Efficiency in the Regulatory Crucible: Navigating 21st Century 'Smart' Technology and Power

Steven Ferrey*

The flow of money in U.S. energy policy choices has consequences,[1] and the Obama administration's 2009 federal stimulus package presents an interesting policy scenario. The current administration wants to pivot postindustrial America away from emitting global-warming gases and powering its economy with fossil fuels.[2] Indeed, changing the energy technology and infrastructure of the United States has been the cornerstone of the Obama administration's domestic policy.[3] The federal government devoted significant amounts of stimulus funding to this agenda.[4] It also maintained preferences for certain investments in energy efficiency and renewable energy through the tax code.[5] A change of this significance revolving around a resource as essential as energy is a fundamental shift that has happened only a few times in history[6] and could well be one of the most profound changes of the century.

Even though the Obama Administration's goal was to change the technology of American energy use, the most pressing energy issues are *not* technological in nature; they are legal, regulatory, practical, and political.[7] This article will follow the money in the 2009 federal stimulus package for each part of the new energy infrastructure puzzle[8] and will chart the policy conundrums and legal barriers that each element confronts.[9] Part I will provide an introduction to the challenges that the development of renewable energy, energy efficiency, and conservation present. Part II will focus in great detail on the development of the smart grid and renewable power in the United States, and the associated legal, regulatory, political, and practical challenges. Part III will focus on the progress of the promotion of energy efficiency and conservation measures in this country, and the primary challenges that these measures face. This article concludes that energy efficiency and conservation measures are a cost-efficient means of beginning to transform our country's use of and relationship with energy, and that these strategic measures face dramatically fewer roadblocks to progress than do development of renewable energy and its integration into the grid.

I. Renewable-Energy Programs Face Challenges that Energy-Efficiency Incentives Do Not Encounter

A. *Challenges Faced by Renewable-Power Programs*

Some renewable power incentives enacted at the state level have met a barbed wire fence of legal, constitutional, and

* *Steven Ferrey is Professor of Law at Suffolk University Law School and served as Visiting Professor of Law at Harvard Law School in 2003. Since 1993, Professor Ferrey has served as legal consultant to the World Bank and the United Nations Development Program on their renewable energy and climate control policies in developing countries, working extensively in Asia, Africa, and Latin America. He holds a B.A. in economics, a J.D., and a master's degree in regional planning. Upon completing his J.D., he was a postdoctoral Fulbright Fellow at the University of London. He is the author of seven books on energy and environmental law and policy, the most recent of which is Unlocking the Global Warming Toolbox: Key Choices for Carbon Restriction and Sequestration (2010). He has also penned many articles on these topics which have been published in law reviews at Harvard University; NYU; Stanford University; the University of California, Berkeley; Boston College; the College of William & Mary; the George Washington University; UCLA; the University of Notre Dame; the University of Minnesota; Fordham University; the University of Virginia; Duke University; and other journals.* *Professor Ferrey thanks his research assistants, Christopher Ng, Jennifer Warren, and Justin Elliott, for their research assistance with citations.*

1. *See, e.g.*, *infra* Part II.B (discussing, in part, substantial federal expenditures on new energy initiatives).
2. *See* Democratic Policy Comm., Fact Sheet: Key Obama Budget Investment in Clean Energy, the Environment, and Natural Resources (2010) *available at* http://dpc.senate.gov/docs/fs-111-2-26.html.
3. *See* The President's Weekly Address, 1 Pub. Papers 13 (Jan. 24, 2009).
4. American Recovery and Reinvestment Act (ARRA) of 2009, Pub. L. No. 111-5, 123 Stat. 115 (2009).
5. *Consumer Energy Tax Incentives*, U.S. Dep't Energy, http://www.energy.gov/taxbreaks.htm (last visited July 10, 2011).
6. For a discussion of one such fundamental shift, see Gregory Clark, Kevin H. O'Rourke & Alan M. Taylor, *Made in America? The New World, the Old, and the Industrial Revolution*, 98 Am. Econ. Rev. 523 (2008).
7. *See, e.g.*, Megan Hiorth, Note, *Are Traditional Property Rights Receding with Renewable Energy on the Horizon?*, 62 Rutgers L. Rev. 527, 530–31 (2010) (discussing the role of property rights in development of wind and solar technology).
8. *Infra* Part II.B.
9. *Infra* Part II.

political challenges.[10] These challenges include recent court challenges that directly or indirectly adversely affect renewable energy development, or threaten to do so, in California[11] Missouri,[12] Massachusetts,[13] and New York.[14] Additional challenges are pending in New Jersey[15] and Colorado.[16]

