DOES ENERGY STORAGE FIT IN AN RPS?

Prepared for the

State-Federal RPS Collaborative

by

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About This Report

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Disclaimer

Introduction

Hardly a day passes without a news item or blog entry about energy storage, 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 (USDOE 2013; RMI 2014; Morgan Stanley 2014; Wilkinson 2014).

Regulators are likewise paying attention. The Federal Energy Regulatory Commission (FERC) has taken steps to recognize the benefits of storage. In 2013, FERC issued Order 784, which revises regulations affect-ting ancillary service markets in ways that should favor energy storage. Specifically, FERC ordered that pay-for-performance tariffs adopted by public utility transmission providers take into account speed and accuracy in determining reserve requirements for regulation and frequency response services. This should make battery and flywheel storage more attractive, for example. FERC also adopted new accounting and reporting rules that will help utilities achieve cost recovery for storage equipment in rates (FERC 2013; Wesoff 2013).[1]

Policymakers have also taken notice. For example, Sen. Ron Wyden (D-OR) introduced S.1030, the Storage Technology for Renewable and Green Energy Act of 2013, which would have amended the Internal Revenue Code to benefit energy storage.[2] As the full name of this bill suggests, storage is often discussed in conjunction with the increasing penetration of variable renewable energy resources connected to the electric grid, or for that matter coupled with customer-sited distributed generation. States, which have taken the lead in promoting clean energy through Renewable Portfolio Standards (RPS), may look to increase the value of renewable energy by adopting policies encouraging energy storage. Although there are several ways they 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 explores that question, and in so doing, assesses alternative ways to encourage storage as well. The paper attempts to stimulate thinking by posing a series of questions that policymakers and regulators should consider.

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[1] For a summary of the FERC orders, see Sanders and Milford (2014). Some FERC orders and decisions are the subject of court cases whose outcomes could influence the extent to which new markets for storage develop.

[2] The STORAGE 2013 Act would have amended the Internal Revenue Code to: (1) allow, through 2020, a 20% energy tax credit for investment in energy storage property that is directly connected to the electrical grid and that is designed to receive, store, and convert energy to electricity, deliver it for sale, or use such energy to provide improved reliability or economic benefits to the grid; (2) make such property eligible for new clean renewable energy bond financing; (3) allow a 30% energy tax credit for investment in energy storage property used at the site of energy storage; and (4) allow a 30% nonbusiness energy property tax credit for the installation of energy storage equipment in a principal residence (CRS 2013).

Energy Storage and RPS - Questions States Should Ask Themselves

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 promote energy storage.

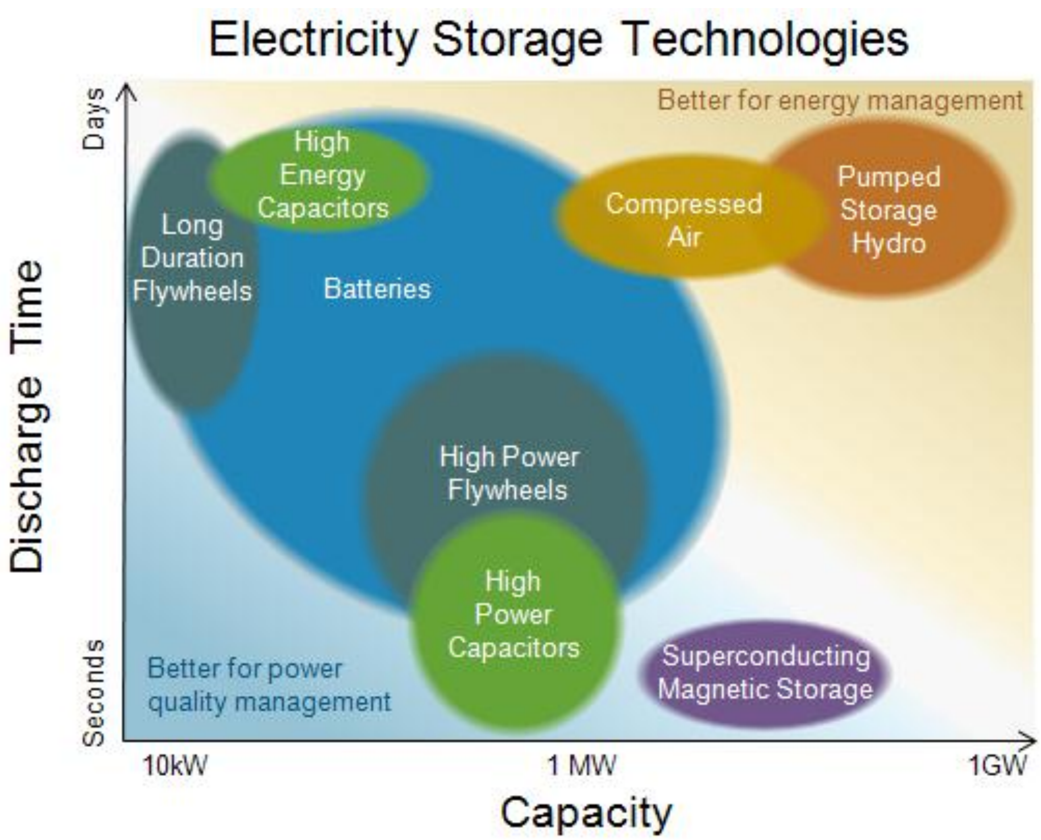
Further, there are many examples of states using RPS policies to promote goals other than simply establishing an overall renewable energy target. For example, some RPS statutes encourage distributed generation by creating special targets for solar energy or customer-sited renewable generation. Others encourage certain technologies by providing credit multipliers favoring those technologies. So it would not be unprecedented to use an RPS to promote 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. **Electricity Storage Technologies**



