DEPLOYING DISTRIBUTED ENERGY STORAGE:
Near-Term Regulatory Considerations to Maximize Benefits

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EXECUTIVE SUMMARY

In the last 10 years the percentage of electricity generated in the United States from renewable sources, has grown at an impressive rate, including significant amounts of generation located on the distribution system. Solar photovoltaic (PV) electricity systems in particular have evolved rapidly from a once-niche technology to one that is now widely used by schools, households, businesses and utilities across the country. Distributed renewable energy offers a wide range of environmental, societal and customer benefits, however their introduction in large numbers will require innovative and forward thinking regulatory policies in order to smoothly integrate them into the existing electrical system.

While there are significant benefits to generating electricity closer to load, the electric system was also not originally designed with large amounts of local generation in mind and there are implications of two-way power flow that need to be taken into account in order to maintain power quality and reliability. At low penetrations, issues associated with the integration of distributed renewable energy resources can likely be managed with existing grid management technologies and techniques, without the need for significant regulatory changes. However, as penetration levels grow, more significant regulatory changes and modifications to the topology of the grid may be necessary.

Some states are already experiencing some of the benefits as well as the challenges of high renewables penetration and have begun to look into the potential for distributed energy storage and other distributed energy resources (DERs) to help ease integration of renewables, while also expanding the quality of service for ratepayers. While the number of markets already at this tipping point is relatively small, it is likely that a significant number of states will achieve high levels of distributed renewable energy penetration within the next 10 years. The states that take proactive steps to establish the appropriate regulatory, market and technical foundations for DERs are less likely to experience delays or market slow-downs as a result of integration challenges.

Among the technologies that can facilitate increased deployment of renewable energy, distributed energy storage – i.e. storage systems interconnected to the utility-owned distribution system, on either the customer or utility’s side of the meter – has particularly notable potential to address grid integration challenges while also providing valuable services to the grid and to energy customers. Distributed storage has the ability to address a very wide range of potential issues – including but not limited to renewable energy integration, variability management, peak management, voltage and frequency regulation, grid resiliency, and energy management – and thus...
is gaining specific attention from customers, utilities and regulators. (See Table ES-1). Storage also has the potential to offer additional benefits to customers, both by helping them directly manage their energy use and offering distribution system managers new tools to help maintain and even enhance the functionality of the electricity system.

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Accurately tracking and properly valuing the benefits of distributed storage will impact the short-term and long-term deployment of this promising technology. Moreover, how we track and value storage services will have a significant impact on whether storage technologies will be deployed in locations that maximize those benefits for all potential beneficiaries.

The potential of distributed energy storage to lower costs and improve the quality of electric service is considerable. However, since the market for distributed energy storage is still in its infancy there is a significant need for regulatory guidance and proactive policies to ensure a smooth rollout of this technology.

State policymakers and regulators are beginning to focus on the importance of distributed energy storage and are using a variety of different approaches to begin aligning policies and opening markets to enable energy storage to play a significant role in the electricity system in the coming years (see Figure ES-2). Some states are just beginning to demonstrate an interest in energy storage and have begun taking exploratory steps to evaluate the potential costs, benefits, functions and
regulatory needs of energy storage. States with higher penetrations of distributed generation and increased customer demand for storage paired with distributed generation facilities are working to clarify and amend interconnection and net metering regulations to address energy storage. Others have begun to move beyond just exploration of energy storage and have elected to provide direct stimulus to help facilitate the growth of the market. To date California is the only state to require the regulated utilities to procure energy storage, but numerous other states, such as New Jersey, Massachusetts, and Hawaii have also begun to consider a variety of other regulatory changes that will help facilitate the use of energy storage going forward.

Figure ES-2: Hierarchy of Possible State Policy Actions on Distributed Storage

While energy storage may be a challenging issue for regulators and policy-makers, various changes in the electricity sector are now resulting in an increased interest in storage technologies, and, thus, an increased need to address the issue proactively in the regulatory arena. With this paper, IREC seeks to help overcome this challenge and assist regulators in identifying some of the most important near-term steps to help facilitate growth in distributed energy storage.

Organized in four parts, this paper first outlines why regulators should be interested in helping establish foundational policies to enable deployment of distributed storage. Building on this discussion, the paper then discusses the various specific uses and benefits of distributed storage. It then turns to the regulatory arena and looks at the nature of current state policy efforts to address distributed energy storage in the United States. Finally, taking those insights into account and building upon the research regarding the potential applications of distributed energy storage, IREC identifies six key near-term regulatory policy considerations to help regulators, utilities, ratepayers, and states as they evaluate distributed storage and seek to capture the greatest benefit from distributed energy storage.

The goal is not to identify the specific policy decisions that should be made, but rather to highlight the key areas where regulations may need to created, clarified or updated in the near term. Specifically, regulators may consider:
• Designing rate structures that send economic signals to energy storage customers to encourage them to operate their system in a manner that benefits the electric grid as well as the customer.

• Creating or modifying markets for ancillary services and demand response to enable energy storage customers to offer those services, either individually, or in the aggregate.

• Updating interconnection standards to ensure that energy storage systems have fair and efficient access to the electrical grid.

• Clarifying eligibility rules for Net Energy Metering (NEM) programs to maintain integrity of those programs while also allowing storage systems to participate.

• Implementing a broader scope for distribution system planning and management than has been seen historically to create an electrical system that fully takes advantage of the benefits of energy storage when deployed with other distributed energy resources.

• Coordinating oversight of energy storage systems with other governmental authorities to ensure safety without imposing duplicative or conflicting regulatory requirements.

IREC hopes that the ideas presented in this paper will help regulators in identifying the critical steps that need to be taken in the early stages of addressing the promise – and the challenge – of accelerating the deployment of distributed energy storage. As states begin to take action, IREC will continue to keep regulators informed about the lessons learned by other states and will help to identify best practices as they emerge to ease the learning curve for states.
1. INTRODUCTION

In the last ten years the percentage of electricity generated in the United States from renewable sources, including significant amounts of generation located on the distribution system, has grown at an impressive rate. Solar photovoltaic (PV) electricity systems in particular have evolved rapidly from a once-niche technology to one that is now widely used by schools, households, businesses and utilities across the country.

Solar PV’s impressive market growth is partly due to significant advancements in technologies and innovations in manufacturing that have resulted in more efficient and cost-effective panels. New business models, incentives, and financing mechanisms have also emerged over the years, which have further improved the economics of solar PV. Yet, perhaps the most significant contributors to this market evolution are the regulatory and policy innovations in the electricity sector that have spurred the adoption of solar PV, and other renewable energy technologies, and helped to overcome the real and perceived challenges related to the integration of DERs on the electricity grid.

While regulators and policymakers deserve credit and a moment to reflect on the success of these policies to date, the continued growth of distributed renewable energy, and other distributed energy resources (DERs)\(^1\), is posing new challenges that will continue to require innovative and forward thinking regulatory policies. Distributed renewable energy offers a wide range of benefits that make tackling these challenges worth the effort, but the challenges cannot be ignored if states want to maximize those benefits and achieve increasing penetrations of clean energy on the grid. For example, most of the renewable energy capacity in the United States comes from wind and solar resources, which are inherently variable due to the influence of weather patterns on their ability to generate power. While utilities are adept at managing some variability on the electric system, the introduction of greater amounts of variable generation will require new management techniques and technologies, many of which will be dependent upon regulatory approval. The electric system was also not originally designed with large amounts of local generation in mind. While there are significant benefits to generating electricity closer to load, there are also implications of two-way power flow that need to be taken into account in order to maintain power quality and reliability. At low penetrations, these and other issues associated with the integration of renewable energy resources can likely be managed with existing technologies and without significant regulatory changes. However, as penetration grows, more significant regulatory changes and modifications to the topology of the grid may be necessary.

With the rapid growth in distributed generation, some states are already experiencing some of these challenges and have begun to look into the potential for distributed energy storage and other DERs to help ease integration of high penetrations of renewables, while also expanding the quality of service for ratepayers. While the number of markets already at this tipping point is relatively small, it

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\(^1\) Distributed Energy Resources include distributed generation (solar PV, wind, combined heat and power), electric vehicles, energy storage, energy efficiency and demand response.

is likely that a significant number of states will achieve high levels of distributed renewable energy penetration within the next ten years. The states that take proactive steps to establish the appropriate regulatory, market and technical foundations for DERs are less likely to experience delays or market slow-downs as a result of integration challenges. This paper identifies an appropriate set of such proactive steps.

Among the technologies that can facilitate increased deployment of renewable energy, distributed energy storage, in particular, has potential to disentangle grid integration challenges while also providing valuable services to the grid and to energy customers. Utility executives responding to a recent survey overwhelmingly chose energy storage as the emerging technology in which they think their utility should invest. With recent cost declines in energy storage spurring a new wave of growth, there is increasing speculation regarding whether energy storage (when combined with distributed generation) will result in mass customer defections from utility provided electric service. Although many argue that it is unlikely that there is a real risk of this happening to any significant extent, such speculation highlights the fact that strategically deployed energy storage on a utility’s distribution system has the potential to provide a wide variety of benefits (to utility customers, to utilities, and to the grid). For this reason alone, accurately tracking and properly valuing the benefits of distributed storage will impact the short-term and long-term deployment of this promising technology. Moreover, how we track and value storage services will have a significant impact on whether storage technologies will be deployed in locations that maximize those benefits for all potential beneficiaries.

