DOES ENERGY STORAGE FIT IN AN RPS?

Prepared for the

The RPS Collaborative

by

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About This Report

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Disclaimer

Introduction

When the original version of this report was written in 2014, the introduction noted that energy storage had become a topic of almost daily news coverage. "Hardly a day passes without a news item or blog entry about energy storage," we wrote, "whether the story is announcing a new storage project (St. John 2014b), forecasting explosive growth of storage technology (Navigant 2013; Elsässer 2013; Wang 2014), or analyzing the benefits of and challenges to energy storage on the electric grid (U.S. DOE 2013; RMI 2014; Morgan Stanley 2014; Wilkinson 2014)."

Two years later, the ubiquity of energy storage in the news has only increased. From Tesla's announcement of its Powerwall home battery to be produced at a mega-factory in Nevada, to grid-scale energy storage procurement in California, to hundreds of millions in funding for resilient power grants to support behind-the-meter battery projects in New England,[1] storage is attracting investment on a scale not previously seen for this emerging technology.

State and federal policy are also ramping up. At this writing, the Massachusetts Department of Energy Resources (DOER) and Clean Energy Center (MassCEC) are preparing to release a jointly-funded energy storage study, which will guide state policy and investment; New York is incorporating energy storage in its Reforming the Energy Vision (REV) initiative; demonstration projects are moving forward all over the map, many with federal and/or state support;[2] and the Federal Energy Regulatory Commission (FERC), which opened energy markets to storage with a series of orders in 2012-2013 (FERC 2013; Wesoff 2013),[3] is requiring documentation from Independent System Operator (ISO) or Regional Transmission Organization (RTO) officials regarding barriers to the participation of energy storage in those energy markets, and is soliciting comments from other stakeholders on the same topic (FERC 2016).

[1] For more information on resilient power and solar+storage technology, see the Clean Energy Group's Resilient Power Project at http://www.cleanegroup.org/ceg-projects/resilient-power-project/.

[2] The U.S. Department of Energy Office of Electricity Delivery and Energy Reliability offers an excellent program for energy storage demonstration projects. DOE works in collaboration with states to support innovative large-scale energy storage deployment; DOE also supports energy storage analysis and optimization through the national laboratories. One of the authors of this report, Todd Olinsky-Paul, directs Clean Energy States Alliance's Energy Storage Technology Advancement Partnership (ESTAP) under contract with Sandia National Laboratories and with funding from U.S. DOE-OE. For more information, see http://www.cesa.org/projects/energy-storage-technology-advancement-partnership/. For information about Sandia's energy storage projects, see http://www.sandia.gov/ess/projects/.

3 For a summary of the FERC orders, see Sanders and Milford (2014).

This paper explores the question of how states, which have taken the lead in promoting clean energy through Renewable Portfolio Standards (RPS), could facilitate increased deployment of energy storage.

States may be interested in storage for numerous reasons, including a desire to increase the value of renewable energy, address "duck curve" ramping[4] and integration issues, provide resilient power to critical infrastructure, increase the reliability of electrical grids, or support grid modernization efforts. Although there are several ways states could do this, the 29 states plus the District of Columbia and Puerto Rico that already have an RPS in place may think that including storage as an eligible resource in their RPS is a good idea. But is it a good fit for an RPS? This paper attempts to stimulate thinking by posing a series of questions that policymakers and regulators should consider.

4 The "duck curve" is a term coined to describe the shape of the electricity load curve at certain times of the year in California and other locations with high renewables penetration. The net load, excluding solar, drops in the afternoon, giving the appearance of a duck's belly and then quickly ramps up in the late-afternoon and early-evening to produce an arch that looks like a duck's neck.

Energy Storage and RPS - Questions States Should Consider

The link between high penetrations of renewable energy, especially intermittent and non-dispatchable renewable energy, and the need for storage to stabilize the grid (Denholm et al. 2010) would suggest the RPS is a logical policy vehicle to facilitate deployment of energy storage.

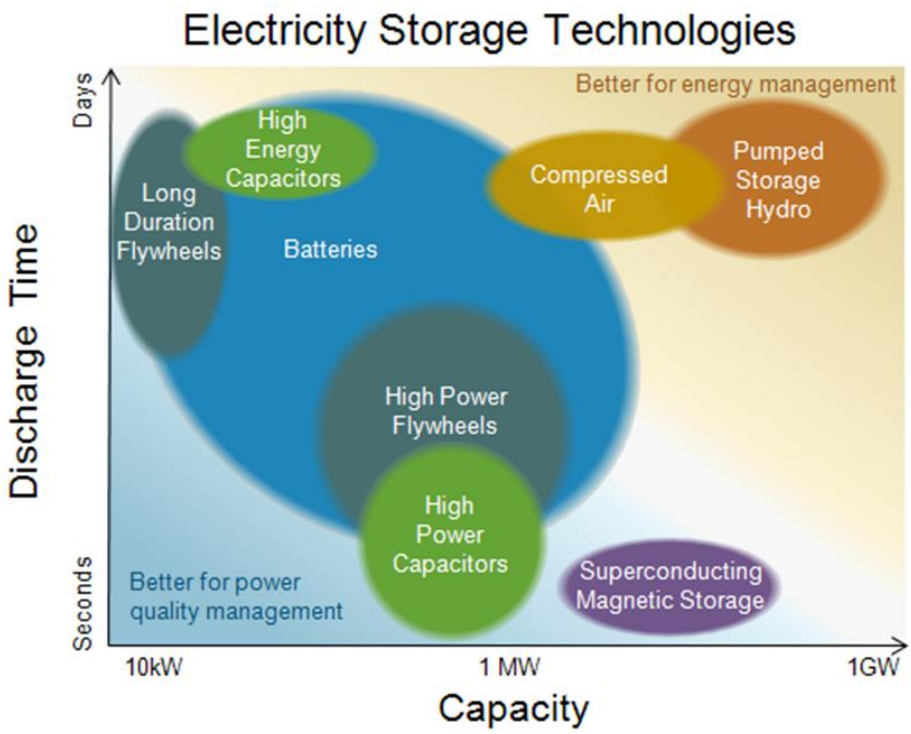
Further, there are many examples of states using RPS policies to promote their broader public policy goals, not just to simply establish an overall renewable energy target. For example, some RPS statutes encourage distributed generation by creating special targets for solar energy or customer-sited renewable generation. Others encourage certain technologies by providing credit multipliers favoring those technologies. So it would not be unprecedented to use an RPS to support deployment of energy storage.

Before making storage an eligible RPS resource, here are some questions for states to consider.

What's the policy objective?

If the purpose is clear, it will be easier to decide how best to support it. Some storage technologies are best applied to time-shifting supply to meet demand, while others are best used for short-duration power quality management, as shown in Figure 1.

Figure 1 - Energy Storage Technologies



Source: U.S. EIA (2011)

Some possible objectives for energy storage include:

- Shift renewable generation to more closely match peak loads
- Address fast ramping needs
- Provide generation and load balancing services in a microgrid
- Provide resilient power to critical infrastructure
- Help meet reliability needs
- Help meet power quality needs
- Integrate intermittent renewable energy
- Defer T&D upgrade investments
- Reduce greenhouse gas emissions by supporting higher levels of carbon-neutral generation
- Improve the efficiency or economics of intermittent renewable energy.
- Provide efficiency and energy cost savings for commercial/industrial customers.
- Reduce the need for peaking and backup generators on the grid, by reducing peak demand.
- Reduce customer demand charges.
- Provide ancillary services to the grid.
- Support grid modernization efforts.

Not all of these objectives demand, or would best be addressed by, state policy changes. For those objectives that do indicate a state policy response, the RPS may not be the most appropriate vehicle to achieve the objective. States may even question whether they need to do anything at all to directly encourage storage. For example, simply requiring higher RPS targets may put utilities and balancing authorities in a position where they must do something to smooth out the variability of renewable generation. If storage is the right answer, then these actors will respond by procuring or ordering more storage.

