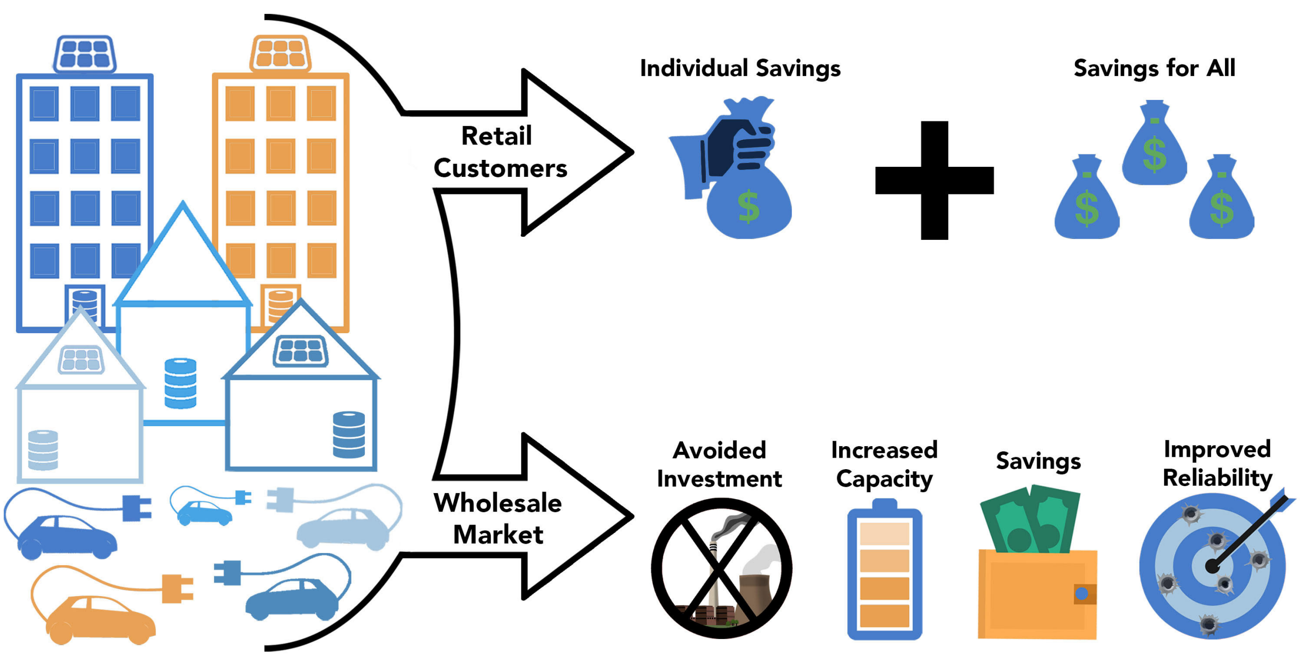
PUTTING DISTRIBUTED ENERGY RESOURCES TO WORK IN WHOLESALE ELECTRICITY MARKETS

Case Studies of Emerging Applications and Their Benefits for Customers and the Grid



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INTRODUCTION

The deployment of different types of distributed energy resources (DERs) in regions across the United States has accelerated significantly in recent years, creating opportunities and raising important questions about how they will be utilized to improve the current and future operation of the power system. In 2018, revenue from sales of plug-in electric vehicles jumped 75%, the market for energy storage grew 18%, and smart meter investment exceeded $1 billion.[1] Proliferation of customer-sited DERs has largely been driven by technological and manufacturing advances that have led to major cost declines, and by customer demand for solutions to improve the reliability of their operations. Additionally, many states have enacted policies to incentivize DERs to meet multiple goals, including lowering the carbon intensity of their power system, improving overall system resilience, and meeting customer demand for more energy choices.