State renewable-power incentives also face difficult political challenges arising from contentious resource and environmental issues.[17]

The political challenges to concentrated solar collectors are demonstrative. With the supply of fresh water becoming scarce in parts of the United States as global warming advances, concentrated solar collectors have drawn criticism because they consume up to three hundred percent more water than coal- and other fossil-fuel-fired power plants.[18] Less than one percent of the earth's water is fresh water available for human use,[19] and more than half of that one percent is located within just 6 of the world's 200 nations, excluding the United States.[20] Four states have already denied permits for solar generation facilities due to a lack of sufficient fresh water.[21]

Additionally, some renewable energy resources have drawn criticism because they can require significant amounts of land.[22] Concentrated solar collectors that generate power require up to ten times as much land area as typical fossil-fuel-fired power plants.[23] Wind turbines require up to roughly seventy times as much land area.[24] Solar energy requires large amounts of land because solar technology is less efficient at generating electricity[25] through centralized turbine technology than are concentrated fossil-fuel technologies.[26] This use of land has turned out to have a noted impact on the national debate over renewable energy; indeed, national environmental organizations generally supporting renewable energy have seen their local chapters divide in response to specific siting decisions involving renewable projects.[27]

Moreover, renewable-energy technologies have a troubling, overly dependent relationship with public funding.[28] Many renewable projects depend on federal and state subsidies to even be constructed.[29] Recent government decisions in Spain to renege on previously pledged subsidies for renewable technologies further underscore the fragility of alternative energy projects amid regulatory change.[30] In fact, major subsidization of renewable power has come under increasing criticism.[31] Push-backs to renewable power initiatives have occurred in California, Massachusetts, and Rhode Island.[32] These resource issues are ongoing.[33]

Lastly, policy- and law-makers face a variety of practical challenges to and unresolved questions surrounding the development of renewable energy. These include how to best address the intermittent nature of the dominant forms of