Each state will likely arrive at a state-specific set of answers to these questions. Regardless, before addressing policy options, it is a good idea for states to articulate their energy storage objectives clearly.

How might energy storage eligibility for an RPS be determined?

If states decide to include energy storage in an RPS, they will need to determine what kinds of storage should be eligible.

If eligibility is to be determined by defining eligible technologies, states should consider batteries, compressed air, flywheels, pumped hydro, hydrogen, and perhaps other storage technologies as well.[5]

Alternatively, eligibility could focus on storage performance characteristics, such as minimum or maximum capacity, speed and accuracy in load-following or tracking a signal, minimum duration the

[5] This paper is focused on electricity storage, but some states include renewable thermal energy in their RPSs, in which case thermal storage could also be considered.

technology can hold a charge, or whether or not the storage installation can be remotely controlled for dispatchability. This approach does not require identifying specific technologies, although it may create conditions under which certain technologies are ineligible. It may also require more administrative effort to determine whether a specific project is eligible. However, it may help to ensure that storage actually addresses the state's objectives.

Realistically, states may wish to employ a combination of both methods for determining storage eligibility. For example, a state could decide to exclude non-renewable hydrogen-based storage technologies if non-renewable hydrogen-fired generation is not eligible within the RPS, while also requiring that storage capacity be 1 MW or above (individually or in aggregate) and capable of being dispatched by a regulated utility, in order to achieve stated objectives.

The configuration of the storage relative to the energy source may also be an important eligibility criterion. For example, if the policy objective is to use storage to integrate renewable energy generation, then the state may want to specify that eligible storage must be connected directly to an eligible generator—otherwise it could be difficult to determine if the storage resource is really supporting renewable energy. In this case, an RPS may be an appropriate vehicle to facilitate deployment of energy storage. On the other hand, if the emphasis is on storage capacity and the energy source is irrelevant, then stand-alone storage achieves the policy objective and RPS may not be the best policy tool to support it because there is no direct link between renewable energy and storage.[6]

It is important to understand that some eligibility requirements can impact the financial viability of storage projects. For example, a state policy objective might suggest that energy storage devices should be required to charge from the grid, or prohibited from doing so, in order to provide specific benefits or meet clean energy eligibility criteria. But in order to fully qualify for the federal Investment Tax Credit (ITC), energy storage devices must charge exclusively from eligible renewable renewables during the first five years of operation. Any percentage of charging that is not from an associated renewable generator reduces the percentage of the ITC that may be taken. Below 75 percent charging from renewables, the storage device does not qualify for the ITC at all (Internal Revenue Service 2012). On the other hand, some potentially lucrative energy services markets, such as frequency regulation, may require that energy storage devices charge from the grid in order to participate. States should understand these financial implications before placing restrictions on how eligible energy storage devices may be operated.

How should states encourage storage—mandate or incentives?

States could establish mandatory storage targets, or encourage storage with financial or market incentives, or a combination. A mandatory approach is more compatible with most RPS policies, but states could provide credit multipliers as incentives within an RPS, as was proposed in Washington State, or

[6] An example of an exception to this general statement might be a situation where there is insufficient transmission capacity to serve an area with lots of wind generation. Storage could help to mitigate the need to curtail wind generation by substituting for transmission upgrades that would otherwise be needed to address capacity inadequacy. In this case, storage would not need to be directly connected to the wind resource to benefit renewables.

financial incentives in parallel with an RPS, as some states do in providing incentives for solar installations even while mandating that certain solar targets be met.

In determining whether a mandate or incentives are most appropriate, states may want to consider whether they want to deploy storage in quantity (which might lend itself to a mandatory approach), or whether they want grid operators to gain experience through a smaller pilot program, or whether they want to encourage storage developers to take advantage of markets recently supported by the Federal Energy Regulatory Commission (FERC 2013; Wesoff 2013).

States have employed a number of different approaches to energy storage. Several of these are summarized below; discussions of select programs follow.[7]

- **Storage mandates**. California, Oregon and Puerto Rico have adopted mandates. None has done so as part of its RPS, but storage output may be used to comply with California's RPS.
- **Credit multipliers or adders**. A Washington State bill proposed a credit multiplier for storage connected with renewables within its RPS. This bill has not been adopted into law; however, the State has made several grant awards to energy storage demonstration projects under the State's clean energy fund (Washington 2013; Washington 2013-2015).
- **Storage incentive programs**. New Jersey has adopted an incentive program that has offered both competitive grants and rebates, both separate from its RPS.
- **Microgrid planning and implementation grants**. Connecticut and New York are focusing on microgrids—which may or may not include storage—to protect critical infrastructure, and New York is additionally implementing regulations in support of storage as parts of its Reforming the Energy Vision (REV) initiative.
- **Resilient power incentives**. Massachusetts has issued a resilient power solicitation for which microgrids, energy storage, and other technologies are eligible. The state is also finalizing an energy storage study, is engaged in a grid modernization effort, and has announced an upcoming program of incentives for energy storage demonstration projects (Massachusetts 2015).

California storage mandate

Based on state law (Assembly Bill 2514), the California Public Utilities Commission (CPUC) established a mandate on investor-owned utilities to integrate 1.3 gigawatts (GW) of storage by 2020 (California Code; CPUC 2013). The goal is market transformation.

The CPUC set MW capacity targets for each utility, separate from the RPS. For each utility, the CPUC also set sub-targets for storage connected at the transmission, distribution, and customer levels.

Each utility may own up to 50 percent of its target capacity. Customer or third-party owned storage for the remaining capacity will be procured by competitive solicitation.

[7] For more information about state programs for resilient power, which generally include storage as an eligible resource, see "What States Should Do: A Guide to Resilient Power Programs and Policy." http://www.cleanegroup.org/ceg-resources/resource/what-states-should-do-a-guide-to-resilient-power-programs-and-policy/.

In addition to the investor-owned utility targets, electric service providers and community choice aggregators have targets to purchase energy storage projects equal to 1 percent of their 2020 annual peak load by 2020, with installation and operation of the projects required by the end of 2024.

A wide range of storage technologies are eligible, but pumped storage hydro larger than 50 megawatts (MW) is excluded because it could otherwise quickly crowd out other technologies.

Although California's storage targets are separate from its RPS, storage output may still count towards the RPS if certain conditions are met (e.g., the generator and storage are integrated or directly connected, and fuel input measurement meets certain criteria).

In addition to the storage mandate, California's Self-Generation Incentive Program (SGIP) has been successfully used to support smaller, customer-sited storage projects. And a new law, AB 693 (the Multifamily Affordable Housing Solar Roofs Program), provides $1 billion over 10 years for solar PV and energy storage in multifamily affordable housing.

Oregon storage mandate

Oregon House Bill 2193 provides that "an electric company shall procure, on or before January 1, 2020… one or more qualifying energy storage systems that have the capacity to store at least five megawatt hours of energy…. The total capacity of qualifying energy storage systems procured under this section by any one electric company may not exceed one percent of the electric company's peak load for the year 2014." (Oregon 2015) This mandate applies only to the State's two largest utilities, and is unique in that it provides both a floor and a ceiling for energy storage procurement. The bill has been signed into law, and implementation is under discussion at the State's Public Utility Commission (OR PUC).

The Oregon mandate admits all sorts of energy storage, including both electricity and thermal storage, and expresses a state interest in the value of energy storage in various applications. The bill directs the OR PUC to: "Examine the potential value of applying energy storage system technology" related to "Deferred investment in generation, transmission or distribution of electricity… reduced need for additional generation of electricity during times of peak demand… improved integration of different types of renewable resources… reduced greenhouse gas emissions… improved reliability of electrical transmission or distribution systems… reduced portfolio variable power costs; or… any other value reasonably related to the application of energy storage system technology." (Oregon 2015)

Because Oregon is not served by an ISO/RTO and does not have ancillary services markets, establishing the value of energy storage for the provision of some of these services is difficult. One goal of the Oregon mandate is to promote a better understanding of the value of those services, which could in turn help storage to become economically self-sustaining in the future.