While many DERs have been deployed for on-site uses, they often have the technical potential to quickly respond to market signals and provide a wide range of valuable grid services beyond their original use case, including in wholesale energy, capacity, and ancillary services markets. Integration of DERs in wholesale markets can save all consumers money by optimizing overall asset utilization, increasing competition, and providing alternative solutions that limit the need for costly infrastructure upgrades.

Competitive wholesale electricity markets were developed to incentivize innovation and facilitate robust competition among suppliers, while preserving overall system reliability at the lowest possible cost. However, current wholesale market rules are structured mostly around the technical and operational characteristics of traditional large central station generators and monopoly load-serving entities. Given the rapid deployment of DERs, federal regulators and regional market operators need to actively consider adopting new rules and operating practices to account for the characteristics and capabilities of new distributed technologies. Similarly, state regulators and distribution utilities should consider how DERs being deployed on their distribution systems can be fully utilized to provide multiple services in retail and wholesale markets.

DERs can be optimized to significantly enhance system reliability, improve resilience during extreme weather events, and reduce the cost of energy services, but only if they are able to participate and compete fairly in wholesale markets. More coordination between federal and state regulators and wholesale market operators and distribution utilities is needed to ensure that DERs are deployed and operated in

[1] Advanced Energy Economy, Advanced Energy Now 2019 Market Report (2019), available at https://www.advancedenergynow.org/aen-2019-market-report.

a way that optimizes benefits to asset owners, grid operators, and ratepayers.

Role of Regulators and Market Operators

The Federal Energy Regulatory Commission (FERC), regional market operators, and state regulators are currently considering how rules and practices need to be revised to properly integrate DERs into both wholesale and retail electricity markets. For several years, FERC has recognized the value of DER participation in the wholesale markets, ruling that removing barriers to such participation is necessary to ensure that wholesale rates are just and reasonable, as the Federal Power Act requires. The Commission is actively considering how to direct Regional Transmission Organizations and Independent System Operators (RTOs/ISOs) to update their market structures and operations to ensure that aggregations of DERs are eligible to provide wholesale services.

Both FERC and state regulators have important roles in ensuring the cost-effective and reliable deployment of DERs for wholesale and retail uses. FERC must ensure that DERs have the ability to deliver all of the wholesale services they are capable of providing, and that RTO/ISO market rules and operational practices do not erect barriers to market entry for DERs. FERC can also establish the foundation for efficient and reliable integration of DERs into wholesale markets by ensuring that RTOs/ISOs establish appropriate market participation frameworks, clear communication protocols, and reasonable metering and telemetry requirements. State regulators have authority to design and approve retail programs to encourage the development of DERs to meet state policy goals and improve local reliability and distribution system resilience. They also have important roles in regulating the interconnection of DERs to the distribution system, studying and planning for distribution system reliability as DER penetration grows, and establishing mechanisms to ensure that any costs incurred as a result of wholesale participation of DERs are appropriately allocated and recovered.

RTOs/ISOs and other wholesale market operators and distribution utilities also have important roles, including coordinating interconnection requirements (to speed connection and avoid unnecessary duplication of studies), facilitating communications between themselves and DER aggregators and operators to improve visibility of DER operations, and ensuring that DERs do not face duplicative charges.

Benefits for All

If structured properly, rules governing aggregated DER participation in wholesale markets can create benefits for all participants in the electricity sector:

- **Transmission Grid and Wholesale Market Operators:** DERs include fast responding and flexible resources that can significantly improve reliability and grid resilience. When aggregated DERs participate in wholesale markets, RTOs and other transmission operators gain visibility into the current and future location and behavior of these important energy producing and consuming assets. Further, by incorporating DERs into market dispatch, grid operators gain the ability to utilize these assets to meet the needs of the larger grid. This increased visibility can also improve coordination and dispatch instructions at the transmission and distribution interface. Furthermore, distributed generation assets are often deployed in areas that experience inconsistent service or long down times, and their integration into wholesale markets can limit congestion and line losses while improving system resilience. Finally, allowing the growing number of DERs to fully participate in wholesale markets improves wholesale competition and ensures just and reasonable rates.

