RESTRUCTURING A GREEN GRID: LEGAL CHALLENGES TO ACCOMMODATE NEW RENEWABLE ENERGY INFRASTRUCTURE

BY

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Things are never as simple as they might appear—and that is particularly true of understanding the demands on the new "smarter" grid. That "smarter" grid will include expanded renewable energy sources and new copper wire transmission to connect these new sources to load centers. Sounds simple, but there is much more to it to get it right. Electricity is our one form of energy that is not capable of efficient or low-cost storage; the grid must remain perfectly balanced second by second, or the power system collapses, as it did in California during its 2000–2001 electric system crisis, or in the eastern United States in August 2003.

There is much more to the grid than just poles and wires. It is a carefully balanced, second-by-second, replenished network of almost 5000 interconnected generating sources in the United States; modern society depends on speed-of-light movement of electrons over thousands of miles in a system that never creates a single new electron in the process. As the last of the regulated industries in America, legal conventions, fictions, and protocols decide where these electrons are delivered and consumed, although no actual consumption or possession of moving electrons actually exists. In this world of shadow and light, the author maintains that electric infrastructure in the twenty-first century is every bit as important a societal force as the more opined-upon oil and the automobile. While there are substitutes for oil, there are no substitutes for electricity in the information age.

This Article examines specific aspects of the new grid. As we move more to wind and solar power, these technologies are

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intermittent resources, which on an hourly basis ebb and flow in only partly predictable manners. What does this do to the grid? This will decentralize and alter the balance of resources and responsibilities in the electric network vertically, horizontally, and virtually. The heretofore largely hidden issue of whether the grid has the backup quick-start power resources to deal with this intermittency is examined—it doesn't. Fights are already brewing on the financial value of intermittent renewable resources—some wanting to pay more for them, and others noting that they have less value for providing reliable power. The answers to this debate have profound social and financial consequences on the power future, and their legal issues are analyzed herein. How we physically extend the grid to accommodate new renewable power resources is examined. The role of distributed generation and cogeneration, as new active elements with environmental advantages, is analyzed. Welcome to the new "smart" grid with its pending legal and regulatory issues.

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I. INTRODUCTION

A. Overview of the New Grid

Let me roll back the clock for a decade. The energy situation is both quite distinct from and very similar to how it was five years ago. The economy, obviously, is in quite different shape. Energy is very different than it was five years ago. In 2004, global warming was not much in the nomenclature of energy policy—the European Union Emission Trading System (ETS) of carbon control, the first carbon control in the world, had not yet started;[1] the Kyoto Protocol had not been ratified by the necessary percentage of countries to make it effective;[2] and no one had won a Nobel Peace Prize for highlighting carbon imperatives.[3] In another sense, things are similar. The long-term solution to global warming has not changed[4]—and it is actually a good thing that there is some certainty in the solutions for global warming. There needs to be a sound solution for a political, legal, and technological response—and there is.[5] In fact, the technological response of renewable energy infrastructure to limit carbon emissions has been available for three decades; it is the legal and policy response that has proved more elusive and has not been realized.[6]

This Article focuses on how the new power grid must be modified and the legal and policy challenges this poses. This is a two-headed question. In a straightforward regard, the grid is a strand of copper and aluminum wires that connects the places where power is produced to society.[7] It is a transportation network. But in a more interactive sense, the power grid is the network of thousands of generators and hundreds of millions of consumers interlinked by legal and regulatory protocols and procedures that interconnect a virtual electronic web that powers and energizes modern

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1 The European Union ETS began with its initial phase in 2005. Council Directive 2003/87, art. 9, 2003 O.J. (L 275) 32, 33 (EC), *available at* http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:275:0032:0032:EN:PDF.

2 The required ratification was not achieved until February 2005. United Nations Framework Convention on Climate Change, Status of Ratification, http://unfccc.int/kyoto_protocol/status_of_ ratification/items/2613.php (last visited Nov. 15, 2009). The Kyoto Protocol entered legal force on the 90th day after at least 55 parties to the Protocol, including Annex I parties accounting for at least 55% of total 1990 carbon dioxide emissions, ratified the treaty. Kyoto Protocol to the United Nations Framework Convention on Climate Change art. 24, Dec. 10, 1997, 37 I.L.M. 22, 41 [hereinafter Kyoto Protocol]. 182 of these countries later ratified the Kyoto Protocol, which set emission targets for 37 countries. *See* KYOTO PROTOCOL: STATUS OF RATIFICATION (2009), *available at* http://unfccc.int/files/kyoto_protocol/status_of_ratification/application/pdf/kp_ratification_20090826corr.pdf.

3 *See* Press Release, Nobel Found., The Nobel Peace Prize 2007 (Oct. 12, 2007), *available at* http://nobelprize.org/nobel_prizes/peace/laureates/2007/press.html (awarding the Intergovernmental Panel on Climate Change and Albert A. Gore Jr. the 2007 Nobel Peace Prize "for their efforts to build up and disseminate greater knowledge about man-made climate change").

4 *See* BERT BOLIN, A HISTORY OF THE SCIENCE AND POLITICS OF CLIMATE CHANGE: THE ROLE OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 48 (2007) (describing a 1988 conference that identified the need to reduce carbon dioxide emissions).

5 STEVEN FERREY & ANIL CABRAAL, RENEWABLE POWER IN DEVELOPING COUNTRIES: WINNING THE WAR ON GLOBAL WARMING 194–200 (2006).

6 Steven Ferrey, *Why Electricity Matters, Developing Nations Matter, and Asia Matters Most of All*, 15 N.Y.U. ENVTL. L.J. 113, 133–42 (2007) [hereinafter *Why Electricity Matters*]; *see* Steven Ferrey, *Corporate Governance and Rational Energy Choices*, 31 WM. & MARY ENVTL. L. & POL'Y REV. 113, 113–15 (2006); Steven Ferrey, *Renewable Orphans: Adopting Legal Renewable Standards at the State Level*, ELECTRICITY J., Mar. 2006, at 52, 52.

7 *See* Steven Ferrey, *Inverting Choice of Law in the Wired Universe: Thermodynamics, Mass, and Energy*, 45 WM. & MARY L. REV. 1839, 1912 (2004) [hereinafter *Inverting Choice of Law*].

society.[8] This system must remain perfectly balanced second by second, or the system collapses, as it did in the northeastern United States in 2003.[9]

In this regard, to adapt to renewable power use in the grid there are issues of changing the backup power resources and reliability of the grid, as well as more intelligent demand for power resources, when accommodating the new, intermittent character of renewable resources. It has implications on both ends of the grid—in the mix of supply resources and in the use of power by consumers of power. These legal and regulatory issues are the more challenging aspects of the new grid, which this Article explores.

Let me roll back in time those five years with a specific frame of reference. I spoke at an energy symposium at Duke Law School about five years ago on the great topic of the *Power Future*.[10] I was allowed to be a futurologist, which is a great assignment. In that presentation and the article that followed, I took license to identify twelve trends that would change the future of electric power production and use in the United States as set forth in Table 1.[11] They were: 1) increasing vulnerability to the supply of fossil fuels, including natural gas; 2) depletion of supplies of economically recoverable fossil fuels; 3) relative inefficiency of U.S. energy use on a global scale; 4) mounting concern about environmental degradation; 5) increasing concern about terrorist threats to energy security; 6) vulnerability of the centralized transmission and distribution system; 7) choices about whether we transport natural gas fuel or produce electricity; 8) the need for greater reliability of the system; 9) differentiation of the needs for higher digital quality electricity for some uses; 10) inconsistent state-level incentives for renewable energy; 11) deregulation and restructuring in eighteen of the fifty states; and 12) globalization of energy markets and environmental impacts.[12]

Of note, deregulation and restructuring have been frozen at the retail level over the past five years as a result of the debacle in California's electric deregulation in 2001.[13] Electricity restructuring is not the same as electricity deregulation. Utilities, even in states where retail power sale is deregulated, are still regulated by independent system operators (ISOs), regional transmission organizations (RTOs), state public utility commissions (PUCs), the North American Electric Reliability Corporation (NERC), and the

8 *See* Steven Ferrey, *Exit Strategy: State Legal Discretion to Environmentally Sculpt the Deregulating Electric Environment*, 26 HARV. ENVTL. L. REV. 109, 111 (2002) [hereinafter *Exit Strategy*].

9 *See* U.S.-CAN. POWER SYS. OUTAGE TASK FORCE, FINAL REPORT ON THE AUGUST 14, 2003 BLACKOUT IN THE UNITED STATES AND CANADA: CAUSES AND RECOMMENDATIONS 1 (2004), *available at* https://reports.energy.gov/BlackoutFinal-Web.pdf; *see also* Steven Ferrey, *Soft Paths, Hard Choices: Environmental Lessons in the Aftermath of California's Electric Deregulation Debacle*, 23 VA. ENVTL. L.J. 251 (2004) [hereinafter *Soft Paths*] (discussing the causes of the 2001 utility system collapse in California).

10 *See* Steven Ferrey, *Power Future*, 15 DUKE ENVTL. L. & POL'Y F. 261 (2005) [hereinafter *Power Future*].

11 *Id.* at 292 tbl.1.

12 *See id.* at 268–91 (describing the 12 pivot points forming the future of energy).

13 *Id.* at 288.

Federal Energy Regulatory Commission (FERC).[14] ISOs and RTOs serve two-thirds of electricity consumers in the United States.[15] There has been dramatic change and even failures in sectional power markets. In 2000 to 2001, the California power market imploded, resulting in billions of dollars of additional public debt and the bankruptcy of major utilities—and halting all further retail deregulation across the country.[16] The largest power trader in the country, Enron Corporation, collapsed in 2001, and there was a massive blackout in the Northeast United States in 2003.[17]

Table 1:
Issues for the Future, "Pivot" Points, and Their Societal Forces, as of 2005[18]

	Issue	Pivot Point	Type of Societal Force
1.	Natural Gas Dependence	Increased International Vulnerability	Interdependence
2.	Fossil Fuel Depletion	Renewable Energy Deployment	Democratization
3.	Inefficiency of U.S. Energy Use	Cogeneration	Decentralization
4.	Environmental Degradation	Renewable Energy; Cogeneration	Decentralization; Democratization
5.	Terrorist Threat	Dispersed Generation & Supply	Decentralization
6.	T&D Vulnerability	Dispersed Generation	Decentralization
7.	Move Gas or Electricity?	Dispersed Generation	Decentralization
8.	Need Greater Systems Reliability	Dispersed Generation	Decentralization
9.	Digital Electric Quality	Dispersed Generation or System Redundancy	Mixed
10.	Inconsistent State-Level Incentives/Disincentives	New Legal Authority	Mixed

14 *See, e.g.*, MASON WILLRICH, MASS. INST. OF TECH., ENERGY TRANSMISSION POLICY FOR AMERICA: ENABLING A SMART GRID, END-TO-END 14, 19 (2009), *available at* http://npec.xykon-llc.com/documents/20090921-MW_MIT_EIP_trans_FINAL.pdf.

15 ISO/RTO Council, ISO/RTO Council Home, http://www.isorto.org (last visited Nov. 15, 2009).

16 *Soft Paths*, *supra* note 9, at 338–39.

17 *See Timeline of Enron's Collapse*, WASH. POST, Sept. 30, 2004, http://www.washingtonpost.com/wp-dyn/articles/A25624-2002Jan10.html (last visited Nov. 15, 2009); Matthew L. Wald et al., *The Blackout: What Went Wrong; Experts Asking Why Problems Spread So Far*, N.Y. TIMES, Aug. 16, 2003, at A1 (examining cause of 2003 blackout across northeastern United States).

18 *Power Future*, *supra* note 10, at 292.

	Issue	Pivot Point	Type of Societal Force
11.	Deregulation and Restructuring in Only Eighteen States	New Legal Authority Required	More Competition
12.	Global Energy Markets Environmental Impacts	Deploy Renewable Technologies Internationally	Democratization; Decentralization

All these trends from five years ago are still in play and the points remain valid. We are just as dependent on natural gas and we have continued to deplete fossil fuels without achieving its "pivot point" to deploy more renewable power resources, as set forth in points one and two in Table 1. Renewable energy and greater efficiency have become primary elements of the new Obama energy plan, set forth in points three and four in Table 1. I will address these elements, as well as the odd facets of state incentives (point 11 in Table 1) in Part III of this article. Points six and eight in Table 1, which were first set forth five years ago at the Duke symposium, concern demands on the transmission system to adapt a more reliable grid amid this new transition in dispersed supply resources. The Article addresses points six and eight in Part II.

The impact of these dozen forces on society, summarized in Table 1 as set forth five years ago, create energy "pivot points" for policymakers to respond to these forces.[19] Many of the "pivot points" create more vulnerability for the energy system and decentralization of supply resources, and indicate more opportunity for renewable energy, dispersed power, and cogeneration supply.[20] We are now implementing policy, both at the state and federal levels, to transition to more dispersed sources of power supply and more intermittent resources, which will have decentralizing societal impacts to which the grid must adapt.[21] This is the brink upon which the electric system is today. There is a significant push for a sustainable energy future with renewable energy and energy efficiency options, both at the state and, now, federal levels.[22] They are even more pronounced now with the emphasis on immediate reduction of global warming emissions from the power sector, and a new administration in Washington.[23] This poses new challenges for what we have come to call the "grid."

19 *Id.* at 262.

20 *Id.* at 272, 279, 291. Cogeneration on a neighborhood or regional scale is discouraged by the inability to easily move power outside the conventional grid, even though an extension cord would do the trick. *See generally* COGEN EUR., CUT YOUR ENERGY BILLS WITH COGENERATION 12 (2009), *available at* http://www.cogeneurope.eu/wp-content/uploads//2009/02/basic_guide.pdf (presenting information on how to use cogeneration on a local scale in Europe). There remains an almost universal, unexamined bar to crossing streets with any private distribution network for power.