As the Electric Power Research Institute (EPRI) has noted, “[h]istorically, energy storage has been a challenging issue for regulators and policy-makers.” Yet, various changes in the electricity sector are now resulting in an increased interest in storage technologies, and, thus, an increased need

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3 See, e.g. Peter Bronski, Distributed Defectors, Rocky Mountain Institute, Winter 2014, available at: http://www.rmi.org/winter_2014_esj_distributed_defectors; Peter Kind, Disruptive Challenges: Financial Implications and Strategic Responses to a Changing Retail Electric Business, Energy Infrastructure Advocate for Edison Electric Institute, at 3, 2013 (“But, even if cross-subsidies are removed from rate structures, customers are not precluded from leaving the system entirely if a more cost-competitive alternative is available (e.g., a scenario where efficient energy storage combined with distributed generation could create the ultimate risk to grid viability). While tariff restructuring can be used to mitigate lost revenues, the longer-term threat of fully exiting from the grid (or customers solely using the electric grid for backup purposes) raises the potential for irreparable damages to revenues and growth prospects.”); Stephen Lacy, Morgan Stanley: Fixed Charges on Solar May Cause ‘Tipping Point’ for Grid Defection, Aug. 4, 2014, available at: http://www.greentechmedia.com/articles/read/Solar-Fixed-Charges-May-Cause-Grid-Defection

to address the issue proactively in the regulatory arena. To date California is the only state to require the regulated utilities to procure energy storage, but numerous other states, such as New Jersey, Massachusetts, and Hawaii have also begun to consider a variety of other regulatory changes that will help facilitate the use of energy storage going forward. With this paper, IREC seeks to help overcome this challenge by identifying some important issues that regulators should consider addressing to help utilities, ratepayers, and states capture the greatest benefit from distributed energy storage.

This paper is organized in four parts. The first outlines why regulators should be interested in helping establish foundational regulatory policies to enable deployment of distributed storage. Building on this discussion, the paper then discusses the various specific uses and benefits of distributed storage. It then turns to the regulatory arena and looks at current state policy efforts to address distributed energy storage in the United States. Finally, taking those insights into account, the report identifies six near-term policy considerations for regulators to address as they evaluate distributed storage and the means to capture the many benefits of this technology. Specifically, regulators may consider:

- **Designing rate structures that send economic signals to energy storage customers** to encourage them to operate their system in a manner that benefits the electric grid as well as the customer.
- **Creating or modifying markets for ancillary services and demand response** to enable energy storage customers to offer those services, either individually, or in the aggregate.
- **Updating interconnection standards** to ensure that energy storage systems have fair and efficient access to the electrical grid.
- **Clarifying eligibility rules for Net Energy Metering (NEM) programs** to maintain integrity of those programs while also allowing storage systems paired with renewable generators to participate.
- **Implementing a broader scope for distribution system planning and management** than has been seen historically to create an electrical system that fully takes advantage of the benefits of energy storage when deployed with other distributed energy resources.
- **Coordinating oversight of energy storage systems** with other governmental authorities to ensure safety without imposing duplicative or conflicting regulatory requirements.

While not all of these actions are going to be necessary in every state, the information presented in this paper demonstrates that there is a need for regulators to take conscious steps to clarify and improve regulations and market conditions for energy storage in order to capture the greatest benefits and to avoid delays in the move toward a more efficient, low carbon electric grid that offers improved service to customers and enables greater penetrations of DERs on the system.

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5 In 2013 the California Public Utilities Commission adopted an energy storage procurement framework and target of 1,325 megawatts in operation by 2024. Decision 13-10-04 (Oct. 17, 2013).
2. IDENTIFYING THE ROLE AND VALUE OF DISTRIBUTED ENERGY STORAGE

What is Distributed Energy Storage?

Energy storage systems have the ability to be deployed in a variety of locations depending upon the technology used and functionality desired. This paper focuses specifically on distributed electric energy storage – storage systems that are interconnected to the utility-owned distribution system, on either the customer or utility’s side of the meter. While virtually the full range of energy storage technologies could be deployed on the distribution system, pumped storage systems and large Compressed Air Energy Storage (CAES) systems are more likely to be found on the transmission system. A wide range of battery technologies and flywheel applications are well suited for deployment on the distribution system.⁶

Why is There Increased Interest in Distributed Energy Storage?

Energy storage systems have the potential to add value across the full span of the electric system, from uses on the transmission and distribution systems to customer-side applications. Some storage technologies have been marketable for years, and there already are limited numbers of energy storage systems deployed across the electric system.⁷ However, while energy storage has long had the potential to offer value to the electric system, a number of key changes to our electric power system over the past several years have brought to the fore the fundamental role that distributed storage can play in assuring the long-term reliability of the grid. Distributed storage has a particular ability to address a very wide range of potential issues and thus is gaining specific attention from customers, utilities and regulators.

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Renewables Integration

First, in recent years, there has been a rapid move toward increasing the amount of variable renewable energy upon which the electric system relies. The majority of US states have adopted Renewable Portfolio Standards (RPS) or similar policies and the price of renewable energy, particularly solar PV, has fallen dramatically. Between 2003 and 2013 there were over 2,500 utility-scale solar PV systems installed in the United States and nearly 422,000 residential systems, and these numbers are expected to continue to grow steadily in coming years. While the aggregate capacity of the residential and small commercial systems is dwarfed by the utility-scale systems, the task of managing the large number of smaller systems on the distribution system is considerable.

Distributed renewable energy offers significant environmental, societal and customer benefits, but the integration of high volumes of variable generation onto the distribution system is not without its challenges. Accommodating low levels of variable generation can likely be done using existing grid management technologies and techniques. As penetration grows, however, utilities and regulators will need to more proactively manage the impacts of variability and to minimize the costs of integration in order to maximize the benefits of distributed renewable energy. Energy storage applications are well suited to address most of the challenges associated with distributed renewable integration (which are further explained below), although the cost of these applications varies.

Managing Variability

Most renewable energy resources, such as wind and solar, are variable, meaning their output can change based upon climactic conditions and the time of day. At certain penetrations, this variability can create planning challenges that, in the absence of storage, would require the electricity system operator to obtain greater amounts of system reserves in order to maintain the balance.

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10 Data from Solar Market Trends Report.
11 Id. (Between 2003 and 2013, the U.S. saw just under 2,500 MW of residential PV systems installed compared to about 5,700 MW of utility-scale PV).
13 “Multiple integration studies have suggested that the challenge of integrating renewables increases in a non-linear fashion as penetration levels exceed 20%.” EPRI Storage White Paper at 3-19.
14 Accommodating High Levels of Variable Generation, North American Electric Reliability Corporation, at 4, April 2009 [Accommodating High Levels of Variable Generation].
between generation and load at all times. In addition, while integration techniques have improved significantly, wind and solar generation can still pose forecasting challenges that may result in a need to maintain further fast responding reserves to hedge against forecasting errors. The inherent flexibility of energy storage systems makes them optimal candidates to help smooth the variability associated with integrating high volumes of renewable resources. Currently, utilities generally rely on older fossil fuel generators for balancing this variability. These generators are generally less efficient, resulting in greater carbon emissions and other air pollutants. Using such plants to manage system variability effectively undermines one of the primary reasons behind the expanded use of renewable generation, namely, emission reductions. By contrast, substituting fossil-fired generators with energy storage would simultaneously help manage variability while also optimizing the emission reduction potential of renewable energy.

**Peak Management**

The single most important factor in electric system planning may be determining when the peak load will occur and whether there will be adequate generating resources and capacity to deliver instantaneous energy to meet that peak demand. Similarly, during non-peak hours the electric system must be managed to avoid over-generation. While solar generation is relatively coincident with peak (i.e., solar systems generate power during the day when the demand is high), there is a critical period in the late afternoon and evening hours when solar generation begins to ramp down, and wind generation generally only begins to ramp up, when the greatest energy demand increasingly occurs – particularly on residential circuits. The peak may shift even more toward the evening hours as greater amounts of renewable energy displaces load during the daytime hours. For this reason, the ability of storage systems to charge during off-peak periods and to discharge during on-peak periods now has increased value in light of these shifting load curves. Moreover, distributed storage systems can help address these peak load challenges on a circuit specific basis while also providing other direct benefits to utility customers. These systems can also offer ramping services that can assist with the transitions between peak periods.