Source: U.S. EIA 2011

Some possible objectives for energy storage include:

- Shift renewable generation to more closely match peak loads.
- 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.

The objectives identified don't necessarily demand a particular policy response. For those objectives that can be met using storage that is not dependent on renewable energy, a policy other than an RPS may be appropriate. Others point to a renewable energy linkage, but still, several different approaches could achieve the objective(s). States may even question whether they need to do anything to encourage storage. Simply requiring higher RPS targets puts the 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. Nevertheless, it is a good idea for states to articulate their policy objectives clearly.

Which storage technologies are eligible?

If states determine eligibility for an RPS by defining eligible technologies, they should consider batteries, compressed air, flywheels, pumped hydro, hydrogen, and perhaps other technologies as well.[3]

Alternatively, eligibility could focus on storage performance characteristics, such as minimum or maximum capacity, minimum duration the 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.

The configuration of the storage relative to the energy source may also be an important eligibility criterion. States may want to specify whether storage must be co-located or integrated with specific generation, or can stand alone on the grid. If the policy objective relates to renewable energy generation and storage, then the state should specify that the storage must have a direct connection to the generating source—otherwise it could be difficult to determine if storage is really supporting renewable energy. In this case, an RPS may be an appropriate vehicle to promote storage. On the other hand, if the

[3] 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.

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.[4]

Who should be responsible?

If policymakers want to encourage storage, they should think about who would be responsible for planning and implementing storage projects. A PJM executive has suggested four options (Glazer 2013):

A. Generators "partner" with storage devices and bid the total product into the market. In response to the market that FERC is trying to create, project developers could specify new projects that combine both generation and storage as a package. The package would provide greater value and be compensated by the tariffs resulting from the FERC order.

B. Transmission planners order strategically placed energy storage devices. Just as transmission system operators now assess reliability and approve transmission upgrades, they could incorporate storage as another tool in their toolkit to increase system reliability. They would be in a position to specify the locations most needing storage.

C. Customers use energy storage to meet their own reliability needs, and use it to bid demand response into the market. The focus here is on distributed generation, and key to its success would be the ability or willingness of the customer to program an automatic response to system operator signals or to provide remote control to a control center.

D. States mandate storage through integrated resource planning (IRP). State regulators could require that jurisdictional utilities plan for storage as part of an IRP process.[5]

What's interesting about this list is that none of the options contemplate RPS as an implementation mechanism. Nevertheless, the last option, involving utilities and IRP, could conceivably extend into mandates on utilities, at least in traditionally regulated states. If Options A, B or C are seen as most appropriate, then an RPS with the obligation falling on utilities, is probably not a good vehicle for planning and implementing storage because the actors—generators, transmission planners and customers—are not regulated by state utility commissions.

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

[4] 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.

[5] IRP may not be effective in restructured states, where regulated utilities and generation are separate businesses, utilities may be prohibited from owning generation, or where competitive electricity providers do not perform long-term resource planning.

states could provide financial incentives in conjunction with a mandatory RPS, just as some 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).

Several different state approaches to energy storage are summarized below. Although California and Puerto Rico have adopted mandates, neither has done so as part of its RPS, but storage output may be used to comply with California's RPS. New Jersey is close to adopting an incentive program, also separate from the RPS, and Hawaii utilities are pursuing incentive payments as well. Connecticut and New York are focusing on microgrids—which may or may not include storage—to protect critical infrastructure, and Maryland has recently issued a report indicating that it, too, will focus on microgrids. Massachusetts has issued a resilient power solicitation for which microgrids, energy storage, and other technologies are eligible.

