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QUARTER 3, 2023



WELCOME TO OUR Q3 2023 NEWSLETTER!

Welcome to the Modern Grid Solutions Q3 2023 newsletter, where we curate and share some of the latest insights and trends on the design and operation of a modern electric grid.

We hope you enjoy reading our newsletter and find it helpful for your grid modernization journey. If you have any questions or feedback, don't hesitate to [contact us](#).

Thank you for subscribing to the Modern Grid Solutions newsletter!

Thank you for reading!
Dr. Mani Vadari, President

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.



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CHECK IT OUT!

Journal of Modern Power Systems and Clean Energy

The paper, "Distribution Control Centers in the US and Europe: Commonalities, Differences, and Lessons" co-authored by Dr. Mani Vadari, has been published in MPCE and has so far had 746 full-text downloads in [IEEE Xplore](#), garnering widespread visibility. The other authors of this paper are Izudin Dzafic, University of Sarajevo; Dan'l Koch and Ryan Murphy from Puget Sound Energy; Daniel Hayes, Commonwealth Edison; and Tarik Donlagic of Siemens AG.



INDUSTRY EVENTS

Upcoming events

CONFERENCE & EXHIBITION: [Distributech International 2024](#)
February 26-29, 2024 in Orlando, Florida

Once again, the MGS team will be at Distributech in Orlando. Before the exhibition opening, Dr. Vadari is presenting a "Utility University" course on Monday, February 26, from 8am-12pm PST in Room W204A in the Orange County Convention Center. The course #UU204 is titled "A Primer on Energy Transition to Net Zero – the Opportunity and Challenges." Other instructors include Glenn Pritchard, Mark Carpenter and Anant Venkateswaran.

CONFERENCE: [IEEE PES General Meeting 2024](#)
July 21-25, 2024 in Seattle, Washington

Dr. Vadari has joined the IEEE Power and Energy Society (PES) 2024 Plenary Committee. He will be involved in reviewing and selecting papers for the Super Sessions. The 2024 General Meeting theme is "The new electric system: reinvention and resilience."

Recent past events

CONFERENCE: Sustainable Aviation Conference
August 17, 2023

Dr. Vadari presented at the Sustainable Aviation Conference hosted by the Washington State Academies of Science. His presentation topic was "Electric Aviation – Challenges to the Power Grid," part of the session "Infrastructure Changes for Sustainable Aviation." A report summarizing the presentation and discussions will be shared in a future newsletter.



MERGERS AND ACQUISITIONS

ESG drove M&A in Q2 2023

Environmental, social and governance (ESG) was the key disruptive theme that drove the most mergers and acquisitions (M&A) activity globally and across sectors during the second quarter of 2023, research from GlobalData, Energy Monitor's parent company, shows. The Thematic intelligence: Global M&A Deals in Q2 2023 – Top Themes by Sector report explores the themes that drove M&A activity in Q2 2023 across all sectors. It found that ESG drove 104 M&A deals worth a combined total of \$145bn during the quarter. ESG was also the top theme driving deals in the business and consumer services and the energy sectors – specifically, the environmental aspect of it. Read more [here](#).

Enbridge to buy three utilities from Dominion Energy for \$14B

Enbridge, a Canadian pipeline operator, will buy three utilities from Dominion Energy for \$14 billion including debt, creating North America's largest natural gas provider and doubling its gas distribution business. The deal is seen as a bet on the future of natural gas in a regulated market even as energy companies and consumers are transitioning to a greener future by phasing out fossil fuels.. Read more [here](#).

TransAlta Corp merges with TransAlta Renewables

TransAlta Corp. and its majority-held wind power supplier TransAlta Renewables Inc. (RNW) have agreed to merge to strengthen their position in the clean electricity sector. TransAlta operates power generation assets in Canada, the USA and Australia. In Canada, it claims to be one of the country's biggest wind power producers, as well as Alberta province's top producer of hydroelectricity. The three countries present growing opportunities in the clean energy sector having increased investments to reduce planet-warming emissions. Read more [here](#).

FirstLight Power to acquire Hydromega Services

FirstLight Power (FirstLight), a leading clean power producer, developer, and energy storage company, today announced that it has finalized an agreement to acquire Hydromega Services Inc. (Hydroméga), including ownership interest in five hydropower generating stations in Québec and five additional hydropower generating stations in Northeastern Ontario. In addition, FirstLight will add Hydroméga's clean energy development pipeline that includes over 2 gigawatts (GW) of wind, solar, storage, and hydroelectric projects, doubling FirstLight's development pipeline to approximately 4 GW in the United States and Canada. The transaction is expected to close in Q4 2023 and is subject to customary closing conditions. Read more [here](#).

Duke Energy to sell its commercial renewables business to Brookfield for \$2.8B

Duke Energy announced that it agreed to sell its 3.4 GW unregulated, utility-scale commercial renewables business to Brookfield Renewable Partners for \$2.8 billion, after the utility's board approved a sale late last year. The utility said it plans to use those proceeds to strengthen its balance sheet and avoid additional holding company debt issuances, allowing Duke to "focus on the growth of its regulated businesses," in particular investments into enhancing grid reliability and incorporating 30 GW of regulated renewable energy by 2035. Read more [here](#).

Electriq Power merges with TLG

Electriq Power, a provider of intelligent energy storage and management for homes and small businesses, acquired TLG Acquisition One through a reverse merger for \$495 million to facilitate installations of solar energy and intelligent storage solutions. The transaction (including pre-closing financings) generated over \$45 million in equity for Electriq through private placements, PIPEs, loan conversions, and non-redemptions. Read more [here](#).