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15 Id. at 6-11.
16 EPRI Storage White Paper at 3-5 to 3-8.
17 Id. at 3-7 (“Meeting wind integration requirements with fossil generation will result in added emissions associated with part-load operation of thermal plants when they are placed into the duty cycles needed to support renewables integration. Energy storage systems can partially mitigate such effects.”). To address fast grid power balancing requirements, utilities typically rely on hydroelectric or gas combustion turbine generators. In the case of the former, operating these clean generator resources at less than full capacity results in higher emissions. In the case of the latter, operating gas turbine generators in load following mode, results in less efficient operation and higher emissions.
Voltage and Frequency Regulation

Utilities are generally required to maintain both frequency and voltage on the electric system within narrow ranges in order to ensure reliability and power quality. In some instances, the variability associated with high penetrations of renewables, particularly on the distribution system, can increase the potential for deviations to occur and thereby increase the requirements for load following and regulation services to help control frequency. Frequency regulation services are used to help maintain real time generation and load equilibrium and are provided by on-line generation, storage or load that is controlled with automatic generation control or automatic demand response. The quick response time and control of energy storage systems make it an ideal resource for providing regulation. Voltage regulation needs are more localized and are often provided through distribution circuit based voltage regulators and in rare instances through local generators. Because voltage regulation is best provided locally, distributed storage is particularly well suited to offer dynamic voltage regulation through reactive power adjustments to address voltage concerns in load centers – where most voltage variation arises. It should be noted that other technologies outside the scope of this paper, such as smart inverters, are also demonstrating significant promise in helping to address voltage regulation challenges.

Grid Resiliency

In addition to playing a role in helping states achieve their carbon reduction goals on the electric system through integration of higher amounts of renewable energy – distributed energy storage is also being viewed as a critical piece in climate adaptation strategies that seek to enhance the ability of the electric system to withstand increasingly severe weather events. In particular, energy storage is often a key component in the development of micro-grids that are able to operate independently from the larger electrical system during blackouts or for other purposes. In addition, customers who install storage paired with a generator (such as PV or wind) are able to utilize their storage system to provide continuous backup

20 Accommodating High Levels of Variable Generation, at XX.
21 For a full discussion of both the challenges of managing these issues with higher penetrations of renewables, as well as renewable resources’ ability to also help address these issues, see: Accommodating High Levels of Variable Generation; L. Bird, et. al. Regulatory Considerations Associated with the Expanded Adoption of Distributed Solar, National Renewable Energy Laboratories, Nov. 2013.
power during system outages. This backup service can be particularly valuable for certain types of customers that are reliant on a steady power supply, such as hospitals.

**Customer Energy Management**

Another driving force behind the interest in distributed energy storage is the growing role of the customer in energy generation and management. Until recently only a limited segment of utility customers – generally industrial and large commercial customers – invested significantly in tools and infrastructure to help manage their energy use. The increased awareness of energy efficiency and demand response programs, the drop in prices for solar PV, the growth in financing mechanisms, the availability of NEM programs and the variety of different incentives offered for customer-sited renewable energy have allowed a whole new range of customers to become more active managers of their energy use. In addition to the increased adoption of solar PV, there have been significant advancements in technologies that give customers increased transparency into their energy use and the corresponding rates associated with such use at different times of the day and year. Along with this improvement in the quality of energy use data that is now available to customers, utilities and regulators are moving more toward time-variant pricing techniques, including time-of-use rates, which may further incentivize customers to look for ways to alter their energy demand. Taken together, these factors have created a growing segment of customers who are considering how energy storage located on their side of the meter may assist them in lowering their electricity bills.

In sum, the demand for distributed energy storage is being driven by its potential to help address many of the challenges that are arising as the electric system in the United States undergoes some of the most significant changes it has experienced in the last century. Energy storage also has the potential to offer additional benefits to customers, both by helping them directly manage their energy use and offering distribution system managers new tools to help maintain and even enhance the safety and reliability of the system going forward. The following section will take a closer look at the specific functions of distributed energy storage systems.
Applications and Benefits of Distributed Energy Storage

Generally, there are between 17 and 21 storage services or applications highlighted in the technical literature. The U.S. DOE Global Energy Storage Database, which tracks energy storage projects and policies worldwide, is more detailed and lists 28 services. There is an extensive and rapidly growing body of research addressing energy storage applications, services and end-use benefits, which this paper will not endeavor to duplicate. Rather, this section will seek to provide a high-level overview of the potential uses and values of distributed generation to inform the regulatory policy considerations found in Section 4. The following table summarizes seventeen energy storage applications in five different categories.

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Currently, for most energy storage systems to be cost effective, especially in the organized energy markets, these systems often must be able to create revenue or reduce costs through the

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25 See: [http://www.energystorageexchange.org](http://www.energystorageexchange.org)
provision of multiple services or applications, spanning the energy value chain. This aggregation of compatible, complementary applications is called “stacking.” Distributed energy storage can be compatible with all the applications listed in Table 1, except for area regulation, transmission support, and some wind integration-related issues. These 14 remaining applications will be referred to as the “distributed storage applications” in the remainder of this paper. In considering the potential value of various storage applications it is helpful to keep in mind what services may be stacked together. Appendix A includes a table prepared by Sandia National Laboratories showing which of the distributed storage applications can be stacked together.

The following descriptions and definitions of the relevant distributed energy storage applications are high level and do not attempt to describe the full technical requirements. Rather, these descriptions are intended to provide general information to help regulators understand the many uses for energy storage that may be taken into account in evaluating potential regulatory actions. These definitions are derived from three sources: Sandia National Laboratories’ 2010 Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide; DOE/EPRI 2013 Electricity Storage Handbook in Collaboration with NRECA; and EPRI’s Cost-Effectiveness of Energy Storage in California: Application of the Energy Storage Valuation Tool to Inform the California Public Utility Commission Proceeding R. 10-12-007.

Category 1: Electric Supply

Electric Energy Time-shift

Electric energy time shift, or energy arbitrage, is the use of storage to buy energy during low-price (off-peak) hours so that it can be stored and then sold back during high-price (on-peak) hours. It can also include storing energy that would otherwise be curtailed.

Electric Supply Capacity

Electric supply capacity is the use of energy storage (in lieu of a combustion turbine or other generator) to provide the system with peak generation capacity during peak hours. In other words, storage could be used to defer and/or to reduce the need to buy new central station generation capacity and/or purchase capacity in the wholesale electricity marketplace.

27 EPRI Storage White Paper.
28 Sandia’s Benefits and Market Potential Assessment Guide.
29 Id.
32 Sandia Electricity Storage Handbook at 3.
Category 2: Ancillary Services

Load Following/Ramping

Load following is the matching of generation to load as it fluctuates during the day. Historically the market for this service required the device be capable of altering its power output as frequently as every five minutes, however recent standards now also allow for markets with some resources responding in seconds. The output changes in response to the changing balance between electric supply and load within a specific region or area. Load following is a particularly valuable service that storage can provide as the system accommodates greater amounts of variable generation. Storage has the ability to respond within seconds, which makes its service particularly valuable. It may also reduce the wear-and-tear associated with using traditional generators for this service.

Electric Supply Reserve Capacity

Operation of an electric grid requires reserve capacity that can be called upon when some portion of the normal electric supply resources becomes unavailable unexpectedly. There are three types of reserve: spinning reserve (synchronized), non-spinning reserve (non-synchronized), and supplemental reserve. When serving as electric supply reserve capacity, storage cannot typically serve other applications simultaneously.

Voltage Regulation/Support

The purpose of voltage support is to maintain voltage levels on the electric system by providing or absorbing reactive power or through the use of voltage tap changers that mechanically adjust voltage. The provision and absorption of reactive power is an application for which distributed storage may be especially attractive, because reactive power cannot be transmitted efficaciously over long distances. Notably, many major power outages are at least partially attributable to problems related to transmitting reactive power to load centers. So, distributed storage – located within load centers where need for reactive power is greatest – can be especially helpful in managing voltage.

Category 3: Grid System

Transmission Congestion Relief

Transmission congestion occurs when available, least-cost energy cannot be delivered to all or some loads because transmission facilities are not adequate to deliver that energy. When transmission capacity additions do not keep pace with the growth in peak electric demand, the transmission systems become congested. Thus during periods of peak demand, the need and cost for more transmission capacity increases along with transmission access charges. Transmission

53 Id. at 7.
54 Sandia’s Benefits and Market Potential Assessment Guide at 33.
congestion may also lead to increased congestion costs or higher locational marginal pricing (LMP) for wholesale electricity at certain transmission nodes.\textsuperscript{35}

Electricity storage can be used to avoid congestion-related costs and charges, especially if the costs become onerous due to significant transmission system congestion. In this service, storage systems installed at locations that are electrically downstream from the congested portion of the transmission system can store energy when there is no transmission congestion, and discharge that energy (during peak demand periods) to reduce peak transmission capacity requirements.\textsuperscript{36}

\textit{Transmission \\& Distribution Upgrade Deferral}

Transmission and distribution (T\&D) upgrade deferral involves delaying – and in some cases avoiding entirely – utility investments in transmission and/or distribution system upgrades, by using relatively small amounts of storage. There is particular interest in the ability of storage to enable deferral of upgrades (such as wire replacement) that might otherwise be needed as a result of growing distributed generation capacity.

\textit{Substation On-site Power}

Sandia National Labs estimates that there are already over 100,000 batteries in use at utility substations in the United States. These energy storage systems provide power to protection equipment and to substation communication and control equipment when the grid is not energized.

\textit{Category 4: End User/Utility Customer}

\textit{TOU Energy Cost Management}

Time-of-use (TOU) energy cost management involves storage used by utility customers to reduce their overall costs for electricity. Customers charge the storage during off-peak time periods when the electric energy price is low and then discharge the energy to meet onsite loads during times when on-peak TOU energy prices apply.

