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An Integrated Green Urban Electrical Grid

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AN INTEGRATED GREEN URBAN ELECTRICAL GRID

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Relying on only renewable resources for generating electricity once seemed like a dream.[1] Yet, an island in Denmark is now achieving that dream by generating all the electricity it needs with renewable resources.[2] Other communities throughout the world now want to achieve this same milestone.[3] To critics, these goals are not attainable due to the intermittent nature of the primary renewable resources, wind and solar power, which many of these communities plan to rely on.[4] But, several studies have confirmed that it can be done, and plans are already underway to switch communities to one hundred percent renewable energy in just a few years.[5] This dream of relying only on renewables can also be

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[1] *Living the Dream*, L.A. TIMES (July 29, 2008), http://articles.latimes.com/2008/jul/29/opinion/ed-gore29.

[2] David Biello, *100 Percent Renewable? One Danish Island Experiments with Clean Power*, SCI. AM. (Jan. 19, 2010), http://www.scientificamerican.com/article.cfm?id=samso-attempts-100-percent-renewable-power.

[3] *See, e.g.*, *Germany Targets Switch to 100% Renewables for Its Electricity by 2050*, THE GUARDIAN (July 7, 2010), http://www.guardian.co.uk/environment/2010/jul/07/germany-renewable-energy-electricity. Companies have also set goals of having a net-zero footprint. *See, e.g.*, Avery Fellow, *Google Reports Carbon Footprint of 1.46 Million Metric Tons in 2010*, 42 ENV'T REP. 2068 (Sept. 16, 2011) (noting Google's claim that it has a net-zero carbon footprint due to its purchase and generation of renewable energy and its purchase of carbon offsets).

[4] *See, e.g.*, Avery Fellow, *Siting, Flexibility Cited as Challenges to Integrating Renewable Energy Into Grid*, 42 ENV'T REP. 2065 (Sept. 16, 2011).

[5] *See, e.g.*, Mark Jacobson & Mark Delucchi, *Providing all Global Energy with Wind, Water, and Solar Power, Part I: Technologies, Energy Resources, Quantities and Areas of Infrastructure*, 39 ENERGY POL'Y 1154 (Mar. 2011); ENERGY CITY FREDERIKSHAVN, http://www.energycity.dk/en/energycityfrederikshavn/ (last visited Apr. 4, 2012); HENRIK LUND & POUL ALBERG ØSTERGAARD, SUSTAINABLE TOWNS: THE CASE OF FREDERIKSHAVN AIMING AT 100 PER CENT RENEWABLE ENERGY, DRAFT VERSION 5 (Oct. 31, 2008), *available at* http://www.energibyen.dk/fundanemt/files/Chapter_Sustainable_Towns_v5.pdf; *see also* FORTZED, http://fortzed.com/ (describing plans to create a model community of net-zero energy in Fort Collins, Colorado) (last visited Apr. 4, 2012).

realized in the near future in communities in the United States by integrating energy efficiency, demand response, distributed generation and energy storage into an integrated green urban grid. This Article presents a vision for a new integrated green urban grid that could reliably supply a community with all of its net energy needs.

INTRODUCTION

Over a century ago, the United States began constructing an electrical grid that delivers electricity to the far reaches of the country.[6] The grid relied primarily on large fossil-fuel facilities to generate electricity, and an inefficient collection of cables, poles, and wires that transports this electricity over large distances.[7] This decades-old electrical system, which most of this country still relies on, is inefficient, harmful to public health and the environment, outdated, and needs to change.[8] To reduce greenhouse gas emissions and mitigate the impacts of climate change, the United States will need to drastically change its electrical generation and grid infrastructure.

Scientists have found that significant reductions of greenhouse gases are necessary to avoid the likely devastating impacts of climate change.[9] Federal, state, and local governments are currently evaluating

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[6] *See* THOMAS PARKE HUGHES, NETWORKS OF POWER: ELECTRIFICATION IN WESTERN SOCIETY, 1880–1930, 226 (1993) (describing how Insull, one of the first owners of a utility company in the United States, "acquired isolated utilities serving small towns and their vicinities, shut down their inefficient generating plants, erected substations, and supplied electricity from a few large generating plants by means of transmission lines").

[7] *See generally* MATTHEW H. BROWN & RICHARD P. SEDANO, NAT'L COUNCIL ON ELEC. POLICY, ELECTRICITY TRANSMISSION: A PRIMER (June 2004), *available at* http://www.oe.energy.gov/DocumentsandMedia/primer.pdf (describing the history of the development of the U.S. electricity transmission system).

[8] *See id.* at 7. In addition to legions of studies discussing the public health and environmental impacts from the operation of electrical generation studies, studies also demonstrate that transmission infrastructure may be linked to health impacts. *See, e.g.*, WORLD HEALTH ORG., FACTSHEET: ELECTROMAGNETIC FIELDS AND PUBLIC HEALTH (June 2007), *available at* http://www.who.int/mediacentre/factsheets/fs322/en/. Transmission is also known to cause line losses. *See, e.g.*, AM. ELEC. POWER, TRANSMISSION FACTS 4, *available at* http://www.aep.com/about/transmission/docs/transmission-facts.pdf (listing a utility company's estimates of line losses in its transmission).

[9] *See generally* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, FOURTH ASSESSMENT REPORT ON CLIMATE CHANGE 2007: SUMMARY FOR POLICYMAKERS (2007), *available at* http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html (containing links to the report); James Hansen, et al., *Target CO2: Where Should Humanity Aim?*, 2 OPEN ATMOSPHERIC SCI. J. 217 (2008). Notably, the Supreme Court called the rise in global temperatures "well-documented" and recognized that well-respected scientists see the trend

many different options to reduce greenhouse gases.[10] Many of these efforts are focused on the electrical generation industry, since approximately forty percent of carbon dioxide emissions in the United States are created from burning fossil fuels to generate electricity.[11] To reduce the levels of greenhouse gases emitted by the electrical industry sector, many greenhouse reduction plans have required increased generation of electricity, less polluting, and renewable resources.[12]

Plans that require the development of renewable energy are progressing, while other responses to climate change have been coming under attack.[13] International efforts for a global treaty, and domestic efforts for a federal climate change law, have been largely unsuccessful.[14] Not surprisingly, a recent United Nations report found that the best way to achieve

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in global temperatures and greenhouse gas concentration as interrelated. Massachusetts v. EPA, 549 U.S. 1438, 1446 (2007). In addition, EPA found that the body of evidence "compellingly supports" finding that greenhouse gas emissions endanger human health and that "human-induced climate change has the potential to be far-reaching and multidimensional." Envtl. Prot. Agency, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66496, 66497 (Dec. 15, 2009) (to be codified at 40 C.F.R. pt. 5).

[10] *See* PEW CTR. ON GLOBAL CLIMATE CHANGE [*now* CTR. FOR CLIMATE AND ENERGY SOLUTIONS], CLIMATE CHANGE 101: STATE ACTION (Jan. 2011), *available at* http://www.pewclimate.org/docUploads/climate101-state.pdf (summarizing the policies that states and regions are developing as related to climate change).

[11] *See Energy Explained: Electricity and the Environment*, U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, http://www.eia.doe.gov/energyexplained/index.cfm?page=electricity_environment (last visited Apr. 4, 2012).

[12] *See* TERRY BARKER ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, SUMMARY FOR POLICY MAKERS, CLIMATE CHANGE 2007: MITIGATION, CONTRIBUTION OF WORKING GROUP III TO THE FOURTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 20–22 (2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/wg3/ar4-wg3-spm.pdf (recommending that policy makers reduce reliance on fossil-fuel-generated electricity as part of any climate change mitigation plan).

[13] *See* PEW CTR. ON GLOBAL CLIMATE CHANGE [*now* CTR. FOR CLIMATE AND ENERGY SOLUTIONS], RENEWABLE AND ALTERNATIVE ENERGY PORTFOLIO STANDARDS (2012), *available at* http://www.pewclimate.org/sites/default/modules/usmap/pdf.php?file=5907 (detailing the states that have promulgated requirements for a certain percentage of their energy to be generated from renewable resources) (updated Jan. 20, 2012). At the same time that renewable development has been increasing, other climate change policies have not been targeted. *See, e.g.*, Amena H. Saiyid, *EPA Authority to Regulate Greenhouse Gases to be Targeted in 2012 Spending Measure*, 42 ENV'T REP. 1295 (June 10, 2011) (discussing recent plans by a U.S. Representative to offer an amendment to a bill to bar EPA from using fiscal 2011 funds to regulate greenhouse gases); *see also* Coal. for Responsible Regulation, Inc. v. EPA, No. 09-1322, 2009 WL 7339935 (D.C. Cir. Dec. 23, 2009), at *1–2 (challenging EPA's finding of endangerment for greenhouse gas emissions).

[14] *See* Bryan Walsh, *Fighting Climate Change by Not Focusing on Climate Change*, TIME (July 26, 2011), http://www.time.com/time/health/article/0,8599,2085220,00.html.

climate reduction is through a "bottom-up process rather than in response to a global treaty."[15]

Consistent with a bottom-up approach, the United States has been increasing efforts to transition to renewable energy. For instance, President Obama called for limiting the subsidies to fossil-fuel companies.[16] In addition, grids throughout the country are currently seeing major changes with the installation of renewable energy and the retirement of some of the dirtiest energy generation resources.[17] As a result of these changes, questions are being raised at the local and federal levels regarding how renewable resources can be reliably integrated into the grid.[18] To respond to these concerns, the Federal Energy Regulatory Commission and other entities have been studying the current potential of the grid to integrate renewables.[19]

The energy grid structure that most commonly still exists in urban areas, even the areas transitioning to renewable energy, relies on large centralized power generation facilities that transmit and distribute generated energy across long transmission lines.[20] In fact, the initial focus of

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[15] *See* GLOBAL GOVERNANCE 2020, BEYOND A GLOBAL DEAL: A UN+ APPROACH TO CLIMATE GOVERNANCE 5 (Jan. 2011), *available at* http://www.gg2020.net/fileadmin/media/gg2020/GG2020_2011_Climate_Beyond_Global_Deal.pdf. Others have advocated for this as well. *See, e.g.*, Edna Sussman, *Reshaping Municipal and County Laws to Foster Green Building, Energy Efficiency, and Renewable Energy*, 15 N.Y.U. ENVTL. L.J. 1, 2–3 (2008) (explaining why local action is necessary and describing how local governments can have an impact on global warming by utilizing local tools).

[16] *See* Ari Natter, *Obama's Budget to Seek More Funding for Clean Energy, Fewer Oil, Gas Subsidies*, 42 ENV'T REP. 155 (Jan. 28, 2011).

[17] *See* Source Watch, *Existing U.S. Coal Plant Retirements and Conversions*, http://www.sourcewatch.org/index.php?title=Existing_U.S._Coal_Plants#Plant_retirements_and_conversions (last visited Apr. 4, 2012) (listing recent coal plant retirements in the United States).

[18] *See* Lynn Garner, *Adding Renewables Unlikely to Diminish U.S. Grid Reliability, FERC Study Indicates*, 42 ENV'T REP. 163 (Jan. 28, 2011) (discussing how questions about reliability of grid after renewables are integrated has been raised in Congress); *see also* Cal. Pub. Util. Comm'n, Order Instituting Rulemaking 10-05-006 (May 2010) (initiating a rulemaking to determine how California will integrate up to 33% renewables).

[19] *See* Garner, *supra* note 18. The National Labs have also been conducting a variety of studies to determine how to integrate renewables on the grid. *See, e.g.*, ANDREW MILLS & RYAN WISER, BERKELEY NAT'L LAB., IMPLICATIONS OF WIDE-AREA GEOGRAPHIC DIVERSITY FOR SHORT-TERM VARIABILITY OF SOLAR POWER (2010), *available at* http://eetd.lbl.gov/ea/emp/reports/lbnl-3884e.pdf. In addition, states are also evaluating how to integrate large amounts of renewable energy on the system. *See, e.g.*, Cal. Pub. Util. Comm'n, *infra* note 37 (policy-making proceeding to determine how to integrate up to 33% of energy in California from renewables).

[20] J.C. MOLBURG ET AL., ARGONNE NAT'L LAB., ENVTL. SCI. DIV., THE DESIGN, CONSTRUCTION, AND OPERATION OF LONG-DISTANCE HIGH-VOLTAGE ELECTRICITY

the renewable energy sector was primarily on constructing large decentralized renewable generation resources.[21] These large renewable resources would still rely on the old grid transmission and distribution system to transport electricity over substantial distances to load centers.

More recently, the benefits of distributed generation, or local generation close to load centers, have become more evident. Policymakers in the United States and throughout the world are recognizing the substantial benefit in distributed generation.[22] For example, a recent study predicts that Europe could generate up to forty percent of its energy from decentralized power sources in 2020, which would lead to the displacement of centralized power plants.[23] The prime example of this shift is Germany, which has installed tens of thousands of small distributed generation systems close to load centers.[24] This increased emphasis on decentralized generation is necessary to efficiently transition urban environments away from their fossil-fuel dependence to a new urban grid.[25]

The integrated green urban grid that this Article envisions has four key components: energy efficiency, demand response, distributed generation, and distributed energy storage. By effectively integrating these four components, the new urban green grid can reduce air pollution, including greenhouse gases, while maintaining reliability of the electrical system and creating local opportunities. However, the transition to the new integrated green urban grid will not happen solely with accolades. In order to switch to this new energy system, regulations will need to be developed that encourage the development and transition to a decentralized system.[26]

TRANSMISSION TECHNOLOGIES, TECHNICAL MEMORANDUM ANL/EVS/TM/08-4 (2007), *available at* http://www.osti.gov/bridge/product.biblio.jsp?osti_id=929262.

[21] AL WEINRUB, COMMUNITY POWER: DECENTRALIZED RENEWABLE ENERGY IN CALIFORNIA 4–6 (2011), *available at* http://www.oregonrenewables.com/Publications/Reports/Aweinrub_Community_Power_0211.pdf.

[22] *See generally* MILLS & WISER, *supra* note 19 (discussing the variables behind mathematically determining the benefits derived from geographic diversity in plant generation).

[23] *Europe Headed for More Decentralized Power: Study*, REUTERS (July 29, 2010), http://www.reuters.com/article/idUSTRE66S2VB20100729.

[24] *See generally* KEMA, INC., DISTRIBUTED GENERATION IN EUROPE—PHYSICAL INFRASTRUCTURE AND DISTRIBUTED GENERATION CONNECTION (2011), *available at* http://www.energy.ca.gov/2011publications/CEC-400-2011-011/CEC-400-2011-011.pdf (describing the distributed generation ("DG") system in Germany, and finding that "[t]he growth of renewable DG in Germany continues unabated").

[25] WEINRUB, *supra* note 21, at 3–4.

[26] JOHN FARRELL & DAVID MORRIS, NEW RULES PROJECT, RURAL POWER: COMMUNITY-SCALED RENEWABLE ENERGY AND RURAL ECONOMIC DEVELOPMENT 1 (2008), *available at* http://www.ontario-sea.org/Storage/27/1909_Rural_Power-_Community-Scaled_Renewable_Energy_and_Rural_Economic_Development.pdf.