Energy Resourcing acquired by Airswift

Airswift, a global workforce solutions provider, announced its acquisition of Energy Resourcing, Worley's global recruitment and contractor management business. Energy Resourcing will fully integrate into Airswift's existing brand, systems and processes. The acquisition allows Airswift to better support both existing Airswift and Energy Resourcing clients' global ambitions by providing access to an even deeper pool of the industry's top technical talent, spread across a broader range of both industries and locations. This includes enhancing the business's especially strong presence in the Americas, Asia Pacific, United Kingdom, and Europe. Read more [here](#).

Constellation to acquire 44% of NRG Energy

Constellation, operator of the nation's largest fleet of reliable, carbon-free nuclear plants, announced it is acquiring NRG Energy Inc.'s 44 percent ownership stake in the South Texas Project Electric Generating Station, a 2,645-megawatt, dual-unit nuclear plant located about 90 miles southwest of Houston. The transaction is valued at \$1.75 billion, with an effective purchase price of \$1.4 billion after considering the present value of tax benefits to Constellation. After the transaction, Constellation will be one of three owners overseeing the South Texas Project Nuclear Operating Company (STPNOC), which will continue to operate the plant. The purchase is subject to approval by the Nuclear Regulatory Commission and Department of Justice. The deal is expected to be completed by year end. One of the U.S.'s newest and largest nuclear plants, the South Texas Project generates enough carbon-free power for two million average homes. Read more [here](#).



Eversource selling offshore wind stake to Ørsted for \$625M

Eversource Energy agreed to sell its 50% stake in a wind development site off the south coast of Massachusetts to joint venture partner Ørsted, the world's largest developer of offshore wind farms, for \$625 million in cash. The company said that the agreement to sell the lease area of about 175,000 developable acres is expected to close in the third quarter of 2023 and will require the approval of the Committee on Foreign Investment in the United States. Read more [here](#).

DNV acquires ANB Systems

DNV has bought Houston-based ANB Systems, a SaaS company providing energy program services to utility and regulatory body customers. DNV states this move will strengthen the company's energy transition skill set. By integrating ANB's well-established business process management software with DNV's expertise, DNV aims to facilitate its customers' journey towards decarbonized, safe, and efficient energy systems. Read more [here](#).



KEY HIGHLIGHTS

New England's first-ever agreement to coordinate offshore wind procurement

Massachusetts, Rhode Island and Connecticut announced New England's first offshore wind multi-state coordination memorandum of understanding (MOU), which creates a pathway for a potential coordinated selection of offshore wind as each state solicits offshore wind energy generation through their respective state procurements. This MOU is the first of its kind in the United States. Through this MOU, the three states will together seek multi-state offshore wind proposals that would expand benefits for the region, capture cost reductions by developing projects at scale, and develop into viable projects. In coordinating, the states will amplify efforts to foster regional economic development, create high-paying, in-demand jobs, and promote environmental justice and equity. Read more [here](#).



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Report shows U.S. could reach net-zero target through three key steps

The U.S. could meet its net-zero-emissions target by 2050 through three key portfolios of actions, a new [report](#) (this link includes a paywall) from the ICT finds. The report finds that achieving U.S. climate goals is possible through existing measures—transportation electrification, building decarbonization, and clean energy—and aims to chart achievable pathways for each measure. The report finds that U.S. federal agencies, state and local governments, and utilities will need to work together to increase electric vehicles (EVs) by 100 times the current number on the road, install more than a billion decarbonization measures in buildings, and increase renewable energy to 85% of total electricity generation to meet national climate goals. The report also modeled the impact of two signature U.S. climate laws, the Bipartisan Infrastructure Law (BIL) and the Inflation Reduction Act (IRA), finding that the laws could reduce enough planet-warming greenhouse gas (GHG) emissions to get the U.S. halfway to its climate goals. Read more [here](#).

DTE vows to invest in grid improvements to the tune of \$9B

After the most expensive storm in its history for Michigan's largest electric utility, DTE Energy rolled out a five-year, \$9 billion plan to build a "grid of the future" and prevent such incidents from happening again. As part of this roadmap, DTE announced three customer-focused goals:

- Increase average reliability by over 60% within five years, putting DTE on track to be in the top half of best performing utilities nationwide for both the frequency and duration of outages.
- Transition to a smart grid with full automation within five years, resulting in smaller and shorter outages.
- Within three years, 90% of the circuits in Detroit will have been updated, with the remaining 10% actively undergoing upgrades. Read more [here](#).

US to provide up to \$522M for Ukraine's energy system

Ukraine and the United States have signed a memorandum of understanding (MoU) under which Kyiv will receive up to \$522 for strengthening the resilience of the Ukrainian energy system, the U.S. embassy in Ukraine said. Ukraine will receive \$422 million in new energy assistance and a further \$100 million will be subject to the implementation of certain measures including reforms, the embassy said. One of the aims is to help Ukraine restore critical infrastructure following Russian air attacks on power plants and transformers that left millions of people without

electricity at times last winter. The MoU is also intended to help Ukraine work towards reform of the energy sector and its transition after the war with Russia to a low-carbon, competitive energy economy integrated with the European Union, the U.S. embassy said. Read more [here](#).

Hawaiian Electric begins restoration work in Lahaina

In continued partnership with federal, state and county agencies, and with the clearance to re-enter parts of Lahaina, Maui emergency management officials have asked Hawaiian Electric to start replacing poles and other electrical equipment that were damaged by the windstorms and wildfires in and around Lahaina. This work will restore power to wastewater pumps and telecommunication services and improve electrical service reliability to surrounding residents and neighborhoods. The work involves the installation of temporary poles, transformers, power lines and other equipment in and around the Lahaina area to provide safe and reliable power while long-term, community-driven plans are developed for future energy needs. This

temporary infrastructure would not preclude the possibility of underground utilities in the future. Read more [here](#).

