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Storage Portfolio Standards: Incentivising Green Eenrgy Storage

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I. INTRODUCTION

Electricity usage in the United States will continue to grow over the next several decades. The U.S. Energy Information Administration predicts that electricity consumption in the United States will grow over twenty-eight percent from 2011 levels by 2040.[1] In 2010, one-third of total U.S. carbon dioxide equivalent emissions resulted from combustion of fossil fuels to generate electricity.[2] If the United States remains as dependent on combustion of fossil fuels for generating electricity as it was in 2010, the most recent year for which reliable figures are currently available, the country's greenhouse gas emissions from this sector alone will grow by nearly ten percent over total emissions in 2010 by the year 2040.[3] However, if the United States replaces a sufficient percentage of this electricity generation with renewable energy sources, the switch could drastically decrease the amount of greenhouse gas emissions from electricity.

Renewable energy policy has focused on building more renewable energy facilities and putting those sources online. Renewable energy supporters rely on incentives such as tax credits,[4] net metering,[5] and Renewable Portfolio Standards[6] to

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[1] U.S. ENERGY INFO. ADMIN., DOE/EIA-0383(2013), ANNUAL ENERGY OUTLOOK 2013 WITH PROJECTIONS TO 2040, at 17-18 (2013), *available at* http://www.eia.gov/forecasts/aeo/pdf/0383%282013%29.pdf. In 2011, electricity consumption in the United States amounted to 3,841 billion kilowatt hours (kWh); the report predicts that by 2040, this will increase to 4,930 kWh.
[2] ENVTL. PROT. AGENCY, EPA 430-R-13-001, INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS: 1990 – 2010, at 2-8 (2012), *available at* http://www.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2013-Main-Text.pdf.
[3] *Id.* at 2-1.
[4] The two largest tax credits are the production tax credit (PTC) and the investment tax credit (ITC). *See, e.g.*, PHILIP BROWN & MOLLY F. SHERLOCK, CONG. RESEARCH SERV., R41635, ARRA SECTION 1603 GRANTS IN LIEU OF TAX CREDITS FOR RENEWABLE ENERGY: OVERVIEW, ANALYSIS, AND POLICY OPTIONS 3–4 (2011), *available at* http://assets.opencrs.com/rpts/R41635_20110208.pdf (explaining the PTC and ITC grants).

promote their production. However, because renewable energy sources produce power intermittently, they require backup power.[7] This backup power often comes from deployable energy sources[8] such as natural gas.[9] Natural gas extraction for use at natural gas plants emits methane, which has a global warming potential far greater than that of carbon dioxide.[10] This source of backup power decreases the effectiveness renewable energy sources have on reducing greenhouse gas emissions in comparison to the effectiveness a renewable backup power source would have. Energy storage would allow renewable energy sources to capitalize on the reductions to greenhouse

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[5] *See, e.g.*, THOMAS J. STARRS & HOWARD J. WENGER, POLICIES TO SUPPORT A DISTRIBUTED ENERGY SYSTEM 5B-7 (1999) (explaining how net metering works).

[6] *See, e.g.*, Joshua P. Fershee, *Changing Resources, Changing Market: The Impact of A National Renewable Portfolio Standard on the U.S. Energy Industry*, 29 ENERGY L.J. 49, 51 (2008) (A Renewable Portfolio Standard "require[s] electric utilities to procure a certain percentage of their electricity from renewable resources or purchase renewable energy credits from other sources to meet the standard.").

[7] *See, e.g.*, Ralph Vartabedian, *Rise in renewable energy will require mor use of fossil fuels*, L.A. TIMES, Dec. 9, 2012, http://articles.latimes.com/2012/dec/09/local/la-me-unreliable-power-20121210.

[8] Deployable energy is energy that utilities can turn on at a moment's notice. *Id.*

[9] A natural gas backup plant is a plant that maintains spinning turbines that do not produce electricity "until complex data networks detect a sudden drop in the output of renewables. Then, computerized switches are thrown and the turbines roar to life, delivering power just in time to avoid potential blackouts." *Id.*

[10] The most recent study found the global warming potential of methane to be 105 times that of carbon dioxide over a twenty year period, and thirty-three times that of carbon dioxide over a one hundred year period. Howarth et al., *Methane Emissions from Natural Gas Systems: Background Paper Prepared for the National Climate Assessment* 5 (2012), *available at* http://www.eeb.cornell.edu/howarth/Howarth%20et%20al.%20--%20 National%20Climate%20Assessment.pdf (citing Shindell et al., *Improved Attribution of Climate Forcing to Emissions*, 326 SCIENCE 716 (2009)).

gases they could create. In order to promote energy storage, policy makers could take advantage of the existing incentives for renewables—that is, tax credits, net metering, and mandates.

In addition to renewable energy requiring backup power, as more renewable sources come online, electrical grid operators will have a more difficult time balancing the grid. The U.S. electrical grid must be kept at a frequency of 60 hertz.[11] If the frequency of the grid rises or falls significantly from 60 hertz, a blackout may occur,[12] which would subsequently cost billions of dollars.[13] As more time-intermittent wind and photovoltaic power supplies increase, the shortcomings of the grid will become even more problematic.[14] In fact, a recent report from the National Renewable Energy Laboratory found, "renewable electricity generation from technologies that are commercially available today, in combination with a more flexible electric system, is more than adequate to supply 80% of total U.S. electricity generation in 2050 while meeting electricity demand on an hourly basis in every region of the United States."[15] The key here is the presence of "a more flexible electric system," which, to date, is not a reality. Energy storage could help combat

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[11] Scott Backhaus & Michael Chertkov, *Getting a Grip on the Electrical Grid*, PHYSICS TODAY, May 2013, at 42, 44, *available at* http://scitation.aip.org/docserver/fulltext/aip/magazine/physicstoday/66/5/PT.3.1979.pdf?expires=1396821868&id=id&accname=476573&checksum=7005A93F845669A795F42187AE1E45F0.

[12] *Id.*

[13] U.S.–CANADA POWER SYSTEM OUTAGE TASK FORCE, FINAL REPORT ON THE AUGUST 14, 2003 BLACKOUT IN THE UNITED STATES AND CANADA: CAUSES AND RECOMMENDATIONS 1 (2004), *available at* http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/BlackoutFinal-Web.pdf (citing ELECTRIC CONSUMER RESEARCH COUNCIL, THE ECONOMIC IMPACTS OF THE AUGUST 2003 BLACKOUT (2004)).

[14] *See, e.g.*, MATTHEW CORDARO, *Understanding Base Load Power: What it is and Why it Matters* 2–3 (2008), *available at* http://www.area-alliance.org/documents/base%20load%20power.pdf.

[15] NATIONAL RENEWABLE ENERGY LABORATORY, NREL/TP-6A20-52409-ES, RENEWABLE ELECTRICITY FUTURES STUDY: EXECUTIVE SUMMARY at iii (2012), *available at* http://www.nrel.gov/docs/fy13osti/52409-ES.pdf.

the challenge of adding renewable energy to the grid by providing electrical grid operators with a reliable, fast-responding energy sink or source when predictions of energy use are not accurate.[16]

In fact, the Federal Energy Regulatory Commission ("FERC") has already acknowledged the many advantages to energy storage. FERC found that the electrical grid suffered from resource adequacy, resource management, and reduced system inertia.[17] FERC also observed that energy storage could address both the resource adequacy and resource management issues.[18] Depending on the type of technologies used, energy storage may, in addition, help to reduce system inertia. These three concerns FERC has identified are all exacerbated by renewable generation.[19] However, because energy storage has the ability to combat all three concerns, energy storage perfectly compliments renewable sources.

Most initiatives to develop energy storage have focused on large-scale storage,[20] but emerging technologies that can store energy on a small scale are becoming more advanced and their installation could reduce financial risk to developers.[21] Large-

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[16] Bradford P. Roberts, *Energy Storage Solutions*, PUB. UTIL. FORTNIGHTLY, May 2012, at 46.

[17] FEDERAL ENERGY REGULATORY COMMISSION, SMART GRID POLICY, 126 F.E.R.C. 61253, 62419 (2009), *available at* Westlaw 2009 WL 725041.

[18] *Id.* at 62419 – 420.

[19] Jason Rugolo & Michael J. Aziz, *Electricity Storage for Intermittent Renewable Sources* 2, *available at* http://www.seas.harvard.edu/matsci/people/aziz/publications/mja212.pdf.

[20] INT'L RENEWABLE ENERGY AGENCY, ELECTRICITY STORAGE: TECHNOLOGY BRIEF E18 at 1 (2012), *available at* http://www.irena.org/DocumentDownloads/Publications/Electricity%20Storage%20-%20Technology%20Brief.pdf. [hereinafter TECHNOLOGY BRIEF] (explaining that pumped hydropower is currently the only commercial storage option).

[21] *See infra* Part IV(B).

scale storage technologies include pumped hydroelectric energy[22] and Compressed Air Energy Storage.[23] These technologies require large amounts of space and cost a considerable amount to build.[24] Conversely, small-scale technologies include used car batteries,[25] vanadium redox flow cells,[26] and small-scale compressed air.[27] Because of their small size, developers can situate these technologies in a myriad of locations.[28] In addition, small-scale distributed storage could reduce transmission congestion.[29] Another option proponents of the Smart Grid have

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[22] Pumped hydro systems store energy by moving water uphill; the systems rely on gravity to push the water back down through turbines. TECHNOLOGY BRIEF, *supra* note 20, at 8.

[23] Compressed Air Energy Storage systems store energy by compressing air and storing that compressed air in underground mines or caverns. TECHNOLOGY BRIEF, *supra* note 20, at 8.

[24] TECHNOLOGY BRIEF, *supra* note 20, at 8-9.

[25] *See, e.g., GM and ABB Demonstrate Chevrolet Volt Battery Reuse – World's First Use of Electric Vehicle Batteries for Homes*, ABB (Nov. 15, 2012), http://www.abb.us/cawp/seitp202/8cb38a9d238161 74c1257ab500497848.aspx.

[26] Vanadium redox flow cells are "electro-chemical energy storage systems based on the vanadium ability to exist at four different oxidation levels. During energy charging, vanadium ions in a diluted solution of sulphuric acid vary their oxidation, thus storing electricity in the form of electro-chemical energy." TECHNOLOGY BRIEF, *supra* note 20, at 11.

[27] ***SEE, E.G.*, ERICA GIES, *A STORAGE SOLUTION IS IN THE AIR*, N.Y. Times, OCT. 1, 2012, HTTP://WWW.NYTIMES.COM/2012/10/02/BUSINESS/ENERGY-ENVIRONMENT/A-STORAGE-SOLUTION-IS-IN-THE-AIR.HTML?PAGEWANTED =ALL.**

[28] *See, e.g.*, LIGHTSAIL ENERGY, http://lightsailenergy.com/tech.html (last visited May 8, 2013) (small-scale compressed air packed in shipping containers).

[29] *See infra* Part IV(C) for an explanation of transmission congestion; *2012 National Electric Transmission Congestion Study*, ENERGY.GOV, http://energy.gov/oe/services/electricity-policy-coordination-and-implementation/ transmission-planning/2012-national (last visited May 8, 2013) ("[T]here are three ways to mitigate congestion where it is significant enough to merit remediation. These are: 1)[] reduce electricity demand in the congested area through energy efficiency and demand management programs; 2) build more generation capacity *close to the demand area*; and 3) build

proposed is using plug-in electric vehicles for small-scale distributed energy storage.[30] However, this approach depends on consumers, who may want to keep their cars charged at all times.[31] If consumers prove reluctant to allow utilities to draw significant amounts of energy from their car batteries, utilities will not have sufficient storage capacity to meet the needs that will result from shifting reliance from fossil fuels to renewable energy resources.[32] Small-scale, widely distributed facilities dedicated to energy storage may therefore provide the best source of backup power for renewable energy facilities.

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additional transmission capacity so as to enable more electricity to be delivered from distant generators." (emphasis added)).

[30] Mark A. Delucchi & Mark Z. Jacobson, *Providing All Global Energy with Wind, Water, and Solar Power, Part II: Reliability, System and Transmission Costs, and Policies*, 39 ENERGY POLICY 1170, 1173 (2011). In theory, customers would plug their plug-in vehicles to the grid overnight (and during the work day), allowing the utility to store excess energy in the batteries (i.e. charge the batteries); when the utility required more electricity, the utility could draw stored energy from the batteries. *E.g.*, Eric Baxter, *Charging Plug-in Hybrids on a Smart Grid*, HOWSTUFFWORKS, http://auto.howstuffworks.com/car-models/plug-in-hybrids/charging-plug-in-hybrids-on-a-smart-grid.htm (last visited May 10, 2013).

[31] Customers would be able to set their car batteries to a minimum discharge level. That is, a customer could prohibit the utility from drawing more than a certain amount of energy from the car's battery. *See* Baxter, *supra* note 30 (a plug-in hybrid vehicle's driver can "choose" whether to run on gas or electricity, depending on the price difference).

[32] *Cf.* Ned Smith, *Electric Cars Face Rough Road in Changing Perceptions*, BUSINESS NEWS DAILY, Apr. 1, 2013, http://www.businessnewsdaily.com/4246-electric-vehicles-still-encounter-misperceptions.html (explaining that "range anxiety," or the fear that a plug-in vehicle's car battery will not have enough charge for a planned trip, is the number one reason why customers decide not to buy plug-in vehicles. Similarly, owners of plug-in vehicles may fear that if they let their batteries drain, they will not have enough charge for an unplanned trip.). *See also* Patrick Connor, *Eight Tips to Extend Battery Life of Your Electric Car*, PLUGINCARS.COM (Sept. 27, 2011), http://www.plugincars.com/eight-tips-extend-battery-life-your-electric-car-107938.html (advising owners of electric vehicles to not allow their batteries to drain too far).

Three main impediments have slowed the growth of small-scale distributed energy storage facilities.[33] First, siting storage systems can be difficult. Second, the technologies are not as developed as investors might like. And third, the cost of building storage systems can be prohibitively expensive.

As to siting energy storage facilities, small urban sites, such as brownfields, provide an ideal location. A "brownfield site" is defined as "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant."[34] These frequently abandoned sites remain contaminated for years, leaving eyesores in communities and potential legal suits.[35] Cleaning these sites is good for communities, the economy, and the environment.[36]

Some people in the energy field have already considered transforming brownfield sites into facilities for renewable energy production.[37] However, some brownfields are better suited to supporting renewable energy development than others. Before converting a brownfield into a renewable energy production site, a developer should consider: (1) which types of renewable energy would thrive on the site, (2) the proximity of the potential site to transmission lines, and (3) the environmental remediation

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[33] *See infra* Part IV(D).
[34] Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. § 9601(39)(A) (2012).
[35] NAT'L ASS'N OF LOCAL GOV'T ENVTL. PROF'LS, UNLOCKING BROWNFIELDS: KEYS TO COMMUNITY REVITALIZATION 2 (2004), *available at* http://www.csu.edu/cerc/documents/UnlockingBrownfields.pdf.
[36] *Id.*
[37] For example, NALGEP created a primer to help local governments determine if developing renewable energy on brownfield sites would be a good option for their community. NAT'L ASS'N OF LOCAL GOV'T ENVTL. PROF'LS, CULTIVATING GREEN ENERGY ON BROWNFIELDS: A NUTS AND BOLTS PRIMER FOR LOCAL GOVERNMENTS (2012), *available at* http://www.nalgep.org/uploads/pdf/publi02.pdf.

required of the site.[38] In addition, before a developer can build anything on a brownfield site, the developer must remediate the site to the point where it is not contaminated. However, cleaning a site up can be prohibitively expensive.[39] The Environmental Protection Agency provides three types of grants for brownfield site cleanup that make the process more financially feasible.[40] The current U.S. Congress (2013–2014) will also consider a bill to revamp these grants to incentivize brownfield redevelopment as well as cleanup.[41]

As to the development and cost of technologies, the government already provides various funding mechanisms to help defray the costs. FERC recently issued two separate orders, which will increase the payments utilities must pay energy

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[38] *Id.* at 3.