10. *See* Cameron Ferrey, Steven Ferrey & Chad Laurent, *Fire and Ice: World Renewable Energy and Carbon Control Mechanisms Confront Constitutional Barriers*, 20 Duke Envtl. L. & Pol'y F. 125, 180–95 (2010) (detailing constitutional concerns in various state programs).
11. *Id.* at 195–200; *e.g.*, S. Cal. Edison Co., 133 FERC ¶ 61,059 (Oct. 21, 2010); *see also* Ass'n of Irritated Residents v. Cal. Air Res. Bd., No. CPF-09-509562 (Cal. Super. Ct. Mar. 18, 2011) (order granting in part petition for writ of mandate) (ruling that the California Air Resources Board ("CARB") violated state environmental law by not thoroughly evaluating alternatives before adopting a cap-and-trade program, and enjoining CARB from any further cap-and-trade rulemaking until it had complied with applicable law), amended by Cal. Air Res. Bd. v. Ass'n of Irritated Residents, No. A132165 (Cal. Ct. App. June 24, 2011) (order granting writ of supersedeas) (staying the injunction issued by the trial court while the California Court of Appeal hears and decides on its merits the state's appeal of the trial court's decision); Lisa Weinzimer & Geoffrey Craig, *Delaying California GHG Cap-and-Trade Regime a Year Draws Support from Stakeholders*, Electric Util. Wk., July 4, 2011, at 11.
12. *See* Steve Everly, *Missouri's Solar Rebate Program is in for Some Changes*, Kan. City Star, Aug. 5, 2011, *available at available atit Weea GHG lders,"*http://www.kansascity.com/2011/08/05/3059870/missouris-solar-rebate-program.html (discussing a recent case in which the county circuit court found Missouri's rebates for solar energy systems unconstitutional, before the presiding judge set aside his own decision the following month).
13. Joel H. Mack et al., *All RECs Are Local: How In-State Generation Requirements Adversely Affect Development of a Robust REC Market*, Electricity J., May 2011, at 8, 9–10, 19–20.
14. *Indeck Corinth, L.P. v. Paterson* resulted in a settlement with the state of New York in which the ConEdison Company agreed to pay the plaintiff cogeneration project for the cost of its additional carbon allowances through the end of its pre-existing long-term contracts. Indeck Corinth, L.P. v. Paterson, No. 10-E-0025, 2010 WL 2021947, (N.Y.P.S.C. May 18, 2010) (order approving tariff filing). The settlement allows ConEdison to ask the New York Public Services Commission to pass on the cost of these allowances—which may reach $15 million by 2016—to utility customers. Brian Nearing, *$7.7M Ends Global Warming Case,* Times Union (Albany), Dec. 24, 2009, *available at* http://www.timesunion.com/default/article/7-7M-ends-global-warming-case-559869.php. In addition to the Indeck project, the Brooklyn Navy Yard Co-Generation Project and Selkirk Cogen Partners also received similar settlements, shifting the economic impact of their activities to ConEdison and/or its ratepayers. *Id.*
15. PJM Interconnection, L.L.C. v. PJM Interconnection, L.L.C., 135 FERC ¶ 61,022 (2011), *modified*, PJM Interconnection, L.L.C. v. PJM Interconnection, L.L.C., 135 F.E.R.C. ¶ 61,228 (2011).
16. *American Tradition Institute v. State of Colorado (Constitutionality of Renewable Energy Standards)*, Am. Tradition Inst., http://www.atinstitute.org/american-tradition-institute-v-state-of-colorado-constitutionality-of-renewable-energy-standards/ (last visited Jan. 8, 2011).
17. *See* Robert Glennon & Andrew M. Reeves, *Solar Energy's Cloudy Future*, 1 Ariz. J. Envtl. L. & Pol'y 91, 95 (2010).
18. *Id.* at 101.
19. *Where is Earth's Water Located?*, U.S. Geological Survey, http://ga.water.usgs.gov/edu/earthwherewater.html (last updated Feb. 8, 2011).
20. *Id.*
21. Glennon & Reeves, *supra* note 17, at 95 n.27; *See* U.N. Food & Agric. Org., Review Of World Water Resources by Country 19, 78–82 (2003) *available at* ftp://ftp.fao.org/docrep/fao/005/y4473E/y4473e00.pdf.
22. Glennon & Reeves, *supra* note 17, at 100 tbl.1, 103, 103 nn.76–77, 104 n.2, 105.
23. *Id.* at 103.
24. *Id.* at 105.
25. *Id.* at 127 (citing U.S. Energy Info. Admin., DOE/EIA-0348(2008) Electric Power Annual 2008, at tbl.ES1 (2010), *available at* http://www.eia.gov/FTPROOT/electricity/034808.pdf (showing less than 20% efficiency of installed solar capacity)).
26. *Id.* at 101 n.64.
27. *See id.* at 120–21 & n.211.
28. *See* Heidi N. Moore, *Federal Money for Alternative Energy is Drying Up*, N.Y. Times, Dec. 14, 2010, *available at*: http://dealbook.nytimes.com/2010/12/14/federal-money-drying-up-for-alternative-energy/.
29. *Id.*
30. Glennon & Reeves, *supra* note 17, at 111.
31. *Id.* at 124 n.232.
32. Jay Lindsay, *FINALLY: Decision on Cape Cod Wind Project Due This Month*, Bus. Insider, Apr. 15, 2010, *available at* http://www.businessinsider.com/decision-on-cape-cod-wind-project-due-this-month-2010-4; Tom Zeller, Jr., *California Renewable-Energy Initiatives Defeated*, N.Y. Times, Nov. 5, 2008, *available at* http://green.blogs.nytimes.com/2008/11/05/california-renewable-energy-initiatives-tank/; *Cape Wind Plan Draws Opposition*, OffshoreWind.biz (Mar. 1, 2011), http://www.offshorewind.biz/2011/03/01/cape-wind-plan-draws-opposition-usa/.
33. *See* Elisa Wood, *Congress Snubs Obama over Legacy Energy Bill*, RenewableEnergyWorld.com (Sept. 14, 2010), http://www.renewableenergyworld.com/rea/news/print/article/2011/03/congress-snubs-obama-over-legacy-energy-bill.

renewable energy;[34] how to cost-effectively connect remote renewable power sources to the grid and who should pay to do so;[35] conflicts between and uncertainty surrounding relevant federal and state jurisdictions;[36] consumer and regulatory skepticism about the effects of dynamic pricing of electricity on consumers;[37] and the limits of current federal and state authority.[38] This article will delve into the nuances of these challenges in Part II.