Report says US and Canada to spend \$12T on grid and renewables between 2023-2050

Federal and household spending on energy in the U.S. and Canada will drop sharply as the two countries reduce their reliance on fossil fuels, according to [DNV's Energy Transition Outlook North America](#). The new report explores the most likely energy future of the U.S and Canada to the middle of the century and it forecasts that 12 trillion dollars will be spent in the two countries on grid and renewables between now and 2050 with the grid expanding its capacity 2.5 times to support the integration of renewables. Read more [here](#). *The report is gated; available via request from DNV's website.*

SPP expanding with commitments from western utilities

Southwest Power Pool (SPP) will soon become the first organization in the U.S. to provide full regional transmission organization (RTO) services in both the Eastern and Western Interconnections of the nation's power grid. SPP has received commitments from seven western utilities to become full members in the RTO. Basin Electric Power Cooperative, Colorado Springs Utilities, Deseret Generation and Transmission Cooperative, Municipal Energy Agency of Nebraska (MEAN), Platte River Power Authority, Tri-State Generation and Transmission Association, and three regions of the Western Area Power Administration (WAPA)—Colorado River Storage Project (CRSP), Rocky Mountain Region (RM) and Upper Great Plains-West (UGP)—are preparing to join the RTO in early 2026. Expanding SPP's service territory is expected to create economic and reliability benefits for its member companies through access to a larger generation fleet, greater geographic diversity, and increased trading opportunities in SPP's energy markets.. Read more [here](#).

UK selects six SMR technologies to advance in competition

Six companies' designs for the next generation of nuclear reactors have been selected to progress in a government competition supporting the development of this innovative technology for greater energy security. EDF, GE-Hitachi Nuclear Energy International LLC, Holtec Britain Limited, NuScale Power, Rolls Royce SMR and Westinghouse Electric Company UK Limited have been chosen for the next stage of the process. The Small Modular Reactor (SMR) competition is part of the government's plan to revive nuclear power and for the UK to lead the global race to develop cutting-edge technologies to rapidly deliver cleaner, cheaper energy and greater energy security. The government's ambition is for up to a quarter of all UK electricity to come from nuclear power by 2050. Read more [here](#).

Norway's Hystar expands to the US with 4 GW electrolyzer factory

Hystar AS announces a fully automated 4 GW electrolyzer factory in Høvik, Norway (just west of Oslo), that will be delivered in 2025, with construction commencing in early 2024. Furthermore, the high-tech company is expanding into North America, establishing a location in 2024 and a multi-GW factory by 2027. Hystar will soon initiate the hiring process for its new North American headquarters as part of its expansion. Additionally, the company is in discussions with key stakeholders in both the United States and Canada to establish its first GW factory on the continent, where Hystar expects its commercial operations may exceed its European plans within the decade. The company has not ruled out the possibility of investing in further GW factories before 2030. Read more [here](#).



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Energy-as-a-service firm launched to help smart cities decarbonize

Generate Capital and McKinstry entered a formal partnership to launch Viridis Initiative, a joint venture that leverages a turnkey development approach that allows municipalities, universities, schools and hospitals to upgrade their aging energy systems, address deferred maintenance and reduce emissions without taking any financial or operational risk. The new venture combines the sustainable investment and operating expertise of Generate with the engineering and project delivery expertise of McKinstry, delivering an affordable way for communities across the United States to access clean resources, improve indoor air quality, increase building comfort, reduce operating expenses and meet long-term sustainability goals. In 2021, the operation of buildings accounted for 30% of global final energy consumption and 27% of total energy sector emissions, making Viridis Initiative's EaaS model an important and practical decarbonization solution for building owners. Read more [here](#).

BMW, Ford, Honda to create new EV grid services company

BMW Group, Ford Motor Company and American Honda Motor Co., Inc. announced that they have entered into an agreement to create ChargeScape, LLC, a new equally-owned company that will create a single, cost-effective platform connecting electric utilities, automakers and interested electric vehicle customers. Benefiting both EV customers and the electric utility industry in the U.S. and Canada, ChargeScape will unlock entirely new value that EVs can provide to the electric grid, while enabling EV customers to earn financial benefits through a variety of managed charging and energy-sharing services never before possible with traditional gasoline-powered vehicles. The closing of the transaction and subsequent formation of ChargeScape is pending regulatory approvals, with the company expected to be operational early next year. Read more [here](#).

MIT engineers create an energy-storing supercapacitor from ancient materials

Using ancient materials, MIT researchers have designed a supercapacitor that could one day help power homes and even wirelessly charge EVs. A team of MIT researchers has figured out a way to create a supercapacitor simply by mixing cement, the binding ingredient of concrete, and a fine charcoal product called carbon black together with water. Better yet, this mixture could allow a home to store a full day's worth of energy in its foundation, potentially paving the way to an efficient renewable energy storage solution that doesn't rely on mining rare Earth metals. Another potential application for carbon-cement supercapacitors is for building concrete roadways that could store energy produced by solar panels alongside the road and then deliver that energy to electric vehicles traveling along the road using the same kind of technology used for wirelessly rechargeable phones. A related type of car-recharging system is already being developed by companies in Germany and the Netherlands, but using standard batteries for storage. Read more [here](#). Read the full MIT research article [here](#).