- **Distribution Utilities:** When DERs participate in wholesale markets, utilities gain information that can help guide more informed system planning. This includes better real-time load management, the ability to reduce localized congestion, and the potential to defer expensive infrastructure investment over time. Importantly, DERs can improve the resilience of the distribution system against disruption from storms and fires by reducing system downtime and providing emergency backup power supply.

- **States:** DERs support state goals to improve distribution grid resilience, and they allow greater consumer choice in managing electricity supply. Additionally, for states with renewable energy and/or greenhouse gas-reduction targets, allowing the aggregated capacity from DERs to be bid into wholesale markets can increase deployment and expedite the realization of state goals by increasing penetration of distribution-tied clean energy resources *and* by increasing system flexibility and enabling higher penetration of variable large-scale renewable resources.

- **DER Consumers and Utility Ratepayers:** Many households and businesses purchase DERs for reliability benefits and potential cost savings on electricity and heating services. By unlocking additional revenue streams for asset owner-operators through wholesale market participation, customers can see even larger cost savings when they purchase or install DERs. Wholesale market participation can also increase and optimize asset utilization, which can improve project economics and lower rates for all customers by limiting the need for other higher-cost resources or infrastructure.

- **Developers and Aggregators:** Wholesale market participation can improve DER portfolio economics by adding new revenue streams, allowing developers to pass on cost savings and accelerate deployment. Additionally, the ability to participate in wholesale markets can limit the risk that asset managers face from possible curtailment due to limits of distribution infrastructure.

This paper provides five examples of existing or potential use cases involving aggregation of various DER technologies for participation in wholesale markets across the country. These use cases demonstrate that opening wholesale markets to aggregated DERs will unlock new business models that will benefit all stakeholders and improve the reliability and resilience of the grid.

CASE STUDIES OF DER WHOLESALE MARKET PARTICIPATION

Case #1: Battery Storage for Demand Charge Management and Other Market Options

Battery energy storage systems are flexible resources that can provide numerous services to the electric grid. Increasing grid-connected storage capacity can also indirectly enable deployment of more intermittent renewable generation. Accelerating deployment of battery storage capacity has become an important energy policy objective, and many states are incentivizing battery deployment with ambitious procurement targets, among other mechanisms. Deployment to date has included both large scale transmission-connected systems and small scale distribution-connected and behind-the-meter systems. Large scale systems are successfully participating in frequency regulation markets and have also helped utilities defer infrastructure upgrades. Customer-sited systems are becoming popular investments for commercial and industrial buildings looking to manage peak load charges, and sometimes as replacements for backup generation.

In some markets, using customer-sited battery systems to facilitate the provision of demand response has provided a pathway for these resources to participate in wholesale markets. However, using these battery storage systems under demand response participation models does not currently allow them to offer the full range of grid services they are capable of providing. Moreover, this narrow path to participation limits grid operator visibility into DER locations and capabilities, presenting challenges for interactions between the transmission system and local distribution systems. As deployment of battery systems accelerates, regulators should consider how market structures and coordination procedures can maximize grid benefits from new, customer-sited storage systems. Both grid operators and battery asset owners would likely benefit if batteries were granted access to a wider range of market participation avenues.

In addition to offering front-of-meter storage solutions, Stem Inc. has been offering storage-as-a-service products to commercial and industrial customers to help shift their load profiles and deliver cost savings by limiting consumption from the grid during times of peak demand. Stem utilizes an artificial intelligence platform to aggregate these distributed energy storage assets and participate in the California ISO as demand response resources through the ISO's Proxy Demand Resource (PDR) mechanism.[2]

In California, aggregated DER portfolios also can participate directly in wholesale energy and ancillary service markets using a pathway

[2] Conversation with Ted Ko, Director of Policy (Stem).