This Article will discuss the vision of a new green urban grid that relies on decentralized generation and storage, energy efficiency, and demand response. Much of the literature focuses on the development of aspects of the green grid, such as energy efficiency, without consideration of how these resources should be integrated to effectively reduce greenhouse gas emissions and pollution, maintain reliability, and create economic opportunity.[27] After discussing the components of the green urban grid, this Article will discuss why integrating these components is essential to meeting renewable policy goals, and finally, this Article will discuss steps that regulators and policymakers can take to encourage the development of this integrated green urban grid.

I. THE VISION—THE GREEN URBAN GRID

The new urban grid will integrate energy efficiency, demand response, distributed renewable generation, and distributed energy storage. This integrated vision of a new urban energy system has the potential to reliably supply urban electricity users with all of their electricity needs.[28] Integration of these four types of resources is essential to enable a community to maximize greenhouse gas and pollution reductions.[29] Thus, each of these four resources plays a critical role in the ability of the system to supply electricity while meeting its environmental goals.

A. Distributed Renewable Generation

The new urban grid will rely on local renewable resources to generate electricity that are close to the load requirements, instead of large, distant facilities. Distributed generation is generally defined as small

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[27] Although the literature has hit on a variety of aspects of the new green urban grid, it has not described how energy efficiency, demand response, distributed generation, and storage are integrated. *See, e.g.*, John Dernbach, *Stabilizing and Then Reducing U.S. Energy Consumption: Legal and Policy Tools for Efficiency and Conservation*, 37 Envtl. L. Rep. (Envtl. L. Inst.) 10,003 (2007) (discussing ways that the United States can reduce consumption through energy efficiency); Sussman, *supra* note 15, at 1–3 (describing how involvement at the local level is needed and how to employ mechanisms to foster renewable energy development); Steven Ferrey, *Restructuring a Green Grid: Legal Challenges to Accommodate New Renewable Infrastructure*, 39 ENVTL. L. 977 (2009) (focusing on the infrastructure of the grid and the role of new renewable energy on a green grid).

[28] AM. PHYSICAL SOC'Y, INTEGRATING RENEWABLE ELECTRICITY ON THE GRID 2–5 (2010), *available at* http://www.aps.org/policy/reports/popa-reports/upload/integratingelec.pdf (suggesting that while we may have the resources available, there will be several challenges faced and steps to be taken to realize this potential).

[29] *Id.* at 6–7.

electricity generation resources[30] located close to the demand. The types of renewable resources that could be used as distributed generation resources are technologies that can be scaled down and sited near load requirements such as wind, solar, and geothermal.[31] Most of the developed distributed generation is solar because it can be readily sited on roofs and other available urban areas such as parking lots and transportation infrastructure.[32] Distributed fuel cells are also gaining popularity, but due to the fact that most of them still rely on fossil fuel, their benefits related to climate change and pollution are more limited than other resources such as wind and solar.[33]

The deployment of large amounts of distributed generation has already begun. Germany has already successfully started transitioning its grid to a significant portion of distributed generation.[34] In fact, Germany

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[30] U.S. DEP'T OF ENERGY, THE POTENTIAL BENEFITS OF DISTRIBUTED GENERATION AND RATE-RELATED ISSUES THAT MAY IMPEDE THEIR EXPANSION, I (Feb. 2007), *available at* http://www.ferc.gov/legal/fed-sta/exp-study.pdf. The size of what qualifies as distributed generation varies throughout different jurisdictions. Regulators and policymakers have suggested that the definition is not limited to a particular size limit. *See, e.g.*, MARK RAWSON, CAL. ENERGY COMM'N, DISTRIBUTED GENERATION COSTS AND BENEFITS ISSUE PAPER (July 2004), *available at* http://www.energy.ca.gov/papers/2004-08-30_RAWSON.PDF.

[31] Notably, the eligibility of renewable resources depends on the jurisdiction in which the resource is located: some states include various forms of biomass and hydropower, while other states have replaced restrictions on counting these resources toward renewable portfolio standard obligations. *See* RYAN WISER ET AL., BERKELEY NAT'L LAB., RENEWABLES PORTFOLIO STANDARDS: A FACTUAL INTRODUCTION TO EXPERIENCE FROM THE UNITED STATES 5 (Apr. 2007), *available at* http://eetd.lbl.gov/ea/ems/reports/62569.pdf. Moreover, a report from the California Energy Commission emphasizes the need for flexibility in the definition of distributed generation:

> [T]he definition of DG should not be solely defined on the basis of size, technology, application, or ownership. DG uses many different technologies and can be applied in so many different ways, as mentioned above. The benefits that a particular DG project can provide are driven more by application than technology type. To a large extent, the ownership of a particular DG device, whether by the utility, a third party or the end-use customer, is unrelated to ability to capture DG benefits.

RAWSON, *supra* note 30, at ii.

[32] The type of renewable resource that is developed will depend on what resources are available. Some resources are more prevalent in some areas of the country than others. *See Dynamic Maps, GIS Data, and Analysis Tools*, NAT'L RENEWABLE ENERGY LAB., http://www.nrel.gov/gis/maps.html (containing links to searchable renewable-energy-technology maps in the United States) (last visited Apr. 4, 2012).

[33] *See What Is an Energy Server?*, BLOOM ENERGY, http://www.bloomenergy.com/products/data-sheet/ (last visited Apr. 4, 2012); *see also* S.B. 124, 146th Gen. Assemb. (Del. 2011) (classifying energy output from fuel cells as renewable energy).

[34] *See* KEMA, *supra* note 24 (describing the distributed generation system in Germany).

installed a record 7400 MW of solar photovoltaic facilities in one year.[35] Recent estimates show that Germany has installed approximately 20,000 MW of distributed generation resources, providing an example of large-scale deployment of solar photovoltaic resources for the rest of the world.[36] In the United States, regulators are just starting to realize the many benefits of smaller distributed generation projects, which include the "relative ease and certainty of deployment that these facilities offer."[37]

Smaller distributed generation projects have several benefits over large-scale renewable projects. Distributed generation is deployed more easily than large-scale renewable resources due to the fact that "these facilities can be located close to load without the need for transmission additions, and may face fewer environmental barriers and public opposition than large scale projects."[38] Consequently, "it is reasonable to conclude that development of smaller projects can be accomplished more quickly and with less risk than larger facilities."[39] Thus, a major benefit of a decentralized system is that the electricity is generated close to the load center eliminating the need for reliance on transmission lines. For

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[35] Paul Gipe, *New Record for German Renewable Energy in 2010*, RENEWABLE ENERGY WORLD (Mar. 25, 2011), http://www.renewableenergyworld.com/rea/news/article/2011/03/new-record-for-german-renewable-energy-in-2010??cmpid=WNL-Wednesday-March30-2011. The German installation rates dwarf the installation rates of solar photovoltaics ("PV") in the United States:

> In December alone, the German solar PV industry installed 1,000 MW of solar PV, enough solar capacity to generate 1 TWh of electricity under German conditions. While they represented only half that installed in June 2010, the December installations were 50% greater than total solar PV installed in the USA in 2010 and as much as that rumored to have been installed in Japan last year.

Id. at 2.

[36] *See generally* KEMA, *supra* note 24 (showing over 9000 MW of solar capacity in Germany by the end of 2009); John Landers, *Germany's Solar Photovoltaic Market: The World's Installed Capacity Leader*, ENERGYTREND (Apr. 10, 2011), http://www.energytrend.com/Germany_Solar_Installation_20111004 (describing Germany as having a total capacity of 17,193 MW at the end of 2010); Stephen Lacey, *Germany Installed 3 GW of Solar PV in December—The U.S. Installed 1.7 GW in All of 2011*, RENEWABLE ENERGY WORLD (Jan. 12, 2012), http://www.renewableenergyworld.com/rea/news/article/2012/01/germany-installed-3-gw-of-solar-pv-in-December-the-u-s-installed-1-7-gw-in-all-of-2011 (describing Germany's addition of 3000 MW (3 GW) of solar capacity in December 2011).

[37] Cal. Pub. Util. Comm'n, Decision Adopting a Solar Photovoltaic Program for Pacific Gas & Electric, D.10-04-052 at 19 (Apr. 2010). This benefit is important as viability concerns continue to plague renewable development. *See* David Huard & Jack Stoddard, *Murphy's Law and Renewable Energy Products: If It Can Go Wrong, It Probably Will*, 42 ENV'T REP. 1790 (Aug. 5, 2011) (detailing ways energy projects can and have failed).

[38] Cal. Pub. Util. Comm'n, *supra* note 37, at 16.

[39] *Id.* at 17.

example, in Germany, one solar developer is constructing solar panels on a highway tunnel, which is located close to a load center.[40]

Notably, reliance on distributed generation projects helps eliminate transmission questions that arise over how lines should be paid for and who decides whether a line should be sited.[41] The complexity of these questions and issues can delay potential transmission projects for several years.[42] These types of complicated, contentious transmission issues plague plans to install large-scale renewable facilities in remote locations leading to increased costs and lengthy delays.[43] A study by the National Renewable Energy Lab concluded that "two external factors [that] have the most impact on what an RPS [Renewable Portfolio Standard] can accomplish on a large scale . . . [are] available resources (e.g., wind, solar radiation, geothermal potential, or biomass stocks) . . . and available transmission capacity."[44] Other studies have similarly found that renewable development results depend on transmission policy.[45] Distributed generation resources also reduce transmission costs and losses at peak demand time (often the hottest or coldest part of the day), which could help "avoid the need for new power plants or expansion of existing plants."[46] In addition to the transmission issues, large renewable projects can have other negative environmental impacts including high water usage, which

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[40] *See 2.8-MW A3 Highway Solar System Near Completion*, RENEWABLE ENERGY WORLD (Feb. 26, 2009), *available at* http://www.renewableenergyworld.com/rea/news/article/2009/02/2-8-mw-a3-highway-solar-system-nears-completion.

[41] *See* Timothy Duane, *Greening the Grid in California*, 25 NAT. RESOURCES & ENV'T 31, 35–36 (2010).

[42] *See, e.g.*, Lawrence Hogue, *A Battle for California's Energy Future*, DESERT REPORT (June 2008), *available at* http://www.desertreport.org/wp-content/uploads/2009/07/DR_Summer20081.pdf (describing the long and contentious battle over the siting of the Sunrise Powerlink Transmission in Southern California).

[43] *See* Bill Powers, *Today's California Renewable Energy Strategy—Maximize Complexity and Expense*, NAT. GAS & ELEC., Sept. 2010, at 19–20 (detailing California's over-reliance on large renewable facilities).

[44] *See* DAVID HURLBUT, NAT'L RENEWABLE ENERGY LAB., TECHNICAL REPORT NREL/TP-670-43512, STATE CLEAN ENERGY PRACTICES: RENEWABLE PORTFOLIO STANDARDS 3 (July 2008), *available at* http://www.nrel.gov/docs/fy08osti/43512.pdf.

[45] *See id.* at 1 ("States with an RPS that have significantly increased renewable resources either have available transmission, or have developed strategies to build it.").

[46] *See* CAL. PUB. UTIL. COMM'N & CAL. ENERGY COMM'N, CALIFORNIA'S CLEAN ENERGY FUTURE IMPLEMENTATION PLAN 55 (Sept. 2010), *available at* http://www.cpuc.ca.gov/NR/rdonlyres/ED820DFE-46A3-40A8-8E84-F728BC94DCA5/0/CleanEnergyFuture092110.pdf. The plan also recognizes that other instruments are necessary to achieve high levels of distributed generation: "policies, such as feed-in tariffs for small scale generation, are being expanded to encourage installation of renewable distributed generation sized to serve demand within a local neighborhood." *Id.*

is a major problem related to the development of large solar plants since the best solar resources are in areas that are generally dry.[47]

One state administrative agency has recognized solar photovoltaic distributed generation as a viable replacement for a natural-gas peaker plant, stating the following:

> Photovoltaic arrays mounted on existing flat warehouse roofs or on top of vehicle shelters in parking lots do not consume any acreage. The warehouses and parking lots continue to perform those functions with the PV in place. . . . In addition, while PV is not a quick-start technology which can be dispatched on ten minutes' notice any time of the day or night, PV does provide power at a time when demand is likely to be high—on hot, sunny days.[48]

Another significant benefit of the most widely used[49] distributed technology, solar photovoltaic systems, is that the panels have dropped greatly in price, making deployment more economical. Large-scale integration of PV for the urban grid is now both technically and economically feasible. Prices for solar PV have dropped drastically in the last few years, and projections estimate that PV will further drop to a price point of $2.60 per watt installed.[50] These prices will likely drop further as deployment of photovoltaic systems increases.[51] On the other hand, large-scale renewable projects have been shown not to be cost-effective or viable. In fact, recent estimates have demonstrated that distributed solar photovoltaic resources can cost the same as central station solar photovoltaic facilities, but the distributed generation can be developed in a much shorter time frame.[52]

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[47] Bill Powers, *PV Pulling Ahead, But Why Pay Transmission Costs?*, NATURAL GAS & ELECTRICITY, Oct. 2009, at 19.

[48] CAL. ENERGY COMM'N, FINAL COMMISSION DECISION, CHULA VISTA ENERGY UPGRADE PROJECT, 07-AFC-4, at 29–30 (June 2009), *available at* http://www.energy.ca.gov/2009publications/CEC-800-2009-001/CEC-800-2009-001-CMF.PDF.

[49] OLUFEMI OLAREWAJU & H. STERLING BURNETT, NAT'L CTR. FOR POLICY ANALYSIS, DISTRIBUTED SOLAR POWER (July 31, 2011), *available at* http://www.ncpa.org/pdfs/ba748.pdf.

[50] *See* Stephen Lacey, *Why Clean Energy Can Scale Today*, CLIMATE PROGRESS (May 9, 2011), http://thinkprogress.org/romm/2011/05/09/208051/clean-energy-scale-stephen-lacey/ (discussing projections of PV prices by industry leaders).

[51] Prices of photovoltaic systems dropped by half since 2004 in Germany, and prices in Germany are currently 61% of prices in the United States. *See* Paul Gipe, *Should California Simply Adopt German Solar Tariffs?*, RENEWABLE ENERGY NEWS (July 8, 2011), http://www.renewableenergyworld.com/rea/news/article/2011/07/should-california-simply-adopt-german-solar-tariffs.

[52] *See* Todd Woody, *Transmission Constraints Derail Solar Project*, GRIST (June 28, 2010), http://www.grist.org/article/transmission-constraints-derail-solar-project.

Notably, the California Public Utilities Commission recently rejected an application for a large-scale wind project, finding that the project was "not cost effective and poses unacceptable risks to ratepayers."[53] Finally, another beneficial aspect of distributed generation is that geographical diversity increases the likelihood that solar power will be available when needed.[54] Likely as a result of all of these benefits, the United States has started to make investments in distributed generation resources. For instance, the Department of Energy committed to a $1.4 billion loan guarantee for an installation of approximately 733 megawatts of rooftop solar.[55] The project's generation will be connected directly to the grid, and is expected to power over 88,000 homes.[56]

In sum, the new green urban grid should rely on distributed resources to generate electricity. Distributed generation provides a way to meet renewable goals while minimizing investment in transmission and costs of development to the environment.