According to a representative of the Oregon Department of Energy (OR DOE), the 1 percent cost cap was included to address concerns that there could be a push from regulators or stakeholders to implement more energy storage than the affected utilities thought was cost effective. Essentially, state legislators included the cap to reassure utilities that their obligation to procure storage would remain modest for the immediate future (Broad, 2016). However, the cost cap can be waived if utilities submit a project proposal that is considered by the OR PUC and OR DOE to be "of statewide significance."

Puerto Rico storage mandate

Puerto Rico relies on imported oil (65%), natural gas (18%) and coal (16%) for nearly all electricity generation. Reducing this dependence on imported fossil fuel has been a motivation for adopting an RPS requiring 20 percent of net electricity sales to come from renewable energy resources by 2035.

As an island territory, Puerto Rico is a small control area with no connections to other grids. This makes it more challenging to integrate the variable output of increasing renewables. To minimize the impact of adding variable renewable energy to the grid, the government-owned Autoridad de Energia Electrica has made it mandatory for developers of renewable energy projects to incorporate energy storage into new installations, applying a performance requirement to individual renewable energy projects. Under new regulations, "all new green power projects must include some minimum energy storage capabilities aimed at helping to stabilize the Island's grid. First, each project must have enough energy storage to provide 45 percent of the plant's maximum generation capacity over the course of one minute, for use in smoothing out the "ramp rate" of power coming on and off with changes in sunlight or wind speeds.... Second, each new Puerto Rico project must have enough storage to meet 30 percent of its rated capacity for approximately 10 minutes or less, to be called on for frequency regulation, or for keeping the grid's power constant at 60 hertz." (St. John 2013)

Washington State proposed RPS compliance incentive

Washington State House Bill 1289 of 2013 proposed an RPS credit multiplier for renewable generation linked to energy storage. The bill states that: "A qualifying utility may count electricity dispatched to an electrical transmission or distribution system from an energy storage facility at two and one-half times the facility's output, if the energy storage facility is capable of storing energy from an eligible renewable resource during off-peak hours and dispatching the energy as electricity to an electrical transmission or distribution system during peak hours" (Washington 2013). Although this bill was not adopted into law, it provides an example of how energy storage could be included in an RPS, not as a stand-alone technology, but as an enhancer of the value of renewable generation.

Washington also has a Clean Energy Fund under which it has made several grant awards to support energy storage demonstration projects (Washington 2013-2015).

Hawaii Energy storage request incentive

Hawaiian Electric Company (HECO), serving the island of Oahu, has chosen a performance-based specification for storage, and will encourage storage using a payment rather than a mandate. Whether or how the resulting storage will contribute to the state's RPS has not been described.

In this case, the state did not adopt a specific program or requirement. Instead, the Hawaii Public Utilities Commission (HI PUC) ordered the Hawaiian electric companies to be more aggressive in supporting distributed generation, particularly PV, and to be more proactive in integrating greater quantities of customer-sited distributed energy resources (Hawaii PUC 2014). Although the orders articulate general policy rather than specific programs, HECO responded by issuing a request for proposals for large-scale energy storage projects on Oahu that can store 60 to 200 MW for up to 30 minutes. Other than the storage capacity and duration, detailed specifications are left to bidders. Eligible projects must be in service by the first quarter of 2017 (HECO 2014).

HECO says it needs energy storage because wind and solar power generation has grown dramatically. More than 11 percent of HECO customers have solar panels on their homes. Oahu also has several large-scale wind and solar power projects generating electricity, some with integrated storage. The utility says energy storage will help it ride through sudden fluctuations in the availability of wind and solar-generated power (Francescato 2014). While HECO's solicited storage projects are meant specifically to help stabilize the effects of wind and solar power, they aren't required to be integrated with specific renewable energy projects.

New Jersey storage incentive program

The New Jersey Office of Clean Energy (NJ OCE) developed its Renewable Electric Storage Program in 2014. Administered by the New Jersey Board of Public Utilities (NJ BPU), program priorities included:

- Projects that can be completed in one year
- Building a sustainable market that doesn't rely on public funding
- Firming PV production so PV can participate in demand response programs
- Supporting operation of critical facilities during widespread power outages

Initially, the program was based on competitive solicitations and award of financial incentives, with a budget of $3 million.

Energy storage projects were required to be integrated with renewable energy systems behind the customer's electric meter at public and critical facilities. Storage devices were not allowed to be charged by non-renewable generators, or by electricity imported from the distribution system, although an exception was made for the purpose of allowing the sale of frequency regulation services onto the grid.

In the first round of funding, the New Jersey program received 22 applications and made 13 awards. Winning projects ranged in storage capacity from 250 kW to 1.5 MW, and all employed lithium ion battery technology. Awards ranged from $70,000 to $468,708 per project. A total of 8.75 MW of storage were selected under this round of funding, and significantly, all 13 projects included the sale of frequency regulation services as an integral portion of their *pro formas* (CESA 2016).

This shows the importance of the PJM frequency regulation market during this time. In 2012, PJM had developed the country's premier frequency regulation market by establishing a two-tiered, pay-for-performance system under which fast-responding resources, such as batteries and flywheels, would be paid a premium as compared with slower-responding resources. The richness of this premium allowed the New Jersey energy storage program to incentivize a large number of projects using a relatively small incentive budget.

However, nine of the original 13 projects were ultimately withdrawn by the grantees, in part due to PJM market rules that were not well understood by developers. Because PJM considers behind the meter systems to be demand response resources, customer-sited storage can provide only as much frequency regulation as would correspond to the average load of the facility connected with the battery. New Jersey has since doubled its storage budget and has announced a second and third round of funding. The NJ BPU is now offering $3 million in incentives in the form of a prescriptive rebate – the first such rebate for energy storage in the country – and will offer a second $3 million in the form of a competitive solicitation (New Jersey, 2016). At this writing, four projects have been approved for rebates.

The rebate is intended to support "electric energy storage systems that are integrated with Class 1 renewable energy projects installed behind-the-meter at non-residential customer sites" (NJOCE, 2016). One purpose of the program is to provide emergency backup power for essential services, but although there is a preference for such projects, this is not a requirement of the program. Other purposes include offsetting peak loads by shifting renewable generation to hours of higher demand, and providing frequency regulation services. The incentive is set at $300 per kWh of energy capacity, up to a maximum of $300,000 per project, or 30 percent of the project cost.

In addition to direct energy storage incentives, New Jersey has established a first-in-the-nation Energy Resilience Bank (NJERB) using $200 million in federal disaster recovery funds. The NJERB, which is modeled on the green bank concept, is tasked with providing grants, loans, and other financing resources to resilient power projects. Energy storage coupled with renewable generation is included among the eligible technologies (NJ ERB 2016).

Connecticut and New York microgrids

Connecticut and New York are taking a different approach to increasing reliability, without focusing specifically on energy storage. Following Hurricane Irene in 2011, Connecticut passed a law intended to keep critical buildings powered during electric grid outages (Connecticut Act). The law calls for the Connecticut Department of Energy and Environmental Protection (CT DEEP) to establish a $45 million microgrid grant and loan pilot program to support local distributed energy generation for critical facilities.

CT DEEP issued two requests for proposals from municipalities, utilities and private entities to develop microgrid distributed energy generation to support critical facilities, and awarded a total of $23 million to 11 microgrid projects over the first two rounds of funding, though only two of the projects include energy storage (Connecticut 2016). State investment in the initiative was raised to a total of $50 million, and a third round of funding was offered in the form of an open enrollment solicitation.

