Sustainable Development Law & Policy

Volume 17 | Issue 2 Article 5

Batteries Included: Incentivizing Energy Storage

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Abstract

Distributed Energy Storage ("DES") technologies that allow households and businesses to store substantial amounts of electricity on site are rapidly advancing and could soon have dramatic impacts on the nation's electricity generation, transmission, and distribution markets. These technologies could provide numerous benefits, including enhanced energy security, grid stability, and greater support for renewable generation technologies, but several obstacles are slowing their adoption throughout the country. Among these obstacles are stubbornly high manufacturing costs and the potential impacts of DES development on utilities and the traditional energy regulatory framework. Fortunately, policymakers in California, New York, Hawaii, and some other states are beginning to proactively address these challenges through an innovative array of programs, consortiums, partnerships, and regulations designed to incentivize more widespread adoption of DES systems. This Article explores these states' approaches and offers suggestions for improving upon them to better incentivize DES development and clear the way for these important technologies to revolutionize electricity generation and distribution in the twenty-first century.

Introduction

Someday, in the not-too-distant future, household distributed energy storage ("DES") units may be as common in American homes as water heaters or washing machines. Homeowners will use these devices to store electricity that they purchase from the electric grid or generate from their own rooftop solar panels. During times of day when electricity demand is high and per-kilowatt-hour prices are elevated, such as in the evening when many utility customers are at home cooking dinner, those with DES systems will use energy stored on these systems rather than buying it from the grid. To encourage this practice, utilities will implement time-of-use pricing structures that more closely correlate the price of grid-supplied electricity to its true real-time cost based on supply and demand. Utilities may likewise allow customers to sell energy stored on their DES units back to the grid at different rates based on the time of day. When storms knock out power lines, the electricity stored in DES units will help to keep lights on and refrigerators running until full electricity service is restored.

Obviously, several advancements in technology and policy must occur and numerous obstacles must be overcome before this futuristic vision of DES can become reality. So what can policymakers do now to help accelerate the transition toward more distributed storage of electric power? This Article explores this complicated question and argues that many of the policy strategies that have successfully driven the impressive expansion of rooftop solar energy markets in recent years could serve a similar function in promoting the growth of DES. Part I of this Article provides background information on DES and its potential applications within businesses and homes. Part I also highlights some shortcomings of the existing United States electricity distribution system and describes how DES could help to address these shortcomings and provide additional economic and other benefits. Part II describes several current impediments to the widespread deployment of DES, including unit manufacturing costs, utility opposition, consumer reluctance, and environmental concerns. Part III examines recently-adopted policy strategies in New York, California, and Hawaii aimed at increasing the market penetration of DES and suggests that valuable lessons can be learned from these states and certain other countries' experiences in promoting new energy technologies. Part IV then offers specific policy proposals for hastening the development and deployment of DES in the coming years.

I. The Potential Power of DES

Energy storage technologies could someday play a critically important role in the United States electricity system. Arguably, no other area innovation has greater potential to make the nation's electricity grid more reliable, flexible, and cost effective. The array of impacts that energy storage, and particularly DES, could have on the nation's electric utilities is awe-inspiring and potentially more transformative than any other energy technology that has emerged in recent decades.

Energy storage technologies on a variety of scales can offer substantial value both on and off the grid.[1] For instance, companies are already beginning to build large scale energy storage projects with the goal of addressing grid-related problems. California's Tehachapi Wind Energy Storage Project, paid for by Southern California Edison Company and federal stimulus funds, features 32MWh of lithium-ion battery energy storage specifically designed to stabilize the grid and integrate renewables with the grid, among other objectives.[2]

DES products with higher capacities than home DES units but less storage capacities than utility-scale energy storage

* All three authors were Sustainability Law Student Research Fellows within the Program on Law and Sustainability at Arizona State University's Sandra Day O'Connor College of Law. This Article was researched and written under the supervision and guidance of Professor Troy A. Rule as part of the Sandra Day O'Connor College of Law's Sustainability Law Research Clusters project. The authors wish to thank other students working within the Clusters project for their invaluable input on early stages of this Article.

projects also have great potential as components of micro-grid systems. Micro-grids are comparatively small, self-sustained energy grids that have independent means of generation and transmission.[3] Energy systems on a growing number of military bases and university campuses make use of micro-grid technologies.[4] Micro-grids do not need to be connected to the larger grid system. Communities that install a micro-grid might plausibly be able to go "off-grid"—or disconnect from the larger national grid system—if they generate enough electricity to meet their energy needs. On the other hand, maintaining a connection to the grid might nonetheless be desirable for such communities to provide an additional source of back-up power for emergency situations. Regardless, as photovoltaic solar and other renewable energy technologies become more cost-effective, micro-grids may begin to make more and more sense for geographically remote communities.

Although the potential applications of utility-scale and community-scale energy storage are substantial, this Article focuses on smaller-scale, DES technologies. In contrast to utility-owned energy storage systems ("Centralized Energy Storage"), DES units are installed and operated in individual homes, businesses, and industrial sites. Owners of DES units can choose to integrate them with renewables such as rooftop solar or can use them in conjunction with traditional power sources delivered through the electric grid. When combined with a rooftop solar panel system, a DES unit allows a homeowner to store excess energy produced during the day for use at night or any other time that the home's energy demands exceed its supply. And DES systems could be a cost-justifiable investment even for homeowners without rooftop solar if their electric utility offers a progressive time-of-use pricing plan[5] and storage net metering[6] program. Homeowners under such plans and programs could potentially purchase electricity from the grid when the price is low and store it on the home's DES unit for use or resale later when the electricity price is high.

Many businesses are also beginning to install DES to help meet their electricity needs and reduce their operating costs. For example, Target has announced plans to install Tesla's 100kW battery block, known as the Powerpack, in some of its stores instead of a generator to better meet its energy needs.[7] Likewise, the wine producer Jackson Family Wines plans to use Powerpacks to store energy for use during periods of the wine-making process that require a higher amount of energy.[8] Like homeowners, business owners can also use DES in combination with rooftop solar panels or as a way to draw energy from the grid and store it for when their energy needs spike.

A. Legacy Grids and Their Shortcomings

The physical infrastructure of the United States electricity system of "legacy" grids is traditionally viewed as serving three main functions: generation, transmission, and distribution.[9] The majority of the nation's electricity generation occurs at power plants that use fossil fuels, such as coal and natural gas.[10] To meet daily and annual fluctuations in consumer demand for electricity, an electricity system operator must decide which power plants to run at a given time.[11] Legacy grids currently do not handle these fluctuations in demand very efficiently. The introduction of renewable energy generation to legacy grids only frustrates the efforts to accommodate changes in demand.

1. Basic Features of Legacy Power Grids

The nation's legacy electric grids utilize different types of electricity generation facilities, also known as power plants, to meet the public's changing demand for electricity. Power plants fit into four main categories for purposes of grid load management.[12] Each category serves a specific purpose and has both benefits and drawbacks. Baseload plants have low fuel costs but cannot be turned on and off quickly.[13] Variable "must run" plants, including wind and solar energy systems, tend to involve lower marginal costs of production, but wind and solar plants can only operate during times that renewable resources are readily available.[14] Intermediate load plants, usually old coal plants, are more expensive to operate.[15] Although peaking plants have high operating costs, they can be taken on and offline quickly.[16] They are typically natural gas or diesel plants.[17]

The transmission system consists of power lines that transport electricity from generating plants to consumers.[18] These high-voltage lines must maintain a voltage within certain narrow limits to meet customer demand without overstraining the grid system.[19] To keep the voltage within these limits, the system operator relies on "spinning reserve" and "operating reserve" to add electricity to the grid quickly when it is needed.[20] "Spinning reserve" refers to generating plants that are being run and are ready to be switched onto the network immediately.[21] Operating reserve plants generally can be brought on or off the network within about ten minutes.[22]

Electricity distribution systems consist of substations, poles, wires, and underground lines that deliver electricity from high-voltage transmission infrastructure to retail customers.[23] Substations within these systems reduce the voltage of power coming from transmission lines so that it can travel along lower-voltage lines into homes and businesses.[24] An entity that operates an electricity distribution system typically has a duty to serve all customers in its service area.[25]

2. Shortcomings of Legacy Grids

Although legacy grids have served the nation well for a long time, they suffer from several major shortcomings. First, for these grids to function properly, the grid operator must maintain a strict balance between energy supply and consumer demand.[26] This delicate balancing act requires that the grid quickly respond to changes in demand as well as to problems caused by equipment failure.[27] Since legacy grids do not have an easy way to store energy, changes in demand must be addressed by increasing or decreasing energy generation almost instantaneously.[28] Legacy grids presently handle this problem by relying on peaking plants, spinning reserve, and operating reserve. Spinning reserve[29] and operating reserve are inefficient because they generate power that is wasted until it is needed to meet an increase in demand on the grid.

A second shortcoming of legacy grids is that their current design requires that they be capable of supplying a quantity of electricity through the grid equal to the greatest amount of energy that the system's consumers ever demand at any one time.[30] In other words, this "peak load" requirement necessitates that the grid be built to accommodate a level of electricity demand that it only rarely actually experiences. Peaking plants run during these periods of highest demand.[31] While the adaptive capacity of peaking plants makes them valuable tools for system operators, they are costly to operate and discharge more pollution than base-load plants.[32] Peaking plants are one of the most inefficient parts of the legacy grid but are currently a necessary part of the legacy grid and a critical means for it to meet the public's peak demand for energy.[33]

Lastly, "must run" generating facilities, including some that use renewable energy, create additional challenges for legacy grids. As renewable energy technologies improve, more and more utilities are supplementing their fossil-fuel fired generation facilities with renewable generation facilities such as wind farms and utility-scale solar energy plants.[34] Renewable energy generation facilities can exacerbate grid operators' challenge of balancing supply and demand because of their intermittent nature.[35] Unlike fossil fuel plants, which can be turned on and off, wind and solar energy facilities are considered "must-run" technologies whose outputs are controlled by forces of nature rather than grid operators. This can create problems because renewable energy systems continue producing energy regardless of whether there is demand for it.[36]

B. How DES Can Benefit Legacy Grids

The potential benefits of widespread DES implementation for power generation and distribution are tremendous. DES has the potential to address many of the current shortcomings of legacy grids. It can make them better equipped to handle peaks and dips in electricity demand. For consumers, DES can provide increased energy security during storms and other threats to legacy grids. From an economic standpoint, there are likewise many potential benefits for the United States as a whole if the nation were to become a world leader in the DES industry.

