State of the Grid

3RD QUARTER 2022

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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 Q3 2022 NEWSLETTER!

Now more than ever, we are all witnesses to devastating weather events and the way our electric grids are pushed to their limits. They are also more resilient thanks to technology and collaboration across borders. As an example, did you know that more than 44,000 workers from at least 33 states helped in the response to Hurricane Ian in Florida? This is the kind of news that gives me hope for our country and our world.

I hope you enjoy the news we've curated in our newsletter. I look forward to your feedback.
Thank you for reading!
Dr. Mani Vadari, President

IN THIS ISSUE

INDUSTRY EVENTS

CONFERENCE & EXHIBITION: Distributech 2023
February 7-9, 2023 at the San Diego Convention Center

WHITE PAPER: PNNL Report: "Introducing the 9500 Node Distribution Test System to Support Advanced Power Applications: An Operations Focused Approach", Alexander Anderson, Mani Vadari, et. al., Sep 2022, PNNL-33471

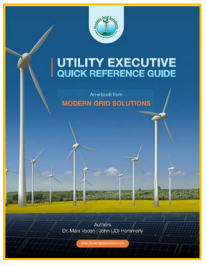
WHITE PAPER: PNNL/DOE White Paper: "Evolving Architectures and Considerations to address DERs and NWAs: – The Emergence of the O.T./Control Bus", Mani Vadari, August 6th, 2021.

CHECK IT OUT!

REPORT: Floating wind: The power to commercialize
Offshore wind capacity could grow 56-fold by 2050, driven by a growing need for decarbonization, energy security, and decreasing costs. Regarding the latter, bottom-fixed and floating offshore wind levelized costs of energy (LCoE) are forecast to drop by 39 percent and 8 percent, respectively, according to the new Energy Transition Outlook from DNV. Download the (gated) report here.

REPORT: Rethinking the modern grid
Decarbonization is intensifying, and extreme weather events attributed to climate change are forcing electric utilities to harden systems at a time of regulatory and investment uncertainty. Yet despite such headwinds, the new, generational influx of billions of dollars in federal funding for grid improvements is spurring optimism. According to Black & Veatch's 2022-2023 Electric Report, the U.S. electric sector's repowering hinges on grid modernization, renewable energy sources and storage. Get the (gated) report here.

Dr. Vadari and John (J.D.) 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 e-book – a primer on Energy Storage. Look for it in a future newsletter, or follow us on LinkedIn.

MERGERS AND ACQUISITIONS

Chevron acquires Renewable Energy Group

Chevron acquired the outstanding shares of REG in an all-cash transaction valued at $3.17 billion. The transaction is expected to accelerate progress toward Chevron's goal to grow renewable fuel production capacity to 100,000 barrels per day by 2030. The transaction closed on June 12, 2022. Read more here.

TotalEnergies acquires 50% of Clearway Energy Group

TotalEnergies announced its agreement to acquire 50% of Clearway Energy Group (CEG), the 5th U.S. renewable energy player. This constitutes TotalEnergies' largest acquisition in renewable energy in the United States, one of the top 3 renewable markets in the world. CEG is a developer of renewables projects and controls and owns 42% of the economic interest of its listed subsidiary, Clearway Energy Inc. (CWEN), into which projects are dropped when they reach commercial operation. Read more here.

RWE agrees to buy Con Ed's clean energy arm for $6.8b

RWE AG, a global renewable energy company, signed a purchase agreement with Con Edison, Inc. to acquire all shares in Con Edison Clean Energy Businesses, Inc. (Con Edison CEB). Headquartered in Valhalla, New York, Con Edison CEB is a leading operator and developer of renewable energy plants in the United States, with about 3 gigawatts (G.W.) of operating capacity, thereof 90% in solar energy, and a strong development pipeline of more than 7 G.W. The transaction marks a milestone in RWE's growth ambitions in the United States. Once completed, this will make RWE the number 4 renewable energy company and the second largest solar operator in the United States, one of the largest and fastest-growing markets for renewable energy globally. The Inflation Reduction Act sets a stable and reliable 10-year framework for investments in clean energy. Read more here.

Westinghouse Electric Company to be sold

Cameco Corporation and Brookfield Renewable Partners are forming a partnership to acquire U.S. nuclear services business Westinghouse Electric Company. The $7.8 billion deal will see the pairing of Brookfield Renewable, one of the world's largest clean energy investors, with the largest publicly-traded uranium supply company Cameco, and clearly represents nuclear's increasingly important role in the energy transition. Brookfield Renewable, with its institutional partners, will own a 51% interest in Westinghouse and Cameco will own 49%. Read more here.

XL Fleet buys Solar-as-a-Service provider Spruce Power

L Fleet Corp. announced the acquisition of Spruce Power, the largest privately held owner and operator of residential rooftop solar systems in the U.S. with more than 52,000 subscribers. In connection with the acquisition of Spruce Power, XL Fleet also unveiled its new corporate strategy to provide subscription-based solutions for rooftop solar, battery storage, E.V. charging and other distributed energy resources. Read more here.