B. Distributed Energy Storage Resources

Distributed energy storage resources are an essential component of a green urban grid. Significant interest in energy storage began in the 1970s with an initial focus on pumped hydro storage.[57] At that time, energy storage was evaluated as an option of peaking power due to the high price of the fuels (natural gas and oil) that were typically used to generate peaking power.[58] These analyses demonstrated that the cost of relying on energy storage for peaking power rather than natural gas or oil generation was cheaper during the mid-1970s to the early 1980s.[59] This initial focus on energy storage as a potential resource receded in the 1980s, when the price of natural gas peaking energy was reduced.[60]

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[53] Cal. Pub. Util. Comm'n, Decision 11-03-036 (Mar. 24, 2011), *available at* http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/132654-08.htm.
[54] MILLS & WISER, *supra* note 19, at 8.
[55] *See* Ari Natter, *DOE Announces $1.4 Billion Loan Guarantee for Largest Solar Rooftop Project in the Nation*, 42 ENV'T REP. 1391 (June 24, 2011).
[56] *See id.*
[57] PAUL DENHOLM ET AL., NAT'L RENEWABLE ENERGY LAB., TECHNICAL REPORT NREL/TP-6A2-47187, THE ROLE OF ENERGY STORAGE WITH RENEWABLE ELECTRICITY GENERATION 6 (Jan. 2010), *available at* http://www.nrel.gov/docs/fy10osti/47187.pdf.
[58] *See id.* (citing EPRI, ASSESSMENT OF ENERGY STORAGE SYSTEMS SUITABLE FOR USE BY ELECTRIC UTILITIES, EPRI-EM-264, (July 1976)).
[59] *See* DENHOLM, *supra* note 57, at 7.
[60] *Repeal of the Powerplant and Industrial Fuel Use Act (1987)*, U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, http://www.eia.doe.gov/oil_gas/natural_gas/analysis_publications/ngmajorleg/repeal.html (last visited Apr. 4, 2012).

Now, due to the proposed increased reliance on renewable energy and advancements in energy storage technology, the interest in energy storage has been renewed.[61] But, the current level of energy storage deployment is low.[62] One suspected reason for the low level of energy storage currently constructed is that the benefits of energy storage have been subject to a simplistic calculation of economic benefit that does not quantify all of the advantages of energy storage on a grid.[63] In reality, energy storage can provide many separate benefits for a grid.[64]

Distributed energy storage resources can be used by the urban grid in several different ways. The new green urban grid will rely on distributed renewable generation resources such as solar photovoltaic systems on residences. Wind and solar renewable resources are considered variable or intermittent because the sun does not always shine and the wind does not always blow.[65] To meet the real-time demand of a system, a grid relying on variable resources needs to have resources available to back up the intermittent resources.[66] This backup requirement can be met by energy storage resources.[67] Grids also need to be able to supply peaking power to meet peak loads.[68] In addition to relying on energy efficiency and demand response as a way to reduce peaking needs, the new urban grid can and should rely on energy storage to provide peaking power. It can also rely on energy storage to provide electricity to the urban grid when the renewable generation resources are not providing power.

To minimize air pollution and greenhouse gases that negate the positive impacts of renewable resources, it is important to make thoughtful

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[61] *See, e.g.*, Assem. B. 2514, 2009 Leg., 10th Reg. Sess. (Cal. 2010), *available at* http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_2501-2550/ab_2514_bill_20100219_introduced.pdf (requiring the California Public Utility Commission to study energy storage and set goals for procurement of energy storage).
[62] DENHOLM, *supra* note 57, at 8.
[63] *Id.*
[64] *See* CAL. INDEPENDENT SYS. OPERATOR, SMART GRID ROADMAP, IS-1 ISO USES ENERGY STORAGE FOR GRID OPERATIONS AND CONTROL (Nov. 2010), *available at* http://www.caiso.com/285f/285fb7964ea00.pdf (articulating many benefits of energy storage on the grid) [hereinafter CAL. ISO, SMART GRID ROADMAP].
[65] *Id.* at 4. Notably, some types of distributed resources are considered "base-load" resources. For example, geothermal energy has a high availability comparable to fossil-fuel resources. *See* LISA SCHWARTZ, OR. PUB. UTIL. COMM'N, DISTRIBUTED GENERATION IN OREGON: OVERVIEW, REGULATORY BARRIERS AND RECOMMENDATIONS 3 (Feb. 2005), *available at* http://www.oregon.gov/PUC/electric_gas/dg_report.pdf?ga=t (stating that distributed generation can supply primary power).
[66] DENHOLM, *supra* note 57, at 17.
[67] *Id.* at 2.
[68] *Id.*

choices about how to back up renewable resources. The type of resources necessary to back up intermittent resources are called ancillary services, which refer to resources that can rapidly come online and ramp up their capability quickly.[69] Unfortunately, many grid operators currently rely on fossil-fuel facilities to provide this backup.[70] To provide the necessary ancillary services, a large percentage of backup facilities are spinning reserves, meaning that they are online and running so that they can supply energy to the grid quickly if another resource goes offline.[71] Running fossil-fuel facilities as spinning reserves increases fuel costs and harmful air emissions from these facilities.[72] Grid operators also tend to rely on fossil-fuel facilities to provide peaking power, and due to this, reliance on natural gas is anticipated to increase.[73] Using fossil-fuel generation for peaking facilities also increases fuel costs and emissions.[74] Energy storage provides a viable alternative to the reliance on fossil-fuel facilities for spinning and peaking reserves and will be an essential component of the new green urban grid.

In addition to the environmental benefit, the particular characteristics of energy storage resources are beneficial for integrating renewables. Storage technologies are predicted to have an important role in the integration of intermittent renewable generation: "looking forward, some of the firming services provided by gas-fired generation will need to come from existing and emerging energy storage technologies that allow generators and transmission operators to fill the gap between the time of generation (off-peak) and the time of need (on-peak) for intermittent renewable energy."[75]

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[69] *Id.* at 3.
[70] DENHOLM, *supra* note 57, at 6.
[71] *Id.* at 3.
[72] *Id.* Startup and shutdown of units are often associated with the highest emissions of the unit because emission reduction technology generally does not work at full removal efficiency during these time periods. *See, e.g.*, *In re* RockGen Energy Center, 8 E.A.D. 536 (EAB 1999); *In re* Tallmadge Generating Station, PSD Appeal No. 02-12, Order Denying Review in Part and Remanding in Part (May 22, 2003), *available at* http://www.epa.gov/eab/orders/tallmadge.pdf. The increased reliance on natural gas facilities could also reduce the impact that a transition to renewable power has on climate change. *See* Umair Irfan, *Switching to Natural Gas Power Generation May Not Slow Climate Change*, Sci. Am. (Sept. 9, 2011), *available at* http://www.scientificamerican.com/article.cfm?id=switching-to-natural-gas-power.
[73] N. AM. RELIABILITY COUNCIL, LONG-TERM RELIABILITY ASSESSMENT 2009–2018 (2009), *available at* http://www.nerc.com/files/2009_LTRA.pdf.
[74] DENHOLM, *supra* note 57, at 6–7, 9, 17.
[75] CAL. ENERGY COMM'N, 2009 INTEGRATED ENERGY POLICY REPORT, FINAL COMMISSION REPORT, 86, 193 (Dec. 2009) [hereinafter CAL. ENERGY COMM'N, 2009 INTEGRATED ENERGY POLICY REPORT], *available at* http://www.energy.ca.gov/2009publications/CEC-100-2009

Energy storage resources can thus help handle the variability of renewable resources.[76] Importantly, energy storage can provide almost immediate backup capability for either increases or decreases to the electricity supply level.[77] Regulators have found that storage can replace the number of natural gas power plants that are required to back up the system,[78] and that the technology has advanced to the extent that several technologies will be able to provide utility-size storage.[79]

Energy storage also has many economic benefits, which show its enormous potential for using storage on the new urban grid.[80] Not only are energy storage projects a potential alternative for integrating renewables that are under development, but they can be a more cost-effective backup than fossil-fuel plants.[81] Combining renewable energy generation with storage allows the capacity to be firmed, and the energy generation to be "somewhat-to-very constant."[82] The value of this benefit has been estimated to be $709–$915 per kilowatt, or in broader terms, a potential benefit to the U.S. economy in the amount of $29.9 billion.[83] In fact, as a recent analysis found, "storage can achieve better performance in the system per MW installed [for backing up renewable energy] than regulation from conventional generation."[84] Storage also provides significant

-003/CEC-100-2009-003-CMF.PDF ("Other solutions [aside from natural-gas plants] such as energy storage and hybrid renewable plants are also possible and could be preferable in the longer term as more aggressive climate mitigation targets are addressed.").

[76] CALIFORNIA ISO, SMART GRID ROADMAP, *supra* note 64, at 4.

[77] CAL. INDEPENDENT SYS. OPERATOR, PARTICIPATION OF LIMITED ENERGY STORAGE RESOURCES IN CAISO ELECTRICITY MARKETS 8 (Jan. 16, 2009), *available at* http://www.caiso.com/2338/233810ac4147a0.pdf [hereinafter CAL. ISO, PARTICIPATION IN LIMITED ENERGY STORAGE].

[78] *See* CAL. ENERGY COMM'N, 2009 INTEGRATED ENERGY POLICY REPORT, *supra* note 75, at 87 ("[b]attery energy storage technology has improved over time to the point where there are several emerging battery technologies that can provide utility-scale energy storage.").

[79] *Id.* at 194 (stating that the use of new energy-storage technologies "can reduce the number and amount of natural gas-fired power plants that would otherwise be needed to provide the firming characteristics the system needs to operate reliably").

[80] *See* JIM EYER & GARTH COREY, SANDIA NAT'L LAB., ENERGY STORAGE FOR THE ELECTRICITY GRID: BENEFITS AND MARKET POTENTIAL ASSESSMENT GUIDE, 11–13 (2010), *available at* http://prod.sandia.gov/techlib/access-control.cgi/2010/100815.pdf.

[81] CAL. ENERGY STORAGE ALLIANCE, ENERGY STORAGE—A CHEAPER AND CLEANER ALTERNATIVE TO NATURAL GAS-FIRED PEAKER PLANTS (Feb. 2011), *available at* http://www.storagealliance.org/whitepapers/CESA_Peaker_White_Paper_2011-02-08.pdf.

[82] *See* EYER & COREY, SANDIA NAT'L LAB., *supra* note 80, at 44.

[83] *See id.* at 10.

[84] *See* KEMA, INC., RESEARCH EVALUATION OF WIND GENERATION, SOLAR GENERATION, AND STORAGE IMPACT ON THE CALIFORNIA GRID, PREPARED FOR THE CAL. ENERGY COMM'N

environmental benefits because it avoids greenhouse gases associated with increased use of combustion turbines as spinning reserves.[85] Considering all these benefits, it is not surprising that system operators have started to develop ways to facilitate the use of energy storage to provide backup for intermittent renewables.[86]

Energy storage will also be useful for the new green urban grid as a resource that provides peaking power. It can be used to decrease the need of peaking facilities by storing power generated by baseload resources for use during peak times.[87] This is beneficial to the urban grid, which relies on renewable energy, because it reduces the fuel usage and emissions related to reliance on fossil-fuel facilities for peak power.[88]

Another benefit of using energy storage on the new urban grid is that it will help avoid situations of curtailment.[89] When renewable resources are generating more energy than the current level of demand, grid operators have needed to quickly reduce the load generated by other resources.[90] In the new urban grid, because of its primary reliance on renewable generation, energy storage is necessary to store the excess energy and avoid curtailment in over-generation situations.[91] Finally, energy storage will be able to provide electricity on the new green urban grid when the renewable resources are not generating energy.[92]

Integration of energy storage resources in an urban grid is feasible because several energy storage systems are already operating and being developed. As the grid operator in California has recognized: "Small-scale or limited energy storage technology has evolved and matured over the past several years. The technology has now reached the stage where it is being commercially deployed in California and elsewhere."[93] For example, the Southern California Public Power Authority signed an agreement with

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7 (June 2010), *available at* http://www.energy.ca.gov/2010publications/CEC-500-2010-010/CEC-500-2010-010.PDF.

[85] *Id.* at 76.

[86] *See id.* at 10–11 (listing potential policy recommendations to facilitate energy storage).

[87] DENHOLM, *supra* note 57, at 14; CAL. ISO, SMART GRID ROADMAP, *supra* note 64, at 7.

[88] DENHOLM, *supra* note 57, at 14; CAL. ISO, SMART GRID ROADMAP, *supra* note 64, at 7.

[89] DENHOLM, *supra* note 57, at 32–33 (graphically illustrating how energy storage can reduce the curtailment rate of renewables); CAL. ISO, SMART GRID ROADMAP, *supra* note 64, at 7.

[90] DENHOLM, *supra* note 57, at 17.

[91] *Id.* at 32; *see also Energy Storage: Technology that Makes Commercial Sense*, PRUDENT ENERGY CORP., http://www.pdenergy.com/benefits_technologythatmakes.html (last visited Apr. 4, 2012).

[92] DENHOLM, *supra* note 57, at 34–35.

[93] CAL. ISO, PARTICIPATION IN LIMITED ENERGY STORAGE, *supra* note 77, at 4.

Ice Energy in January 2010 to install 53 MW of load-shifting storage capacity this year.[94] In addition, a 2 MW battery storage project in Huntington Beach has been operational since 2008.[95] In addition to these examples, there are several other energy storage projects being planned and implemented.[96] High-temperature battery storage, such as the sodium-sulfur battery, has installations that exceed 270 MW.[97] More hydro pumped storage is also currently being proposed and developed.[98] The projects that are currently being developed and constructed include utility scale storage. Notably, electric vehicles have the potential to provide this distributed storage by storing energy during high-generation times to avoid curtailment, and allowing the energy stored in the batteries to be used on the grid.[99] This type of cycling usage, however, could negatively impact the life of the battery.[100]

New kinds of storage technologies are constantly being developed.[101] For example, the Department of Energy recently helped finance a molten

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[94] Press Release, Ice Energy Corp. & S. Cal. Pub. Power Auth., SCPPA to Undertake Industry's Largest Utility-Scale Distributed Energy Storage Project (Jan. 27, 2010), *available at* http://www.ice-energy.com/content10197.

[95] *See* AES CORP., ENERGY STORAGE ROLE IN SMART GRID, PRESENTATION FOR CALIFORNIA PUBLIC UTILITY COMMISSION, SMART-GRID RULEMAKING, at Slide 2, *available at* http://www.cpuc.ca.gov/NR/rdonlyres/FF391276-27FB-4BA3-80FF-6EFBC5EF5948/0/DaurenKilishAES.pdf.

[96] *See* CAL. ENERGY STORAGE ALLIANCE, PRESENTATION FOR 2010 ESA CONFERENCE, at slide 38 (2010), *available at* http://storagealliance.org/presentations/StrateGen_CESA_ESA_Presentation_2010-05-06.pdf.