[39] Hope Whitney, *Cities and Superfund: Encouraging Brownfield Redevelopment*, 30 ECOLOGY L.Q. 59, 67–68 (2003).

[40] EPA, *Brownfield Sites*, http://www.epa.gov/region4/landrevitalization/program/brownfieldsites.html (last updated Dec. 13, 2012). These grants are: (1) Assessment Pilots/Grants, (2) Cleanup Grants, and (3) Brownfields Revolving Loan Fund Grants. 42 U.S.C. § 9604(k) (2013); EPA, ASSESSMENT PILOTS/GRANTS, http://www.epa.gov/brownfields/assessment_grants.htm (last visited Mar. 25, 2013); EPA, CLEANUP GRANTS, http://www.epa.gov/brownfields/cleanup_grants.htm (last visited Mar. 25, 2013); EPA, REVOLVING LOAN FUND GRANTS, http://www.epa.gov/brownfields/rlflst.htm (last visited Mar. 25, 2013). The majority of these grants are for up to $200,000. EPA, FY13 GUIDELINES FOR BROWNFIELDS CLEANUP GRANTS 4, *available at* http://www.epa.gov/oswer/docs/grants/epa-oswer-oblr-12-09.pdf. However EPA can also award grants up to $1 million for "capitalizing revolving loan funds." JEFFREY MILLER & CRAIG JOHNSTON, THE LAW OF HAZARDOUS WASTE DISPOSAL AND REMEDIATION: CASES–LEGISLATION–REGULATION–POLICIES 701 (Thompson/West 2nd ed. 2005).

[41] The Brownfields Utilization, Investment, and Local Development Act of 2013, also known as the BUILD Act, S. 491, 113th Cong. (2013-2014), *available at* http://beta.congress.gov/bill/113th-congress/senate-bill/491/text. *See infra* Part V(A)(3).

storage facilities.[42] Congress may provide a second source of funding for energy developers in the future when it considers a bill that would provide tax incentives to investors—similar to those tax incentives for renewable sources.[43] If Congress were to adopt this legislation, developers of energy storage projects would have an even greater number of financial incentives to help fund their projects. Finally, agency funding for research may help reduce the cost of emerging technologies,[44] further reducing costs to developers.

Alternatively, states could provide incentives to build energy storage projects. States have been extremely effective in promoting renewable energy production through the use of Renewable Portfolio Standards ("RPSs").[45] RPSs are mandates that require states to procure a set minimum amount of energy from renewable energy sources.[46] This paper recommends the adoption, in addition, of Storage Portfolio Standards ("SPSs"). An SPS would mandate that states acquire a minimum amount of energy storage potential. SPSs should award multipliers[47] for storage sites located on remediated brownfields and, if states

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[42] Frequency Regulation Compensation in the Organized Wholesale Power Markets, 76 Fed. Reg. 67260-01 (Oct. 31, 2011) (codified at 18 C.F.R. pt. 35); Third-Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies, 78 Fed. Reg. 46178-01 (July 30, 2013) (codified at 18 C.F.R. pts. 35, 101).

[43] S. 1030, 113th Cong. (as introduced, May 23, 2013). *See also infra* Part V(B)(2).

[44] *See infra* Part V(A)(3).

[45] *See New Study Shows Benefits of State RPS, Plus a Great New Resource for Tracking State Energy Legislation*, CLEANTECH FINANCE, July 24, 2013, *available at* http://www.cleantechfinance.net/2013/state-rps-study/ (RPS "policies have been extremely effective at maximizing the amount of private investment in renewable energy projects.").

[46] Lincoln L. Davies, *Power Forward: The Argument for A National RPS*, 42 CONN. L. REV. 1339, 1342 (2010).

[47] *See, e.g.*, ENVTL. INFO. SERVS., COMPARISON OF RENEWABLE PORTFOLIO STANDARDS (RPS) PROGRAMS IN PJM STATES (2013), *available at* http://www.pjm-eis.com/~/media/pjm-eis/documents/rps-comparison.ashx (explaining what multipliers are for renewable sources).

desire, storage paired with particular types of production. As a case study, this paper considers California's new storage procurement law, which requires California's Public Utility Commission to adopt a procurement target, but only if it finds that a procurement target is appropriate.[48] This law resulted in California's Public Utility Commission requiring the Southern California Edison Company to obtain fifty megawatts of storage potential.[49] This paper applauds California's storage procurement law as a good starting point, but argues that a law with a direct mandate to obtain a minimum amount of energy storage potential would achieve greenhouse gas emission reductions more effectively.

This paper argues states should adopt SPSs to help renewable energy facilities increase their effectiveness at reducing greenhouse gases. Part II of this paper discusses the current renewable energy policies in the Unites States and considers their limitations; it also suggests that energy storage policies could take advantage of the existing renewable policies. Part III considers another limitation in energy—the difficulty electrical operators face in balancing the grid. Part IV then explains that energy storage facilities could provide an ideal backup source of energy to renewable energy facilities and that energy storage facilities could ease the strain on the electrical grid that renewable energy and other sources create. Finally, Part IV describes why distributed storage is superior to large-scale storage options and identifies three difficulties distributed storage faces: finding a location for distributed energy, developing technologies, and reducing the cost of the technologies.

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48 Cal. Pub. Util. Code §§ 2835–39 (West 2010).

49 Draft Decision Authorizing Long-Term Procurement for Local Capacity Requirements, Rulemaking 12-030114 (Cal. P.U.C. Feb. 13, 2013), *available at* http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M049/K133/49133558.PDF.

Part V(A) addresses the first of the issues identified in Part IV by suggesting that locating energy storage facilities on remediated brownfields would be beneficial to both brownfields and the electrical grid. Part V(A) then considers various funding mechanisms to building energy storage facilities. Part V(B) considers the second two issues distributed energy storage faces and suggests that raising payments to the energy storage facilities or lowering costs (i.e. taxes) for those facilities might provide an incentive to build more energy storage. Part VI advocates that requiring a mandate for energy storage, or SPSs, would be an even more effective way to create a market for energy storage facilities. Part VI then considers California's current energy storage procurement law as a case study. This paper concludes that states should adopt SPSs that mandate the procurement of a minimum amount of energy storage potential.

II. RENEWABLE POLICIES AND THEIR LIMITATIONS

Many U.S. renewable energy policies focus on building renewable energy facilities through incentives such as tax credits,[50] net metering,[51] and RPSs.[52] Many of these incentives have succeeded in increasing the number of renewable facilities on the electric grid. However, due to the intermittent nature of renewable energy, the sources require backup power.[53] This backup power often comes from peaker plants,[54] such as natural

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[50] The two largest tax credits are the PTC and the ITC. *See, e.g.*, BROWN & SHERLOCK, *supra* note 4, at 3–4 (explaining the PTC and ITC grants).

[51] *See, e.g.*, STARRS & WENGER, *supra* note 5, at 5B-7 (explaining how net metering works).

[52] *See, e.g.*, Fershee, *supra* note 6, at 51 (An RPS "require[s] electric utilities to procure a certain percentage of their electricity from renewable resources or purchase renewable energy credits from other sources to meet the standard.").

[53] *See, e.g.*, Vartabedian, *supra* note 7, at 1.

[54] *See, e.g.*, U.S. ENERGY INFO. ADMIN., GLOSSARY, http://www.eia.gov/tools/glossary/index.cfm?id=P (last visited May 9, 2013) (defining a peak 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").

gas plants,[55] which means the utilities cannot use the renewable sources to their full potential on decreasing emissions from greenhouse gas ("GHG") emissions from the electricity sector. An alternative backup power source that could help renewables reach their full potential is energy storage. Just as the government has used tax credits, net metering, and RPSs to incentivize the development and installation of renewable energy sources, it could also use these policies to incentivize the development of storage.

A. An Overview of Renewable Energy Policy

Tax credits and net metering provide financial incentives to building renewable resources, but mandates have been more productive in increasing renewable generation. The production tax credit ("PTC") has, to date, fluctuated, creating a boom-bust cycle of development. Nevertheless, both the PTC and investment tax credit ("ITC") have helped companies build more facilities. Net metering, on the other hand, gives a financial incentive for individuals and businesses to install solar panels. Finally, RPSs provide incentives for utility companies to purchase renewable energy from both developers that can benefit from tax credits and individual businesses that can benefit from net metering.

1. Tax Credits

The two largest tax credits on which renewable energy advocates rely are the PTC and the ITC. Renewable energy generators can only use either the PTC or the ITC.[56] The PTC

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[55] Vartabedian, *supra* note 7, at 1.

[56] *See, e.g.*, MARK BOLINGER ET AL., NATIONAL RENEWABLE ENERGY LABORATORY, NREL/TP-6A2-45359, PTC, ITC, OR CASH GRANT? AN ANALYSIS OF THE CHOICE FACING RENEWABLE POWER PROJECTS IN THE UNITED STATES 1 (2009), *available at* http://www.nrel.gov/docs/fy09osti/45359.pdf.

"provides a per kilowatt-hour tax credit for renewable energy produced at qualified facilities."[57] The PTC usually generates income for an applicant for ten years after the eligible facility's placed-in-service date.[58] Alternatively, the ITC is a tax incentive that allows companies to receive a specified percentage of their investment costs in renewable energy technology as a tax credit.[59] The ITC 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.[60]

Developers of renewable energy generators can benefit from the two tax credits in different ways depending on the type of renewable energy they build. Wind manufacturers have benefitted more from the PTC,[61] but because Congress has put the PTC through a series of sunsets and reauthorizations,[62] and because lead times in the production of wind farms generally last

[57] BROWN & SHERLOCK, *supra* note 4, at 3. The tax credit amount is 2.3¢ per kWh for wind, geothermal, and closed-loop biomass technologies and 1.1¢ per kWh for other eligible technologies. *Federal Renewable Electricity Production Tax Credit*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (DSIRE), http://dsireusa.org/incentives/incentive.cfm?Incentive_Code=US13F (last visited May 10, 2013).

[58] *Federal Renewable Electricity Production Tax Credit, supra* note 57.

[59] *Federal Business Energy Investment Tax Credit*, DATABASE OF STATE INCENTIVES FOR RENEWABLES & EFFICIENCY (DSIRE), http://www.dsireusa.org/incentives/ incentive.cfm?Incentive_Code=US02F (last visited Apr. 2, 2013).

[60] *See, e.g.*, *Federal Incentives*, TRINITY SOLAR, http://www.trinity-solar.com/business-owner/commercial-incentives/federal-incentives (last visited May 9, 2013).

[61] *See* Energy Info. Admin., *Wind Energy Tax Credit Set to Expire at the End of 2012* (Nov. 21, 2012), http://www.eia.gov/todayinenergy/detail.cfm?id=8870.

[62] PHILLIP BROWN, CONG. RESEARCH SERV., R42576, U.S. RENEWABLE ELECTRICITY: HOW DOES THE PRODUCTION TAX CREDIT (PTC) IMPACT WIND MARKETS? 3 (2012), *available at* http://www.fas.org/sgp/crs/misc/R42576.pdf.

twelve to eighteen months,[63] the wind industry has undergone a boom–bust cycle of production.[64] The American Wind Energy Association "seeks long-term tax policies, lasting more than just a few years, to provide consistency and market certainty."[65] The Association reports that "[i]n the years following expiration [of the PTC, wind] installations dropped between 73 and 93%."[66] Meanwhile, the solar industry has focused more on the ITC:

> The expansion of the ITC in 2005 and its 8-year extension in 2008 were inflection points that spurred significant activity in the U.S. solar industry . . . . Approximately 90 percent of the nearly 5,000 megawatts of solar capacity in the U.S. today has been installed since the ITC was increased at the beginning of 2006.[67]

Both the PTC and ITC are crucial to the expansion of renewable energy in the United States. In fact, when Congress reauthorized the PTC and the ITC on January 1, 2013, Renewable Energy World reported, "[t]he extension of the [PTC] and [ITC]

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[63] *Id.*

[64] *See* Energy Info. Admin., *supra* note 61 ("From 1999 to 2004, Congress allowed the PTC to expire three times, each time retroactively extending it several months after the expiration deadline had passed. The two-year cycle of expiration and re-extension is apparent . . . . In the 12-month period immediately prior to the expiration dates . . . , new installations reached high levels as developers rushed to beat the legislative deadline, followed by a substantial retrenchment in the following year as the status of the tax credit was sorted out.").

[65] BROWN, *supra* note 62, at 3.

[66] Am. Wind Energy Ass'n, *Federal Production Tax Credit for Wind Energy Fact Sheet* 1, *available at* http://aweablog.org/blog/post/federal-production-tax-credit-for-wind-energy_1..

[67] U.S. P'SHIP FOR RENEWABLE ENERGY FINANCE, PAID IN FULL: AN ANALYSIS OF THE RETURN TO THE FEDERAL TAXPAYER FOR INTERNAL REVENUE CODE SECTION 48 SOLAR ENERGY INVESTMENT TAX CREDIT (ITC) 1 (2012), *available at* http://www.uspref.org/images/docs/SC_ITC-Payback_July_12_2012.pdf (citing the Solar Energy Industries Association and GTM Research).

is expected to save up to 37,000 jobs and . . . to revive business at nearly 500 manufacturing facilities across the country."[68]

Recently, Congress considered creating tax credits for energy storage production.[69] Considering how successful the PTC and ITC have been for incentivizing renewable energy production, a tax credit could be extremely helpful in bringing energy storage production off the ground.

2. *Net Metering*

Net metering programs incentivize customers to install their own renewable energy systems.[70] Under net metering, a utility company installs a two-way meter at a customer's place of residence and charges the customer for the "net" energy the customer consumes.[71] To date, solar photovoltaics have benefitted the most from net metering programs because the technology is the cheapest and easiest technology for individual customers to install on their own property.[72] For example, according to the California Public Utilities Commission, "the installed capacity for solar rose 47 percent from 2009 to 2010 alone" due to California's net metering program.[73] In Vermont,

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[68] ***WIND ENERGY TAX CREDIT EXTENSION PASSES WITH FISCAL CLIFF DEAL*, Renewable Energy World.com, JAN. 2, 2013, . HTTP://WWW.RENEWABLEENERGYWORLD.COM/REA/NEWS/ARTICLE/2013/01/BREAKING-WIND-ENERGY-TAX-CREDIT-EXTENSION-PASSES-WITH-FISCAL-CLIFF-DEAL.**

[69] *See infra* Part V(B)(2).

[70] *See, e.g.*, STARRS & WENGER, *supra* note 5, at 5B-7 (explaining how net metering works).