1. How DES Can Make Grids More Efficient

The implementation of DES can address the major supply and demand issues that grid operators currently face. Among other things, DES can make it easier for grid operators to balance supply and demand, thereby reducing utilities' reliance on spinning reserve, operating reserve, and peaking plants. As described above, energy storage technologies have the capacity to store excess power when grid supply exceeds demand and then send that energy back onto the grid later in a very short response period.[37] Some utility-scale energy storage facilities already store energy generated by baseload plants and discharge that energy when it is needed.[38] If DES systems were more widely used and coupled with technologies such as net metering and smart meters, grid operators could draw stored energy from customers' DES units to achieve similar effects.

DES also has the ability to smooth consumer demand for electric power. Rather than relying solely on electricity bought from the grid in real time, consumers with DES systems can draw from their own stored electricity when it is needed. In particular, this practice could help grid operators during times of peak energy use by shaving off the peak of the demand curve. Ideally, after enough customers install DES, peak demand will be so reduced that utilities will no longer need to build and operate as many peaking plants. And by enabling grid operators to better adapt to real-time fluctuations in supply and demand and by smoothing consumer demand for power, DES systems could make it easier to incorporate must-run renewable energy generating facilities to the grid.

2. How DES Can Enhance Energy Security

More widespread use of DES could additionally improve energy security by better protecting electricity customers against storms and other episodic threats to grid infrastructure. If a transmission line or some other important element of grid infrastructure suffers substantial damage, many customers downstream of it can be left without electricity until the infrastructure is repaired. Utility-scale energy storage only helps address this problem if the infrastructure damage occurs between the generation facility and the energy storage facility. If the damage occurs downstream of it, however, customers can still be affected. DES can offer a more reliable protection against these situations, providing precious power while neighbors suffer from blackouts or brownouts.

In a broader sense, these additional benefits of widespread use of DES could improve communities' resiliency and ability to aid recovery in the wake of natural disasters. In recent years, huge storms have caused substantial power outages and left large numbers of households and businesses without power for extended periods of time. For example, after Hurricane Katrina hit the Gulf Coast on August 29, 2005, over one million people were left without power.[39] Superstorm Sandy left 8.5 million people without electricity service[40] and prompted a surge in home generator sales in the months that followed.[41]

Someday, DES could be a key component of storm and emergency planning. Homes and businesses with installed DES systems have a source of back-up power to use during power outages. When a powerful storm threatens a community, those citizens with DES units could anticipate the need for excess energy and charge their DES units with energy from the grid. Then, if the power goes out, energy from the DES units could serve critical electricity needs until damage to the grid is repaired.

3. How DES Can Spur Economic Growth in the United States

The United States economy could also benefit if the nation becomes a leader in the development of DES technologies. Businesses in the United States would not need to rely on imports of storage units, and the United States could even put itself in the position of exporting such technologies. States could similarly boost their economies if they became leaders in this emerging industry.

Germany provides a good example of a country that strategically used policies and regulations to become a leader in an emerging renewable energy technology. The policy regime that Germany put in place to govern and incentivize the development of wind energy has been so successful as to render Germany "a world leader in renewable energy development."[42] Germany's policies created a stable market for wind energy that gave investors the confidence required for rapid investment and development.[43] This in turn resulted in a highly competitive market. As a direct result of the stable marketplace that Germany was able to create, Germany is among the top exporters of wind turbines in the world.[44]

Because the United States already has the lead in the DES industry,[45] the creation of a stable market for batteries through policy should be a high priority. By adopting a regulatory scheme that incentivizes DES and creates a stable market for it, the United States can cement its position as a top worldwide manufacturer of DES units. Among other things, this would be a boon for job creation and potentially allow the United States to become an exporter of DES technology. The United States has already demonstrated its desire to become a world leader in clean energy,[46] and the establishment of a strong DES industry supports that goal.

II. Obstacles to the Widespread Adoption of DES

DES technology has tremendous potential to fix the shortcomings of the nation's legacy grid system, increase energy security, and give the United States a lead role in an important emerging industry. One company in the United States has already introduced DES units to the market,[47] and several more companies are working to get their DES products ready for consumers.[48]So what is the problem? Why incentivize DES if so many, including utilities and consumers,[49] are already on board?

There are several reasons why strengthening incentives for electricity users to invest in DES seems like a justifiable policy strategy. First, DES is an emerging technology that has not yet fully realized economies of scale capable of substantially reducing per-unit manufacturing costs.[50] Secondly, citizens generally must pay high up-front costs to purchase and install DES units and are unlikely to earn a positive return on that investment for several years.[51] Third, utilities are increasingly resistant to policies that promote distributed electricity generation, and this opposition could similarly stall the growth of DES. Lastly, the manufacture and disposal of DES units can create environmental harms and the magnitude of those harms my increase and become substantial as DES technologies become increasingly common.[52]

A. High Manufacturing Costs

Because the energy storage industry is new and has not yet achieved an economy of scale, its manufacturing costs are still relatively high. Although public and private research on energy storage has been conducted for decades,[53] only recently has there been signs that the energy storage industry is ready to take off.[54] Manufacturing costs remain the greatest barrier to getting this fledgling industry fully off the ground.[55] Growth in DES has been particularly slow. Out of the $128 million in battery storage installed in 2014, only 1% of the storage capacity was installed in homes.[56] Moreover, many DES technologies are emerging technologies that are still in their early development stages.[57]

In order to drive down the price of DES units for customers, development and manufacturing costs must be decreased. According to one prominent researcher, prices for home batteries will need to drop 75% in order for DES to become widely adopted.[58] Once DES reaches an economy of scale, the price for DES units will naturally drop. In the interim, however, policies that provide a financial incentive to the industry will need to be put in place. These policies will need to specifically include DES and not just provide incentives for energy storage generally.

B. Consumer Budgetary Constraints

The high manufacturing costs for DES units result in products that are still prohibitively expensive for many consumers. A property owner must make up-front payments to purchase and install a DES unit. While the price point for home-level DES units is falling, it is still much higher than would be sensible for an average household's purchase.[59] For example, the Tesla Powerwall, a battery for residential energy storage, costs $5,500 for the 14 kWh model.[60] A consumer who wants a DES unit may rationally decide to delay purchasing one until prices come down. It would be many years before a homeowner could recoup such an investment through savings on the electricity bill alone. Additionally, a homeowner who does not also have distributed energy generation will not save money on the electricity bill if he or she pays a flat rate for electricity.[61]

C. Utility Opposition

Some utilities fear that the widespread introduction of Distributed Renewable Generation ("DRG") and DES will complicate their role in maintaining the grid and decrease their revenues.[62] When customers install DRG and DES, utilities lose revenue as those customers buy less energy from the grid. However, utilities must still make investments in grid infrastructure.[63] Therefore some utilities argue that customers who utilize DRG but remain connected to the grid for a secure source of backup power do not pay their fair share of the grid's infrastructure costs, which inequitably shifts costs to non-DRG users.[64] In other words, utilities argue that those customers who can generate and store their own energy unfairly shift the costs of grid maintenance to those who rely wholly on energy from the grid.

Utilities' resistance is complicated by the fact that DES is emerging side by side with another technology, distributed renewable generation ("DRG"). Unlike the automobile, which largely displaced the older system for transportation and technology like tramcars,[65] DES and DRG augment, rather than replace legacy grids. However, many utilities have proven to be resistant to DRG introduction.[66] These policies also have the potential to slow the adoption of DES.

Utilities also harbor existential concerns related to DRG and DES reducing their revenue. As customers install DRG, particularly rooftop solar panels, they generate their own energy and thus purchase less electricity from the grid. However, these customers remain connected to the grid and still benefit from this connection when they purchase power at night. Because utilities pay for the installation and maintenance costs of grid infrastructure through a charge incorporated into the price per kWh of energy they sell[67], utility companies argue that customers who have DRG do not pay their fair share of grid maintenance costs[68]. As solar panels and other DRG become more prevalent, utilities will have an increasingly difficult time affording the maintenance of the grid, and may fail to operate profitably. DES further exacerbates this situation, as homes with both DRG and DES may be able to generate and store enough electricity to meet all of their energy needs without purchasing anything from the grid.

Many utilities have already enacted or proposed policies to discourage the adoption of DRG. If these policies achieve their goal of discouraging DRG, they will also hinder the adoption of DES. In Arizona, the Arizona Public Service Co. ("APS") attempted to increase its monthly fee for customers who have rooftop solar panels from about five dollars to about twenty-one dollars.[69] The backlash against the proposal was so strong that APS ultimately decided to withdraw its request for the fee increase. However, APS asked the Arizona Corporation Commission to study the costs of serving solar users[70] and is expected to bring a new rate case in June 2016.[71]

Utilities have also demonstrated opposition to the implementation of net metering.[72] In Nevada, the Public Utilities Commission recently voted to increase the service fee for solar users in one utility's service area and to decrease the amount of credit that customers in that area can receive from net metering.[73] These changes were met with huge opposition. Two large companies that install rooftop solar decided to pull their businesses out of Nevada, causing at least 650 people to lose their jobs,[74] and solar advocates have filed a lawsuit against NV Energy for violating the Nevada's fair trade statutes and engaging in consumer fraud, negligence and unjust enrichment.[75] While the commission and NV Energy argue that solar customers unfairly shift costs for infrastructure maintenance to non-solar customers, the solar industry contends that the commission should consider the benefits of solar.[76] The opposition to the changes culminated in referendum proposed by a solar group that would change the language in Nevada's statutes so that the changes would become illegal.[77]

D. Concerns about Environmental Impacts

Another obstacle to incentivizing DES may be its potentially harmful impacts on the environment.[78] As these potential harms become more apparent, stakeholders are less likely to support DES development, especially given the appeal of DES as an eco-friendly technology.[79] By identifying these potentially harmful impacts early, governments can better prevent the harm and resolve environmental concerns.