[97] Dan Rastler, *New Demand for Energy Storage*, ELECTRIC PERSPECTIVE, Sept./Oct. 2008, at 36–37, *available at* http://www.eei.org/magazine/EEI%20Electric%20Perspectives%20Article%20Listing/2008-09-01-EnergyStorage.pdf.

[98] Daniel M. Adamson, *Realizing New Pumped-Storage Potential Through Effective Policies*, HYDRO REV., Apr. 2009, at 28–30, http://www.hydroworld.com/index/display/article-display/358938/articles/hydro-review/volume-28/issue-3/feature-articles/viewpoint/realizing-new-pumped-storage-potential-through-effective-policies.html.

[99] PAUL DENHOLM & W. SHORT, NAT'L RENEWABLE ENERGY LAB., TECHNICAL REPORT NREL/TP-620-40293, AN EVALUATION OF UTILITY SYSTEM IMPACTS AND BENEFITS OF OPTIMALLY DISPATCHED PLUG-IN HYBRID ELECTRIC VEHICLES (revised Oct. 2006), *available at* http://www.nrel.gov/docs/fy07osti/40293.pdf. There are potential benefits of using controlled charging and allowing batteries to feed energy to the grid, but there are also potential disadvantages because of the high cost of energy cycling and the limited capacity of the batteries. DENHOLM, *supra* note 57, at 40.

[100] *See, e.g.*, Scott B. Peterson et al., *The Economics of Using PHEV Battery Packs for Grid Storage*, 195 J. POWER SOURCES 2377, 2378 (2010); *see also* ADAM KEECH, PJM INTERCONNECTIONS (PJM), PJM MANUAL 12: BALANCING OPERATIONS, REVISION 23 (Nov. 16, 2011), *available at* http://www.pjm.com/markets-and-operations/ancillary-services/~/media/documents/manuals/m12.ashx.

[101] *See Energy Storage*, INT'L ENERGY AGENCY, http://www.iea.org/techno/iaresults.asp?id_ia=13 (last visited Apr. 4, 2012).

salt storage system that would allow energy to be stored for up to ten hours.[102] Storage projects will help the new green urban grid maintain reliability, which has been a concern to some policy makers as conventional fossil-fuel facilities are shut down to make way for renewables.[103]

Initial steps have been taken to integrate energy storage into the grid. In fact, one California administrative agency has specifically recommended integrating storage into its planning process: "Consider explicitly placing EES [electricity energy storage] within the state's energy resource loading order and require utilities to incorporate EES in their integrated resource planning processes."[104] This likely will happen soon, as the California legislature recently passed AB 2514, which would require the Commission to consider energy storage issues.[105] The Federal Energy Regulatory Commission has also taken some initial steps to facilitate the use of energy storage on the grid. In particular, it has directed the grid managers, including the independent system operators, to change tariffs to allow non-generation resources to participate in the ancillary-services markets.[106] This was important as the tariffs in the ancillary-services markets were originally geared towards traditional generation, not storage.[107]

Energy storage resources are an important component of the new urban grid. These resources will help the grid meet peak power demands and back up intermittent renewables.

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[102] *See* Ari Natter, *$737 Million Conditional Loan Guarantee Offered by DOE for Innovative Solar Project*, 42 ENV'T REP. 1166–67 (May 27, 2011) (describing the 110-MW Crescent Dunes Solar Energy Project and the contract to sell the energy to Nevada Power).

[103] *See, e.g.*, Letter from U.S. Senator Lisa Murkowski to Jon Wellinghoff, Chairman, Fed. Energy Regulatory Comm'n (May 17, 2011), *available at* http://republicans.energycommerce.house.gov/Media/file/Letters/112th/050911ChuandWellinghoff.pdf.

[104] *See* CAL. PUB. UTIL. COMM'N, ELECTRIC ENERGY STORAGE: AN ASSESSMENT OF POTENTIAL BARRIERS AND OPPORTUNITIES, POLICY AND PLANNING DIVISION STAFF WHITE PAPER 9 (July 9, 2010), *available at* http://www.cpuc.ca.gov/PUC/energy/reports.htm.

[105] California Assembly Bill 2514, Energy Storage Systems, (Skinner) became law in 2010. This is notably the first energy storage law passed in the United States. Although the initial proposed energy storage targets were removed from the final bill, advocates still consider the bill's passage a major victory due to its recognition of the importance of consideration of energy storage. *See, e.g.*, Press Release, Cal. Energy Storage Alliance, California State Assembly Passes Energy Storage Bill AB 2514 (June 4, 2010), *available at* http://www.storagealliance.org/pressreleases/CESA_PRESS_RELEASE_2010-06-04.pdf; *see also* Todd Woody, *California Legislature Passes Energy Storage Bill*, GRIST (Aug. 31, 2010), http://www.grist.org/article/california-legislature-passes-energy-storage-bill.

[106] Fed. Energy Regulatory Comm'n, Order No. 890, Statutes and Regulations, Para. 31,241.

[107] CAL. ISO, PARTICIPATION IN LIMITED ENERGY STORAGE, *supra* note 77, at 6–7.

C. *Energy Efficiency*

Energy efficiency is considered the most important aspect of an energy plan,[108] which, as the Energy Secretary commented, is a vital aspect of transitioning to clean energy.[109] The easiest way to meet climate-change related goals is to reduce energy consumption.[110] Indeed, the Pew Center has argued that the United States needs to focus on improving "the efficiency of energy conversion and utilization so as to reduce the demand for energy" to mitigate climate change.[111] Although energy efficiency measures are considered essential for climate change mitigation, and will be essential for a green urban grid, many of today's current policies do not reflect the seriousness that is needed to fully realize the potential of energy efficiency.[112] As an illustration of this, many of the energy efficiency policies in this country are goals or targets, not enforceable limits.[113]

Nevertheless, the United States has realized significant reductions in energy usage due to energy efficiency measures. For example, Vermont has been able to effectively reduce load by a couple of percentage points each year over the last couple of years.[114] Several other states have

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[108] Efficiency improvements are considered a critical component for reducing emissions. *See* BARKER ET AL., INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, *supra* note 12, at Table SPM.3.

[109] *See* Janice Valverde, *Chu Says 'Transformational Technologies' Vital for Transition to Clean-Energy Economy*, 40 ENV'T REP. 621 (Mar. 20, 2009). Notably, energy efficiency proposals have received widespread support. *See* Ari Natter, *19 Companies Urge Senate to Act on Stand-Alone Energy Efficiency Legislation*, 42 ENV'T REP. 2067 (Sept. 16, 2011).

[110] *See* S. Pacala & R. Socolow, *Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies*, 305 SCI. 968 (2004), *available at* http://www.sciencemag.org/content/305/5686/968.full.pdf (describing different strategies for reducing greenhouse gas emissions as wedges and stating that efficiency and conservation offer the "greatest potential to provide wedges").

[111] *See* JOHN A. ALIC ET AL., PEW CTR. FOR GLOBAL CLIMATE CHANGE [*now* CTR. FOR CLIMATE AND ENERGY SOLUTIONS], U.S. TECHNOLOGY AND INNOVATION POLICIES: LESSONS FOR CLIMATE CHANGE iii (Nov. 2007), *available at* http://www.c2es.org/docUploads/us-technology-innovation-policies.pdf.

[112] This has been noted in the literature. *See* John Dernbach, *Stabilizing and Then Reducing U.S. Energy Consumption: Legal and Policy Tools for Efficiency and Conservation*, 37 Envtl. L. Rep. (Envtl. L. Inst.) 10,003 (2007) (noting that "no energy policy choice creates as much ambivalence as energy efficiency and, perhaps more pointedly, energy conservation").

[113] *See* Richard Defendorf, *Undercurrents of Conflict in Energy Efficiency Goals*, GREEN BUILDING ADVISOR (June 28, 2011), http://www.greenbuildingadvisor.com/blogs/dept/green-building-news/undercurrents-conflict-energy-efficiency-goals; *see also* Press Release, W. Governors' Ass'n, Policy Resolution 11-8, Promoting Industrial Energy Efficiency, *available at* http://www.westgov.org/component/joomdoc/doc_download/1442-11-8.

[114] *See* EFFICIENCY VERMONT, ANNUAL PLAN 2010–2011 (Nov. 2, 2009), *available at* http://www.efficiencyvermont.com/docs/about_efficiency_vermont/annual_plans/EVT_AnnualPlan2010-2011.pdf; EFFICIENCY VERMONT, ANNUAL REPORT 2010 5, Figure 2

also implemented energy efficiency programs that have resulted in significant savings.[115] Many of these reductions are due to changes made to appliances and homes that make more efficient use of energy.[116] Some energy efficiency savings also have resulted from improved equipment maintenance, because major appliances such as refrigerators and air conditioners are often not properly commissioned when they are installed.[117]

Although significant reductions have been realized, new specifications related to energy efficiency will continue to reduce energy requirements. For instance, the new requirements for light bulbs in the United States would reduce energy usage seventy-five percent from standard light bulbs.[118] New innovative types of energy efficiency technologies are constantly being developed.[119] For example, a company developed a new thin window material that makes windows up to twenty-five to thirty percent more energy efficient during hotter months.[120] Through the energy star program, the U.S. Environmental Protection Agency will continue to update its standards for various types of appliances and technologies to reflect these advancements.[121]

More recently, the federal government appears to be getting more serious about energy efficiency. The Department of Energy ruled that

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(Feb. 2012), *available at* http://www.efficiencyvermont.org/docs/about_efficiency_vermont/annual_reports/2010_Annual_Report.pdf.

[115] *See* SYNAPSE ENERGY ECON., INC., BEYOND BUSINESS AS USUAL: INVESTIGATING A FUTURE WITHOUT COAL AND NUCLEAR POWER IN THE U.S. (May 11, 2011), *available at* http://www.civilsocietyinstitute.org/media/pdfs/Beyond%20BAU%205-11-10.pdf.

[116] *Id.* at 58.

[117] *See* U.S. ENVTL. PROT. AGENCY, STATE CLIMATE & ENERGY PROGRAM TECHNICAL FORUM, SMART GRID'S POTENTIAL FOR CLEAN ENERGY: BACKGROUND AND RESOURCES (Mar. 23, 2010), *available at* http://www.epa.gov/statelocalclimate/documents/pdf/background_paper_3-23-2010.pdf.

[118] A provision in the Energy Independence and Security Action of 2007 (Pub. Law No. 110-140) required a reduction in the wattage requirements for light bulbs. *See* ENVTL. PROT. AGENCY, ENERGY INDEPENDENCE AND SECURITY ACT OF 2007, FREQUENTLY ASKED QUESTIONS: WHAT IS THIS "LIGHT BULB" LAW? (2011), *available at* http://www.energystar.gov/ia/products/lighting/cfls/downloads/EISA_Backgrounder_FINAL_4-11_EPA.pdf. Compact florescent light bulbs are expected to use 75% less energy and last many times longer than standard light bulbs. *Id.* at 4.

[119] CHARLES ROSS & SON CO., MIXING APPLICATIONS IN SELECTED GREEN TECHNOLOGIES (May 10, 2011), *available at* http://www.mixers.com/whitepapers/green.pdf.

[120] *See* Tripp Baltz, *DOE Signs First 'Energy Innovator' Agreement With Colorado Company, Biden Announces*, 42 ENV'T REP. 1166 (May 27, 2011) (discussing U.S. e-Chromic's invention pursuant to the Obama administration's "Startup America Initiative").

[121] *See Energy Star*, Envtl. Prot. Agency, http://www.energystar.gov/index.cfm?c=about.ab_index (last visited Apr. 4, 2012).

states must review and update their energy efficiency codes for residential and commercial buildings.[122] The Department of Energy also recently issued a rule that includes efficiency standards for furnaces, air conditioners, and heat pumps.[123] This rule interestingly also focuses on specific regions, recognizing that efficiency goals may need to be designed differently in diverse climates.[124]

States have used various methods to reach energy efficiency goals. At least ten states have enacted legislation mandating energy savings goals for utilities.[125] Some states have saved seven to eight percent of total energy usage by meeting energy efficiency goals.[126] Problematically, some energy efficiency measures have unintended adverse consequences that should be examined before implementation.[127] For example, changes in ventilation in indoor spaces could be especially harmful to populations more vulnerable to climate change, including the elderly and the poor.[128]

With that in mind, a community attempting to transition to a new green urban grid should first examine potential reductions in energy efficiency. Initially, the community should examine ways to make buildings more efficient. Buildings are currently responsible for forty percent of the energy usage, and carbon emission, in the United States.[129] Tools have been

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[122] *See* U.S. Department of Energy, Updating State Residential Building Energy Efficiency Codes, 76 Fed. Reg. 42688 (July 19, 2011); U.S. Dep't of Energy, Building Energy Standards Program: Determination Regarding Energy Efficiency Improvements in the Energy Standard for Buildings, Except Low-Rise Residential Buildings, 76 Fed. Reg. 42387 (July 20, 2011).

[123] *See* U.S. Dep't of Energy, Appliance Standards for Residences, 10 C.F.R. Part 430, *available at* http://www1.eere.energy.gov/buildings/appliance_standards/residential/pdfs/cacfurn_dfr_final-version.pdf.

[124] *Id.* at 58–59.

[125] *See* ELEC. ADVISORY COMM., KEEPING THE LIGHTS ON IN A NEW WORLD 2 (Jan. 2009), *available at* http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/adequacy_report_01-09-09.pdf.

[126] *Id.*

[127] *See, e.g.*, NAT'L ACAD. OF SCI., INST. OF MED., CLIMATE CHANGE, THE INDOOR ENVIRONMENT, AND HEALTH 1–2 (June 7, 2011), *available at* http://iom.edu/~/media/Files/Report%20Files/2011/Climate-Change-the-Indoor-Environment-and-Health/Climate%20Change%202011%20Report%20Brief.pdf ("A building that was tightly sealed as a response to adverse outdoor conditions or because of efforts to reduce energy use might protect occupants from one set of problems but would increase their exposure to another: such buildings tend to have decreased ventilation rates, higher concentrations of indoor-emitted pollutants, and more occupants reporting health problems.").

[128] *See id.* at 5 (stating that "[t]hose populations experience excessive temperatures almost exclusively in indoor environments.").

[129] *See* U.S. DEP'T OF ENERGY, BUILDINGS ENERGY DATA BOOK, Chapter 1 (2010), *available at* http://buildingsdatabook.eren.doe.gov/.

developed to help a community develop guidelines to create more energy efficient buildings.[130] After potential requirements for energy efficiency measures in buildings are investigated, the community can examine energy efficiency requirements for appliances, heating and ventilation, and lighting energy uses.[131]

By investing in energy efficiency, an urban grid will more effectively be able to meet its electrical demand in a way consistent with environmental goals.[132]

D. Demand Response

Demand response resources are programs that require users to lower their demand during peak times to reduce overall demand.[133] This reduction of demand, in turn, reduces a grid's overall need, and thus reduces the quantity of resources that are necessary to supply that need. Demand response programs are an excellent way to avoid building new capacity. For example, fifteen percent of the peak demand in Massachusetts occurs in eighty-eight hours per year.[134]

A key to maximizing the integration of demand response in the urban grid is a smart-grid system that is able to signal an energy user to reduce demand.[135] Policy makers are increasingly focusing on more installation of smart-grid technology.[136] On an international scale, the

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[130] *See, e.g.*, *Rating Systems*, U.S. GREEN BLDG. COUNCIL, http://www.usgbc.org/DisplayPage.aspx?CMSPageID=222 (describing the LEED standard and how it can be used) (last visited Apr. 4, 2012).