Verdogy to manufacture green hydrogen electrolyzers in new CA factory

Verdogy, a provider of water electrolysis electrolyzer technologies for large-scale industrial applications, announced its new facility opening in Newark, California, with more than 100,000 sq. ft. of advanced manufacturing space. Verdogy's Silicon Valley factory will be one of the first to manufacture advanced water electrolyzers in large volumes in the United States. The commencement of operations at Verdogy's facility will start in Q1 2024. Verdogy says it expects to double the total number of its employees by next summer to support its expansion and the operation of this new facility. Read the report [here \(PDF\)](#).

TVA invests \$1.25M in carbon capture study

The Tennessee Valley Authority announced it will work with TC Energy to jointly invest \$1.25

million to study carbon capture technology to reduce emissions at TVA's natural gas facilities in Ackerman, Mississippi, and in Drakesboro, Kentucky. TVA is exploring several options to decarbonize its power grid, and the partnership's goal is to conduct a feasibility study to determine the costs, technical challenges, and operational impacts of carbon capture technology. Information from this study will be used to assess future asset decisions for the TVA fleet. Carbon capture sends the exhaust from natural gas power facilities to a CO2 scrubber adjacent to the plant. A chemical reaction absorbs the CO2 before the exhaust is released into the air. The CO2 is then pumped to another vessel and treated with heat that releases the CO2. This released CO2 is compressed and sent deep into the earth for safe storage. Read more [here](#).

Green Mountain Power launches first in nation 2030 zero outage initiative

Green Mountain Power (GMP) launched its Zero Outages Initiative, the first utility in the country to commit to a comprehensive, data-driven plan that creates layers of resiliency across Vermont by building on GMP's successful and proactive undergrounding and storm-hardening of lines, as well as deployment of energy storage through batteries and microgrids. This work is purported to keep customers and communities connected while lowering costs for all. The phased initiative rapidly accelerates this resiliency work through 2030, tackling the hardest hit areas in rural central and southern Vermont first, following a devastating year for the state that saw an unprecedented string of damaging storms due to climate change. Here's how it works: the Zero Outages Initiative leverages circuit-level resiliency data, combined with the Centers for Disease Control (CDC) community vulnerability data, topography, and other metrics to determine the right resiliency approaches for each of GMP's 300 circuits. This ensures that all customers experience zero outages, whether in a remote area or in a densely developed downtown. Read more [here](#).

DoE awards Xcel Energy \$70M for long duration energy storage

Xcel Energy announced that it has received a grant of up to \$70 million from the U.S. Department of Energy (DOE). The award will partially fund two long duration energy storage systems in Minnesota and Colorado. Each demonstration-scale system will be a 10 megawatt/1,000 megawatt-hour iron-air battery developed by Massachusetts-based Form Energy. The batteries will be located at the sites of two retiring Xcel Energy coal plants. Once operational, the systems will allow Xcel Energy to store renewable energy such as solar and wind when it is being produced and then later distribute the energy during periods of lower renewable production. While most existing battery technologies serve fewer than eight hours of energy storage, Form Energy's iron-air batteries deliver electricity for up to 100 hours. The long duration energy storage systems aim to strengthen the grid against day-to-day and week-to-week variability of renewable energy. Read more [here](#).



FEATURED ARTICLE



Efficacy of Grid-Forming Inverters: A neoteric solution towards stability and resilience in a Smart Grid

By: Shriram S. Rangarajan, Senior Engineer, Enerzinx LLC
Amritpal Singh, Senior Director, Enerzinx LLC

Grid dynamics and control tactics have advanced greatly as the penetration of inverter-based renewable energy (IBR) resources has increased in a Smart Grid environment. Grid-forming inverters (GFI or GFM) are one of these developments that stands out as a potential transformative technology for the power sector. Grid scale PV Solar plants, Wind energy systems, Battery Energy Storage Systems (BESS), and hybrid plants are some of the examples of energy generation where GFI technology is used to improve resilience in energy systems and enhance grid stability. Grid Forming Control (GFC) mechanisms are adopted by GFI can act as a modulated voltage source, is designed to establish, and regulate both voltage and frequency within the grid. Although research into GFI controls is still in its infancy, these devices appear to have considerable promise for boosting the efficiency of the power grid. GFM technology holds significant potential in bolstering the electricity grid and facilitating the seamless integration of renewable energy, particularly in areas with weak grid infrastructure. This article delves into the efficacy of GFIs and how they are changing the face of electrical systems thereby forming the crux of the smart grid environment.

Need for Grid Forming Inverters

Present day inverter-based resources (IBR) are "grid-following" (GFL). There are limitations to how far the grid can be isolated due to equipment failures, bad weather, or human error when grid-following inverters are available. Since they run at the same voltage and frequency as the grid, these inverters cannot work without power. This exemplifies the limits of grid-following inverters in such circumstances and may hamper the grid stability. The frequency change following a resource trip is determined by inertia rather than resource reactions. Synchronous machines are currently the major contributors of system inertia. IBR has the potential to reduce system inertia when less synchronous equipment is online. With Grid Following (GFL) IBRs, neither inertia nor strength are improved. Hence it mandates for novel methods of control to overcome these challenges and guarantee that renewable energy sources and battery energy storage can be seamlessly integrated into electric networks. The primary function of GFM inverters is to deliver synthetic inertia and rapidly inject active power into the system. GFI IBRs have the potential to increase grid reliability either on their own or in tandem with other GFI resources.