[71] *See, e.g.*, *Solar Portal*, DSIRE, http://www.dsireusa.org/solar/solarpolicyguide/?id=17 (last visited July 10, 2013).

[72] STARRS & WENGER, *supra* note 5, at 5B-3, 5A-6 (Photovoltaic technology is the "quintessential technology for distributed applications." "[P]olicies that promote distributed generation will, as a practical matter, promote [photovoltaics].").

[73] STEVEN WEISSMAN AND NATHANIEL JOHNSON, THE STATEWIDE BENEFITS OF NET-METERING IN CALIFORNIA 5 (Berkeley Law Feb. 17, 2012), *available*

"[t]he number of [photovoltaic] systems applying for net metering permits annually has grown by a factor of more than four since 2008."[74] However, state net metering plans contain maximum capacity limits,[75] which will reduce their effectiveness as the programs near their capacities.

Net metering could similarly apply to distributed storage if individuals use their plug-in electric vehicles for energy storage.[76] Alternatively, if individuals install small, dedicated energy storage units on their homes, they would be able to benefit from a net metering program.

3. *Renewable Portfolio Standards*

RPSs are mandates that "require electric utilities to obtain a certain percentage of the energy they sell from renewable resources."[77] Since 1983, thirty-eight states have adopted an RPS.[78] Many states allow utilities to use Renewable Energy

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at http://www.law.berkeley.edu/files/The_Statewide_Benefits_of_Net-Metering_in_CA_Weissman_and_Johnson.pdf. In addition to net metering, the California Solar Initiative and other incentive programs were also available to Californians during this time. *Id.*

[74] PUBLIC SERVICE DEPARTMENT, EVALUATION OF NET METERING IN VERMONT CONDUCTED PURSUANT TO ACT 125 OF 2012 3 (Jan. 15, 2013), *available at* http://publicservice.vermont.gov/sites/psd/files/Topics/Renewable_Energy/Net_Metering/Act%20125%20Study%2020130115%20Final.pdf.

[75] *E.g.*, California caps its net metering program at "5% of aggregate customer peak demand." *California Net Metering*, DSIRE, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA02R (last visited May 6, 2013). Vermont caps its net metering program at "4% of utility's 1996 peak demand or peak demand during most recent calendar year (whichever is greater)." *Vermont Net Metering*, DSIRE, http://www.dsireusa.org/incentives/ incentive.cfm?Incentive_Code=VT02R (last updated Oct. 9, 2012).

[76] *See* Delucchi & Jacobson, *supra* note 30, at 1173.

[77] Davies, *supra* note 46, at 1342.

[78] Center for Climate and Energy Solutions, RENEWABLE & ALTERNATIVE ENERGY PORTFOLIO STANDARDS,

Credits ("RECs"), which are tradable certificates that represent the "greenness" of the electricity produced,[79] to satisfy their RPS mandate.[80] Some RPSs include carve-outs, or "requirements that a certain percentage of the portfolio be generated from a specific energy source," to incentivize the development of specific technologies or resources.[81] Other RPSs include multipliers for

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http://www.c2es.org/sites/default/modules/usmap/pdf.php?file=5907 (updated Mar. 21, 2013). This does not include the District of Columbia, which has also adopted its own RPS. Davies, *supra* note 46, at 1341 n.9. Four of these states – Michigan, Ohio, Pennsylvania, and West Virginia – have adopted an Alternative Energy Portfolio Standard (AEPS), which is a law that requires a "certain percentage of a utility's power plant capacity or generation to come from renewable or alternative energy sources by a given date." Center for Climate and Energy Solutions, *supra* note 78, at 1. Of these four states, all but West Virginia requires that renewables account for a certain percentage of the AEPS. *Id.* West Virginia allows renewable energy sources to comprise a portion of the AEPS, but does not require a minimum amount of renewable sources. *Id.* Alternative energy sources include pumped storage hydroelectric projects, energy-efficiency programs, demand side management, third-generation nuclear power plants, fuel cells, waste coal, municipal solid waste, coal integrated gasification combined cycle, carbon capture and storage, supercritical coal technology, ultrasupercritical coal technology, coal bed methane, natural gas, and recycled energy. *Id.* As more states create their own RPSs, some advocates have called for a national RPS that would supersede State RPSs. Davies, *supra* note 46, at 1365–75. However, to date, Congress has been reluctant to adopt a national RPS. *Id.* at 1364–65.

[79] BRUCE ELDER, ENERGY POLICY INITIATIVES CENTER, UNIVERSITY OF SAN DIEGO SCHOOL OF LAW, RENEWABLE ENERGY CREDITS (RECS) IN CALIFORNIA: STATUS AFTER PASSAGE OF SENATE BILL 107 OF 2006, at 7 (2007), *available at* http://www.sandiego.edu/documents/epic/070625_RECs_SB107_FINAL_000.pdf.

[80] *Renewable Energy Certificates (RECs)*, EPA, http://www.epa.gov/greenpower/gpmarket/rec.htm (last visited Mar. 26, 2013) (explaining how RECs work).

[81] Center for Climate and Energy Solutions, RENEWABLE & ALTERNATIVE ENERGY PORTFOLIO STANDARDS, http://www.c2es.org/node/9340 (last visited Apr. 12, 2014).

particular technologies, which permit chosen technologies to count for more RECs than others.[82]

The RPS's renewable energy purchase mandate provides private companies with an incentive to invest in renewable energy. Although some claim that renewable energy's cost competitiveness with traditional energy sources still generates a barrier to installing more renewable energy facilities,[83] an RPS mandate ensures that utilities purchase a minimum amount of renewable energy. Therefore, renewable energy producers can rely on this purchase requirement when calculating potential earnings before constructing renewable energy facilities. This reliability explains why the National Association of Local Government Environmental Professionals ("NALGEP") has said that the most important feature of state policy that affects renewable energy projects is the strength of its RPS.[84]

Because RPSs have been so effective in increasing the amount of renewable energy production facilities, this paper advocates for SPSs as a way to incentivize the installment of energy storage facilities.[85]

B. Renewable Energy Limitations

While tax incentives, net metering, and RPSs have led to an increase in renewable energy production, the U.S. Energy Information Administration predicts that electricity consumption in the United States will continue to rise by increasing approximately thirty percent in less than thirty years.[86]

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[82] Lynn M. Fountain, *Johnny-Come-Lately: Practical Considerations of A National RPS*, 42 CONN. L. REV. 1475, 1486 (2010).

[83] *See, e.g.*, Uma Outka, *Environmental Law and Fossil Fuels: Barriers to Renewable Energy*, 65 VAND. L. REV. 1679, 1690–91 (2012).

[84] *Green Energy Development on Brownfield Sites*, 30 HAZARDOUS WASTE CONSULTANT 1.1, 1.3 (2012).

[85] *See infra* Part VI(B).

[86] U.S. ENERGY INFO. ADMIN., *supra* note 1, at 138.

Renewable energy technologies could provide much of this demand, but barriers to bringing more renewable energy facilities online, including siting and cost, have stunted their growth.[87] As this section explains, many of these barriers relate to the intermittent nature of renewable power. Increased energy storage could help renewable energy developers overcome the impediments intermittency creates.

Traditional siting concerns for all energy production facilities include interconnection to transmission lines; impacts on the surrounding land, water, and wildlife; and the effects on the local community.[88] Renewable energy facilities face additional siting concerns, particularly geographical constraints, because renewable energy resources are not ubiquitous.[89] Wind and solar energy comprise the greatest number of new renewable energy facilities in the United States.[90] However, these two sources can produce the greatest amount of energy in areas of the country that do not contain large transmission lines.[91] Because

[87] Many potential renewable energy projects, such as the infamous Cape Cod wind project, suffer from the "Not in My Back Yard" (NIMBY) phenomenon. This phenomenon rises out of the recognition that energy projects are necessary for electricity consumers, but local opposition prefers that energy projects be located elsewhere. *See* Iva Ziza, *Siting of Renewable Energy Facilities and Adversarial Legalism: Lessons from Cape Cod*, 42 NEW ENG. L. REV. 591, 604–06 (2008). However, distributed generation projects generally do not raise NIMBY problems. This is likely due to the fact that these projects are generally small and often contained in cities, where people expect construction to occur.

[88] Uma Outka, *Siting Renewable Energy: Land Use and Regulatory Context*, 37 ECOLOGY L.Q. 1041, 1067 (2010).

[89] *Id.* at 1068.

[90] *Large-scale hydroelectric power has largely been built out in the United States. The proposed Susitna-Watana hydroelectric dam is a rare proposal in the past couple of decades. See, e.g., Felicity Barringer, Proposed Dam Presents Economic and Environmental Challenges in Alaska, N.Y. TIMES, Mar. 6, 2013, available at http://www.nytimes.com/2013/03/07/science/earth/proposed-dam-presents-twin-conundrums-in-alaska.html? pagewanted=all.*

[91] Outka, *supra* note 88, at 1068.

energy producers must provide their own interconnection to the grid,[92] and because building a transmission line is costly[93] and takes more time to build than small renewable energy projects themselves,[94] developers may forego building renewable energy facilities.

In addition, some renewable resources do not produce power continuously. Solar facilities—both concentrated solar and photovoltaic—generally produce energy during the day, with a greater amount produced during the summer months.[95] However, variables such as cloud cover can interrupt solar energy production.[96] Wind, on the other hand, generally produces more energy at night,[97] when consumer use declines.[98] Further, calm spells can follow gusts, so that, while forecasting can predict, to a large extent, how much wind to expect, utilities can only rely on such forecasting on a short-term basis.[99] This unreliability

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[92] MARCELINO MADRIGAL & STEVEN STOFT, TRANSMISSION EXPANSION FOR RENEWABLE ENERGY SCALE-UP: EMERGING LESSONS AND RECOMMENDATIONS (Energy and Mining Sector Board Discussion Paper No. 26) 6 (2011), *available at* http://siteresources.worldbank.org/EXTENERGY2/Resources/Transmission-Expansion-and-RE.pdf.

[93] *Id.* at 15 (building transmission costs "can require significant upfront investments from renewable developers").

[94] *Id.* at 6.

[95] *See, e.g.*, *Energy Basics: Solar Energy Resources*, DEP'T OF ENERGY, http://energy.gov/eere/energybasics/articles/solar-energy-resource-basics (last visited May 9, 2013).

[96] *See, e.g.*, *id.*

[97] *See, .g.*, Peter Dizikes, *Energy Answer: Blowing in the Wind?*, MIT NEWS, May 25, 2010, http://web.mit.edu/newsoffice/2010/wind-economics-0525.html.

[98] *E.g.*, Shannon Baker-Branstetter, *Distributed Renewable Generation: The Trifecta of Energy Solutions to Curb Carbon Emissions, Reduce Pollutants, and Empower Ratepayers*, 22 VILL. ENVTL. L.J. 1, 27 (2011).

[99] *See* G. GIEBEL ET AL., THE STATE-OF-THE-ART IN SHORT-TERM PREDICTION OF WIND POWER 50 (2nd ed. 2011), *available at* http://130.226.56.153/zephyr/publ/GGiebelEtAl-StateOfTheArtInShortTermPrediction_ANEMOSplus _2011.pdf.

creates a need for backup power[100] utilities can deploy[101] as needed, which often comes from peaker plants[102] such as natural gas plants. However, natural gas extraction emits methane, which has a global warming potential far greater than that of carbon dioxide.[103] Therefore, the use of natural gas plants to back up renewable energy sources seriously diminishes those renewable sources' effectiveness in reducing GHG emissions.

One option that could help renewables reach their full potential in decreasing the amount of GHG emissions is energy storage. Energy storage could store and use clean, renewable energies and, if ubiquitous, eventually replace the need for natural gas backup plants. Reducing the need for natural gas backup plants could decrease the need to extract methane for those plants. This reduced need, in turn, would reduce methane emissions and increase the effectiveness of renewable energy sources in reducing GHG emissions.

III. BALANCING THE GRID AT 60 HERTZ

In addition to the limitations discussed above in bringing renewable energy online, the intermittent nature of renewable energy faces a large infrastructure challenge. One large limitation in the current electrical system, no matter what the generating source is, is the electrical grid's susceptibility to power failures. Grid failure occurs either when insufficient electricity is available for consumers to use or when energy suppliers put more electricity on the grid than consumers

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[100] *See, e.g.*, Vartabedian, *supra* note 7.

[101] Deployable energy is energy that utilities can turn on at a moment's notice.

[102] *See, e.g.*, U.S. ENERGY INFO. ADMIN, *supra* note 54 (defining a peak 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").

[103] The most recent study found the global warming potential of methane to be 105 times that of carbon dioxide over a twenty year period, and thirty-three times that of carbon dioxide over a one hundred year period. HOWARTH ET AL., *supra* note 10, at 5.

demand.[104] This imbalance can lead to blackouts, which can be costly and take time to mend. Because the balance of the system is so central to avoiding blackouts, the intermittent nature of renewable energy makes those sources more complicated to manage.

In the normal course of use, generators inevitably fail on occasion. When one generator fails, the electrical grid operator will compensate for that failure by pulling power from other sources.[105] Electrical engineers rely on "spinning reserves" when this occurs.[106] Spinning reserves are "the extra generating capacity that is available by increasing the power output of generators that are already connected to the power system."[107] This extra generating capacity is "ready to instantaneously respond to control signals from the system operator in order to maintain transmission system integrity."[108] However, when grid operators pull too much energy from compensating sources, they can cause the generators providing the extra generating capacity to fail, which in turn causes the grid operator to over-tax different power generators, which may also fail, creating what is known as

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[104] *SEE, E.G.*, RICHARD FUCHS, *WIND ENERGY SURPLUS THREATENS EASTERN GERMAN POWER GRID*, European Dialoge, (JAN. 4, 2011), *AVAILABLE AT* HTTP://WWW.EURODIALOGUE.ORG/WIND-ENERGY-SURPLUS-THREATENS-EASTERN-GERMAN-POWER-GRID.

[105] B. J. KIRBY, OAK RIDGE NAT'L LAB., SPINNING RESERVE FROM RESPONSIVE LOADS 13 (Jan. 2003), *available at* http://certs.lbl.gov/pdf/spinning-reserves.pdf (explaining the role of spinning reserves).

[106] *Id.* at 3.

[107] Claudio Martino, *Any Way the Wind Blows*, DISTRIBUTED ENERGY (Nov. 26, 2012), *available at* http://www.distributedenergy.com/DE/Articles/Any_Way_the_Wind_Blows_19543.aspx.

