Clean Energy States Alliance

USING STATE RPSs TO PROMOTE RESILIENT POWER AT CRITICAL INFRASTRUCTURE FACILITIES

by

Todd Olinsky-Paul

Project Director

Clean Energy States Alliance

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Disclaimer

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Abstract

Recent severe storms have resulted in electric grid failures in the U.S. In many cases, the provision of emergency services to the public has been hindered by the loss of electric power; many critical facilities (facilities necessary for the provision of emergency services, such as medical facilities, police stations, gas stations, and community shelters) do not have emergency generators, and where they do exist, such generators are prone to failure. As a result of recent experience with storm-related electric grid damage, and predictions by climate scientists that extreme weather events will occur more frequently in the future, states are increasingly seeking ways to enhance energy resiliency at critical facilities (defined as the ability to self-supply electricity sufficient to provide critical services while the grid is down). The challenge is to find a mechanism by which states can promote and support critical facility energy resiliency projects. This paper explores whether renewable portfolio standards, which have been adopted by 29 states, the District of Columbia and Puerto Rico, could offer such a mechanism. By adopting appropriate incentives, definitions and safeguards, states could use their existing RPSs to support increased energy resiliency at critical facilities, while simultaneously promoting the increased deployment of clean energy resources.

Introduction

The need for critical infrastructure energy resiliency[1] measures is increasingly in the spotlight. In recent natural disasters, such as hurricane Irene, which knocked out electric power to 5.8 million people, and Superstorm Sandy, which left 8 million without power, the loss of critical services due to power outages has exacerbated the effects of the disaster and hindered aid efforts. If hospitals, gas stations, police stations, places of refuge, and other critical facilities were served by distributed generators capable of continuing to operate when the electric grid is down (i.e., islanding), they could continue to deliver essential services when and where they are most needed. This paper explores how state renewable portfolio standards (RPSs) could support deployment of clean energy resiliency technologies at critical facilities. It also provides existing examples of such state efforts, and discusses policy considerations.

The Need for Clean Energy Resiliency Technologies

Traditionally, critical facilities have relied on backup generators to ensure power availability, typically diesel generators (diesel gensets) consisting of a diesel engine, a generator, and starting and control systems. Hospitals, for example, are required by many states to have such backup generators. However, these generators too frequently fail when called upon. For example, during Superstorm Sandy, New York University Langone Medical Center was forced to evacuate all of its 215 patients due to the failure of backup generators. Patients at Palisades Medical Center in New Jersey and Bellevue Hospital in New York City were similarly evacuated when generators failed (Ornstein, 2012). These are merely the most recent examples in a long and painful history of hospital power outages.[2]

Repeatedly, backup generators, which sit idle most of the time, have proved less reliable than equipment that is in daily use (Koerth-Baker, 2012). The effects extend far beyond cost and inconvenience; in the case of hospitals, when the electricity goes out, people can suffer and even die unless moved to another facility immediately. The same may be true when other

[1] For the purposes of this paper, critical infrastructure energy resiliency is defined as the ability of facilities necessary for the provision of emergency services to self-supply electricity during grid outages. These facilities might include medical facilities, first-responder facilities, communications facilities, places of refuge, supermarkets, gas stations and other fuel distribution facilities, and other providers of critical or emergency services.

[2] Other recent examples include hospital generator failures in New Orleans after Hurricane Katrina; in San Diego during a blackout; and in Connecticut during Hurricane Irene (Ornstein, 2012). During the Northeastern U.S. black-out of 2003, several New York City hospitals suffered failures in their backup power generators (Levy and Zernike, 2003). In contrast, Montefiore Medical Center in New York City, and South Oaks Hospital in Amityville, New York, were able to continue operations by relying on their combined-heat-and-power systems. Also during the 2003 blackout, generator failures at Verizon offices caused communication gaps for 911 dispatchers attempting to relay emergency calls to ambulances (Grace, 2003).

critical services, such as emergency response, fuel supplies, and places of refuge, cannot be effectively provided due to power failure during a natural disaster or other emergency.