GFI Controls

GFI controls mainly consist of a Virtual Synchronous Generator (VSG) integrated into a high-power Grid Forming converter. This system incorporates a rotor flux model of a synchronous generator, an Automatic Voltage Regulator (AVR), synthetic inertia, and synthetic impedance. Both in steady-state and transient operation, the VSG is controlled in a manner like a synchronous generator. Independent operation, parallel operation with other voltage and/or current sources, and grid connection are all examples of how the system's improved performance can be witnessed. The converter functions reliably as a voltage source, allowing for easy transition between grid and off-grid modes. The VSG layer also offers tuning options and flexibility, facilitating easy connection to the electrical grid. GFIs reduce the system's dependence on external components, simplifying maintenance and delivering great results across a wide range of inertia grids. These inverters and other black-start supplies can reconnect to the grid after an outage regardless of grid state. This improves system dependability. Transmission

Operators decide based on the requirements and compliance of GFI interconnection with NERC FAC-001.

Why GFI are preferred over GFL Inverters?

The benefit that GFI offers over GFL is substantial. Some of them are as follows:

- GFL requires a PLL or similar for synchronization, but GFI does not.
- GFI operates grid at 100% IBR, unlike GFL.
- GFI can function independently and is most effective during islanding conditions, while GFL requires grid resources for stable operation and grid support.
- GFI units can be blackstart resources, while GFL cannot.
- GFI can inject energy faster on the inertial timeframe, while GFL can respond faster with a slight delay.
- GFI controls IBR terminal voltage, angle, and frequency, while GFL-based IBR controls current and phase angle.
- GFI is stable in weaker grids with low SCR conditions, such as $SCR < 1$, however GFL is unstable in most systems with $SCR < 3$.

Some of the functionalities of the Grid Forming Inverters that makes the grid robust are:

- Sharing of Active and Reactive power
- Damping of oscillations
- Strategic mitigator of harmonics
- Response to voltage step magnitude and phase angle step
- Response of RoCoF event (MW loss)
- Ability to ride through balanced and unbalanced faults
- Ability to operate under low SCR conditions of the grid
- Island operation

Challenges associated with Grid Forming Inverters

As more GFIs are added to the grid, their functions are changing to address grid challenges. Most IBRs use grid signals and are grid-following. GFI restrictions are being capped by IBRs. Since system operators and planners have trouble estimating equipment capabilities and requirements, IBRs have operating constraints, lower output, and limited communication. Identification of equipment capabilities are difficult, and lack of market incentives and norms discourages manufacturers from investing in breakthrough technology. This slows the adoption of more advanced IBRs controls.

Grid Forming Inverters as a key market player in Smart Grid

Grid-forming inverters benefit from market requirements, competitive edge, and long-term growth. GE, Eaton, Hitachi Energy, Siemens, Solectria Renewables, and others lead these innovative Grid forming inverter functions. Enerzinx LLC, a leading consulting firm with offices in the US, Canada, Australia, and India, provides expert engineering solutions and technical support for renewable energy projects worldwide and is actively involved in Grid Forming Inverter impact studies with several power system networks. As GFIs control voltage and frequency in IBR-equipped electrical networks, Grid stability requires advanced GFI controllers. GFI controls can improve bulk power system efficiency, but the technology is still in its infancy. The prerequisites for the implementation of GFI technology in a system can only be established through collaboration between system operators, equipment makers, and owners. More research is required to evaluate consistency and integrate different types of research. Hence GFI is gradually becoming the crux of the smart grid for enhanced grid stability and resilience.



FEATURED ARTICLE



Revising the Interconnect Process: A Primer for FERC NOPR 2023

By JD Hammerly, CEO of The Glarus Group

On July 27, 2023, FERC issued the long-awaited Order 2023 on Improvements to Generator Interconnection Procedures and Agreements. Order 2023 implements comprehensive reforms to the interconnection study process, requiring a first-ready, first-served cluster study process. Also, it imposes new and heightened financial requirements on interconnecting customers and transmission providers.

Cluster Study Process and Costing

Order 2023 requires transmission providers to employ a cluster study process rather than the serial first-come, first-served process in place for decades but doesn't prescribe how transmission providers should form clusters. Further, Order 2023 revises the interconnection requirements for interconnection requests and processing. Among other changes, an interconnection customer must specify a definitive interconnection point when executing the cluster study agreement. Additionally, section 3.4.1 requires interconnection customers to submit an interconnection request during a specified 45-calendar day submission period, the cluster request window, with the start date to be determined by each transmission provider. Order 2023 provides parameters for allocating study costs among interconnection customers (Section 13.3 a).

Order 2023 (section 4.2.1) also details how interconnection facilities and network upgrade costs identified in cluster studies must be allocated amongst interconnection customers. E.g. for substation network upgrades, including all switching stations, costs are allocated per capita to each generating facility interconnecting at the same substation. It also states that each transmission provider must describe how the cost for each facility type designated as a network upgrade will be allocated using its proportional impact method. Lastly, it allows interconnection customers in the cluster to agree to share interconnection facilities and their costs. In that case, the cost of such interconnection facilities will be allocated based on the number of generating facilities sharing the use of such interconnection facilities unless the customers mutually agree to a different cost-sharing arrangement. Regarding the study deposits, transmission providers must collect a single study deposit only once upon entry into the cluster when the interconnection customer submits an interconnection request. The amount of the initial study deposit is calculated using a tiered approach.