\textit{Demand Charge Management}

Utility customers could use energy storage to lower demand charges by reducing power drawn during the utility’s peak demand periods. To reduce load when demand charges are high, storage is charged when there are no or low demand charges. The stored energy is discharged to serve load during times when demand charges apply.

\textit{Reliability (Back-up)}

This application uses energy storage to provide highly reliable and/or back-up electric service. In the event of a complete power outage lasting more than a few seconds, the storage system provides enough energy to ride through the outages; to complete an orderly shutdown of processes at a

\textsuperscript{35} Sandia Electricity Storage Handbook at 17.

\textsuperscript{36} Id.
facility; and/or to transfer to on-site generation resources. In addition, storage co-located with a generator such as PV, can provide on-going backup power services for customers.

**Power Quality**

The electric service power quality application involves using energy storage to protect on-site loads downstream against short-duration events that affect the voltage, frequency, power factor, or other quality of power delivered to the load.

**Category 5: Renewables Integration**

**Renewable Energy Time-Shift**

Some renewable energy generation resources produce electric energy at times when electricity has a lower financial value (off-peak times, *e.g.*, at night, on weekends and during holidays). Energy storage used in conjunction with renewable energy generation could be charged using lower-value energy from the renewable energy generation so that energy may be used to offset other purchases or sold when it is more valuable.

**Capacity Firming**

Renewable energy capacity firming applies to circumstances involving renewable energy generation whose output is variable. Storage can be used to “fill in” so that the combined output from renewable energy generation plus storage can meet the capacity needs of utilities or the grid operator.

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57 Sandia’s Benefits and Market Potential Assessment Guide at 47.
3. CURRENT STATE POLICY ON DISTRIBUTED ENERGY STORAGE

Estimates indicate that there are at least 270 distributed energy storage projects (deployed or planned) across the United States. These projects are concentrated in certain jurisdiction, such as Hawaii, California, and the Mid-Atlantic. The majority of states are home to just one or a handful of projects, while 14 states have no distributed storage projects at all, as depicted in Figure 1.

**Figure 1: Planned and Deployed Distributed Storage, August 2014**

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38 It should be noted that this statistic, from August 2014, is changing rapidly and the number of distributed energy storage projects is growing. For example, there are over 1,000 advanced energy storage applications in the queue for California’s Self-Generation Incentive Program (SGIP) program, 625 of which have been submitted during program year 2014. See the January 1, 2015 SGIP Quarterly Projects Report available at: http://www.cpuc.ca.gov/PUC/energy/DistGen/sgip/

As one might expect, the states where distributed energy storage is being deployed are also the states taking policy and regulatory actions related to energy storage. The approaches taken by states so far are varied in both the mechanisms they use and the types of issues they attempt to address. State policy actions on distributed storage can be grouped in the following four ways (Figure 2).

**Figure 2: Hierarchy of Possible State Policy Actions on Distributed Storage**

### Demonstrate Interest in Storage

Many states are just beginning to demonstrate an interest in energy storage and have begun taking exploratory steps to evaluate the potential costs, benefits, functions and regulatory needs of energy storage. Regulators at this stage have yet to enact policy or take regulatory actions required to enable energy storage, but are demonstrating interest with studies, working groups, workshops, and/or pilot programs. Table 2 on the following page provides a summary of states engaged at this level. The potential direct impact of these activities on the storage market may be limited, yet these may serve as precursors to future policy action or development.

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40 A recent report catalogs on a state-by-state basis information relating to active and completed dockets that address storage in any way, storage demonstration and pilot projects, integrated resource plans that require storage studies, proposed legislation, microgrids and plug-in vehicles, research & development centers, how storage is treated within an RPS, storage mandates, financial incentives, and storage working groups. Tom Stanton, *Envisioning State Regulatory Roles in the Provision of Energy Storage*, National Regulatory Research Institute, Briefing Paper No. 14-08, June 2014, available at: [http://www.nrri.org/documents/317330/12823dfa-2938-45f0-b44b-684c484e91fd](http://www.nrri.org/documents/317330/12823dfa-2938-45f0-b44b-684c484e91fd)
Table 2: Summary of State Actions Demonstrating Interest in Storage

<table>
<thead>
<tr>
<th>State</th>
<th>Activity</th>
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</thead>
<tbody>
<tr>
<td>Arizona</td>
<td>The Commission initiated an investigation into potential impacts on current utility business models from innovation and developments in the generation and delivery of energy. It held two workshops focused specifically on distributed and central energy storage in spring 2014 as part of this investigation.⁴¹</td>
</tr>
<tr>
<td>Colorado</td>
<td>The Commission required the Public Service Company of Colorado (dba Xcel Energy) to investigate potential storage options for its electric system and report back. The report is pending.⁴²</td>
</tr>
<tr>
<td>Iowa</td>
<td>The Iowa Utilities Board initiated an “Inquiry on Distributed Generation” to address a variety of issues related to distributed generation. Storage was included in the scope of the inquiry, although it was not the only focus.⁴³</td>
</tr>
<tr>
<td>Minnesota</td>
<td>Per legislation passed in 2013, consultants to the Department of Commerce published the “White Paper Analysis of Utility-Managed, On-Site Energy Storage in Minnesota.”⁴⁴</td>
</tr>
<tr>
<td>New Jersey</td>
<td>New Jersey’s Clean Energy Program created the Energy Storage Working Group in July 2013 with the purpose of providing stakeholder input into the development of energy storage incentives.⁴⁵</td>
</tr>
<tr>
<td>New Mexico</td>
<td>In 2013, the New Mexico Renewable Energy Storage Task force held four meetings to review, discuss, and study energy storage. The Task Force developed a list of recommendations to the legislature for future activities and actions.⁴⁶</td>
</tr>
<tr>
<td>New York</td>
<td>New York State Energy Research and Development Authority (NYSERDA) supported the creation of the New York Battery and Energy Storage Technology Consortium (NY-BEST) in 2010. With more than 130 members, it focuses on research and development, hosts conferences and industry networking events, and participates in select regulatory proceedings.⁴⁷</td>
</tr>
<tr>
<td>Oregon</td>
<td>The Oregon Department of Energy and the Oregon Public Utility Commission hosted an Energy Storage Workshop in March 2014.⁴⁸ The Department subsequently sought comments on the design of a potential program to support demonstration projects.⁴⁹</td>
</tr>
<tr>
<td>Connecticut,</td>
<td>All four states have developed funding opportunities or financing targeting municipalities and/or community-identified “critical facilities” to install microgrids (resilient power projects) able to disconnect from the grid in the case of emergency.⁵⁰,⁵¹</td>
</tr>
<tr>
<td>Massachusetts,</td>
<td></td>
</tr>
<tr>
<td>New York, New</td>
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<tr>
<td>Jersey</td>
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</tbody>
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⁴² See Colorado Docket No. 11A-869E.
⁴³ See Iowa Docket NOI-2014-0001.
⁴⁵ Prior to creating the Working Group, New Jersey Board of Public Utilities in cooperation with Rutgers University, commissioned Navigant Energy to conduct a market assessment to characterize opportunities for renewable energy in the state. The report included energy storage as part of the assessment. Available at: http://www.njcleanenergy.com/files/file/Library/NJ%20Renewable%20Energy%20Market%20Assessment%20-%20Final%20-%20Public%20Version.pdf; For more on the New Jersey Energy Storage Stakeholder Group, see http://www.njcleanenergy.com/committees/energy-storage
⁴⁷ See http://ny-best.org
Clarify Existing Rules as they Apply to Storage

Several states with high penetrations of distributed generation and increased customer demand for storage paired with distributed generation facilities are working to clarify and amend interconnection and net metering regulations to address energy storage. Quality net metering and interconnection standards have proven to be critical foundations for the development of the solar PV market in many states, and the same is likely true for the energy storage market. The ability to interconnect systems in a fair and efficient manner is particularly fundamental to allowing energy storage to provide the grid services discussed in the previous section. Allowing energy storage systems to access the benefits of these policies will be an important first step to stimulating the market, without requiring the creation of entirely new programs. Table 3 summarizes the actions of some states that have sought to clarify the application of their interconnection and net metering policies to storage systems.