known as a Distributed Energy Resource Provider (DERP). Despite this option, Stem and other DER aggregators in the California market have to date found it more advantageous to bid into the PDR mechanism.[3] While PDR restricts participation to load curtailment, it is a more profitable participation option due to barriers within the DERP structure. Specifically, participants have noted that DERP's 24/7 settlement requirement precludes potential participants from taking advantage of opportunities outside the wholesale markets, which is cumbersome, as DERs depend on multiple revenue streams. In addition, under DERP, energy storage systems must pay twice for the energy they use to charge their systems, once at the retail rate and again at the wholesale rate. Furthermore, DERP requires the installation of detailed and expensive telemetry in each individual DER, undermining the financial case for aggregating hundreds or thousands of small assets into a portfolio.

These restrictions do not apply to PDR, and Stem has provided fast responding and reliable demand response for years under that participation model. CAISO is further advanced than most RTOs/ISOs in its efforts to facilitate aggregated DER participation in wholesale markets, but both the CAISO grid and customers stand to benefit from allowing additional access to wholesale markets by correcting flaws like those in the DERP model. Doing so would bring multiple benefits:

- √ Increased visibility of DERs for transmission and distribution grid operators;
- √ Improved utilization of distributed storage assets, lowering overall system costs;
- √ Enhanced resilience to infrastructure threats (e.g., weather) through reliance on local DERs;
- √ Accelerated achievement of state policy goals;
- √ Unlocking new revenue streams, lowering costs for developers and customers; and
- √ Improved competition and lower wholesale rates, benefitting all ratepayers.

Case #2: Commercial Solar + Storage for Corporate Sustainability, Demand Charge Reduction, and Wholesale Market Load Reduction

Large commercial and industrial customers often look to DERs to provide multiple benefits, including operational improvements, cost savings, and delivery on corporate sustainability goals, which increasingly include carbon reduction targets. In New York City, Glenwood Management, one of New York's largest builders and owners of luxury rental apartments, has worked with Enel X since 2012

[3] Gundach and Webb, "Distributed Energy Resource Participation in Wholesale Markets: Lessons from the California ISO" Energy Law Journal Vo. 39:1 (May 2018), available at http://columbiaclimatelaw.com/files/2018/05/Gundlach-and-Webb-2018-05-DER-in-Wholesale-Markets.pdf.

to install and operate a range of DER solutions across 13 buildings, including both standalone storage and solar-plus-storage.[4]

The DERs across Glenwood's properties are used to protect residents against disturbances in grid energy (e.g., brownouts due to voltage instability in New York City) and to reduce demand charges. In addition to these direct benefits, the assets also participate in retail programs offered by Consolidated Edison (ConEdison) as well as wholesale programs offered by the New York Independent System Operator (NYISO). These multiple uses are co-optimized by Enel X through its optimization software platform.

At the retail level, Glenwood's portfolio of storage assets participate in ConEdison's retail demand response programs. The assets are aggregated but can be deployed individually according to ConEdison's location-specific needs. The aggregated DERs are optimized to manage locational needs and also balance participation in ConEdison's DR program against demand charge reduction to lower Glenwood's electricity costs.

In addition, Glenwood's portfolio of resources participates in NYISO's Special Case Resource (SCR) Program, which is available to end-use loads that can curtail demand and local generators (100kW or above). Enel X bids these resources into the NYISO Installed Capacity market (ICAP) through the regular auction process.

By participating in both retail and wholesale programs, in addition to meeting onsite needs, Glenwood Management's DER assets are able to deliver greater overall value, both to Glenwood and to the grid and other customers. Specifically, by participating in retail and wholesale markets, these DERs bring multiple benefits:

- √ Increased visibility for transmission and distribution grid operators;
- √ Improved utilization of distributed storage assets, lowering overall system costs;
- √ Improved reliability and resilience for customers and increased customer choice and control;
- √ Unlocking new revenue streams, lowering costs for developers and customers; and
- √ Enhanced competition and lower wholesale rates, benefitting all ratepayers.