Dynapower bought by Sensata Technologies

Sensata Technologies announced it has completed the acquisition of Dynapower Company LLC, a leading provider of energy storage and power conversion solutions from private equity firm Pfingsten Partners for $580 million in cash. Dynapower provides energy storage and power conversion solutions including inverters, converters, rectifiers and custom transformers for renewable energy generation, green hydrogen production, electric vehicle charging stations, and microgrid applications, as well as industrial and defense applications. Read more here.

Brookfield acquires Scout Clean Energy

Brookfield Renewable has agreed to acquire Scout Clean Energy ("Scout") for $1 billion with the potential to invest an additional $350 million to support the business' development activities. Scout's portfolio includes over 1,200 MW of operating wind assets, including 400 MW managed on behalf of third parties, and a pipeline of over 22,000 MW of wind, solar and storage projects across 24 states, including almost 2,500 MW of under construction and advanced-stage projects. Read more here.

Enbridge acquires Tri Global Energy

Enbridge, Canada's largest energy company, announced the acquisition of Tri Global Energy—the third-largest onshore wind developer in the U.S., with a development portfolio of wind and solar projects representing more than 7 gigawatts (G.W.) of renewable generation capacity. Founded in 2009, Tri Global Energy has been the largest developer of wind energy projects currently under construction in Texas, the nation's leader in wind capacity. The company is also one of the top 10 developers of overall renewable energy (wind, solar, battery storage) in the U.S. Read more here.

Duke considering $4b renewable spin-off

Duke Energy says it's considering the sale of its commercial renewable energy business, to focus future investments on its consumer utilities. The Duke division operates solar and wind farms around the country that sell electricity to corporations, institutions and other utilities. Unlike Duke's commercial utilities, it is not regulated. The unit generates about 5% of Duke profits. In a press release about their Q2 financial results, Duke CEO Lynn Good said, "Commercial renewables has played an important role in our business strategy for over 15 years, establishing a core competency in renewable energy development and operations that will continue to serve us well as we advance our strategy, but as we look forward to the remainder of this decade and beyond, we see significant investment opportunities in our regulated operations and believe now is the time to review the strategic fit of our commercial portfolio." Read more here (PDF).

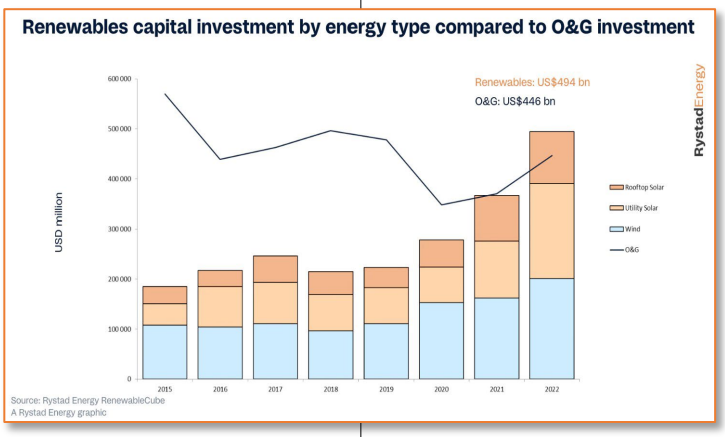
ABB to sell remaining stake in Hitachi Energy to Hitachi

ABB has agreed to sell its remaining 19.9% equity stake in Hitachi Energy to Hitachi, Ltd. Hitachi Energy is the joint venture that was formed from ABB's Power Grids business in 2020, with Hitachi holding a stake of 80.1%. According to ABB, the divestment is a conclusion to the original agreement signed between the parties in December 2018. The transaction, valued at $1.679 billion, is expected to close in the fourth quarter of 2022 with ABB continuing to provide transition services to Hitachi Energy for them to fully separate from ABB's systems. Read more here.

KEY HIGHLIGHTS

Renewable investments outstrip oil and gas for first time

According to Rystad Energy, capital investments in renewables have increased significantly and are set to reach $494 billion in 2022, outstripping upstream oil and gas at $446 billion for the year. This is the first time that investment in renewables is set to be higher than for oil and gas. Up until now, returns on renewable energy projects (solar P.V. and wind) have been unspectacular, primarily relying on subsidies to get projects over the line. Cost pressures due to recent commodity and supply chain issues should have made matters worse as they have reversed years of rapid unit cost improvements in the sector. However, Rystad Energy analysis demonstrates current spot prices in Germany, France, Italy, and the U.K. would all result in paybacks of 12 months or less. Read more here.



Solar is now 33% cheaper than gas power in the U.S.