[131] Some of this may overlap with the investigation of reductions in buildings.

[132] The ability for energy efficiency measures to replace fossil-fuel facilities has been recognized. *See, e.g.*, R. NEAL ELLIOTT ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., AVOIDING A TRAIN WRECK: REPLACING OLD COAL PLANTS WITH ENERGY EFFICIENCY (2011), *available at* http://aceee.org/files/pdf/white-paper/Avoiding_the_train_wreck.pdf.

[133] INDEP. SYS. OPERATORS & REG'L TRANSMISSION ORG. COUNCIL, INCREASING DEMAND RESPONSE AND RENEWABLE ENERGY RESOURCES: HOW ISOS AND RTOS ARE HELPING MEET IMPORTANT PUBLIC POLICY OBJECTIVES 6 (Oct. 2007), *available at* http://www.isorto.org/atf/cf/%7B5B4E85C6-7EAC-40A0-8DC3-003829518EBD%7D/IRC_Demand_Renewables_Glossy.pdf.

[134] ENVTL. PROT. AGENCY, SMART GRID AND CLEAN ENERGY FOR LOCAL GOVERNMENTS: BACKGROUND AND RESOURCES 3, *available at* http://www.epa.gov/statelocalclimate/documents/pdf/background_paper_smartgrid_4-29-2010.pdf.

[135] PETER CAPPERS ET AL., BERKELEY NAT'L LAB., MASS MARKET DEMAND RESPONSE AND VARIABLE GENERATION INTEGRATION ISSUES: A SCOPING STUDY 4 (Oct. 2011), *available at* http://eetd.lbl.gov/ea/ems/reports/lbnl-5063e-ppt.pdf (describing how smart-grid technology will allow for increased reliance on demand response).

[136] *See* Lynn Garner, *White House Science Office Unveils Framework for Development of Smart Grid*, 42 ENV'T REP. 1336–37 (June 17, 2011) (describing the Obama administration's

Interntional Energy Agency found that smart electricity grids, which are able to respond with instruments like demand response, could help reduce peak load by thirteen to twenty-five percent by 2050.[137] Reducing this demand in turn reduces the need for generation facilities and transmission lines.

The next development in demand response is intelligent demand response. Intelligent or automated demand response uses signals to cut energy demand at times necessary to reduce peak load or integrate renewables.[138] Intelligent or automated demand response has significant potential to be an integral component in the new urban grid. Key issues will be how to determine the appropriate compensation for demand response and how to technically integrate demand response into the grid.[139] FERC had a recent rulemaking, known as the demand-response compensation rule, which tried to determine how demand response customers should be compensated.[140]

II. WHY COMMUNITIES AND POLICYMAKERS SHOULD FOCUS ON THE NEW URBAN GRID

A. *The New Urban Grid Is a More Efficient Way to Reduce Greenhouse Gas Emissions*

Environmentalists and policy makers have expended substantial effort towards developing policies and requirements that will have national and international implications for mitigating climate change.[141] These efforts, though, have been met by fierce opposition, which has delayed and stymied various proposals and attempts. This has occurred on the international level, and is most recently demonstrated by the United

announcement of several new public and private initiatives for promoting development of a smart grid).

[137] INT'L ENERGY AGENCY, SMART GRID ROADMAP 5 (Apr. 2011), *available at* http://www.iea.org/Papers/2011/SmartGrids_roadmap.pdf.

[138] *See, e.g.*, Stephen Lacey, *The Five Coolest Ways to Integrate Renewable Energy into the Grid*, GRIST (June 18, 2011), http://www.grist.org/article/2011-06-17-top-5-coolest-ways-companies-are-integrating-renewable-energy (describing efforts by EnerNOC to integrate intelligent demand response into the grid).

[139] Fed. Energy Regulatory Comm'n, Order 745, Docket No. RM10-17-000 (Mar. 15, 2011).

[140] *Id.*

[141] Others have pointed to the failure of federal and international climate change efforts as a reason to focus on local efforts. *See, e.g.*, Sussman, *supra* note 15, at 7–8.

States' recent objection to an attempt by the European Union to institute a top-down cap and trade regime for airlines.[142]

On the federal level, the U.S. Environmental Protection Agency has started regulating some aspects of greenhouse gas emissions after the Supreme Court found that it had authority to do so in *Massachusetts v. EPA*.[143] In particular, after the Supreme Court's decision, pursuant to the Clean Air Act's requirements, the EPA first found that greenhouse gases endanger human health and welfare.[144] This finding, which is a prerequisite to regulating mobile sources under the Clean Air Act, has been challenged by numerous entities in the Circuit Court of the District of Columbia.[145] EPA's actions have also been closely scrutinized and challenged by legislators.[146] Consequently, many of the regulations and actions to mitigate climate change on a federal level by EPA have been delayed.[147] Due to this, only a limited subset of the EPA's greenhouse gas rules have been finalized and are moving forward.[148] In the spring of 2011, in the *American Electric Power v. Connecticut* case, the Supreme Court found that federal common law actions related to reducing greenhouse gases were displaced by federal law because Congress has delegated authority

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142 *See* Leora Falk, *U.S. Asks European Union to Exempt Airlines from Emissions Limits Due to Start in 2012*, 42 ENV'T REP. 1386–87 (June 24, 2011) (quoting a U.S. administration official as stating: "We don't oppose market-based measures, but there are other ways to address climate change . . . . We don't feel it is appropriate for the U.S. to apply its mechanisms to all other countries.").

143 *See Greenhouse Gas Reporting Program*, Envtl. Prot. Agency, http://www.epa.gov/climatechange/emissions/ghgrulemaking.html (last visited Apr. 4, 2012).

144 Envtl. Prot. Agency, Greenhouse Gas Endangerment Finding, *supra* note 9, at 66,496.

145 *See, e.g.*, Coal. for Responsible Regulation, Inc. v. EPA, No. 09-1322, 2009 WL 7339935 (D.C. Cir. Dec. 23, 2009); *see also* Greg Wannier, *EPA Lawsuits: Digging Through the Morass of Litigation*, CLIMATE LAW BLOG (Oct. 18, 2010), http://blogs.law.columbia.edu/climatechange/2010/10/18/epa-lawsuits-digging-through-the-morass-of-litigation/.

146 *See, e.g.*, Amena H. Saiyid, *EPA Authority to Regulate Greenhouse Gases to be Targeted in 2012 Spending Measure*, 42 ENV'T REP. 1295 (June 10, 2011) (discussing recent plans by a Representative to offer an amendment to a bill to bar EPA from using fiscal 2011 funds to regulate greenhouse gases); Amena H. Saiyid, *House Panel Moves to Strip EPA Authority Over Greenhouse Gases, Other Pollutants*, 42 ENV'T REP. 1593 (July 15, 2011).

147 *See* Andrew Childers, *EPA, Environmental Groups Agree to Extend Deadline for Power Plant Rule Until Sept. 30*, 42 ENV'T REP. 1334 (June 17, 2011).

148 *See, e.g.*, Ari Natter, *Greenhouse Gas, Fuel Economy Standards For Trucks Due in July, White House Says*, 42 ENV'T REP. 1387 (June 24, 2011) (describing how the greenhouse gas standards related to medium and heavy duty trucks are expected to be released mid-July). But, even the regulations that have gone forward, such as the emissions-reporting requirements, have been relaxed. *See* Andrew Childers, *EPA Proposal Would Allow Energy Companies to Use Alternative Reporting Through 2011*, 42 ENV'T REP. 1443 (July 1, 2011).

to regulate greenhouse gas emissions to the EPA.[149] This suggests that EPA's delay in regulating greenhouse gas emissions could mean that climate change will not be meaningfully addressed at the federal level anytime soon.[150]

States and regional actions, although more successful, have also been met by opposition. Top-down efforts by states have been contested and challenged by various entities.[151] Some states are also now debating the effectiveness of regional efforts such as the Regional Greenhouse Gas Initiative.[152]

While these efforts are largely continuing without substantial progress, the climate-science news continues to show that the situation is getting more dire. Reputable scientists have notably found that we are nearing a tipping point where the impact of climate change will be irreversible.[153] In addition, recent reports found that 2010 was among the warmest years on record, and studies continue to link the warm temperatures to extreme weather events.[154]

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[149] Am. Elec. Power v. Connecticut, 131 S.Ct. 2527, 2537 (2011). It is, however, unclear whether all common law actions related to climate change are precluded. *See id.* at 15–16. In addition, if Congress takes away EPA's authority to regulate greenhouse gases, it is likely that common law actions will no longer be displaced.

[150] The federal government has implemented various types of incentive programs to encourage renewable development, and to encourage research and innovation in areas related to climate change mitigation and adaption. *See, e.g.*, U.S. GLOBAL CHANGE RESEARCH PROGRAM, http://www.globalchange.gov/ (describing federal program devoted to integrating government research to create innovative climate solutions) (last visited Apr. 4, 2012).

[151] *See, e.g.*, Cal. Proposition 23 (2010) *available at* http://cdn.sos.ca.gov/vig2010/general/pdf/english/text-proposed-laws.pdf#prop23 (attempting to delay implementation of California's greenhouse gas law until unemployment levels decrease); Ass'n of Irritated Residents v. Cal. Air Res. Board, No. CPF-09-509562, 2011 WL 312702 (Cal. Super. Jan. 24, 2011) (challenging the California Air Resources Board's compliance with California's environmental assessment requirements when it attempted to implement the Global Warming Solutions Act of 2006 ("AB 32")).

[152] *See* Lorraine McCarthy & Gerald B. Silverman, *Governor Says New Jersey Pulling Out of Regional Greenhouse Gas Initiative*, 42 ENV'T REP. 1210 (June 3, 2011) (summarizing the Governor's remarks that allowances are not expensive enough to curb emissions).

[153] *See* James Hansen et al., *supra* note 9, at 217–31 (2008); *see also* JAMES E. HANSEN & MAKIKO SATO, PALEOCLIMATE IMPLICATIONS FOR HUMAN-MADE CLIMATE CHANGE, DRAFT PAPER, *available at* http://www.columbia.edu/~jeh1/mailings/2011/20110118_MilankovicPaper.pdf (concluding that if the current rates of increases in CO_2 emissions are not soon reduced, "there is a possibility of seeding irreversible catastrophic effects").

[154] *See* Leora Falk, *NOAA Says 2010 Among Warmest on Record; Pew Links Climate, Harsh Weather Frequency*, 42 ENV'T REP. 1449 (July 1, 2011) (quoting the executive editor from Scientific American as saying that "the existence of the link between climate change and extreme weather is not so much theoretical anymore as it is observational"); J. Blunden et al. eds., NAT'L OCEANIC AND ATMOSPHERIC ADMIN., SUPPLEMENTAL BULLETIN OF THE

The news related to renewable development policies is more optimistic than the news related to climate change policies. A recent report by the Intergovernmental Panel on Climate Change found that deployment of renewable energy has been steadily increasing in the last few years.[155] In addition, numerous estimates have shown that the global potential for renewable energy exceeds global energy demand.[156] Importantly, the majority of states now have renewable portfolio standards, which require that a certain percentage of electricity is generated from renewable resources.[157]

Integration of distributed renewable generation, energy storage, energy efficiency, and demand response in the green urban grid is necessary to maximize reduction of greenhouse gases to mitigate climate change for several reasons. Initially, reliance on renewable projects close to load pockets is important because distant projects require long transmission lines that lead to efficiency losses.[158] Next, in the green urban grid, renewables are backed up by storage, demand response, and energy efficiency instead of fossil-fuel facilities.[159] Integrating renewable energy into the grid without a greenhouse gas ("GHG") neutral backup can nullify a great portion of the perceived GHG reductions, because grid operators

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AM. METEOROLOGICAL SOC'Y, STATE OF THE CLIMATE IN 2010 (June 2011), *available at* http://www1.ncdc.noaa.gov/pub/data/cmb/bams-sotc/climate-assessment-2010-hi-rez.pdf; DANIEL J. HUBER & JAY GULLEDGE, PEW CTR. ON GLOBAL CLIMATE CHANGE [*now* CTR. FOR CLIMATE AND ENERGY SOLUTIONS], EXTREME WEATHER AND CLIMATE CHANGE: UNDERSTANDING THE LINK AND MANAGING THE RISK, *available at* http://www.c2es.org/docUploads/white-paper-extreme-weather-climate-change-understanding-link-managing-risk.pdf.

[155] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, SPECIAL REPORT ON RENEWABLE ENERGY SOURCES AND CLIMATE CHANGE MITIGATION 7 (Ottmar Edenhofer et al. eds., 2011), *available at* http://srren.ipcc-wg3.de/report (finding that "[a]dditional policies would be required to attract the necessary increases in investment in technologies and infrastructure" to support projected future increases in the use of renewable energy).

[156] *See id.* at 7 (finding that "[t]he technical potential for solar energy is the highest among the RE [renewable energy] sources, but substantial technical potential exists for all six RE sources.").

[157] *See* PEW CTR. ON GLOBAL CLIMATE CHANGE [*now* CTR. FOR CLIMATE AND ENERGY SOLUTIONS], RENEWABLE & ALTERNATIVE ENERGY PORTFOLIO STANDARDS, *available at* http://www.pewclimate.org/sites/default/modules/usmap/pdf.php?file=5907 (updated Jan. 20, 2012) (presenting an interactive map showing the states that have developed renewable portfolio standards). But, notably, there are still considerable challenges associated with passing a federal renewable portfolio program. *See* Ari Natter, *Republicans' Renewable Energy Bills Draw Opposition from Obama Administration*, 42 ENV'T REP. 1448 (July 1, 2011).

[158] *See, e.g.*, Nami Sung, *Lost in Transmission: Distributed Generation v. Transmission Lines*, SUNRUN (Jan. 13, 2010), http://www.sunrunhome.com/blog/transmission/.

[159] ENVTL. PROT. AGENCY, SMART GRID AND CLEAN ENERGY FOR LOCAL GOVERNMENTS, *supra* note 134.

often spin fossil-fuel reserves.[160] Fossil-fuel facilities burn fuel while spinning,[161] and thus produce GHG emissions.