21 ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ANNUAL ENERGY OUTLOOK 2005, at 20–21 (2005), *available at* http://tonto.eia.doe.gov/ftproot/forecasting/0383(2005).pdf; Cathy Cash, *Senate Tries a Push for Big-Picture Grid Plans, Though 'Shovel-Ready' Projects Still a Question*, ELECTRIC UTIL. WK., Feb. 2, 2009, at 1, 35.

22 ENERGY INFO. ADMIN., *supra* note 21, at 21; Cash, *supra* note 21, at 34–35.

23 Cash, *supra* note 21, at 34–35.

B. Stimulus and Response

The Obama stimulus package included a significant incentive package for the electric sector,[24] pouring $80 billion in spending and $20 billion in tax incentives into renewable energy and efficiency, as part of the $787 billion stimulus plan.[25] This includes $12.35 billion for energy efficiency improvements through low-income weatherization, state block grants, public and Section 8 housing efficiency, and Department of Defense efficiency.[26] Prior expenditure for energy efficiency programs peaked at $1.7 billion in 1993 to 1994 and began a steep decline after the California Public Utilities Commission in April 1994 remarked that it intended to restructure California's electric industry; eighteen other states followed suit.[27] By 1998, demand-side management (DSM) expenditures had been halved.[28] In some cases, the stimulus package increases funding by one thousand percent.[29]

There is $6 billion for a loan guarantee program for renewable energy projects under construction by September 2011, which should support about $60 billion of renewable loans for renewable power and transmission projects.[30] There is a 30% investment tax credit for advanced energy manufacturing, a 30% advanced energy facilities tax credit that applies to transmission and grid-related new equipment, and $1.6 billion of tax credits for renewable energy bonds (CREBs), first created by the Energy Policy Act of 2005.[31] Section 45 of the renewable energy production tax credit was extended through 2012 or 2013 for either different renewable technologies or the option to take a grant from the Treasury that mirrors the tax credit.[32]

There is $4.5 billion for a better and more reliable delivery system, with most of the money expected to be spent within eighteen months—principally in the West and Great Plains where there are more ongoing renewable power resource developments.[33] A 30% advanced energy facilities tax credit applies to transmission and grid-related new equipment. There is a National Transmission Study to assist constrained renewable resources to reach the market through better transmission and to analyze legal challenges for a better grid.[34] Certain transmission upgrades and extensions qualify for

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24 *See, e.g.*, American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, §§ 401–402, 406, 123 Stat. 115, 140–41, 145.

25 David M. Herszenhorn, *A Smaller, Faster Stimulus Plan, but Still Worth a Lot of Money*, N.Y. TIMES, Feb. 14, 2009, at A14.

26 *See* American Recovery and Reinvestment Act, div. A, tits. III, IV, 123 Stat. at 132–33, 138, 222.

27 CARL BLUMSTEIN ET AL., WHO SHOULD ADMINISTER ENERGY EFFICIENCY PROGRAMS? 2–3 (2003).

28 Clark W. Gellings et al., *Assessment of U.S. Electric End-Use Energy Efficiency Potential*, ELECTRICITY J., Nov. 2006, at 55, 62.

29 *See generally* American Recovery and Reinvestment Act, div. A, tit. IV, 123 Stat. at 138–40 (stating that Congress is setting aside $16.8 billion for energy efficiency and renewable energy).

30 *See id.*

31 *Id.* §§ 1111, 1302, 123 Stat. at 322, 345–47.

32 *Id.* § 1101, 123 Stat. at 319.

33 Cash, *supra* note 21, at 1, 35.

34 American Recovery and Reinvestment Act § 409, 123 Stat. at 146.

loan guarantees.[35] It includes $3.25 billion of new borrowing authority for each of the Western Area Power Administration and the Bonneville Power Administration, which operate 15,000 miles of transmission, to invest in electric transmission grids.[36]

There is $11 billion for smart grid grants and programs.[37] The definition of a smart grid in the Energy Independence and Security Act (EISA)[38] includes 1) use of information and control technology to manage and optimize dynamically the transmission and distribution infrastructure, 2) integration of distribution, 3) demand response, efficiency, and demand-side resources, 4) smart metering technologies to monitor energy use or deploy smart appliances, 5) advanced electricity storage and peak-shaving technologies, and 6) better grid communication.[39]

The EISA requires advancement of a smart grid.[40] A "smart grid," according to the United States Department of Energy, provides a digital quality of power and more efficient use of supply resources.[41] The smart grid involves many pieces, but particularly an information and control loop at the delivery point of the grid dividing into millions of consumer nodes.[42] Issues remain as to whether the smart grid is centrally controlled or responds to consumer intervention.[43] Peak shaving, electricity storage, and other similar controls are the objective. President Obama stated that he hoped to see smart meters in 40 million homes, doubling U.S. capacity for renewable energy, and to "build a new electricity grid that [lays] down more than 3,000 miles of transmission lines to convey this new energy from coast to coast."[44]

Focusing on forces that decentralize power decisions, as noted in Table 1, a smart grid decentralizes central control of power resource use decisions. In essence, users can become day traders in power resources through DSM. Google has made a major investment to provide prototype software, the Google Power Meter, for creation of smart meters on Google home pages to allow consumers to manage their electric consumption.[45]

Today, we are addressing the other side of the energy coin—whether the grid can handle these changes and, if so, how it needs to be modified. In

35 *Id.* § 406, 123 Stat. at 145 (to be codified at 42 U.S.C. § 1705).

36 *Id.* §§ 401–02, 123 Stat. at 140.

37 Tom Tiernan & Jeff Ryser, *Revised Language in House Bill Eases Fears on Smart Grid Provisions, but Concerns Linger*, ELECTRIC UTIL. WK., Feb. 2, 2009, at 1, 33.

38 Energy Independence and Security Act of 2007, 42 U.S.C. § 17381 (Supp. I 2007).

39 *See id.*

40 *Id.*

41 *See* U.S. DEP'T OF ENERGY, THE SMART GRID: AN INTRODUCTION 13 (2008), *available at* http://www.oe.energy.gov/DocumentsandMedia/DOE_SG_Book_Single_Pages(1).pdf.

42 *Id.*

43 *See generally id.* at 19–29 (describing potential consumer interaction and current industry discussions regarding smart grids).

44 President Barack Obama, Weekly Address (Jan. 24, 2009) (transcript available at Posting of Macon Phillips to The White House Blog, President Obama Delivers Your Weekly Address, http://www.whitehouse.gov/president-obama-delivers-your-weekly-address (Jan. 24, 2009, 05:55 EST) (last visited Nov. 15, 2009)).

45 Google.org, Google PowerMeter, http://www.google.org/powermeter/howitworks.html (last visited Nov. 15, 2009).

Part II, this Article examines what the grid really is, and how it needs to extend horizontally in terms of reaching new renewable resources, extend vertically in terms of changing the fundamental inventory of backup resources to support intermittent renewable resources such as wind deployment, and make regulatory changes in grid interconnection incentives. In Part III, the Article examines the virtual and legal issues of the new grid, focusing on constitutional concerns in the new grid structure, the legal vulnerability of the new feed-in tariffs many states are moving toward, and the alternative option of Renewable Portfolio Standards now employed in twenty-eight states. The Article will first examine the hardware and legal software of the grid.

II. NEW GRID, OLD GRID: DO THE TWO CONNECT?

A. What Really Is the Grid?

Let us initially set forth a concept of the power "grid" as used in this Article. The grid is not just the transmission component of copper wire that carries power at the speed of light from point *A* to point *B*. The grid is the mechanism to have power enter the interconnected U.S. power network, be dispatched and managed, and thereafter be available to meet electric power requirements in North America. The "grid" is composed not only of the 4800 interconnected power generation resources in the United States, but also of future, more dispersed power generation resources, efficiency capabilities, and self-generation resources, as well as the cable to connect them with consumers, and the human intervention and hardware to manage them in an energized instantaneous network.[46] One does not function without the other in a centralized, regional grid, which characterizes the United States and the states.

There is much more to the "grid" than just wire and poles. It is a constantly replenished energized network. The system requires a constant and simultaneous balancing of supply and demand.[47] Power moves according to Kirchhoff's Current Law[48] almost at the speed of light on this energized grid, to which people can tap into what is as much or more an energizing service than it is the purchase of a commodity.[49] It is much more like a living virtual organism that has both the transmission and delivery function of the

46 *See* Energy Info. Admin., U.S. Dep't of Energy, Energy Glossary, http://www.eia.doe.gov/glossary/glossary_e.htm#electr_pow_grid (last visited Nov. 15, 2009) (defining "[e]lectric power grid").

47 *See* Andrew Howe, *Demanding Times*, UTIL. WK., Sept. 19, 2008, at 20, 20 (discussing the challenges of balancing supply and demand within the energy grid).

48 This law is also called Kirchhoff's first law, Kirchhoff's point rule, Kirchhoff's junction rule, and Kirchhoff's first rule. *See* StateMaster, Encyclopedia: Kirchhoff's Circuit Laws, http://www.statemaster.com/encyclopedia/Kirchhoff%27s-circuit-laws (last visited Nov. 15, 2009). The principle of conservation of electric charge is that at any point in an electrical circuit where charge density is not changing in time, the sum of currents flowing towards that point is equal to the sum of currents flowing away from that point. LEONARD S. HYMAN ET AL., AMERICA'S ELECTRIC UTILITIES: PAST, PRESENT AND FUTURE 32 (8th ed. 2005).

49 *See Inverting Choice of Law*, *supra* note 7, at 1863.

physical grid, and the regulatory and incentive function applying to various creators of moving current and its consumption. Each of these elements is discussed below.

The importance of the electric sector in global warming abatement is reflected in its changing role. In 1949, only eleven percent of energy-related carbon dioxide emissions in the United States came from the electric sector; today it is more than one-third.[50] The Energy Information Administration in 2008 concluded that the electric power sector offered the most cost-effective opportunities to reduce carbon dioxide emissions, compared to the transportation sector.[51] So the power sector will be the carbon reduction focus, and where "additionality," discussed below,[52] has its primary application. The types of technologies in the power generation capital stock largely determine the long-term concentrations of atmospheric carbon.[53]

The grid itself is a function of how the points of production and consumption are interconnected and what combination of power generation resources are necessary to keep that grid energized to meet instantaneous demand. The physical interconnection is accomplished by well-proven technology.[54] However, the new sources of renewable power are not going to be located where the traditional sources of centralized power have been located.[55] New grid connections will be required, and a smarter grid will be required to balance even more sources in a more complex and intelligent manner.

In addition, renewable power introduces an unparalleled degree of intermittency of power supply to the modern grid.[56] To keep the grid in balance and operational within this new reality, there must be the proper mix of new resources not only for primary production of power, but of additional new resources to respond to the constant intermittency of a system more dependent on renewable resources. This is not as simple or easy as just plugging in new renewable hardware. The legal and regulatory match of the resources must be managed. The importance of this match is underscored by the fact that a slight mismatch in the supply and demand of electric power in California caused brownouts, billions of dollars of extra

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50 *See* ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, TOTAL ENERGY-RELATED CARBON DIOXIDE EMISSIONS BY END-USE SECTOR, AND THE ELECTRIC POWER SECTOR, BY FUEL TYPE, 1949–2007, *available at* http://www.eia.doe.gov/oiaf/1605/ggrpt/excel/historical_co2.xls.

51 *Energy Estimates Show Rise in CO_2 Emissions, Offer Mitigation Options*, CARBON CONTROL NEWS, June 30, 2008, at 20, 20.

52 Steven Ferrey, *When 1 + 1 No Longer Equals 2: The New Math of Legal "Additionality" Controlling World and U.S. Global Warming Regulation*, 10 MINN. J. L. SCI. & TECH. 591, 593 (2009) [hereinafter *The New Math*].

53 *Id.* at 657.

54 *See* ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ELECTRIC POWER INDUSTRY OVERVIEW 2007, http://www.eia.doe.gov/cneaf/electricity/page/prim2/chapter7.html (last visited Nov. 15, 2009).

55 Many renewable power resources, such as wind power, are located far from the load for power. *See* 1 STEVEN FERREY, THE LAW OF INDEPENDENT POWER § 2:11 (25th ed. 2009) [hereinafter LAW OF INDEPENDENT POWER].

56 *See* Geoffrey Heal, *The Economics of Renewable Energy* 11–12 (Nat'l Bureau of Econ. Research, Working Paper No. 15081, 2009).

expense to consumers, and the recall of the governor.[57] Getting the balance right between supply and demand has major repercussions.

B. What and Where: Ensuring that the Power Resource Mix Supports Greater Reliance on Renewable Power

With respect to the grid itself and how it adapts to increased renewable power, there are significant issues looming for policymakers and regulators. Mainstay supplies of renewable power in the near and intermediate term are wind power and solar power, both of which are intermittent in nature.[58] In other words, wind and solar power at a given hour are available in a somewhat unknown duration and strength, due to intermittent natural forces.

There are two basic roles for power from a given source in a centralized grid: baseload power and backup and peaking power.[59] Where in this model can renewable power perform? Intermittent renewable resources cannot supply reliable baseload power, as they demonstrate a relatively low availability factor in the twenty to forty percent range of hours during a week or month.[60] Correspondingly, intermittent renewable resources are not of value as reliable backup and peaking power resources, as they more often than not are not available for being called on to fill a need or supplement peak power demand.[61]

Given this dichotomy, intermittent renewable resources, such as solar or wind resources, will be operated as part of baseload supply, but they inherently decrease baseload system reliability. This is because renewable power resources have relatively high capital costs, and near zero operating costs because they do not need to purchase any fuel source.[62] What this means is that intermittent renewable resources will be run as much as possible, when available, because their marginal cost of operation, with no fuel costs, is near zero. Most independent system operators,[63] which dispatch the regional generation resources, do such resource dispatch in the

57 *Soft Paths*, *supra* note 9, at 253–54, 266.

58 *See* LAW OF INDEPENDENT POWER, *supra* note 55, § 2:11.