Calls for more reliable distributed generation and/or energy storage solutions at critical facilities are not new. Typically, these discussions take on an urgency in the aftermath of disasters and blackouts, only to fade in importance as conditions return to normal. However, the recent series of severe weather events on the east coast, coupled with predictions by climate scientists that such events will occur more frequently in the future, has sparked a higher level of concern. The northeastern states, in particular, have begun seeking ways to support the deployment of energy resilience technologies, such as microgrids and combined-heat-and-power (CHP), at critical facilities. Connecticut, for example, has initiated a $15 million microgrids initiative aimed at securing critical infrastructure against future grid outages, and New York State has announced $40 million in funding for large scale CHP projects capable of islanding during power outages, with bonus incentives for those projects serving critical infrastructure facilities. Unfortunately, many states do not have the resources for this type of initiative, and those with clean energy funds typically have committed those funds to supporting more conventional distributed renewable energy projects, such as rooftop solar and small- to medium-scale wind turbines (CESA, 2012). Without the addition of special switching equipment and energy storage resources, these renewables, even if placed at critical facilities, will not continue to supply electricity during a grid outage.

Background on RPSs

Renewable Portfolio Standards have been adopted by 29 states, the District of Columbia and Puerto Rico.

Because of their association with large-scale deployment of variable renewables, such as wind and solar technologies, RPSs are sometimes viewed as working counter to electricity grid resiliency goals. For example, a 2011 report for the Oregon Department of Energy includes this assessment of the challenges that higher penetrations of renewable energy might bring to grid operation:

> Oregon's RPS for future renewable resources will create new demands and challenges for ancillary services, especially in the areas of energy dispatch, voltage and frequency regulations, and hour-ahead forecasting. Over time, the increase in renewable resources is expected to be accompanied by a reduction in the dispatch, and possibly the commitment of conventional resources. Having fewer conventional resources on-line might create difficulties in maintaining voltage and frequency control. This condition is not unique to Oregon and is considered to be of concern in other states as well. (Beck, 2011)

But concerns such as these focus on a different sort of grid reliability issue than the one that arises from outages caused by natural disasters. There are significant differences between large, utility-scale renewable resources and smaller, facility or campus-scale renewable resources. The former, in the case of variable generators such as wind and solar, may at high penetration levels require modifications, for example, to grid operations. The latter, by contrast, can, if properly configured, provide power to critical facilities when the grid is impaired. Furthermore, dispatchable distributed generation (DG), or variable DG coupled with energy storage, can in some cases provide the ancillary services required for enhanced grid stability, as discussed in the Oregon report above.

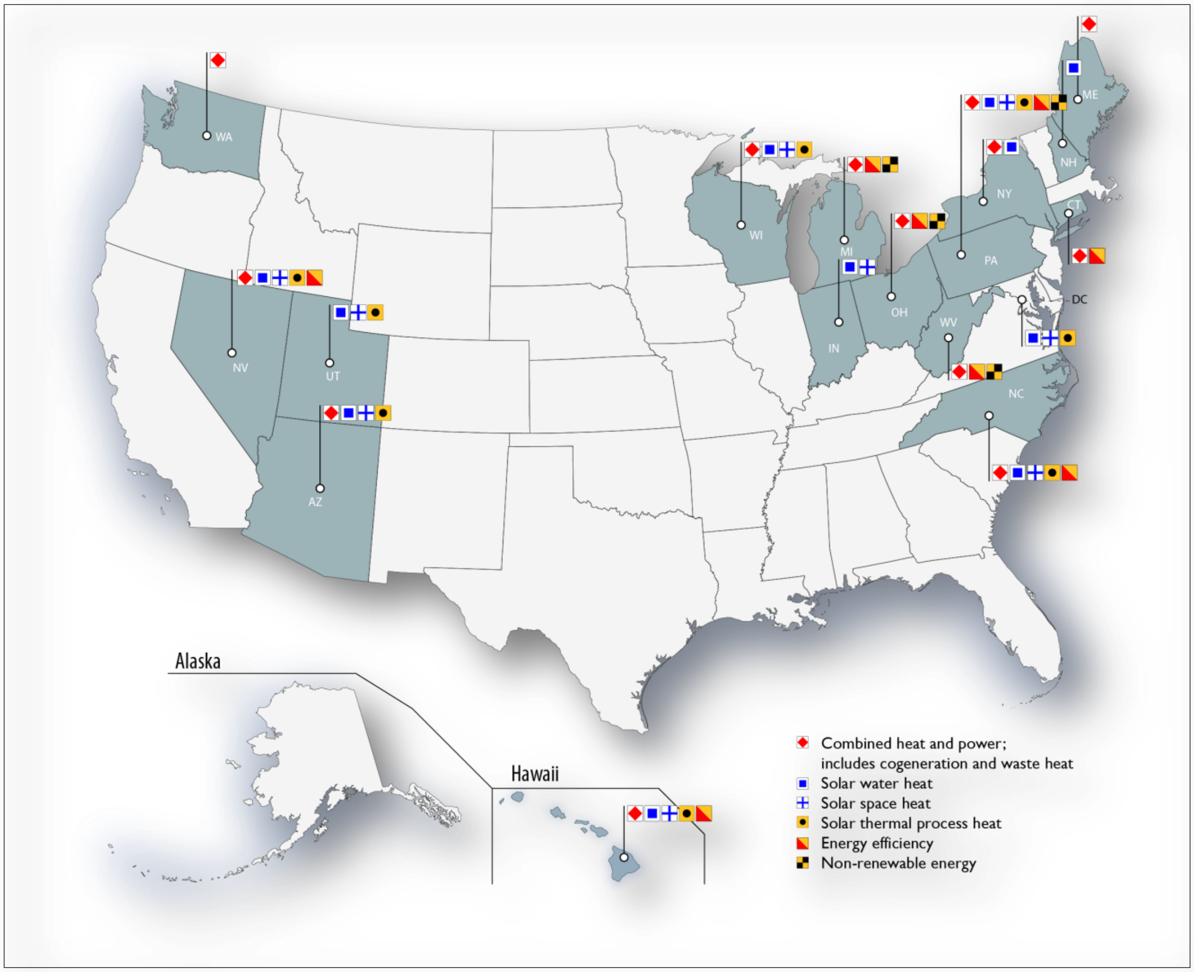
Basis for RPS Support of Alternative Energy Resources