Case #3: Residential Solar + Storage – Forward Capacity Market Participation

For years, states across the country have introduced policies aimed at incentivizing the deployment of residential solar PV systems. As penetration of distributed PV has grown rapidly, states have started to rethink how these systems are compensated for energy they export back to the local distribution grid. Recently, several states have decided to move beyond policies like net energy metering and

[4] Enel X, "Glenwood Management Earns Demand Response Revenue, Reduces Energy Costs with Intelligent Energy Storage," https://www.enelx.com/n-a/en/resources/case-studies/cs-glenwood-management.

have begun providing incentives for residential PV owners to incorporate battery storage and shift their energy exports to better align with peak system demand. One prominent example is in Massachusetts, where customers are offered significant benefits for installing energy storage through the Solar Massachusetts Renewable Target (SMART) Program.

In 2019, ISO New England (ISO-NE), the New England grid operator, conducted its annual capacity auction for power system resources, and residential solar installer Sunrun won a bid to deliver 20 MW of capacity from distributed solar-plus-storage systems.[5] This marks the first time that a bid comprised of capacity from aggregated distributed solar-plus-storage systems has successfully cleared a U.S. forward capacity auction. According to ISO-NE, the primary auction closed at $3.80/kW-month, which was the lowest clearing price in six years.

The successful bid has its origins in a partnership between Sunrun and National Grid, established in 2016 to identify and develop grid services with Sunrun's distributed solar and storage assets. The San Francisco-based installer utilized this partnership to inform its bid and ensure that it met the rigorous requirements for participation in the capacity auction.

Sunrun received the capacity supply obligation under the renewable technology resources (RTR) designation, which allows a limited number of qualified resources to participate in the capacity auction without having to meet the requirements of ISO New England's minimum-offer price rule (MOPR). This MOPR requires certain resources encouraged by state policy programs that have not received an RTR designation to bid at pre-defined minimum prices, creating the risk that their capacity will not clear the auction and be recognized toward regional capacity requirements. About 145 MW of resources were awarded capacity contracts under the RTR, which leaves about 300 MW of capacity remaining in the RTR exemption cap that will be carried over to next year's auction. The limited capacity available for RTR treatment could become a barrier to future capacity market participation for aggregations like Sunrun's.

This example demonstrates how both the grid operator and the DER asset developer can find additional benefits through wholesale market participation for distributed solar-plus-storage systems that likely would have been deployed anyway, due to incentives provided through state-level policies. Allowing such participation ensures optimal use of these assets, and therefore brings multiple benefits:

- √ Increased visibility for transmission and distribution grid operators;
- √ Improved utilization of distributed storage assets, lowering overall system costs (and in this example, avoiding the construction of additional unneeded capacity);
- √ Accelerated achievement of state policy goals;
- √ Unlocking new revenue streams, lowering costs for developers and customers; and

[5] Utility Dive, Iulia Gheorghiu, "Residential solar+storage breaks new ground as Sunrun wins ISO-NE capacity contract," Feb. 8, 2019, https://www.utilitydive.com/news/residential-solarstorage-breaks-new-ground-as-sunrun-wins-iso-ne-capacity/547966/.

√ Enhanced competition and lower wholesale rates, benefitting all ratepayers.

Case #4: Electric Vehicle Fleets for Demand Response

Electric vehicle (EV) sales are projected to increase rapidly in the coming decades. This growth will be driven by declining battery costs and by federal and state incentives for adoption of both vehicles and EV service equipment (EVSE), like charging stations. High penetration of EVs will present challenges and opportunities for distribution grids and grid operators. In the United States, 80% of EV charging happens at home.[6] Charging one EV can increase household electricity consumption by 50% and non-coincident peak consumption by a factor of 10.[7] Without careful planning and coordination, high penetration of EVs could destabilize the grid or cause other issues.