59 *See* James F. Wilson, *Restructuring the Electric Power Industry: Past Problems, Future Directions*, 16 NAT. RESOURCES & ENV'T 232, 235 (2002) (distinguishing baseload and peaking power).

60 *See* LAW OF INDEPENDENT POWER, *supra* note 55, § 2:11 (noting inability of intermittent sources to serve as baseload resource); RENEWABLE ENERGY RESEARCH LAB., UNIV. OF MASS. AT AMHERST, WIND POWER: CAPACITY FACTOR, INTERMITTENCY, AND WHAT HAPPENS WHEN THE WIND DOESN'T BLOW? 1, *available at* http://www.ceere.org/rerl/about_wind/RERL_Fact_Sheet_2a_Capacity_Factor.pdf (stating that typical wind power capacity is 20–40%, hydro power capacity is 30–80%, and solar power capacity is 12–15%); BRITISH WIND ENERGY ASS'N, BLOWING AWAY THE MYTHS: A CRITIQUE OF THE RENEWABLE ENERGY FOUNDATION'S REPORT: REDUCTION IN CARBON DIOXIDE EMISSIONS: ESTIMATING THE POTENTIAL CONTRIBUTION FROM WIND POWER 4 (2005), *available at* http://www.bwea.com/pdf/ref_three.pdf (noting that the average wind capacity factor in the United Kingdom has never sunk below 31%).

61 *See id.*

62 *See* ENERGY INFO. ADMIN., *supra* note 21, at 92.

63 For a discussion of independent system operators, see LAW OF INDEPENDENT POWER, *supra* note 55, §§ 3:27–:30.

ascending order of lowest cost of operation per unit.[64] Therefore, renewable resource units, with zero or low operating cost, will always be the first to run in place of other baseload units.[65]

According to the American Public Power Association, carbon regulation will compromise grid reliability, while carbon sequestration can require up to half of the electricity produced by the generator.[66] The impact of carbon control regulations is uneven. The European Union (EU) carbon reduction program is not even yet in its fifth year, yet carbon dioxide emissions in the EU have increased each year and increased faster than recent increases in the United States, which as a nation is not regulating carbon.[67] Several leading carbon scientists, including at least one leader at the National Aeronautics and Space Administration and the Obama Administration's top science advisor, warn that we have until 2015, as a world economy, to drastically reduce carbon emissions or risk catastrophe.[68] Additionally, not only is it unlikely that worldwide carbon levels will be dramatically reduced by 2015, it is unknown whether they will have been reduced at all—or, if they have, if it will be enough.[69] Population growth alone threatens reduction of carbon dioxide emissions.[70] In fact, the Intergovernmental Panel on Climate Change's fourth assessment report in 2007[71] may already be surpassed, given that it did not take into account a subsequent increase in emissions in major Asian countries or the increasing ice melt in Greenland and West Antarctica, all of which accelerate impacts.[72] Rather than allowing

64 *Id.* § 3:18.

65 *See* ENERGY INFO. ADMIN., *supra* note 21, at 92.

66 Charles Davis, *Public Utilities Fear that GHG Cuts Might Threaten Electricity Supply, Reliability*, CARBON CONTROL NEWS, July 28, 2008, at 1, 19.

67 Drew Thornley, *Carbon Dioxide Emissions Fall in U.S., Rise in Europe*, ENV'T & CLIMATE NEWS, Mar. 2008, http://www.heartland.org/policybot/results/22791/Carbon_Dioxide_Emissions _ Fall_in_US_Rise_in_Europe.html (last visited Nov. 15, 2009). *But see EU Cap-and-Trade Cited by Opponents, Backers of Lieberman-Warner*, CARBON CONTROL NEWS, May 8, 2008, at 3, 3–4 (noting that EU carbon emissions increased by 1.1% during regulation period); ENERGY INFO. ADMIN., EMISSIONS OF GREENHOUSE GASES IN THE UNITED STATES 2007, at 1 (2008), *available at* http://www.eia.doe.gov/oiaf/1605/ggrpt/pdf/0573(2007).pdf (noting that "U.S. greenhouse gas emissions in 2007 were 1.4 percent above the 2006 total").

68 *See* Jim Hansen, *The Threat to the Planet*, N.Y. REV. BOOKS, July 13, 2006, at 12, 14 (attempting to establish that we have only until 2015 to reverse carbon emissions or face a radically changing planet).

69 *Id.*

70 *See* POPULATION RES. CTR., EXECUTIVE SUMMARY: POPULATION DYNAMICS AND GLOBAL CLIMATE CHANGE 2–3 (2002), *available at* http://www.prcdc.org/files/2002%20Population%20Dynamics%20 and%20Global%20Climate%20Change.

71 INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT (2007), *available at* http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

72 *Id.* at 45 (projecting future climate changes based in part on increased ice flow from Greenland and Antarctica at rates observed from 1993 to 2003); *see* ENERGY INFO. ADMIN., DEP'T OF ENERGY, INTERNATIONAL ENERGY OUTLOOK: 2009, at 110 (2009), *available at* http://www.eia.doe.gov/oiaf/ieo/ pdf/0484(2009).pdf (noting that China and India's combined share of world carbon dioxide emissions rose from 13% in 1990 to 25% in 2006); *Alarming Growth in Expected Carbon Dioxide Emissions in China, Analysis Finds*, SCIENCEDAILY, Mar. 11, 2008, http://www.sciencedaily.com/releases/2008/03/080310155857.htm (last visited Nov. 15, 2009).

a small atmospheric concentration until emissions plateau and decrease, it may require an immediate decrease.

There is real debate whether more sustainable resources could negatively affect grid reliability.[73] There is concern among NERC, which manages the reliability of the North American utility grid, that the RPS standards in twenty-nine states and three Canadian provinces could cause early substitution of tradition coal-fired power with renewables, while simultaneously decreasing grid reliability.[74] Most renewable power projects being deployed today are intermittent and supply power for no more than one-third of a day, and those systems that use wind cannot control when the wind is sufficient to generate power.[75] The reality is that coal-fired power plants, once shut down to accommodate renewable power resources, cannot be quickly brought back online. They require very long warm-up periods to restart, lack quick start capability, and cannot follow changes in load or power supply.[76] Many new renewable power resources are located a long transmissions distance from the load that uses that power.[77]

While in the past power planners were concerned about changes in consumer demand raising the need to follow changing load (demand), an increase in grid-connected renewable power resources, most of which will be intermittent wind resources that will substitute for high-carbon, coal-fired baseload power resources, creates a new dimension to the grid: Variability is now created on the electric supply side rather than the demand side of the power equation.[78] Renewable intermittent power sources can become quickly unavailable, in addition to demand quickly altering.[79] The electric power system must constantly, second by second, balance supply with demand to keep the grid operational.[80] If power supply does not respond and

See generally Andrew C. Revkin, *Seasonal Factor Seen in Melting and Ice Shifts in Greenland*, N.Y. TIMES, Jul. 4, 2008, at A8 (discussing the melting of Greenland's ice sheet).

73 Jeff Postelwait, *NERC: Climate Change Rules Could Hurt Generation Reliability*, POWER ENGINEERING, Nov. 18, 2008, http://pepei.pennnet.com/Articles/Article_Display.cfm?ARTICLE_ID=345518&p=6 (last visited Nov. 15, 2009).

74 *See* N. AM. ELEC. RELIABILITY CORP., SPECIAL REPORT: ELECTRIC INDUSTRY CONCERNS ON THE RELIABILITY IMPACTS OF CLIMATE CHANGE INITIATIVES 3–8, 13, 18 (2008), *available at* http://www.nerc.com/files/2008-Climate-Initiatives-Report.pdf (discussing the impact of climate change policy initiatives on coal-fired power plants and grid reliability).

75 See LAW OF INDEPENDENT POWER, *supra* note 55, § 2:11, for a discussion of intermittent renewable wind and solar power deviation of supply.

76 *See id.* § 10.37 (noting the difficulty in quickly starting conventional power plants); *see also* Steven Lefton & Phil Presuner, *The Cost of Cycling Coal Fired Power Plants*, COAL POWER MAG., Winter 2006, at 16, 20, *available at* http://www.aptecheng.com/corporate/CurrentEvents/100_CoalPowerWinterMag16-20.pdf.

77 *See* LAW OF INDEPENDENT POWER, *supra* note 55, § 2:11.

78 *See* Darren Brady & Rob Gramlich, *Getting Smart About Wind and Demand Response*, WIND SYSTEMS, July–Aug. 2009, at 28, 28, *available at* http://www.windsystemsmag.com/articles/PDF/Enernoc0809.pdf.

79 *Id.* at 29.

80 STEVEN FERREY, ENVIRONMENTAL LAW: EXAMPLES & EXPLANATIONS 530 (4th ed. 2007).

is deficient to instantaneous demand, the grid can shut down and blackout large areas, as happened in the northeastern United States on August 14, 2003.[81]

This increased share for intermittent resources will reduce the reliability of the power grid as a system, unless there are advancements in power storage technology from what is now available.[82] A larger percentage of baseload operating power generation capacity will have lower availability than the conventionally configured system.[83] With decreased system resource availability and reliability, there will be more demand for backup power generation resources to compensate for the increased and more common volatility and fluctuation of the collection of baseload resources.[84]

What does this do to the United States or its regional power systems? First, it changes how units are dispatched and the need for new backup power generation technology to fill the voids created by carbon control. Economist Brent Bartlett has modeled all 4800 existing power projects in the United States and how they respond to carbon allowance auction in the United States.[85] His modeling indicates that what happens with auction of carbon allowances is that certain high-carbon baseload resources, especially those powered by coal, are forced out of the dispatch queue and are not dispatched; they do not operate because of the higher cost of obtaining carbon allowances to support their operation.[86] In their place, certain existing gas-fired backup generation units are pressed to operate more due to their lower cost, and this changing role means that they are available less for backup power and more for baseload power.[87] Second, because of this phenomenon, a carbon regulating system requires more, rather than less, backup power resources in the grid at the same time that it actually converts and diminishes the number of existing backup power generation resources available to the grid in this mode.[88]

Moreover, the current grid configuration in the United States and in other countries already features a significant shortfall of existing backup power resources, and particularly backup resources that are either capable of operating on dual-fuel inputs or have quick-start capability to be available on short (ten minute) notice.[89] Each of these factors will prove critical in a period where the availability of sufficient fossil fuel resources and their pricing have been volatile and unreliable.[90] The New England grid control

81 *See generally* Wald et al., *supra* note 17 (examining cause of 2003 blackout across northeastern United States).

82 For discussion of power storage technology, see LAW OF INDEPENDENT POWER, *supra* note 55, § 2:20.

83 *Id.* § 2:11.

84 *See generally id.* (discussing intermittency of renewable energy sources).

85 Interview with Brent Bartlett, Economist, in Palo Alto, Cal. (Sept. 18, 2008).

86 *Id.*

87 *Id.*

88 *Id.*

89 *See generally* LAW OF INDEPENDENT POWER, *supra* note 55, § 2:20 (discussing the economic benefits of energy storage).

90 *See, e.g.*, Hess Corp., NYMEX Settlement History, http://www.hessenergy.com/reports/NymexSettlementReport.aspx (last visited Nov. 15, 2009) (providing information about recent average prices of natural gas).

area provides an interesting example. With about 31,052 megawatts of rated generating capacity to serve a peak demand of 28,127, this barely affords the recommended 15% to 25% surplus for equipment repairs and unit unavailability.[91] However, the peak power demand has been increasing over time as a percentage of average demand. For example, in 1980, New England peak demand was 154% of average load, but increased in 1990 to 159% and in 2005 to almost 175%.[92] The peak is forecast to continue to increase over time.[93] This is a function of increasing air conditioning usage during the summer peak days.[94] New York City, for example, has a peak demand almost twice its average load.[95]

The need for peaking power resources in New England is established as 7000 megawatts.[96] However, only 1510 megawatts of non-pumped storage peaking resources are available.[97] With pumped storage counted, there are about 3000 megawatts of peak power resources.[98] This is less than 10% of total supply, even before the rollout of renewable resources.[99] This is more than a 50% deficiency between peak need and supply.[100] Moreover, these limited available peaking power resources are fossil-fueled when there is a need for dual-fuel capability; less than 20% of this peak power resource has

91 *See* Montgomery Energy Billerica Power Partners, No. EFSB 07-02 (Mass. Energy Facilities Siting Bd. Mar. 3, 2009), 2009 WL 1532821, at *16, *available at* http://www.mass.gov/Eoeea/docs/dpu/siting/efsb07-2/3309efsbord.pdf; PowerPoint: Henry Yoshimura, ISO New England, Inc., New England Demand Response Resources: Present Observations and Future Challenges, Presentation at the NARUC-FERC Demand Response Collaborative 2, 16 (Feb. 17, 2008), *available at* http://www.narucmeetings.org/Presentations/DR%20ISO%20New%20England%20NARUCFERC%202008-Final.ppt; H. WAYNE BEATY, HANDBOOK OF ELECTRIC POWER CALCULATIONS 8.19 (3d ed. 2001). For current data on generating capability and demand, see also ISO New England, Generation and Resources, http://www.iso-ne.com/genrtion_resrcs/index.html (last visited Nov. 15, 2009).

92 *See* PowerPoint: Gordon van Welie, President & Chief Executive Officer, ISO New England, Ensuring Long Term Reliability of New England's Regional Electricity System, Presentation at Platts Northeast Power Markets Forum 15 (Mar. 30, 2006), *available at* http://www.iso-ne.com/pubs/pubcomm/pres_spchs/2006/iso-ne_platts_gvw.pdf.

93 Petition of Montgomery Billerica Energy Partners at 3-16, Montgomery Energy Billerica Power Partners, No. EFSB 07-02 (Mass. Energy Facilities Siting Bd. Mar. 3, 2009), 2009 WL 1532821 [hereinafter Petition]; ISO NEW ENGLAND, 2006–2015 FORECAST REPORT OF CAPACITY, ENERGY, LOADS AND TRANSMISSION 1 (2006), *available at* http://www.iso-ne.com/trans/celt/report/2006/2006_CELT_Report.pdf.