B. Energy Conservation and the Law

Energy efficiency and conservation occupy the opposite side of the energy equation from renewable-energy options: The former uses power more efficiently,[39] while the latter produces power without burning traditional fossil fuels.[40] Energy conservation and efficiency improvements are not intermittent,[41] unlike some renewable sources of supply,[42] and are among the most cost-efficient ways to make existing power systems serve a greater demand.[43] While renewable-energy incentives have hit legal and constitutional impediments,[44] and renewable energy faces the drawback of relatively high costs,[45] energy conservation remains the nonsubsidy, consumer-side option.[46] This is true of energy conservation because conservation and a "smarter" grid meet none of the legal and policy challenges confronting certain renewable programs that states have implemented:[47]

- Conservation programs do not attempt to regulate the price or terms of power markets,[48] so they do not implicate the Federal Power Act, which does not cover or restrict conservation.[49] Conservation on the customer side of the meter implicates neither the wholesale nor the interstate sale of power,[50] and therefore, no jurisdictional provisions of the Federal Power Act are triggered.[51]
- Energy efficiency delivers the capital investment on the customer/rate payer side of the meter,[52] which is generally within state rather than federal jurisdiction.[53]
- The winners and losers of public subsidies for efficiency projects are dispersed and not selectively limited to project developers,[54] as are some renewable subsidies.[55]
- There is a history of shared federal and state legal authority over energy efficiency and different parts of the grid.[56]

Energy conservation is the ultimate universal, near-term, shovel-ready option. First, in contrast to the development of some renewable technologies, because conservation is implemented in myriad dispersed locations on the *consumer* side of the meter,[57] it does not require the high initial capital costs of permitting before being implemented.[58] Second, energy efficiency serves flexible purposes and thus has ongoing longevity.[59] For example, after the Republican victories in the 2010 Congressional election, energy efficiency advocates shifted their strategy from promoting efficiency as a way to cut greenhouse gases and boost renewable energy, to instead focusing on efficiency's ability to cut waste.[60] Third, energy conservation and efficiency efforts are crucial to achieving larger, more popular environmental goals.[61] As explained in the Executive Summary of New York's 2010 Climate Action Plan, controlling greenhouse gas emissions requires energy efficiency, greener buildings, renewable generation, and a smart grid:

> To meet this [climate control] goal, we must transform the way we make and use energy—we must maximize efficiency and make a major shift toward zero-[greenhouse gas] emissions in electricity generation, smart electric transmission and distribution systems, low-carbon buildings, and zero-emission vehicles, and increase options for alternative modes of travel and land use.[62]

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34. *See infra* Part II.C.2.
35. *See infra* Part II.D.1–2.
36. *See infra* Part II.D.2.
37. *See infra* Parts II.C.1, II.D.2.
38. *See infra* Part II.D.2.
39. *See infra* Part III.C.
40. *See* Ferrey et al., *supra* note 10, at 131 & n.14 (discussing wind turbines and solar power technologies that are the "renewable power options of choice").
41. *See, e.g.*, *infra* Part III.C.1–2.
42. *See infra* Part II.E.
43. *See* Ceres, The 21st Century Electric Utility: Positioning for a Low-Carbon Future, at iv (2010).
44. *See supra* notes 3–5 and accompanying text.
45. *See id.*
46. *See* Ferrey et al., *supra* note 10, at 168.
47. *See id.* at 158–64, 169, 174, 180–83, 195–202 (exploring the legal and policy challenges that can confront certain renewable energy programs when implemented at the state level).
48. *Compare infra* Part III.C.1–2 (discussing new conservation standards in the form of LEEDS and wasted energy recapture), *with* Ferrey et al., *supra* note 10, at 201–02 (discussing the legal obstacles, including those posed by the Federal Power Act, that certain state efforts to promote renewable energy have faced).
49. Federal Power Act of 2005, 16 U.S.C. § 824 (2006). *See* Ferrey et al., *supra* note 10, at 127 (discussing some state renewable energy programs that have attempted such regulation and problematically implicated the Federal Power Act).
50. *Compare infra* Part III.C.1 (discussing standards for the energy efficiency of new buildings and new major appliances), *with* Ferrey et al., *supra* note 10, at 180 (discussing the Federal Power Act's federal preemption of state authority over wholesale power sales and rates).
51. *See* 16 U.S.C. § 824; *infra* notes 605, 681, 687, 689 and accompanying text.
52. *See infra* Part III.B (discussing federal energy efficiency expenditures and programs).
53. 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, 612 (2004).
54. *See infra* Part III.B.
55. *See, e.g.*, Ferrey et al, *supra* note 10, at 135 (discussing the narrow range of renewable energy producers that qualify for the Federal Production Tax Credit, "which remains the cornerstone of federal policies supporting renewable energy").
56. *See infra* notes 114, 129 and accompanying text.
57. *See infra* Part III.B–C.
58. Ferrey et al., *supra* note 10, at 170.
59. *See* Bobby McMahon, *Advocates May Shift Strategy to Tout Cutting Waste*, Clean Energy Report, Dec. 10, 2010 (discussing ways in which efficiency advocates have changed their message in the wake of a changing political climate).
60. *Id.*
61. *See* N.Y. State Climate Action Council, Executive Summary New York State Climate Action Plan Interim Report 1–2 (2010) (discussing, in part, efficiency's role in reducing greenhouse gas emissions).
62. *Id.*