California storage mandate

Based on state law (AB 2514), the California Public Utilities Commission (CPUC) established a mandate on investor-owned utilities to integrate 1.3 gigawatt (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% of its target capacity. Customer or third-party owned storage for the remaining capacity will be procured by competitive solicitation.

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% 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 storage targets are separate from the 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).

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 a Renewable Portfolio Standard requiring 20% 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)

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, but rather the Hawaii Public Utilities Commission 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 recently responded by issuing a request for proposals for large-scale energy storage projects 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. The project(s) must be in service by the first quarter of 2017.

HECO says it needs energy storage because wind and solar power generation has grown dramatically. More than 11 percent of Hawaiian Electric 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 the storage projects being requested 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 (OCE) is developing a proposed energy storage program for recommendation to the Board of Public Utilities in 2014. Program priorities include:

- 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

OCE created an Energy Storage Stakeholder Working Group in 2013. In January 2014, OCE issued a straw proposal (NJOCE 2014a). For purposes of load shifting or emergency backup, the straw proposal calls for the storage system to provide the host facility's full electric demand for a minimum of one hour and a maximum of four hours.

Rather than specify amounts of storage provided by different market actors, the proposed program will be based on competitive solicitations and award of financial incentives. To ensure the widest and most equitable distribution of funds, the proposal would establish maximum incentive amounts. Applicants will request only the minimum incentive required for their projects, and no greater than $500,000 per project or 30% of the project's total installed cost after deducting any other incentives, whichever is less.

If the program is adopted as currently proposed, energy storage projects approved by the state would be limited to those that are integrated with renewable energy systems. The proposal also stipulates that storage devices may not be charged by electricity imported from the distribution system or generated by on-site fossil fueled generators, but this proposed requirement received a lot of comment from stakeholders. For example, stakeholders argued that the proposal would prevent storage from charging at night and discharging during the day, eliminate the opportunity to provide frequency regulation, create unnecessary engineering complexity and cost, limit return on investment, and diminish the value of storage as a grid buffering asset. Instead, they urged OCE to allow the storage device to draw energy from the grid in times of low energy value and feed back to the grid when energy is most needed, lowering peak demand that is expensive to serve and increasing cost-effectiveness (NJOCE 2014b).

The OCE will consider these comments and recommend a solicitation to the Board of Public Utilities.

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 Department of Energy and Environmental Protection (DEEP) to establish a $45 million microgrid grant and loan pilot program to support local distributed energy generation for critical facilities. DEEP issued a request for proposals from municipalities, utilities and private entities to develop microgrid distributed energy generation to support critical facilities, and awarded a total of $18 million to nine microgrid projects (Magill 2013). Connecticut is now receiving new project proposals in the second of three planned solicitations under the microgrids program. In this second round RFP, the state has elected to require that renewable generation be paired with energy storage in order to be counted toward the microgrid's generating capacity; and proposals that include renewable generators will receive a bonus in scoring relative to proposals that do not include renewables.

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. As currently contemplated, the offer will be a competition intended to stimulate at least ten independent, community-based electric distributions systems across the state. During emergencies, the microgrids will be able to disconnect from the grid and power themselves, providing islands of stable power for hospitals, police department, fire stations, gas stations and other critical systems (St. John 2014a).

Massachusetts Community Clean Energy Resiliency Initiative

As part of the state's comprehensive climate change preparedness effort, the Massachusetts Department of Energy Resources (DOER) has dedicated $40 million over two RFPs for resilient power projects, including those employing energy storage. The solicitation also includes a $200,000 set-aside for technical assistance to communities that need help in designing a project. Project implementation awards are capped at $5 million per project (Mass. EEA 2014).

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. DOER expects to announce the winners of the first round solicitation in August, 2014.

Is storage a generation or distribution asset?

There are important implications of defining storage one way or the other. 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. 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 if utilities might be prohibited from owning storage, they could presumably still satisfy an RPS goal by purchasing storage services.

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.

How should progress 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,[6] 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.

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

California Net Metering and Storage

The California Public Utilities Commission's 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 issued a proposed decision that renewable generation plus storage is eligible for net metering, without any extra utility fees or studies, if they meet certain requirements (CPUC 2014). For systems over 10 kW, the storage component would have to be smaller than the net metering-eligible generator. Systems larger than 10 kW will also require a separate meter (capped at $500 cost) for the purpose of metering renewable energy separately from non-renewable energy.

Systems less than 10 kW capacity would not be subject to the sizing restriction. These small systems could also rely on the local data acquisition system instead of a utility-grade meter to measure the energy drawn from the grid to charge the storage device. The amount drawn from the grid would be used to de-rate, or reduce, the annual excess generation eligible for net metering credit (St. John 2014b; CPUC 2014).