94 *See, e.g.*, Paul Marks, *Forecast: Record Power Demand; Supply Getting Tighter, Region's Grid Operator Warns*, HARTFORD COURANT, Apr. 27, 2006, at E1, *available at* LEXIS.

95 Lisa Wood, *New York Readies for Stimulus Funds with Order to Utilities on Metering Pilots*, ELECTRIC UTIL. WK., Feb. 16, 2009, at 33, 33.

96 *See* Braintree Elec. Light Dep't, No. EFSB 07-1/D.T.E./D.P.U. 07-5, at 77 (Mass. Energy Facilities Siting Bd. Feb. 29, 2008), *available at* http://www.mass.gov/Eoeea/docs/dpu/electric/07-5/ efsb07-1/22908findec.pdf.

97 *Id.* at 78.

98 Montgomery Energy Billerica Power Partners, 2009 WL 1532821, at *16.

99 *Id.*

100 *See* Braintree Elec. Light Dep't, No. EFSB 07-1/D.T.E/D.P.U. 07-5, at 16, 78, 82 (establishing 7000 megawatts peaking power need); Montgomery Energy Billerica Power Partners, 2009 WL 1532821, at *16 (indicating that only about 3000 megawatts of peaking resources were available).

dual-fuel, oil and gas capability.[101] Two-thirds of the remaining 80% of the peaking power is generated by oil fuel only.[102] Oil is more polluting and thus emits more carbon dioxide global warming emissions per unit of power generated than natural gas.[103]

Therefore, the existing backup and peaking capacity is dramatically short of where it needs to be, even though the system has enough resources in gross, and this deficiency is compounded by a lack of either dual-fuel or less polluting gas-fuel alternatives.[104] The grid operator for New England, ISO New England (ISO-NE), concluded after analyzing this situation that "[a] lack of fast-start resources in transmission-constrained subareas could require the ISO to use more costly resources to provide these necessary services. In the worst case, reliability could be degraded."[105]

What is important in an age of renewable power and carbon control is quick-start capability of the backup and peaking resources. Most of the existing backup and peaking capacity now installed in the grid is not the newer aero-derivative quick start technology.[106] Quick-start allows the generator to go from a cold start to full power production in less than ten minutes, which is the shortest category for start maintained by system operators.[107] Therefore, it is almost instantaneously available, without having to be spinning and operating prior to need, just to be ready. Conventional, nonaero-derivative generators take an extended period of hours to bring their temperatures up gradually from a cold start, and similarly must ramp

101 Braintree Elec. Light Dep't, No. EFSB 07-1/D.T.E./D.P.U. 07-05, at 77–78 (noting that a quadrupling of dual-fuel fired backup and peaking capability is needed immediately); *see also* ISO NEW ENGLAND, REGIONAL SYSTEM PLAN 2005, at ES-2 (2005), *available at* http://www.iso-ne.com/trans/rsp/2005/05rsp.pdf.

102 Braintree Elec. Light Dep't, No. EFSB 07-1/D.T.E/D.P.U. 07-5, at 78. Only 260 megawatts of peaking capacity in New England has dual-fuel capability. *See* ISO NEW ENGLAND, *supra* note 93, at 10.

103 *See* Eng'g Toolbox, Combustion Fuels — Carbon Dioxide Emission, http://www.engineeringtoolbox.com/co2-emission-fuels-d_1085.html (last visited Nov. 15, 2009) (showing oil emitting about 15% more carbon dioxide than natural gas, and coal emitting more than 50% more carbon dioxide than natural gas).

104 *See generally* ISO NEW ENGLAND, 2006 REGIONAL SYSTEM PLAN 2 (2006), *available at* http://www.iso-ne.com/trans/rsp/2006/rsp06_final_public.pdf (recommending increased dual-fuel capability and fuel diversity to deal with increased peaking requirements in the future).

105 *Id.* at 5.

106 The bulk of fossil-fueled power generation was built prior to 1990, when aero-derivative quick-start technology began to be used for power generation. *See* ENERGY INFO. ADMIN., EXISTING GENERATION CAPACITY BY FUEL TYPE (2008), *available at* http://www.eia.doe.gov/cneaf/electricity/page/capacity/existingunitsbs2008.xls (listing all U.S. energy plants with fuel type and date built). Demand for additional generating technology has only been increasing at one to two percent annually, so new additions during the past two decades constitute a distinct minority of installed generation. ISO NEW ENGLAND, *supra* note 104, at 4; *see also* Montgomery Energy Billerica Power Partners, No. EFSB 07-02 (Mass. Energy Facilities Siting Bd. Mar. 3, 2009), 2009 WL 1532821, at **16, 18, 20 (providing information regarding the small amount of peaking or backup generation in systems).

107 Braintree Elec. Light Dep't, No. EFSB 07-1/D.T.E/D.P.U. 07-5, at 94. ISO-NE has separate reserve markets for 10-minute nonspinning reserve capacity and 30-minute operating reserves. ISO NEW ENGLAND, *supra* note 104, at 43. Many units have to "spin" to meet either of these criteria. *Id.* at 42–43.

down their temperatures slowly.[108] This means that conventional backup and peaking fossil fuel fired units continue to burn fossil fuel, and thus to pollute, just to get ready to provide peaking power when later needed, if needed. These "spinning" reserve units also expel a much less contained profile of environmental emissions when operating at partial operation trying to ramp up to be available.[109] Moreover, while spinning to increase their temperatures to their design values, the power that these units could produce may or may not be used by the grid and could cause power "uplift" costs to the grid.[110] This multiple loss is incurred by the grid and its ultimate power consumers, regardless of whether or not these units are ever required to supply power when the peak time of day actually arrives.

However, with more reliance on solar and wind power, when the wind suddenly ceases to blow or the sun is unexpectedly blocked by clouds and renewable power generation units are not available, there is no ability to quickly start conventional peaking units.[111] There were record wind installations in 2008, in excess of 8000 megawatts, or 42% of all new generation additions.[112] The impact of this on existing systems already is manifest. On February 26, 2008, the Electric Reliability Council of Texas (ERCOT) grid operator—a leader in wind power deployment—was unable to compensate with sufficient backup power resources when wind production unexpectedly dropped by more than 80%.[113]

So, the reality today, as one attempts to transform the grid to accommodate an unprecedented increase in renewable power, is that the power generation grid in many places is short of needed backup and peaking power resources, and what backup resources they do have are not quick-start or suited to serve a grid utilizing more unexpectedly intermittent renewable resources. Conventional power generation does not depend on unreliable factors such as the weather and is thus less subject to failure.[114] Many renewable resources are much more profoundly affected by regular daily generation failure due to natural cycles of wind and sunlight.[115] With a rollout of more intermittent renewable resources, conventional backup and peaking generation resources with long, multi-hour warm up periods are unable to quick start on unpredictable short notice.[116] As more wind

108 *See generally* Petition, *supra* note 93, at 3-2 to -3 (comparing the heat rates and start times of aeroderivative turbines and frame units).

109 *Id.*

110 *Id.*

111 *See, e.g.*, *How Renewables Can Be Undermined by Intermittency*, ELECTRICITY J., June 2008, at 5, 6.

112 Housley Carr, *AWEA Reports a Record 8,358 MW of US Wind Capacity*, ELECTRIC UTIL. WK., Feb. 2, 2009, at 12, 12.

113 *How Renewables Can Be Undermined by Intermittency*, *supra* note 111, at 6.

114 Charles J. Murray, *Capturing the Wind*, DESIGN NEWS, Nov. 3, 2008, at 42, 42–43.

115 CANADIAN WIND ENERGY ASS'N, WIND POWER IS RELIABLE (2006), *available at* http://www.canwea.ca/images/uploads/File/NRCan_-_Fact_Sheets/3_reliability.pdf; Hugh Sharman, *Why Wind Power Works for Denmark*, CIV. ENGINEERING, May 2005, at 66, 67, *available at* http://www.thomastelford.com/journals/DocumentLibrary/CIEN.158.2.66.pdf.

116 LAW OF INDEPENDENT POWER, *supra* note 55, §§ 2:20, 2:42; Paul Gipe, Grid Integration of Wind Energy, http://www.wind-works.org/articles/GridIntegrationofWindEnergy.html (last visited

resources are developed, it will require more dynamic forecasts of reliable supply, increased regulatory oversight of the grid, and the ability to follow load with other resources and more quick-start resources.

A new type and deployment of backup and peaking power generation resources will be needed to accommodate greater renewable resources. The very good news is that the technology is available, demonstrated, and cost-effective, so there are few technological barriers to overcome.[117] The reality, however, is that greater use of intermittent wind and solar power generation, without significant advancements in energy storage, will increase the need for typically fossil fuel-fired, quick-start backup power resources as the corollary development with grid-connected renewable power.[118] Certain renewable power sources, such as landfill gas, biomass projects, or certain new wave power technologies, offer some baseload nonintermittent renewable power resources to complement the intermittent renewable resources.[119]

Therefore, the grid will need to accompany more renewable resources with a whole new battalion of quick-start peaking power resources to fill in their potentially unpredictable, intermittent daily operation. This reality is just now beginning to be thought through, and how the costs of this requirement will be assigned has not yet been resolved.[120] Are these costs to be borne by the renewable power generators whose lack of reliability will increase backup requirements for the grid? Transmission imbalance penalties can be imposed by transmission owners on certain intermittent power sources, such as intermittent renewable project.[121] Alternatively, are these costs to be borne by all consumers and ratepayers of power? In either case, there is a major change in the nature of the grid that will be required as the country moves to more use of wind and solar power, with their inherent intermittency due to natural forces, and the current lack of cost-effective power storage.[122] Energy storage would serve a similar purpose, but aside from hydro-pumped storage resources, and even given the incentives in the stimulus legislation, storage of electricity on a significant wholesale level is still not widely available.[123]

There are suggestions that demand response resources might be able to fill this gap when solar resources are not available.[124] In the 2008 ISO New

Nov. 15, 2009) (describing the inability of conventional generators such as coal or nuclear to respond quickly to changes in wind speed).

117 Murray, *supra* note 114, at 43–44.

118 *See generally id.* (discussing need for backup storage to support intermittent renewable energy sources during down times).

119 *See, e.g.*, Press Release, Mass. Executive Office of Energy & Envtl. Affairs, Patrick Administration Announces Rules Providing More Support for Renewable and Alternative Energy (Jan. 6, 2009), http://www.mass.gov/?pageID=eoeeapressrelease&L=1&L0=Home&sid=Eoeea&b=pressrelease&f=090106_pr_rps_regs&csid=Eoeea (last visited Nov. 15, 2009).

120 *See* Murray, *supra* note 114, at 44.

121 *See* LAW OF INDEPENDENT POWER, *supra* note 55, § 10:83 (discussing imbalance penalties).

122 *See id.* § 2:20.

123 *Id.*

124 *See, e.g.*, Fred Wellington & Forrest Small, *The Carbon-Smart Grid*, PUB. UTIL. FORT., Oct. 2008, at 24, 24. *See generally* FED. ENERGY REGULATORY COMM'N, 2008 ASSESSMENT OF DEMAND

England forward capacity auction, the forward capacity market new demand response resources totaled 1188 megawatts and existing demand response resources totaled 1366 megawatts.[125] These demand response bids comprise nearly a tenth of total current peak load.[126] It is generally concluded that energy efficiency is available at a cost of about three cents per kilowatt hour—the amount saved by the efficiency investment.[127] The demand-side management (DSM) possibilities between 2007 and 2010 are estimated to be over 230 terawatt-hours (TWH), which is equivalent to about 5.5% of the forecast electricity power requirements in 2010.[128] This total DSM potential could trim 7.5% of peak electric consumption.[129] The NERC estimates that interruptible load and direct control load management reduces national summer peak by about 2.5%.[130] This contemplates a significant role for demand response resources in the maintenance of grid system reliability.

The recent report of the Federal Energy Regulatory Commission (FERC) on demand-side response and metering identifies the components of this smarter grid as advanced metering technologies, pricing, and demand response programs (8% of U.S. customers already have some version of demand response program).[131] The report states that through its regulation of regional transmission organizations and independent system operators, FERC can ensure comparable treatment of demand response resources in ancillary service markets, and allow these resources to bid into the organized energy market and reflect these contributions of lost load during an operating reserve shortage.[132] The Energy Policy Act of 2005[133] required that within eighteen months, electric utilities would offer certain customer classes a time-based rate schedule, options for which included time-of-use pricing, critical peak pricing, and real-time pricing.[134]

It is equally important that the American grid capture wasted disperse energy sources behind the meters. For example, industry expels as waste

RESPONSE AND ADVANCED METERING, at ii (2008) [hereinafter FERC 2008 ASSESSMENT] (stating that demand response resources helped respond to sudden changes in generation output).

125 Press Release, ISO New England, Wholesale Marketplace Helping to Achieve Long-Term Power System Reliability Goals (Feb. 13, 2008), *available at* http://www.iso-ne.com/nwsiss/pr/2008/press_release_fcm_auction_results_02_13_08.pdf.

126 ISO NEW ENGLAND, NET ENERGY AND PEAK LOAD REPORT (2009), *available at* http://www.iso-ne.com/markets/hstdata/rpts/net_energy/index.html (follow "Net Energy & Peak Load Report" hyperlink).

127 NAT'L ACTION PLAN FOR ENERGY EFFICIENCY LEADERSHIP GROUP, NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY REPORT, at ES-12 n.5 (2006), *available at* http://www.epa.gov/cleanenergy/documents/napee/napee_report.pdf.

128 Gellings et al., *supra* note 28, at 55, 56 tbl.1.

129 *Id.* at 56.