On the other hand, if well-coordinated, EVs become a flexible resource that can provide a number of grid services in both retail and wholesale markets, including energy, generation and distribution capacity, ancillary services, and voltage regulation. EV grid services fall into two categories of vehicle-grid integration (VGI): managed or smart EV charging, or V1G, or bi-directional EV charging, which spans vehicle-to-building, or V2B and vehicle-to-grid, or V2G. Smart EV charging involves a one-way flow of electricity and entails modifying the timing or rate of EV charging in response to an economic, environmental, or operational signal. Vehicle-to-building and vehicle-to-grid connections involve two-way flows of electricity, allowing car batteries to act as energy consumers or generators to provide behind- or front-of-the-meter grid services.

Today, VGI services are primarily provided through smart EV charging for utility programs that focus on ensuring charging occurs during beneficial times. While highly valuable on their own, V1G services represent only one set of the broad scope of grid services EVs can provide. Policymakers have thus begun focusing on catalyzing the marketplace for VGI services, which in turn can spur technology development for things like V2G to respond to expanded grid service revenue opportunities. California's proposed SB 676 (2019), for example, would require the California Public Utilities Commission to establish strategies and quantifiable metrics to maximize the use of cost-effective VGI through 2030. As EV market share increases, regulators should consider how market structures and coordination procedures can maximize grid benefits from EVs while reducing the need for grid upgrades on crowded feeders.

Beyond utility programs, Enel X e-Mobility (formerly eMotorWerks) currently manages over 35 MW of "virtual battery" capacity contained in EVs and EV chargers, a portion of which is offered into the California ISO (CAISO) day-ahead and real-time energy markets. Stopping, starting, modulating, and delaying charging

[6] U.S. Department of Energy, "Charging at Home," https://www.energy.gov/eere/electricvehicles/charging-home.

[7] Letter from David Schlosberg, VP, Energy Market Operations, eMotorWerks (Feb. 2018), available at https://ebce.org/wp-content/uploads/EBCE-DR-Assessment-Comments-eMotorWerks-2-7-18-FIN.pdf.

this network of EVs and EV chargers allows Enel X e-Mobility to provide automated, dispatchable energy through California's Proxy Demand Resource (PDR) model for demand response resources. Through the PDR model, Enel X e-Mobility receives market award notifications from the CAISO for intervals when the market clearing price is greater than its bid price and is compensated for its measured load reduction during those intervals. As discussed in Case Study #1, CAISO's DERP model could theoretically unlock even greater value from batteries, including those within EVs, particularly through compensation for the high value service of frequency regulation. However, DERP non-generator resources (NGR) are settled at wholesale prices for charging (and discharging) 24 hours, seven days per week, which prohibits providing other services (as is inherent to the PDR model), and behind-the-meter resources face duplicative costs for consumption at wholesale prices for the DER Provider and retail rates for the site host. These barriers make the DERP-NGR pathway infeasible for behind-the-meter DER aggregators, including EV and EV charging fleets. CAISO continues to refine its market participation models for DERs through the Energy Storage and Distributed Energy (ESDER) initiative. Still, Enel X e-Mobility's successful provision of demand response to CAISO markets is a concrete demonstration that aggregated EV fleets can provide meaningful grid services. Some benefits of aggregated EV grid services include:

- √ Increased flexibility for transmission and distribution grid operators to manage new loads;
- √ Accelerated achievement of state policy goals for EV deployment;
- √ Unlocking new revenue streams, lowering costs for developers and customers; and
- √ Enhanced competition and lower wholesale rates, benefitting all ratepayers.

Case #5: Microgrid for District Heating and Cooling and Electricity Export During Extreme Weather Events

Deployment of microgrids – self-contained systems of electricity generation, storage, and management that can operate separately from the power grid – has accelerated in recent years thanks to cost declines for various DERs (including energy storage) and advances in software solutions to improve scheduling and coordination of various DER assets within a microgrid. Companies that require an uninterrupted supply of electricity and communities concerned about grid resilience are increasingly considering microgrids as a reliability solution with more economic and environmental upside than conventional technologies like back-up diesel generators.