Potentially harmful environmental impacts of DES may include issues with the storage technology's manufacture and disposal.[80] DES disposal practices can harm the environment when technologies are discarded in landfills instead of recycled. Because mining is often cheaper than recycling, producers are less likely to back recycling efforts.[81] A recent study indicated that particles released by a compound rapidly being incorporated into lithium batteries may harm natural bioremediation organisms that break down and clean up pollution.[82] Accordingly, researchers have stressed the importance of keeping discarded lithium ion batteries out of landfills, where they can leak toxic materials and contaminate the environment.[83]

III. Existing Policy Strategies for Incentivizing DES

Several state and local entities have already created successful policies to incentivize energy storage. In fact, the energy storage market grew by 185% in 2015, from $134 million in 2014 to $381 million in 2015.[84] By 2020, energy storage is projected to be a $2 billion dollar market.[85] This growth is attributed to have "come largely from a few states and a few big trends" like California, New York, and Hawaii.[86] This Section will provide an overview of several policies that have been used to incentivize energy storage.

A. State and Local DES Incentive Programs

The following case studies provide examples of how states and utilities can use ex ante regulation to incentivize consumer adoption of DES. California, New York, and Hawaii, motivated to meet their Renewable Portfolio Standards and address concerns about grid reliability, have all enacted sweeping policies for energy storage.[87] Vermont utility Green Mountain Power became the first utility to offer DES directly to its customers when it entered a partnership with Tesla to sell or rent DES batteries.[88] Though the *ex ante* regulations and policies in each case study are unique, they are all helpful examples of methods that can be used to successfully address the barriers hindering the emergence of DES.

1. California's Incentive Program

California's Self Generation Incentive Program ("SGIP") is one of the oldest and better developed distributed generation programs in the United States.[89] It was established in 2001 to incentivize, by payments to SGIP participants, new distributed generation, which could save transmission and distribution infrastructure costs for utilities that could in turn be passed on to ratepayers.[90] In 2009, as part of its effort to meet greenhouse gas reduction goals, the California Energy Commission and Air Resources Board expanded the SGIP to include energy storage technology as part of its incentive program.[91] Under the emerging technologies category, the SGIP provides advanced energy storage with a $1.46/W incentive.[92] This means that, based on a portion of generation from a project's on-site load, participants using advanced energy storage can be entitled to up-front and performance-based incentives ("PBI").[93] The program is available to customers of specific utilities.[94] After implementation of the program, SGIP saw a dramatic increase in the number of DES applications received.[95] California state officials believe that these projects will "deliver benefits through numerous value streams including increased customer reliability, reduced customer demand, reduced peak energy consumption (arbitrage), and balancing of intermittent renewable resources such as solar photovoltaics and wind."[96]

California also established aggressive energy storage procurement targets in order to promote energy storage. In 2010, the California legislature enacted AB 2514, which instructed the California Public Utilities Commission ("CPUC") to create an energy storage procurement target by 2013.[97] Shortly after the bill's enactment, the CPUC established a procurement target mandating the addition of 50MW of energy storage within Southern California Edison territory to meet the long-term energy needs of the Los Angeles Basin.[98] In 2013, CPUC issued a rule that required the state's public utilities to procure 1,324MW of energy storage in total by 2020.[99]

Regulatory programs like these incentivize both utilities and consumers to implement DES by providing price signals to the market. Consumers are incentivized by the potential to save money on their electricity bills. Consumers are provided PBI, are charged a cheaper rate, and can purchase less energy from the grid. Utilities are incentivized to implement DES to retain and attract customers seeking these benefits from other utilities. A utility's failure to participate would make energy more expensive as consumers relocated their businesses or homes for cheaper and greener energy elsewhere.[100]

2. New York's Energy Storage Consortium

The state of New York has also adopted zealous goals for increasing its use of renewable energy and for becoming a leader in the energy storage movement. New York's "state policies, incentives, and access to private capital" make it "well positioned to develop its clean energy resources and industry market share."[101] In 2010, the state created the New York Battery and Energy Storage (NY-BEST) initiative, a consortium of manufacturers, academic institutions, utilities, materials developers, and other groups that are interested in energy storage technologies.[102] The majority of the consortium members are based in New York.[103] The mission of NY-BEST is to promote growth of the energy storage industry and establish New York State as a leader in the industry.[104] To achieve this mission, NY-BEST plans to facilitate connections amongst stakeholders, speed up the commercialization of energy storage technologies, educate policymakers, and promote New York manufacturers and intellectuals.[105] In 2014, it awarded $1.4 million to several companies that are performing battery storage research and development.[106] NY-BEST also oversees a battery storage test center.[107]

The New York State Energy Research and Development Authority ("NYSERDA") supports the energy storage industry by administering proposals and providing funding for various energy projects.[108] The agency funds projects which address New York state and national energy challenges, including those related to energy storage.[109] NYSERDA also established a Green Bank that connects private funding with renewable energy projects in need of financing.[110] New York's efforts to foster the energy storage industry could potentially provide widespread benefits for customers, utilities, and the state's economy.

3. Hawaii's Clean Energy Program

Hawaii recently adopted ambitious legislation to promote renewable energy that will encourage the use of both rooftop solar and DES. On June 8, 2015, Hawaii Governor David Ige signed a bill that called for the state's electricity sector to transition entirely to renewable energy in 30 years.[111] The governor, a trained electrical engineer, spearheads the program with the cooperation of Hawaii's major utility ("HECO") and U.S. military bases on the islands.[112] The program is fitting for Hawaii because of the state's prolific sunshine and isolation from the U.S. mainland's energy grid. Hawaii cannot import energy from neighbors in the same way that mainland states do. Its geographic isolation has caused an increase in the cost of traditional energy and propelled it to be proactive in pursuing energy self-sufficiency goals. Hawaii's unique conditions make it a prime laboratory for finding cost-effective solutions to legacy energy systems.

Part of Hawaii's cost-effective strategy is a combination of tariff schemes and energy storage implementation. Utilities in Hawaii have recommended two tariffs to cope with the addition of renewables to the grid. The first, known as a Self-Supply tariff, is for customers who want to self-supply their own solar electricity on-site. The Self-Supply tariff limits the amount of electricity these users are allowed to send back to the grid and does not allow users to be compensated for the electricity they send to the grid.[113] However, these customers do become eligible for an expedited review of their self-supplying installation, a process often delayed for months by the utility.[114] The second tariff, known as a Grid-Supply tariff, gives customers a lower retail electricity rate.[115] In addition, customers who choose the Grid-Supply tariff are allowed to send solar generated electricity back to the grid for compensation at the wholesale rate.[116]

An integral part of Hawaii's strategy has been to implement DES. In 2013, Hawaii experienced a boom in distributed energy generation from renewables like solar panels, throwing the grid into chaos as safety was jeopardized and circuits overloaded.[117] To solve this problem, HECO implemented a major utility-run DES scheme. HECO secured the help of DES specialists from California who signed up the utility's customers to install lithium-ion batteries and DES software.[118] Hawaii's new energy policies strike a balance between maintaining the grid and promoting renewables. In addition, by actively promoting DES, Hawaii has helped to resolve both grid security and consumer affordability concerns.

4. A Utility's Private Partnership in Vermont

Another utility that has promoted rather than resisted the addition of DES to its customers' households is Green Mountain Power ("GMP") in Vermont. In 2015, GMP became the first utility to sell DES units directly to its customers. GMP advertises the Tesla Powerwall battery on its website, touting it as "an opportunity to save money by storing energy when it costs less off-peak" as well as a backup energy source that can be used during a blackout.[119] In addition, GMP states that it will use energy from the batteries during peak demand periods in order reduce transmission costs and lower prices for consumers.[120] The utility offers three different payment options. Customers can buy a battery, rent a battery and participate in a utility-shared access program, or buy a battery and participate in a utility shared access program in exchange for a monthly credit on their energy bill.[121]

The shared access options pose a potential win-win situation for a utility and its customers. The utility is allowed to borrow energy from its customers' batteries to meet demand during peak periods, lessening the utility's reliance on peaker plants and long-distance transmission. Customers can receive credit on their monthly electricity bill for electricity stored on their batteries that is used by the utility. The rental option benefits customers who cannot afford to purchase a battery or who are renting their property. GMP's partnership with Tesla, if it is a success, proves that utilities and DES companies share enough common interests to form mutually beneficial relationships and peacefully coexist.

IV. Strengthening Incentives for DES

The right mix of laws and policies could help to accelerate the manufacture and installation of DES so that it becomes widely used and competitive in the market. The following proposed laws and policies for DES will help achieve four general goals. First, they will increase financial support for research, development, and manufacturing of DES technologies so that they can achieve an economy of scale. Second, they will create incentives that increase demand for DES technologies. Third, they will prevent the implementation of policies that aim to slow or prohibit the use of DES. Finally, they will address the environmental harms associated with DES. Some of the policies will take advantage of incentives that are already in place for renewables, and others will introduce new ideas that are specifically tailored to DES' unique role in the energy system.

A. Subsidy Programs

Since its inception, the United States energy industry has been heavily subsidized. Energy subsidies are desirable because of the sector's high up-front capital costs and the significant social benefit that electricity provides. DES is no exception to this pattern of costs and benefits, so it is an attractive candidate for government subsidy.