Finally, integration of the four components of the green urban grid allows a community to make greater GHG reductions than are possible when just relying on renewable energy production. As an illustration, plans for zero-net energy buildings focus on the integration of resources that reduce the demand and that produce the energy.[162] Although the components of the new urban grid are technically available and are increasing, policies are necessary to substantially increase investment and deployment.[163]

B. *The Green Urban Grid Can Improve Energy Security, Promote Economic Development, and Could Result in Cost Savings*

A positive aspect of relying on an integrated green urban grid is that its many benefits can appeal to a diverse group of constituents and entities.[164] For instance, advocates of renewable energy have highlighted energy security as a primary development of investment in renewable energy.[165] Not surprisingly, several states have relied on this purpose as a basis for the passage of renewable requirements to mitigate security concerns related to relying on foreign fuel.[166] Demonstrating this emphasis,

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[160] *See* DENHOM, *supra* note 57, at 3–5.
[161] *See id.*
[162] *See Net-Zero Energy Building Definitions*, U.S. DEP'T OF ENERGY, http://www1.eere.energy.gov/buildings/commercial_initiative/printable_versions/zero_energy_definitions.html (last visited Apr. 4, 2012).
[163] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, SPECIAL REPORT ON RENEWABLE ENERGY SOURCES AND CLIMATE CHANGE MITIGATION, *supra* note 155, at 7 (finding that "[a]dditional policies would be required to attract the necessary increases in investment in technologies and infrastructure").
[164] Policymakers have debated whether the varying purposes of climate change and renewable energy policies lead one to undercut the other. After weighing the competing arguments, the International Energy Agency concluded that: "developing new renewable resources (e.g., wind, solar and others) from a very narrow basis today allows learning that will unlock their climate-change mitigation potential. By contrast, the associated minor change in the rate of switching fuel from coal to gas does not lock the energy sector into more polluting technologies." CÉDRICK PHILIBERT, INT'L ENERGY AGENCY, INTERACTIONS OF POLICIES FOR RENEWABLE ENERGY AND CLIMATE 5 (2011), *available at* http://www.iea.org/papers/2011/interactions_policies.pdf.
[165] *See, e.g.*, WORLDWATCH INST. & CTR. FOR AM. PROGRESS, AMERICAN ENERGY: THE RENEWABLE PATH TO ENERGY SECURITY 9 (2006), *available at* http://images1.americanprogress.org/il80web20037/americanenergynow/AmericanEnergy.pdf.
[166] *See* Barry Rabe et al., *State Competition as a Source Driving Climate Change Mitigation*, 14 N.Y.U. ENVTL. L.J. 1, 29 (2005).

a federal energy bill considered by Congress was called a "Security Act."[167] In addition to the fuel-security aspect, the job potential of green technology has been gaining increased emphasis due to the current economic climate.[168] Importantly, studies have shown that green jobs are likely to significantly increase as renewable deployment increases.[169] The connection to green jobs thus is often highlighted by policymakers as a reason to promote renewable development.[170]

Reliance on localized generation instead of remote renewable energy also has benefits over decentralized generation. Siting of wind turbines in either undeveloped or scenic areas has been met with significant opposition.[171] Some of this opposition is due to the infrastructure impairing a scenic view.[172] Other opposition to siting in undeveloped areas comes from environmental groups concerned about the impact of the development on wildlife.[173] Rural development of decentralized wind resources has lead to deep divisions in small communities due to the tension between the potential negative impact of the development and its economic and environmental benefits.[174]

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[167] American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong, 1st Sess (2009).

[168] *See* Maria Gallucci, *New U.S. Institutes Help Tackle Cleantech Workforce Shortage*, REUTERS (May 16, 2011), http://www.reuters.com/article/2011/05/16/idUS186336334820110516; *see also* U.S. DEPT. OF ENERGY, GREEN ENERGY TECHNOLOGIES CREATE GREEN JOBS (Oct. 2009), *available at* http://www1.eere.energy.gov/library/pdfs/corporate_green_jobs.pdf.

[169] *See* PEW CHARITABLE TRUST, THE CLEAN ENERGY ECONOMY: REPOWERING JOBS, BUSINESSES AND INVESTMENTS ACROSS AMERICA (2009), *available at* http://www.pewcenteronthestates.org/uploadedFiles/Clean_Economy_Report_Web.pdf (finding that investment in clean energy generates significant job growth); MARK MURO ET AL., BROOKINGS INST., SIZING THE CLEAN ECONOMY: A NATIONAL AND REGIONAL GREEN JOBS ASSESSMENT (2011), *available at* http://www.brookings.edu/~/media/Files/Programs/Metro/clean_economy/0713_clean_economy.pdf.

[170] *See, e.g.*, Press Release, Governor of Mass., Governor Patrick Signs Bills to Reduce Emissions and Boost Green Jobs (Aug. 13, 2008), *available at* http://www.mass.gov/governor/priorities/jobs/smartgrowth/governor-patrick-signs-bills-to-create-green.html.

[171] *See* Alexa B. Engelman, *Against the Wind: Conflict Over Wind Energy Siting*, 41 Envtl. L. Rep. (Envtl. L. Inst.) 10,549, 10,560 (2011).

[172] A highly publicized example of this is the controversy over a proposed wind farm off of Cape Cod. *See, e.g.*, Robert F. Kennedy Jr., *An Ill Wind Off Cape Cod*, N.Y. TIMES (Dec. 16, 2005), http://www.nytimes.com/2005/12/16/opinion/16kennedy.html.

[173] *See, e.g.*, *American Bird Conservancy's Policy Statement on Wind Energy and Bird-Smart Wind Guidelines*, AM. BIRD CONSERVANCY, http://www.abcbirds.org/abcprograms/policy/collisions/wind_policy.html (last visited Apr. 4, 2012).

[174] *See* Engelman, *supra* note 171, at 10,588 (describing the conflict that occurred in Hammond, New York, over a potential wind project).

In addition to the environmental benefits, distributed renewable energy in various contexts has become economically competitive.[175] Indeed, the cost of many different renewable energy technologies has declined recently and is expected to further decline.[176] Thus, distributed renewable development may also appeal to investors interested in economical ways to generate electricity.

C. *The New Green Grid Can Reduce Pollution and Provide Economic Development in Environmental Justice Neighborhoods*[177]

An integrated urban grid focused on local renewable resources such as solar panels and wind turbines will also have positive public health impacts due to the reduced reliance on fossil-fuel energy. In fact, in an optimal situation, an integrated urban grid can end reliance on burning fossil-fuel because the resources do not use fossil-fuel and the energy storage helps eliminate the need for fossil-fuel facilities to act as a backup.[178] This reduced reliance on fossil-fuel electricity generation decreases greenhouse gases and other harmful co-pollutants such as sulfur dioxide, nitrous oxides, and particulate matter.[179] These co-pollutant emissions have been consistently linked to adverse cardiovascular and respiratory effects including asthma and premature death.[180] Consequently, a reduction of these co-pollutants decreases these health risks.

Although reliance on solar and wind power generally results in positive public health benefits, not all renewable energy resources have the same beneficial impact on public health. For example, many states allow combustion of biomass and municipal waste to qualify as renewable energy.[181] Burning these resources does not necessarily reduce the

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[175] *See* INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, SPECIAL REPORT ON RENEWABLE ENERGY SOURCES AND CLIMATE CHANGE MITIGATION, *supra* note 155, at 13.
[176] *See id.*
[177] Parts of this section are taken from Deborah Behles, *Examining the Air We Breathe: EPA Should Evaluate Cumulative Impacts When It Promulgates National Ambient Air Quality Standards*, 28 PACE ENVTL. L. REV. 200, 231–34 (2010).
[178] *See* DENHOLM, *supra* note 57, at 3.
[179] *See* Luis Cifuentes et al., *Hidden Health Benefits of Greenhouse Gas Mitigation*, 293 SCI. 1257 (2001), *available at* http://www.sciencemag.org/content/293/5533/1257.short.
[180] *See* Behles, *Examining the Air We Breathe*, *supra* note 177, at 206–12 (2010) (discussing health impacts associated with sulfur dioxide, nitrous oxides and particulate matter).
[181] *See, e.g.*, *Renewable Portfolio Standards*, ENVTL. PROT. AGENCY, http://www.epa.gov/agstar/tools/funding/renewable.html (presenting map showing states that allow burning of digester gas to count as renewable energy) (last visited Apr. 4, 2012).

quantity of harmful pollutants released into the air.[182] In addition, the greenhouse impact of the combustion of biomass and municipal waste has recently come under scrutiny, leading one state to reevaluate whether biomass should count as a renewable resource.[183] Due to these potential issues, the green urban grid should rely primarily on clean renewable resources such as solar, wind, geothermal, and small hydro to meet its generation needs. Reliance on these types of resources can reduce air pollution including greenhouse gases. These reductions, if planned correctly, can help communities currently overburdened by pollution.

Numerous studies have shown that low-income and minority communities that often live in urban areas bear more of the cumulative burden of pollution.[184] In particular, minority and low-income communities disproportionately bear the adverse environmental and health impacts from fossil-fuel exploration, extraction, production, consumption, and disposal.[185] These activities produce and lead to several criteria pollutants including fine particulate matter and nitrous oxides,[186] which could be reduced by increased reliance on the green urban grid. For example, in the San Francisco Bay Area, the Bay Area Air Quality Management District has designated urban neighborhoods with high populations of minorities, such as Bayview Hunters Point and Richmond, as high impact areas for air pollution.[187]

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[182] *See, e.g.*, *Smoke from Biomass Burning*, AUSTRALIAN DEP'T OF SUSTAINABILITY, ENV'T, WATER, POPULATION, & COMMUNITY, http://www.environment.gov.au/atmosphere/airquality/publications/biomass.html (last updated Sept. 16, 2009).

[183] *See Biomass Energy—Renewable Portfolio Standard Suspension Announcement and Clarification*, MASS. DEP'T OF ENERGY & ENVTL. AFFAIRS, http://www.mass.gov/eea/energy-utilities-clean-tech/renewable-energy/biomass/biomass-energy-renewable-portfolio-standard.html (last visited Apr. 4, 2012). Notably, the EPA has delayed deciding whether greenhouse gases from burning biomass should count under the Clean Air Act Tailoring Rule. *See* Stacy Feldman, *Is Biomass Clean or Dirty Energy? We Won't Know for 3 Years*, REUTERS (Jan. 13, 2011), http://www.reuters.com/article/2011/01/13/idUS247207368220110113.

[184] *See, e.g.*, Clifford Rechtschaffen, *The Evidence of Environmental Injustice*, 12 ENVTL. L. NEWS, No. 3, 2003; ROBERT D. BULLARD ET AL., UNITED CHURCH OF CHRIST JUSTICE & WITNESS MINISTRIES, TOXIC WASTES AND RACE AT TWENTY 1987–2007, 10 (2007), *available at* http://www.ucc.org/justice/environmental-justice/pdfs/toxic-wastes-and-race-at-twenty-1987-2007.pdf.

[185] *See* BULLARD, *supra* note 184, at 10; *see also Cal. Envtl. Justice Movement's Declaration on Use of Carbon Trading Schemes to Address Climate Change*, E.J. MATTERS, http://www.ejmatters.org/declaration.html (last visited Apr. 4, 2012).

[186] *Clean Energy*, ENVTL. PROT. AGENCY, http://www.epa.gov/cleanenergy/energy-and-you/affect/air-emissions.html (last visited Apr. 4, 2012).

[187] *See CARE Program*, BAY AREA AIR QUALITY MGMT. DIST., http://www.baaqmd.gov/Divisions/Planning-and-Research/CARE-Program.aspx (last visited Apr. 4, 2012).

These overburdened communities also often experience higher incidences of respiratory health effects (which have been linked to criteria pollutants) than other communities.[188] Several studies have demonstrated that asthma rates are higher among minorities.[189] Other studies have found that asthma rates are higher in low-income areas. One study found that children living in a low socioeconomic status community had a seventy percent higher risk of acquiring asthma than children living in a higher socioeconomic status neighborhood.[190] Studies also show that exposure to road traffic emissions worsens asthma in children.[191]

Disparities due to a higher cumulative burden of pollution will only increase due to climate change.[192] In particular, cap-and-trade regulatory

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[188] For example, the Bayview-Hunters Point community in San Francisco, which houses the majority of industry in the city, suffers higher bronchitis and asthma rates than the rest of the area. *See* Clifford Rechtschaffen, *Fighting Back Against a Power Plant: Some Lessons from the Legal and Organizing Efforts of the Bayview-Hunters Point Community*, 14 HASTINGS W.-N.W. J. ENVTL. L. & POL'Y 537, 542 (2008).

[189] *See, e.g.*, Marielena Lara et al., *Heterogeneity of Childhood Asthma Among Hispanic Children: Puerto Rican Children Bear a Disproportionate Burden*, 117 PEDIATRICS 43, 44 (2006); Marla McDaniel et al., *Racial Disparities in Childhood Asthma in the United States: Evidence from the National Health Interview Survey, 1997 to 2003*, 117 PEDIATRICS e868, e869 (2006), *available at* http://www.pediatrics.org/cgi/content/full/117/5/e868; Diane R. Gold & Rosalind Wright, *Population Disparities in Asthma*, 26 ANN. REV. PUB. HEALTH 89 (2005).

[190] *See* Luz Claudio et al., *Prevalence of Childhood Asthma in Urban Communities: the Impact of Ethnicity and Income*, 16 ANNALS OF EPIDEMIOLOGY 332, 337 (2006).

[191] HEALTH EFFECTS INST., SPECIAL REPORT 17, TRAFFIC-RELATED AIR POLLUTION: A CRITICAL REVIEW OF THE LITERATURE ON EMISSIONS, EXPOSURE, AND HEALTH EFFECTS xii–xiii (Jan. 2010), *available at* http://pubs.healtheffects.org/getfile.php?u=553.

[192] For example, in 2004, the Congressional Black Caucus Foundation reported that African Americans are twice as likely to die than the general population as a result of a heat wave and nearly three times more likely to die of asthma than whites. *See* CONG. BLACK CAUCUS FOUND., AFRICAN AMERICANS AND CLIMATE CHANGE: AN UNEQUAL BURDEN 2–3 (2004), *available at* http://www.sustainlex.org/BlackCaucusfullCBCF_REPORT_F.pdf. The limited capability of low-income and minority communities to adapt to climate change was also recently recognized by California's Attorney General:

> The impacts of global warming experienced by [communities of color] and poor communities will be exacerbated because these groups are often the least able to adapt. They typically have less access to health care and medical, home, and renter's insurance; less money to purchase air conditioning or to move away from droughts, floods and fires caused by global warming; and spend a higher percentage of their income on necessities such as gasoline, water, and electricity, which will become scarcer and more expensive with climate change.

Global Warming's Unequal Impacts, OFFICE OF CAL. ATTORNEY GEN., http://web.archive.org/web/20101111182000/http://ag.ca.gov/globalwarming/uequal.php (accessed via Internet Archive).

regimes, which are the primarily regulatory regime being examined in Congress, can create hot spots in areas already experiencing high levels of pollution, which in turn leads to a greater cumulative health risk.[193] Greenhouse gas levels are directly related to the environmental burden these communities currently face, partly because stationary sources that burn fossil-fuels also emit a host of other harmful air pollutants including particulate matter, nitrogen oxides, sulfur dioxide, and mercury.[194]

In addition to heat-related impacts, increases in temperature increase smog and thus deteriorate air quality.[195] As temperatures increase, nitrogen oxides will react with volatile organic compounds and sunlight at an increased rate, which will increase the atmospheric concentrations of ozone in urban areas.[196] This predicted air-quality deterioration in urban areas will most severely impact low-income and minority communities that live in these areas already overburdened by pollution.[197] Thus, the green urban grid's reduction in air pollution, including greenhouse gases, could substantially benefit low-income and minority communities that are currently overburdened by the impacts of pollution.