However, some microgrid operators have expressed concerns that they are compelled by their distribution utility to pay the full cost of standby service and interconnection infrastructure upgrades even when the grid operator sees significant benefits from utilizing the microgrid assets as a power supply in times of grid stress. Allowing microgrid operators to aggregate their resources and participate in wholesale energy and demand response markets, as well as retail level programs, could help improve project economics and accelerate the deployment of both cooperatively owned and privately owned microgrids at vulnerable points on the grid.

Co-op City in the Bronx owns and operates one of the largest residential end-use microgrids in the world, serving nearly 50,000 residents. The system, which centers around a combined heat and power (CHP) facility with a total capacity of about 40 MW, was originally installed in the mid-1960s as a district heating and cooling system, but it now provides 90% to 95% of the community's electricity needs. Co-op city sells excess power back to Con Edison through the utility's buy-back tariff and receives the wholesale locational marginal price, which means they are compensated similarly to an independent power producer. Importantly, thanks to CHP's ability to serve the community's thermals loads, Co-op City has been able to export power during both the polar vortex and summer heat waves, making it a valuable power supply and resilience resource for ConEdison during times of grid stress. Co-op City is looking to expand the facilities served by the microgrid assets and incorporate additional DERs, including up to 5 MW of rooftop solar, but without changes in standby charges, there is a convincing economic argument to sever Co-op City's grid connection, which would adversely affect utility operations.[8]

Market reforms and opportunities for wholesale market participation could resolve these misaligned incentives, greatly improve microgrid project economics, limit the need for major infrastructure investments, and improve overall system reliability and resilience. Allowing increased participation by CHP-powered district heating and cooling DERs would bring multiple benefits:

- √ Increased visibility for transmission and distribution grid operators;
- √ Improved utilization of distributed dispatchable generation assets, lowering overall system costs;
- √ Accelerated achievement of state policy goals for climate resilience;
- √ Unlocking new revenue streams, lowering costs for developers and customers; and
- √ Improved reliability and resilience for customers, and limits expensive infrastructure upgrades where are microgrids deployed at vulnerable points on the system.

[8] Navigant, prepared for New York State Smart Grid Consortium, Community Microgrid Case Study and Analysis Report (Aug. 2015), available at http://nyssmartgrid.com/wp-content/uploads/CommunityMicrogridCaseStudyandAnalysisReport_2015-08-133.pdf.

CONCLUSION

Aggregated DER portfolios can provide many useful services to the energy system. As the number of deployed DERs grows, regulators and grid operators should work to ensure that these valuable resources can be fully utilized to provide grid services and to lower costs for consumers.

In particular, growth in DER deployment and the imperative to more fully utilize them heightens the need for aggregated DER portfolios in wholesale markets. Today, DER participation in these markets is minimal, limiting overall asset utilization and optimization. The case studies in this report point to examples where aggregated DERs are providing reliable and cost-effective wholesale services while also providing retail services and/or meeting the needs of host customers. Ensuring that aggregations of DERs have viable pathways to provide all the wholesale services they are capable of would bring numerous benefits across the system, including increased reliability and resilience for both customers and the grid, greater customer choice regarding their energy supply, enhanced competition to ensure just and reasonable rates, and lower overall system costs through avoidance of more costly investments.

FERC, regional grid operators, and state regulators all have important roles to play in ensuring the reliable and cost-effective integration of DERs into wholesale markets. Working together, these actors can establish frameworks that allow DERs to provide retail and wholesale services while ensuring distribution system impacts are effectively addressed. Taking these steps would capture the full promise and value of the growing adoption of DERs, allow for greater innovation in energy technology and the provision of energy services, and increase reliability and lower costs for consumers.

FURTHER READING

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