The program was revised in each successive round of funding; for example, in the second round RFP, the State required that renewable generation be paired with energy storage in order to be counted toward the microgrid's generating capacity and proposals that included renewable generators received a bonus in scoring relative to proposals that did not include renewables. Despite these amendments, which were intended to increase the renewables and storage included in proposals, most of the funded microgrids have been based on fossil fuel generators, such as CHP units, gas turbines and reciprocating engines, and diesels.

New York, in response to Hurricane Sandy in 2012, has proposed to offer $40 million to bolster the State's storm resilience with community microgrids. The New York Prize program, administered by the New York State Energy Research and Development Authority (NYSERDA), has funded 83 microgrid feasibility studies in communities around the State, and program administrators anticipate awarding up to $8 million in a second round of funding to a smaller number of projects for detailed engineering design, financial analysis, and business plans.

A handful of implementation grants will be awarded in the third and final round (NYPrize 2016). During emergencies, the microgrids will be able to disconnect from the utility grid and power themselves, providing islands of stable power for hospitals, police department, fire stations, gas stations and other

critical systems located within the microgrid (St. John 2014a). Aside from funding microgrid demonstrations, the program aspires to boost the nascent microgrid industry in New York State and hopes to show that microgrids can be an attractive investment opportunity for private funders.

New York is also addressing energy storage as an enabler of grid modernization through its REV initiative. In the REV Track 1 proceeding, the New York Public Service Commission (NY PSC) included energy storage among a set of distributed energy resources (DER) that would be granted an exemption from restrictions on regulated utility ownership of generation resources (energy storage, although it is not an energy generating technology, is nonetheless regulated as a generator by many states). The NY PSC states in its Track 1 REV proceeding that:

> "Utility ownership of DER will only be allowed under the following circumstances:
>
> 1) procurement of DER has been solicited to meet a system need, and a utility has demonstrated that competitive alternatives proposed by nonutility parties are clearly inadequate or more costly than a traditional utility infrastructure alternative;
> 2) a project consists of energy storage integrated into distribution system architecture;
> 3) a project will enable low or moderate income residential customers to benefit from DER where markets are not likely to satisfy the need; or
> 4) a project is being sponsored for demonstration purposes." (NY PSC 2015)

In cases where these conditions are met, the NY PSC considers the benefits of allowing regulated utilities to own energy storage and other DER more compelling than concerns that regulated utility ownership of DER could out-compete private market efforts.

Massachusetts Community Clean Energy Resiliency Initiative and Energy Storage Initiative

As part of the state's comprehensive climate change preparedness effort, the Massachusetts Department of Energy Resources (MA DOER) dedicated $40 million to its Community Clean Energy Resiliency Initiative (CCERI). This program provides grant funding to municipality-led resilient power projects, including those employing energy storage. The solicitation included a $200,000 set-aside for technical assistance to communities that need help in designing a project. Project implementation awards were capped at $5 million per project (Mass. EEA 2014). Eighteen implementation awards were made in the first two rounds of grant-making in 2014, and a third round is planned in 2016.

As with the Connecticut and New York programs, the focus in Massachusetts is on municipalities. Eligible applicants include cities, towns, regional planning agencies and public/private partnerships. Eligible technologies include microgrids, energy storage, renewable energy, combined heat and power, fuel cells, energy management systems and islanding technology. Proposed projects must use clean generation; serve critical facilities; be able to isolate critical loads from non-critical loads; operate both in parallel with the grid and in island mode; and meet utility interconnection strategy guidelines. In addition to the CCERI grant program, Massachusetts energy agencies have announced several other energy storage efforts, including a $10 million Energy Storage Initiative (MA ESI 2015) that will fund demonstration projects; an energy storage opportunity study, that will direct how the state allocates funds and guide the formation of policy; and a microgrids program that seeks to support multi-owner microgrid development by Massachusetts communities. Massachusetts has also embarked on a grid modernization effort similar to New York's REV initiative.

Is storage a generation or distribution asset?

There are important implications of how energy storage is defined. In some restructured states, utilities are prohibited from owning generation. In that case, utility regulators will need to define storage as either a generation or a distribution asset, and that definition will determine whether utilities can own storage. Obviously this will have a significant impact on how a state structures a storage program. Even where utilities are prohibited from owning storage, they could presumably still satisfy an RPS goal by purchasing storage services, but this would require the development of a market sufficiently attractive to third-party storage providers.

It is not always easy to tell if storage is a generation or distribution asset. Many storage devices do not clearly fall into either category. Storage can behave like a generator or like a distribution asset depending on the type of storage, where it is deployed, how it is used and who controls it. Utilities and grid operators tend to see storage as a form of generation because it is indistinguishable from generation when it is discharging. If interconnected at the distribution level (especially behind the customer meter) storage may be viewed by customers as a way to increase the usefulness of renewable energy and to provide on-premise reliability. Another consideration is that generators generally do not consume energy (except for station service), whereas storage assets can consume significant amounts of energy. The fact that storage devices both absorb and discharge electricity makes them difficult to categorize.

Just as some states have a two-tiered RPS—a main tier for utility-scale renewables and a customer-sited tier for distributed generation—utility-scale storage might be classified as a generation asset, while customer-sited storage might be classified as a distribution asset. The two classifications could have different purposes, such as transmission grid integration vs. customer-side resilient power. A state could take a different programmatic approach to each, using different rules and incentive structures.

A few states that have initiated grid modernization programs are considering different approaches. Foremost among these is the New York REV initiative, which seeks to increase the role of distributed energy resources and sees distribution utilities as key to making this work. Under REV, utilities are being granted special dispensation to own storage if the storage asset meets certain criteria (NY PSC 2015).

How should progress toward storage goals be evaluated?

Evaluation metrics depend in part on the policy objectives (see *What's the policy objective?* above). If the storage application relates to balancing load and energy management, then tracking energy output may be appropriate. Because most RPS targets are measured in percent of load and calculated using MWh units,[8] in this case, storage might be compatible with a state's RPS.

When storage is measured by energy output, policy-makers need to decide whether to measure gross generation from the generator (before charging the storage device), or to count only net generation from the storage device (subtracting losses). In contrast, if progress is evaluated by storage capacity, there is no need to adjust for conversion losses.

[8] Three states, Iowa, Texas and Kansas, have established RPS targets in capacity terms.

California Net Metering and Storage

The California Public Utilities Commission's (CPUC) goal is to ensure that renewable generators combined with storage is configured and metered in ways to ensure that net metering credit can only be given to eligible renewable electric generation.

Three California investor-owned utilities restricted participation in their net metering programs by customers with PV integrated with storage. They argued that customers with storage should not be eligible for net metering because the utilities could not distinguish between power produced by the renewable energy generator and power coming from the storage device. These customers could charge their storage device with power from the grid and be improperly credited for the storage output (Clover 2013).

The utilities were willing to enroll such systems in the net metering program if one of two conditions was met: (1) the storage device only stores energy produced by the renewable energy system, or (2) the storage device serves only the customer and never discharges to the grid. It would require two separate meters capable of verifying that only renewable energy is being put onto the grid (Jenal 2013).

This issue was brought to the CPUC, which ultimately decided in a net energy metering (NEM) successor tariff that "storage, when paired with a NEM-eligible generator, is an addition or enhancement to that NEM-eligible generating facility and accordingly, customer-sited systems interconnecting under NEM with storage should be treated in the same manner as those systems interconnecting without storage." (CPUC 2016).

If the policy objectives relate more to reliability and power quality, then the amount of energy produced is probably not a good metric. Storage installations might be better evaluated by the amount of time that energy can be stored and their capacity relative to local demand. In these cases, storage is less likely to be a good fit for an energy-based RPS in measurement terms, but it could work as a separate capacity target or in a state where the RPS goals are already established in capacity terms.

Should RECs be issued for storage?

Renewable energy certificates (RECs) are used to demonstrate compliance with state RPS requirements. RECs are denominated in energy units, usually megawatt hours (MWh). If storage goals are also measured in energy output, and if storage is eligible for compliance with RPS targets, then it might seem logical to issue RECs for storage output. But storage does not create additional energy, it just absorbs and then discharges energy generated elsewhere.