130 N. AM. ELEC. RELIABILITY CORP., DATA COLLECTION FOR DEMAND-SIDE MANAGEMENT 1 (2007), *available at* http://www.nerc.com/docs/pc/drdtf/NERC_DSMTF_Report_040308.pdf.

131 FERC 2008 ASSESSMENT, *supra* note 124, at i–ii, 23.

132 *Id.* at ii.

133 Energy Policy Act of 2005, Pub. L. No. 109-58, 119 Stat. 594 (codified in scattered sections of the U.S.C.).

134 *Id.*; 16 U.S.C. § 2621(d)(14)(A) (2006).

heat a significant fraction of energy use.[135] By capturing that waste heat before it exits the stack, and converting it to electric power, there can be a substantial dispersed creation of power into the grid.[136] This changes the basic flow of power on the grid,[137] but it is an essential part of an efficient and smart grid to capture as usable energy what is now exhausted as a waste. New load control software allows the capability to control building management systems remotely, capture real-time energy data, and accurately compute customer baselines of energy use.[138]

C. Transmission Infrastructure Extension Supporting a More Sustainable Power System

The transmission grid is relatively old. As an example, the New England grid has been criticized for now engaging in $11 billion in annual trades of electricity over wires built approximately forty years ago to serve a much more limited number (about one-third) of players in a tightly regulated utility environment.[139] With the aging of the transmission system, efficiency of that system decreases. For example, in 1970, average line loss was 5%; in 2001, average line loss increased to 9.5% as lines, transformers, and circuit breakers of the transmission system aged.[140] Aging is not an asset.

However, again, the good news is that these questions are technologically resolvable. While there can be extended controversy in siting transmission infrastructure, these are political and legal disputes, not technical.[141] These issues of transmission infrastructure were present in the past, as exemplified by U.S. utilities after World War II, which frequently chose to construct large baseload facilities that were located a distance from load centers.[142] Large transmission infrastructure had to be created to move this power.[143] However, from technical and legal perspectives, this poses new challenges for the existing power grid.

135 Thomas R. Casten & Phillip F. Schewe, *Getting the Most from Energy*, 97 AM. SCIENTIST 26 (2009).

136 *Id.* at 30.

137 *See generally id.* at 30 fig.6 (illustrating "an ideal system of recycled-energy use").

138 *See* LAW OF INDEPENDENT POWER, *supra* note 55, § 3:68 n.6 (discussing the capabilities of software packages).

139 *New England Grid Is on Borrowed Time; Groups Warn It Will Soon Exceed Limits*, ELECTRIC UTIL. WK., Jan. 14, 2008, at 1. The report charges that transmission inadequacy already results in approximately $1.6 million in extra charges to consumers since 2003. *Id.* at 23. Approximately 70% of U.S. transmission lines and transformers are at least 25 years old, and 60% of circuit breakers are more than 30 years old. *Id.*

140 OFFICE OF ELEC. TRANSMISSION & DISTRIBUTION, U.S. DEP'T OF ENERGY, "GRID 2030": A NATIONAL VISION FOR ELECTRICITY'S SECOND 100 YEARS 5 (2003), *available at* http://www.oe.energy.gov/DocumentsandMedia/Electric_Vision_Document.pdf.

141 *See generally* LAW OF INDEPENDENT POWER, *supra* note 55, § 2:11 (discussing wind facility location).

142 *See generally* PETER FOX-PENNER, ELECTRIC UTILITY RESTRUCTURING: A GUIDE TO THE COMPETITIVE ERA 128–31 & fig.5-3 (1997) (discussing the growth in the total miles of transmission lines, which were needed to accommodate the growth of the average boiler size).

143 *Id.*

Issues also exist concerning the cost of new transmission infrastructure to reach the location of some wind and solar installations in more remote locations. For wind, facilities must be sited where there is a good wind regime.[144] This often is not in densely populated load centers.[145]

While renewable resources are distributed across the United States and the world, they are not distributed evenly.[146] Nine states east of the Mississippi River do not have any subregions with very high wind resources.[147] Six states from Virginia to Massachusetts do not have any subregions with at least 250 million metric tons of currently available biomass annually.[148] These northeastern regions of the United States have relatively dense populations and significant electricity demand.[149] While they have access to renewable resources, those renewable resources are not as concentrated as in other areas of the United States.[150] However, with many buildings, energy efficiency may potentially be utilized as a substitute for the creation of additional generation capacity.[151]

Transmission infrastructure must be constructed to bring renewable power from the generation source to the load center, but who pays for this transmission infrastructure is at issue. Texas allows cost recovery through rate base for transmission connections within Competitive Renewable Energy Zones.[152] California offers special cost sharing for transmission in "locationally constrained" areas.[153] This includes rate base recovery.[154]

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144 *See* LAW OF INDEPENDENT POWER, *supra* note 55, § 2:11.

145 *See id.*

146 *See generally* FERREY & CABRAAL, *supra* note 5, at 37 (describing the location-restricted nature of renewable energy sources).

147 Charles F. Kutscher, Am. Solar Energy Soc'y, *Overview and Summary of the Studies*, *in* AM. SOLAR ENERGY SOC'Y, TACKLING CLIMATE CHANGE IN THE U.S.: POTENTIAL CARBON EMISSIONS REDUCTIONS FROM ENERGY EFFICIENCY AND RENEWABLE ENERGY BY 2030, at 7, 22 fig.14 (Charles F. Kutscher ed., 2007), *available at* http://ases.org/images/stories/file/ASES/climate_change.pdf.

148 *Id.* at 25 fig.19. These resources count agricultural residues, animal manure, wood residues, municipal discarded materials, and methane from landfill, as well as dedicated crop biomass. *See id.* at 25. With the exception of Florida, the eastern half of the United States is devoid of subregions capable of producing six kilowatt hours per square meter per day with solar photovoltaic resources on south-facing structures and surfaces. *Id.* at 20 fig.10.

149 *See, e.g.*, JESSE A. COHEN ET AL., ERNEST ORLANDO LAWRENCE BERKELEY NAT'L LAB., U.S. REGIONAL ENERGY DEMAND FORECASTS USING NEMS AND GIS 19 fig.16, 33 figs.25 & 26, 36 fig.28 (2005), *available at* http://eetd.lbl.gov/ea/EMS/reports/57955.pdf.

150 *See* Kutscher, *supra* note 147, at 20 fig.10, 22 fig.14, 25 fig.19, 30 fig.24.

151 MARILYN A. BROWN ET AL., PEW CTR. ON GLOBAL CLIMATE CHANGE, TOWARDS A CLIMATE-FRIENDLY BUILT ENVIRONMENT 14 (2005), *available at* http://www.pewclimate.org/docUploads/Buildings_FINAL.pdf.

152 *See* Alborz Nowamooz, *Inadequacy of Transmission Lines: A Major Barrier to the Development of Renewable Energy*, 3 ENVTL. & ENERGY L. & POL'Y J. 176, 179 (2008) (discussing Texas plan).

153 *See* CAL. ISO, 2008 SUMMER LOADS AND RESOURCES OPERATIONS PREPAREDNESS ASSESSMENT 9 (2008) (noting connection of remote resources).

154 ISO/RTO COUNCIL, INCREASING RENEWABLE RESOURCES: HOW ISOS AND RTOS ARE HELPING MEET THIS PUBLIC POLICY OBJECTIVE 19 (2007), *available at* http://www.isorto.org/atf/cf/%7B5B4E85C6-7EAC-40A0-8DC3003829518EBD%7D/IRC_Renewables_Report_101607_final.pdf; CAL. ISO, CALIFORNIA ISO NEAR-FINAL PROPOSAL FOR LOCATION CONSTRAINED RESOURCE INTERCONNECTION 3 (2007), *available at* http://www.caiso.com/1c59/1c59edff29c40.pdf.

An increase in use of renewable energy will require new transmission corridors and capacities to transport that power from the generation site to the load centers. Regional planning for transmission facilities may be necessary. The Fourth Circuit Court of Appeals recently denied FERC's claim that it had authority under the Energy Policy Act to override a state denial of transmission permission.[155] A related issue is whether renewable resources should have their own transmission corridors, or whether they should use general transmission corridors. Southern California Edison Company, alone, is looking to spend more than $5 billion on transmission projects between 2008 and 2013, adding roughly 7000 megawatts of renewable generation to its system.[156] The California Public Utilities Commission allowed Southern California Edison to spend $4.5 million of ratepayer money to participate in identifying renewable resource zones and developing transmission plans to access resources placed in those zones to deliver power to load centers.[157] These zones would tend to be in Nevada, Arizona, and Southern California.[158] The Arizona Corporation Commission rejected Southern California Edison's proposal to build a 230-mile line to provide Southern California with access to cheaper Arizona power, fearing that the exported power would increase costs to Arizona consumers who enjoyed the benefits of cheap existing plant output.[159] Texas utilities are also spending a similar sum to bring Texas competitive renewable energy resources to market.[160]

Massachusetts regulators have shown skepticism about paying for new interconnections and a power line to Maine that would allow transport of wind power south to load centers.[161] The new transmission line from Maine to load centers in southern New England states is opposed by the Maine Public Advocate.[162] Traditionally, the interconnection from the independent power producer (IPP), whether renewable or not, to the existing transmission lines has been the responsibility of the IPP to construct.[163] Maine utilities also have requested adders to their base return on equity for transmission facilities to move new renewable power from northern

155 Piedmont Envtl. Council v. FERC, 558 F.3d 304, 315 (4th Cir. 2009).

156 *Transmission Boom Calls for Reconsidering Cost Allocation Methods, Some Officials Say*, POWER MARKETS WK., Jul. 28, 2008, at 11, *available at* 2008 WLNR 15002223 [hereinafter *Transmission Boom*] (reporting Southern California Edison spending $5.5 billion on transmission costs).

157 *See* Press Release, Cal. Pub. Utils. Comm'n, PUC Approves Edison Transmission Study to Help State Meet Renewable and Greenhouse Gas Goals (Aug. 23, 2007), *available at* http://docs.cpuc.ca.gov/word_pdf/NEWS_RELEASE/71776.pdf.

158 *Id.*

159 *See* Ed Taylor, *ACC Rejects California Power Line*, E. VALLEY TRIB., May 31, 2007, http://www.eastvalleytribune.com/story/90674 (last visited Nov. 15, 2009).

160 *Transmission Boom*, *supra* note 156, at 11 (reporting that the Texas Public Utility Commission spent $5 billion on transmission costs).

161 Jason Fordney & Lisa Wood, *Northeast Transmission Projects Embody Arguments About Who Should Pay for What*, ELECTRIC UTIL. WK., Aug. 18, 2008, at 6, 7.

162 Lisa Wood, *Solar Company Proposes Unique Project to Displace Need for 350 Mile Maine Line*, ELECTRIC UTIL. WK., Feb. 2, 2009, at 1, 10–11.

163 LAW OF INDEPENDENT POWER, *supra* note 55, § 4:34.

Maine.[164] There are ongoing disputes as to whether new capacity on transmission lines must be made available on a competitive open access basis or not.[165]

There is a plan for construction of additional wind power resources in remote areas of northern Maine and Canada, where there is a robust wind regime and a sparse population settlement, and therefore little resistance to the siting of power generation resources.[166] Because wind is an intermittent resource, wind power projects do not use the grid's transmission capacity efficiently.[167] A study released in 2008 by Cambridge Energy Research Associates found that the production patterns of wind farms "do not correlate well with peak summer demand," and "capacity provided by wind projects is typically valued at 10% to 20% of their maximum rated capacity."[168]

Massive new transmission infrastructure is planned to bring externally generated power into the carbon-regulated states. For example, the largest of these projects is the American Electric Power (AEP) Interstate Project, which would put in place a 765-kilovolt transmission line stretching from West Virginia to New Jersey. Other examples include the Trans-Allegheny Interstate Line (TrAIL) Project, being undertaken by Allegheny Energy to enhance transmission capability from western Pennsylvania to Maryland and Virginia,[169] and the Meadow Brook to Loudoun 500 kilovolt line under construction by Dominion, which would carry that power into the Washington, D.C. metropolitan area.[170] Recently, Oncor and others were selected for a $5 billion transmission project to connect future wind farms in West Texas to the load centers in metropolitan areas.[171] Western governors have asked the federal government to pay for transmission extensions to reach areas where renewable energy projects might be built as part of economic stimulus efforts.[172]

The advantage is that there is still time to deal with all of these changes. The U.S. Department of Energy forecast in 2008 that the United States could

164 *See* Cent. Me. Power Co., 125 F.E.R.C. ¶ 61,182, at 61,952 (2008).

165 Amit Bansal & Umesh Agrawal, *Transmission Expansion: The Key to Competitive Electricity Markets*, POWER LINE, Dec. 2003, at 39, 39, 40.

166 *See* Beth Quimby, *$2 Billion Power Grid Upgrade Proposed*, PORTLAND PRESS HERALD, Aug. 3, 2008, http://pressherald.mainetoday.com/story_pf.php?id=202672&ac=PHnws (last visited Nov. 15, 2009) (describing a wind farming and transmission line project in Maine).

167 Jeffrey Ryser, *With Wind Power at Their Back, 13,000 at Conference Weigh Its Pros and Cons*, ELECTRIC UTIL. WK., June 9, 2008, at 1, 32.

168 *Id.* at 32 (discussing a Cambridge Energy Research Associates study that analyzed the production patterns of wind farms).

169 Allegheny Energy, Inc., Trans-Allegheny Interstate Line (TrAIL): Project Overview, http://www.aptrailinfo.com/index.php?page=overview (last visited Nov. 15, 2009).

170 Dominion, Meadow Brook to Loudoun 500 kV Line, http://www.dom.com/about/electric-transmission/meadow-brook/index.jsp (last visited Nov. 15, 2009).

171 Housley Carr, *Oncor, AEP/MidAm, LCRA, Others Are Selected for $4.92 Billion Buildout of Texas Transmission*, ELECTRIC UTIL. WK., Feb. 2, 2009, at 3.