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 discharges a portion of the energy used as input to storage.

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.

Any storage: California, Kansas, and Montana accept any storage technology if it stores energy from an eligible renewable energy resource.[7] 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 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.[8] 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

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[7] 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.

[8] 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.

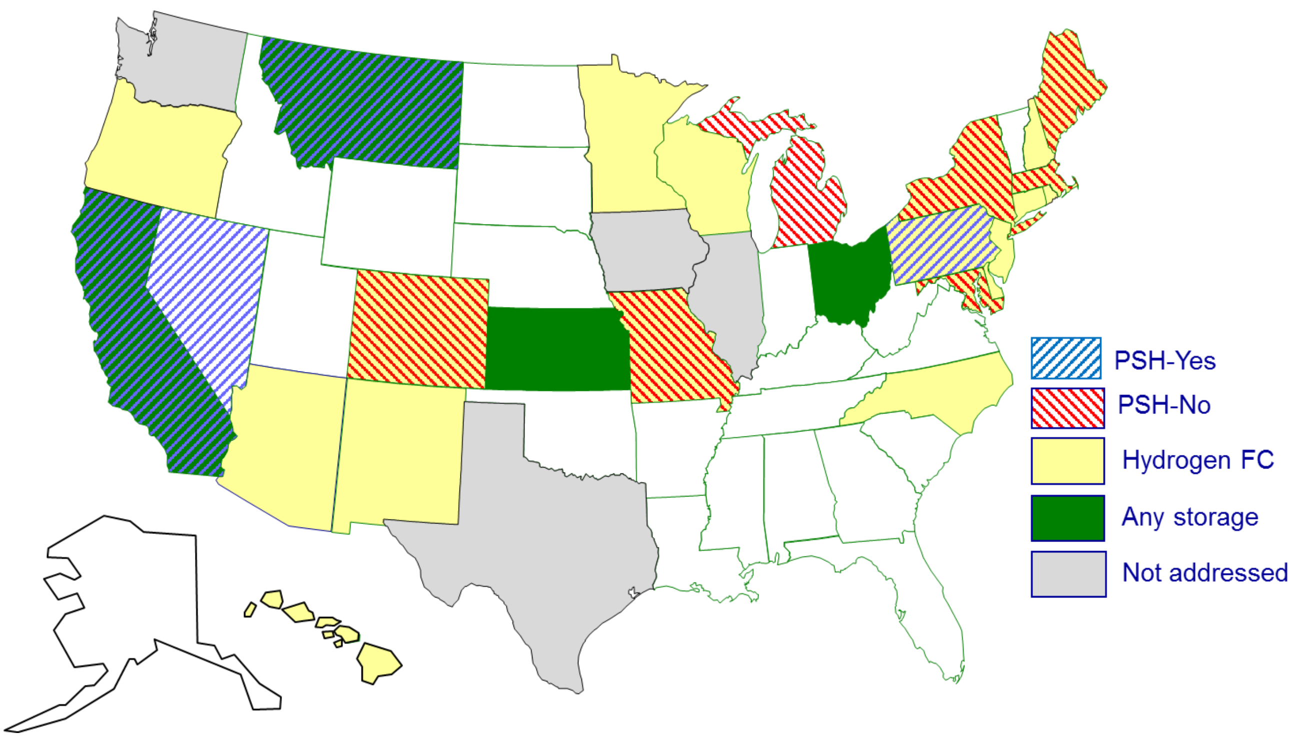
refer to fuel cell eligibility rather than hydrogen eligibility, but hydrogen is the storage medium, while a fuel cell is the conversion technology. The states that require renewable energy resources are Arizona, California, Colorado, Delaware, District of Columbia, Hawaii, Kansas, Maryland, Massachusetts, 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.

Figure 2. **Storage in State RPS**



Source: Database of State Incentives for Renewables and Energy Efficiency

Tracking System Treatment

States may decide whether or 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.[9]

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 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, the GIS will create certificates for flywheel energy storage output, which is eligible for the Massachusetts Alternative Energy Portfolio Standard, 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 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.

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

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

residual mix attributes to the energy consumed by the device (the GIS and 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.

Illustration of GIS and 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

- 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.

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 Implications

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.

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

1) Within an RPS—and many states already have limited examples of storage in their RPS;
2) As a mandate separate from the RPS (the California and Puerto Rico examples); and
3) As a financial incentive program (the New Jersey, Hawaii, Connecticut 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.
- 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 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.

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), as well as payments for ancillary services on the wholesale market as required by FERC.
- 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) or by performance-based subsidies. In deciding 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).

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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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The State-Federal RPS Collaborative, mangaed 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 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/.