Size of Proposed Generating Facility Interconnection Request	Amount of Deposit
> 20 MW < 80 MW	\$35,000 + \$1,000/MW
> 80 MW < 200 MW	\$150,000
> 200 MW	\$250,000

Interconnection customers must also provide evidence of 90% site control for the generating facility at the time of interconnection request submission and 100% site control for the generating facility at the time of execution of the facilities study agreement and when executing an interconnection agreement. Order 2023 eliminates the option to provide a deposit in place of site control demonstration, except in limited circumstances where an interconnection customer demonstrates a regulatory limitation to obtaining site control and eliminates the option to post non-refundable security instead

of site control for interconnection agreement execution. Finally, Order 2023 imposes withdrawal penalties that increase throughout the interconnection process on customers who withdraw an interconnection request from the interconnection queue absent qualifying for one of the limited exemptions. Thus, the withdrawal penalty for an interconnection customer will be calculated as the greater of the study deposit or the amounts provided in the table below:

Phase of Withdrawal	Total Withdrawal Penalty (if greater than study deposit)
Initial Cluster Study	2 times study costs
Cluster Restudy	5% of network upgrade costs
Facilities Study	10% of network upgrade costs

After execution of the interconnection agreement, 20% of network upgrade costs.

Transmission Provider Queue Processing Timing Requirements

Order 2023 establishes firm study deadlines to complete interconnection studies. Section 7.4 now requires that the transmission provider complete the cluster study within 150 calendar days from the close of the customer submission window. Similarly, Section 7.5 now requires that the transmission provider complete the cluster restudy within 150 calendar days of notifying interconnection customers in the cluster that a cluster restudy is required. It also provides for study delay penalties when transmission providers fail to meet their firm interconnection study deadline, although transmission providers can appeal the penalty imposition. Lastly, the order also requires transmission providers to use a standardized and transparent affected systems study process and establish a detailed affected systems study process and uniform modeling standards.

Technological Advancements

Order 2023 incorporates technological advancements into the interconnection process through reforms that increase flexibility in the generator interconnection process, incorporate enumerated alternative transmission technologies, and adopt the model and ride-through requirements for non-synchronous generating facilities. Order 2023 requires transmission providers to allow more than one generating facility to co-locate on a shared site behind a single interconnection point and share a single interconnection request. All co-located generating facilities must adhere to all other applicable laws and regulations, including PURPA.

Order 2023 revises the material modification standard and allows interconnection customers to add a generating facility to an existing interconnection request under certain circumstances without such a request being automatically deemed a material modification. Specifically, the order revises section 4.4.3 to require transmission providers to evaluate the proposed addition of a generating facility at the same interconnection point before deeming such an addition a material modification if the addition does not change the originally requested interconnection service level. This change may allow for the addition of energy storage resources to existing facilities. Order 2023 includes an exception for transmission providers that use fuel-based dispatch assumptions in their interconnection studies because a request to add a generating facility of a different fuel type to an existing interconnection request would always constitute a material modification requiring a study.

Transmission providers must also use operating assumptions in interconnection studies that reflect the proposed charging behavior of electric storage resources (whether standalone, co-located generating facilities, or part of a hybrid generating facility). In the initial interconnection request, the interconnection customer must provide the transmission provider with the requested operating assumptions for the interconnecting

electric storage resource and a description of any applicable control technologies.

Order 2023 requires transmission providers to evaluate specific alternative transmission technologies in their cluster studies. The rule expands the list of alternative transmission technologies from those identified in the NOPR to include static synchronous compensators, static VAR compensators, advanced power flow control devices, transmission switching, synchronous condensers, voltage source converters, advanced conductors, and tower lifting. These technologies must be evaluated during feasibility and system impact studies of the generator interconnection process where network upgrades are identified.

Transition Process

Transmission providers offer existing interconnection customers up to three transition options depending on the progress of the interconnection request. Interconnection customers that have been tendered facilities study agreements may either (a) proceed to a transitional serial study (a facilities study) or (b) opt to move to the transitional cluster study. Interconnection customers with an assigned queue position that have not been tendered a facilities study agreement will be eligible for the transitional cluster study, including clustered system impact study and individual facilities studies.

Interconnection customers can withdraw from the queue without penalty before the transitional studies. Order 2023 includes deposit and site control requirements and withdrawal penalties for transitional studies. Transmission provider compliance filings are due 90 days after publication in the Federal Register (likely November 1st, 2023).

resulting in a dispatchable energy supply curve shaped like a duck where the duck neck is the increase in required energy.

The effects of the duck curve

Because of this, energy generators must quickly ramp up dispatchable power technologies, which still need to have a power capacity greater than the solar PV installed in an area. For example, if 1000 MW of PV can satisfy the daytime needs, it can be assumed that the evening peak will be higher and greater than 1000 MW of dispatchable generation. This means that even with a large penetration of solar farms, a huge amount of carbon-based generation is still used (notwithstanding that energy production is still required overnight.) This reliance on carbon-based generation not only leads to higher emissions but also results in higher peak prices, as the quick energy ramp-up commands higher prices.

The "canyon" curve

As the uptake in renewable generation continues to grow in line with the global push towards carbon neutrality, the inevitable increase in solar PV generation is further worsening the duck curve phenomenon into what now appears to be becoming more of a canyon. As an example, CAISO (California's Independent System Operator) reveals how their load curve has morphed from resembling a duck in 2015 to a canyon in 2023. (see image below.)

The recent gradual growth in solar PV generation further increases the difference between the demand on the network and the available solar generation throughout the day, thus making the challenges of meeting the demand requirements in the evening as the solar generation ramps down and the demand ramps up even steeper.

Unfortunately, in an attempt to reduce the strain on the network to overcome the steep climb in demand during the evening, the "free" green energy produced by the increased solar PV generation in some instances needs to be curtailed to prevent such a large dip in the net demand. This waste of renewable energy is inefficient and does not align with the global target of becoming carbon neutral and as such, mitigation strategies must be sought.