172 Ethan Howland, *Western Governors Seeking Federal Aid to Build Transmission Links to Renewables*, ELECTRIC UTIL. WK., Feb. 2, 2009, at 15, 15.

achieve 20% of its electricity from wind power by 2030.[173] This possibility is actually much more aggressive than is likely under current scenarios, but is technologically feasible.[174] The Green Communities Act,[175] enacted in Massachusetts in 2008, set goals to achieve 20% of energy supplies through renewable resources and alternative energy (defined as not traditionally renewable[176]) and 25% of electric load through demand-side management by 2020.[177] It also sought to have certain renewable resources be onsite generation resources, instead of remote grid-connected resources.[178] This puts very different demands on an aging grid that now connects large, centralized plants in a few locations to consumers.[179]

Although the push into renewable and efficient energy may be relatively vigorous, the transition is likely to come in smaller increments than more concentrated, conventional fossil fuel or nuclear power projects. Each energy supply project, whether conventional or renewable, requires siting and permitting, which involves process and time.[180] In addition, the rollout of renewable and energy efficiency projects will not be immediate in impact, but gradual.[181] Because of this, the utility grid and supply system can adapt to these changes as they occur.

There are several things that can be done to improve deliverable operating opportunities of power systems. First, monitoring frequency, voltage, and control areas can be switched to monitoring phase angles of output of the electric current wave.[182] Second, grid operators can control an increasing percentage of the load remotely. Third, more distributed generation can supplement new capacity that is controlled by the grid.

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173 U.S. DEP'T OF ENERGY, 20% WIND ENERGY BY 2030: INCREASING WIND ENERGY'S CONTRIBUTION TO U.S. ELECTRICITY SUPPLY 1 (2008), *available at* http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf.

174 *Id.* at 105.

175 S. 2768, 185th Gen. Ct., Reg. Sess. (Mass. 2008) (enacted) (providing an act relative to "green communities").

176 The alternative resources would include gasification of coal with carbon capture and storage, combined heat and power, flywheel storage, and other alternatives. *Id.* § 32.

177 *Id.* § 116(a)(1)–(2).

178 *Id.* § 32.

179 *See generally* GLOBAL ENV'T FUND & GLOBAL SMART ENERGY, THE ELECTRICITY ECONOMY: NEW OPPORTUNITIES FROM THE TRANSFORMATION OF THE ELECTRIC POWER SECTOR 10, 24 (2008), *available at* http://www.globalenvironmentfund.com/data/uploads/The%20Electricity%20Economy.pdf (describing traditional and new approaches to electricity generation and transmission).

180 Energy Policy Act of 2005, 16 U.S.C. § 824p (2006); *see also* U.S. DEP'T OF ENERGY, *supra* note 173, at 118–19 (discussing the complex set of laws and permitting regulations applicable to wind energy projects).

181 *See generally* U.S. DEP'T OF ENERGY, *supra* note 173, at 12–13 (analyzing the impact of increasing the United States' electricity supply to 20% wind energy by 2030 and discussing the need to increase rates of wind turbine installation to meet efficiency goals).

182 *See* LAW OF INDEPENDENT POWER, *supra* note 55, § 8:2; STEVEN FERREY, THE NEW RULES: A GUIDE TO ELECTRIC MARKET REGULATION 12–13 (2000) [hereinafter THE NEW RULES].

D. Regulatory Mechanics for a More Renewable, Decentralized Grid

Both sides of the grid are in play. Future supply sources are less centralized and more diverse, whether these are dispersed via renewable generation or onsite generation.[183] On the customer side of the grid, self-generation and cogeneration are a critical part of the new grid. Cogeneration of electric power and usable heat by facilities on the customer sides of the meter and grid can be more efficient than conventional power generation.[184] Cogeneration can use any means of production and prime mover for the production of electricity.[185] Cogeneration systems reduce congestion of transmission and distribution networks, thus avoiding paying retail charges for conventional power supply.[186] The total energy produced by the system has much higher efficiency under the first and second laws of thermodynamics.[187] There also can be environmental advantages.[188] When one self-generates, one can avoid paying transmission, distribution, and regulatory charges that can make up roughly half of the electric charge.[189] The promise of energy efficiency and regulatory savings make this option very attractive to many consumers.[190] The new grid will have to accommodate an increase in dispersed generation, self-generation, and cogeneration over time.

From a regulatory perspective, new ways of regulating transmission providers to decouple their rates and earnings exclusively from the total volume of power handled—to reflect various rate recovery mechanisms tied to explicit policy incentives—are gaining some support.[191] Decoupling the revenue stream determination of regulated distribution utilities from the volume of power they sell is a critical reform; several states are trying to provide incentives to gain efficiency in energy supply. Originally, there was a revenue decoupling requirement in the proposed 2009 stimulus proposal for states to delink utility rate of return determinations from the volume of power sales to garner competitively awarded funds, which was dropped in the version enacted to now only require an indication that the state is moving in that direction.[192]

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183 *See* LAW OF INDEPENDENT POWER, *supra* note 55, § 10:114.

184 *Exit Strategy*, *supra* note 8, at 118; LAW OF INDEPENDENT POWER, *supra* note 55, § 2:2. For a treatment of distributed generation, see *id.* § 10:144.

185 LAW OF INDEPENDENT POWER, *supra* note 55, §§ 4:17–:18 (providing a definition of small power producers under federal law).

186 *See generally Exit Strategy*, *supra* note 8, at 120 n.46 (discussing congestion as a factor that impacts the distribution of power across transmission networks).

187 *See id.* at 119.

188 *Id.* at 121–22.

189 LAW OF INDEPENDENT POWER, *supra* note 55, § 10:144 n.23.

190 *See, e.g.*, *id.* § 10:144.

191 For a brief review of ratemaking procedure, see FERREY, *supra* note 80, at 543–45. For a review of legal precedent for ratemaking, see LAW OF INDEPENDENT POWER, *supra* note 55, §§ 5:41–:44.

192 *Compare* Cathy Cash, *Decoupling Mandate Keeps the Pot Stirred as Congress Advances Stimulus Package*, ELECTRIC UTIL. WK., Feb. 2, 2009, at 1, 1, 30, *with* American Recovery and Reinvestment Act of 2009, Pub. L. 111-5, div. A, 123 Stat. 115, 146–47.

Various environmental groups in 2009 urged Congress, as part of economic stimulus legislation, to provide incentives or enticements for states to decouple electric utility revenues from utility sales volume.[193] This move has split 1) consumer groups, state regulators, and some industrial groups, which are concerned about increasing costs through various incentives, from 2) environmental groups that want to provide more conservation incentives to utilities.[194] This split between environmental and consumer groups also occurred over similar issues in the last great flurry of new federal energy legislation during the energy crises in the late 1970s: "It's consumers versus utilities and environmentalists," according to one observer.[195] Three states already have embarked on such decoupling of economic incentives for power sales, including Massachusetts and California.[196] Even Massachusetts and California, not to mention the bulk of the states that have not so embarked, are just starting to feel their way along this new path. Yet, it is a critical component of changing regulatory incentives for power system operation.

FERC reported at the end of 2008 that ten states had adopted polices to decouple changes in utility revenue from changes in utility sales volume.[197] According to one source, California, New York, New Jersey, Maryland, and Massachusetts are the five states leading decoupling.[198] This list of states is similar to the list of states that led electric utility restructuring and retail deregulation a decade ago,[199] development of renewable portfolio standards and renewable system benefit charges in the decade since,[200] and state carbon regulation over the past year.[201] These states have some of the highest consumer retail electric prices in the United States.[202]

Massachusetts, in the middle of 2008, passed new renewable power legislation that will dramatically compel the adoption of renewable energy technologies.[203] Certain renewable energy owners are urging regulatory commissions to allow utilities to sign long-term contracts with power

193 Cash, *supra* note 192, at 1.

194 *Id.* at 31.

195 *Id.*

196 *See id.*

197 FERC 2008 ASSESSMENT, *supra* note 124, at ii.

198 *See* Cash, *supra* note 192, at 31.

199 *See* THE NEW RULES, *supra* note 182, at 140–41, 158 n.1. *See generally* LAW OF INDEPENDENT POWER, *supra* note 55, §§ 10:61–:64 (discussing the early attempts of New Hampshire, Massachusetts, New York, New Jersey, and California to restructure electric utilities and tax utilities at the state level).

200 *See* Steven Ferrey, *Sustainable Energy, Environmental Policy, and States' Rights: Discerning the Energy Future Through the Eye of the Dormant Commerce Clause*, 12 N.Y.U. ENVTL. L.J. 507, 508 (2004).

201 *See* Steven Ferrey, *Goblets of Fire: State Programs on Global Warming and the Constitution*, 35 ECOLOGY L.Q. 835, 845 (2008) [hereinafter *Goblets of Fire*].

202 ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, ELECTRIC POWER MONTHLY: SEPTEMBER 2009, at 107 tbl.5.6.A, 108 tbl.5.6.B (2009), *available at* http://tonto.eia.doe.gov/ftproot/electricity/epm/02260909.pdf (providing average retail price of electricity to ultimate customers by end-use sector and by state).

203 *See supra* notes 173–79 and accompanying text.

suppliers.[204] A bill in Rhode Island would allow such a utility to earn an incentive profit of three percent of annual contract payments under such a long-term contract, in addition to its normal rate of return.[205] In addition, the Rhode Island legislation would eliminate stranded costs for the purchasing utility by allowing it to immediately resell such long-term renewable power in the wholesale spot market.[206] Massachusetts also is supporting such long-term contracts with renewable energy suppliers to be entered by utilities.[207]

Overall, adapting the new grid not only requires adapting the architecture of copper wire to connect more dispersed renewable and other generating sources to load centers, but it also requires the development of an alternative suite of backup and peaking generating sources to fill the more intermittent profile of the new grid, with wind and solar resources providing a larger share of the power. While at one level this is an issue of new hardware, it is accompanied by regulatory issues of who is to pay for the significant cost of this new architecture. It is a challenge where the regulatory and legal challenges are at least as vexing as the engineering rollout. Next, this Article focuses on the next generation of legal issues accompanying the step across the brink to an increasingly renewable-based power grid. The difficulty is that these challenges are palpable; the good news is that they are all solvable with creative workmanship.

III. CONSTRUCTING THE LEGAL ARCHITECTURE FOR A MORE RENEWABLE NEW GRID

What is clear is that the grid, which is the system for delivering power to consumers, can handle relatively modest near-term amounts of renewable power and demand-side management resources.[208] What is important to the operation of the grid of the future is how we will incentivize other renewable resources to function as part of the grid. Here, this Article will briefly highlight several legal aspects of this challenge. First, this Part examines two facets involving the constitutional issues confronting these incentives. Then, this Part will address briefly the flip side of this coin: Other legal mechanisms and issues that states are deploying now to try to attract more renewable power resources to their grids through either European-style feed-in tariffs, or the alternative deployment in twenty-eight states of renewable energy portfolio standards (RPSs). The page limitations require that the Article treat each subject in less space than the issues deserve. However, for those who want to dive into the topics below in detail, other

204 *See, e.g.*, Press Release, Executive Office of Energy & Envtl. Affairs, Mass., Proposed Regulations Promote Adoption of Renewable Energy (Mar. 11, 2009), http://www.mass.gov/?pageID=eoeeapressrelease&L=1&L0=Home&sid=Eoeea&b=pressrelease&f=090311_pr_net_metering&csid=Eoeea (last visited Nov. 15, 2009).

205 *See* S. 2849, 2008 Gen. Assem., Jan. Sess. (R.I. 2008), *available at* http://www.rilin.state.ri.us/billtext08/senatetext08/s2849.pdf.

206 *See id.*

207 S. 2768, 185th Gen. Ct., Reg. Sess. § 83 (Mass. 2008) (enacted).

208 *See, e.g.*, *Goblets of Fire*, *supra* note 201, at 851.

law review articles on some of these issues are available in law journals from the University of California at Berkeley,[209] Minnesota,[210] Notre Dame,[211] and Stanford.[212] This Part first briefly highlights the constitutional issues that state policymakers must circumvent in their control of global warming and promotion of renewable resources.

A. Constitutional Issues Confronting State Renewable and Carbon Regulation

Over the past decade, states have been the primary engine in the United States of both renewable power development and the control of global warming gases from the power sector. A majority of states have driven the development of renewable energy,[213] and twenty-three states now have in place, but in all cases not yet in force, regulations controlling carbon dioxide emissions from power plants.[214] At the leading edge of this new grid architecture, states must navigate around constitutional restrictions in the U.S. federal system.

First, there are Commerce Clause issues when states promote renewable resources in state to the exclusion of power produced out of state.[215] States are trying to restrict "leakage" into their borders of less-costly power whose carbon or renewable characteristics are not regulated or affected.[216] Because the states may employ point-of-origin regulations to create islands into which externally-produced wholesale power cannot enter without penalty,[217] they will have to navigate limitations on this under the dormant Commerce Clause of the Constitution.

While these regulatory responses would deal with leakage, they also enact a form of regulation that discriminates against certain sources of power based on its state-based geographic origin.[218] Such controls on the free flow of electricity from other states, where electricity is a commodity or

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209 *Id.* at 900.

210 *The New Math*, *supra* note 52, at 622.

211 Steven Ferrey, *Auctioning the Building Blocks of Life: Carbon Auction, the Law and Global Warming*, 23 NOTRE DAME J.L. ETHICS & PUB. POL'Y 317, 357 (2009).

212 Steven Ferrey, *Power Paradox: The Algorithm of Carbon and International Development*, 19 STAN. L. & POL'Y REV. 510, 529 (2008).

213 *See* Steven Ferrey et al., *Fire and Ice: World Renewable Energy and Carbon Control Mechanisms Confront Constitutional Barriers*, 20 DUKE ENVTL. L. & POL'Y F. (forthcoming 2009) (manuscript at 42–44, on file with author) [hereinafter *Fire and Ice*].