As another example of groups implementing efficiency efforts to help achieve larger climate-related goals, six midwestern states involved with a regional greenhouse-gas-reduction program are also likely to shift their efforts toward energy efficiency.[63]

In a 2010 report, Ceres, a nongovernmental organization, forecasted that greater implementation of smart-grid and energy-efficiency technologies was a key trend in the energy industry.[64] Such trends foresee both significant environmental changes regarding global warming mitigation and a fundamental shift in how the economy produces and utilizes electricity in a post-industrial economy.[65] The Ceres report foresees that, from a policy perspective, industry and consumers will have to pursue cost-effective increases in energy efficiency[66] and incorporate smart-grid technologies.[67] As specific means to meet these practical changes, Ceres suggests that, to achieve the necessary energy efficiency, industry and consumers must decouple utility revenues from volumetric sales using incentive ratemaking.[68] In addition, they must realize that efficiency measures cost only about $0.03 per kilowatt–hour of energy saved, while the alternative of producing new electricity costs $0.06 to $0.12 per kilowatt–hour produced.[69]

Changes that ultimately revamp basic technology[70] are not made easily or seamlessly within a democratic political and constitutional legal system.[71] Yet, there are at least two potentially compatible ways to effect fundamental change in our country's energy use: by becoming more efficient, and by becoming less dependent on traditional, nonrenewable fossil fuels.[72] The choice among these options has become more than just a policy preference, since efforts to decrease dependence on fossil fuels have run headlong into legal barriers.[73] Before examining these legal barriers and energy efficiency, the following section illuminates what a smart grid is and then follows the flows of money that have attempted to transform infrastructure to sculpt the legal form of the new energy future.

II. Developing the Smart Grid and Sources of Renewable Energy

A. *Understanding the Role of the Electricity Grid and the Nature of the New "Smart" Grid*

"A smart grid, like cell phones or the Internet, is socially transformational technology and will change the human experience with electricity."[74] Yet, before one can understand the nature of a smart grid, one must have a basic understanding of the role of a "grid"—"smart" or otherwise—in an electricity network. As I have previously noted:

> The grid is the mechanism that conducts power through the interconnected U.S. power network, is dispatched and managed, and thereafter is available to meet electric power requirements in North America. The *grid* is composed not only of approximately 4,800 interconnected power generation resources in the United States, but also of planned more dispersed power generation resources, efficiency capabilities, and self-generation resources. As well, it includes the cable to connect them with consumers, and the human intervention and smart hardware to manage them in an energized instantaneous network. One does not function without the other in a centralized, regional grid, which characterizes a modern power network.[75]

A smart grid is an electricity network integrated with the internet.[76] It utilizes modern information and communication technology to monitor and control electricity sources, sinks, and flow through the network in nearly real time.[77] Smart-grid infrastructure may include sensors that detect fluctuations in load and supply, switches that route electric currents to regions of high demand and around zones experiencing disturbances, dispatch controllers that start up generating facilities as needed, load controllers that turn down smart appliances as necessary, and smart meters that record electricity use.[78] Information flows through anadvanced metering infrastructure that includes smart meters and a communications network operating in both directions between the supplier of electricity and the consumer's meter.[79] This infrastructure provides access to real-time information on the electricity consumption of each customer.[80] In-home information displays will provide real-time electricity con-