Although state RPSs have traditionally been used primarily to support utility-scale renewable energy development, many states have incorporated an RPS tier for small, behind-the-meter (distributed) renewables that primarily serve a single facility or campus. Such systems often include residential and commercial scale solar PV, and small and medium scale wind turbines. Thus, there is precedent for the use of RPSs to support smaller distributed generation projects supporting a single facility or campus.

In addition, a significant number of state RPSs support “alternative” energy deployment, including energy efficiency and non-renewable electricity generation; and this alternative application for RPSs has increased. Four of the last six states to adopt RPSs included alternative energy resources as eligible technologies (Heeter and Bird, 2012).[3] Other states have expanded existing RPSs to include alternative energy resources (see Figure 1). These alternative energy resources can include renewable thermal (non electricity generating) resources such as solar and biomass thermal applications; energy efficiency resources such as geothermal and CHP; and technologies that use fuels that may not be considered entirely renewable or non-polluting, such as some biomass technologies. Because the inclusion of these technologies can displace renewables developed under an RPS, most states that include alternative energy technologies place a cap on the percentage of the total RPS that these technologies may account for.

[3] States use various names to describe energy portfolio standards that include alternative energy technologies. For the purposes of this report, clean energy standards and alternative energy portfolio standards are considered to fall into the broader category of RPSs. Some of the technologies discussed may also be supported by state energy efficiency resource standards (EERS) or portfolio standards (EEPS).

Figure 1: Alternative Energy Technologies Included in State RPSs



Source: Heeter and Bird, 2012

There is also precedent for states to use RPSs to promote various goals other than maximizing total renewable energy generation. For example, Colorado's RPS includes a 150% renewable energy credit (REC) multiplier for community-based renewable generation projects, defined as projects not greater than 30 MW in capacity that are "owned by individual residents of a community or by an organization or cooperative that is controlled by individual residents, or by a local government entity or tribal council." Michigan offers extra credits for non-wind renewable generation produced at peak demand times. West Virginia's RPS offers a credit multiplier for renewable energy generated by any facility sited on a reclaimed surface mine. New York's RPS includes a Geographic Balancing Program within its Customer Sited Tier, which provides added incentives for renewable generation deployed in specific areas of the state (RPS information from DSIRE.com). These examples illustrate a variety of social welfare goals that are promoted through state RPSs. In some cases, such as where credits are offered for peak generation, the goal is clearly related to the provision of energy. In other cases, states appear to be using their RPSs to support goals that are arguably outside the realm of energy provision, such as brownfield redevelopment.

Given these existing examples, it would appear that there is ample precedent for RPS incentives supporting the deployment of energy resiliency technologies at critical facilities, which would serve both an electricity provision purpose (continuing to provide electricity to select facilities during grid outages) and a social welfare purpose (ensuring that these facilities can continue to provide critical services to the public during grid outages).

Early Examples of States Supporting Critical Infrastructure Energy Resiliency

A few states have, on a small scale, supported the use of clean energy technologies for critical infrastructure energy resiliency, either within or outside of their RPSs. Some of these are very recently enacted programs, and therefore provide little program history. A summary table of these programs is provided below, with summaries for each state following.