1. Research and Development Grants

Since energy storage technologies are still in their nascent stages, government funding for research could potentially be a justifiable means of helping these technologies to more rapidly mature and reach markets. The federal government is already significantly funding energy storage technology research that will surely help toward this goal. In the United States Energy Storage Competitiveness Act, Congress allocated about $2.7 billion to the Department of Energy ("DOE") to support research and development of advanced storage technologies.[122] The Act specifically orders the Secretary of the DOE to "conduct a basic research program on energy storage systems to support electric drive vehicles, stationary applications, and electricity transmission and distribution."[123]

Government funding for research on DES technologies could be highly effective in helping to get these consumer-oriented technologies market-ready. One research program, the Joint Center for Energy Storage Research, headquartered at DOE's Argonne National Laboratory has a goal of developing technologies that store five times more energy than current batteries do at a fraction of the cost.[124] At the Laboratory, the Argonne Collaborative Center for Energy Storage Science is working together to do research to solve energy storage problems.[125] Another federal program that is already in place is the Advanced Research Project Agency–Energy (ARPA-E). ARPA-E provides funding for short-term research projects and claims to choose only those projects that have potential to make "transformational impacts."[126] It is critical that Congress continues to provide funding for these and other DOE basic research initiatives until their objectives are met.

Of course, federal research grants have both advantages and drawbacks as a means of incentivizing investments in energy storage innovation. Unlike federal tax credits, which can harness market forces and incentivize private investment, federal programs such as ARPA-E arguably empower federal officials to pick the winners of emerging technologies. This top-down approach could be detrimental if the government picks the wrong winners and does not give viable competing technologies opportunities to develop. Still, so long as they are managed carefully, these programs can have merit as means of driving valuable new technologies.

2. Tax Credits and Rebates

Tax credits and other subsidy programs designed to attract private investment are another important potential means of driving DES innovation and adoption. A relevant example of how federal tax credits were successfully used to promote innovation in a renewable technology is with the wind and solar industry. In order to spur growth in the wind and solar energy sector, the federal government implemented policies to make wind and solar energy projects more financially attractive for private investors. The Obama administration's 2009 American Recovery and Reinvestment Act ("ARRA") created two large tax credits for renewable energy: the Production Tax Credit (PTC) and the Investment Tax Credit (ITC). The PTC provides a per kilowatt-hour tax credit for renewable energy generated at qualified facilities.[127] The ITC gives companies a tax credit for a specific percentage of their investment costs in renewable energy technology.[128] For solar and small wind turbines, the tax credit is 30%.[129] The tax credit "encourages private investment in renewable technologies because it reduces the risk companies face by offsetting their federal taxes by the amount they invest in the emerging technologies."[130] The tax credits were considered to be critical to the growth of the renewable energy industry.[131]

The federal government has created similar tax credits for the energy storage industry. ARRA implemented the Advanced Energy Manufacturing Tax Credit, a 30% investment tax credit, "to support domestic manufacturing of energy storage" technologies.[132] It is important that this tax credit is applied to DES technology and not just large-scale energy storage technology. The tax credit should continue for as long as investment in DES technologies remains risky. If implemented wisely, it could provide critical support to the DES industry, like the ITC and PTC did for the solar and wind energy industries. State and municipal tax credits and rebates can similarly spur demand for DES.

B. Financing Assistance Programs

Governments can also help to incentivize the installation of DES systems by providing financing assistance through property tax programs or other means. For example, a municipality could conceivably allow qualifying property owners pay either zero or little money up-front for the purchase of a DES unit and then pay for the unit over time through added charges on property tax bills.

Such property tax schemes, which some jurisdictions have used to help promote rooftop solar installations and other clean energy,[133] could help more citizens interested in acquiring DES units to do so. These schemes sometimes include benefits such as 100% financing on qualifying improvements and tax deductible interest.[134] Where these property tax schemes already exist, DES can be explicitly added as a qualifying clean energy technology. Jurisdictions that do not already have these property tax schemes can look to existing programs for guidance in implementing one. The financing can be made available to both residential and commercial properties.

Another way governments can incentivize the installation of DES is through property tax exclusions. The state of California created a property tax exclusion for certain qualifying active solar energy systems.[135] A state could similarly exclude from property tax assessments the value of DES units so that the purchasing a DES unit does not increase a citizen's property tax bill. Although this method does not directly finance the DES unit, it encourages consumers to adopt DES by removing the obstacle of increased property taxes.

Financial assistance for consumers could be a straightforward way to jumpstart adoption of new DES technologies. These programs are especially beneficial at this time because very few people have installed DES units, and many are not even aware of the technology's existence. As more consumers adopt DES and DES prices decrease, these programs can be discontinued or faded out.

C. Utility-Level Policies

Utilities can support the growth of DES by establishing policies and rate structures that benefit the customers who adopt it. Utility policies such as time-of-use pricing and net metering can send price signals to customers that encourage them to install DES.[136] The prohibition of rate structures and fees that negatively impact customers who install DRG and DES will provide certainty for consumers and promote the adoption of these technologies. Ultimately, utilities must embrace, and not fight, these emerging technologies in order for their use to become widespread.

1. Time-of-Use Electricity Pricing

One of the most promising ways that utilities can promote DES unit installations is by making time-of-use power pricing plans available to their customers. Under time-of-use pricing plans, customers pay higher per-kWh electricity rates when overall demand is high and lower rates when demand is low. For example, if demand is usually highest during the evening hours, the utility increases the price of electricity during those hours. Such plans send valuable price signals to customers, encouraging them to change their habits so that they use fewer electrical appliances during high demand hours.

Customers with DES units can benefit significantly under a time-of-use pricing scheme, particularly if it is implemented in conjunction with net metering.[137] When customers without DES units opt in to a time-of-use pricing scheme, they are incentivized to change their energy consumption patterns by shifting energy use to off-peak times when energy is less expensive. However, few customers want to completely stop consuming electricity during peak hours. For example, a refrigerator cannot be turned off for hours without food spoiling, and sometimes dinner needs to be cooked at a certain hour. DES helps to address this problem. When a customer with a DES unit opts in to a time-of-use pricing scheme, that customer can buy all of his or her power at the low off-peak price and then use power from the battery when the on-peak price is in effect. In addition to potentially reducing the customer's energy bill, under this scenario, the time-of-use pricing plan lowers the customer's demand on the grid to zero for the on-peak period.

Of course, as DES units become more commonplace, time-of-use pricing could gradually become a less potent means of driving DES investment. As more customers install DES units and opt in to time-of-use pricing schemes, the demand for grid-supplied electricity will likely become more smooth across the day and year, and the gap between off-peak and on-peak electricity prices will likely decrease. Accordingly, time-of-use pricing schemes should be seen as a temporary measure. They are crucial for incentivizing the installation of DES units and alleviating the peak load on the grid in the short term, but they are not well suited to serve as a permanent policy strategy.

It is possible that some people will oppose time-of-use pricing, even as a temporary measure. One could argue that time-of-use pricing disproportionately impacts vulnerable populations, such as the elderly, who may have less flexibility in changing the times they use electricity. If such opposition occurs, utilities could consider making time-of-use pricing optional at first to allow customers the time to change their habits and to purchase DES units. Once customers become accustomed to time-of-use pricing, utilities can make it mandatory. Utilities may choose to provide exceptions for certain customers if it is found that time-of-use pricing would have adverse effects on vulnerable or low-income populations. Alternatively, states can make tax credits or subsidies available to address this problem.

2. Storage Net Metering Programs

Net metering is a utility billing approach that allows a customer to receive credit for electricity he or she sends to the grid.[138] Under a net metering program, a utility installs a two-way meter in a customer's home that measures electricity coming into and out of the home.[139] The customer is credited for the electricity that the home sends back to the grid and is charged only for the "net" electricity used.[140] For example, a residential user with more energy in her home's battery than she needs can offset the home's electricity bill by sending excess energy back to the grid.

Net metering schemes are also essential for enabling utility shared access programs. Utility shared access programs allow utility companies to both store electricity on and take electricity from their customers' DES units. To be effective, the shared access program must allow the utility to store and take electricity without approval from the customer. The amount of electricity stored or taken should be limited to a certain percentage of the DES unit's capacity so that the customer can enjoy the benefits of the DES unit at all times. Utility companies should be required to compensate customers for electricity they take and for the ability to store excess electricity customers' DES units. Rather than developing a separate scheme for this access, the simplest method of ensuring fairness for customers is to use net metering regulations to govern this relationship.

It should be noted that some negative consequences of utility shared access programs may arise for customers with both a DES unit and rooftop solar panels. For example, utilities could force customers to purchase some amount of energy during the morning when demand for power is low but the sun is also shining. This reduces the amount of solar energy that customers could store, potentially forcing customers to sell excess energy to the grid sooner in the day and at a lower price than they otherwise would. Similarly, if the utility company buys too much power from customers during an evening peak period, there may not be enough sunshine remaining in the day to charge their DES units enough to power their homes overnight, forcing them to buy energy overnight. For these reasons, utility companies should be allowed to gain access only to a percentage of any given customer's energy reserves.

As time-of-use pricing incentivizes widespread adoption of DES units and gives way to a real-time pricing scheme, net metering regulations will be critical to the way that the real-time energy market functions. When there are enough DES units installed with smart technology that enables them to buy, sell, and store energy, net metering regulation will determine the way that those transactions occur and the costs imposed on them.

3. DES-Friendly Rate Structures

Another important means of incentivizing greater adoption of DES technologies is to ensure that utility rate structures do not deter customers from purchasing DES devices.[141] For example, suppose that a customer is considering whether to purchase a rooftop solar system and a DES unit. The customer will have to pay up-front costs and will want to know how long it will take to recover those costs. If the utility imposes special monthly charges on the customer's account or charges higher rates to customers with DES and DRG, it will take much longer for those customers to recover their initial investment, and many customers may decide that such an investment is not cost-effective. The pace of growth for DRG and DES will depend in large part on whether utilities are permitted to charge special fees for customers who use these technologies.

Although utilities have not yet proposed special fees or rates for customers who install DES, such charges are a possibility in the future. AS DES systems become more widespread, some utilities may feel threatened by DES because of its potential to help some customers exit the grid entirely or purchase far less electricity from the grid. Widespread adoption of DES could help utilities in the long run as it becomes more widespread and smooths the demand curve. However, in the interim, utilities will still rely costly peaking plants and likely want some customers paying the high prices when demand is high. Accordingly, policymakers should be vigilant not to allow utilities to charge special fees or otherwise penalize customers who install DES technologies.