Natural gas's dominance as power-plant fuel in the U.S. is fading fast as the cost of electricity generated by wind farms and solar projects tumbles, according to Guggenheim Securities. Utility-scale solar is now about a third cheaper than gas-fired power, while onshore wind is about 44% less expensive, Guggenheim analysts led by Shahriar Pourreza said. "Solar and wind now present a deflationary opportunity for electric supply costs," the analysts said, which "supports the case for economic deployment of renewables across the U.S." Gas prices have surged amid a global supply crunch after Russia's invasion of Ukraine, while tax-credit extensions and sweeping U.S. climate legislation have brought down the cost of wind and solar. Read more here.

MISO internconnection queue sets new record

This year, MISO received another record-setting number of submittals during the 2022 Generator Interconnection Queue (GIQ) application period. The interconnection requests included 956 applications representing approximately 171 GW of new generation across the MISO footprint. Last year queue applications totaled 487 for 77 G.W. The 2022 submittals exceeded the previous all-time high for the third year in a row. The MISO queue currently consists of 769 projects totaling 118 GW – 97% percent of which is renewable or storage. If all the projects submitted this year are accepted as valid applications, the MISO queue would balloon to 289 GW. Read more here.

Exelon moves some key systems to Oracle Cloud Infrastructure

Oracle announced that the Exelon Corporation, the nation's largest transmission and distribution utility company, is moving its cloud-first vision forward with Oracle Cloud Infrastructure (OCI). By moving several of its Oracle utility applications to OCI - including Oracle's customer information system (CIS) and meter data management solutions. Exelon will be able to further meet its sustainability goals by consolidating data centers, reducing costs, and continuing to deliver on its strong record of customer satisfaction. Exelon serves more than 10 million customers in the Midwest and Mid-Atlantic United States through six fully regulated transmission and distribution utilities. Read the press release here.

Duke Energy ups grid modernization investment to $145b

To meet customer needs, the company is updating its capital investment plan for its seven regulated utilities to $145 billion over the next decade, a $10 billion increase over its previous 10-year plan. Eighty-five percent of the planned investment will fund the company's generation fleet transition and grid modernization. This includes approximately $75 billion to modernize and harden its transmission and distribution infrastructure; $40 billion for zero-carbon generation, such as solar, wind and battery storage resources, and extending the life of its nuclear fleet; and approximately $5 billion in hydrogen-enabled natural gas technologies. Read more here.

The Illuminating Company finishing grid modernization project

The Illuminating Company, a FirstEnergy Corp. subsidiary, is wrapping up smart grid upgrades across greater Cleveland to help prevent or minimize the length of service disruptions, particularly during severe weather. The work includes installation of new, automated equipment and technology in substations and along power lines serving more than 76,000 customers in parts of Cleveland, Independence, Bedford, Beachwood, Solon and nearby areas. Upgrades began in 2020 under the company's initial three-year portfolio of grid modernization work and are on track to be completed this fall. Read more here.

Northern Ireland smart grid demo delivers savings

Northern Ireland's first smart electricity grid, 'Project Girona', was designed by The Electric Storage Company to demonstrate the potential benefits of a SLES (Smart Local Energy System). A £4.5M renewables project, has saved a combined £27,000 in energy costs for 60 properties concentrated around the Ballysally area of Coleraine in just one year. This represents an average saving of 55% per property across the Project. Bringing cheaper, smarter, greener electricity to homes and communities in Coleraine, The Electric Storage Company is yesterday, 28th September 2022, announcing the findings of the 12-month study. Read more here. Watch the summary video here.

White House launches $7b hydrogen plan

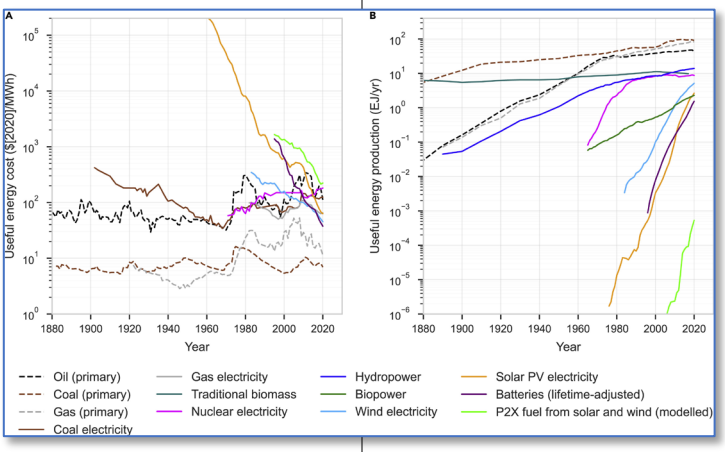
The Energy Department has opened up applications for $7 billion to establish up to 10 regional hydrogen hubs, part of a broader road map unveiled that officials described as essential to lowering emissions in industrial sectors such as energy, transportation, steel, and cement. The hub program—established by Congress in the infrastructure bill passed last November—plans to select at least four regional hubs, with at least one from "green" hydrogen produced by renewable energy; one from "blue" hydrogen sourced from natural gas and using carbon capture and storage; and one "pink" hydrogen project from nuclear power. Rea road map here.