[108] *ID.*

a "cascading failure."[109] Cascading failures can eventually lead to blackouts.[110]

One of the largest cascading failures resulting in a blackout in North America occurred on August 14, 2003.[111] That blackout affected an estimated fifty million people in eight U.S. states and Ontario, Canada for up to a week.[112] The blackout cost the United States between $4 billion and $10 billion,[113] and in Canada, "gross domestic product was down 0.7% in August, there was a net loss of 18.9 million work hours, and manufacturing shipments in Ontario were down $2.3 billion (Canadian dollars)."[114]

To avoid blackouts, the electrical grid requires the balancing of supply and demand to a near-perfect degree. In the United States, operators maintain the electrical grid at 60 hertz ("Hz").[115] Ideally, this means that "the transmission grid would always operate precisely at 60 Hz . . . even as its millions of consumers impose varying loads at tens of thousands of substations."[116] A demonstrative case of electrical grid balancing

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[109] U.S.–CANADA POWER SYSTEM OUTAGE TASK FORCE, *supra* note 13, at 73–74.
[110] U.S.–CANADA POWER SYSTEM OUTAGE TASK FORCE, *supra* note 13, at 73–74.
[111] U.S.–CANADA POWER SYSTEM OUTAGE TASK FORCE, *supra* note 13, at 179.
[112] U.S.–CANADA POWER SYSTEM OUTAGE TASK FORCE, *supra* note 13, at 1.
[113] U.S.–CANADA POWER SYSTEM OUTAGE TASK FORCE, *supra* note 13, at 1 (citing ELECTRIC CONSUMER RESEARCH COUNCIL, THE ECONOMIC IMPACTS OF THE AUGUST 2003 BLACKOUT (2004)).
[114] U.S.–CANADA POWER SYSTEM OUTAGE TASK FORCE, *supra* note 13, at 1 (citing Statistics Canada, *Gross Domestic Product by Industry*, STATISTICSCANADA.CA (Aug. 2003), http://www.statcan.gc.ca/daily-quotidien/031031/dq031031a-eng.htm; Statistics Canada, *Monthly Survey of Manufacturing*, STATISTICSCANADA.CA (Aug. 2003), http://www.statcan.gc.ca/daily-quotidien/031216/dq031216a-eng.htm.)
[115] Backhaus & Chertkov, *supra* note 11, at 44.
[116] Backhaus & Chertkov, *supra* note 11, at 44.

occurs in England, in what is known as the "TV pick-up."[117] After a popular television show or sporting event ends, "[m]illions of lights and kettles are simultaneously switched on" while "[t]he National Grid . . . must keep the frequency at 50hz."[118] This often requires turning additional peak load generators online specifically to combat the power surge.[119] To combat the threat of blackouts, electrical operators "'have to forecast [energy demand] second by second, minute by minute.'"[120] They base predictions on what customers required on a similar day with "'exactly the same weather.'"[121]

Maintaining the grid at an exact frequency is nearly impossible. Electrical grid operators must not only balance supply with changing power demands, but also compensate for equipment failure. To make the task even more difficult, the electrical grid operator needs to take into account the "finite response time of each generator."[122] That is, some generators react more quickly to commands than others—some generators can come online at the flip of a switch (i.e. natural gas), while others take some time to warm up.[123] Because an electrical operator cannot predict demand with perfect accuracy, operators set limits that define a range of frequencies within which they must maintain operations. "Operators of the grid maintain its reliability by ensuring that deviations [from the ideal 60 Hz] never grow to catastrophic size."[124] These limits give operators a

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[117] *See, e.g.*, *Can you have a big 'switch off'?*, BBC NEWS, *available at* http://news.bbc.co.uk/2/hi/uk_news/magazine/6981356.stm (last updated Sept. 6, 2007).

[118] *Id.* Note that England keeps its grid at 50 Hz, while the U.S. keeps its grid at 60 Hz. The principles behind balancing the grid, however, remain the same. Backhaus & Chertkov, *supra* note 11, at 44.

[119] BBC NEWS, *supra* note 117.

[120] BBC NEWS, *supra* note 117.

[121] BBC NEWS, *supra* note 117.

[122] Backhaus & Chertkov, *supra* note 11, at 44.

[123] *See, e.g.*, CORDARO, *supra* note 14, at 3.

[124] Backhaus & Chertkov, *supra* note 11, at 44.

minimal amount of wiggle room to balance the grid, but if the electrical grid operator allows the frequency to go outside of the outer bounds, the grid can fail and cause blackouts.

Time-intermittent wind and photovoltaic power create even more challenges for grid operators. As the demand for renewable energy sources increases, the shortcomings of the electrical grid will become more problematic. "The changes will lead to grids that are more stochastic and exhibit dynamics requiring new stability criteria that address emerging problems and can be evaluated faster, closer to real time."[125] In Germany, where renewable energy sources have priority over traditional power plants, transmission companies send excess renewable energy to other counties because of the grid's inability to store electricity efficiently.[126] In the United States, the Bonneville Power Administration, based in the Pacific Northwest, has taken another approach, which includes booting wind energy supplies off line in favor of hydroelectric power when too much supply exists, allowing clean energy to go unused.[127] While grid operators make these decisions based on the necessity to balance the grid, decisions like Bonneville's can make investments in clean energy superfluous.

An alternative to wasting renewable energy sources is energy storage. Energy storage could help balance the grid

[125] Backhaus & Chertkov, *supra* note 11, at 44.
[126] Fuchs, *supra* note 104.
[127] CASSANDRA PROFITA, *WIND VS. WATER: THE POWER STRUGGLE CONTINUES*, OPB.org (MAY 13, 2011, 10:26 AM), http://www.opb.org/news/blog/ecotrope/wind-vs-water-the-power-struggle-continues/. Bonneville faces an interesting dilemma: it has to choose between using wind energy and hydroelectric power. *Id.* Even though electric operators can generally control hydroelectric power sources, in situations where too much water could harm fish, the Endangered Species Act requires that the electric operator not harm the fish. *Id.* Iberdrola Renewables filed a case with FERC against Bonneville to fight the Administration's decision to take wind energy offline. *Id.* Iberdrola Renewables, Inc., 141 FERC 61233 (Dec. 20, 2012).

because of its potential to store excess supply when consumers do not require it and provide energy at a moment's notice when demand increases. Energy storage has a very short reaction time,[128] which would allow electrical grid operators to rely on energy storage to help maintain the required 60 Hz frequency in the system. In addition, energy storage could eventually replace spinning reserves, making each individual power plant more energy efficient.

IV. THE MISSING LINK: ENERGY STORAGE

As explained in Part II, renewable energy requires backup power. However, the source of backup power can make an enormous difference in the amount of GHG emissions those backup sources produce. Because the impetus for building renewable energy facilities is to reduce GHG emissions, a fossil fuel plant, like natural gas, would not help achieve that goal. Instead, energy storage creates a viable backup option. An added benefit of energy storage is that it could increase the reliability and integrity of the electrical grid. This section discusses various energy storage technologies and explains that small-scale, distributed technologies have increased benefits over large-scale technologies; namely, that distributed storage could help reduce transmission congestion.

A. Potential for Storage

Renewable energy sources require backup power, at least as technology currently exists. However, choosing the source of backup power can make a significant difference in the amount of GHG emissions these backup sources produce. For example, the production, transportation, and use of natural gas for natural gas plants results in the leakage of methane into the atmosphere.[129]

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[128] Roberts, *supra* note 16, at 46.
[129] *See* HOWARTH ET AL., *supra* note 10, at 2-3.

This is particularly true for hydraulic fracturing,[130] or fracking, which is important because future natural gas production will largely come from fracking.[131] This leakage negates some of the GHG emissions reduction benefits that renewable energy sources provide.[132] Natural gas is therefore not an ideal backup power for renewable energy production, if the purpose of renewable energy production is to reduce the amount of GHG emissions.

Energy storage could serve as backup power for renewables in place of peaker plants to help renewables reach their full potential in decreasing GHG emissions. Because wind generally produces more power when consumer use declines, energy storage could provide a reserve of power during the day using the energy those facilities create at night. Storage facilities would not produce their own source of power, but rather bank power from other sources for use later. Therefore, the energy generated by energy storage facilities would only produce as many GHG emissions as the original source of energy produces. Hence, if a renewable energy source charged an energy storage facility, the energy storage facility would effectively produce renewable energy power. Similarly, if a fossil fuel plant charged an energy storage facility, the energy storage facility would effectively produce fossil fuel power. However, because renewable energy sources are the sources that require backup power on a more regular basis, energy storage facilities would

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[130] Hydraulic fracturing is the process in which individuals send fluid, often with proppants, into drilled wells, fracturing the rock underneath the surface. Afterwards the individuals draw both the fluid and the natural gas out from the top. *E.g.*, *Hydraulic Fracturing: The Process*, FRACFOCUS.ORG, http://fracfocus.org/hydraulic-fracturing-how-it-works/hydraulic-fracturing-process (last visited July 13, 2013). Another problem with fracking is the leakage of chemicals into drinking water. *E.g.*, Abrahm Lustgarten, Nicholas Kusnetz & ProPublica, *EPA: Natural Gas Fracking Linked to Water Contamination*, SCIENTIFIC AMERICAN, Dec. 9, 2011, *available at* http://www.scientificamerican.com/ article.cfm?id=fracking-linked-water-contamination-federal-agency.

[131] U.S. ENERGY INFO. ADMIN., *supra* note 1, at 79.

[132] HOWARTH ET AL., *supra* note 10, at 2-3.

most likely serve as backup power to renewable energy facilities, not as backup to fossil fuel plants. Policymakers should therefore consider energy storage as complimentary to renewable energy facilities.

The Federal Energy Regulatory Commission ("FERC") has recognized the many benefits storage can yield. In its 2009 Smart Grid Policy statement, FERC identified three important operational and planning issues: (1) resource adequacy; (2) resource management; and (3) reduced system inertia.[133] Resource adequacy is the "potential loss and unavailability of variable resources at peak periods and other critical times such as loss of other generators or transmission lines."[134] Resource management is the "potential for over-generation by variable resources during off-peak periods when there is sufficient load to accommodate such generation."[135] Reduced system inertia is the "potential loss of system stability due to the high penetration of variable resources with low inertia properties."[136] FERC stated, "investment in large amounts of electricity storage could ultimately address both the resources adequacy and resource management concerns."[137]

Energy storage could go a long way in balancing the electrical grid described in Part III. Energy storage could provide resource management services because it can accommodate and remove excess generation from the electricity grid.[138] Energy storage could also help resource adequacy because energy storage can compensate for drastic unexpected reductions in supply.[139] In fact, as an increased number of renewable energy sources

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[133] Smart Grid Policy, 126 F.E.R.C. P 61,253, 62,419 (Mar. 19, 2009).
[134] *Id.*
[135] *Id.*
[136] *Id.*
[137] *Id.*
[138] *Id.* at 62,420.
[139] *Id.*

come online, the frequency of the grid may begin to fluctuate more with increased uncertainty. Energy storage compensates for the exact challenges that intermittent renewable energy sources create: wind power can create excess energy from gusts of wind[140] and solar power can drop in supply due to cloud cover,[141] while energy storage can absorb excess energy and redeploy it as necessary. Because energy will enter the storage system before the utility disperses it to consumers, the utility will know the exact amount of energy it can expect to have available from storage. In addition, changes in renewable energy supplies can fluctuate rapidly. Depending on the kind of energy storage technologies deployed, energy storage may be able to combat these rapid fluctuations in power supply or help reduce system inertia.[142] Because storage can accommodate all of the complications renewable energy sources create, storage appears to be the ideal match for renewable generators.

One final incentive for storage is that developers may be able to earn back their investment in constructing the storage facility. Buying and "[s]toring low-cost electricity (e.g. overnight) and selling it during peak-demand periods could soon become cost effective due to the increasing cost of peak electricity."[143] Energy storage operators may therefore have the opportunity to take advantage of this change in price to defray investment costs.

B. Technology Options

In the past, research has largely focused on large-scale storage, such as pumped hydroelectric power and Compressed Air Energy Storage ("CAES"), because electric utilities generally prefer to build large power plants rather than accommodate small,

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140 *See* G. GIEBEL ET AL., *supra* note 99.
141 *See, e.g.*, *Energy Basics: Solar Energy Resources*, *supra* note 95.
142 *See, e.g.*, Roberts, *supra* note 16, at 46 (batteries and flywheels are fast-ramping systems).
143 TECHNOLOGY BRIEF, *supra* note 20, at 4.

distributed generation facilities owned by others.[144] However, many emerging small-scale technologies have developed significantly in recent years and have achieved greater efficiency than large-scale energy storage plants.

Pumped hydro is the furthest advanced and most commonly used storage technology.[145] A hydro system consists of two bodies of water located at different elevations. The system stores energy by pumping water from the lower reservoir to the higher reservoir.[146] The system releases energy by allowing the water in the upper reservoir to flow downhill through a turbine, which creates electricity.[147] Because of the distance required to move the water, the major drawback of this technology is that it requires a significant amount of space.[148] Pumped hydro has an efficiency[149] of seventy to eighty percent.[150] However, pumped hydro is less efficient than lithium-

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[144] Utilities only earn a rate of return on the structures they build; therefore, utilities can charge consumers for a rate of return on large power plants but they cannot charge consumers for a rate of return for maintaining small distributed generation owned by others. *See, e.g.*, PETER FOX-PENNER, SMART POWER: CLIMATE CHANGE, THE SMART GRID, AND THE FUTURE OF ELECTRIC UTILITIES 181–82 (2010) (explaining how a utility's rate-of-return works). One additional large-scale storage technology is concentrated solar plants, which use molten salt to store energy. *E.g.*, David Biello, *How to Use Solar Energy at Night*, SCIENTIFIC AMERICAN, Feb. 18, 2009, *available at* http://www.scientificamerican.com/article.cfm?id=how-to-use-solar-energy-at-night. This paper does not discuss molten salt storage because it is specific to one type of renewable power.

[145] TECHNOLOGY BRIEF, *supra* note 20, at 7.

[146] *Id.* at 7–8.

[147] *Id.*

[148] *Id.* at 8.

[149] The "efficiency," or "roundtrip efficiency" of an energy storage system is "the ratio of energy discharged by the system to the energy needed to charge it at each cycle and accounts for energy lost in the storage cycle." *Id.* at 7. In other words, the efficiency of an energy storage system is a measure of how much energy is lost when the facility stores energy and then re-releases it.

[150] *Id.* at 8.

ion's efficiency rate of ninety percent.[151] Research cannot significantly improve the efficiency of the system because much of the loss in efficiency comes from the power needed to lift the water from the lower reserve to the higher reserve.[152] However, where space is not a constraint, and where efficiency is not of the utmost importance, pumped hydro is a well-established, reliable source of energy storage.

CAES is another large-scale energy storage technology that has recently gained momentum. CAES systems store energy by compressing air and storing that compressed air in underground mines or caverns. The system then produces energy by releasing the stored air through a turbine.[153] Despite recent advancements in CAES systems,[154] they typically have a lower efficiency than that of pumped hydro, at forty-five to sixty percent.[155] Further, because of their need to compress a large amount of air, CAES systems also require a significant amount of space.[156] Currently, only three CAES systems are in operation in the world,[157] but there are plans to build two more.[158] If the

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[151] *Id.* at 15.
[152] *See id.* at 8.
[153] *Id.* at 8.
[154] The first adiabatic CAES system is planned for construction in Germany for 2019. Gies, *supra* note 27. An adiabatic system is a system that does not allow heat to enter or leave the system. *Id*
[155] TECHNOLOGY BRIEF, *supra* note 20, at 15.
[156] TECHNOLOGY BRIEF, *supra* note 20, at 9.
[157] These include: the 290 MW Huntorf plant in Germany, the 110 MW McIntosh plant in Alabama, and the 2 MW near-isothermal plant in Gaines, Texas. *Id.*; WHO WE ARE, GENERAL COMPRESSION, http://www.generalcompression.com/index.php/who (last visited March 29, 2013); WHAT WE DO, GENERAL COMPRESSION, http://www.generalcompression.com/index.php/ tdw1 (last visited March 29, 2013).
[158] Anderson County, Texas is planning a CAES system that could be online by mid-2016. Paul Stone, *Anderson County Getting Energy Center: Company to Build Compressed Air Energy Storage Plant*, PALESTINE HERALD-PRESS, July 11, 2012, *available at* http://palestineherald.com/local/x941521205/Anderson-County-getting-

technology improves significantly, CAES may become a more popular and efficient storage option.