States should be careful about double counting generation and storage. If a generating facility reports generation to a certificate tracking system, the tracking system will issue RECs to the generating facility. If the electricity from that generating facility is used to charge a storage device, and that storage device then discharges electricity, the tracking system might issue RECs for the storage output. Issuing RECs

both for energy into the storage device and for energy out of the storage device would be double-counting. It is the same MWh minus the net energy consumed.

For example, say a wind generator produces 100 MWh, and this is sent to storage. A short time later, the storage device produces 80 MWh (assuming there is a net consumption, or loss, of 20 MWh). If state RPS rules direct that both the wind generator and the storage device are eligible to be issued RECs, 180 RECs would be issued. If these were all used for RPS compliance, 80 MWh would be double-counted and the RPS would be effectively lowered by that amount. If wind RECs and the storage RECs were sold to different parties, say a voluntary buyer, these RECs could result in a double claim on the same attributes.

RPS rules in some states recognize this potential problem. For example:

- **California**: "A pumped storage hydroelectric facility may qualify for the RPS if: 1) the facility meets the eligibility requirements for small hydroelectric facilities, and 2) the energy used to pump the water into the storage reservoir qualifies as an RPS-eligible resource. *The amount of energy that may qualify for the RPS is the amount of electricity dispatched from the pumped storage facility*" (CEC 2012).
- **Kansas**: "Renewable energy resources" means net renewable generation capacity from:…(11) energy *storage that is connected to any renewable generation* by means of energy storage equipment including, but not limited to, batteries, fly wheels, compressed air storage and pumped hydro…" (KSA 2014).
- **Missouri**: "RECs that are generated with fuel cell energy using hydrogen derived from a renewable energy resource are eligible for compliance purposes *only to the extent that the energy used to generate the hydrogen did not create RECs*" (Missouri CSR).

If storage is eligible in an RPS, the state should be careful not to issue RECs for both generation and storage—just one or the other, accounting for the net consumed energy as they see fit.

Instead of issuing RECs to both the original generation and to the storage facility, a state could provide a credit multiplier for the output of a renewable energy generator integrated with storage. Renewable generators connected to storage would receive one REC for each MWh generated, but the output from storage would receive none. Instead, the RECs issued to the eligible generator could count as 1.8 RECs (for example) if used for RPS compliance. This would avoid double counting, but would have the effect of lowering the amount of renewable energy required to satisfy the RPS.

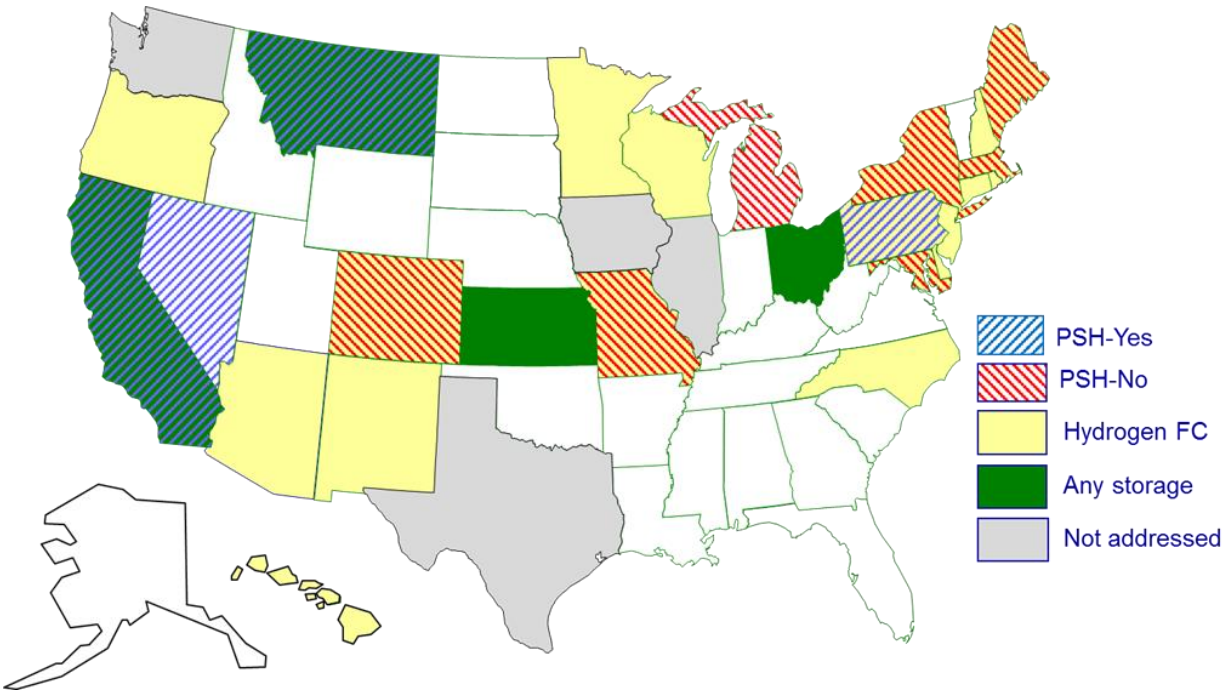
Alternatively, states could establish a carve-out for renewables connected to storage. A REC issued for integrated renewables and storage need not be worth more than any other REC and therefore would not reduce the amount of renewables developed under the RPS. The RPS could simply require that some percentage of the renewables developed to fulfill the RPS requirements must have storage. Measurement and double-counting would still need to be addressed.

A state could also measure compliance with a quantitative storage target by tracking capacity, and not issue RECs for storage at all. Similarly, a state could avoid issuing RECs for storage by using financial incentives, rather than RECs and a mandatory target, to stimulate storage installations.

Storage in States with Mandatory RPS Targets

Many of the RPS states have addressed storage in their RPS statutes or rules, but most often in a limited, indirect way rather than comprehensively. Figure 2 shows some of the state treatment of storage, but the great variety cannot be displayed in a single map.

Figure 2 - Energy Storage in state RPS



Source: Database of State Incentives for Renewables and Energy Efficiency

States have included various storage technologies in a number of ways.

Any storage: California, Kansas, and Montana accept any storage technology if it stores energy from an eligible renewable energy resource.[9] Ohio also accepts any storage technology but does not similarly limit storage eligibility to renewable energy sources.

Pumped storage hydro (PSH): Colorado, the District of Columbia, Maryland, Massachusetts, Michigan, Missouri and New York do not accept pumped storage hydro as an eligible RPS resource. The portion of

[9] Specific measurement conditions apply to storage in California. Montana accepts "the renewable energy fraction" of flywheel, pumped storage hydro, batteries, and compressed air stored energy, which includes most current storage technologies.

Maine served by ISO-New England (which is most of the state) treats pumped storage as it is treated by the regional tracking system (see below), which means it is ineligible. In contrast, pumped storage hydro is eligible in California, Montana, Nevada, Pennsylvania, and a small portion of Maine. However, California and Maine impose capacity limits and require that a pumped storage facility serve all of its pumping requirements using an eligible resource. Montana accepts for RPS compliance only the fraction of pumped storage output that is supplied by an eligible renewable energy resource. Nevada allows pumped storage over 30 MW if no fossil fuels are used in pumping; under 30 MW there is no such restriction.

Hydropower: Hydro is RPS-eligible in many states, but the following jurisdictions don't specify whether that includes pumped storage, so it is unclear if pumped storage hydro would be certified as eligible: Arizona, Colorado, Connecticut, Hawaii, Montana, New Mexico, Ohio, Oregon, Puerto Rico, Rhode Island, Texas, and Wisconsin.