Table 1: Summary Table of State Critical Infrastructure Resiliency Programs

STATE	PROGRAM	WITHIN RPS?	PROGRAM DATES	NUMBER OF KNOWN INSTAL-LATIONS	ELIGIBLE TECHNOLOGY	NOTES
New York	PON 2157 (and prior PON 1150)[4]	YES	PON 1150: 2007 – 2009 PON 2157: 2009 - 2015	PON 1150: 22 small fuel cells (cell tower appli-cations) PON 2157: 2 large fuel cells approved, 7 pending, and 6 in queue.	Fuel Cells	PON 1150 (closed) offered an incentive for both large and small fuel cells at critical sites. PON 2157 (open through 2015) offers a useful incentive for large fuel cells only.
New York	CHP Acceleration Program (PON 2568)	NO	2013 - 2016	None at this writing	CHP (up to 1.3 MW capacity)	

[4] NYSERDA solicitations are called "program opportunity notices" or PONs.

STATE	PROGRAM	WITHIN RPS?	PROGRAM DATES	NUMBER OF KNOWN INSTAL-LATIONS	ELIGIBLE TECHNOLOGY	NOTES
New York	CHP Performance Program (PON 2701)	NO	2013 - 2016	None at this writing	CHP (larger than 1.3 MW capacity)	
New York	CHP Demonstration Program	NO	2000 - 2011	26	CHP	
Pennsylvania	AEPS "Customer Generator"	YES	Definition added in 2007	1	Systems up to 5 MW capacity **Tier 1** technologies include solar PV, solar thermal, wind, low-impact hydro-power, geothermal, biologically derived methane (including landfill gas), fuel cells, biomass, coal mine methane, black liquor and large-scale hydro-power (certain restrictions apply). **Tier 2** technologies include waste coal, distributed gener-ation systems, demand-side management, large-scale hydropower, municipal solid waste, wood and wood pulp by-products, and integrated com-bined coal gasifi-cation technology.	Most eligible technologies will be smaller Tier 2 projects

STATE	PROGRAM	WITHIN RPS?	PROGRAM DATES	NUMBER OF KNOWN INSTAL-LATIONS	ELIGIBLE TECHNOLOGY	NOTES
Connecticut	Microgrid Grant and Loan Pilot Program	NO	2013 - 2014	None at this writing (RFP still open)	Any	Governor has proposed additional funding for another round of this program (budget not yet adopted at this writing).
New Jersey	CHP Portfolio Standard (draft proposal)	NO			CHP	This straw proposal would establish a CHP PS administered by NJ BPU; projects would be financed by loans from the state's natural gas utilities.

New York

The New York State Energy Research and Development Authority (NYSERDA) broadly defines critical infrastructure, in accordance with the definition used by the New York State Office of Emergency Management, as "[t]hose systems and assets essential to the functioning of society and the economy" (NYS OEM). NYSERDA, which administers both the state's RPS and its clean energy fund, has three relevant programs.

Within the RPS, NYSERDA's large fuel cell program offers an accelerated capacity incentive for fuel cells placed at critical facilities. PON 2157, within the Customer Sited Tier of the RPS, contains a bonus capacity payment of $500 per kW, up to $100,000 per project site[5], for

[5] Ordinarily, the NYSERDA fuel cell incentive is paid in installments. When the equipment is delivered, the first half of the capacity incentive is paid; when the system is commissioned, the second half of the capacity incentive, plus critical infrastructure bonus, if applicable, is paid; and the remaining portion of the incentive is distributed in three annual performance payments. Thus, the capacity incentive for critical infrastructure facilities doesn't necessarily enable a project to get more money, but it does give the project more money at commissioning, rather than during the performance phase. This could result in a larger overall incentive if performance fell short of expectations during the first three years, though this would be unusual for fuel cells.

“approved systems that provide secure power/standalone capability at sites of Essential Public Services, such as police stations and hospitals, or where the fuel cell system will be an integral part of a documented and verifiable ‘facility of refuge’.” The PON defines a facility of refuge as “a structure or facility capable of providing shelter for a significant portion of the local population during times of man-made or natural disaster, and is cooperating and coordinated with county or city emergency management officials, as appropriate.” The PON also includes a list of essential public services that may qualify for the bonus payment, including emergency services (emergency communication services, repeaters and communication infrastructure, police, fire services, ambulance/emergency medical services, emergency management services, facilities of refuge, emergency shelters and rest centers, and public utilities such as water, gas, and electricity); health care services (hospitals and managed care facilities); communication services (broadcasting/public information and telecommunications); food distribution/retail; and fuel distribution/retail. Determination of host site eligibility is at NYSERDA’s discretion. This PON remains open through December 31, 2015.