D. Storage Portfolio Standards

Renewable Portfolio Standards ("RPS") have been highly successful at speeding up the installation of renewable energy generation facilities in the United States.[142] Analogous Storage Portfolio Standards ("SPS") could be used similarly to accelerate the adoption of DES.

RPS policies generally obligate retail electric suppliers to install enough renewable generation facilities so that a certain percentage of all of the electricity that that utility generates comes from renewable resources.[143] Some RPS policies go further by taking measures to actively incentivize the development of a particular type of renewable resource. For instance, some RPS policies require that some percentage of the renewable generation requirement be filled by a particular type of technology such as solar or wind.[144] Policies in other jurisdictions multiply the credit toward RPS goals for certain favored renewable technologies.[145]

A successful SPS scheme should impose requirements based on a percentage of the grid's overall electricity capacity within a given utility service area. Each state should determine how much energy storage capacity is necessary to achieve its desired improvements in grid security. Policymakers could choose either of two methods to decide what amount of energy storage to require on the grid.

The first method is to require a certain percentage of the utility's total generation capacity to be matched by an equal amount of storage capacity. One great advantage of this method is its simplicity. Utility companies are aware of their overall generation capacity, and this knowledge is typically available to the public,[146] so the quantitative requirements would be easy to determine and to track as storage capacity is installed. Fixing the required amount of storage to a percentage of overall generation capacity also allows for the storage requirement to grow with the energy grid.

The second method is to require an amount of storage capacity to be installed equal to a certain generation capacity over a specified period of time. This could be the amount of energy generated by a particular peaking plant on its annual peak day. This method is distinctly better for phasing out old or inefficient generation plants, especially peaking plants. Installation of an amount of storage equal to the highest per-day output that a peaking plant must produce would allow for the utility company to decommission the peaking plant and replace its output with stored energy. Measures like this could be adopted on a per-plant basis alongside development of renewable energy generation facilities.

It is possible in theory to mix these two methods within the same policy. The policy could begin by setting a baseline storage capacity requirement per the first method. Once that baseline or a predetermined portion of it has been met, the SPS could expand per the second method so as to more rapidly decommission outdated fossil fuel burning power plants. Each state should consider both methods when adopting policy to create the SPS regime most favorable to its individual energy situation.

An SPS policy that merely requires a certain percentage of energy storage on the grid would heavily favor the installation of centralized energy storage over DES. If SPS policies strictly follow in the footsteps of their RPS progenitors, the burden would fall on the utility companies to install energy storage. Utility companies installing storage have little incentive to distribute that storage across their service area, much less within customers' homes, when they could install all of it in just a few locations and under their own control. Of course, DES arguably increases grid security and resilience more than centralized energy storage does because it spreads energy storage throughout a utility territory rather than confining it to just a handful of locations.[147] SPS policies that incentivize utility companies only to install centralized energy storage miss the opportunity to use DES to further strengthen the grid.

Relying on utilities to install the nation's energy storage capacity is also arguably undesirable from a cost perspective. To fund the purchase and installations of that storage capacity, utilities would need to increase the rate which they charge to their customers[148]. Utility companies already complain that when too many customers operate rooftop solar panels, the resulting loss in revenue makes it more difficult for them to afford the maintenance necessary to operate their existing infrastructure.[149] Raising electricity rates to pay for energy storage could be politically difficult and suboptimal from a policy perspective.

Policymakers could address these challenges and ensure that DES makes up a significant proportion of all energy storage development by including DES "carve-out" provisions in SPS policies. The carve-out provisions would require that some minimum percentage of the total energy storage capacity installed to meet SPS goals be in the form of residential or commercial-scale DES systems. Establishing such SPS policies and DES carve-outs alongside utility shared access programs[150] could drive rapid growth in DES development. At the same time, it would still give utilities the control they need to smooth energy demand and ensure grid stability.

Incentivizing utility customers to purchase their own DES units is arguably a more appealing method of funding the addition of storage capacity to the grid. Shifting the cost of the majority of energy storage development to customers who choose to purchase their own DES units could allow for the grid's storage capacity to grow sustainably and with less significant impacts on electricity rates. In conjunction with net metering, time of use pricing, and utility shared access programs, such an approach could incentivize efficient growth in DES development while giving grid operators the ability to utilize that increasing energy storage capacity to smooth energy demand.

E. Regulations to Address DES' Environmental Harms

The potential environmental harms associated with DES[151] can largely be prevented through ex ante regulations. Policymakers can proactively protect against environmental hazards associated with DES technology by creating a robust recycling infrastructure for the materials used in DES. Regulations carefully designed to accomplish this can ensure that DES retains its eco-friendly appeal and positive public image.

The federal government has established specific guidelines for responsible practices that protect the environment from hazardous waste. The Environmental Protection Agency ("EPA") has developed hazardous waste recycling regulations to promote and require reclamation of materials which are safe to dispose of in the environment.[152] These regulations can be extended to DES and can require that specific guidelines are followed for DES technology disposal and recycling. Responsible practices would cover the transport, treatment, storage, disposal, recycling, and corrective action for hazardous DES materials.[153]

State governments could likewise hold DES producers accountable for environmental impacts. States can mandate that DES producers help to fund a recycling infrastructure for DES systems. States could require that manufacturers fund the collection and recycling of DES batteries, advertise such programs to consumers, and report on their progress.[154] States could impose civil penalties on DES producers who violate these requirements and increase the penalties for repeated offenses.[155] Although it may be less expensive in many instances for producers to mine new materials for DES rather than recycle them, subsidies or tax credits for DES recycling could provide the additional incentive needed to get producers to lead in recycling efforts.[156] In summary, governments can and should take proactive steps to ensure that the growth of DES is not stunted by concerns about the potential environmental harms associated with DES technology.

F. Promoting the Use of DES in Remote Areas

As DES makes micro-grids and DRG more effective, some rural areas may eventually be able to go "off-grid" and rely solely on energy they generate and store on site. Policies that encourage energy independence for remote areas through the use of DES and other technologies could ultimately benefit utilities and customers alike. Utility customers could have a more resilient system that was less susceptible to blackouts or brownouts, and utilities would save money by not needing to service properties in remote areas. In addition, utilities would be spared from having to build costly new transmission lines to rural areas with few customers to foot the bill.

Two plausible candidates for eventually going off-grid are small rural communities and many of the nation's remote national parks. Some rural electricity customers are often serviced through utilities that must build dozens of miles of transmission and distribution lines just to connect them to the grid. Eventually, state public utility commissions might consider policies that allow utilities to refuse rural customers if they can show that an off-grid, renewable energy system is adequate and cost-effective.

Like rural customers, national parks are often located in remote areas that must be serviced by utilities.[157] The National Park Service (NPS) operates and maintains over 600,000 structures in almost 400 national parks.[158] Rather than relying wholly on utilities, NPS could determine which parks were capable of using DRG and DES technology or micro-grids and begin working to transition park infrastructure to be off-grid.

Conclusion

DES technologies have tremendous potential to smooth peaks in energy demand, increase grid security, and address the intermittency problems associated with distributed solar power, all while making the entire energy system more efficient. However, several roadblocks continue to slow the growth of DES markets in the United States. Fortunately, a wide range of policy tools is available to help drive the development and adoption of DES technologies.

Among the most promising policy strategies for driving DES growth are time-of-use pricing structures, storage net metering programs, tax credits programs, and SPS programs with DES carve-outs designed to incentivize utilities' support of DES installations within their territories. Analogs to most of these policy strategies have already done much to drive astounding growth in distributed solar energy throughout the United States over the past decade. Adapting them to promote DES is the next obvious step toward helping the nation's legacy grids and increasingly outmoded electricity structure transition into a more sustainable and modern system.

Endnotes

1 *See* Int'l Energy Agency, Technology Roadmap: Energy Storage 5 (2014), https://www.iea.org/publications/freepublications/publication/TechnologyRoadmapEnergystorage.pdf.

2 *See* U.S. Dept. of Energy, Southern California Edison Company Tehachapi Wind Energy Storage Project (May 2014), http://energy.gov/sites/prod/files/2015/05/f22/SoCal-Edison-Tehachapi-May2014.pdf.

3 *See* Mariya Soshinskaya et al., *Microgrids: Experiences, Barriers and Success Factors*, 40 Renewable & Sustainable Energy Revs. 659, 661 (2014) (describing that the basic concept of microgrids, despite a variety of definitions, "is to aggregate and integrate distributed energy resources (DER) . . . distributed storage (DS) and loads . . .").

4 *See* About Microgrids, Microgrid Inst., http://www.microgridinstitute.org/about-microgrids.html (last visited Apr. 17, 2017) ("Typical examples [of campus microgrids] serve university and corporate campuses, prisons, and military bases."); *see also* Niles Barnes, *Smart Microgrids on College & University Campuses*, AASHE Blog: Campus Sustainability Perspectives (May 18, 2011, 12:30 PM), http://www.aashe.org/blog/smart-microgrids-college-university-campuses (providing examples of specific universities that employ microgrids to manage electricity on campus).

5 *See* discussion *infra* Section IV.C.1.

6 *See* discussion *infra* Section IV.C.2.

7 *See* Rich McCormick, *Tesla's Huge New Batteries Will Store Power for Amazon, Target, and Others*, The Verge (May 1, 2015), http://www.theverge.com/2015/5/1/8527699/tesla-battery-amazon-target-for-renewable-energy.

8 *Id*.

9 Joel B. Eisen et al., Energy, Economics and the Environment 66 (2015); *see also* U.S. Dep't of Energy Office of Electricity Delivery & Energy Reliability, United States Electricity Industry Primer 6 (2015), https://www.energy.gov/sites/prod/files/2015/12/f28/united-states-electricity-industry-primer.pdf (defining the traditional structure of the electricity grid) [hereinafter Dep't of Energy].

10 *See id.* at 67.