<table>
<thead>
<tr>
<th>State - Policies</th>
<th>Summary of Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hawaii - Interconnection</td>
<td>In January 2014, the Hawaii Public Utility Commission required that the Hawaiian Electric Companies modify their interconnection tariffs to clarify that distributed generating facilities with battery back-up systems must obtain an interconnection review by the utility. The utility filed the required tariffs June 2014 and the proceeding is underway. The resulting interconnection tariffs will likely address multiple generating-facility-plus-storage scenarios and provide technical considerations and requirements for these systems.</td>
</tr>
<tr>
<td>California - Interconnection</td>
<td>Commission staff recently issued a report in the state’s Interconnection Proceeding regarding “Issues, Priorities, and Recommendations for Energy Storage Integration”. The report outlines the issues that may need to be addressed in the interconnection process to reduce barriers to deploying and integrating energy storage facilities in support of state policies. The Commission accepted comments on this report and recently held a workshop to address the issues in depth and consider next steps.</td>
</tr>
<tr>
<td>California - Net Metering</td>
<td>Net metering facilities in California have been exempt from interconnection fees, supplemental review fees, costs for distribution upgrades, and standby charges since 2002. In May 2014 the Commission extended these exemptions to storage paired with net metering facilities, as long as certain sizing and metering requirements are met.</td>
</tr>
</tbody>
</table>

52 D. Steward and E. Doris, The Effect of State Policy Suites on the Development of Solar Markets, National Renewable Energy Laboratories, at v, Nov. 2014, available at: http://www.nrel.gov/docs/fy15osti/62506.pdf (“States in all contexts experienced more robust markets with the implementation of interconnection and net metering. Although these policies alone are not usually sufficient to spur solar markets, they are foundational for distributed generation market growth.”).
55 See CPUC R.11-09-011.
### State - Policies

<table>
<thead>
<tr>
<th>State - Policies</th>
<th>Summary of Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>California – Net Metering, cont.</td>
<td>The Commission has also begun to develop an estimation methodology to determine the billing credits for net energy metered systems paired with storage devices.59</td>
</tr>
<tr>
<td>New Jersey - Interconnection</td>
<td>The New Jersey Board of Public Utilities Staff issued a request for comments to determine steps towards developing application, metering and control protocols for interconnecting energy storage systems with behind the meter NJ class 1 renewable electric generating facilities.60</td>
</tr>
</tbody>
</table>

### Stimulate the Market

Certain states have begun to move beyond just exploration of energy storage and have elected to provide direct stimulus to help facilitate the growth of the market. California’s Storage Mandate is the most visible and ambitious policy aimed at stimulating the storage market to date in the United States. Established by legislation in 201061 and implemented by the CPUC, the policy requires investor owned utilities to meet an overall energy storage procurement target of 1.325 Gigawatts (GW) by 2020.63 The procurement targets for each utility are further specified and sub-targets for transmission-connected, distribution-connected, and customer-side storage have been established (with certain flexibility built-in). The CPUC approved the utilities’ storage procurement plans in October of 2014,64 and the utilities are in the process of issuing their first solicitations.65 This policy is a significant boost to energy storage within California. Whether or not other states will chose to follow this policy path, states may benefit from California’s lead by taking advantage of the resulting lower technology costs as well as additional research and information on lessons learned as the policy is implemented and matures.

Another way to stimulate the storage market is through the use of financial incentives. There are only a few states that provide direct financial incentives for energy storage as part of an established program.66 Table 4 on the following page summarizes these programs. With the exception of California’s Self-Generator Incentive Program, these programs are new and emerging and the impacts on the overall storage market have yet to be measured.

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62 See CPUC Rulemaking R.10-12-007.
63 See October 17, 2013 CPUC Decision No 13-10-040, in Rulemaking R.10-12-007.
64 See October 16, 2014 CPUC Decision No. 14-10-045.
65 The policy also includes storage procurement targets for Electric Service Providers and Community Choice Aggregators: 1% of their 2020 annual peak load by 2020.
66 Additional states have funded demonstration or pilot storage projects; here we are only including states with established, multi-year programs with a stable funding stream.
### Table 4. Programs Providing Financial Incentives for Energy Storage

<table>
<thead>
<tr>
<th>Program</th>
<th>State</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Generator Incentive Program (SGIP)</td>
<td>California</td>
<td>The SGIP program started providing incentives to advanced energy storage systems in 2008.67 Currently, advanced energy storage projects receive a base incentive of $1.62/W. As of Feb. 2015, there are over 1,000 active advanced energy storage project applications.68</td>
</tr>
<tr>
<td>FY2015 Renewable Electric Storage Incentive Competitive Solicitation.69</td>
<td>New Jersey</td>
<td>This program, which had been under development for over a year, finally launched at the end of 2014. With a budget of $3 million and a maximum incentive of $500,000 per project, the program prioritizes projects that are defined as “public and critical”. There is a FY2016 program planned.</td>
</tr>
<tr>
<td>NYSERDA’s Performance-Based Incentives for Existing Facilities Program</td>
<td>New York</td>
<td>This program offers incentives of between $300 to $600 per kilowatt for energy storage systems, with a maximum incentive of $2,000,000 or 50% of the project cost.70</td>
</tr>
<tr>
<td>Con Edison and NYSERDA’s Demand Management Program</td>
<td>New York</td>
<td>This program provides $2,100/kW up to 50% of installed cost for battery storage projects that are operational by June 1, 2016 and that achieve a peak demand reduction of 50 kW or greater.71</td>
</tr>
<tr>
<td>Energy Storage for Renewables and Grid Support72</td>
<td>Massachusetts</td>
<td>In 2015, Massachusetts plans to provide $10 million “to establish a range of programs to further MA energy storage activities, including pilot projects, market development, and industry support.”</td>
</tr>
</tbody>
</table>

One intriguing idea to stimulate the storage market is to include storage as part of an existing renewable energy portfolio standard.73 Michigan is an example of a state that attempted this by providing bonus renewable energy credits for energy storage; however the results have been negligible thus far.74

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67 Initially, in 2008, only storage coupled with distributed wind or fuel cell generation was eligible. In 2011, Assembly Bill 1150 was passed adding energy storage to the self-generation incentive program statute. See the California Energy Storage Alliance for a concise summary of events, available at: [http://www.storagealliance.org/content/our-work](http://www.storagealliance.org/content/our-work)
74 See Comments from “Ensuring Michigan’s Future”, available at: [http://www.michigan.gov/energy/0,4580,7-230-68204_54285-293406--,00.html](http://www.michigan.gov/energy/0,4580,7-230-68204_54285-293406--,00.html).
Include Storage in Broader Context when Planning for the Future

Some of the most compelling factors driving interest in distributed energy storage are tied to the ability of storage to ease integration of high penetrations of renewable resources on the grid. It follows that considerations of how to best deploy storage would happen in the context of other discussions about how to create a more integrated grid. New York, California, Massachusetts and Hawaii are all engaged in complex proceedings aimed to modernize the grid and plan for the future of the electricity sector. At the heart of each of these proceedings are efforts to modify existing policies to enable greater penetrations of DER, including energy storage. While none of these states target increased penetrations of distributed storage specifically within their more far-reaching proceedings, storage will necessarily play an important role as part of the increased deployment of DERs that the policies of these states is encouraging. Not only do the proceedings in these four states seek to improve access to storage and better integrate it into the grid, but storage is also poised to serve as a tool to help regulators and utilities better integrate other DERs. Because each state is taking a somewhat different approach, the ultimate outcome of the efforts being undertaken by these four states is likely to provide a variety of insights and potential policy approaches for incorporating increased amounts of storage into their respective distribution systems.

New York’s proceeding, called “Reforming the Energy Vision” (REV), is the most ambitious and comprehensive proceeding on these issues to date. Through the REV effort, New York is attempting to reform electric utility and regulatory practices to promote more efficient use of energy, additional renewable energy generation, wider deployment of distributed energy resources, greater use of advanced energy management, and improved consumer engagement and empowerment. Better integration and leveraging of the technical potential of energy storage is only one of many paths to achieve these goals, nested within a broader effort to better integrate and leverage all DER; others include rate redesign, rethinking utility cost recovery, updated tariffs, improved data sharing, and more. The New York proceeding is moving forward on two tracks, with Track 1, focusing on bigger picture policy guidance, moving forward first, and Track 2, addressing more specific implementation tools, moving forward later in 2015.

California’s proceeding is rooted in Assembly Bill (AB) 327 (Perea 2013), which requires California utilities to develop “distribution resources plan” proposals by July 1, 2015, which must “identify optimal locations for the deployment of distributed resources,” including energy storage. The statute includes five specific components for the plans and the California Public Utilities Commission just issued its first guidance to provide a more detailed framework on which the utilities can rely to develop their plans. As in New York, energy storage will be just one of the several types of DER that the California utilities must address, but unlike in New York, the California proceeding is more narrowly focused on the technical barriers and solutions for integrating DER into the grid.

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77 Id.
At this stage, California is not tackling the broader questions associated with rates, cost recovery and the utility business model that New York expects to address.

In the past two years, Massachusetts has made great strides in its grid modernization proceeding. In June 2014, after extensive stakeholder engagement and deliberation, the Massachusetts Department of Public Utilities issued an order requiring utilities to submit Grid Modernization Plans (GMPs), which must demonstrate how each utility expects to make “measurable progress” toward four goals, one of which is integrating distributed resources. As in California and New York, Massachusetts does not focus on energy storage specifically, but rather treats it as one of several DER that utilities must better incorporate into their system planning. Like California, Massachusetts is not as far-reaching as New York; instead Massachusetts has placed particular emphasis on the grid investments, including advanced metering infrastructure (AMI) that may be necessary to meet its four goals. Nonetheless the Massachusetts utilities have been given substantial discretion to develop plans not only to detail grid modernization investments but also to address other changes in tariffs and processes necessary to meet the State’s goals. The Massachusetts utilities’ GMPs are currently due in August 2015.