The new green urban grid can also provide economic opportunity to workers in low-income and minority communities.[198] Investment in

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[193] Richard Drury et al., *Pollution Trading and Environmental Injustice: Los Angeles' Failed Experiment in Air Quality Policy*, 9 DUKE ENVTL. L. & POL'Y F. 231, 272 (1999); *see also* Carol M. Rose, *Hot Spots in the Legislative Climate Change Proposals*, 102 NW. U. L. REV. 189, 190 (2008) (discussing how cap-and-trade systems create hot spots); Alice Kaswan, *Environmental Justice & Domestic Climate Change Policy*, 38 Envtl. L. Rep. (Envtl. L. Inst.) 10,287, 10,299 (2008); Ida Martinac, Comment, *Considering Environmental Justice in the Decision to Unbundled Renewable Energy Certificates*, 35 GOLDEN GATE U. L. REV. 491, 523 (2005) (explaining how the Los Angeles Regional Clean Air Initiatives Market ("RECLAIM") created hot spots).

[194] See Behles, *supra* note 177, at 233.

[195] *See* RACHEL MORELLO-FROSCH ET AL., THE CLIMATE GAP: INEQUALITIES IN HOW CLIMATE CHANGE HURTS AMERICANS & HOW TO CLOSE THE GAP 5, 13 (2010) [hereinafter CLIMATE GAP REPORT], *available at* http://dornsife.usc.edu/pere/documents/The_Climate_Gap_Full_Report_FINAL.pdf.

[196] *See id.* at 13.

[197] *See id.* at 5.

[198] *See id.* at 15–17 ("Addressing greenhouse gas emissions without an adequate transition plan for incumbent workers and targeting opportunities for communities of color in the new 'green jobs' sector could widen the racial economic divide"). *See also* Anne C. Mulkern, *Calif. Initiative Lets Low-Income Homes Bask in Solar Power*, N.Y. TIMES (Sept. 14, 2011), http://www.nytimes.com/gwire/2010/09/14/14greenwire-calif-initiative-lets-low-income-homes-bask-in-17335.html?pagewanted=all.

green resources has been shown to create more jobs than investment in fossil-fuel resources from the old urban grid.[199]

III. DEVELOPMENT OF THE GREEN URBAN GRID

Structural changes and regulatory reforms are likely necessary to overcome the current barriers that hinder the transition to a green urban grid. Utility policy and regulations are currently geared towards maintaining and incentivizing a grid that relies on large fossil-fuel facilities.[200] Market mechanisms will not be enough to transition away from this old model, as demonstrated by other failed attempts to reform energy markets.

In particular, California's failed experiment with deregulation illustrated that "light-handed regulation combined with the entrepreneurial profit-maximizing behavior of private participants in electricity markets does not serve the public well."[201] Specifically, as one commentator articulated,

> California's failed "deregulation" experiment arose largely from the failure of California to create properly functioning market rules, lack of diligence in market oversight, and the expectation that antitrust law would cure that which it was not designed to cure: market ills cultivated by regulatory rules that legitimized anticompetitive conduct and made that conduct the norm.[202]

Put another way, markets "cannot be trusted to work without a high degree of government intervention."[203]

These same principles apply here to the transition to an integrated grid. Thus, to move towards a new energy model, targeted regulatory

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[199] *See* ROBERT POLLIN ET AL., POLITICAL ECON. RESEARCH INST., UNIV. OF MASS., AMHERST, GREEN PROSPERITY: HOW CLEAN ENERGY POLICIES CAN FIGHT POVERTY AND RAISE LIVING STANDARDS IN THE UNITED STATES 3, 8 (2009) (stating that "investing in clean energy can provide significant new opportunities at all levels of the U.S. economy, and especially for families who are poor or near-poor.").

[200] Large-scale renewable development is often approved for inclusion into the rate-base while smaller scale projects have to rely on piece-meal incentives.

[201] *See* Jacqueline L. Weaver, *Can Energy Markets Be Trusted? The Effect of the Rise and Fall of Enron on Energy Markets*, HOUS. BUS. & TAX L.J. 133, 137–38 (2004).

[202] *See* Darren Bush & Carrie Mayne, *In (Reluctant) Defense of Enron: Why Bad Regulation Is To Blame for California's Power Woes (or Why Antitrust Law Fails to Protect Against Market Power When the Market Rules Encourage Its Use)*, 83 OR. L. REV. 207, 212 (2004).

[203] *See* Weaver, *supra* note 201, at 138.

reforms need to be developed to reduce barriers and ensure fairness. Studies have recognized various barriers limiting the growth of a decentralized grid. The primary barriers generally cited are economics, technical interconnection barriers, and integration issues.[204]

As an initial step towards a new green grid, communities should engage in integrated resource planning that maps out how the community can change the way energy is generated, delivered, and used in its area through reliance on energy efficiency, demand response, distributed generation, and distributed storage. The integrated plan should determine how the community could rely on this green grid infrastructure to meet all of its energy needs. This planning should become the basis for targeted incentives and regulatory reform. The incentives should include the development of targeted feed-in tariff programs and economic incentives to encourage development of the green urban grid resources identified by the integrated resource plan. The permitting changes should introduce a tiered structure that allows projects that are more desirable, such as rooftop solar photovoltaic resources, a more efficient permitting process. These regulatory measures are necessary for a community to reduce the barriers that could hamper the transition towards a new energy grid.

A. Community-Led Integrated Resource Planning

An important step for transitioning to a new green urban grid is developing an integrated resource plan to determine how best to deploy resources to meet the needs of the community. Integrated resource planning is an evaluation of how to meet electricity requirements for an area while meeting other objectives.[205] Currently, the majority of states require some form of an integrated resource plan that is either developed by the state or by a utility.[206] These integrated resource plans attempt to identify the needs for the particular area studied for a period into the

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[204] *See, e.g.*, CAL. ENERGY COMM'N, STAFF REPORT, DEVELOPING RENEWABLE GENERATION ON STATE PROPERTY 4 (2011), *available at* http://gov.ca.gov/docs/ec/State_Property_Report.pdf.

[205] *See* U.S. AGENCY FOR INT'L DEV., OFFICE OF ENERGY, ENV'T & TECH., BEST PRACTICES GUIDE: INTEGRATED RESOURCE PLANNING FOR ELECTRICITY 1, *available at* http://pdf.usaid.gov/pdf_docs/PNACQ960.pdf (defining integrated resource planning as "a process of planning to meet users' needs for electricity services in a way that satisfies multiple objectives for resource use").

[206] UTILITY MOTIVATION & ENERGY EFFICIENCY WORKING GROUP, USING INTEGRATED RESOURCE PLANNING TO ENCOURAGE INVESTMENT IN COST-EFFECTIVE ENERGY EFFICIENCY MEASURES 2 (Sept. 2011), *available at* http://www1.eere.energy.gov/seeaction/pdfs/utility_motivation_irpportfoliomanagement.pdf.

future.[207] These studies are beneficial to state planners because they represent a comprehensive view of how to develop resources to support the electricity demand of an area.[208] Traditionally, however, these integrated resource plans have focused on how to supply the electricity to an area through construction of generation, transmission, and distribution facilities.[209] To plan for the green urban grid, the integrated resource plan must take into account demand-side options, such as demand response and energy efficiency, for determining how best to meet a community's electricity needs.

Initially, to start this exercise, it is important to have the grid operator or service provider supportive of developing a green grid. Cooperation by the service provider is essential for a thoughtful integrated resource plan because the grid operator possesses important information related to energy usage, distribution, and transmission in the area.[210] This information is necessary for the development of a complete plan to transition to the green urban grid.[211] To accomplish this support, renewable energy proponents advocate for electricity to be administered by community choice programs rather than traditional utilities.[212] Community choice programs allow a government entity to contract with a commercial service provider to provide electric power on behalf of their constituents.[213] Community choice programs have been shown to be successful in practice by increasing renewable energy development, boosting local employment, reflecting local choices, and maintaining reliable and reasonable costs.[214]

After obtaining the required information, the community can work with technical experts to start mapping out how to transition to a green

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[207] *See* U.S. AGENCY FOR INT'L DEV., *supra* note 205, at 1.
[208] *See id.* at 9.
[209] *See id.* at 1.
[210] *Id.*
[211] *See* WEINRUB, *supra* note 21, at 39.
[212] *Id.*
[213] *See, e.g.*, Cal. Cmty. Choice Aggregation Legislation, AB 117 (2002), *available at* http://www.leginfo.ca.gov/pub/01-02/bill/asm/ab_0101-0150/ab_117_bill_20020924_chaptered.pdf. Notably, although this law was passed almost a decade ago, only one community has been able to implement a community choice program. *See* WEINRUB, *supra* note 21, at 39. This is blamed partly on the significant resistance that utilities have to community choice programs. *Id.*
[214] *See* GOLDMAN SCH. OF PUB. POLICY, UNIV. OF CAL., BERKELEY, COMMUNITY CHOICE AGGREGATION: THE VIABILITY OF AB 117 AND ITS ROLE IN CALIFORNIA'S ENERGY MARKETS 8–9 (June 13, 2005), *available at* http://www.local.org/goldman.pdf. The report highlights the Cape Light Compact in Massachusetts, which reportedly saved consumers between 11% and 22% on the generation portion of their bill. *Id.*

grid. The community first will need to identify the objectives of the planning exercise and the goals for the green urban grid.[215] The process needs to be transparent and open in order to assure that the community plan reflects the intended values. Some examples of objectives can include maximization of energy efficiency and rooftop solar, and focused development in low-income and high minority areas. Then, the demand forecast needs to be developed. To develop this forecast, the community can initially rely on data that has been developed by the state agency in charge of energy forecasting.[216] This will then need to be adjusted to reflect the demand for the community being studied. After the demand forecast has been developed, the community can then investigate how to meet that demand. To transition to the green urban grid, the community should first maximize the efforts to reduce load through energy efficiency and demand response programs. After this, the community should identify places on the distribution system where distributed generation and storage should be located to achieve the community's goals and the maximum benefit for the grid.[217] To do this, it is important that granular information describing the location of the energy demand is made available. For example, the integrated planning should attempt to forecast how electric vehicles will fit into the community.[218]

Using all of this information, the community can identify the best location of distributed generation and storage. This exercise will thus allow the community to move on to plans to incentivize the development of these resources.

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[215] *See* U.S. AGENCY FOR INT'L DEV., *supra* note 205, at 4 (presenting a schematic illustrating the steps involved for integrated resource planning).

[216] States generally designate an agency as responsible for energy forecasting. *See, e.g.*, OR. REV. STAT. §§ 469.060, 469.070 (2011). In California, for example, the California Energy Commission performs the forecasts through an integrated resource planning process. CAL. ENERGY COMM'N, 2011 INTEGRATED ENERGY POLICY REPORT 1–2 (Feb. 2012) *available at* http://www.energy.ca.gov/2011publications/CEC-100-2011-001/CEC-100-2011-001-CMF.pdf.

[217] Modeling renewable generation in an integrated planning exercise can be difficult due to its various attributes. *See* D. LOGAN ET AL., NAT'L RENEWABLE ENERGY LAB., MODELING RENEWABLE ENERGY RESOURCES IN INTEGRATED RESOURCE PLANNING 5-1 (June 1994), *available at* http://www.nrel.gov/docs/legosti/old/6436.pdf. Nevertheless, models have started to be developed to allow communities to model the variety of attributes of different resources, such as energy storage. *See* ICE ENERGY, INC., ICE BEAR ENERGY STORAGE SYSTEM: ELECTRIC UTILITY MODELING GUIDE, 1-1 (2010), *available at* http://www.ice-energy.com/stuff/contentmgr/files/1/b702a58fadd37593808dd7cb8b6c1668/misc/ice_bear_modeling_guide_rev_1.pdf.

[218] States are already trying to figure out how electric vehicles will be managed on the grid. *See, e.g.*, Cal. A.B. 631 (2011) (proposing to exempt EV recharging services from traditional electricity delivery regulations).

B. Targeted Economic Incentives

Using the outputs from the integrated resource planning exercise, the community should then develop targeted economic incentives to encourage development of those resources. Economic incentives are necessary because the old, centralized grid has regulations that incentivize large capital investment in facilities and transmission infrastructure.[219] For many facility owners, investment in a large electrical generation facility involves limited economic risk due to the regulatory structure that assures a return on the initial investment.[220] This paradigm makes the development of green grid infrastructure an uphill battle unless similarly clear and predictable economic incentives are developed.

Initially, to economically incentivize investment in a decentralized urban grid, investors need to know that mechanisms are in place to limit the risk associated with that investment.[221] The largest economic barrier for investment in distributed generation resources is the initial capital cost.[222] These costs are likely to continue to decrease as deployment of distributed generation facilities becomes more widespread. For example, the cost for the installation of a solar photovoltaic system in 1998 was around $11 per watt and then around ten years later, in 2009, this was reduced to approximately $8 per watt.[223]

To provide an economic incentive to overcome the barrier of the initial capital cost, various states and countries have implemented regulatory programs that provide predictable revenue for sales of energy generated from a distributed generation resource. The most widely used

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[219] *See, e.g.*, RICHARD J. CAMPBELL, CONG. RESEARCH SERV., R42068, REGULATORY INCENTIVES FOR ELECTRICITY TRANSMISSIONS—ISSUES AND COST CONCERNS 2 (Oct. 28, 2011), *available at* http://www.ieeeusa.org/policy/eyeonwashington/2011/documents/electrans.pdf.

[220] *See, e.g.*, *Loan Programs Office, Our Mission*, U.S. DEP'T OF ENERGY, https://lpo.energy.gov/?page_id=17 (last visited Apr. 4, 2012).

[221] These mechanisms and the policies that employ them need to be in a reliable regulatory framework. *See, e.g.*, STEPHEN A. KISKER & DANIEL T. MCKILLOP, BUREAU OF NAT'L AFFAIRS, INC., NEW JERSEY'S SOLAR RENEWABLE PORTFOLIO STANDARDS—A MODEL FOR SUCCESS, DAILY ENV'T REP., Aug. 22, 2011, at 1–2 (describing how solar development in New Jersey increased after a regulatory framework was developed).

[222] R. MARGOLIS AND J. ZUBOY, NAT'L RENEWABLE ENERGY LAB., NONTECHNICAL BARRIERS TO SOLAR ENERGY USE: REVIEW OF RECENT LITERATURE (Sept. 2006), *available at* http://www.nrel.gov/docs/fy07osti/40116.pdf.