Utilities are considering using plug-in electric vehicles ("PEVs") as small-scale distributed energy storage.[159] "[C]harging the batteries of electric vehicles overnight would offer a unique opportunity for distributed electricity storage."[160] However, American consumers prefer to have access to their cars at a moment's notice. Therefore, consumers may not allow their batteries to drain below a certain level, minimizing PEV batteries' usefulness as a reliable distributed storage mechanism.[161] Instead, utilities should consider obtaining dedicated distributed storage facilities that they can control and maintain.

Recently, companies have improved small-scale technologies and a few companies have researched small-scale compressed air systems.[162] Others have researched using old PEV car batteries, combined in sequence, as a dedicated storage system.[163] Because old PEV batteries retain three-quarters of their storage potential even after they are no longer adequate for driving,[164] these systems should be relatively cheap to produce

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energy-center. Germany is planning the first adiabatic CAES system, which could be online by 2019. Gies, *supra* note 27.

[159] Delucchi & Jacobson, *supra* note 30, at 1172.

[160] TECHNOLOGY BRIEF, *supra* note 20, at 20.

[161] *Cf.* Smith, *supra* note 32 "Range anxiety," or the fear that a PEV's car battery will not have enough charge for a planned trip, is the number one reason why customers decide not to buy PEVs. *Id.* Similarly, owners of PEVs may fear that if they let their batteries drain, they will not have enough charge for an unplanned trip.

[162] Gies, *supra* note 27.

[163] Don Sherman, *When Electric-Car Batteries Dies, Where Will They End Up?*, N.Y. TIMES, June 11, 2010, http://www.nytimes.com/2010/06/13/automobiles/13RECYCLE.html?pagewanted=all&_r=0

[164] "[W]hen a battery pack is no longer able to provide full performance or driving range and a replacement is deemed necessary, three-quarters of its

and provide significant storage capacity. In addition, these systems could solve the problem of improper disposal of PEV batteries, which, if left unimpeded, has the potential to "undo the good accrued through years of zero-emissions motoring."[165]

Two additional technologies, which lend themselves well to being reliable backup for wind energy, are vanadium redox flow cells and lithium-ion cells. Vanadium redox flow cells are "electro-chemical energy storage systems based on the vanadium ability to exist at four different oxidation levels. During energy charging, vanadium ions in a diluted solution of sulphuric acid vary their oxidation, thus storing electricity in the form of electro-chemical energy. The process reverses during discharging."[166] Vanadium redox flow cells have an efficiency of sixty-five to eighty percent with a "relatively low energy density by volume" of twenty to forty watt-hours per liter.[167] Lithium-ion batteries charge when lithium ions move from the cathode to the anode through a non-aqueous electrolyte; the ions move back during discharging.[168] These batteries are one of the most efficient options with a ninety percent efficiency rate.[169] Their energy density by volume is much higher, with a range of 140 to 630 watt-hours per liter.[170]

The Energy Information Administration has said, "[c]ost is currently one of the major barriers to wider implementation of energy storage technologies."[171] This is particularly true with emerging technologies. For example, vanadium redox flow cells currently have a capital cost of approximately $3,000 to $4,000

energy capacity remains." *Id.*

165 *Id.*

166 TECHNOLOGY BRIEF, *supra* note 20, at 11.

167 TECHNOLOGY BRIEF, *supra* note 20, at 11.

168 TECHNOLOGY BRIEF, *supra* note 20, at 13.

169 TECHNOLOGY BRIEF, *supra* note 20, at 15.

170 TECHNOLOGY BRIEF, *supra* note 20, at 13.

171 Energy Info. Admin, *Electricity Storage Technologies Can be Used for Energy Management and Power Quality*, TODAY IN ENERGY, Dec. 14, 2011, *available at* http://www.eia.gov/todayinenergy/detail.cfm?id=4310.

per kilowatt ("kW").[172] However, rapid reductions in price could lead to a capital cost closer to $2,000 per kW, with an "overall storage cost of $250–$300/([megawatt-hours ("MWh")]), depending [on] actual lifetime."[173] Compared to a levelized cost of energy[174] of $58–108 per MWh for land-based wind and $118–292 per MWh for offshore wind, this is a lofty, though attainable, price tag.[175] Due to improvements in the lithium-ion technology, "capital cost is declining quickly to less than $1000/kW."[176] Therefore, the cost barrier to these emerging technologies is likely to recede in the near future.

C. Benefits of Distributed Storage

Distributed storage provides a wide range of benefits for utility systems. In general, energy storage systems will accrue energy from the electricity grid overnight when customers use less energy. They will then return this energy to the grid during the day, likely during peak use. If distributed storage systems are located in areas where consumers use energy, the system could also help transmission congestion problems.[177] Congestion on the electricity grid is similar to congestion in vehicular traffic. Congestion on the road occurs most often during rush hour, when more cars are on the road. Similarly, congestion on transmission

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[172] TECHNOLOGY BRIEF, *supra* note 20, at 18.
[173] TECHNOLOGY BRIEF, *supra* note 20, at 18.
[174] The levelized cost of energy is a metric cost used by the DOE. S. TEGEN ET AL, 2010 COST OF WIND ENERGY: REVIEW vi (2012), *available at* http://www.nrel.gov/docs/fy12osti/52920.pdf. It is the present value of total costs ($) divided by the present value of all energy produced over project lifetime (MWh) ($/MWh). *Id.*
[175] *Id.* at vii.
[176] TECHNOLOGY BRIEF, *supra* note 20, at 18.
[177] "[C]ongestion is the result of [a] physical limitation in the power system that prevents low-cost resources from reaching some markets." MATTHEW H. BROWN & RICHARD P. SEDANO, ELECTRICITY TRANSMISSION: A PRIMER 31 (2004), *available at* http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/primer.pdf.

lines occurs most frequently during peak load because more customers require electricity during this time rather than during base load.[178] By moving energy supply into an area where consumers use energy and storing that supply before consumers need that energy, such storage systems could help reduce congestion on the transmission lines.[179] This could delay the need for upgrades to the transmission grid, which could save utilities money.[180]

In addition, because distributed storage projects are small, they may not be subject to delays associated with large projects, such as "extensive federal and state environmental review processes, local opposition, and related issues that result in long lead times before large-scale projects are 'shovel-ready.'"[181] Further, although a distributed storage project could fail, the financial risk to the investor is minor in comparison to the risk the investor would face if a larger storage project failed because the cost of a distributed storage project is much lower than the cost of a large storage project.[182] Advocates of distributed energy generation have also pointed to the added community resiliency

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[178] *See* U.S. ENERGY INFO. ADMIN., GLOSSARY, *supra* note 54 (defining base load as "[t]he minimum amount of electric power delivered or required over a given period of time at a steady rate", defining peak load as "[t]he maximum load during a specified period of time", defining congestion as "[a] condition that occurs when insufficient transfer capacity is available to implement all of the preferred schedules for electricity transmission simultaneously").

[179] Dep't of Energy, *supra* note 29 "[T]here are three ways to mitigate congestion where it is significant enough to merit remediation. These are: 1) reduce electricity demand in the congested area through energy efficiency and demand management programs; 2) build more generation capacity *close to the demand area*; and 3) build additional transmission capacity so as to enable more electricity to be delivered from distant generators." *Id.* (emphasis added).

[180] *See id.*

[181] Stephanie Wang et al., *Local Power: Generating Clean Energy in our Communities*, 63 PLAN. & ENVTL. L. No. 7, 3, 3–4 (2011).

[182] *Cf.* Melissa Powers, *Small Is (Still) Beautiful: Designing U.S. Energy Policies to Increase Localized Renewable Energy Generation*, 30 WIS. INT'L L.J. 595, 631 (2012) (explaining that small distributed generation projects reduce financial risk).

and energy security distributed generation provides.[183] These benefits translate to the realm of distributed storage.

D. Impediments to Distributed Storage

As explained above, siting concerns for all energy production facilities include interconnection to transmission lines; impacts on the surrounding land, water, and wildlife; and effects on the local community.[184] Unlike developers of renewable energy projects, developers of storage facilities could build their projects in a variety of places. However, because energy producers must provide their own interconnection to the grid,[185] and because building a transmission line is costly[186] and takes time,[187] siting a storage facility close to existing transmission lines would help energy storage investors cut both cost and time.[188] In addition, developers of energy storage facilities may encounter physical limitations, which could lead to inefficient storage systems. For example, developers wishing to build energy storage facilities outside of the areas that require electricity may cause transmission congestion;[189] to avoid this from occurring, the developer may need to build additional transmission capacity.[190]

One of the more prominent impediments to building distributed storage systems is the cost. Emerging technologies

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[183] *See* Wang et al., *supra* note 181, at 4–5, 7.
[184] *See* discussion *supra* Part II(D); Outka, *supra* note 88, at 1067.
[185] MADRIGAL & STOFT, *supra* note 92, at 14.
[186] *Id.* at 15. Building transmission costs "can require significant upfront investments from renewable developers." *Id.*
[187] *Id.* at 6.
[188] *Id.* at 69.
[189] *See supra* Part IV(C).
[190] Dep't of Energy, *supra* note 29 One way "to mitigate congestion where it is significant enough to merit remediation . . . [is to] build additional transmission capacity so as to enable more electricity to be delivered from distant generators." *Id.*

are often quite expensive because the kinks in the supply chain have not yet been worked out. This situation often creates a "valley of death," which refers to the transition from research and development to the market, over which emerging technologies must cross.[191] The cost of these emerging technologies, even after they cross the valley of death, could still be so high that they deter developers from building storage facilities. Government funding or a storage procurement mandate could help these technologies advance beyond the valley of death to commercial-ready products.[192]

V. BRINGING DISTRIBUTED STORAGE ONLINE: SUPPLY SIDE

As explained above, three main problems have impeded the growth of distributed storage. First, siting storage systems can be difficult. Second, the technologies are not completely developed. And third, the cost of building storage systems can be prohibitively expensive. This section attempts to address these central complications to making energy storage a reality. Part A suggests that brownfields are an ideal location to site energy storage and considers government funding that could make siting energy storage projects on brownfields financially feasible. Part B concedes that while there are many competing storage technologies, no one "winning" technology has emerged. However, further research, possibly funded by government agencies, could help improve these technologies. Part B also considers some of the financial incentives to bringing distributed storage online once they are fully developed.

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[191] *See, e.g.*, Evan Mills and Jonathan Livingston, *Traversing The Valley Of Death*, FORBES.COM (Nov. 17, 2005, 4:00 PM), http://www.forbes.com/2005/11/17/utilities-emerging-tech-cz_1117energy_programs.html.
[192] *See infra* Parts V(B) & VI.

A. Location: Brownfields

Brownfields offer an ideal location to situate distributed energy storage because they are located in an area where consumers use large amounts of energy.[193] In addition, existing infrastructure on brownfield sites might lower the cost of an energy storage project because the developer would already have a connection to the electricity grid.[194] Finally, brownfields often cost less than greenfields[195] and Environmental Protection Agency ("EPA") funding might help lower the cost of remediating land, which could lower the overall costs of building energy storage facilities on brownfield sites.

1. Location Benefits

Small urban sites, such as brownfields, offer an ideal location to situate distributed energy storage. A "brownfield site" is defined as "real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant."[196] In other words, a brownfield is a site that requires the removal of contamination before a developer can build a new project. Different final uses require different levels of cleanliness. For example, industrial uses require less cleanup than residential uses.[197] The cost of a cleanup can vary and depends both on the final use and on how much contamination exists before cleanup.[198] Brownfields often remain untouched for years,

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[193] *See* NAT'L ASS'N OF LOCAL GOV'T ENVTL, *supra* note 37, at 4.
[194] *See* NAT'L ASS'N OF LOCAL GOV'T ENVTL, *supra* note 37, at 15.
[195] *See* NAT'L ASS'N OF LOCAL GOV'T ENVTL, *supra* note 37, at 4.
[196] 42 U.S.C. § 9601(39)(A) (2012).
[197] EPA, BROWNFIELDS AND URBAN AGRICULTURE: INTERIM GUIDELINES FOR SAFE GARDENING PRACTICES 1 (2011), *available at* http://epa.gov/brownfields/urbanag/pdf/bf_urban_ag.pdf. "Residential reuse requires the most stringent cleanup." *Id.*
[198] The price of environmental remediation can easily cost over a million dollars. Whitney, *supra* note 39, at 67–8.

leaving the landscape blighted. Continued neglect of such properties can escalate contamination problems and also lead to potential lawsuits.[199] Because EPA estimates that over 450,000 brownfields exist in the United States,[200] developers have many options in deciding where to build their energy storage systems.

Cleaning brownfield sites is healthy for communities, the economy, and the environment.[201] Brownfield cleanup addresses environmental problems by removing pollutants, chemicals, and other health and safety concerns.[202] Redevelopment of an area can remove ugly, discarded areas from a neighborhood, which can make that neighborhood more attractive to homeowners and businesses.[203] Redevelopment can also bring new jobs and higher tax revenues to local and state governments.[204]

Some people in the energy field have already considered transforming brownfield sites into renewable energy production facilities. For example, NALGEP created a primer to help local governments determine if developing renewable energy on brownfield sites would be a good option for their communities.[205] The primer states, "[t]he first step is determining whether a local brownfield site is physically suitable for renewable energy development."[206] Developers must consider which, if any, types of renewable energy would thrive on the site. The EPA produced a document that could help developers identify brownfield sites and other contaminated sites that could potentially support

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[199] NAT'L ASS'N OF LOCAL GOV'T ENVTL., *supra* note 37, at 2.
[200] EPA, *Brownfield Sites*, *supra* note 40.
[201] EPA, *Brownfield Sites*, *supra* note 40.
[202] Envtl. Law Inst., *Brownfield Basics*, http://www.brownfieldscenter.org/big/bfbasics.shtml (last visited Apr. 3, 2013).
[203] *Id.*
[204] *Id.*
[205] NAT'L ASS'N OF LOCAL GOV'T ENVTL., *supra* note 37, at 3.
[206] NAT'L ASS'N OF LOCAL GOV'T ENVTL., *supra* note 37, at 5.

renewable energy development.[207] The EPA and the Department of Energy ("DOE")'s National Renewable Energy Laboratory produced a separate document to assess solar and wind potential on contaminated and underutilized land.[208]

Some brownfield sites lend themselves to renewable energy development better than others. This can depend on the proximity of the potential site to transmission lines and the environmental remediation required of the site.[209] Urban brownfields often abut neighborhoods that draw energy from the electricity grid.[210] Therefore, if a developer wanted to build renewable energy generation on an urban brownfield, the site would likely have access to transmission lines (or distribution lines).[211]

Energy storage does not have the same physical complication that renewable energy production has. That is, when a developer considers where to place an energy storage facility, the developer may not need to consider whether the natural resources in the area are physically capable of supporting

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[207] EPA, HANDBOOK ON SITING RENEWABLE ENERGY PROJECTS WHILE ADDRESSING ENVIRONMENTAL ISSUES, *available at* http://www.epa.gov/renewableenergyland/docs/handbook_siting_repowering_projects.pdf (last visited April 6, 2014).