New Mexico outlines $344m grid modernization plan

The Public Service Company of New Mexico has asked the state's Public Regulation Commission to approve a six-year "grid modernization" effort with $344 million in upgrades to its distribution system. About half of the total investment would go toward smart meters. The new technology, once fully implemented, will allow customers to monitor electricity rates and choose when to increase and decrease electricity usage, saving money. The smart meters will allow faster response time to electricity outages, by notifying PNM of a lack of power.. Read PNM's press release here.

New study says fast transition to renewables will save the world $ U.S. 12 trillion

A new study led by Oxford University published in the journal Joule, features a "fast transition" scenario that ramps up investment in solar, wind, batteries, electric vehicles and green hydrogen. The study found that it will be profitable and save the world $ U.S. 12 trillion if the target is reached by 2050. The report's findings are based on looking at historic price data for renewables and fossil fuels and then modeling how they're likely to change in the future. The report's expectation that the price of renewables will continue to fall is based on "probabilistic" modeling, using data on how massive investment and economies of scale have made other similar technologies cheaper. Read the full study here. See related chart to right.



Ocean energy smart grid integration pilot enters full-scale testing

A BMT-led consortium partnered to design, build, and test a smart grid controller to integrate multiple energy sources and regulate energy distribution for islands and remote communities, increasing the opportunity for use of renewable sources of energy while reducing the dependence on diesel power generation. The BMT Smart Grid Controller is designed to efficiently manage and integrate an unlimited number of energy sources in a fully off-grid remote microgrid. The pilot recently successfully tested prototypes and has moved into full-scale testing. Read more here. Watch a video about the new facility here.

PGE commissions first-of-its-kind utility-scale renewable energy plant in North America

The Wheatridge Renewable Energy Facility in Lexington, Oregon, is the first development of its scale in North America to co-locate wind and solar generation with battery storage. This project is playing a big part in getting PGE to its goal of reducing the greenhouse gas emissions from power served to customers by at least 80% by 2030. PGE owns and operates this new facility in partnership with NextEra Energy Resources, joining forces to accelerate Oregon's transition to a clean and reliable future. The site includes 350 megawatts of emissions-free generation, plus 30 megawatts of battery storage and can power 100,000 homes. Read more here.

TerraPraxis and Microsoft collaborate to decarbonize coal

TerraPraxis, a non-profit focused on actionable solutions for climate and prosperity, is collaborating with Microsoft to deliver a digital solution to tackle a significant decarbonization challenge – repurposing over 2,400 coal-fired power plants worldwide to run on carbon-free energy. TerraPraxis is looking to combine its deep expertise in energy with Microsoft to build and deploy a set of tools to automate the design and regulatory approval needed to decarbonize coal facilities with nuclear power, helping transition one of the world's largest sources of carbon to zero emissions. TerraPraxis intends to develop a software application with Microsoft designed to analyze the existing coal fleet to determine the best avenue to retrofit the plants, saving coal plant owners time and money while giving their assets and the communities around them a new lease on life for decades to come. Read more here .

Entergy to triple Louisiana's renewable capacity with solar

Entergy Louisiana received approval from the Louisiana Public Service Commission to grow its portfolio of renewable power by adding 475 megawatts of new-build solar generating capacity, which will nearly triple the company's total renewable generating capacity in the state. The commission also approved the company's Geaux Green option, a new green tariff – the first in the state – which will provide customers the opportunity to subscribe to, and get benefits from, renewable energy resources. Geaux Green will offer an additional option for Entergy Louisiana customers interested in renewable sources and, for some, help them address their sustainability goals. Read more here.

IEA forecasts fossil fuels to peak this decade

For the first time, global demand for each of the fossil fuels shows a peak across all World Energy Outlook scenarios, with Russian exports, in particular, falling significantly as the world energy order is reshaped. This is one of the key findings in the International Energy Agency's (IEA) World Energy Outlook 2022 report (WEO), released amidst what has been hailed as the first truly global energy crisis. IEA's executive director Fatih Birol said at the report launch, "It's the first time since the Industrial Revolution that we will see a fossil fuel peak in the 2030s."

Dutch students develop carbon-eating E.V.

Dutch students from the Eindhoven University of Technology have created a zero-emissions car that actually captures CO2 from the air as it drives. Called ZEM or Zero Emission Mobility, the sporty two-seater is able to capture more carbon than it emits. It does this by using two filters capable of taking in two kilograms of CO2 over 32-thousand-kilometers of driving. The students are attempting to obtain a patent for direct air capture technology, which flows through what appears to be a fairly typical grille and scrubs the air as the car moves. According to the team, for every 12,800 miles (20,600 km) traveled annually at an average speed of 37 mph (60 kph), up to 2 kg of CO2 might be removed. Read more here.