63. *Election Shifts MidWest Focus to Clean Energy: Away from Cap and Trade*, Carbon Control News (D.C.), Dec. 13, 2010.
64. *See* Ceres, *supra* note 43, at i, vi–vii.
65. *Id.* at iv.
66. *Id.* at ix.
67. *Id.*
68. *Id.* at 32.
69. *Id.* at iii.
70. *Cf. Welcome, Smart Meters. Will Smart Devices and Prices Follow?*, Electricity J., Aug.–Sept. 2010, at 3 [hereinafter *Welcome, Smart Meters*] (discussing the advantages that newer "smart meters" have over old spinning-disk meters).
71. *See, e.g.*, Karl Coplan, *Is Democracy Bad for the Environment? Some Thoughts about REINS*, Green L. (Feb. 4, 2011), http://greenlaw.blogs.law.pace.edu/2011/02/04/is-democracy-bad-for-the-environment-some-thoughts-about-reins/.
72. *See infra* Part III.
73. *See infra* Part II.D.2.
74. Ashley Brown & Raya Salter, Smart Grid Issues in State Law and Regulation 32 (2010), *available at* http://www.deweyleboeuf.com/en/Firm/MediaCenter/PressReleases/2010/10/~/media/Files/pressreleases/2010/20101021_SmartGridIssuesinStateLawandRegulation.ashx.
75. Steven Ferry, Unlocking the Global Warming Toolbox: Key Choices for Carbon Restriction and Sequestration 149 (2010).
76. *See* Hermione Crease, *Electricity 2.0: Smart Grid Will Bring Internet-Like Energy Revolution*, Greenbang (Feb. 3, 2010), http://www.greenbang.com/electricity-2-0-smart-grid-will-bring-internet-like-energy-revolution_13536.html.
77. *See* Ferrey, *supra* note 75, at 157.
78. *See* Rob van Gerwen, Saskia Jaarsma, & Rob Wilhite, Leonardo Energy, Smart Metering 2, 4 (2006), *available at* http://www.helio-international.org/projects/SmartMetering.Paper.pdf.
79. *See* Jay Cline, *Will the Smart Grid Protect Consumer Privacy?*, Computerworld (Nov. 17, 2009, 5:00 PM), http://news.idg.no/cw/art.cfm?id=0323F828-1A64-6A71-CE28C8EF148325D4.
80. *See id.*

sumption data to the consumer either over the Internet or to simple monitoring displays.[81] Consumers will then be able to log into their electric company's website to view energy usage and cost, outlet by outlet, in fifteen-minute increments.[82]

As explained above, there is much more to extant and future electric power grids than just wire and poles;[83] what the grid offers and delivers to the consumer more resembles an energizing service than a simple commodity.[84] The grid is "a constantly replenished energized network"[85] and requires "[a] constant simultaneous balancing of supply and demand,"[86] in a setting where "[p]ower moves according to Kirchoff's Law almost at the speed of light."[87] The grid is much more like a living, virtual organism that has both the transmission and delivery functions of the physical grid, and the regulatory and incentivizing function that applies to various creators of moving current and its consumption.

The high-voltage transmission network was recognized as the most important engineering feat of the twentieth century.[88] The high-voltage transmission network, at 230 kilovolts and higher, comprises 167,000 miles of line in the United States.[89] Structurally, the U.S. grid is comprised of three main interconnections: the Eastern Interconnection, the Western Interconnection, and a separate interconnection that includes most of Texas.[90] There are, however, limited power transactions between these three major interconnections.[91] Adding further complexity, the transmission system operates at fifteen different voltage levels.[92] This is in contrast to some industrialized countries that have coordinated their transmission systems to operate at just a few voltage levels.[93]

The need for improved grid technology is paramount.[94] The efficiency of the U.S. energy transmission system has decreased with age.[95] In 1970, average line loss was five percent;[96] by 2001, average line loss had increased to nine percent as the transmission system's lines, transformers, and circuit breakers aged.[97] These losses have amounted to significant energy loss—even a seemingly small loss of four percent results in losses of 83 million megawatt–hours annually,[98] enough to power more than 6.5 million American homes for a year.[99]

Although adding capacitors or distributed generation at key points in the grid can help make significant efficiency improvements in distribution,[100] grid operators do not appear to be embracing this strategy.[101] For example, the New England grid has faced criticism for engaging in $11 billion in annual trades of electricity over wires built approximately forty years ago to serve a much more limited number of players in a tightly regulated utility environment.[102] Critics have described lingering grid technology, such as the "ubiquitous spinning disk meters," as "relics of Thomas Edison's days."[103] Aging is not an asset for the grid.

These spinning-disk meters, however, exist at a key location in the grid, separating the two basic sides of the grid.[104] First, there is the utility side of the grid, which is characterized by the distribution system for the electricity.[105] Since power cannot be efficiently stored, the utility side of the grid is a constant, instantaneous lifeline connection,[106] not unlike the hose from a scuba tank to the diver. Consumers must be continuously connected to this distribution system to receive electricity.[107] The second side of the grid is the consumer side, which encompasses the usage of the product.[108] Because of the inability to cost-effectively store electricity, the cost of this service, and its value to the consumer, vary based on the season and the time of day.[109]

The role of public funding is critical to the improvement of power transmission and meter technology—improvements that are crucial to nationwide energy-efficiency efforts. Let's follow the money to each side of the grid, first to the utility side and then to the consumer side.