According to NYSERDA project manager Scott Larsen, the Large Fuel Cell program got off to a slow start, but at this writing is seeing a significant increase in activity. To date, two large fuel cell projects have been approved and installed: a 200 kW project at a Price Chopper supermarket, which has been granted the public service incentive; and a project at the Rochester Institute of Technology Institute for Sustainability, which will have the capability of running during a grid outage but did not apply for the public service incentive because the site was not intended to provide services to the general public (Larsen, 2013). The Large Fuel Cell program is fully subscribed, with a queue of projects awaiting additional funding. The pending applications are for telecommunications and grocery store applications; these projects are expected to have the technical ability to provide services during a grid outage (Larsen, 2013).

NYSERDA has also provided an incentive for approximately 22 small fuel cell projects sited at cell towers. These projects qualified for the capacity bonus under the fuel cell program’s prior iteration (PON 1150, issued in 2007). The projects were successful in that the cell towers provided with fuel cells continued to operate during Hurricane Irene and Superstorm Sandy. However, the bonus capacity incentive for small fuel cell projects was discontinued when the program was reissued in 2009 as PON 2157. Because the basic goal of the program is to provide renewable electricity, the capacity incentive for backup (small) systems was removed during the program’s midpoint review, and a requirement for a 50% capacity factor was instituted (meaning that to qualify for the program, a fuel cell would have to be designed to run at a minimum of 50% of its nameplate capacity). No applications for this incentive have been received since the capacity incentive was discontinued, since no small fuel cell manufacturers meeting the program requirement for continuous operation have applied. Large fuel cells, which are designed to run continuously, may still apply for the capacity payment as well as the performance payment (Larsen, 2013).

NYSERDA also administers two CHP programs with critical facility adders that are not in the RPS: The CHP Acceleration Program, and the CHP Performance Program. For these programs, the critical facility bonus payments are additional to the base incentive, not merely an acceleration of payments as in the fuel cell program.

1. The CHP Acceleration Program (PON 2568) offers a "Facility of Refuge Incentive Bonus of 10%" for small CHP systems up to 1.3 MW in capacity, placed at "sites that are official facility of refuge as recognized by the American Red Cross or the local Office of Emergency Management," where "the electric and thermal output of the CHP system benefits the portion of the building designated as such." The incentive is capped at $1.5 million per project.
2. The CHP Performance Program (PON 2701) for large CHP systems (greater than 1.3 MW) that provide summer on-peak demand reduction offers a similar bonus incentive of up to 10% (on a base incentive capped at $2,000,000) for projects serving critical infrastructure, including facilities of refuge. Critical Infrastructure is defined as "Energy, Financial Services, Communications, Data Center/Information Technology, Hospitals, Emergency Service Facilities, Food Distribution, Prisons, Chemical Industry and Hazardous Material, Water and Wastewater, Transportation, Dams, Critical Manufacturing, Defense Infrastructure, and Nuclear Reactors (Materials and Waste)." Facilities of Refuge are defined as those facilities recognized by the American Red Cross or the local Office of Emergency Management, where the electric and thermal outputs of the CHP unit benefit the portion of the building designated as such. Due to the recent history of backup generators flooding during storms, qualifying systems must have all critical components located above anticipated flood levels (NYSERDA PON 2701).

NYSERDA's CHP programs have pre-approved vendors, but the programs are very new and there are no approved projects yet, although a few applications have been received.

For both the fuel cell and the CHP programs, the critical infrastructure incentive was based on NYSERDA's prior experience with its 12-year CHP Demonstration program, which during its last eight years also offered a 10 percent incentive bonus for projects located at critical infrastructure facilities. Twenty-six projects out of more than 100 approved under the demonstration program are sited at critical infrastructure facilities. (Larsen, 2013; Kear, 2013).

Pennsylvania

The Pennsylvania Alternative Energy Portfolio Standards Act (73 PS §§ 1648.2 *et seq.*) defines "customer-generators" as non-residential customers with distributed generation systems having a nameplate capacity of not greater than 3 MW. However, this capacity cap increases to 5 MW "for customers … who make their systems available to operate in parallel with the electric utility during grid emergencies as defined by the regional transmission organization or where a microgrid is in place for the primary or secondary purpose of maintaining critical infrastructure, such as homeland security assignments, emergency services facilities, hospitals, traffic signals, wastewater treatment plants or telecommunications facilities" (DSIRE.org). This definition was added to the legislation in 2007 (Clark, 2013).