Mitigation strategies

Since reliable energy is required, dispatchable generation is needed to combat the duck/canyon curve. Most dispatchable generation at present is carbon-based, such as open-cycle gas turbines which do not help with climate goals.

However, it is possible to still use solar energy after dark by using energy storage. The good news is that energy storage is evolving rapidly. Energy storage can mean various things, but the principles are the same. If you build PV bigger than required for daytime demand, the excess can be channeled into a storage technology and used at night. The first large-scale storage technology was pumped-hydro storage, which is still very efficient and practical but requires very specific topographies.

Today, battery technologies such as lithium-ion and even newer types such as vanadium-flow and iron-air are beginning to play a big role in our fight against climate change.

Finally, demand-side response can also help. If non-essential loads can be switched off during the peak of the duck/canyon curve, this will also help to mitigate the effects. This can be done via financial incentives where people can be paid for switching off these loads.

(image source: [EIA](#))



FEATURED ARTICLE



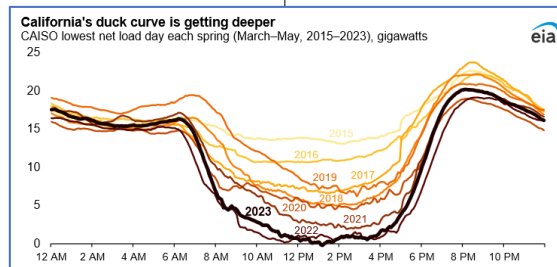
The duck curve is turning into a canyon

By [PSC, Power Systems Consulting](#)

Solar PV technology is forecast to surpass coal as the world's largest source of power with capacity tripling in the next five years, per [IEA's Renewables 2022 report](#). What was once expensive and provided only small amounts of power, now provides real, cheap energy without the need for fuels or even significant maintenance outside bi-annual panel cleanings. However, apart from the land space required, the major drawback is that it is only available when the sun is shining.

How the duck curve is formed

Most single-axis tracking PV panels form a rounded trapezoidal power production shape, where power production ramps up after sunrise and ramps down towards sunset, with peak energy output occurring in the middle of the day. However, in most regions of the world peak demand occurs just after sunset, as people heat their homes and perform cooking and other activities. Because of this, there is a rapid decrease in available power simultaneously with a sharp rise in electrical demand,





WHAT's on MANI's MIND?

Debunking Carbonization Myths

Decarbonization is a complex and challenging process that requires a radical transformation of our energy system and our society. However, it is also a feasible and desirable process that can deliver multiple benefits for our planet and our people. By debunking the myths and presenting the facts about decarbonization, we hope to inspire and inform more action and support for this vital cause.

The [NPUC \(National Public Utilities Council\) annual utility decarbonization report 2023](#) has identified six reasons for decarbonizing utilities calling it the "Grounds for Change". My analysis of these reasons are in the right-hand, shaded column below.

1	Mounting Levels of CO2: The 2023 IPCC (Intergovernmental Panel on Climate Change) report warns that as CO2 concentrations and global temperatures continue to rise, there is a pressing need for immediate action toward decarbonization across all sectors. Specifically for utilities, shifting away from emission-intensive electricity sources is more important than ever before.	FACT: <i>There is now enough evidence pointing to this as a fact. Global temperature is rising. The oceans are getting warmer. The ice sheets are shrinking. Glaciers are retreating. Sea levels are rising. Extreme weather events are increasing in frequency.</i> ¹
2	Growing Demand: With population growth, electrification, and increased industrial activity, electricity demand across the globe is rising each year. Decarbonizing the electricity sector could trigger decarbonization in other sectors that rely on electricity, resulting in a domino effect.	FACT: <i>Both points are factual. Between 1980 and 2022, electricity consumption more than tripled, while the global population reached almost eight billion. Growth in industrialization and electricity access across the globe have further boosted electricity demand.</i> ²
3	The ESG Advantage: The adoption of sustainable practices can attract climate-conscious investors, enhance brand reputation, boost investor confidence, and strengthen relationships with regulators.	Part FACT and part MYTH: <i>Customers, boards and investors are increasingly focused on ESG. However, many investors are hesitant to accept a lower rate of return in exchange for ESG benefits.</i> ³ <i>Many utilities are part of competitive markets where capital chases returns. No concrete evidence exists that people who invest in utilities are ESG-conscious. This becomes even more true across the world where most utilities are government-owned.</i>
4	Monetary Incentives: Utilities can reap significant monetary advantages from decarbonization. Examples of such advantages include lower fuel costs, increased revenue streams (e.g., through the sale of renewable energy credits), reduced regulatory costs, and increased opportunities to obtain tax credits. In turn, consumers also stand to benefit from lower costs or rebates as a result of more competitive pricing.	More MYTH than FACT: <i>This is questionable since most utilities are heavily regulated requiring them to pass costs or benefits back to the rate-base. Also, lower costs for the customer have not yet been borne out due to significantly higher delivery costs. On the other hand, in the US, utilities have many new federal incentives to encourage them to make different investment choices. Regulatory reform is needed to create a just transition that is reliable and fair to ratepayers.</i>
5	Electrified Transport: As the transportation fleet electrifies worldwide, the two sectors contributing the most to GHG emissions, electricity, and transportation, are merging. Decarbonizing electricity can decarbonize the use phase emissions of all electric vehicles (EVs).	Mostly FACT: <i>Electrifying transportation will reduce carbon emissions, improve air quality, lower EV operating costs, enhance grid stability by providing new sources of demand response, energy storage and ancillary services, and increase energy security by reducing reliance on imported oil and diversifying energy sources.</i>
6	Energy Security: The Russia-Ukraine conflict of 2022 demonstrated that dependence on foreign oil and gas can trigger economic shockwaves. Embracing clean energy sources like wind, solar, and nuclear enhances energy security, reducing dependency on other nations and protecting against fossil fuel price volatility and supply disruptions.	More MYTH than FACT: <i>Nuclear is not a solution for all countries, which leaves other clean energy sources like solar and wind, which are intermittent. So, where does the energy security come from for countries where nuclear generation is not an option? Can we make up the difference with energy efficiency and conservation? Or is hydrogen or carbon capture the answers? There is no one-size-fits-all solution for every country.</i>

These are only six issues surrounding decarbonization. When we start to analyze them, more questions quickly emerge...