Hydrogen: Energy stored in the form of hydrogen for use in fuel cells is RPS-eligible in a number of states.[10] In some states, the hydrogen must be derived from eligible renewable energy resources, but in other cases, non-renewable resources may be used to produce hydrogen. RPS rules usually refer to fuel cell eligibility rather than hydrogen eligibility, but hydrogen is the storage medium, while a fuel cell is the conversion technology. The states that require renewable energy resources are Arizona, California, Colorado, Delaware, District of Columbia, Hawaii, Kansas, Maryland, Massachusetts, Minnesota, Missouri, Montana, New Hampshire (only produced from biomass fuel and methane gas), New Jersey, New Mexico (not produced using fossil fuels), New York (only produced from biogas), North Carolina, Oregon, Rhode Island and Wisconsin. Fuel cells are eligible, but the energy source is not specified or restricted, in Connecticut, Maine, Ohio and Pennsylvania.

Flywheels: Massachusetts accepts flywheel energy storage for its Alternative Energy Portfolio Standard (not its main tier requirement), subject to certain conditions.

Not mentioned: Four RPS states (Iowa, Illinois, Texas and Washington) do not mention storage or specific storage technologies as either eligible or ineligible.

This enumeration demonstrates that many states already include (or exclude) certain kinds of storage technologies in their RPS rules—even if they don't think of them as storage.

[10] There are several ways to isolate hydrogen, one of which is electrolysis, in which electricity is used to split water into hydrogen and oxygen. The hydrogen is stored, and a fuel cell converts the hydrogen back to electricity. When renewable electricity is used to release hydrogen from water, the electricity-hydrogen-electricity cycle is clean, but energy is lost in the process. Energy losses are generally too large to make this an attractive option.

Tracking System Treatment

States may decide whether and how they want certificates issued to storage, but tracking systems usually strive for policy neutrality. Further, multistate tracking systems may face conflicting state policies for issuing certificates to storage. Even if states have no storage programs or measurement policies, storage will be added to the grid, and tracking systems will still have to decide how to treat the output. They will have to accommodate multiple physical configurations of generators and storage, each potentially with different metering capabilities.

Because tracking systems have to issue a certificate for every (eligible) MWh, they should develop operating procedures to address the output from storage facilities within their state or region regardless of whether or not storage is eligible for a state RPS.[11]

Some of the certificate tracking systems have in fact addressed certificate issuance in the case of pumped storage hydro, if not for storage facilities generally.

- The New England Power Pool (NEPOOL) Generating Information System (GIS) and the PJM Generation Attribute Tracking System (GATS) track the MWh for the net energy consumed (losses) in a non-tradable pumped storage account controlled by the system administrator. At the end of each certificate trading period, the administrator assigns residual mix attributes to each MWh in the pumped storage account.
- Following Massachusetts policy, NEPOOL GIS will create certificates for flywheel energy storage output, which is eligible for the Massachusetts Alternative Energy Portfolio Standard (AEPS), but per Massachusetts rules, the flywheel energy storage output must be verified by an independent third party and will be credited at 65% of the output for AEPS compliance.
- The Western Renewable Energy Generation Information System (WREGIS) treats pumped storage as a non-renewable fuel of a multi-fueled generator for which certificates are not created.
- In the Michigan Renewable Energy Certificate System (MIRECS), a storage facility may be eligible to receive Incentive Credits that are different from RECs and are useful only for that state's RPS.
- The New York Generation Attribute Tracking System (NYGATS) does not issue certificates for the output from storage technologies. Only the original generation is tracked (NYGATS 2016). However, because pumped storage hydro is reported by the New York Independent System Operator as a generation source, it must be accounted for. It is treated as a non-renewable fuel source and excluded from environmental disclosure labels and the residual mix calculation.
- The Electricity Reliability Council of Texas (ERCOT), Midwest Renewable Energy Tracking System (M-RETS), North American Renewables Registry (NAR), and the North Carolina Renewable Energy Tracking System (NC-RETS) do not address storage in their rules.

[11] If a storage device stores energy produced on-site for on-site use, it's possible the on-site generator and/or the storage device would never be registered with a tracking system.

Options for issuing certificates in the case of storage include:

- If the tracking system knows what generation charged the storage device, it could issue certificates with the generator's attributes for the storage output, and assign system average or residual mix attributes to the energy consumed by the device (the NEPOOL GIS and PJM-GATS approach to PSH).
- If the tracking system does not know what generation charged the storage device, it could issue certificates only for the generation (with known attributes) and ignore the energy consumed and produced by the storage device. This would not reward storage, however.
- If the generator is integrated with storage, the tracking system could issue certificates based on the output from storage. However, if the generator is not credited for electricity lost in storage, the generator is effectively penalized for using storage, even though the use of storage may benefit the grid or the state. Some sort of compensatory mechanism may need to be provided. Also, in the case of distributed storage, the owner would lose the benefit of receiving RECs for energy used onsite unless additional metering is used.
- If the generator is integrated with storage, the tracking system could issue certificates based on the original generation, ignoring losses in the storage system. This would be analogous to issuing certificates for generation at the busbar, ignoring transmission losses as most tracking systems do. However, storage losses are generally more significant than transmission losses.
- If the storage devices integrated with generation meet certain metering standards, then different rules could apply.
- To account accurately for all renewable generation and storage output, a tracking system needs to know the quantity and type of generation going into the storage device (whether undifferentiated from the grid or from an integrated generator), the quantity of stored energy consumed onsite (for integrated systems), and the quantity of energy discharged from storage to the grid.

Illustration of NEPOOL GIS and PJM-GATS approach to pumped storage hydro (PSH)

100 MWh generated to grid

100 MWh used by storage

- 80 MWh production from storage

20 MWh net load (losses)

- 80 MWh of PSH certificates issued to generator
- 20 MWh of net load are recorded in tracking system administrator's account
- Tracking system assigns residual mix attributes to 20 MWh of net load

The solutions are not obvious or simple. But the short story is that accurate metering (including more than one meter) is essential to be able to assign the right attributes to generation. This may be necessary if storage owners are going to realize the full REC benefit of their systems.

Summary of Considerations for States

Before deciding how to support energy storage, states should consider specifically what they want to accomplish, how they would measure progress, who should be responsible for planning and implementing storage, and whether they prefer mandates or incentives (or both) as the means to accomplish their goals. Further, they should consider whether energy storage is best supported within an RPS, or outside of it. As shown by the examples given in preceding sections of this report, numerous states have adopted energy storage mandates and/or incentive programs separate from their RPS, and many states include at least some forms of storage as eligible resources within their RPS.

This paper has identified three different approaches to encouraging the development of energy storage:

1) Within an RPS, as an eligible technology or as a credit multiplier when coupled with eligible technologies. Many states already have limited examples of storage in their RPS;
2) As a mandate separate from the RPS (as in the California, Oregon and Puerto Rico examples); and
3) As a financial incentive program (as in the New Jersey, Connecticut, Massachusetts and New York examples).

States could also adopt different rules and incentive structures based on the storage application, taking one approach with utility scale storage for renewables integration at the transmission level, and another approach with customer-sited or distributed storage focused on resilient power.

1) Including energy storage in an RPS suggests the following considerations:

- It provides a rationale to focus only on renewable energy generation (or any eligible RPS resource) as a means of charging a storage device. This may be preferred, or it may be too constraining to meet state policy objectives for storage, and it can preclude storage from participating in some energy markets.
- Because most RPS compliance is measured in MWh (or kWh), storage targets and progress would logically be measured in energy output, for consistency. This may, or may not, support the metrics needed to measure progress toward other storage policy objectives.
- A state choosing this approach should adopt regulations regarding double counting of the energy generation from the eligible renewable energy facilities used to charge the storage device, and the energy output from storage.
- Ensuring that only renewable energy is used to charge the storage device may limit the storage technologies to those integrated with renewable energy generating facilities, or with a dedicated power line connecting the generation with the storage. This also significantly limits the use of the storage device and the revenue streams available to it.