11 *See id.*

12 *See id.*

13 *See id.*

14 *See id.*

15 *See id.*

16 *See id.; see also* Dep't of Energy, *supra* note 9, at 12 (explaining that peaking plants can be taken on and offline quickly).

17 *See* Eisen, *supra* note 9, at 67*; see also* Dep't of Energy, *supra* note 9, at 12 (explaining that although natural gas-fired plants have higher fuel costs, they also have a faster start up time).

18 *See* Eisen, *supra* note 9, at 68.

19 *See id.*

20 *Id*.

21 *Id*; *see also* Dep't of Energy, *supra* note 9, at 90 (defining "Spinning Reserve" as Electric generating units connected to the system that can automatically respond to frequency deviations and operate when needed")

22 *Id*.

23 *Id.* at 69; *see also* Dep't of Energy, *supra* note 9, at 13 (diagramming the electricity supply chain) (particularly Figure 12).

24 *See id*; *see also* U Dep't of Energy, *supra* note 9, at 15 (providing background on substations' role in linking transmission and distribution networks).

25 *See id*.

26 Victoria Johnston, *Storage Portfolio Standards: Incentivising Green Energy Storage*, 20 J. of Envtl. & Sustainability L. 25, 47 (2014) (describing the limitations of the current electricity system).

27 *See id.* at 50.

28 Eisen, *supra* note 9, at 67.

29 *See Glossary of Terms Used in NERC Reliability Standards*, N. Am. Elec. Reliability Corp., (Apr. 4, 2017), http://www.nerc.com/pa/stand/glossary%20of%20terms/glossary_of_terms.pdf (defining "Spinning Reserve" as "Unloaded generation that is synchronized and ready to serve additional demand").

30 *See* Eisen, *supra* note 9, at 74.

31 *See* Johnston, *supra* note 26, at 47; *see also Glossary,* U.S. Dep't of Energy Info. Admin., http://www.eia.gov/tools/glossary/index.cfm?id=P (last visited Feb. 2, 2016) (defining "[p]eak load plant" as "[a] plant usually housing old, low-efficiency steam units, gas turbines, diesels, or pumped-storage hydroelectric equipment normally used during the peak-load periods").

32 *See* Eisen, *supra* note 9, at 74 ("When demand is modest, the cheapest generators are able to satisfy it, resulting in modest prices. However, during peak periods, all generation resources—even the most expensive—must be called upon."); *see also* U.S. Dep't Energy Info. Admin., *supra* note 32; *see also* N. Am. Elec. Reliability Corp., *supra* note 30.

33 *See* Dep't of Energy, *supra* note 9, at 12 ("[N]atural gas-fired plants . . . have faster start up times but typically higher fuel costs.").

34 *See*, *CPUC Improves and Streamlines Self-Generation Incentive Program*, Cal. Pub. Utils. Comm'n (Sept. 8, 2011) http://docs.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/142914.htm; *see also* Marianne Levelle, *After Hurricane Sandy, Need for Backup Power Hits Home*, Nat. Geographic (Oct. 29, 2013) http://news.nationalgeographic.com/news/energy/2013/10/131028-hurricane-sandy-aftermath-need-for-backup-power/ (referencing a backup solar energy project in Brooklyn, NY).

35 *See* Johnston, *supra* note 26, at 51.

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[201] While the end result of the CAO's compliance function could be a recommendation, by the CAO to the IFC that it should divest from the project this rarely occurs–and would not necessarily lead to the entire project being halted.
[202] Samantha Balaton-Chrimes & Fiona Haines, *The Depoliticisation of Accountability Processes for Land-Based Grievances, and the IFC CAO*, 6 Global Pol'y 446 (2015).
[203] Balaton-Chrimes & Haines, *supra* note 12, at 446, 448.
[204] *See id.* at 4447
[205] *See* Int'l Fin. Corp., Project Information Portal: Lydian Int'l 3 https://disclosures.ifc.org/#/projectDetailESRS/384 (last visited Apr. 17, 2017) ("The main driver for IFC equity investment involvement is the support of Lydian's development of the Drazhnje and Amulsar exploration projects, as a basis for setting benchmarks on sustainability in resource development in Kosovo and Armenia. IFC's second equity investment will be used primarily to fund the continued exploration of Lydian's mineral resource properties in Kosovo and Armenia, including feasibility studies, environmental and social impact assessments and other preparatory activities.").
[206] *See* Int'l Fin. Corp., Cases: Armenia/Lydian Int'l 3, http://www.cao-ombudsman.org/cases/case_detail.aspx?id=222 (last visited Apr. 17, 2017) ("[The] IFC is a 7.9% shareholder and has invested over $16 million in stages since 2007.").
[207] *Id.*
[208] Office of the Compliance Advisor/Ombudsman (CAO), Dispute Resolution Conclusion Report in Lydian Int'l 3-02/Gndevaz, Armenia 2 (Aug. 2015), http://www.cao-ombudsman.org/cases/document-links/documents/LydianIntl3-02_ConclusionReport_ENG.pdf.
[209] IFC Cases, *supra* note 207.
[210] Office of the Compliance Advisor/Ombudsman (CAO), Compliance Appraisal Report: IFC Investment in Lydia Int'l ltd. (Project #27657), Armenia, Complaint 01, 12 (2015), http://www.cao-ombudsman.org/cases/document-links/documents/CAOCompliance_AppraisalReport_Armenia_Lydian-01_042715-English.pdf.
[211] Office of the Compliance Advisor/Ombudsman (CAO), Terms of Reference 2 (Jan. 8, 2016), http://www.cao-ombudsman.org/cases/document-links/documents/ToRforLydianInvestigation-08-Jan2016.pdf.
[212] *See supra* notes 40-50 and accompanying text.
[213] *See* Office of the Compliance Advisor/Ombudsman (CAO), Compliance Appraisal: Summary of Results: IFC Investment in Lydian International Ltd. (Project #27657), Armenia, Complaint 02 8 (2015), http://www.cao-ombudsman.org/cases/document-links/documents/CAOCompliance_Appraisal-Report_Armenia_Lydian-02_10222015forweb_English.pdf (suggesting that the IFC's supervision of the project was insufficient, particularly in light of the fact that Lydian International was operating through a joint venture agreement with Newmont); *see also* CAO Compliance Appraisal Report Lydian Int'l, *supra* note 209 (noting that Newmont's investment in the project "should provide comfort regarding the quality of Lydian's management team and assets as well as assurance that Lydian's assets would be developed in line with industry best practice.").
[214] *See e.g.*, Mariel Aguilar-Støen & Cecile Hirsch, *Environmental Impact Assessments, Local Power and Self-Determination: The Case of Mining and Hydropower Development in Guatemala*, 2 Extractive Indus. & Soc'y 472, 478 (2015).
[215] *See id.* at 477.

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[36] *See id*. at 54 (defining the problem of "Resource Management" as the "potential for over-generation by variable [renewable] resources during off-peak periods when there is sufficient load to accommodate such generation").
[37] *See* Johnston, *supra* note 26, at 51-52.
[38] *See generally* Mathias Aarre Maehlum, *Grid Energy Storage*, Energy Informative (May 3, 2013), http://energyinformative.org/grid-energy-storage-caes-pumped-hydro-and-flywheel/. (discussing how this is already possible with some technologies such as compressed air energy storage (CAES) and pump-storage hydroelectricity. However, these technologies have their limitations, including deployment in locations with certain existing geological features which they require to store the large amounts of air or water which are necessary to generate power at scale).
[39] *See* Joseph B. Treaster and Kate Zernike*, Hurricane Katrina Slams Into Gulf Coast; Dozens Are Dead*, N.Y. Times, (Aug. 30, 2005), http://www.nytimes.com/2005/08/30/us/hurricane-katrina-slams-into-gulf-coast-dozens-are-dead.html.
[40] *See* Jim Polson and Mark Chediak, *Sandy's Blackouts Fall to 1.9 Million, Half in New Jersey,* Bloomberg, (Nov. 12, 2012), http://www.bloomberg.com/news/articles/2012-11-04/sandy-s-blackouts-fall-to-2-5-million-with-new-jersey-worst-off.
[41] *See Hurricane Sandy Boosts Generac Sales, Earnings Power,* Investor's Bus. Daily (June 28, 2013), http://www.nasdaq.com/article/hurricane-sandy-boosts-generac-sales-earnings-power-cm256506 (stating that Hurricane Irene and other storms convince people to purchase generators).
[42] Peter Kayode Oniemola, *Integrating Renewable Energy into Nigeria's Energy Mix through the Law: Lessons from Germany*, 2 Renewable Energy L. & Pol'y Rev. 29, 29 (2011); *see* Lucy Butler & Karsten Neuhoff, *Comparison of Feed-in Tariff, Quota and Auction Mechanisms to Support Wind Power Development*, 33 Renewable Energy 1854, 1858 (2008) (indicating an installed wind energy capacity in Germany of 20,622MW by the end of 2006).
[43] *See* Butler, *supra* note 43, at 1864 (stating that the strong competition among developers could have led to more share in the profits for landowners).
[44] *See id.* at 1863 (describing German turbine manufacturer presence in the domestic and international market).
[45] *See generally* Tesla Powerwall, https://www.teslamotors.com/powerwall (last visited Apr. 27, 2017).
[46] *See, e.g., U.S. Department of Energy Launches $40 Million Effort to Improve Materials for Clean Energy Solutions*, U.S. Dep't of Energy (Feb. 24, 2016), http://energy.gov/articles/us-department-energy-launches-40-million-effort-improve-materials-clean-energy-solutions (announcing a new U.S. Department of Energy initiative that aims to bring clean energy materials to market more quickly in order to "give American entrepreneurs and manufacturers a leg up in the global race for clean energy").
[47] *See* Tesla, *supra* note 46 (showcasing Tesla's Powerwall system).
[48] *See, e.g.*, Ucilia Wang, *12 Energy Storage Startups To Watch in 2015*, Gigaom, (Jan. 22, 2015, 7:00 AM), https://gigaom.com/2015/01/22/12-energy-storage-startups-to-watch-in-2015/
[49] *See generally* Zachary Shahan, *US Solar + Storage Market to Go Beyond $1 Billion a Year by 2018*, Clean Technica (Dec. 18, 2014), http://cleantechnica.com/2014/12/18/solar-storage-market-go-beyond-1-billion-year-2018/ (discussing a report by GTM Research, predicting that the U.S. "will install 328 MW of behind-the-meter energy storage by 2018").
[50] *See* Amy L. Stein, *Reconsidering Regulatory Uncertainty: Making a Case for Energy Storage*, 41 Fla. St. U. L. Rev. 697, 698-701 (2014) (indicating technological and financial concerns facing DES).
[51] *See Press Kit*, Tesla Motors (2016), https://www.teslamotors.com/presskit/teslaenergy.
[52] *See* Terry DeVitt, *Lithium Battery Catalyst Found to Harm Key Soil Microorganism*, PhysOrg (Feb. 4, 2016), http://phys.org/news/2016-02-lithium-battery-catalyst-key-soil.html (explaining environmental dangers posed by lithium batteries); *see also Airlines Ban Hoverboards over Battery Danger*, 10News (Dec. 11, 2015), http://www.wtsp.com/story/news/2015/12/10/airlines-ban-hoverboards-over-battery-danger/77123728/. S*ee generally* Monte Whaley, *Vaping Dangers: Reports of Burns, Injuries from Exploding E-cigarettes*, Denver Post (Jan. 29, 2016), http://www.thecannabist.co/2016/01/29/vaping-dangers-colorado-reports-exploding-e-cigarettes/47430/.
[53] *See* Diane Cardwell, *Energy Storage Industry Gaining Momentum*, N.Y. Times, (Oct. 25, 2015), http://www.nytimes.com/2015/10/26/business/energy-environment/energy-storage-industry-gaining-momentum.html?_r=0 (stating that only as energy policies and technologies have battery storage systems started to become financially viable).