IRA smart grid grants and grid innovation program totaling $8b

On August 12, 2022, Congress passed the Inflation Reduction Act of 2022 ("Act" or "IRA"), a $400 billion legislative package containing significant tax and other government incentives for the energy industry, in particular the renewable energy industry. The bill which contains $370 billion in funding for clean energy and electric vehicle tax breaks, domestic manufacturing of battery and solar panels, and pollution reduction, will have an immediate impact on the wind and solar industries, along with other clean energy projects and businesses. The smart grid grant objectives are to increase transmission capacity, mitigate wildfires, electrification of "edge devices" and to incorporate secure communications/cybersecurity. Read more here (PDF).

G.E.'s energy business to be known as GE Verona

GE's portfolio of energy businesses, including G.E. Renewable Energy, G.E. Power, G.E. Digital, and G.E. Energy Financial Services, will come together as GE Vernova. In early 2024, G.E. plans to execute the tax-free spin-off of GE Vernova. The new name is a combination of "ver," derived from "verde" and "verdant" to signal the greens and blues of the Earth, and "nova," from the Latin "novus," or "new," reflecting a new and innovative era of lower carbon energy that GE Vernova will help deliver. Read more here.

FEATURED ARTICLE

Offshore wind in North America: What's new, what's next

Submitted by the PSC Group

Considered by many to be a banner year in the progress of offshore wind, 2021 saw 21,100 megawatts of offshore wind connection to the grid worldwide. That's three times more than in 2020, setting an all-time record for the offshore wind industry.

And how does North America measure up as far as progress toward expanding offshore wind resources? According to YaleEnvironment360, a publication of The Yale School of the Environment, developers are currently investing most heavily in the East Coast because of its reliable supply of wind and proximity to populous markets.

A 2016 report from the U.S. Department of Energy found that under an aggressive development scenario, offshore wind could provide 14% of the electricity consumed in the U.S. by 2050. Being able to achieve this goal would translate to a 1.8% reduction in U.S. greenhouse gas emissions, and the decreases in ambient nitrogen oxides, sulfur dioxide, and particulate matter would result in a savings of $2 billion in economic losses and healthcare costs.

So what are today's biggest challenges to the growth of offshore wind resources in North America—and what's next as look toward 2050?

Overcoming infrastructure, industry and overhead

The offshore wind energy movement in North America has ramped up considerably in the last two years. Less than 10 wind turbines are installed in U.S. waters now. By 2030, there could be thousands.

In March 2021, the Biden-Harris Administration announced a goal of deploying 30,000 megawatts of offshore wind energy by 2030—a dramatic increase from the 42 megawatts of offshore wind currently operating in the U.S. But as always, there are roadblocks to navigate.

The hurdles for offshore wind are numerous and come from industry stakeholders, logistics concerns, infrastructure challenges, and more. Commercial fishers have emerged as some of the strongest opposition to offshore wind development, expressing concerns that wind farms will inhibit the ability to fish in the area, make historical fishing grounds unavailable, and cause conflict among competing fishers.

The lack of accessible ports is another concern. Few ports are designed to handle the load volume and bridge clearance required for offshore wind development, which limits development options considerably.
Our supply chain for materials, installation vessels and labor is also serving as an impediment to achieving our offshore wind goals in North America. Unfortunately, our aggressive goals cannot be met until we have a more robust domestic supply chain in place. Until the supply chain gap in North America is resolved, offshore wind growth will be limited.

Even if all the aforementioned challenges are resolved, interconnection queues, transmission network upgrade projects, and maintenance overhead can still delay offshore wind expansion in North America. Long, inefficient grid connection processes are creating a bottleneck for offshore wind developers, and even after a project is approved for interconnection, there's still the challenge of installing significant offshore infrastructure and a network of underwater/underground cable to transmit to the onshore grid.

As wind turbines grow in size and power, the prices have also declined from $1,800/kW in 2008 to $770-$850 per kW now. Still, the turbine represents 23% of the overall LCOE (levelized cost of energy) whereas Operations & Maintenance is over 33% of the cost.

There has also been pushback on offshore wind farms from local residents and environmental groups. In many areas targeted for offshore wind development, local communities have come together to protest offshore wind projects through petitions and lawsuits, citing concerns about property values, underground high voltage cables, the loss of local sailing and watersports, and the potential to cause other environmental problems. Birds colliding with wind turbines are the most common environmental issue mentioned. The American Bird Conservancy has estimated that 1.17 million birds are killed by wind turbines each year, but in better news, scientists in Norway have found that painting just one of the three blades on a wind turbine black, can reduce avian deaths by 72%.

What's next for offshore wind in North America?

At the time of this writing, the United States currently has only two small projects in operation, with seven turbines in total. The International Renewable Agency (IRENA) expects the offshore market to grow significantly over the next three decades, with the total installed offshore wind capacity rising nearly ten-fold from just 23,000 megawatts in 2018 to 228,000 megawatts in 2030 and near 1, 000,000 megawatts in 2050.

Based in New Bedford, Massachusetts, Vineyard Wind is currently building the nation's first utility-scale offshore wind energy project. Situated over 15 miles off the coast of Massachusetts, the Vineyard 1 project is anticipated to generate renewable energy for more than 400,000 homes and businesses, reducing carbon emissions in the region by over 1.6 million tons per year.