Hawaii has the highest retail electric prices in the country, which have driven the State, and its residents and businesses, to make significant investments in clean energy resources, in particular distributed solar. Due to its increasingly high penetrations of solar and other renewable generation, Hawaii’s grid integration and reliability issues are arguably more immediate and pressing than those in the other states described above, and have led the State to set an ambitious grid modernization agenda. The Hawaii Public Utilities Commission has taken a broad approach to these issues, similar to the REV proceeding in New York, but rather than addressing them comprehensively, the Hawaii Commission has opened several separate dockets. Many of these dockets touch on the important role that energy storage can play in achieving the State’s goals, although none is dedicated to storage exclusively. Somewhat similar to California’s distribution resource plan and Massachusetts’ grid modernization plan requirements, the Hawaii Commission has required the Hawaii utilities (collectively, the Hawaii Electric Companies, or HECO) to file three plans detailing the various ways in which they are moving toward a more modern, integrated grid—a Distributed

80 See US EIA, Average Retail Price of Electricity to Ultimate Customers by End-Use Sector, www.eia.gov/electricity/monthly/epm_table_grapher.cfm?t=epmt_5_6_a (listing Hawaii’s average electricity rate as $0.3167 per kWh in 2014).
82 See HB 1943 (Lee C 2014) (stating that “moving beyond the current levels of renewable energy on each grid will likely require further investment in advanced grid modernization technology to meet the State’s aggressive clean energy goals and maintain a reliable electricity grid.”).
Generation Interconnection Plan (DGIP), a Power Supply Improvement Plans (PSIP), and an Integrated Demand Response Portfolio Plan (IDRPP). Within these plans, HECO has likewise identified energy storage as an important component of a modernized grid. All three plans are under consideration at the Commission.

Although each of these states is taking a different approach, all of their proceedings seek to integrate energy storage and other DER into utilities' grids and planning decisions. All four states have recognized the importance of incorporating DER into a broader effort, which is especially important with respect to energy storage, since it can provide significant value to the grid but is unlikely to be strategically deployed to do so if the proper market signals, or regulatory policies, do not exist.

4. KEY REGULATORY CONSIDERATIONS TO ADVANCE ENERGY STORAGE

As Section 3 above illustrates, state policymakers and regulators are beginning to focus on the importance of distributed energy storage and are using a variety of different approaches to begin aligning regulatory policies and opening markets to enable energy storage to play a significant role in the electricity system in the coming years. However, in light of the diversity of approaches and the variety of different issues that energy storage integration presents, IREC seeks to assist regulators in identifying some of the most important near-term steps to help facilitate growth in distributed energy storage. Building upon the research presented above regarding the potential applications of distributed energy storage, the evolution of current state efforts, and conversations with distributed energy storage experts and industry representatives, IREC has identified six key considerations for regulators as they evaluate distributed energy storage in their state. The goal of the following discussion is not to identify the specific policy decisions that should be made, but rather to highlight the key areas where regulations may need to created, clarified or updated in the near term.

IREC seeks to assist regulators in identifying some of the most important near-term steps to help facilitate growth in distributed energy storage.

84 Dhruv Bhatnagar, et al., Market and Policy Barriers to Energy Storage Deployment, Sandia National Laboratories, at 21, Sept. 2013 [Market and Policy Barriers] ("Administrative delay in the implementation of new regulations to address barriers to energy storage deployment itself presents a barrier to deployment. . . The sluggish progress is due in part to the complexity of regulatory issues facing energy storage and a need for a comprehensive evaluation of the proposed changes to operational and market rules. Numerous stakeholders with varying, and sometimes competing, interests add additional complexity and require careful navigation of the regulatory process. Recognizing these limitations and challenges, administrative delay still remains an impediment for energy storage development.").
Design Rate Structures that Send Appropriate Economic Signals to Customers with Energy Storage Systems

While the potential for distributed energy storage systems to assist with critical grid needs in coming years is significant, current utility rate structures in most places make it difficult to capture the full value that these systems can provide. Distributed storage developers have identified rate structures – specifically rates that provide energy storage customers with the proper economic signals that enable them to offer services to the grid when and where they are needed – as the most critical regulatory change needed to help facilitate growth in the distributed storage market. While incentives and procurement mandates may be important to facilitating faster growth, (i.e., by helping to create early markets that can bring storage technology costs down) these mechanisms will not create a self-sustaining market if rate structures that will enable storage customers to capture the actual value they provide to the grid are not in place.

TOU rates with sufficiently high differentials between on-peak and off-peak periods that are designed to discourage energy use during peak periods are a particularly important innovation in rates that could improve the ability of customers with storage systems to reduce their electricity bills while helping to minimize the cost of providing peak system capacity. Some utilities have already begun to implement TOU rates for a range of different customer classes. However, there is some hesitation to do this on a universal basis, since not all residential customers have the same ability to control their energy demand. Moreover, some regulators are understandably concerned that customers will be unable to understand, and thus respond effectively, to the TOU rate structures. Where such concerns predominate, it is still worth considering adoption of optional TOU rates for customers who might choose to take a more active role in managing their energy use through the adoption of storage or

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85 Paul Denholm, et al., *The Value of Energy Storage for Grid Applications*, National Renewable Energy Laboratories, at 34, May 2013 ("Economic deployment of energy storage is further challenged by its potentially limited ability to obtain the full value of services provided to the system.").
86 Phone interviews with IREC.
other demand management techniques. Some utilities have already begun to create special rates for electric vehicle owners that encourage them to charge during off-peak periods. The same methodology could be applied to customers that have storage systems on their side of the meter.

In addition to TOU rates, demand charges for commercial and industrial customers are another important rate design mechanism that can have a beneficial impact on energy storage customers. Customers with high demand charges and with sufficiently “peaky” load profiles can simultaneously reduce strain on the energy grid while also reducing their energy bills with a properly sized energy storage system. Customers in some limited markets in the United States are already able to economically install storage on this basis, and some companies are already selling storage solutions to such customers. As regulators evaluate demand charges in existing or new rate structures they may want to consider how those rates can be structured to encourage customers with energy storage to offer the greatest benefit to the system as a whole while also reducing customer bills.

Open up Markets for Ancillary Services and Demand Response to Distributed Storage Providers and Aggregators

As discussed in Section 2 above, at least in the near term, it will be important for distributed energy storage systems to be able to “stack” various different services in order to be economically viable in organized energy markets. As with intelligent rate structures, creating opportunities for storage customers to stack services may also help ensure that customers are incentivized to operate their systems in a manner that benefits the grid more broadly, while also making investments in such systems more viable for the customer. In order for stacking to occur, however, there need to be markets in place for the needed and desired grid services, and these markets need to be transparent and accessible to distributed energy storage customers.

One important potential value stream for energy storage customers can come from participation in ancillary services and demand response markets. Ancillary services can include regulation, voltage support, spinning and non-spinning reserves, and black start, amongst others, though the existence and structure of markets for the provision of these services will vary across the

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90 EPRI Storage White Paper, at 2-11 (”[E] energy storage applications that achieve the highest estimated revenues do so by aggregating several benefits across multiple categories. The analysis indicates that capturing multiple benefits—including transmission and distribution (T&D) deferral and ancillary services—will be critical for high-value applications.”).
91 See, e.g., Market and Policy Barriers at 28 (“The lack of markets and market prices makes it difficult and sometimes impossible, depending on the situation, for an energy storage developer to consider a resource to provide [certain ancillary services], either independently or as part of providing other system services, and thus makes it difficult for a developer to make a business case for deployment. This issue is relevant for all generation technologies, but perhaps more important as energy storage, at its current cost point, may necessitate a need to provide multiple services to be economically competitive.”): EPRI Storage White Paper at 2-3 (“Due to the current high installed capital costs of most energy storage systems, applications (for either utilities or end users) must be able to realize multiple operational uses across different parts of the energy value chain, an aggregation of complementary benefits known as “stacking.”).
country. As referred to here, demand response refers to a program under which customers reduce their electricity use in response to economic signals, either through wholesale markets or special rates, to help utilities manage peak demands.

A key policy element for individual storage customers is to ensure that customer sited storage has easy access to the grid ancillary services and demand response markets. For example, in the PJM ISO territory, customer-sited storage may participate in and earn revenues from the PJM ancillary services markets through curtailment service providers. The curtailment service providers sign up individual customers and then simultaneously dispatch the storage systems as a single unit in the PJM market.\textsuperscript{92} In addition, in the case of both ancillary services and demand response, another critical change that will facilitate a greater deployment of customer-owned energy storage would be to allow, or improve, the opportunities for these services to be aggregated at the distribution level.\textsuperscript{93}

While the provision of ancillary services has a clear economic value to the system, the value of those services is limited on an individual system basis. Although the total revenue stream available to distributed energy storage customers for these services will likely remain small,\textsuperscript{94} and may even shrink as a greater number of systems are able to provide those services, regulators should still give serious consideration to programs that would allow third party providers to aggregate those services at the distribution level. Without a market that allows for such aggregation, the ability of energy storage providers to assist utilities and grid managers will likely go untapped.

Aggregation of demand response services is potentially even more valuable for energy storage providers than the aggregation of ancillary services. Since planning for and managing peak loads is such a significant driver behind the overall costs of providing reliable electric service, properly designed demand response programs can help reduce those costs. While demand response programs have existed for a long time, the market has generally only been open to industrial and commercial customers with large and highly controllable loads. However, the falling costs of energy storage systems can provide easy access to a new set of customers that would not have otherwise been able to participate in existing demand response programs.