[208] EPA & NREL, SCREENING SITES FOR SOLAR PV POTENTIAL: EMPHASIS ON REDEVELOPMENT OF POTENTIALLY CONTAMINATED SITES, UNDERUTILIZED SITES, OR ROOFTOPS, *available at* http://www.epa.gov/renewableenergyland/docs/solar_decision_tree.pdf (last visited April 6, 2014).

[209] NAT'L ASS'N OF LOCAL GOV'T ENVTL., *supra* note 37, at 3.

[210] NAT'L ASS'N OF LOCAL GOV'T ENVTL., *supra* note 37, at 4.

[211] Urban brownfields are often located where "gas stations[,] dry cleaning facilities, or former industrial properties" were once located. Envtl. Law Inst., *Brownfield Basics*, http://www.brownfieldscenter.org/big/bfbasics.shtml (last visited Apr. 3, 2013). Former businesses generally have access to transmission or distribution lines. Transmission lines carry power from a large power generator to an area where it is needed, while distribution lines distribute power on a local scale.

renewable generation because energy storage facilities do not have to produce energy; instead they may store energy that energy production facilities produce elsewhere.[212] This flexibility could make siting energy storage facilities more straightforward than siting renewable energy projects.[213]

2. Government Grants

The EPA provides three types of brownfield-specific grants under the Comprehensive Environmental Response, Compensation, and Liability Act ("CERCLA") § 104(k).[214] First, the EPA can award Assessment Pilots/Grants of up to $200,000 to "eligible entities"—which the statute defines as states, tribes, or various local government authorities—to inventory, characterize, assess, and conduct planning related to brownfield sites.[215] Second, the EPA can award Cleanup Grants of up to $200,000 for the remediation of brownfield sites owned by eligible entities.[216] And third, the EPA can award Brownfields Revolving Loan Fund Grants of up to $1 million to eligible

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[212] *See supra* Part III.

[213] However, to maximize profits, a developer may wish to build an energy storage facility on the same site as a renewable energy project. For example, a developer could install a solar photovoltaic system on top of an energy storage facility. If the developer sells this energy, it could create revenue for the investor, which would allow the developer to earn back his investment more quickly. See *infra* Parts V(B) & VI for a discussion on further monetary considerations.

[214] 42 U.S.C. § 9604(k)(1); Michelle Weiler, *The Environmental Protection Agency's New Standard for CERCLA All Appropriate Inquiry: More Time and Money for Compliance, but Well Worth the Cost to Avoid CERCLA Liability*, 14 U. Balt. J. Envtl. L. 159, 168 (2007) (listing the three types of brownfield-specific grants under CERCLA § 104(k).

[215] 42 U.S.C. §§ 9604(k)(1) and (k)(2); EPA, ASSESSMENT PILOTS/GRANTS, *supra* note 40. In some cases, this grant can amount up to $350,000, based on the "anticipated level of contamination, size or status of ownership of the site." *Id.* § 9604(k)(4)(A)(i)(II).

[216] 42 U.S.C. § 9604(k)(3)(A)(ii); EPA, CLEANUP GRANTS, *supra* note 40. Due to budget limitations, EPA limits the number of grants an individual can apply for to up to "three site-specific cleanup proposals." EPA, FY13 GUIDELINES FOR BROWNFIELDS CLEANUP GRANTS, *supra* note 40, at 4.

entities to capitalize revolving loan funds.[217] "Eligible entities" can then award these loans to site owners or developers to clean up a site on their own. Because these grants designate states, tribes, and other government authorities as the only eligible entities that can request such grants, individual developers must work with these entities to receive any federal help in cleaning up brownfield sites.[218] While these grants provide resources to clean up brownfields, they do not provide grants for further development on those sites. However, because brownfields generally cost less to purchase than greenfields,[219] a developer may end up spending less on a brownfield site than she might spend on a greenfield site. These grants could therefore lower the overall cost a developer would encounter when purchasing property for an energy storage facility.

A second opportunity for funding comes from the Department of Housing and Urban Development's ("HUD's") § 108 loan guarantee, which "provides communities with a source of financing for economic development, housing rehabilitation, public facilities, and large-scale physical development projects."[220] Section 108 loans allow local governments "to transform a small portion of their [Community Development Block Grant] funds into federally guaranteed loans large enough to pursue physical and economic revitalization projects that can renew entire neighborhoods."[221] However, § 108 funding limits

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[217] 42 U.S.C. § 9604(k)(3)(A); EPA, REVOLVING LOAN FUND GRANTS, *supra* note 40.
[218] *See, e.g.*, *Portland Brownfield Program Services*, THE CITY OF PORTLAND, OREGON, http://www.portlandoregon.gov/bes/article/316740 (last visited May 9, 2013) (accepting applications for brownfield grants).
[219] Greenfields are previously undeveloped sites.
[220] HUD, *Section 108 Loan Guarantee Program*, HUD.GOV, http://portal.hud.gov/hudportal/HUD?src=/program_offices/comm_planning/communitydevelopment/programs/108 (last visited Mar. 25, 2013).
[221] *Id.*

recipients to local governments, requiring any potential developer to work with municipalities to receive this federal funding.

Just as the EPA's brownfield grants allow individual developers to work with local governments to receive federal help in cleaning up brownfield sites, § 108 loans allow individual developers to work with local governments to receive federal help in developing projects in a community. One of the specified "eligible activities" is for "[a]cquisition, construction, reconstruction, rehabilitation . . . or installation of public facilities . . . , including . . . public utilities, and remediation of known or suspected environmental contamination in conjunction with these activities."[222] "Public utilities" is not defined in the code of Federal Regulations, but projects that include "reconstruction [or] rehabilitation . . . of . . . public utilities" presumably includes improving the electrical grid.[223] As explained above, energy storage systems can help with resource adequacy, resource management, and reduced system inertia. In other words, installing energy storage systems could help "reconstruct [or] rehabilitate" the electric grid, which means that § 108 loans could help fund energy storage projects in communities.[224]

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[222] 24 C.F.R. § 570.703(l) (2013).

[223] The Federal Power Act, 16 U.S.C. §§ 791–828(c), defines a "public utility" as "any person who owns or operates facilities subject to the jurisdiction of the [Federal Power] Commission..." 16 U.S.C. § 824(e); it defines an electric utility as "a person or Federal or State agency . . . that sells electric energy." 16 U.S.C. § 796(22)(A).

[224] In the past, HUD also oversaw the Brownfields Economic Development Initiative (BEDI), which provided funds "to support and enhance the financial viability of projects assisted with Sec[ti]on 108 loan guar[an]tee funds by helping to ensure that the project is fin[an]cially successful and able to repay the related Section 108 loan gua[r]antee." HUD, *Brownfields Economic Development Initiative*, HUD.GOV, http://portal.hud.gov/hudportal/HUD?src=/hudprograms/bedi (last visited Feb. 29, 2013). Congress has not reauthorized BEDI since fiscal year 2011. However, if Congress were to reauthorize BEDI, it could dedicate some of § 108 loan funds to redevelopment projects on brownfields. A second expired funding opportunity was EPA's Brownfields Expensing Tax Incentive, which

3. *New Development?*

On March 7, 2013, Senators Lautenberg, Inhofe, Udall,[225] and Crapo introduced the Brownfields Utilization, Investment, and Local Development Act of 2013, also known as the BUILD Act.[226] The BUILD Act would amend CERCLA by reauthorizing both the Brownfields Revitalization Funding and the State Response Programs through 2016.[227] The bill would also revamp the EPA's brownfields grants.[228] First, the bill would broaden the definition of an "eligible entity" under CERCLA to include "non-profit organizations, certain limited liability corporations, limited partnerships and 'qualified community development entit[ies]' among those that can obtain site assessment grants."[229] Second, the bill would increase the $200,000 cap on EPA's Assessment/Pilot Grants to $500,000.[230]

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allowed for "federal taxpaying owners of qualifying brownfield properties to deduct cleanup expenses from their taxable income." *Green Energy Development on Brownfield Sites*, *supra* note 84, at 1.3. However, that program sunset on December 31, 2011. EPA, *Brownfields Tax Incentive*, EPA.GOV, http://www.epa.gov/brownfields/tax/index.htm (last updated Mar. 13, 2013). Similarly, if Congress reauthorized this program, it could reduce the funding necessary for cleaning up brownfields, which could help lower the overall cost of building an energy storage facility for the investor.

[225] Senator Udall of New Mexico.

[226] Brownfields Utilization, Investment, and Local Development Act of 2013, S. 491, 113th Cong. (2013).

[227] *Id.*

[228] Matthew Dondiego, *Gillibrand, Tonko push for new and improved federal brownfields program,* THE LEGISLATIVE GAZETTE (July 30, 2013), http://www.legislativegazette.com/Articles-Top-Stories-c-2013-07-30-84584.113122-Gillibrand-Tonko-push-for-new-and-improved-federal-brownfields-program.html.

[229] S. 491, 113TH CONG.; KRISTEN SHERMAN, *BREATHING NEW LIFE INTO BROWNFIELDS – THE BUILD ACT OF 2013*, JD Supra Law News(MAR. 13, 2013), *available at* http://www.jdsupra.com/legalnews/breathing-new-life-into-brownfields-th-68786/ (last visited Mar. 2, 2014).

[230] *Id.* The Act allows the possibility of increasing that amount to $650,000 based on the "anticipated level of contamination, size, or ownership status of the site." Sherman, *supra* note 229.

And third, the bill would provide incentives for redevelopment of brownfield sites for three particular types of redevelopment, including clean energy projects. The bill defines a "clean energy project" as "(i) a facility that generates renewable electricity from wind, solar, or geothermal energy; and (ii) any energy efficiency improvement project at a facility, including combined heat and power and district energy."[231] On July 31, 2013, Representatives Slaughter, Higgins, Maffei, and Tonko introduced an identical bill in the House.[232]

By broadening the definition of "eligible entities," the BUILD Act would make federal funds for brownfield redevelopment more accessible to private developers.[233] This could dramatically change the number of developers interested in the EPA's brownfields grants. Increasing the size of the Assessment/Pilot Grants could allow more developers to assess the level of contamination of a site with less strain on their finances, which could mean that developers would be more likely to consider brownfield sites for redevelopment. Once a developer knows the cost of cleaning up a site, she would be able to calculate the entire cost of the project more easily than in a situation where the cleanup cost is unknown. Fear of unknown cleanup costs may deter developers from pursuing building projects on brownfield sites. The BUILD Act's provision that is aimed at developing clean energy projects on remediated brownfields could provide funding for energy storage projects located on these sites. In order to promote clean energy from a holistic perspective, the Act should expressly include funding for energy storage projects on those sites. As Smart Growth America reported, "[i]f passed, the bill will help communities

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[231] S. 491 at § 9(12)(A)(i)-(ii).
[232] Brownfields Utilization, Investment, and Local Development Act of 2013, H.R. 2896, 113th Cong. (2013).
[233] Sherman, *supra* note 229.

across the country clean up contaminated and abandoned land and put it back into productive use."[234]

B. Increasing Payments, Decreasing Taxes, and Research

One of the hurdles energy storage faces is that the available technologies are not cheap enough to make them attractive to developers. Therefore, some mechanism is needed to make storage technologies more affordable for developers. There are multiple ways this could occur: first, payments to the developer could increase; second, innovation could lead to a decrease in the cost of technologies;[235] and third, a mandate could create market-based competition, which could lower the cost of technologies even further. Innovation requires funding—without a source of revenue, engineers cannot conduct the research necessary to improve the technologies. The most straightforward way engineers could receive funding for innovation is through grants. This section lays out a few of the funding mechanisms the government provides to increase payment to the developer, increase research funding, and decrease the cost of existing technologies to developers on the short term.

1. FERC Regulations

One way building storage facilities would become more attractive to developers is if the payments they receive increase. That is, if utilities pay energy storage facilities more for the services they provide, developers may have a greater incentive to

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[234] ALEX DODDS, *A NEW BILL IN CONGRESS IS GREAT NEWS FOR AMERICA'S NEIGHBORHOODS*, Smart Growth America (MAR. 7, 2013), *available at* http://www.smartgrowthamerica.org/2013/03/07/a-new-bill-in-congress-is-great-news-for-americas-neighborhoods/.

[235] *See, e.g.*, JESSIE JENKINS ET AL., BEYOND BOOM & BUST: PUTTING CLEAN TECH ON A PATH TO SUBSIDY INDEPENDENCE 35 (2012), *available at* http://thebreakthrough.org/blog/Beyond_Boom_and_Bust.pdf.

build more energy storage facilities. One benefit energy storage facilities provide is frequency regulation services.[236] Frequency regulation is one of the ways Regional Transmission Organizations ("RTOs") and Independent System Operators ("ISOs") "balance supply and demand on the transmission system, maintaining reliable operations."[237] Batteries and flywheels[238] have more control over their ability to increase or decrease their supply of frequency regulation service than fossil fuel plants have.[239] Therefore their supply is inherently more valuable in balancing the energy grid than is the supply from fossil fuel plants.

In the past, RTOs and ISOs paid providers "the same rate for frequency regulation services supplied by fast-ramping storage systems, such as batteries and flywheels, as they paid for services supplied by traditional fossil-fuel plants and gas-fired turbines, which are slower, less efficient, and not as environmentally friendly."[240] On October 20, 2011, the FERC

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[236] Frequency Regulation Compensation in the Organized Wholesale Power Markets, 76 Fed. Reg. at 67,260 (Oct. 31, 2011) (to be codified at 8 C.F.R. pt. 35).

[237] Frequency regulation service, also known as "ramping ability," "is defined as the ability to change the output of real power from a generating unit per some unit of time, usually measured as megawatts per minute (MW/min). A generator ramps up to produce more energy and ramps down to produce less. A storage device ramps up by discharging energy and ramps down by charging. A demand response resource, in the context of the provision of frequency regulation, ramps up by consuming less energy and ramps down by consuming more."
Frequency Regulation Compensation in the Organized Wholesale Power Markets, 76 Fed. Reg. at 67,260 n.3.

[238] A flywheel is a system that "store[s] electrical energy as kinetic (rotational) energy. During charging, the flywheel rotation speed increases up to 30,000–50,000 rpm, driven by a motor-generator. During discharging, the flywheel rotation drives the generator to produce electricity." TECHNOLOGY BRIEF, *supra* note 20, at 9.

[239] Roberts, *supra* note 16, at 46.