Another priority will be ensuring availability of the neodymium magnets used in offshore wind. The demand created by our aggressive offshore wind strategies is expected to total more than 15.5 Gg (15.5 kt) of neodymium by 2050.

Moving forward, offshore wind energy deployment is expected to be a significant part of the North American decarbonization strategy. The Inflation Reduction Act, passed by the U.S. Senate in August 2022, includes significant investments in offshore wind development and transmission projects related to this energy infrastructure, including interconnections.

The U.S. government has also just announced new actions to expand offshore wind including initiatives on floating offshore wind to deploy 15,000 megawatts, power five million homes and lower costs 70% by 2035.

FEATURED ARTICLE

Energy Storage: Beyond batteries, what else is there on the horizon?

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

This is the final article in a six-part series on stationary storage and its long-term importance to supply reliable, affordable and environmentally attractive electricity for a viable society.

The Battery Energy Storage System (BESS) marketplace is challenged with rapid change, driven by technological introductions, deployment announcements, and supply chain challenges. Although chaotic, the marketplace has also become more structured, with the general acceptance of technological categorization into four base classifications: thermal, electromagnetic, kinetic, and electrochemical.

Thermal Energy Storage

Beyond ice and chilled water HVAC, thermal energy storage trails the others in its evolution. Emerging thermal storage technology charges when it heats a material, for example, sand, with electricity. Discharging requires heat recovery from heated air or steam to turn a turbine. Although this technology suffers from low roundtrip efficiency, the cost and risk are also low. The target cost is below five cents per kWh, including the impact of low efficiency for 50- to 100-hour storage. All of the technology necessary is off-the-shelf, and deployment requires no additional research and development. Thermal storage brings significant longevity with an expected useful life of over 40 years. Lastly, thermal storage is well adapted to large-scale deployments of 100s or 1000s MWH.

Thermal energy storage of this type is well-suited for deployment at retired power plant sites with large physical footprints, transmission interconnections, and existing turbines that may be repurposed. Although brownfield deployments are more likely, greenfield deployments may appear under specific circumstances.

Electromagnetic Energy Storage

Electromagnetic energy storage takes multiple forms, from capacitors to superconducting magnetic storage (SMES). The technology applied impacts scale, efficiency, and cost. Capacitor storage excels at very short-duration applications, usually less than one hour, while SMES brings significantly longer-duration capabilities. Electromagnetic energy storage also is very efficient, with most technology exceeding 90% roundtrip efficiency.

Other key considerations, cost, and scalability vary with the technology deployed. SMES require significant scale and bring very high cost, while capacitor storage scale from small to large cost competitively.

Kinetic Energy Storage

The major threat to electrochemical storage is kinetic, which comes in several forms, with the two most promising technologies being gravity and gaseous expansion. Gravity-based energy storage systems use weights moving up an incline or vertically into the air to charge and discharge when those weights are again lowered. Gravity technology uses off-the-shelf technology and therefore brings low cost and risk. Also, it brings some efficiency improvements because it uses A.C. motor/generator technology, removing the need for inverters. Further, these solutions have very low friction losses, either only air friction for vertical designs or rail for incline deployments. Gravity technology adapts well to larger-scale deployments and brings relatively infinity duration flexibility.

Gaseous expansion energy storage technology relies on compressing a gas into a vessel or compressing gas sufficiently that it liquifies to charge. The expansion of the gas or conversion of the liquid back into a gas allows it to spin a turbine to discharge. Some gaseous expansion technology, such as compressing gas into underground caverns, is well understood and deployed where such formations exist.

Compression of CO2 into a liquid, capturing the heat given off by the compression process and storing the liquid enable charging of the energy storage. Gasification of the liquid using the stored heat allows the expanding gas to spin a turbine to discharge. This technology can serve short, medium, or even long-duration storage, with flexibility from 1-to 100- hours. It scales up to large deployments but not down to residential scale. The technology is again primarily off-the-shelf, keeping the risk low, but its complexity raises cost and reliability concerns. Its efficiency remains a question since deployment must be at scale.