214 *Goblets of Fire*, *supra* note 201, at 838–39. States with regulations include Arizona, California, Montana, New Mexico, Oregon, Utah, Washington, Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, Vermont, Illinois, Iowa, Kansas, Michigan, Minnesota, and Wisconsin. *See* MIDWESTERN GREENHOUSE GAS REDUCTION ACCORD 4 (2007), *available at* http://www.midwesternaccord.org/midwesterngreenhousegasreductionaccord.pdf; Reg'l Greenhouse Gas Initiative, Participating States, http://www.rggi.org/states (last visited Nov. 15, 2009); W. Climate Initiative, WCI Provincial and State Partner Contacts, http://www.westernclimateinitiative.org/wci-partners (last visited Nov. 15, 2009).

215 *See generally Goblets of Fire*, *supra* note 201, at 866–73 (describing the impact of the dormant Commerce Clause on regional greenhouse gas initiatives).

216 *Id.* at 862–65.

217 *See id.* at 864–65.

218 *Id.*

service that is a quintessential article in interstate commerce, run up against the dormant Commerce Clause.[219] The effort against power leakage by the early prorenewable, low-carbon emission states is ultimately a fight of "us" versus "them." This immediately raises dormant Commerce Clause concerns, and invokes the most exacting strict scrutiny legal standard, under which few similar state regulations have survived.[220]

In the United States Supreme Court's decision in *West Lynn Creamery, Inc. v. Healy*,[221] the Court found a violation of the dormant Commerce Clause in the state regulatory scheme.[222] In *Healy*, the environmental purpose of the Massachusetts state regulation did not save the regulation from being struck by the Supreme Court. The state argued that any incidental burden on interstate commerce resulting from the pricing order in *Healy* is outweighed by local benefits, including "protecting unique open space and related benefits."[223] The Court states that "even if environmental preservation were the central purpose of the pricing order, that would not be sufficient to uphold a discriminatory regulation."[224] The use of facially discriminatory economic means taints an otherwise laudable end and violates the dormant Commerce Clause.[225]

Second, state regulation can also overstep federal authority and trigger unauthorized intrusion under the Supremacy Clause.[226] There are constitutional Supremacy Clause issues when states attempt to regulate the price of wholesale power or the dispatch queue of wholesale power dispatch.[227] When states deliberately, even if indirectly, change wholesale electric power dispatch order by regulations inflating the otherwise federal-jurisdictional wholesale power price at which power plants are approved to operate, that regulation can be questioned constitutionally pursuant to the Supremacy Clause as not within state power.[228]

Major fights have erupted in California over the allocation and auction of carbon dioxide emission allowances.[229] Sections 201, 205, and 206 of the Federal Power Act empower FERC to regulate rates for the interstate or wholesale sale and transmission of electricity.[230] In doing so, the Act bestows upon FERC broad power to shape the energy markets and affect all

219 *Id.* at 865.

220 *Id.* at 868; *see also* City of Philadelphia v. New Jersey, 437 U.S. 617, 624 (1978).

221 512 U.S. 186 (1994).

222 *Id.* at 188, 192.

223 *Id.* at 204 n.20 (quoting Respondent's Brief on the Merits at 40, West Lynn Creamery, Inc. v. Healy, 512 U.S. 186 (1994) (No. 93-141)).

224 *Id.* at 204–05 n.20; *see also* City of Philadelphia v. New Jersey, 437 U.S. at 626–27 ("[W]hatever New Jersey's ultimate purpose, it may not be accomplished by discriminating against articles of commerce coming from outside the State unless there is some reason, apart from their origin, to treat them differently.").

225 *Healy*, 512 U.S. at 210.

226 FRED BOSSELMAN ET AL., ENERGY, ECONOMICS AND THE ENVIRONMENT 17 (2d ed. 2006).

227 *See id.*

228 *See id.*

229 Margot Roosevelt, *Groups Vow to Fight Carbon Emissions Cap-and-Trade Plan*, L.A. TIMES, Feb. 20, 2008 (on file with Environmental Law).

230 Electric Utility Companies Act, 16 U.S.C. §§ 824, 824d–824e (2006).

stakeholders, including generators. The Act creates a bright line between state and federal jurisdiction with wholesale power sales falling clearly and unequivocally on the federal side of the line.[231] FERC jurisdiction preempts state regulation of wholesale power transactions and prices.[232]

The filed rate doctrine holds that state regulatory agencies may not second guess or overrule on any grounds a wholesale rate determination made pursuant to federal jurisdiction.[233] The Supreme Court in 1986, and again in 1988, 2003, and 2008, articulated and enforced the filed rate doctrine.[234] There was found to be no ability of states to tamper, directly or indirectly, with wholesale market operations approved by a FERC order or operating subject to FERC-approved tariffs.[235] Moreover, courts have stricken attempts by states to indirectly or directly promote higher wholesale energy prices for certain renewable energy projects.[236] In 1994, the Ninth Circuit Court of Appeals rejected the California Public Utilities Commission's claim that it had independent authority to regulate the prices and terms for such renewable power sales.[237]

A state law may not frustrate the operation of federal law, even if the state legislature has a valid purpose for the legislation.[238] The wholesale price determination is reserved exclusively to federal authority.[239] In *Public Utility District No. 1 of Snohomish County v. FERC*,[240] the court affirmed that the federal government, through FERC, must protect all stakeholders in the electric wholesale market against any state regulatory actions or mistakes.[241]

Some of the state programs attempt to craft a new, low-carbon grid and avoid these constitutional pitfalls, while others seem to skate very close to the brink.[242] The first constitutional challenge against a state carbon control scheme

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231 *See* Nantahala Power & Light Co. v. Thornburg, 476 U.S. 953, 966 (1986).

232 *Id.*

233 Entergy La., Inc., v. La. Pub. Serv. Comm'n, 539 U.S. 39, 47 (2003). However, the Supreme Court has determined that Congress, in enacting the Federal Power Act, intended to vest exclusive jurisdiction to regulate interstate wholesale utility rates in FERC. Fed. Power Comm'n v. S. Cal. Edison Co., 376 U.S. 205, 216 (1964).

234 *See* Pub. Util. Dist. No. 1 of Snohomish County v. FERC, 471 F.3d 1053, 1066 (9th Cir. 2006), *aff'd in part and rev'd in part*, Morgan Stanley Capital Group v. Pub. Util. Dist. No. 1, 128 S. Ct. 2733 (2008); *Entergy La., Inc.*, 539 U.S. at 49–50; Miss. Power & Light Co. v. Mississippi *ex rel.* Moore, 487 U.S. 354, 372 (1988); *Nantahala Power & Light Co.*, 476 U.S. at 963.

235 *See Entergy La., Inc.*, 539 U.S. at 48–50 (discussing the application of the "filed rate doctrine" on state regulatory attempts).

236 *See, e.g.*, Indep. Energy Producers Ass'n v. Cal. Pub. Utils. Comm'n, 36 F.3d 848, 856–57 (9th Cir. 1994) (finding no separate basis for the state PUC to establish a premium price for facilities complying with efficiency standards by sanctioning facilities that did not with rate changes).

237 *Id.* at 859.

238 *See, e.g.*, Perez v. Campbell, 402 U.S. 637, 651–52 (1971) (stating that the Supremacy Clause invalidates contradictory state law, even that which is not intended to frustrate federal interest).

239 *Entergy La., Inc.*, 539 U.S. at 39.

240 471 F.3d 1053 (9th Cir. 2006), *aff'd in part and rev'd in part*, Morgan Stanley Capital Group v. Pub. Util. Dist. No. 1, 128 S. Ct. 2733 (2008).

241 *Id.* at 1066–67, 1080.

242 *Goblets of Fire*, *supra* note 201, at 885, 898.

was initiated in February of 2009,[243] while the first real challenge to a state renewable RPS system was initiated in the past year.[244] These issues are real, not academic, and ones legal practitioners must address sooner rather than later.

B. Feed-In Tariffs to Promote Grid-Connected Renewable Power

Feed-in tariffs are the most widely employed renewable energy policy in Europe and, increasingly, the rest of the world.[245] As of 2006, seventeen European Union countries, Brazil, Indonesia, Israel, Korea, Nicaragua, Norway, Sri Lanka, Switzerland, and Turkey all used feed-in tariffs to promote and support renewable energy.[246] A feed-in tariff establishes a secure contract for wholesale electricity sale at a set price that results in a rate of return attractive to investors and developers.[247] Feed-in tariff structures are typically either fixed payments based on an electricity generator's cost to produce electricity, or as a fixed premium paid above the spot market or wholesale market price of electricity.[248] The fixed payments are long-term contracts for up to thirty years in duration.[249] Feed-in tariffs increase the price for certain renewable technologies to an amount that is deemed administratively and politically necessary to encourage their development.[250]

Six states in the United States have introduced actual feed-in tariff legislation, while a handful of others are considering feed-in tariff policies for immediate adoption.[251] However, as discussed above for carbon control measures undertaken by states, under the filed-rate doctrine, state regulatory agencies may not second-guess, or overrule on any grounds, a wholesale rate determination made pursuant to federal jurisdiction.[252] The Supreme Court in 1986, and again in 1988 and 2003, upheld the filed rate

243 Indeck Energy sued New York agencies involved in the RGGI carbon scheme on various grounds in January 2009. Press Release, Indeck Energy Servs., Inc., Indeck Energy Sues State Questioning Legality of Regional Greenhouse Gas Program (Jan. 29, 2009), *available at* http://www.indeckenergy.com/pdfnews/RGGI%20Lawsuit%20012909%20.pdf.

244 Plaintiffs' Motion for Summary Judgment at 3, Miller v. Ariz. Corp. Comm'n, No. CV2008-029293 (Ariz. Super. Ct. Feb. 25, 2009), *available at* http://www.goldwaterinstitute.org/Common/Img/022509-Corp-Com-suit-MSJ.pdf.

245 *See* WILSON RICKERSON & ROBERT C. GRACE, THE DEBATE OVER FIXED PRICE INCENTIVES FOR RENEWABLE ELECTRICITY IN EUROPE AND THE UNITED STATES: FALLOUT AND FUTURE DIRECTIONS 1 (2007), *available at* http://www.ontario-sea.org/Storage/27/1941_Rickerson_Grace_FINAL.pdf.

246 *Id.*

247 *Id.* at 5–9.

248 Wilson H. Rickerson et al., *If the Shoe FITs: Using Feed-In Tariffs to Meet U.S. Renewable Electricity Targets*, ELECTRICITY J., May 2007, at 73, 73, 74.

249 ANNE HELD ET AL., FEED-IN SYSTEMS IN GERMANY, SPAIN AND SLOVENIA: A COMPARISON 30 n.12, 33 (2007), *available at* http://www.feed-in-cooperation.org/wDefault_7/wDefault_7/download-files/research/ific_comparison_of_fit-systems_de_es_sl.pdf.

250 *See* Kate Galbraith, *Europe's Way of Encouraging Solar Power Arrives in the U.S.*, N.Y. TIMES, Mar. 13, 2009, at B1.

251 *See Fire and Ice*, *supra* note 213 (manuscript at 63–66).

252 However, the Supreme Court has determined that Congress, in enacting the Federal Power Act, intended to vest exclusive jurisdiction in FERC to regulate interstate wholesale utility rates. Fed. Power Comm'n v. S. Cal. Edison Co., 376 U.S. 205, 216 (1964).

doctrine.[253] The Federal Power Act creates a "bright line" between state and federal jurisdiction with wholesale power sales falling clearly and unequivocally on the federal side of the line.[254]

Not only does FERC have exclusive authority unaffected by any state actions over wholesale power markets,[255] FERC also has an ongoing obligation to continually monitor and police these markets against state interference.[256] Federal case law and FERC precedent indicate that the Federal Power Act prevents utilities from being *mandated* or *required* to purchase renewable energy above their "avoided cost" for generic wholesale purchases.[257] Even state legislation for feed-in tariffs could not mandate a wholesale electric purchase at a rate per kilowatt hour above the avoided cost under principles of federal preemption.[258] Any theoretical feed-in tariff proposal, in order to be effective, would be well above purchasing utilities' avoided costs and therefore would be subject to a Federal Power Act challenge by ratepayers or utilities.[259] Therefore, there is a constitutional impediment to those states that have not considered this in moving to adopt feed-in tariffs as their way to shift the cost of making the future grid more renewable. These legal and policy issues also are treated in more detail in an upcoming law review article of which I am a coauthor.[260]

C. Renewable Portfolio Standards for the New Renewable Grid

As of 2007, twenty-five states plus the District of Columbia had RPS programs, and four additional states had nonbinding RPS goals.[261] These mandatory RPS programs are projected to cover approximately 35% of nationwide retail electricity sales by 2009.[262] RPS programs were initially created in states that had restructured or deregulated their retail power markets; however, over time, half of the RPS programs came to be in traditional

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253 *See* cases cited *supra* note 234.

254 Pub. Util. Dist. No. 1 of Snohomish County, 471 F.3d at 1066 (9th Cir. 2006), *aff'd in part and rev'd in part sub nom.* Morgan Stanley Capital Group, 128 S. Ct. 2733 (2008).

255 *Id.* at 1067.

256 *See id.*

257 See *supra* Part III.A for a discussion of the filed rate doctrine.

258 *See generally* FERC v. Mississippi, 456 U.S. 742, 775 (1982) (O'Connor, J., dissenting in part) (arguing that the Public Utility Regulatory Policies Act of 1978, Pub. L. No. 95-617, 92 Stat. 3117 (codified as amended in scattered sections of 15, 16, 26, 42, and 43 U.S.C.)), violates Tenth Amendment federalism principles).

259 For a comprehensive legal treatment of feed-in tariffs, see *Fire and Ice*, *supra* note 213 (manuscript at 91–92).

260 *See, e.g.*, FERC v. Mississippi, 456 U.S. at 759 (affirming FERC preemption power over state regulatory goals concerning retail sales of electricity and gas).