Only a single customer-generator project has been approved under the Pennsylvania AEPS: a 5 MW co-generation (CHP) and ice storage project at Duquesne University. A consultant to the AEPS believes other projects that could have qualified under the AEPS did not apply, because the compliance market value of the RECs they could generate would be much less than that generated by the relatively large Duquesne University project, and because of a perception that the application process is difficult and time-consuming.

Connecticut

Connecticut Department of Energy and Environmental Protection (CT DEEP) has initiated a Microgrid Grant and Loan Pilot Program. While not within the state's RPS, the $15 million program has released an RFP with the intention of funding the development of several microgrids supporting critical facilities. Eligible proposals must "support the identified critical facilities during times of electricity grid outages…. be able to continuously operate for a minimum of four weeks with its combined generation resources….include access to uninterruptable fuel resources either on site or delivered for a minimum of two weeks and present a plan to secure additional fuel resources beyond two weeks as part of storm preparation and management" (CT DEEP). Awards are capped at a maximum of $3 million per project. At this writing, CT DEEP is accepting proposals from pre-screened applicants. The eligibility requirements did not stipulate that proposed projects incorporate clean energy technologies, with the result that a large number of proposals featured traditional diesel- and natural gas-fueled generators. However, the DEEP has stated that the use of clean and renewable generation will be given significant weight in funding decisions (Szczerkowski, 2013).

New Jersey

At this writing, the New Jersey Board of Public Utilities is considering a draft proposal for a "smart" (market-responsive) CHP portfolio standard that would include financing for a "CHP storm response program for critical public facilities." The draft proposal defines a critical public facility as "a public facility that could operate 24/7 and either temporarily or long term house, feed and shelter evacuated victims from an emergency such as super storm Sandy." (New Jersey, 2013)

The CHP portfolio standard would be outside of the existing RPS, but would rely on the state's energy efficiency portfolio standard for its authority, as financing for CHP development would be "through the EEPS obligation on the natural gas utilities" (New Jersey, 2013). Essentially, the financing method would be on-bill financing, with natural gas utilities loaning money to CHP project developers (Johnson, 2013). A portion of the loans would be paid back to the utilities and ratepayers from CHP energy savings, and another portion would be forgiven based on system performance over time.

The CHP PS "would be a dynamic standard that responds and changes based on market conditions…. Basically it would respond to market demand, overall system costs, overall environmental and energy benefits and overall economic condition to a cap and down to a floor" (New Jersey, 2013). Essentially, the New Jersey Board of Public Utilities would regulate the market, mandating more or less CHP procurement as appropriate under prevailing market conditions. According to the straw proposal, "[b]asically this process of a more directly managed CHP PS would minimize or eliminate the vertical demand curve that impacts the RPS competitive markets in New Jersey" (New Jersey, 2013).

Other potential sources of funding for CHP development, such as the state's systems benefit charge and bond financing, are also being considered (New Jersey, 2013).

Policy Considerations

Despite the relative lack of specific critical infrastructure energy resiliency program experience among states, there is significant related experience with RPS carve-outs, adders, and credit multipliers associated with the state programs discussed above, as well as with various state renewables incentives such as solar renewable energy certificates (SRECs) and other technology-specific carve-outs. Based on this collective experience, a state wishing to support energy resiliency deployment at critical infrastructure would likely need to consider a number of policy decisions, including:

1. Defining qualifying critical facilities or services to be supported
2. Defining to what degree a qualifying project would be required to involve RPS-eligible renewables, and what portions of such projects would qualify for credits or other incentives
3. Ensuring that qualifying projects would be able to island during a grid outage
4. Ensuring that qualifying projects would have sufficient storage and/or generation capacity to self-sustain for a predetermined number of hours, days or weeks during a grid outage

5. Placing a ceiling on the number of qualifying projects, or on the percentage of the relevant RPS tier that could be satisfied by such projects, to avoid significantly reducing deployment of other renewable resources
6. Appropriately valuing critical facility resiliency, and creating effective adders or credit multipliers to reflect this value

These policy considerations are addressed below.