- Solar and wind are "free." What seems to be the problem?
- Why don't we just add storage to this equation to solve the decarbonization problem?
- If Ireland can provide electricity for an entire day from renewable energy sources, why aren't other countries doing the same?
- How can we balance the trade-offs between decarbonizing the industrial sector and maintaining its competitiveness?
- How can we enhance regional and international cooperation on clean energy development and trade?
- How can we ensure energy equity?
- How do we manage the cost of the energy transition when fuel costs may be lower with renewable energy, but the overall cost of generation is still high?
- How do we optimize planning the path to decarbonization when, for example, moving everyone to solar panels because of the downward costs has a consequence of stranding expensive assets that customers may still be paying for?

Bottom line: We will get there!

We may not all be able to relocate to Mars (cough – Elon Musk – cough), but we are thoughtful engineers who can solve complex problems. Let's not forget that before the International Space Station, the Panama Canal, the Internet, or the automobile, electricity was discovered by scientists and harnessed and improved by engineers over the last 100+ years. Electricity is the foundation for all our modern technologies and has improved the quality of life, health, safety and productivity of millions worldwide.

Today, we are called to help transition our electricity systems by decarbonizing them and positively impacting our environment and society for ourselves and future generations. That, my friends, is all FACT!

¹ <https://climate.nasa.gov/evidence/>

² <https://ourworldindata.org/energy-production-consumption>

³ <https://www.pwc.com/gx/en/services/audit-assurance/corporate-reporting/esg-investor-survey.html>



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.

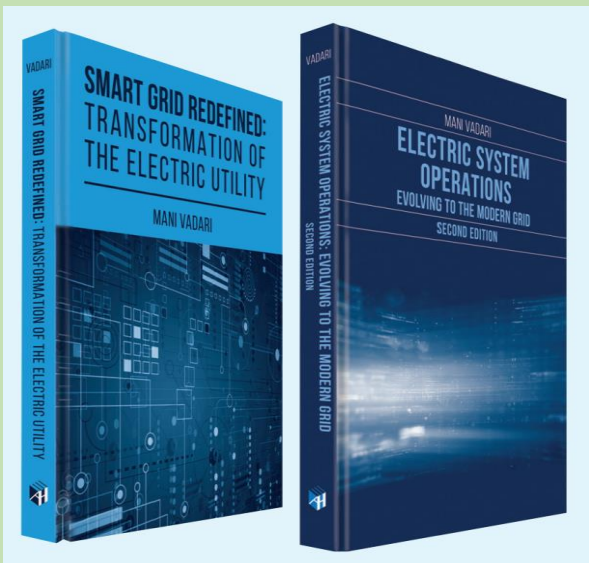
At MGS, our focus is on our clients and helping them connect the dots to make the modern grid possible. This is our obsessive passion and we've mastered the details so that our clients can keep their main focus on their businesses. And, in return, our clients value our boutique consultancy because of 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
<p>For Utilities and Policy Makers</p> <ul style="list-style-type: none"> • 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 <p>For Suppliers and Corporate Clients</p> <ul style="list-style-type: none"> • 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 	<p>For Utilities and Policy Makers</p> <ul style="list-style-type: none"> • 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 <p>For Suppliers and Corporate Clients</p> <ul style="list-style-type: none"> • Solutions design and implementation • Portfolio review and analysis • Adjacency analysis and technology management • Energy, REC and emissions trading

Ongoing MGS Projects

- Assisting a major Canadian municipal utility with the redesign of their system operations capability and the control center to meet the needs of the anticipated future.
- Assisting a major Northwest utility with transforming their planning capabilities to address the influx of Distributed Energy Renewables, Non-Wired and Non-Piped Alternative solutions and to address the needs of the Washington State Clean Energy Act (SB 5116)
- Assisting with a major multi-OpCo distribution operations transformation – Control center consolidation, ADMS implementation and operations standardization.
- Assisting multiple startup companies in the areas of IoT and Blockchain.

- Business Architect role at a major East Coast multi-jurisdictional, multi-state utility with implementing a DER dispatch (People, Process and Technology) solution across Transmission and Distribution.
- Assisting a major east coast gas utility with their decarbonization strategy.
- Assisting several system operations vendors with the development of their product implementation strategies.
- Assisting several energy service providers (consulting companies) by providing deep expertise in the areas of System Operations, Wholesale/ Retail Market Operations, and Power System planning.



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

Dr. Vadari's book is titled, "[Electric System Operations – Evolving to the Modern Grid, Second Edition](#)." 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.

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.

Both of Dr. Vadari's books are regularly used as text books in several universities in the U.S. and abroad. They are also popular with many major utilities. Ordering in bulk offers significant savings... and a lot of knowledge.

MGS is the go-to expert for delivering detailed learning sessions on the hottest topics in the industry, such as: power system fundamentals, grid modernization, smart cities, and advanced distribution management systems (ADMS). If you need one or more of these courses delivered by our senior staff, please [let us know](#).



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.