- Limiting storage technologies to those integrated or directly connected with a specific generator(s) may effectively focus applications on distribution utility or customer-sited storage.
- A state could consider establishing a separate RPS target for storage, and could even take a hybrid approach and establish the set-aside as a capacity target (see next option).

2) Using a mandate separate from an RPS measured in electricity generated suggests the following considerations:

- It gives a state confidence in the amount of storage developed, but is unconstrained by the RPS structure.
- Putting storage outside the RPS provides more flexibility. States could measure progress in capacity terms, or in terms of temporal performance, for example, rather than simply in energy.
- States could still limit storage to that charged by renewable energy—or not—depending on policy objectives.
- An energy storage mandate separate from the state's RPS avoids concerns about diluting RPS targets (storage deployment will not displace renewable energy deployment).

3) Encouraging storage through an incentive program suggests the following be considered:

- It provides maximum flexibility, but there is less certainty about the amount of storage that will be developed.
- In addition to metrics relating to energy and capacity, an incentive program could be structured in terms of pay-for-performance (for example, time-shifting energy output, or duration of storage).
- States could still limit storage to that charged by renewable energy—or not—depending on policy objectives.
- There is flexibility in how incentives could be structured, for example, through competitive bidding (capital cost subsidies), as a prescriptive rebate, or by performance-based subsidies. These various structures come with advantages and disadvantages: for example, competitive solicitations are less attractive to developers than prescriptive rebates, which offer a more reliable and predictable form of support; but competitive solicitations help to assure states that they are getting the maximum return for their incentives, while rebates can be difficult to set at the right level to support development without over-paying. Frequently, states will establish a competitive solicitation to learn about a new technology such as energy storage, and then transition to a rebate once they have some experience with the technology and can better gauge where incentive amounts should be set.

- In deciding how to structure incentives and how much to pay, states could take into account payments that might be received from the storage device bidding into wholesale markets for ancillary services.

Regardless of how a state decides to encourage storage (or even if it doesn't adopt any policies specific to storage), REC tracking systems will nevertheless have to decide how to treat the output from storage devices. In view of the potential for double counting (issuing certificates for both the original renewable generation and storage output), states should engage with stakeholder groups and make their views known to tracking systems, and decide:

- Whether to issue certificates for the original generation only, or for storage output only;
- How to treat losses in storage systems;
- What generation and environmental attributes to assign to the output; and
- To whom the certificates should be issued, the owner of the generation or the owner of the storage device (if different).

References

Bayar, Tildy. 2013. "The Time is Right for Small Pumped Energy Storage, UK Hydropower Developer Says." Renewable Energy World, September 10, 2013. http://www.renewableenergyworld.com/rea/news/article/2013/09/the-time-is-right-for-small-pumped-storage-in-the-uk-developer-says

Broad, Diane. 2016. Personal Communication, June 15, 2016.

California Energy Commission (CEC). 2012. Renewable Portfolio Standard Eligibility (Sixth Edition), August 2012. http://www.energy.ca.gov/2012publications/CEC-300-2012-006/CEC-300-2012-006-CMF.pdf

California Public Utilities Code, Section 2835-2839 (California Code). http://www.leginfo.ca.gov/cgi-bin/displaycode?section=puc&group=02001-03000&file=2835-2839

California Public Utilities Commission (CPUC). 2013. Rulemaking 10-12-007. Decision Adopting Energy Storage Procurement Framework and Design Program. Decision 13-10-040, October 17, 2013. http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M079/K533/79533378.PDF

California Public Utilities Commission. 2014. Rulemaking 12-11-005. Proposed Decision of ALJ MacDonald. Decision Regarding Net Energy Metering Interconnection Eligibility for Storage Devices Paired with Net Energy Metering Generation Facilities. Mailed April 15, 2014. http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M089/K641/89641289.PDF

California Public Utilities Commission. 2016. Rulemaking 14-07-002, Order Instituting Rulemaking to Develop a Successor to Existing Net Energy Metering Tariffs Pursuant to Public Utilities Code Section 2827.1, and to Address Other Issues Related to Net Energy Metering. Decision 16-01-044, January 28, 2016. http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M158/K181/158181678.pdf

Clean Energy States Alliance (CESA). 2016. "New Jersey Energy Storage Rebate Program," Energy Storage Technology Advancement Partnership. February 17, 2016. http://www.cesa.org/webinars/new-jersey-energy-storage-rebate-program/?date=2016-02-17

Clover, Ian. 2013. "Californian Utilities Hit Out Against Battery Stored Solar Power," *PV Magazine*. October 8, 2013. http://www.pv-magazine.com/news/details/beitrag/californian-utilities-hit-out-against-battery-stored-solar-power_100012982/#axzz339dDdkgw

Congressional Research Service (CRS). 2013. S. 1030: STORAGE 2013 Act Summary. https://www.govtrack.us/congress/bills/113/s1030

Connecticut. 2016. Microgrid Grant and Loan Program. http://www.ct.gov/deep/cwp/view.asp?a=4405&Q=508780

Connecticut Public Act No. 12-148, An Act Enhancing Emergency Preparedness and Response. 2012. http://www.cga.ct.gov/2012/act/pa/pdf/2012PA-00148-R00SB-00023-PA.pdf

Denholm, Paul, Erik Ela, Brendan Kirby, and Michael Milligan. 2010. *The Role of Energy Storage with Renewable Electricity Generation*. NREL/TP-6A2-47187. Boulder, CO: National Renewable Energy Laboratory, January 2010. http://www.nrel.gov/docs/fy10osti/47187.pdf

Elsässer, Marcus. 2013. "As Solar Costs Drop, Energy Storage Solutions Take Center Stage," *Renewable Energy World*, July 24, 2013. http://www.renewableenergyworld.com/rea/news/article/2013/07/as-solar-costs-drop-energy-storage-solutions-take-center-stage?cmpid=WNL-Friday-July26-2013

Francescato, Rosana. 2014. "Hawaiian Electric Seeks 60 - 200 MW Energy Storage to Support Renewables for Oahu," *PV Solar Report*, May 5, 2014. http://pvsolarreport.com/blog/item/1734-hawaiian-electric-seeks-energy-storage-to-support-renewables-for-oahu

Glazer, Craig. 2013. "Regulation and Energy Storage: A Match Made in Heaven?" EIA 2013 Energy Conference, June 17, 2013. http://www.eia.gov/conference/2013/pdf/presentations/glazer.pdf

Green, Catherine. 2013. "SolarCity Plans Solar Power Storage Solution, Due in 2015," *Los Angeles Times*, June 27, 2013. http://www.latimes.com/business/money/la-fi-mo-solarcity-storage-2015-20130627,0,2570795.story

Hawaii Public Utilities Commission. 2014. Decision and Order No. 32052, Regarding Integrated Resource Planning (Docket No. 2012-0036), Exhibit A: Commission's Inclinations on the Future of Hawaii's Electric Utilities. http://puc.hawaii.gov/wp-content/uploads/2014/04/Commissions-Inclinations.pdf

Hawaiian Electric Company. 2014. Hawaiian Electric Company Request for Proposal (RFP# 072114-01) for 60 to 200 MW of Energy Storage for Oahu. https://www.hawaiianelectric.com/clean-energy-hawaii/request-for-proposals---energy-storage-system

Internal Revenue Service. 2012. Private Letter Ruling 121432-12. https://www.irs.gov/pub/irs-wd/1308005.pdf

Jenal, Jim. 2013. SCE Clarifies Policy on Storage & Net-Metering. Run on Sun. July 23, 2013. http://runonsun.com/~runons5/blogs/blog1.php/util/sce/sce-clarifies-policy-on-storage

Kansas Statutes Annotated (KSA). 2012. Supp. 66-1257(f)(11). http://www.kcc.state.ks.us/energy/res_statutes.pdf

Magill, Bobby. 2013. "Microgrids: A New Kind of Power Struggle in New York and Connecticut," *GreenTech Media*, September 16, 2013. http://www.greentechmedia.com/articles/read/microgrids-a-new-kind-of-power-struggle

Massachusetts Executive Office of Energy and Environmental Affairs (EEA). 2014. Community Clean Energy Resiliency. http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/resiliency-initiative.html

Massachusetts Executive Office of Energy and Environmental Affairs (EEA). 2015. Energy Storage Initiative. http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/energy-storage-initiative/.