\textsuperscript{92} See PJM Demand Response Fact Sheet, available at: \url{http://learn.pjm.com/three-priorities/buying-selling-energy/markets-faqs/what-is-demand-response.aspx}

\textsuperscript{93} Sandia’s Benefits and Market Potential Assessment Guide, at 62 and 127; Robert Walton, ‘Storage is here: Solar-plus-storage market will surpass $1B by 2018’, Utility Dive, Dec. 17, 2014 (emphasizing the importance of aggregation in monetizing ancillary and demand response services for distributed storage systems).

\textsuperscript{94} Market and Policy Barriers, at 10 (“Deployment of energy storage resources can collapse ancillary service market prices and energy market price differences, resulting in revenue streams for storage that are not commensurate with the value these resources provide to the system.”); Sandia’s Benefits and Market Potential Assessment Guide.
Thus, the installation of energy storage systems that can supply backup energy supply will enable many customers who would not have otherwise been able to curtail load to participate in demand response programs, thereby contributing to the system-wide reduction of peak loads and the associated reduction in the need for utilities to build and operate peaking plants. As with ancillary services, however, the ability of storage customers to participate in demand response programs would be greater if third-party providers were able to aggregate those services at the distribution level. Smaller individual customers may not be able to bid in at a sufficient level to meet program demands, but the aggregator of the activities of a significant number of smaller customers could be an effective market participant. Moreover, aggregation can also reduce the risks of any one customer failing to curtail load. Finally, aggregation will be particularly helpful in enabling residential customers with storage systems to participate successfully in demand response programs.

**Ensure Distributed Energy Storage Systems Have a Clear Path to Interconnection and Are Treated Fairly by State Interconnection Standards**

One of the most critical pieces of developing any grid-tied energy project is ensuring that permission to interconnect to the utility owned electrical grid can be obtained fairly and efficiently. Questions about the applicability of interconnection standards to energy storage systems, as well as the underlying technical standards, have been raised in a number of states as utilities start to get interconnection requests for energy storage projects. Although the existing screens and technical standards that are in place in most state interconnection procedures are already being used to enable review of storage systems in many states, there are some useful modifications to those processes and standards that will facilitate the interconnection of storage systems both more quickly and at a lower cost than is the case today, while still ensuring the safety and reliability of the grid.

In Order 792 issued in late 2013, the Federal Energy Regulatory Commission (FERC) took the first modest step of amending the definition of a “Small Generating Facility” in the federal Small Generator Interconnection Procedures (SGIP) to explicitly include storage systems within that definition. FERC conceded that the earlier definition was probably broad enough to already include storage systems, but

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95 Federal Energy Regulatory Commission, Order 792 at ¶ 228 ("[T]he Commission revises the definition of Small Generating Facility in Attachment 1 to the SGIP and Attachment 1 to the SGIA as follows: “The Interconnection Customer’s device for the production and/or storage for later injection of electricity identified in the Interconnection Request, but shall not include the Interconnection Customer’s Interconnection Facilities.”").
it found that it was important to update this definition “in order to improve the transparency of the SGIP.” 96 Similarly, at a minimum, state utility regulators should consider adding a similar definition or clarification to existing state interconnection standards to specify whether or not and how such standards will apply to energy storage systems.

Once the applicability of the standards is clear, a few additional issues may need to be clarified to ensure fair treatment of storage systems and to avoid disputes in the interconnection process.

First, when evaluating a storage system through the interconnection process, the utility will need to determine the size of the system, or the generating capacity of the system, in order to determine its impacts on the electric system. FERC examined this issue and determined that in evaluating a storage system, utilities “should generally assume that the capacity of the storage device is equal to the maximum capacity that the particular device is capable of injecting” on the system. 97 It also found, however, that in the case of storage systems installed with other onsite generators (i.e. solar PV), the utility is to use the capacity specified in the interconnection request, even if it is lower than the maximum capacity, so long as the utility is satisfied that the manner in which the applicant proposes to limit the output of the facility “will not adversely affect the safety and reliability” of the utility’s system. 98 While this option is helpful to storage applicants, it is possible that the method of limiting output proposed by an applicant will not satisfy the utility and, thus, will be a source of dispute in the interconnection process. Regulators may, therefore, want to consider further clarifying what methods would be acceptable for limiting output of energy storage systems in their interconnection standards.

Secondly, another issue requiring clarification is the extent, if any, to which non-exporting storage systems should be required to undergo interconnection review. In proceedings in California and Hawaii, some storage providers have argued that non-exporting systems should not be subject to any interconnection review, or that the technical requirements for traditional non-exporting systems should be modified to include different methods for verifying that the system will not export. The use of energy management software and/or relays could significantly reduce interconnection costs for such non-exporting storage systems. However, utilities will need to have sufficient assurance that such systems will not export electricity in order to ensure system safety and reliability. Because this is an issue that will require a thoughtful and balanced resolution, it can and should be addressed proactively in a state regulatory proceeding that will facilitate dialogue among storage customers, the storage industry, storage advocates and utilities regarding the right technical and policy solution. Similarly, while the Fast Track screens used in most state procedures and in the federal SGIP are capable of screening storage systems, there may be ways to further streamline the interconnection process by creating storage specific screens. With all these reviews, system integrity should be the

96 Id.
97 Id. at ¶ 229.
98 Id. at ¶ 230.
paramount consideration, but regulators should remain open to allowing new technical solutions where there is sufficient evidence of their effective performance.

Finally, energy storage systems pose something of a conundrum when it comes to the traditional way that states regulate the review of new load and generation. Interconnection standards are generally designed to examine the impacts of adding generation onto the utility system. New sources of load, on the other hand, are not required to go through interconnection procedures and are instead treated by different standards. However, utilities may want to review the system impacts of the charging functions at the same time they evaluate the generation from a new storage system. This could create an issue of double counting if a utility’s review of a proposed storage system determines that upgrades to the distribution system may be required primarily to accommodate the new load resulting from use of that system. In most cases, ratepayers are charged for system upgrades associated with load through a distribution charge on their bill, they do not pay directly for most upstream system upgrades. Thus, charging a storage customer for upgrades associated with the increased load through application of interconnection standards could result in customers being double charged or being unfairly assigned costs that would not normally be directly assigned for other types of new load.

In light of this unique issue, regulators may want to consider whether the interconnection process should be used to evaluate the loading functions of a storage system, or whether traditional methods of managing load should be relied upon for assessing and addressing system impacts from charging. If it is determined that the additional load from storage systems will be evaluated as part of the interconnection process, then there may need to be a mechanism to ensure storage customers are not treated differently from other load when it comes to allocating the costs of upgrades required to accommodate changes in load.

**Address Net Energy Metering Opportunities for Storage Systems**

One of the fastest growing markets for distributed storage is for residential and small commercial customers that already have, or are simultaneously installing, NEM solar PV systems.⁹⁹ Although NEM policies vary state-by-state and utility-by-utility, most offer customers full retail rate credits for excess energy generated onsite by qualified renewable generators.¹⁰⁰ Many NEM programs restrict the individual system capacity (i.e. systems must be 1 MW or smaller in California and must be sized to primarily off-set onsite load), and a few of these programs also put a limit on the aggregate capacity of the program as a whole (i.e. 5% of a utility’s peak load).¹⁰¹ Partly due to these program limitations and the increasing debate about the appropriate rate that NEM customers should be credited, there is a concern that storage systems co-located with NEM systems might

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¹⁰¹ Id.
undermine NEM programs if they are used to store power not generated by the renewable generator and then discharge that energy back onto the grid for a full retail credit.

The primary concern is that customers could be getting NEM credits for energy not produced by the onsite renewable generator. Allowing customers to obtain NEM credits from energy produced using the overall mix of generation supplied by the utility arguably could undermine one of the key policy intents behind NEM program: increasing the use of renewable energy. The secondary concern is that if the storage systems were used in a manner that increases the overall amount of NEM credits generated, that there would be less capacity left in the NEM program.

Although there is little economic incentive today for most NEM customers to store more power than is generated by the renewable energy system, regulators may want to clarify program rules to ensure the integrity of the NEM programs while also not limiting the ability of customers-sited storage systems to help manage peak loads and smooth variability. While requiring a separate meter for storage systems to ensure that they are charging from the NEM system is the most verifiable method, a separate meter will add costs to the systems and is problematic for systems that use a single inverter for the renewable generator and the storage system. When faced with this issue the Commission in California considered a variety of different approaches in lieu of requiring a separate meter, including (1) estimation methodologies instead of a meter, (2) requiring no measurement for systems below a certain size which may pose a de minimis impact on the NEM program and/or (3) requiring no measurement for those who are not on time-varying rates and thus lack an economic incentive to export energy.102 The Commission ultimately chose to utilize an estimation methodology for smaller systems, and required metering for larger systems.

While preserving the integrity of NEM programs designed to promote renewables is important, there are also other beneficial services that netting arrangements for storage systems may be able to promote. As described previously, in some markets there is likely to be a surplus of generation during daytime hours while the peak shifts towards the evening when solar PV systems are generating less. Customers that install storage systems have the ability to store the excess daytime generation and redistribute it onto the grid during the evening peak periods. It is also true that any generation that is stored during off-peak periods could be deployed in a helpful manner during peak periods, regardless of whether it was generated by an onsite rooftop PV system or taken directly from the grid. Where there is a need to reduce peak demand, or increase generation during certain periods, there could be some benefits to allowing customers with storage systems to export energy onto the

Keeping the full scope of energy storage system benefits in mind may help regulators in evaluating the whether to impose metering or other program rules on storage co-located with renewable net metering systems.

grid in exchange for bill credits even if they are not eligible for a renewable-based NEM program. The bill credit and program components could mirror the renewable NEM programs, or be established with storage-only specific rates and parameters. Creating a separate NEM program for storage systems could help reduce electric costs overall, while not eating into the renewable NEM program caps.