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81. *See* van Gerwen et al., *supra* note 78, at 2-3.
82. Cline, *supra* note 79.
83. *See supra* note 75 and accompanying text.
84. *See* Steven Ferrey, *Inverting Choice of Law in the Wired Universe: Thermodynamics, Mass and Energy*, 45 Wm. & Mary L. Rev. 839, 916–17 (2004).
85. Ferrey, *supra* note 75, at 149.
86. *Id.*
87. *Id.* Kirchhoff's Law is also called Kirchhoff's first law, Kirchhoff's point rule, Kirchhoff's junction rule, and Kirchhoff's first rule. The principle of conservation of electric charge states 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. *See* Jon Pumplin, *Statement of Kirchhoff's Laws*, Mich. St. Univ., http://www.pa.msu.edu/courses/2000spring/phy232/lectures/kirchhoff/kirchhoff.html (last visited May 22, 2011).
88. Mason Willrich, *Electricity Transmission Policy for America: Enabling a Smart Grid, End to End* 5 (MIT Indus. Performance Ctr., Energy Innovation Working Paper 09-003, 2009).
89. Stan Mark Kaplan, Cong. Research Serv., R40511, Electric Power Transmission: Background and Policy Issues 2 & n.3 (2009), *available at* http://fpc.state.gov/documents/organization/122949.pdf.
90. *Id.* at 3 & fig.2 (providing a map of the interconnections).
91. *Id.* at 3.
92. Craig Cano, *Efficiency Should Be Viewed As Key Part of Entire Delivery System, Wellinghoff Says*, Electric Util. Wk., Dec. 13, 2010, at 18, 19.
93. *Id.*
94. *See, e.g.*, Willrich, *supra* note 88, at 12.
95. *See id.*
96. *Id.* Line loss occurs when power is dissipated as heat during power transmission due to conductor resistance. U.S. Energy Info. Admin., DOE/EIA-0562(00), The Changing Structure of the Electric Power Industry 2000: An Update 21 (2000), *available at* http://www.eia.gov/cneaf/electricity/chg_stru_update/update2000.pdf.
97. Willrich, *supra* note 88, at 12.
98. Cano, *supra* note 92, at 19.
99. *Department of Energy Offers $90.6 Million Conditional Commitment Loan Guarantee to Support Colorado Solar Generating Facility*, U.S. Dep't Energy, (May 10, 2011), http://www.doe.gov/articles/department-energy-offers-906-million-conditional-commitment-loan-guarantee-support-colorado (explaining that 2.5 million megawatt–hours of electricity is sufficient to power over 2 million homes in the United States).
100. *See id.* ("[T]he US currently has about 15 different transmission voltages compared with three for South Korea.")
101. *See, e.g.*, Lisa Wood, *New England Grid Is on "Borrowed" Time; Groups Warn It Will Soon Exceed Limits*, Electric Util. Wk., Jan. 14, 2008, at 1, 23.
102. *See id.* The article states that transmission inadequacy resulted in approximately $1.6 million in extra charges to consumers between 2003 and the publication date of the article. *Id.* Approximately seventy percent of U.S. transmission lines and transformers are at least twenty-five years old, and sixty percent of circuit breakers are more than thirty years old. *Id.*
103. *Welcome, Smart Meters*, *supra* note 70, at 3.
104. *See* U.S. Energy Info. Admin., *supra* note 96, at 15 (discussing the meter's role in the distribution, and in a limited sense, consumer use of electricity).
105. *See id.*
106. *See* Steven Ferrey, Environmental Law: Examples & Explanations 542 (5th ed. 2010).
107. *See* Ferrey, *supra* note 75, at 149.
108. *See, e.g.*, U.S. Energy Info. Admin, *supra* note 96, at 15.
109. *See infra* Part III.E (discussion of storage).