1. Defining qualifying critical facilities or services to be supported

NYSERDA funded a study of CHP for critical infrastructure resiliency in New York State (NYSERDA, 2009).[6] The resulting report identified four critical end-use sectors to be maintained in an emergency (human impact, economic impact, impact on public confidence or psychological consequences, and impact on government continuity) and six primary market sectors that are compatible with CHP technologies (hospitals, water treatment and sanitary facilities, nursing homes, food processing and food sales facilities, prisons, and places of refuge). The study additionally identified seven secondary market sectors that offer significant potential contributions to community resiliency but do not have strong technical potential for CHP (gas stations, mass transit, fire protection, police, telecommunications, banking and finance, and refrigerated warehouses). (NYSERDA, 2009) This list, combined with the sectors and criteria identified in the existing state efforts discussed above, provides a starting point for similar efforts to define critical facilities and services in other states. Additional criteria may be found in disaster preparedness documents and legislation prepared by other states, for example, in 2009, Texas passed two energy security bills including critical facilities lists (Texas, 2009a and 2009b).

2. Defining to what degree a qualifying project would be required to involve RPS-eligible renewables, and what portions of such projects would qualify for credits or other incentives

Many types of equipment that can achieve the dispatchability and islanding requirements of energy resiliency would not qualify under most current RPSs. For example, in many states, CHP does not meet RPS eligibility criteria unless it is biomass-based; but in most urban and suburban areas, it is easier to implement CHP projects fueled with natural gas. Similarly, for an installation of PV with battery backup, only the PV portion of the project would qualify in most states. Specific language would need to be added to define PV-powered batteries as a qualifying alternative energy technology.

3. Ensuring that qualifying projects would be able to island during a grid outage

Utilities have generally been cautious about approving connections with islandable

[6] The author was a contributor to this study.

(synchronous) distributed generators, due in part to concerns about the safety of utility line repair personnel who could be harmed should a distributed generator begin feeding electricity back onto a grid during a power outage. IEEE Standard 1547-2003 provides settings and connectivity requirements that address this issue. In some cases, utilities may require more stringent protective equipment and standards than provided in this standard (for example, see Con Ed's webpage on synchronous generation, at http://www.coned.com/dg/configurations/synchronous.asp). Furthermore, utilities may need to install fault mitigation equipment before allowing interconnection of synchronous generators (see Con Ed's page on system fault current limitations, at http://www.coned.com/dg/configurations/synFaultLimitations.asp, and maps of synchronous generation placement availability by region, at http://www.coned.com/dg/configurations/maps.asp). Before establishing islandable critical infrastructure energy resiliency incentives, state RPS administrators should discuss these issues with utility representatives. Synchronous generators, proper switchgear and other necessary equipment, and appropriate capacity (sized to handle critical load) should be specified when defining eligible systems. In supporting specific projects, it may be helpful for RPS administrators to broker communications between project developers and the local utility.

4. Ensuring that qualifying projects would have sufficient storage and/or generation capacity to self-sustain for a predetermined number of hours, days or weeks during a grid outage

The full value of energy resiliency projects at critical facilities will only be realized if those facilities are energy self-sustaining for a significant period of time. That period may need to differ for different technologies and applications. RPS administrators may wish to consult with state emergency management offices and agencies when defining these criteria.

5. Placing a ceiling on the number of qualifying projects, or on the percentage of the relevant RPS tier that could be satisfied by such projects, to avoid significantly reducing deployment of other renewable resources

When adding alternative energy resources to an RPS, the question arises of whether deployment of qualifying alternative resources could displace deployment of renewable resources. For this reason, states generally cap the amount of various types of alternative resources that can contribute to the RPS. In some cases, such as energy efficiency, these caps are commonly reached, while in other cases, such as thermal resources, deployment of the alternative resource has been relatively modest in most states (Heeter and Bird, 2012). It is unlikely that energy resiliency projects would displace a significant amount of renewable energy development, due to the numerous criteria energy resiliency projects must meet, the limited number of qualifying critical facilities, the cost of the equipment, and the fact that critical infrastructure energy resiliency services remain largely uncompensated by existing markets, aside from any additional incentives provided by the state.

However, capping the contribution of such projects to the RPS would likely not impede their deployment and could serve to allay concerns about the potential reduction of renewables development.

6. Appropriately valuing critical facility resiliency, and creating effective adders or credit multipliers to reflect this value

If critical facility resiliency is incentivized through renewable energy certificates (RECs), an RPS would likely need to value resiliency RECs at a relatively high multiple of the value of generic RECs in order to have much impact on project finances (and this may be appropriate, given the added value to the community of such projects). In some cases, RPS incentives might work best if paired with grants or financing from a state's clean energy fund and/or office of disaster preparedness. Creating a separate tier within the RPS for critical infrastructure projects could be helpful.