[54] William Pentland, *As Energy Storage Enters Mainstream Markets, System Size Becomes Key Differentiator*, Forbes, (Jan. 19, 2016), http://www.forbes.com/sites/williampentland/2016/01/19/as-energy-storage-enters-mainstream-markets-system-size-becomes-key-differentiator/#6700ffd269db ("IHS Technology is forecasting that the global installed capacity of energy storage systems will double by 2017. The brunt of the new energy storage projects deployed in 2016, or about 45% of the total capacity, is likely to be in the United States.").

[55] *See* Johnston, *supra* note 26, at 62-63 (describing the inefficiencies in the emerging technology supply chain as a "valley of death").

[56] Rebecca Smith & Cassandra Sweet, *Will Tesla's Newest Battery Pan Out?*, Wall St. J. (May 5, 2015), http://www.wsj.com/articles/will-teslas-newest-battery-pan-out-1430522030.

[57] *See* International Energy Agency, Technology Roadmap Energy Storage 41 (2014), https://www.iea.org/publications/freepublications/publication/TechnologyRoadmapEnergystorage.pdf (stating that the high costs and performance issues in battery systems is hindering its growth).

[58] *See S*mith & Sweet, *supra* note 56 (quoting the head of Lawrence Berkeley National Lab whom stated that batteries need to become 75% cheaper before they reach the general market).

[59] *See* Jake Richardson, *70% Decrease In Energy Storage Costs By 2030, Says Report*, Clean Technica (Jan. 25, 2016), http://cleantechnica.com/2016/01/25/70-decrease-energy-storage-costs-2030-says-report/ (stating that the cost to store energy may decrease seventy percent in fifteen years); *see also* Bryn Huntpalmer, *Advancing Solar Storage Solutions*, Altenergymag, (Jan. 26, 2016, 8:18 AM), http://www.altenergymag.com/article/2016/01/advancing-solar-storage-solutions/22648/ (informing that while there is movement to make batteries more affordable, a standard lithium-ion batter currently costs about $1000 per kilowatt hour).

[60] *See* Tesla *supra* note 46, at 2. (displaying costs for the 14 kWh Powerwall battery, which could power a one bedroom home; not including fees for installation and supporting hardware).

[61] Time-of-use pricing schemes offer an alternative to flat rate pricing, which is more amenable to the adoption of DES. *See infra* Section IV.B.3.

[62] *See* Tim Dickinson, *The Koch Brothers' Dirty War on Solar Power*, Rolling Stone (February 11, 2016) http://www.rollingstone.com/politics/news/the-koch-brothers-dirty-war-on-solar-power-20160211 (suggesting that power utilities are poorly able to handle market disruption, and comparing it to what digital photography did to Kodak).

[63] *See* Jeff Winmill, *Electric Utilities and Distributed Energy Resources-Opportunities and Challenges*, 6 San Diego J. Climate & Energy L. 199, 200-01 (2015) (noting that utility infrastructure investments are around $100 billion per year).

[64] *Id.*; *see also* Ivan Penn, *Utilities Push a Solar Pricing Proposal They Say is Fairer for Non-Solar Users*, L.A. Times (Jan. 20, 2016, 6:13 PM), http://www.latimes.com/business/la-fi-solar-subsidy-plan-20160121-story.html.

[65] *See* Elisabeth Graffy & Steven Kihm, *Does Disruptive Competition Mean a Death Spiral for Electric Utilities?*, 35 Energy L.J. 1, 23-28 (2014) (analyzing how disruptive technological competition, automobiles, were met with regulatory protection for tramcars).

[66] *See* Judy Chang, et. al., The Value of Distributed Electricity Storage in Texas: Proposed Policy for Enabling Grid-Integrated Storage Investments, 2-3 (2014). http://www.brattle.com/system/news/pdfs/000/000/749/original/The_Value_of_Distributed_Electricity_Storage_in_Texas.pdf.

[67] *See* U.S. Dep't of Energy Office of Electricity Delivery and Energy Reliability, *supra* note 10, at 30 ("[W]here utilities are vertically integrated, utilities may construct, own, and operate power plants and the costs are reflected in retail prices.").

[68] *See Open Meeting Memorandum*, Ariz. Corp. Comm'n, Utilities Div., 4-5 (Sept. 30th, 2013), http://images.edocket.azcc.gov/docketpdf/0000148646.pdf; *see also* Troy A. Rule, *Solar Energy, Utilities, and Fairness*, 6 San Diego J. Climate & Energy L. 115, 119-120 (2015).

[69] *See* Ryan Randazzo, *Corporation Commission OK's APS Request to Withdraw Application for Higher Solar Rates*, Ariz. Republic, (Oct. 20, 2015), http://www.azcentral.com/story/money/business/energy/2015/10/20/corporation-commission-oks-aps-request-withdraw-application-higher-solar-rates/74301500/.

[70] See *infra* Section IV.C.2. (discussing net metering policies).

[71] *See* Ryan Randazzo, *Arizona Regulators Seek Solar Net-metering Compromise*, Ariz. Republic (Dec. 29, 2015), http://www.azcentral.com/story/money/business/energy/2015/12/28/arizona-regulators-seek-solar-net-metering-compromise/77716104/.

[72] *Id*.

[73] *See* Daniel Rothberg, *Lawsuit Filed Over New Rooftop Solar Utility Rates*, Las Vegas Sun, (Jan. 15, 2016), http://lasvegassun.com/news/2016/jan/15/lawsuit-filed-over-new-rooftop-solar-utility-rates/.

[74] *See id*.

[75] *See id*.

[76] *See id*.

[77] *See* Daniel Rothberg, *Ballot Measure Would Restore Old Rooftop Solar Rates*, Las Vegas Sun (Jan. 25, 2016), http://lasvegassun.com/news/2016/jan/25/ballot-measure-would-restore-old-rooftop-solar-rat/.

[78] *See* Andy Balaskovitz, *Michigan Researchers Issue Guidelines for Sustainable Energy Storage,* Midwest Energy News (Feb. 19, 2016), http://midwestenergynews.com/2016/02/19/michigan-researchers-issue-guidelines-for-sustainable-energy-storage/.

[79] *See e.g.,* Andrew Burger, *Smarter Energy*, Triple Pundit (Mar. 4, 2014), http://www.triplepundit.com/2014/03/smarter-energy-zero-financing-intelligent-power-storage/; *see also Intelligent Energy Storage System Market (2015-2021): Global Market Study and Analysis*, Empowered News (Feb. 5, 2016), http://empowerednews.net/intelligent-energy-storage-system-market-2015-2021-global-market-study-and-analysis/1872252/.

[80] *See* Balaskovitz, *supra* note 79, at 2.

[81] *See* Vaishnovi Kamyamkhane, *Are Lithium Batteries Sustainable to the Environment?* Wayback Machine (Sept. 5, 2012), https://web.archive.org/web/20120905095017/http://www.alternative-energy-resources.net:80/are-lithium-ion-batteries-sustainable-to-the-environment-i.html?.

[82] *See* DeVitt, *supra* note 53, at 1; s*ee generally* U.S. Env't Prot. Agency, *Vocabulary Catalog,* (2017), https://ofmpub.epa.gov/sor_internet/registry/termreg/searchandretrieve/termsandacronyms/search.do?search=&term=bioremediation&matchCriteria=Contains&checkedAcronym=true&checkedTerm=true&hasDefinitions=false (defining Bioremediation as "[u]se of living organisms to clean up oil spills or remove other pollutants from soil, water, or wastewater; use of organisms such as non-harmful insects to remove agricultural pests or counteract diseases of trees, plants, and garden soil").

[83] *See* DeVitt, *supra* note 53, at 2.

[84] *See* Katherine Tweed, *7 Energy Storage Stories You Might Have Missed in 2015*, Energy Collective (Dec. 25, 2015), http://www.theenergycollective.com/martin-lamonica/2304480/7-energy-storage-stories-you-might-have-missed-2015.

[85] *See id.*

[86] *See id.*

[87] *See* Andrew H. Meyer, Comment, *Federal Regulatory Barriers to Grid-Deployed Energy Storage*, 39 Columbia J. of Envtl L. 480, 483 (2014).