[223] *See* GALEN BARBOSE ET AL., BERKELEY NAT'L LAB., TRACKING THE SUN III: THE INSTALLED COST OF PHOTOVOLTAICS IN THE UNITED STATES FROM 1998–2009 (Dec. 2010), *available at* http://eetd.lbl.gov/ea/ems/reports/lbnl-4121e-ppt.pdf.

mechanism is called a feed-in tariff.[224] Feed-in tariffs are payments for electricity generated by a renewable resource.[225] The concept is a relatively simple one: guarantee compensation, generally in the form of long-term contracts, for renewable energy that is generated and delivered to the grid.[226] Feed-in tariffs can help assure small energy generators dependable compensation for electricity generated, and allow small generators to compete with larger generators.[227]

Feed-in tariffs have been adopted throughout many different countries and states.[228] Many of these feed-in tariffs have been successful at encouraging development of distributed generation.[229] For instance, Germany's reliance on feed-in tariffs both encouraged the deployment of significant amounts of solar photovoltaic resources and kept energy costs reasonable.[230] Due to this success, commentators consistently recommend feed-in tariffs as the "most effective policy instruments in overcoming the cost barriers to introducing renewable energy and making it economically viable."[231]

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[224] For example, China recently introduced a feed-in tariff market to help its solar industry. *See* Coco Liu, *China Uses Feed-In Tariff to Build Domestic Solar Market*, N.Y. TIMES (Sept. 14, 2011), http://www.nytimes.com/cwire/2011/09/14/14climatewire-china-uses-feed-in-tariff-to-build-domestic-25559.html?pagewanted=all.

[225] TOBY D. COUTURE ET AL., A POLICYMAKER'S GUIDE TO FEED-IN TARIFF POLICY DESIGN, NAT'L RENEWABLE ENERGY LAB. 6 (July 2010), *available at* http://www.nrel.gov/docs/fy10osti/44849.pdf.

[226] *Id.* at 22. The National Renewable Energy Lab found that successful feed-in tariffs generally include: "(1) guaranteed access to the grid; (2) stable, long-term purchase agreements (typically, 15–20 years); and (3) payment levels based on the costs of RE generation." *Id.* at 6.

[227] *Id.* at 7. Feed-in tariffs can be designed in a variety of ways to accomplish different types of policy goals such as rapid renewable development, jobs and economic development, and greenhouse gas reduction. *Id.* at 18.

[228] *See* TOBY COUTURE & KARLYNN CORY, NAT'L RENEWABLE ENERGY LAB., STATE CLEAN ENERGY POLICIES ANALYSIS (SCEPA) PROJECT: AN ANALYSIS OF RENEWABLE ENERGY FEED-IN TARIFFS IN THE UNITED STATES v (2009), *available at* http://www.nrel.gov/applying_technologies/state_local_activities/pdfs/tap_webinar_20091028_45551.pdf (describing status of renewable energy feed-in tariff policies in the United States in 2009); COUTURE ET AL., *supra* note 225, at 1 (discussing implementation of feed-in tariffs in Europe, Asia, and Africa).

[229] In fact, before 2009, feed-in tariffs were responsible for 75% of worldwide installed solar photovoltaic capacity. DEUTSCHE BANK GROUP, GLOBAL ENERGY TRANSFER FEED-IN TARIFFS FOR DEVELOPING COUNTRIES 6 (2010), *available at* http://www.dbcca.com/dbcca/EN/_media/GET_FiT_Program.pdf.

[230] *See* Gipe, *supra* note 51.

[231] *See* E-PARLIAMENT, SUCCESS STORY: FEED-IN TARIFFS SUPPORT RENEWABLE ENERGY IN GERMANY 1, *available at* http://www.e-parl.net/eparliament/pdf/080603%20FIT%20toolkit

The success of a feed-in tariff is highly dependent on regulatory certainty and the price of the tariff.[232] A community transitioning to the green urban grid should develop a targeted feed-in tariff to encourage development of the distributed generation identified in the integrated planning exercise. In addition, the concept of feed-in tariffs could also be useful for encouraging other types of resources on the new urban green grid such as energy storage.[233]

In addition to developing a feed-in tariff for distributed generation resources, the community should also provide an instrument for signing long-term contracts with energy users that agree to reduce energy usage as a demand response resource. The long-term contract should provide predictable rates for reducing energy usage in response to demand.

To determine the level of compensation, the community will need to come up with the avoided cost from the installation of the distributed generation resources. Avoided cost is an important consideration in the development of a feed-in tariff to comply with the Public Utility Regulatory Policies Act ("PURPA") of 1978.[234] In a recent opinion, the Federal Energy Regulatory Commission ("FERC") provided a road map for how a state can implement a feed-in tariff program consistent with PURPA when determining avoided cost[235]:

> Just as, for example, an avoided cost rate may reflect a state requirement that utilities must "scrub" pollutants from coal plant emissions, so an avoided cost rate may also reflect a state requirement that utilities purchase their energy needs

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.pdf; ETHAN N. ELKIND, UNIV. OF CAL., BERKELEY CTR. FOR LAW, ENERGY AND THE ENV'T & UCLA ENVTL. LAW CTR., IN OUR BACKYARD: HOW TO INCREASE RENEWABLE ENERGY PRODUCTION ON BIG BUILDINGS AND OTHER LOCAL SPACES (Dec. 2009), *available at* http://www.law.berkeley.edu/files/In_Our_Backyard.pdf (finding that "policy makers must expand and improve . . . feed-in tariff incentive programs").

[232] *See* Emma Hughes, *UK vs. German Feed-In Tariff: Where Are We Going Wrong?*, SOLAR POWER PORTAL UK (Jan. 20, 2011), http://www.solarpowerportal.co.uk/blogs/uk_vs._german_feed-in_tariff_where_are_we_going_wrong5478/ (describing the German market's reaction to price changes and the regulatory uncertainty in the UK).

[233] *See What Feed-In Tariffs Could Do for Japan's Electricity Shortage*, LUBI ELECTRONICS, http://lubielectronics.com/blog/wordpress/2011/04/26/what-feed-in-tariffs-could-do-for-japans-electricity-shortage-2/ (discussing how the use of the feed-in tariff concept could be used to encourage the development of energy storage, which could help eventually replace nuclear energy generation in Japan) (last visited Apr. 4, 2012).

[234] Cal. Pub. Util. Comm'n, 134 F.E.R.C. ¶ 61,044, para. 31 (Jan. 20, 2011) (Order Denying Rehearing).

[235] *Id.* at para. 8.

> from, for example, renewable resources. And while in theory a utility might have a cheaper source of capacity and/or energy available to it, in calculating an avoided cost rate a state may properly look at the actual sources of capacity and/or energy available to the electric utility, rather than at some theoretical source, which is not permitted by state law, that may be cheaper.[236]

This FERC opinion made clear that communities can consider avoided transmission and pollution-related costs when determining an avoided cost for a feed-in tariff. These additional considerations will allow a community to set the tariff at a price that is more likely to encourage development of the distributed resources than reliance on energy costs alone.

Along with the targeted feed-in tariff, the new urban grid needs to determine how the distributed generation resources will interconnect to the grid. Under PURPA, facilities should be allowed to connect to the grid. Although the right of PURPA facilities to interconnect is clear, in practice implementation of this structure has been expensive and time-consuming.[237] The regulations need to be standardized for both the generators and the grid managers. Interconnection procedures have also been developed by the balancing authorities. For example, generators that want to connect to the California Independent System Operator's territory apply to them.[238] Increased development of small decentralized generation leads to a large increase in interconnection requests.[239] This has also led to a need to revise interconnection tariffs.[240] When the community is developing its targeted feed-in tariff, it should devise how it will interconnect the resources to at least the distribution grid. Moreover, to integrate photovoltaic resources into the grid, inverters are essential. Inverters are devices that turn the direct current from photovoltaic devices into the grid-friendly alternating current.[241] In addition to this essential function, inverters are now being developed that also assist photovoltaic operations during times of cloud cover.[242]

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[236] *Id.* at para. 30.
[237] ORACLE, MANAGE ENERGY CUSTOMERS PROFITABLY: PEOPLESOFT CRM FOR ENERGY 3 (2003), *available at* http://www.oracle.com/us/media/056932.pdf.
[238] CAL. ENERGY COMM'N, *supra* note 204, at 6.
[239] *Id.*
[240] *Id.*
[241] *See, e.g.*, Lacey, *supra* note 138.
[242] *Id.*

In addition to determining the economic incentives for distributed generation and storage, a community will also need to determine how to meet its demand response and energy efficiency goals. Communities have taken various measures to encourage energy efficiency reductions. For example, San Francisco passed an ordinance that requires an energy inspection and energy and water efficiency measures at the time of sale, and requires that all new buildings meet green building requirements.[243] San Francisco also offers rebates and other economic incentives to encourage reductions.[244] Another method of incentivizing energy efficiency is to tie the requirement of an audit directly to incentives related to installing solar panels or other renewable generation resources.[245] These methods may produce better results than programs that rely solely on rebates, because the incentives are tied to items, such as purchasing solar panels, that are held in high accord in public opinion.[246]

C. *Requirements Targeted Toward Encouraging Desired Development*

After developing the targeted incentives, the community should then focus on its permitting and contracting requirements. These requirements can be revised to assure that permitting does not restrict viable projects that are unlikely to cause adverse environmental impacts.[247]

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[243] *See* San Francisco, Cal. Hous. Code Ch. 12, 13C; *Green Building Ordinance*, SAN FRANCISCO DEP'T OF BLDG. INSPECTIONS, http://www.sfdbi.org/index.aspx?page=268 (last updated Nov. 7, 2011) (describing the requirements of the ordinance and providing forms for compliance).

[244] *See Green Building*, SAN FRANCISCO DEP'T OF THE ENV'T, http://www.sfenvironment.org/our_programs/topics.html?ti=19 (last visited Apr. 4, 2012) (describing various incentive programs).

[245] *See How to Get Started with Solar*, CAL. CTR. FOR SUSTAINABLE ENERGY, https://energycenter.org/index.php/incentive-programs/california-solar-initiative/residential/how-to-get-started-with-solar (describing the process for obtaining the incentives with the first step being an energy efficiency audit) (last visited Apr. 4, 2012).

[246] *See CLEAN LA Solar Plan Supports Governor's Vision for Local, Renewable Power; Rooftop Solar Program Would Spur $2 Billion in Private Investment, Create Thousands of Local Jobs*, ENHANCED ONLINE NEWS (July 25, 2011), http://eon.businesswire.com/news/eon/20110725005436/en (describing a public opinion poll finding "huge support" from the public for solar development, with more than eight in ten local voters in favor).

[247] CHRISTIAAN GISCHLER & NILS JANSON, PERSPECTIVES FOR DISTRIBUTED GENERATION WITH RENEWABLE ENERGY IN LATIN AMERICA AND THE CARIBBEAN 3, *available at* http://competitividad.org.do/wp-content/uploads/2012/01/Perspectives-for-Distributed-Generation-with-Renewable.pdf.

As an initial matter, the community should develop some baseline requirements for contracting for any projects to assure that the projects are viable. Texas has successfully required contract terms that penalize construction delays and other types of operational issues.[248] These provisions have helped eliminate incentives for proposing projects that are likely to prove unviable.[249] In addition to eliminating incentives for unviable projects, Texas's renewable projects have also been shown to be cost competitive.[250] Due to the current cost structure, ratepayers and the environment often have to pay for risky transactions that prove unviable rather than a utility's shareholders.[251] Luckily, the smaller distributed generation projects are, by their nature, less likely than larger projects to run into viability issues.[252] Still, some type of assurance needs to be made, since the community is developing a targeted economic incentive and does not want to expend time and resources on projects that are unlikely to be developed.

Next, the community should look at permitting costs and procedures. Well-intended permitting requirements can be a barrier to development of renewable energy.[253] Permitting needs to be efficient, but should not overlook or minimize possible environment impacts. Forms of distributed generation, such as rooftop solar, likely will have minimal environmental impacts, and, therefore, are the appropriate types of projects for a shorter review.[254] Some states have already made efforts to minimize the permitting requirements for rooftop solar.[255] Legislation has also

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[248] *See* Ole Langniss & Ryan Wiser, *The Renewables Portfolio Standard in Texas: An Early Assessment*, 31 ENERGY POL'Y 527, 528 (2003).
[249] *See id.* at 532.
[250] *See id.*
[251] Cal. Pub. Util. Comm'n, Decision 11-03-036, *supra* note 53 (finding that, "if the Manzana Wind Project fails to achieve production as expected for any reason such as construction delays or curtailments as a result of a collision with a California condor, shareholders face no risks while customers could incur increased costs").
[252] RAM SASTRY, AM. ELEC. POWER, PRESENTATION, ARPA-E WORKSHOP, JUNE 1–2, 2011, DISTRIBUTED GENERATION, slide 7 (2011), *available at* http://arpa-e.energy.gov/LinkClick.aspx?fileticket=4eAS7P61n0k%3D&tabid=437.
[253] *See* Ari Natter, *House Natural Resources Approves Bills to Speed Permitting, Waive Some Reviews*, 42 ENV'T. REP. 1573 (July 15, 2011).
[254] Many large projects, on the other hand, can have significant environmental impacts. Thus, not surprisingly, environmentalists objected to bills in Congress attempting to allow large renewable projects to not undergo environmental assessment under the National Environmental Policy Act ("NEPA"). *See id.*
[255] Many states have enacted legislation that establishes the right to a solar easement. *See* California Solar Rights Act, CAL. CIV. CODE §§ 714, 714.1, 801, 801.5, CAL. GOV'T CODE

been introduced to lower permitting costs for solar.[256] Expedited permitting has been implemented by communities and shown to be an effective way to encourage development consistent with environmental goals.[257]

Thus, the community should incentivize desired projects by allowing applications to be expedited or reducing permitting costs. For example, if a community is targeting rooftop solar development in a particular neighborhood, it could make sure that certain staff are designated to review those applications to ensure expedited processing. These actions would then help incentivize potential developers to create projects that meet the community's goals for desired resources.

CONCLUSION

With careful planning, communities can start the transition to the green urban grid and reduce their reliance on fossil-fuel generation. To make this transition possible, communities will need to engage in detailed integrated resource planning. This planning will help the community develop targeted economic and permitting incentives to encourage the development aligned with the community's goals. This process can hopefully make the dream of one-hundred percent renewable generation a reality.

§§ 65850.5, CAL. HEALTH & SAFETY CODE § 17959.1, CAL. GOV'T CODE §§ 66473.1, 66475.3; ELIZABETH DORIS ET AL., NAT'L RENEWABLE ENERGY LAB., STATE OF THE STATES 2009: RENEWABLE ENERGY DEVELOPMENT AND THE ROLE OF POLICY 70–71 (Oct. 2009), *available at* http://www.nrel.gov/docs/fy10osti/46667.pdf (discussing various state solar-easement provisions).

[256] *See* The 10 Million Solar Roofs Act of 2011, S. 1108, 112th Cong. (2011), *available at* http://sanders.senate.gov/files/CAM11187.pdf.

[257] *See* Sussman, *supra* note 15, at 18 (discussing successful examples in Chicago and San Francisco of encouraging energy efficient development).