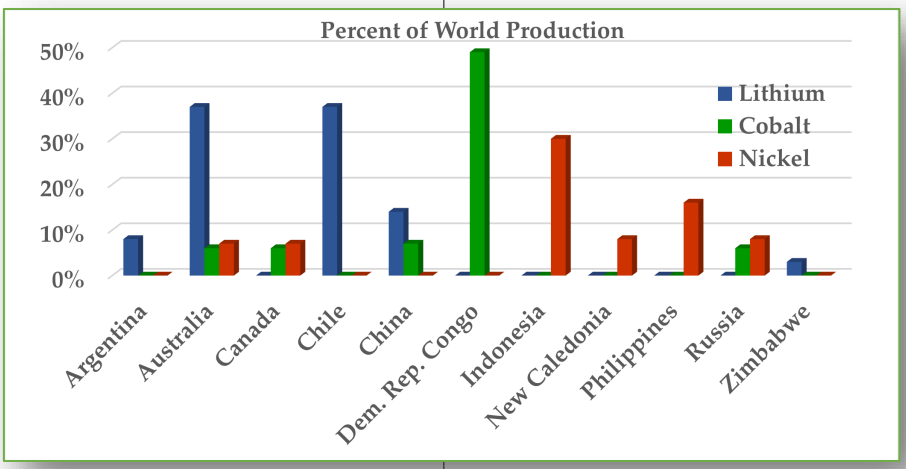
Newer Forms of Storage on the Horizon

- The electrochemical technologies to watch are iron/air and zinc/hydrogen. Both are heavily privately funded, having access to nearly half a billion investor dollars. These technologies left the laboratory within the last five years and now seek manufacturing scale to reach production. Although the technology is proven, manufacturability, achieving scale, and impacting the market remain significant challenges.
- The gravity technologies, based on off-the-shelf technologies deployable at low cost and risk, bring many charge/discharge cycles and long life making them particularly attractive to cautious investors and utilities. Also, their duration flexibility brings additional value to utilities that must deliver capacity, reliability, and resiliency based on weather-variable renewable resources.

Bringing it all Together

For now, electrochemical solutions, Li-NMC and Li-LFP, continue to dominate BESS deployments. Electrochemical solutions will represent the bulk of BESS deployments in the next decade, but non-lithium chemistries threaten lithium's dominance. Zinc and iron chemistry-based BESS suppliers transitioned from the R&D phase into production. Although not as energy-dense and therefore requiring a larger footprint, these chemistries bring increased longevity, with one supplier guaranteeing a ten-year life or 20,000 charge/discharge cycles. Lithium-based suppliers will provide similar guarantees but not without periodic battery component augmentation during the BESS's useful life. Further, zinc and iron chemistries offer cost per kWh stored below lithium-based BESS and significant recycling advantages, reported at nearly 100%. Several emerging BESS suppliers, driven by massive private equity and strategic investments, began to market their solutions as production scales.

Common to emerging technologies, many BESS categories encounter supply chain issues as demand increases. BESS production's greatest supply chain challenges stem from the shortages of lithium, cobalt, and nickel because of limits in USA's access to raw materials from friendly countries, as shown in the chart to the right.



BESS's optimal storage duration results from various factors, including the number of charge/discharge cycles before it's depleted, the required cycling frequency, and BESS cost. As a result, each BESS deployment considers the anticipated storage duration as short, 8 hours or less; medium, 8 to 72 hours; and long, greater than 72 hours. The return on a BESS investment hinges on the cost of energy to charge, the value of energy discharged, the frequency of charge/discharge, ancillary service value, and its role in resiliency. The use case for a BESS deployment has become critically important.

This year 80% of the BESS deployment occurs in ERCOT or CAISO. These BESS resources exploit energy and ancillary service arbitrage to deliver a return on investment, while utility-deployed BESS more likely focuses on storing excess carbon-free electricity when available and discharging when it's not to reduce the utility's carbon emissions.

Over the coming decade, BESS deployments will feature diverse technologies, flexibility (e.g., energy versus power), and storage duration. This diversity will be driven by the use case and justified by the layered benefit streams, streams that will change over time. A BESS resource in a market will see its value for ancillary services and/or energy decline as new storage and supply resources are deployed nearby and demand shifts. Resiliency value will increase because companies implement ESG mandates and replace fossil-fired auxiliary generation. BESS deployments will augment E.V. charging, reducing peak demand when chargers are under heavy use. Also, as BESS costs decline, electricity customers can deploy a BESS solution to reduce demand charges. Finally, utilities will deploy BESS solutions to avoid reconductoring, to solve traditional planning challenges regarding capacity and reliability, or even as mobile supply resources via trucks or rail to provide temporary power during planned or unplanned outages.

At this stage of BESS evolution, the existing use cases aren't fully developed, nor are the supporting justifications fully explored. As BESS capabilities expand, benefiting from technological improvements, existing and emerging use cases will develop quickly.

In the next decade, BESS deployments will be commonplace, each tailored to use cases that are justified by an expected rate of return or return on equity based on layered value streams. Not all will fulfill the expectation, but BESS can be repurposed and relocated as opposed to fossil or weather-variable supply resources.

WHAT's on MANI's MIND?

What does "green energy" really mean?

Nowadays there seem to be more synonyms for green energy than there are fish in the sea. Many of the terms below are used interchangeably, which can lead to confusion and further misuse.

- Green energy
- Clean energy
- Renewable energy
- Sustainable energy
- Alternative energy
- Environmentally friendly energy
- No/low/zero carbon energy
- Carbon-neutral
- Carbon negative
- Net-zero
- Beyond NetZero
- Decarbonization

The way I see it, green energy is not one thing; it encompasses many things. Just as in the early 2000s when we were calling any new digitally connected thing "smart," so too we're now labeling all kinds of things green, when they may more accurately be described as "low-carbon," or some other term.