[240] Roberts, *supra* note 16, at 46.

issued Order No. 755,[241] which attempted to address this inequity.[242] FERC Order No. 755 encourages the "development and deployment of more types of storage systems"[243] because it requires RTOs and ISOs to pay for the quality of the services they receive.[244]

FERC Order No. 755 requires RTOs and ISOs to pay more for frequency regulation services to batteries and flywheels than they pay traditional plants.[245] This benefit to energy storage operators could help provide a market for energy storage development. However, even after the FERC passed Order No. 755, the FERC still "restricted third parties from selling ancillary services at market-based rates to public utility transmission providers"[246] based on its *Avista* policy.[247] This *Avista* policy held that ancillary service providers "should be allowed to sell ancillary services at flexible rates" as long as providers establish an Internet-based site that provides information on transmission service requests to both the producers of and the customers using ancillary services.[248] The restriction that providers establish an Internet-based site "stripped away the benefit of self-supplying ancillary services because customers . . . had to buy services

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[241] Frequency Regulation Compensation in the Organized Wholesale Power Markets, 76 Fed. Reg. at 67,260.
[242] *Id.*
[243] Roberts, *supra*, note 16, at 46.
[244] Frequency Regulation Compensation in the Organized Wholesale Power Markets, 76 Fed. Reg. at 67,260, n. 3.
[245] *Id.*
[246] *TODD GRISET*, FERC ORDER NO. 784 BOOSTS ENERGY STORAGE, *Energy Policy Update (JULY 24, 2013, 4:08 PM), HTTP://ENERGYPOLICYUPDATE.BLOGSPOT.COM/2013/07/FERC-ORDER-NO-784-BOOSTS-ENERGY-STORAGE.HTML.*
[247] Avista Corp., 87 F.E.R.C. ¶ 61,223 (May 27, 1999).
[248] *Id.* at 61,883. These Internet-based sites are similar to FERC's Open Access Same-time Information System (OASIS) site, mandated by FERC Order No. 889. Open Access Same-Time Information System and Standards of Conduct, 18 C.F.R. § 37 (1997).

based on their transmission provider's overall resource mix."[249] In other words, ancillary service purchasers were not free to buy any kind of ancillary services they choose; instead, they had to purchase ancillary services of the kind dictated by their transmission provider.

On July 18, 2013, FERC issued yet another order that could help storage development. FERC Order No. 784 reformed the *Avista* policy by removing limitations on third-party market-based sales of ancillary services to public utility transmission providers in balancing authority areas, provided those areas "have implemented intra-hour scheduling for transmission service."[250] The removal of the restriction of providing an Internet-based site may result in "self-supplying customers buy[ing] a smaller volume of regulation resources (compared to purchasing all reserves through OATT[[251]] service) by using energy storage resources that are faster and/or more accurate than the transmission provider's resources."[252] This order does keep one limitation on third-party market-based sales of ancillary services: on sales of "Reactive Supply and Voltage Control service and Regulation and Frequency Response service to a public utility that is purchasing ancillary services to satisfy its

[249] Griset, *supra* note 246. A "resource mix" is the mixture of energy generation resources a state or other entity uses to reach its energy needs.
[250] Third-Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies, 78 Fed. Reg. at 46,181.
[251] FERC created the OATT, or Open Access Tariff Transmission, in its Order No. 888. *History of OATT Reform*, FERC.GOV, http://www.ferc.gov/industries/electric/indus-act/oatt-reform/history.asp (last updated June 28, 2010). The Order "[r]equired all public utilities that own, control or operate facilities used for transmitting electric energy in interstate commerce to file open access non-discriminatory transmission tariffs that contain minimum terms and conditions of non-discriminatory service." *Id.*
[252] SONAL PATEL, *NEW FERC RULE CREATES NEW OPPORTUNITIES FOR ENERGY STORAGE*, POWER Magazine (JULY 25, 2013), HTTP://WWW.POWERMAG.COM/NEW-FERC-RULE-CREATES-NEW-OPPORTUNITIES-FOR-ENERGY-STORAGE/.

own OATT requirements absent a showing of lack of market power or adequate mitigation of potential market power."[253]

As developers add more variable renewable energy to the grid, the need for frequency regulation services will rise.[254] Because FERC Order No. 755 caused energy storage operators' payments to increase, and because FERC Order No. 784 removed restrictions on what kind of ancillary services purchasers can buy from third-parties, the orders should make energy storage more competitive with traditional fossil fuel plants as backup power for renewable energy sources. This will give developers an incentive to build more energy storage facilities.

2. *Congressional Developments*

A second way the cost to developers could decrease is by reducing taxes to the developer. Just as the PTC and the ITC have resulted in an increase in renewable energy facilities,[255] similar tax credits could result in an increase in energy storage facilities. Recently, Congress has considered giving tax credits for storage projects.[256] While no energy storage tax credit has, to date, passed, Congress has considered variations of one bill over the past few sessions that could provide the necessary tax credits.[257] On April 10, 2013, Congressman Gibson introduced the *Storage Technology of Renewable and Green Energy Act of 2013*, commonly known as the STORAGE 2013 Act, in the House.[258] This bill would:

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[253] Third-Party Provision of Ancillary Services; Accounting and Financial Reporting for New Electric Storage Technologies, 78 Fed. Reg. at 46,181.
[254] Backhaus & Chertkov, *supra* note 11, at 44.
[255] *See supra* Part II(A)(1).
[256] *Id.*
[257] *Id.*
[258] H.R. 1465, 113th Cong. (2013). Previous versions of the bill were introduced in the House during the 111th Congress (House Bill 4210) and the 112th Congress (House Bill 4096). H.R. 4210, 111th Cong. (2009); H.R. 4096,

(1) allow, through 2020, a 30% energy tax credit for investment in energy storage property that is directly connected to the electrical grid (i.e., a system of generators, transmission lines, and distribution facilities) and that is designed to receive, store, and convert energy to electricity, deliver it for sale, or use such energy to provide improved reliability or economic benefits to the grid; (2) make such property eligible for new clean renewable energy bond financing; (3) allow a 30% energy tax credit for investment in energy storage property[[259]] used at the site of energy storage; and (4) allow a 30% nonbusiness energy property tax credit for the installation of energy storage equipment[[260]] in a principal residence.[261]

112th Cong. (2012).

[259] "Energy storage property" is property which--

(i) provides supplemental energy to reduce peak energy requirements primarily on the same site where the property is located, or

(ii) is designed and used primarily to receive and store, firm, or shape variable renewable or off-peak energy and to deliver such energy primarily for onsite consumption.

Such term may include thermal energy storage systems and property used to charge plug-in and hybrid electric vehicles if such property or vehicles are equipped with smart grid equipment or services which control time-of-day charging and discharging of such vehicles.

H.R. 1465.

[260] "Energy storage equipment" is property

(B) which--

(i) provides supplemental energy to reduce peak energy requirements primarily on the same site where the property is located, or

(ii) is designed and used primarily to receive and store, firm, or shape variable renewable or off-peak energy and to

Senator Wyden, who introduced two previous versions of the Senate bill, introduced the Senate version of the bill on May 23, 2013.[262] The bill is very similar to the House bill, except the Senate version would allow a 20% energy tax credit instead of a 30% credit.[263]

If passed, the STORAGE Act could potentially have the same effect on energy storage as the ITC had on the solar industry. Just as the ITC provides a thirty percent tax credit for investment in certain renewable energy production facilities,[264] the STORAGE Act would provide a twenty or thirty percent tax

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> deliver such energy primarily for onsite consumption, and
> (C) which--
> (i) has the ability to store the energy equivalent of at least 2 kilowatt hours of energy, and
> (ii) has the ability to have an output of the energy equivalent of 500 watts of electricity for a period of 4 hours.
>
> Such term may include thermal energy storage systems and property used to charge plug-in and hybrid electric vehicles if such property or vehicles are equipped with smart grid equipment or services which control time-of-day charging and discharging of such vehicles.

Id.

[261] *Summary: H.R.1465 — 113th Congress (2013-2014)*, CONGRESS.GOV, http://beta.congress.gov/bill/113th-congress/house-bill/1465 (last visited April 14, 2014).

[262] S. 1030, 113th Cong. (2013). Previous versions of the bill were introduced in the Senate during the 111th Congress (Senate Bill 1091 and Senate Bill 3617) and 112th Congress (Senate Bill 1845). S. 1091, 111th Cong. (2009); S. 3617, 111th Cong. (2010); S. 1845, 112th Cong. (2011).

[263] *Summary: S.1030 — 113th Congress (2013-2014)*, CONGRESS.GOV, http://beta.congress.gov/bill/113th-congress/senate-bill/1030 (last visited April 14, 2014).

[264] *Federal Business Energy Investment Tax Credit*, *supra* note 57.

credit for investment in energy storage facilities. This means that private investors would have an incentive to invest in energy storage technologies, which could be a huge boost to the storage industry. "Approximately 90 percent of the nearly 5,000 megawatts of solar capacity in the U.S. today has been installed since the ITC was increased at the beginning of 2006."[265] If the STORAGE Act has even a fraction of the effect on the energy storage industry as the ITC had, and continues to have, on the solar industry, energy storage potential in the United States could increase dramatically.

3. Agency Funding

The two largest barriers to energy storage installation are technology and cost. A wide range of emerging storage technologies exist, but so far none of them is ideal.[266] DOE has recognized the difficulty emerging storage technologies face and, to combat this problem, created a new Energy Innovation Hub[267] for Batteries and Energy Storage on February 7, 2012.[268] This hub will "enable exploration of new technologies that move beyond traditional lithium-ion batteries and store at least five times more energy than today's batteries at one-fifth of the cost."[269] "The ultimate goal [of the hub] will be to overcome the

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[265] U.S. P'SHIP FOR RENEWABLE ENERGY FIN., *supra* note 67, at 1.
[266] *See supra* Part IV(B).
[267] Energy Innovation Hubs are "integrated research centers that combine basic and applied research with engineering to accelerate scientific discovery" in critical energy issue areas. DOE, *Hubs*, ENERGY.GOV, http://energy.gov/science-innovation/innovation/hubs (last visited Apr. 3, 2013).
[268] DOE, *ENERGY DEPARTMENT TO LAUNCH NEW ENERGY INNOVATION HUB FOCUSED ON ADVANCED BATTERIES AND ENERGY STORAGE*, Energy.gov (FEB. 7, 2012, 9:32 AM), HTTP://ENERGY.GOV/ARTICLES/ENERGY-DEPARTMENT-LAUNCH-NEW-ENERGY-INNOVATION-HUB-FOCUSED-ADVANCED-BATTERIES-AND-ENERGY.
[269] DOE, *Energy Innovation Hubs*, ENERGY.GOV, http://science.energy.gov/bes/research/doe-energy-innovation-hubs/ (last visited Apr. 2, 2013).

current technical limits for electrochemical energy storage to the point that the risk level will be low enough for industry to further develop the innovations discovered by the Hub and deploy these new technologies into the marketplace."[270] The initial award period is five years.[271] DOE awarded the Joint Center for Energy Storage Research[272] up to a total of $20 million in the first year, and anticipates that it will fund the Hub with up to $25 million per year in the final four years of the initial award period.[273] The research funded by this Hub should decrease the cost and increase the storage capacity of energy storage systems, making them more affordable for developers.

The Department of Defense's ("DOD's") Environmental Security Technology Certification Program is a research, development, and test program that endeavors to help emerging technologies surpass the valley of death.[274] This program routinely solicits new proposals to fund innovative technologies that address specific DOD concerns. For example, DOD recently sought proposals for projects that would "accelerate deployment, field adoption, and commercialization of innovative and promising energy technologies."[275] DOD may seek funding for

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[270] DOE, FINANCIAL ASSISTANCE FUNDING OPPORTUNITY ANNOUNCEMENT *ENERGY INNOVATION HUB – BATTERIES AND ENERGY STORAGE* 1–2 (2012), *available at* http://www.floridaenergy.ufl.edu/wp-content/uploads/DE-FOA-0000559.pdf.
[271] *Id.* at 2.
[272] Joint Center for Energy Storage Research, *DOE Energy Innovation Hub-Batteries and Energy Storage* 2 (2013), http://www.jcesr.org/files/2013/05/JCESR_Fact_Sheet3-15-131.pdf.
[273] DOE, *supra* note 270.
[274] Jeffrey Marqusee, *ESTCP Installation Energy Funding Opportunities*, SERDP-ESTCP.ORG (Feb. 19, 2013), http://www.serdp-estcp.org/Funding-Opportunities/ESTCP-Solicitations/Past-solicitation-pages/Installation-Energy-Solicitation-FY14/ESTCP-Installation-Energy-Funding-Opportunities-Webinar-FY-2014/(language)/eng-US.
[275] Nat'l Renewable Energy Lab., *Defense Department Announces Funding Opportunity for Energy Technology Demonstrations*, NREL.GOV (Mar. 1, 2013), http://www.nrel.gov/tech_deployment/news/2013/2129.html.

similar proposals in the future. These funding opportunities could provide emerging energy storage technologies with the boost needed to become viable in the marketplace.

While grants for installation and research would be a boon to the energy storage industry, they do not guarantee energy storage procurement. Research projects can often significantly improve technologies, making them attractive to developers. If that is the case, individual developers may find that the cost of doing business in the energy storage market is now cost-beneficial and developers may voluntarily begin building more energy storage facilities. However, research grants are necessarily just that: research, not an assurance that the research will result in an improvement to the technology to the point that the cost of the technology will become affordable. A procurement mandate, on the other hand, would guarantee that utilities acquire and use storage facilities from which they would receive all the benefits energy storage provides.

VI. DEMAND SIDE: STORAGE PORTFOLIO STANDARD

As discussed in the previous section, there are multiple ways to make storage technologies more affordable for developers. One of the mechanisms through which this could occur is market-created competition. A market-created competition scheme would develop either from popularity of a technology or a mandate for that technology—if the government passed a mandate for a particular technology, the mandate would create a market for the technology and the market would fund research, spurring innovation, which in turn would lower the cost of the technology. Part A of this section explains that state mandates—RPSs—are the most influential state policy in putting renewable energy online, and Part B argues that a similar mandate for storage—a SPS—would make the greatest difference in putting energy storage on the grid. A state's SPS would help its RPS reduce GHG emissions more than an RPS could on its own. The SPS should provide incentives, such as multipliers, to encourage developers to build energy storage facilities on remediated brownfields. The SPS could also use multipliers to advocate for using energy from particular types of sources to charge the energy storage facilities. As a case study, Part C explores California's recent energy storage procurement law. California's storage procurement law is the first of its kind and provides a starting off point for other states to follow and improve upon.

A. RPSs

The most important feature of state policy that affects renewable energy projects is the state's RPS because renewable energy developers can rely on RPS mandates when considering the potential capital gains of a renewable energy project before constructing it.[276] A mandate creates a market-based approach to funding a technology. For example, if a state requires utilities to purchase five percent of their energy from wind power and there are no wind generators in the state, or anywhere from which the utility can purchase wind power, a wind generator can enter the state and build wind power. While most, if not all, RPSs have penalty charges if they do not purchase a sufficient amount of energy from renewable sources,[277] as long as the price the wind developer charges is less than the penalty amount, the wind developer knows that the utilities will purchase power from him in order to fulfill their five percent purchase mandate. As more wind generators enter the state, they will compete with each other for that five percent purchase mandate and will work to lower their prices, spurring innovation.[278] Similarly, the most critical

[276] *Green Energy Development on Brownfield Sites*, *supra* note 84, at 1.3.
[277] *DSIRE Solar Portal*, DSIREUSA.ORG, http://www.dsireusa.org/solar/solarpolicyguide/?id=21 (last visited July 9, 2013).
[278] YUXI MENG, RENEWABLE PORTFOLIO STANDARD AND STATE-LEVEL RENEWABLES INNOVATION IN THE UNITED STATES 18–19, *available at* http://www.usaee.org/usaee2013/submissions/OnlineProceedings/Yuxi%20Meng_ Renewable%20Portfolio%20Standard%20and%20State-Level%20Renewables%20Innovation%20in%20the%20 United%20States.pdf.

feature of state policy that would impact storage projects would be a SPS. The creation of such a mandate would spur a storage market in a shorter time span than any other state incentive.[279]

B. SPSs

A SPS should mimic an RPS in that it should mandate the acquisition of a minimum amount of energy storage potential. These mandates would allow energy storage facilities to store excess electricity from the grid when energy demand decreases, and then redeploy the stored energy when energy demand increases. Because the price of energy varies with demand, the energy storage operator could purchase energy at a low cost and sell that energy to consumers at a higher cost. Over time, this would allow the energy storage investor to recover the cost of acquiring the storage potential.

