it is needed.

Bottom Line: *Until we are able to generate much more renewable energy and take greater advantage of storage technologies, doesn't it make more sense to use all renewable energy directly as electricity for end uses (heat, transport, etc.), rather than suffer the losses that currently come with green hydrogen production?*

DID YOU KNOW?

While the growing demand for EVs is good news for limiting greenhouse gas emissions from the transportation sector, they still come with environmental costs.

Of particular concern are the materials needed to make EV batteries, some of which are projected to be in short supply and are concentrated in a few countries: cobalt from the Democratic Republic of Congo, lithium from Australia, Chile and Argentina.



A typical EV battery weighs 1,000 pounds. It contains 25 pounds of lithium, 60 pounds of nickel, 44 pounds of manganese, 30 pounds of cobalt, 200 pounds of copper and 400 pounds of aluminum, steel and plastic. Inside are over 6,000 individual lithium-ion cells.

It should concern you that all these toxic components come from mining. For instance, to manufacture each EV auto battery, you must process 25,000 pounds of brine for the lithium, 30,000 pounds of ore for the cobalt, 5,000 pounds of ore for the nickel, and 25,000 pounds of ore for the copper. All told, you dig up 500,000 pounds of the earth's crust for just one battery.[1]

The world needs lithium-ion batteries to transition to carbon-free energy but getting it out of the ground and into our technology – from cell phones to EVs to energy storage systems – comes at a cost to our environment.

[1] https://www.eurasiareview.com/30032022-are-the-environmental-impacts-and-human-atrocities-worth-an-ev-battery-oped/

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.

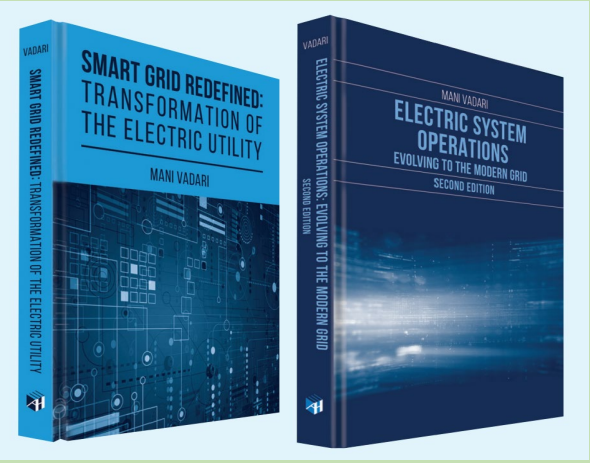
MGS has assembled a team of leading experts all having between 25 – 45 years of experience delivering complex, innovative technology, business, regulatory and finance solutions to electric utilities, corporate clients and policymakers. Our experts bring expansive breadth and tremendous depth in engineering, 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 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 • 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 Suppliers and Corporate Clients** • Solutions design and implementation • Portfolio review and analysis • Adjacency analysis and technology management • Energy, REC and emissions trading

At MGS, our focus is on our clients and helping them connect the dots to make the modern grid possible. This is our obsessive passion and we've mastered the details so that our clients can keep their main focus on their businesses. And, in return, our clients value our boutique consultancy because of our unique value proposition. At MGS, all our consultants are seasoned experts offering their undivided attention and treating our clients' businesses as if they were our own.

Ongoing Modern Grid Solution 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 needs of the 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 implementation and operations standardization.
- Assisting a major multi-jurisdictional utility with defining implantation of a DER dispatch initiative by focusing on the People, Process and Technology aspects of the full implementation.
- Assisting a major multi-jurisdictional utility with defining and updating their Digital Field and Grid Operating Strategy.
- Assisting a major northwest utility with overhaulding their innovation process to make it business-as-usual – across delivery system planning, operations, and beyond through the inclusion of wired and non-wired alternative solutions on the grid.
- 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.