[88] *See Press Kit*, *supra* note 52, at 3.

[89] *See Fuel Cells Fuel Alternative Energy Options*, Energy design resources (Oct. 29, 2013), https://energydesignresources.com/resources/e-news/e-news-90-fuel-cells.aspx.

[90] *See CPUC Improves and Streamlines Self-Generation Incentive Program*, Cal. Pub. Util. Comm'n., (Sept. 8, 2011), http://docs.cpuc.ca.gov/PUBLISHED/NEWS_RELEASE/142914.htm.

[91] *See Fuel Cells*, *supra* note 90.

[92] *See 2015 Handbook*, Self-Generation Incentive Program, 1, 10 (July 17, 2015), http://cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=7722.

[93] *See* Cal. Pub. Util. Comm'n, supra note 91.

[94] *See id.* (listing the specific utilities: Pacific Gas and Electric Company, Southern California Edison, Southern California Gas Company, and San Diego Gas & Electric).

[95] *See 2013 SGIP Impact Evaluation, Advanced Energy Storage Performance,* Cal. Pub. Util. Comm'n, 1, 86 (2013), http://www.cpuc.ca.gov/NR/rdonlyres/AC8308C0-7905-4ED8-933E-387991841F87/0/2013_SelfGen_Impact_Rpt_201504.pdf.

[96] *Id.*

[97] *See* Meyer, *supra* note 88, at 483.

[98] *See id.*

[99] *See id.*

[100] *See* discussion, *supra* Section II.C. for an explanation of utilities' existential concerns over DES.

[101] Kimberly Wojcik, *Energy Storage: The Future of Cleantech has Arrived*, J. of Multistate Taxation and Incentives 7 (2015).

[102] *See About Us*, New York Battery and Energy Storage Technology Consortium, https://www.ny-best.org/About_NY-BEST (last visited Feb. 24, 2016).

[103] *See id.*

[104] *See id.*

[105] *See id.*

106 *See* Wojcik, *supra* note 101, at 7-8.
107 *See id.* at 8
108 *See id.*
109 *See id.*
110 *See id*.
111 *See* Juan Cole, *Hawaii's Governor Dumps Oil and Gas in Favor of 100 Percent Renewables*, TheNation (Aug.262015), http://www.thenation.com/article/hawaiis-governor-dumps-oil-and-gas-in-favor-of-100-percent-renewables/.
112 *Id.*
113 *See* Travis Hoium, *Hawaii may have Just Given Energy Storage a Huge Boost*, The Motley Fool (Oct.22, 2015), http://www.fool.com/investing/general/2015/10/22/hawaii-may-have-just-given-energy-storage-a-huge-b.aspx.
114 *Id.*
115 *Id.*
116 *Id.*
117 *See* Helle Abelvik-Lawson, *Three Problems With Transitioning to Renewable Energy and How to Fix Them*, truthout (Dec. 28, 2015), http://www.truth-out.org/opinion/item/34193-three-problems-with-transitioning-to-renewable-energy-and-how-to-fix-them.
118 *Id.*
119 *See Tesla Powerwall*, Green Mountain Power, (Jan.21,2016) http://products.greenmountainpower.com/tesla-powerwall.
120 *Id.*
121 *Id.* (detailing Green Mountain Power's DES offerings to its customers); *See also* Josh Castonguay, *Re:GMP – Tesla Powerwall Innovative Pilot*, Green Mountain Power, (Dec. 2, 2015) http://www.greenmountainpower.com/upload/photos/426Hudson_12.02.2015_-_Tesla_Pilot_Filing.pdf; *See* discussion *infra* Section IV.C.2. regarding utility shared access programs.
122 *See* Meyer, *supra* note 88, at 482.
123 *See* Energy Storage Competitiveness Act, 42 U.S.C. § 17231(h)(1) (2007).
124 *See Batteries and Energy Storage*, Argonne National Laboratory, (Jan. 21, 2016) http://www.anl.gov/energy/batteries-and-energy-storage .
125 *Id*.
126 Advanced Research Projects Agency-Energy, *General Questions About ARPA-e*, (Jan. 21, 2016), http://arpa-e.energy.gov/?q=faq/general-questions.
127 *See* Johnston, *supra* note 26, at 39.
128 *Id.*
129 *Business Energy Investment Tax Credit*, U.S. Dep't of Energy, (Feb. 24, 2016), http://energy.gov/savings/business-energy-investment-tax-credit-itc..
130 *See* Johnston, *supra* note 26, at 39.
131 *Id.* at 40.
132 *See* Meyer, *supra* note 88, at 483.
133 *Property Assessed Clean Energy Programs*, Center for Sustainable Energy, (Feb. 24, 2016), http://energycenter.org/policy/property-assessed-clean-energy-pace#PACE-FAQs, ("Property assessed clean energy, or PACE, financing allows property owners to fund energy efficiency, water efficiency and renewable energy projects with little or no up-front costs. With PACE, residential and commercial property owners living within a participating district can finance up to 100% of their project and pay it back over time as a voluntary property tax assessment through their existing property tax bill.").
134 *Id.*
135 *Property Tax Exclusion for Solar Energy Systems*, U.S. Dep't of Energy, http://energy.gov/savings/property-tax-exclusion-solar-energy-systems (last visited Apr. 22, 2017).
136 *See Distributed Energy Storage*, Trilliant, http://trilliantinc.com/solutions/consumer/distributed-energy-storage (last visited Apr. 22 , 2017) (noting that utilities must provide price signals to consumers and their distributed energy sources to provide incentives).
137 *See* discussion *infra* Section IV.C.2. (discussing net metering).
138 *See Issues & Policies*, Solar Energy Indus. Ass'n, http://www.seia.org/policy/distributed-solar/net-metering (last visited Apr. 22, 2017) (describing how net metering has been used as a mechanism for offering credits for distributed solar generation).
139 *See* Johnston*, supra* note 26, at 41 (emphasizing that net metering programs also incentivize customers to install their own renewable energy systems).
140 *Id.*
141 *See Rate Design Guiding Principles for Solar Distributed Generation*, Solar Energy Indus. Ass'n, http://www.seia.org/research-resources/rate-design-guiding-principles-solar-distributed-generation-0 (last visited Apr. 13, 2017) (outlining foundational principles for a rate-based approach that balances shareholder's and customer's interests).
142 *See* Fredric Beck & Eric Martinot, *Renewable Energy Policies and Barriers*, *in* 5 Encyclopedia of Energy 365, 372 (2004) (pointing out that at least twelve U.S. states have enacted an RPS ranging from 1 to 30% of electricity generation).
143 *Id.*
144 *See e.g. RPS Solar Carve Out Arizona*, Solar Energy Indus. Ass'n, Feb. 2, 2013, http://www.seia.org/sites/default/files/resources/RPS%20Solar%20Fact%20Sheet%20AZ.pdf (explaining carve outs for solar in Arizona's RPS policy and showing a 15% carve out in Arizona).
145 *See* Galen Barbose, *Renewables Porfolio Standards in the United States: A Status Update*, 7-8, *available at* http://www.cesa.org/assets/2012-Files/RPS/RPS-SummitDec2012Barbose.pdf
146 *See e.g.,* Ted Allrich, *Pinnacle West: The Peak of the Energy Pyramid*, http://seekingalpha.com/article/20935-pinnacle-west-the-peak-of-the-energy-pyramid (last visited Feb. 9, 2016) (indicating APS's 4,000 MW generation capacity); *see also* NYC Special Initiative for Rebuilding and Resiliency, *A Stronger, More Resilient New York*, 108, http://s-media.nyc.gov/agencies/sirr/SIRR_singles_Lo_res.pdf (indicating Con Edison's 11,000+ MW generation capacity).
147 *See* discussion, *infra* Section I.B.2. (regarding the benefits of DES for grid security).
148 *See* U.S. Dep't of Energy Office of Electricity Delivery & Energy Reliability, *supra* note 10, at 30 (explaining that utility infrastructure costs are recouped through retail energy rates).
149 *See* discussion *infra* Section II.C. (regarding utilities' concerns over DRG's diminishing effect on their revenue).
150 *See* discussion*, infra* Section IV.C.2. (regarding utility shared access programs).
151 *See* discussion, *infra* Section II.D on the potential environmental harms associated with DES technology.
152 *See* Hazardous Waste Recycling, EPA (last updated Dec. 28, 2016), https://www.epa.gov/hw/hazardous-waste-recycling.
153 *See* 40 C.F.R. § 261.20(c) (2017); *see also* 1 Caroline N. Broun & James T. O'Reilly, RCRA & Superfund: A Practice Guide § 2:37 (3d ed. 2016) (listing ignitability, corrosivity, reactivity, and toxicity along with relevant qualifiers for consideration of whether a solid waste can be considered hazardous for the purposes of RCRA); EPA, Hazardous Waste Listings: A User-Friendly Reference Document 11 (2012), https://www.epa.gov/sites/production/files/2016-01/documents/hw_listref_sep2012.pdf.
154 *See* 9 Philip Weinberg et al., New York Practice Series–Environmental Law and Regulation in New York § 8:32.30 (2d ed. 2016) (describing a similar law for batteries signed by the Governor of New York in 2010).
155 *See id.* (explaining that manufacturers or retailers are subject to various civil penalties depending on the frequency of violation).
156 *See* Vaishnovi Kamyamkhane, *Are Lithium Batteries Sustainable to the Environment?* Internet Archive: Wayback Machine (Sept. 5, 2012), https://web.archive.org/web/20120905095017/http://www.alternative-energy-resources.net:80/are-lithium-ion-batteries-sustainable-to-the-environment-i.html?.
157 *See also* Ariz. Pub. Serv., Arizona Statewide Service Territory (2017), https://www.aps.com/library/communications1/AZ_Map.pdf.
158 *See* Nat'l Park Serv., Green Parks Plan 4 (2016), https://www.nps.gov/subjects/sustainability/upload/NPS-Green-Parks-Plan-2016.pdf.