Projects may also be able to generate an income stream from the sale of services to the grid. FERC Order 755 (issued October 20, 2011) requires that distributed generators and energy storage providers be fairly compensated for capacity and frequency regulation services provided to transmission grids (FERC, 2011); however, different ISOs and RTOs have established different dates for compliance with this order, so that implementation of FERC 755 is taking place at different times in different service areas. At this writing, ISONE's proposed implementation date of January, 2014 was the latest.

The size range of critical facility energy resiliency projects can be quite large, with a correspondingly large range in the value of RECs that might be generated from these projects. For example, the earlier referenced 5 MW CHP project at Duquesne University provides around 80% of the campus electric load, or about 32,000 MWhs annually, as well as its heating needs. At a 2007 average market price of $1.37 per credit, the university expects to earn approximately $43,840 when it sells its credits. The university is also realizing considerable energy cost savings by generating the majority of its electricity and heat on-site using a highly efficient system. However, a smaller project using a different set of technologies might generate few RECs and less on-site energy cost savings, despite providing an equally important critical facility resiliency service. For example, a gas station or fuel distribution facility that installed solar PV with a battery for energy storage would likely be far smaller in capacity, would generate a smaller fraction of its nameplate rating, and would not be able to realize the added heating cost reduction benefits offered by the campus-wide CHP system. In this case the value of the RECs earned would be relatively small.

The value of RECs in the Pennsylvania AEPS is determined in part by the technology used to generate them. Tier 1 technologies include solar PV, solar thermal, wind, low-impact hydropower, geothermal, biologically derived methane (including landfill gas), fuel cells, biomass, coal mine methane, black liquor and large-scale hydropower (certain restrictions apply). Tier 2 technologies include waste coal, distributed generation systems, demand-side management, large-scale hydropower, municipal solid waste, wood and wood pulp byproducts, and integrated combined coal gasification technology. The 2012 weighted average price for Tier 1 RECs is $5.23, while the weighted average price for Tier 2 RECs is $0.17. This pricing scheme reflects the state's goal to promote clean, renewable electricity generating technologies (Tier 1) over less clean and renewable electricity generating technologies and thermal technologies (Tier 2).

According to a consultant to the PA PUC, most clean energy projects that could contribute to critical infrastructure resiliency will not be able to generate RECs of significant value under this two-tiered pricing system. This is because most such projects will tend to be small, thus generating few RECs; but also because these projects will likely fall into Tier 2, meaning the RECs generated will be worth very little (and may well be worth more on the voluntary market than in the compliance market). There are other barriers as well, including paperwork required by the PA AEPS, which is perceived by project developers to be out of proportion to the benefits offered. Under these circumstances, many developers don't bother to register projects with the AEPS.

Where such tiered REC prices are in effect, it may be useful to establish different critical infrastructure resiliency incentives for different technology tiers, in such a way that technologies ordinarily offered a lesser incentive receive a larger added incentive if they are providing critical infrastructure services.

Experience from NYSERDA's fuel cell and CHP programs indicates that a 10% additional incentive for locating qualifying technologies at critical facilities may be effective. However, the form the incentive takes is important. For larger projects, where the equipment is expected to run all the time, a performance-based incentive may be effective. For smaller projects or where equipment is designed to be used only during a grid outage, incentives should be based on capacity, since a performance-based incentive would be nearly valueless in this circumstance.

It is important to note that CHP technologies in particular tend to work best where a large heat load exists to capture the highest efficiencies of the CHP system. This includes campuses, industrial facilities, hospitals and urban areas where distributed heating can be implemented. Other technologies, such as fuel cells or PV systems with battery backup, may be more scalable for smaller facilities without a large thermal load, such as gas stations, fire stations, communications facilities and the like.

Conclusion

Limited program experience exists on which to base conclusions regarding the success of RPS programs in supporting and promoting the deployment of critical infrastructure energy resiliency technologies. Nevertheless, there is precedent for the use of RPSs for this purpose, and states have shown an interest in achieving energy resiliency outcomes. RPSs represent an existing structure that could be used to support such programs. It is likely that the type and size of incentives will need to be carefully tailored to the type and size of the technologies to be supported, in order to be successful; and for smaller projects especially, efforts should be made to keep transactional barriers low.

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50 State Street, Suite 1
Montpelier, VT 05602
Phone 802.223.2554
Fax 802.223.4967
Email cesa@cleanegroup.org
Web www.cleanenergystates.org