Ideally, stored energy would come from renewable sources rather than fossil fuel sources. SPSs should include the requirement that storage facilities should only acquire energy from renewable sources. If a state wishes to promote any particular renewable energy source, its SPS could allow for an incentive for those energy sources. Just as some RPSs have multipliers for certain types of renewable resources,[280] an SPS could create multipliers for different sources of energy. For example, because wind energy is more prevalent at night, when energy demand decreases, the SPS could have a multiplier for wind energy. Therefore, energy purchased from a wind farm to store in the storage facility would be worth more than energy purchased from other sources.[281]

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[279] *See, Cf. Green Energy Development on Brownfield Sites*, *supra* note 84, at 1.3.

[280] *See, e.g.*, ENVTL. INFO. SERVICES, COMPARISON OF RENEWABLE PORTFOLIO STANDARDS (RPS) PROGRAMS IN PJM STATES 1, 4, 5 (2013), *available at* http://www.pjm-eis.com/~/media/pjm-eis/documents/rps-comparison.ashx.

[281] A multiplied wind energy storage unit would be worth more than a non-

Similarly, the SPS could have a multiplier for the siting of a storage facility. Because brownfields require less remediation to support an industrial use than to support other future uses,[282] and because urban brownfields would provide an ideal location for energy storage facilities from an energy management viewpoint, the SPS could have a multiplier for locating a storage facility on an urban brownfield. That is, a storage facility located on a redeveloped urban brownfield would be worth more than a storage facility located elsewhere. This multiplier would help reduce transmission congestion on the electricity grid by encouraging the development of storage systems in areas where consumers use energy, which means that electricity could move into the area ahead of consumer demand. In addition, this multiplier could help revitalize neighborhoods by encouraging the redevelopment of brownfields.

Pioneering states should base their SPSs on their RPSs; too vigorous of an SPS might be too costly, discouraging other states to create SPSs, while too lenient of an SPS might not make a significant difference in lowering GHGs. Iowa created the first RPS in 1983, requiring a mere two percent of the State's energy to come from renewables.[283] At the time, the technology was relatively new and therefore a minimum procurement requirement acted as a test case. Current statewide mandated RPS targets, in percentage of energy, range from nine and a half percent (Wisconsin, with a target date of 2015) to forty percent (Hawaii, with a target date of 2030).[284] However, consider the

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multiplied energy storage unit because it would take fewer wind energy storage units to reach the SPS requirement than it would for energy storage units to reach the SPS requirement. *Id.*

282 *See* EPA, BROWNFIELDS AND URBAN AGRICULTURE, *supra* note 197, at 1 (explaining that "[r]esidential reuse requires the most stringent cleanup.").

283 Bill Opalka, *Renewable Portfolio Standards Examined: Jobs is a Selling Point*, ENERGYBIZ, (Jan. 19, 2012), http://www.energybiz.com/article/12/01/renewable-portfolio-standards-examined.

284 *DSIRE RPS Data Spreadsheet*, DSIRE,

fact that many of these states already had some form of renewable energy production before they adopted RPSs.[285] Because storage technologies are still relatively young, with very little existing distributed storage,[286] a step-increment SPS would provide the best growth potential. States should start with a small procurement requirement, specifying that they must obtain energy storage potential to accommodate for a realistic and manageable percentage of their energy use a specified number of years after it takes effect. As installation and use of energy storage facilities increase, technologies will improve, making the installation of energy storage facilities more streamlined. States

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www.dsireusa.org/rpsdata/RPSspread042213.xlsx (last visited July 9, 2013).

[285] For example, California has had wind turbines since the 1980s, but California did not establish its RPS until 2002. *See,* Tom Gray, *The AWEA Blog: Into the Wind,* AWEA.ORG (Apr. 16, 2012), http://www.awea.org/blog/index.cfm?customel_dataPageID_1699=16032; *California Renewables Portfolio Standard,* DSIRE, http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA25R (last updated Oct. 5, 2012). But note that the RPS made a huge difference: California had only installed 1,718 megawatts of wind capacity in over twenty years, before the RPS took effect, while it installed more than double that in the past ten years, after the RPS took effect. DORA YEN-NAKAFUJI, CALIFORNIA WIND RESOURCES 6 (2005), *available at* http://www.energy.ca.gov/2005publications/CEC-500-2005-071/CEC-500-2005-071-D.PDF; *Wind Powering America: U.S. Installed Wind Capacity,* DEPARTMENT OF ENERGY, http://www.windpoweringamerica.gov/wind_installed_capacity.asp (last updated Apr. 9, 2013).

[286] *See infra* Part VI(C) for a discussion of the first energy storage procurement mandate. Other states are also exploring the use of distributed storage capacity. For example, Virginia's AEP is testing "[c]ommunity energy storage" as a distributed storage option.

> The use of distributed storage technology, which will involve the placement of small energy storage batteries throughout residential areas, will look similar to the small transformer boxes currently seen throughout neighborhoods. Each box should be able to power four to six houses. AEP is testing this potential distribution game-changing technology.
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> . . .

APPALACHIAN POWER COMPANY, INTEGRATED RESOURCE PLANNING REPORT TO THE COMMONWEALTH OF VIRGINIA STATE CORPORATION COMMISSION 95 (2011), *available at* http://docket.scc.state.va.us/CyberDocs/Libraries/.

should therefore increase the amount of energy storage potential at a reasonable rate over time.

Although enforcement of the procurements may be difficult, "[i]mposing and enforcing a monetary penalty or including an alternative compliance payment provision for electricity suppliers that do not meet solar requirements" is one of the "[b]est practices for promoting solar through RPS policies."[287] Similarly, including a provision that imposes a monetary penalty or an alternative compliance payment provision for electricity suppliers that do not meet energy storage procurement requirements in the SPS should help states enforce their SPSs.

C. California: A Case Study

In 2010, California created its own energy storage procurement law.[288] The law defines an "energy storage system" as a "commercially available technology that is capable of absorbing energy, storing it for a period of time, and thereafter dispatching the energy."[289] An energy storage system must "be cost effective and either reduce emissions of greenhouse gases, reduce demand for peak electrical generation, defer or substitute for an investment in generation, transmission, or distribution assets, or improve the reliable operation of the electrical transmission or distribution grid."[290] The law mandates that the California Public Utility Commission ("PUC") "open a proceeding to determine appropriate targets, if any, for each load-serving entity to procure viable and cost-effective energy storage systems to be achieved by December 31, 2015, and December 31, 2020."[291] The PUC must adopt any procurement targets agreed

[287] *DSIRE Solar Portal*, *supra* note 277.
[288] CAL. PUB. UTIL. CODE §§ 2835–39 (2011).
[289] *Id.* § 2835(a)(1).
[290] *Id.* § 2835(a)(3).
[291] *Id.* § 2836(a)(1).

upon by October 1, 2013.[292] This law does not include any energy storage procurement mandate, rather it only requires that the PUC *consider* energy storage procurement and "determine appropriate targets, if any."[293] The statute does not define what "appropriate" means, and, presumably, each load-serving entity could determine for itself what situation would constitute an "appropriate" target for mandating storage procurement. This soft requirement is not the same as this paper's suggested realistic and manageable target. A low target, if it is a required low target, is a better mandate than a soft requirement of creating a procurement requirement if one is "appropriate."

On February 13, 2013, California's PUC issued a decision mandating that Southern California Edison Company procure fifty megawatts ("MW") of energy storage resources.[294] The decision also required that the company procure a minimum of 150 MW of capacity "through preferred resources . . . in the Energy Action Plan, or energy storage resources."[295] In addition, the decision allowed for the procurement of "up to an additional 600 MW of capacity from preferred resources and/or energy storage resources."[296] This PUC decision is the first storage mandate of its kind; no other state has mandated the procurement of any energy storage resources.

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[292] *Id.* § 2836(a)(2).
[293] *Id.* § 2836(a)(1). The law similarly requires each "local publicly owned electric utility" to "initiate a process to determine appropriate targets, if any, for the utility to procure viable and cost-effective energy storage systems to be achieved by December 31, 2016, and December 31, 2020." *Id.* § 2836(b)(1). However, because load-serving entities have so many more customers than publicly owned electric utilities do in California, this paper focuses on the requirements for load-serving entities rather than for the publicly owned electric utilities.
[294] Draft Decision Authorizing Long-Term Procurement for Local Capacity Requirements, Rulemaking 12-030114 (Cal. PUC Feb. 13, 2013), *available at* http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M049/K133/49133558.PDF. The PUC accomplished this more than seven months before California's law required it to do so.
[295] *Id.* at 2.
[296] *Id.*

The PUC noted several reasons as to why interested parties persuaded it to mandate the procurement of energy storage.[297] First, the California Energy Storage Alliance explained that energy storage could help meet load capacity requirement needs.[298] Second, the California Environmental Justice Alliance stated that energy storage is more effective in demand response than conventional peaker plants.[299] Third, the ISO witness pointed out that energy storage technologies could count for reliability purposes if they met performance requirements.[300] The PUC concluded by requiring a storage procurement mandate of fifty MW, even though the California Environmental Justice Alliance only recommended a minimum procurement level of forty-eight MW of energy storage reserves.[301] The PUC believed fifty MW was "a reasonable and modest level of targeted procurement of an emerging resources, [sic] and [provided] an opportunity to assess the cost and performance of energy storage resources."[302]

Prior to this PUC decision, the California Energy Commission adopted a "loading order" that prioritized the order in which California's PUC would accomplish energy services.[303] "The 'Loading Order' established that the state, in meeting its energy needs, would invest first in energy efficiency and demand-side resources, followed by renewable resources, and only then in clean conventional electricity supply."[304] In its February 13, 2013 decision, the PUC denied Megawatt Storage Farms' motion to rank the energy storage mandate first in the

[297] *Id.* at 119-30.
[298] *Id.* at 60-61.
[299] *Id.* at 60.
[300] *Id.* at 61.
[301] *Id.* at 62.
[302] *Id.*
[303] *Id.* at 10.
[304] *Id.* (citing CAL. ENERGY COMM'N & CAL. PUBLIC UTILITIES COMM'N, ENERGY ACTION PLAN: 2008 UPDATE 1 (2008)).

Loading Order.[305] While the PUC did recognize the importance of energy storage reserves, it stated, "it is premature to consider where energy storage should be placed in the Loading Order."[306]

This loading order appropriately prioritizes energy efficiency over new renewable sources, meaning that the loading order is primarily concerned with decreasing the amount of energy required. An easy way for the PUC to limit the growth of GHG emissions would be to decrease the amount of new energy generation required. The next priority in the loading order, for that of renewable resources, is, among the three investment strategies in the loading order, appropriately placed second. California has prioritized renewable energy in its resource mix; it has a rigorous RPS, with a twenty percent mandate by December 31, 2013; a twenty-five percent mandate by December 31, 2016; and a thirty-three percent mandate by 2020.[307] The energy storage procurement should be placed either right above or right below renewable resources in the loading order. As mentioned in Part IV(A), renewable resources cannot reach their full potential without storage. If the California PUC's aim is to increase the effectiveness of renewable resources and decrease GHG emissions, it not only needs to promote renewable energy generation, but it also needs to promote energy storage procurements. Currently, "clean conventional electricity suppl[ies]" are third in the loading order; the loading order should certainly not prioritize these sources over energy storage procurements. While determining which—renewable generation or energy storage—should be second and which third would require a more detailed analysis, but both should be placed above "clean conventional electricity suppl[ies]" in the loading order. This more detailed analysis includes how much renewable energy resources currently exist in California and whether those resources are currently reaching their full potential. If they are,

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305 *Id.* at 117.

306 *Id.*

307 *California Renewables Portfolio Standard*, *supra* note 285.

then adding more renewable resources should take priority over storage, but if existing renewable resources are not reaching their full potential, the loading order should prioritize energy storage procurement over new renewable resources. It is likely that building energy storage to increase the effectiveness of existing renewable energy sources is more efficient than building entirely new renewable energy sources.

Finally, fifty megawatts is a modest procurement mandate, but California has continued to pioneer in the renewable energy world by creating such a mandate. The nation can learn from and improve upon California's example. While California's model of requiring PUCs to decide whether a storage procurement mandate is appropriate, SPSs should ultimately mandate that states obtain a minimum amount of energy storage potential, just as RPSs mandate that states obtain a minimum amount of renewable energy sources. While California's PUC did decide that fifty megawatts of storage procurement was appropriate in the February 13, 2013, proceeding, PUCs that are less progressive in promoting energy efficiency may not come to the same conclusion. Instead, states should add SPSs that require a minimum energy storage potential to their current RPSs. If states have similar loading orders to that of California's, their loading orders should prioritize energy storage procurement at approximately the same level as obtaining new renewable resources. Deciding which of these two investments should be prioritized over the other depends on how much renewable resources currently exist in the state in question and whether those existing sources are currently reaching their full potential.

VII. CONCLUSION

As this paper demonstrates, energy storage would assist renewable energy generation to achieve its full potential in reducing GHG emissions. Energy storage can: (1) accommodate excess supply and store that supply for later, (2) combat unexpected depletions of energy supply, and (3) help balance the electrical grid. Small urban distributed storage provides additional benefits, such as reducing the strain on transmission lines and decreasing the risk of investment in new projects. This paper explains that some people in the energy community have already started turning brownfields into renewable energy production sites, and advocates that the ideal location for energy storage facilities is also brownfields. The paper suggests that developers should install energy storage facilities and renewable energy facilities on brownfield sites.

This paper explores various funding incentives for developers to reuse brownfields as energy storage facilities. The EPA already provides various grants for remediating brownfields, and Congress is considering expanding these grants in the STORAGE Act, which would not only increase the maximum amount of money for each grant, but also provide grants to redevelop the land after developers clean it up. Additionally, the FERC recently created a greater financial incentive for energy storage over traditional generation, and Congress will consider the BUILD Act in the 113th Congress to provide tax incentives for building energy storage facilities. Furthermore, both DOE and DOD have programs that promote research in and commercialization of emerging technologies.

States have created their own mechanisms to promote projects. Of these, the most effective in creating renewable energy production are state RPSs. This paper therefore advocates for the adoption of SPSs. States should add SPSs to their RPSs, thereby increasing the effect of the RPS in reducing greenhouse gases. California has already adopted a storage procurement law, which has led to California's PUC requiring the Southern California Edison Company to procure fifty MW of energy storage potential. California's law is not a storage procurement mandate, but rather only requires the PUC to decide if an energy storage procurement is appropriate. Because less energy-progressive states' PUCs may not come to the same conclusion as California's PUC, those PUCs may not recommend the procurement of energy storage potential. Therefore, an SPS should mandate that states procure a minimum amount of energy storage potential.