Keeping the full scope of storage system benefits in mind may help regulators in evaluating the whether to impose metering or other program rules on storage co-located with renewable NEM systems, and may also lead to the creation of storage specific programs that allow credits for storage exports outside of renewable NEM programs.

Consider Distributed Energy Storage Solutions in the Context of Broad Distribution Planning Efforts

As the recent changes to the electric system discussed in Section 2 highlight, many of the most significant drivers behind distributed energy storage come down to fundamental changes in the way that the distribution system has been traditionally designed and operated. Not only is electricity now flowing in both directions on the distribution system, but customers now also have the ability to provide grid services that were traditionally the sole domain of the utilities. As the pressure grows to integrate higher penetrations of renewable energy onto the distribution grid at reasonable costs, states are starting to recognize that fundamental changes to distribution planning and operation may be necessary.

These conversations are particularly important when it comes to identifying the best way to deploy energy storage technologies because much of the value of these technologies to the grid is dependent upon where they are located. In addition, early studies are demonstrating that the value of individual DERs may be less than the value that can be captured when the DERs are evaluated together. States are likely to get the greatest benefit from distributed energy storage deployment where it is facilitated through a well thought-out distribution planning effort. In this regard, Section 3 describes the new efforts already underway in a few states and also highlights the diversity of the different approaches being taken. While there is probably no one “right” approach at this time, the following topics would be particularly valuable to include in a distribution planning reform proceeding.

• Starting with an assessment of the existing system capabilities, states will get more value out of storage installations if they require utilities to identify locations where distributed energy storage (and other DERs) may be most valuable and to develop a method for sharing this information with customers and developers in a readily accessible format.

• In conjunction with efforts to identify system locations where energy storage can add value to the system, states may want to develop a methodology for evaluating the benefits of distributed energy storage so that this valuation can be used to help determine rates, incentives and other market tools to help facilitate optimal siting of energy storage.

• Finally, after assessing locations where the greatest value can be added and developing a methodology for determining the value, regulators will have the critical tools in place to be able to develop rates and tariffs that can provide economic signals to help direct distributed energy storage systems to the most beneficial locations.

Coordinate with State Authorities to Ensure Sufficient, but not Duplicative, Oversight of Energy Storage System Safety

As with any new technology, and particularly ones that are installed in customer’s homes, there is a need for clear codes and standards that ensure the technology can be installed and operated safely. The nation’s electric, building and fire codes generally provide the standards for installations at homes and businesses and in most places local government officials are responsible for ensuring compliance with those codes. When it comes to technologies that are interconnected to the electrical grid, however, there is an added level of technical review imbedded in the interconnection standards that are usually overseen by state public utility commissions. As more customers begin to consider installing energy storage systems in their homes and businesses, and as regulators evaluate the policy actions discussed in this paper to further those opportunities, the question of who is overseeing the safety of these systems is important to consider.

The Department of Energy’s SunShot Initiative has highlighted the importance of lowering the soft-costs associated with permitting and interconnection for solar PV systems in order to make them more cost-competitive.104 The same scrutiny of the permitting and interconnection process should also be applied to energy storage systems to enable these systems to provide economically competitive benefits to both customers and grid operators. This does not mean

Regulators should be cautious about imposing duplicative or burdensome safety requirements and should instead focus on ensuring that the right codes and standards are in place and that the bodies responsible for overseeing compliance with those codes and standards is clearly defined.

that safety should be ignored or undermined; rather, it points to a need to ensure that such processes are managed efficiently.105 Thus, when it comes to ensuring the safety of energy storage system installations, regulators should be cautious about imposing duplicative or burdensome safety requirements and should instead focus on ensuring that the right codes and standards are in place and that the bodies responsible for overseeing compliance with those codes and standards is clearly defined.

Since public utility commissions are the state bodies that will be most closely overseeing the market for energy storage systems, commissioners may want to ask the state energy office to facilitate the conversation about energy storage safety across state regulatory agencies. Convening a conversation with the commission, state code officials and the energy storage industry will provide an opportunity to ensure that the necessary safety requirements are in place and that the authority for overseeing their compliance is clearly defined so that it does not have to be duplicated. States can now also look to the Department of Energy’s recently issued guidance on energy storage safety for an identification of key issues for consideration.106

5. CONCLUSION

Recent headlines about the electric industry contain a mix of articles expressing abundant hope for the promise of new technologies to address environmental considerations and to improve the quality of electric service, countered with dire predictions about the challenges of integrating these new technologies and the fate of the traditional electric utility. While it may be that both types of headlines are accurate, the underlying reality is that the dire predictions do not have to be realized if the electric industry moves now to capture the benefits of the new technologies before the challenges associated with integrating these 21st century technologies into a 20th century grid are realized. Regulators have the ability to avoid such problems, and instead capture significant benefits, if they chose to proactively develop regulatory policies for a 21st century grid.

The challenges that Germany has been facing in responding to the high penetration of renewable energy on its electrical grid provide an illustration of the benefits of developing policies proactively. The renewable energy market has taken off much

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faster than most would have predicted and, in some cases, has left states scrambling to respond to customer demands and utility concerns. At the same time, many states have been able to keep their markets moving by being willing to experiment with pilot programs and policy innovations. Inherent in this process is a learning curve, but it is a learning curve that does not have to be faced alone.

The potential of distributed energy storage to lower costs and improve the quality of electric service is considerable. However, since the market for distributed energy storage is still in its infancy there is a significant need for regulatory guidance and proactive policies to ensure a smooth rollout of this technology. State regulators are beginning to explore and take initial steps to address some of the immediate barriers, but best practices have yet to emerge. IREC hopes that the ideas presented in this paper will help regulators in identifying the critical steps that need to be taken in the early stages of addressing the promise -- and the challenge -- of an accelerating deployment of distributed energy storage. As states begin to take action, IREC will continue to keep regulators informed about the lessons learned by other states and will help to identify best practices as they emerge to ease the learning curve for states.

The push for increased use of distributed energy storage is coming from both customers and utilities. This push presents an exciting opportunity for regulators to build collaborative programs that can help meet multiple goals at once. Facilitating dialogue amongst stakeholders about potential regulatory and market approaches to facilitate the deployment of this promising technology will help to ensure that the benefits of energy storage are shared between customers, utilities and ratepayers.
## Appendix A. Stacking Energy Storage Applications: Complimentary/Synergistic Applications

<table>
<thead>
<tr>
<th>Application</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Incompatible</th>
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<tr>
<td>Electric Energy Time-shift</td>
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<td>Electric Supply Capacity</td>
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<td>Load Following</td>
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<td>Area Regulation</td>
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<td>Electric Supply Reserve Capacity</td>
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<td>Voltage Support</td>
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<td>Transmission Congestion Relief</td>
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<td>T&amp;D Upgrade Deferral</td>
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<td>Time-of-Use Energy Cost Management</td>
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<td>Demand Charge Management</td>
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<td>Electric Service Reliability</td>
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<td>Electric Service Power Quality</td>
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<td>Renewables Energy Time-shift</td>
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<td>Renewables Capacity Firming</td>
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<td>Wind Generation Grid Integration</td>
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Table Notes
a. For Area Regulation: Assume that storage cannot be connected at the distribution level.
b. For Voltage support: Assume that a) storage is distributed and b) the storage system includes reactive power capability.
c. For Reserve Capacity: Must have stored energy for at least one hour of discharge (i.e., so can offer use of the storage as reserve capacity on "hour-ahead"
d. For T&D Load Following: For load following up (mornings) or down (evenings) involving charging; must pay prevailing energy price.
e. For T&D Deferral: Annual hours of discharge range from somewhat limited to none. So storage is available for other applications during most of the year.
f. For Time-of-use Energy Cost Management and Demand Charge Management: Assume discharge for 5 hours/day (noon to 5:00 pm), weekdays, May to October
g. Transmission Support (not shown) is assumed to be mostly or entirely incompatible with other applications.

Annotations
1 Requires distributed storage that is located where needed.
x Somewhat to very circumstance-specific, especially regarding timing of operation and/or location.
* Most storage cannot provide power for both applications simultaneously.
† Presumably discharge is somewhat to very coincident for the two applications.
# For distributed storage: charging energy a) from onsite renewable generation and/or b) purchased from offsite renewable generation via the grid.
‡ Requires utility dispatch of onsite storage.
About IREC

The Interstate Renewable Energy Council, Inc. (IREC) is a non-profit organization accelerating the use of renewable energy since 1982. Today, IREC is a nationally recognized thought leader, stakeholder coordinator, independent expert resource and facilitator of regulatory reform. Our work expands consumer access to clean energy; generates information and objective analysis grounded in best practices and standards; and leads national efforts to build a quality-trained clean energy workforce, including a unique credentialing program for training programs and instructors. IREC is an accredited American National Standards Developer.