Missouri Code of State Regulations. 4 CSR 240-20.100(3)(D). https://www.sos.mo.gov/adrules/csr/current/4csr/4c240-20.pdf

Morgan Stanley. 2014. Clean Tech, Utilities & Autos; Batteries + Distributed Gen. May Be a Negative for Utilities. http://www.cleanegroup.org/blog/solar-storage-threatens-utility-model-says-morgan-stanley/#.U6nKq_ldWAU

Navigant Research. 2013. "Compressed Air Energy Storage to Experience Dramatic Growth over the Next 10 Years," August 19, 2013. http://www.navigantresearch.com/newsroom/compressed-air-energy-storage-to-experience-dramatic-growth-over-the-next-10-years

New Jersey Energy Resilience Bank (NJERB). 2016. http://www.state.nj.us/bpu/commercial/erb/

New Jersey Office of Clean Energy (NJOCE). 2016. FY 2016 Renewable Electric Storage Program, June 20, 2016. http://www.njcleanenergy.com/renewable-energy/programs/energy-storage

New Jersey Office of Clean Energy (NJOCE). 2014a. Straw Proposal: Fiscal Year 2014 Energy Storage Program, January 28, 2014. http://www.njcleanenergy.com/files/file/Renewable_Programs/Meeting%20Notes/Energy_Storage_Straw_Proposal012814.pdf

New Jersey Office of Clean Energy (NJOCE). 2014b. Stakeholder Comments on Energy Storage Program Straw Proposal, compiled February 27, 2014. http://www.njcleanenergy.com/files/file/public_comments/Fiscal%20Year%202014%20Energy%20Storage%20Program.pdf

New York Generation Tracking System (NYGATS). 2016. Operating Rules, version 1.0. http://www.nyserda.ny.gov/All-Programs/Programs/NYGATS/Registration-Documents

New York PSC. 2015. CASE 14-M-0101 – Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision. New York State Public Service Commission. http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7b0B599D87-445B-4197-9815-24C27623A6A0%7d

NYPrize. 2016. New York Prize Community Grid Competition. http://www.nyserda.ny.gov/All-Programs/Programs/NY-Prize

Oregon, 2015. Enrolled House Bill 2193. 78th Oregon Legislative Assembly. https://olis.leg.state.or.us/liz/2015R1/Downloads/MeasureDocument/HB2193

Rocky Mountain Institute. 2014. The Economics of Grid Defection. http://www.rmi.org/electricity_grid_defection

Sanders, Robert, and Lewis Milford. 2014. Clean Energy for Resilient Communities: Expanding Solar Generation in Baltimore's Low-Income Neighborhoods. Clean Energy Group, February. http://www.cleanegroup.org/assets/Uploads/2014-Files/Clean-Energy-for-Resilient-Communities-Report-Feb2014.pdf

St. John, Jeff. 2013. "Puerto Rico Mandates Energy Storage in Green Power Mix," *GreenTech Media*, December 27, 2013. http://www.greentechmedia.com/articles/read/puerto-rico-mandates-energy-storage-in-green-power-mix

St. John, Jeff. 2014a. "New York Plans $40M in Prizes for Storm-Resilient Microgrids," *GreenTech Media*. January 9, 2014. http://www.greentechmedia.com/articles/read/new-york-plans-40m-in-prizes-for-storm-resilient-microgrids

St. John, Jeff. 2014b. "A Vanadium Flow Battery Brings Energy Storage to New York City's MTA," *GreenTech Grid*. April 23, 2014. http://www.greentechmedia.com/articles/read/A-Vanadium-Flow-Battery-Brings-Energy-Storage-to-New-York-Citys-MTA

U.S. Department of Energy. 2013. *Grid Energy Storage*, December 2013. http://energy.gov/sites/prod/files/2013/12/f5/Grid%20Energy%20Storage%20December%202013.pdf

U.S. Energy Information Administration (EIA). 2011. "Electricity Storage Technologies Can Be Used for Energy Management and Power Quality." *Today in Energy*, December 14, 2011. http://www.eia.gov/todayinenergy/detail.cfm?id=4310

U. S. Energy Information Administration (EIA). 2013. "Pumped Storage Provides Grid Reliability Even with Net Generation Loss." *Today in Energy*, July 8, 2013. http://www.eia.gov/todayinenergy/detail.cfm?id=11991

U. S. Federal Energy Regulatory Commission (FERC). 2013. 18 CFR Parts 35, 101 and 141 [Order No. 784], Third-Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies, July 18, 2013. https://www.ferc.gov/whats-new/comm-meet/2013/071813/E-22.pdf

U.S. Federal Energy Regulatory Commission (FERC). 2016. Federal Energy Regulatory Commission, April 21, 2016 Open Commission Meeting, Staff Presentation Item A-4. http://www.ferc.gov/CalendarFiles/20160421110616-A-4-Presentation.pdf

U.S. Internal Revenue Service (IRS). 2012. Private Letter Ruling PLR-121432-12, November 20, 2012. https://www.irs.gov/pub/irs-wd/1308005.pdf

U.S. Senate Committee on Energy and Natural Resources. 2013. "Senators Introduce Bipartisan Energy Storage Bill to Encourage Renewable Power," May 24 2013. http://www.energy.senate.gov/public/index.cfm/democratic-news?ID=de6b4c62-e987-4ba9-933b-d52f82ff0309

Washington. 2013. House Bill 1289. http://apps.leg.wa.gov/billinfo/summary.aspx?year=2013&bill=1289#history

Washington. 2013-2015. Clean Energy Fund 1. http://www.commerce.wa.gov/Programs/Energy/Office/Pages/Clean-Energy-Fund-1.aspx

Wang, Ucilia. 2014. "Here Comes a 'Flow Battery' Technology and a $20M Plan to Bring It to Market," *Forbes* Online, February 2, 2014. http://www.forbes.com/sites/uciliawang/2014/02/04/here-comes-a-flow-battery-technology-and-a-20m-plan-to-bring-it-to-market/

Wesoff, Eric. 2013. "FERC's Energy Storage Ruling Could Jump-Start Big Batteries." *Green Tech Media*, August 12, 2013. http://www.greentechmedia.com/articles/read/FERCs-Energy-Storage-Ruling-Could-Jump-Start-Big-Batteries

Wilkinson, Sam. 2014. "The Grid-Connected Energy Storage Market Is Set to Explode, Reaching a Total of over 40 GW of Installations by 2022," *IHS Technology*, January 15, 2014. https://technology.ihs.com/483008/the-grid-connected-energy-storage-market-is-set-to-explode-reaching-a-total-of-over-40-gw-of-installations-by-2022

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The Clean Energy States Alliance (CESA) is a national, nonprofit coalition of public agencies and organizations working together to advance clean energy. CESA members—mostly state agencies—include many of the most innovative, successful, and influential public funders of clean energy initiatives in the country.

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ABOUT THE RPS COLLABORATIVE

The RPS Collaborative, managed by the Clean Energy States Alliance, serves as a forum for the exchange of experiences and lessons learned regarding the implementation of state Renewable Portfolio Standard (RPS) policies. It was established to advance dialogue and cooperation among a broad network of state and federal government officials, renewable energy certificate tracking system administrators, NGO experts, industry representatives, and other stakeholders. It is supported by the U.S. Department of Energy and the Energy Foundation.

The RPS Collaborative offers a free monthly newsletter, regular webinars, reports, an annual National Summit on RPS, and opportunities for information exchange.

For more information see http://www.cesa.org/projects/state-federal-rps-collaborative/.