Perspective is everything

If we ask four people what green energy is, we may get five (or more) answers. Depending on who they are, their perspectives are different. Adding to the confusion are many regulators and policymakers who are promoting generation sources from things like Renewable Natural Gas (RNG, aka biogas) as "green" when in reality it may at best be carbon neutral.

Tower of Babel, Александр Михальчук, CC BY-SA 4.0, via Wikimedia Commons

The increase in the emergence of these new terms points to the need for nuances in addressing several key issues as seen from the eyes of different stakeholders.

- **Legislators, policymakers and regulators** at the state and federal levels want to accelerate the move toward reducing the carbon footprint (decarbonization) of the utility/energy industry in service to its constituency. This is a good thing globally as we strive to take better care of our planet, the only one we can currently call "home."
- **Corporate leaders**, primarily as a part of their ESG goals, feel there is a need to make bold moves in reducing their carbon footprint to manage/maintain their images and in support of the expectations of their employees, customers and shareholders.
- **Utility executives** are trying to be responsive to the needs of their policymakers, regulators and customers as they aim to be ahead of the curve in planning for changes.
- **Utility customers**, who are essentially the one group that spans all the three stakeholder groups above, want to leave the world a better place for their children and grandchildren and lessen pollution for themselves. They, of course, are also sensitive to cost pressures and the need for reliable energy being delivered to their homes and businesses.

And, somewhere through all of this, utility planners and engineers are trying to figure out how to plan for and deliver to everyone's needs while at the same time maintaining affordable, reliable electricity for all.

Words matter

As humans, we tend to simplify in order to cope with complexity. But simplifying too much by using words inappropriately can have unintended consequences. The words we use and how we use them matter a lot because they shape the way we see the world and how we behave in it.

So, who cares what comes under the realm of "green energy"? It is important because expanding any one of these kinds of energy sources will have different levels of impact on our environment, and we need to (1) define it, (2) track it, (3) report on it, (4) make decisions based on it to ensure that we are making progress in the right direction to achieve the right objectives.

Overusing these terms and misusing them (e.g., is nuclear generation green?), all lead to confusion akin to the "*Tower of Babel*" spending money, time, and research – all with the possibility of not achieving our goals. THIS IS NOT GOOD!

So, let's fix it. Let's fix it at the national level by understanding what each one of the terms means and what is its contribution to the decarbonization agenda, and more importantly, let's also understand its cost and impact on the average person, i.e., their electric bills and reliability of power.

The intent of this discussion is not to either agree or disagree with the actions that are taking place in the industry. The main objective is to bring everyone's attention to this interesting incongruence and to try to explain it in plain simple language for everyone to understand.

Signing off,
Dr. Mani Vadari

PS: Here's another set of terms that are often misused, but I'll save this for a future issue. 😊

- Distributed Energy Resources
- Behind-The-Meter
- Net Metering

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.

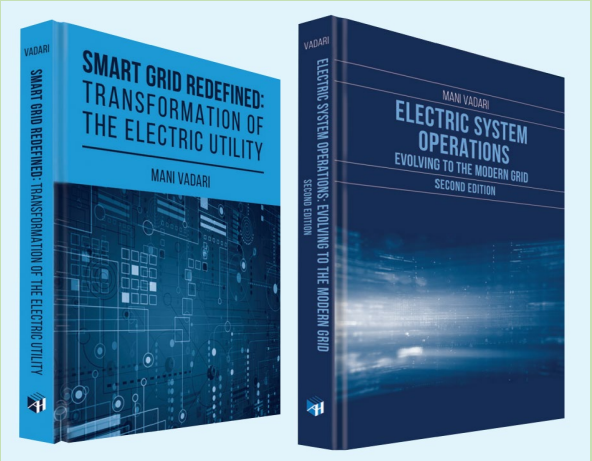
MGS has assembled a team of leading experts all having between 25 – 45 years of experience delivering complex, innovative technology, business, regulatory and finance solutions to electric utilities, corporate clients and policymakers. Our experts bring expansive breadth and tremendous depth in engineering,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

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.

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

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)
- Assisting the Pacific Northwest National Laboratory on a DOE project - development of a distribution application development platform (GridAPPS-D).
- Assisting with a major multi-OpCo distribution operations transformation – Control center consolidation, ADMS implementation and operations standardization.
- Business Architect role with implementing a DER dispatch (People, Process and Technology) solution across Transmission and Distribution
- Assisting a major multi-jurisdictional utility with defining and updating their Digital Field and Grid Operating Strategy.
- Assisting a major northwest utility with overhauling 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.
- Assisting a major east coast gas utility with their decarbonization strategy.
- Assisting several system operations vendors with the development of their product implementation strategies.



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)

Both of Dr. Vadari's books are regularly used as text books in several universities in the U.S. and abroad.

ABOUT THIS NEWSLETTER

This quarterly newsletter is a production of Modern Grid Academy under the auspices of Modern Grid Solutions.
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