261 RYAN H. WISER & GALEN BARBOSE, LAWRENCE BERKELEY NAT'L LAB., RENEWABLES PORTFOLIO STANDARDS IN THE UNITED STATES: A STATUS REPORT WITH DATA THROUGH 2007, at 1 (2008), *available at* http://eetd.lbl.gov/ea/ems/reports/lbnl-154e-revised.pdf. States with new mandatory RPS programs in 2007 included Illinois, New Hampshire, North Carolina, and Oregon. *Id.* at 3.

262 *See id.* at 5–6 & fig.3; AM. WIND ENERGY ASS'N, STATE-LEVEL RENEWABLE ENERGY PORTFOLIO STANDARDS (RPS) (2007), *available at* http://www.awea.org/pubs/factsheets/State_RPS_Fact_Sheet.pdf.

monopolized states.[263] These programs are set forth in Table 2. RPS programs differ widely from state-to-state in terms of what qualifies. For example, some states count cogeneration, while Pennsylvania includes coal gasification and nonrenewable distributed generation.[264] Some states set standards based on a percentage of installed capacity, while other states set standards based as a percentage of total electricity sales.[265] Some states allow credits to be traded, while other states do not.[266] Eligible renewable resources are set forth in Table 3.

Table 2:
Portfolio Standards and Trust Funds in Early Adopter States[267]

State	Renewable Energy Trust Fund	Portfolio Standards
Arizona		x
California	x	x
Colorado		x
Connecticut	x	x
Delaware	x	x
Hawaii	x	x
Illinois	x	x
Iowa		x
Maine	x	x
Maryland		x
Massachusetts	x	x
Minnesota	x	x
Montana	x	x
Nevada		x
New Jersey	x	x
New Mexico		x
New York	x	x

263 *Compare* CTR. FOR ENERGY EFFICIENCY & RENEWABLE TECHS., UNITED STATES RENEWABLE ENERGY MARKET REPORT 58–60 (2004), *available at* http://www.berr.gov.uk/files/file15149.pdf (noting traditional monopolized energy market structure in Colorado, Hawaii, Iowa, Minnesota, Nevada, New Mexico, Vermont, and Wisconsin), *with* U.S. Dep't of Energy, States with Renewable Portfolio Standards, http://apps1.eere.energy.gov/states/maps/renewable_portfolio_states.cfm (last visited Nov. 15, 2009) (illustrating that Colorado, Hawaii, Iowa, Minnesota, Nevada, New Mexico, Vermont, and Wisconsin are RPS states).

264 UNION OF CONCERNED SCIENTISTS, PENNSYLVANIA ALTERNATIVE ENERGY PORTFOLIO STANDARD SUMMARY 4 (2008), *available at* http://www.ucsusa.org/assets/documents/clean_energy/pennsylvania.pdf.

265 *See generally* AM. WIND ENERGY ASS'N, *supra* note 262.

266 *See* FRED SISSINE, CONG. RESEARCH SERV., RENEWABLE ENERGY PORTFOLIO STANDARD (RPS): BACKGROUND AND DEBATE OVER A NATIONAL REQUIREMENT, at CRS-2 (2007), *available at* http://www.seia.org/galleries/pdf/RPS_CRS_Report_12_04_08.pdf.

267 N.C. Solar Ctr. et al., Database of State Incentives for Renewables & Efficiency: Rules, Regulations and Policies for Renewable Energy, http://www.dsireusa.org/summarytables/rrpre.cfm (last visited Nov. 15, 2009).

State	Renewable Energy Trust Fund	Portfolio Standards
Ohio	x	x
Oregon	x	x
Pennsylvania	x	x
Rhode Island	x	x
Texas		x
Vermont	x	x
Wisconsin	x	x

Table 3:
"Renewable" Resources as Defined in State RPS Statutes[268]

State	Solar Thermal Electric	Wind	Fuel Cell	Methane / Landfill	Biomass	Trash-To-Energy
Arizona	x	x	*	x	x	
California	x	x	*	x	x	x
Connecticut		x	*	x	x	
Iowa	x	x		x	x	x
Illinois	x	x		x	x	
Maine	x	x	x	x	x	
Maryland	x	x	*	x	x	x
Massachusetts	x	x	*	x	x	x
Minnesota		x	x	x	x	x
Nevada	x	x		x	x	x
New Jersey	x	x	x	x	x	x
New Mexico	x	x	*	x	x	
New York		x	x	x	x	
Oregon	x	x	x	x	x	
Pennsylvania	x	x	x	x	x	x
Rhode Island		x	*	x	x	
Texas	x	x		x	x	
Wisconsin	x	x	*	x	x	

State	Hydro	Tidal	Geothermal	Photovoltaic	Dedicated Crops / Biofuels
Arizona	x		x	x	x
California	x	x	x	x	x
Connecticut	x	x		x	x
Iowa	x			x	x

268 U.S. ENVTL. PROT. AGENCY, RENEWABLE PORTFOLIO STANDARDS: AN EFFECTIVE POLICY TO SUPPORT CLEAN ENERGY SUPPLY 3 fig.3 (2009), *available at* http://www.epa.gov/chp/documents/rps_fs.pdf.

State	Hydro	Tidal	Geothermal	Photovoltaic	Dedicated Crops / Biofuels
Maine	x	x	x	x	x
Maryland	x	x	x	x	x
Massachusetts	x	x	x	x	x
Minnesota	x	x	x	x	x
Nevada	x		x	x	x
New Jersey	x	x	x	x	x
New Mexico	x		x	x	x
New York	x	x		x	x
Oregon	x	x	x	x	x
Pennsylvania	x		x	x	x
Rhode Island	x	x		x	x
Texas	x	x	x	x	x
Wisconsin	x	x	x	x	x

Note: Photovoltaic is included within solar in some states. Methane and trash-to-energy may be included within a broad definition of "biomass."

* Indicates state only allows renewable fuel cells.

It is estimated that roughly half of new renewable energy power capacity in the United States over the last decade has occurred in states with RPS programs in place,[269] which constitutes over 50% of the states.[270] Over 90% of these capacity additions have come from wind power, with biomass and geothermal resources in second and third position, respectively.[271] The National Renewable Energy Laboratory has estimated that RPS programs may result in only eight gigawatts of new wind capacity (about 1% of U.S. installed total capacity) relative to a base case where no RPS programs existed.[272] Therefore, the contribution of RPS programs appears modest in terms of total U.S. power resources.

It is estimated that 45% of the 4300 megawatts of wind power installed in the United States between 2001 and 2004 was motivated by state renewable portfolio standards, while an additional 15% of these installations was motivated by state renewable energy trust funds and subsidies.[273] Some analysts have concluded that the portfolio standard will be more influential in promoting renewable power development than the separate promotion

269 Ryan Wiser et al., *The Experience with Renewable Portfolio Standards in the United States*, ELECTRICITY J., May 2007, at 8, 14 & fig.3 (quoting an estimate by Black & Veatch that half of the capacity equals approximately 5500 MW); *see* BLACK & VEATCH, RENEWABLE ENERGY OPTIONS 3–4 (2008), *available at* http://www.bv.com/downloads/Resources/Reports/RenewableEnergyPletka2008.pdf.

270 WISER & BARBOSE, *supra* note 261, at 1.

271 Wiser et al., *supra* note 269, at 14.

272 NATE BLAIR ET AL., NAT'L RENEWABLE ENERGY LAB., LONG-TERM NATIONAL IMPACTS OF STATE-LEVEL POLICIES 13–14 & fig.8 (2006).

273 Ryan Wiser & Mark Bollinger, *Balancing Cost and Risk: The Treatment of Renewable Energy in Western Utility Resource Plans*, ELECTRICITY J., Jan.–Feb. 2006, at 48, 48.

mechanism of the system benefit charge and trust fund.[274] This may be because portfolio standards allow market forces to work; developers will develop the most cost-effective and reliable renewable technologies eligible under a state program.[275] The total expected renewable capacity added by portfolio standards and system benefit charges in those states that have adopted them will be dwarfed—making up less than 10%—by the expected total U.S. electric system's nonrenewable capacity increases during the first decade of the new century, and will be less than 1% of total U.S. electric capacity.[276]

Assuming that full compliance is achieved, current mandatory state RPS policies in the half of the states that have the policies will require the addition of roughly sixty gigawatts of new renewable energy capacity by 2025.[277] This amount is equivalent to 4.7% of projected 2025 electricity generation in the United States, and 15% of projected electricity demand growth.[278] Some individuals contend that it is not practically achievable to have the various RPS projects around the country install about sixty gigawatts of new, required generation power.[279] The congested and limited state of infrastructure to move renewable power from generation site to market causes some to state that these requirements cannot be achieved within specified time frames.[280]

Nonetheless, in a number of states, including Massachusetts, Nevada, Arizona, New York, and California, new renewable energy project developments are not currently on track to meet mandatory RPS targets for renewable generation as a percentage of total retail load.[281] Massachusetts had enough renewable energy credit (REC) certificates available to meet the 3% RPS criterion for 2007.[282] Maine and New Hampshire projects supplied 48% of the certificates, with New York providing 17% and Massachusetts in a distant fourth place, tied with projects from the Canadian province of

274 Ryan Wiser et al., *Emerging Markets for Renewable Energy: The Role of State Policies During Restructuring*, ELECTRICITY J., Jan.–Feb. 2000, at 13, 19. These authors conclude that RPSs will be more influential than system benefit charges and trust funds in driving the overall renewable energy market through 2010. *Id.* at 19. Texas, at 2000 megawatts, is predicted to provide the most substantial domestic market for new renewable generation. *Id.* at 17–18. California, Massachusetts, Connecticut, and New Jersey are projected to add 400–600 megawatts each, while the remaining states are expected to add less. *Id.* at 19. These authors expect the total from RPSs and system benefit charges and trust funds to exceed that driven by green power marketing efforts alone. *Id.* at 20.

275 *See id.* at 19.

276 *Id.* at 20.

277 WISER & BARBOSE, *supra* note 261, at 1.

278 *Id.*

279 Tom Tiernan, *EEI Says Some RPS Targets 'Unachievable' as Industry Deals with Infrastructure Debate*, ELECTRIC UTIL. WK., May 5, 2008, at 7, 7.

280 *See id.*; ELEC. POWER RESEARCH INST., THE POWER TO REDUCE CO_2 EMISSIONS: THE FULL PORTFOLIO 3-6 (2007), *available at* http://mydocs.epri.com/docs/public/DiscussionPaper2007.pdf.

281 Wiser et al., *supra* note 269, at 13.

282 DEP'T OF ENERGY RES., COMMONWEALTH OF MASS., MASSACHUSETTS RENEWABLE ENERGY PORTFOLIO STANDARD: ANNUAL RPS COMPLIANCE REPORT FOR 2007, at 3 (2008), *available at* http://www.mass.gov/Eoeea/docs/doer/rps/rps-2007annual-rpt.pdf.

Quebec.[283] Approximately half of the projects were from biomass projects, with landfill gas projects supplying 30%.[284] The Massachusetts Department of Energy Resources concluded it was not possible to determine definitively net import and export transactions for affiliated entities attempting to "green wash" RECs to achieve their creation in more lucrative states.[285] The price impact of RPS-mandated renewable energy projects has been estimated to range between a 0.1% increase in retail rates (in Maine, Maryland, New Jersey, and New York) and up to a 1.1% retail rate impact in Massachusetts.[286]

IV. CONCLUSION: THE FUTURE GRID

The new grid is best envisioned as an organic, growing service infrastructure or entity comprised of both the metal extension of transmission wire between new renewable technologies and load centers, as well as a series of legal mechanisms to promote the rapid development of renewable supply sources. The grid is more than just connection; it is a virtual and real network that intertwines supply and demand of the essential electric resource of the twenty-first century. All aspects dictate what the "grid" will be, facilitating the use of energy in postmodern society.

While the focus on the grid to date has been about how to pay for and extend the copper cable to the new renewable generation sources,[287] an equally challenging and equally expensive component will be the phased creation of new quick-start backup and peak-power generation resources to necessarily supplement the intermittent supply of the new renewable resources. This is essential to maintain a reliable grid capable of servicing the American economy. It appears that the development of a substantial component of renewable power, with siting and financing issues, will take a significant number of years,[288] which allows time to change the supplemental and backup resources on the grid. All of this is solvable technically. The challenge is to make the legal and regulatory system integrate the full changes.

The other side of the "grid" is the incentives to promote renewable power beyond a business-as-usual system. The states have taken the lead on various renewable energy and carbon-reduction policy incentives.[289] However, the states have not focused on legal constraints within the U.S. Constitution.[290] One might assume that inquiries would be an early concern.

283 *Id.* at 10 fig.3.

284 *Id.* at 3.

285 DEP'T OF ENERGY RES., COMMONWEALTH OF MASS., IMPORTS FEASIBILITY STUDY: CAPACITY COMMITMENT AND NETTING REQUIREMENT 8–9 (2008), *available at* http://www.mass.gov/Eoeea/docs/doer/gca/rps_import/feas-study-report.pdf.

286 Wiser et al., *supra* note 269, at 16. An impact of not more than approximately 1% is forecast to be the cost of this implementation. *See id.* at 17–18.

287 *See generally* Ethan Howland, *Western Governors Seeking Federal Aid to Build Transmission Links to Renewables*, ELECTRIC UTIL. WK., Feb. 2, 2009, at 15, 15.

288 U.S. DEP'T OF ENERGY, *supra* note 41, at 3.

289 *Goblets of Fire*, *supra* note 201, at 838–39.

290 *See supra* Part III.A.

As itemized briefly herein with reference to more detailed source articles, there are constitutional concerns with some of these measures.[291] The RGGI program in New York and an RPS program in the West are already the subject of litigation.[292]

The challenge here again with the evolution of the grid is not technological, as various renewable power technologies are proven and await implementation. The challenge is legal, which means the United States has many intriguing issues that have yet to be resolved. May we all continue to live in interesting times.

291 *See supra* Part III.A.

292 *See supra* notes 243–44 and accompanying text.