B. *Follow the Money*

Annual federal investment in energy research and development, measured in real 2005 dollars, amounted to approximately $7.7 billion in 1980, $4.1 billion in 1990, $3 billion in 2000, and $3.5 billion in 2008.[110] New transmission systems, which will both strengthen the grid and support renewable power deployment, could cost $100 billion.[111] The Joint Coordinated System Plan, a study commissioned by several power pools and ISOs of transmission capacity, predicted that a five percent wind-generation component by 2024 would require roughly 10,000 miles of new extra-high voltage transmission lines constructed at an estimated cost of $50 billion.[112] A more aggressive twenty percent wind-penetration target would require 15,000 miles of extra-high-voltage transmission lines constructed at a cost of approximately $80 billion.[113] The Brattle Group, a consulting firm,[114] estimates that it may take as much as $1.5 trillion to update the grid by 2030.[115]

President Obama has come out squarely in support of renewable energy and smart grid development. He has stated that he hopes to see smart meters in 40 million homes,[116] doubling U.S. capacity for renewable energy,[117] and hopes to see "a new electricity grid that lays down more than 3,000 miles of transmission lines to convey this new energy from coast to coast."[118] Walking the walk, President Obama announced that the Department of Energy has awarded $3.4 billion in stimulus funding to 100 smart-grid projects in forty-nine states.[119] These grants fund up to fifty percent of smart-grid projects involving advanced meters and other peak demand-reduction technologies.[120] In total, the federal government made available $11 billion for smart-grid grants and programs.[121] The American Recovery and Reinvestment Act ("ARRA") of 2009, better known as the stimulus package, allotted $4.5 billion to creating a better and more reliable electricity-delivery system,[122] with the majority directed toward expenditure within eighteen months.[123] The funds were allocated principally to the West and Great Plains regions, where more renewable-power resource-development projects are ongoing.[124] In the area of Texas serviced by the Electric Reliability Council of Texas ("ERCOT"), co-ops are using stimulus funding to install 6.5 million advanced meters.[125] Using a grant from the Department of Energy, the Midwest independent system operator ("ISO") transmission network has begun to install more than 150 synchrophasors in its system, monitoring the grid thirty times per second to measure voltage and current in the U.S. grid's Eastern Interconnection.[126]

In addition to those already noted, there are other sources of federal financial incentives and policy support bodies to encourage development of metering technology and transmission projects. First, the Obama Administration has created or extended several federal tax incentives. These include a thirty percent advanced-energy-facilities tax credit that applies to transmission- and grid-related new equipment[127] and a thirty percent investment tax credit for advanced energy manufacturing.[128] The Obama administration has also extended the renewable energy Section 45 production tax credit through 2012 for some renewable technologies and to 2013 for others.[129] Additionally, those who could claim the tax credit option may instead take a cash grant that mirrors the tax credit from the Treasury.[130]

Second, the ARRA also provides for $1.6 billion of Clean Renewable Energy Bonds, first created by the Energy Policy Act of 2005.[131] Third, certain transmission upgrades and

110. J. J. Dooley, Pac. Nw. Nat'l Lab., PNNL-17952, U.S. Federal Investments in Energy R&D: 1961–2008, at fig.3 (2008), *available at* http://www.greentechhistory.com/wp-content/uploads/2009/07/federal-investment-in-energy-rd-2008.pdf.
111. Nuel Navarrete, *U.S. Grid Needs $100 Billion for Renewable Energy Capability*, EcoSeed, Oct. 15, 2010, *available at* http://www.ecoseed.org/en/business-article-list/article/1-business/8218-u-s-grid-needs-$-100-billion-for-renewable-energy-capability.
112. *Study: Billions Needed to Deliver Wind Power to Eastern Interconnection*, Transmission & Distribution World, Feb. 9, 2009, *available at* http://tdworld.com/news/joint-coordinated-system-plan-wind-0209/. *See* Executive Summary Joint Coordinated System Plan 2008 Overview 7, 9, *available at* http://graphics8.nytimes.com/images/blogs/greeninc/jointplan.pdf.
113. *Study: Billions Needed to Deliver Wind Power to Eastern Interconnection*, *supra* note 112
114. *About the Brattle Group*, Brattle Group, http://www.brattle.com/AboutBrattle/Default.asp (last visited July 11, 2011).
115. U.S. Dep't of Energy, Smart Grid System Report, at vii (2009) (citing M. Chupka et al., Brattle Grp., Transforming America's Power Industry: The Investment Challenge 2010–2030 (2008)).
116. *See* 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 34.
117. The President's Weekly Address, *supra* note 3.
118. Cathy Cash et al., *Senate Tries a Push for Big-Picture Grid Plans, Though 'Shovel-Ready' Projects Still a Question*, Electric Util. Wk., Feb. 2, 2009, at 34.
119. Press Release, White House Office of the Press Sec'y, President Obama Announces $3.4 Billion Investment to Spur Transition to Smart Energy Grid (Oct. 27, 2009), *available at* http://www.whitehouse.gov/the-press-office/president-obama-announces-34-billion-investment-spur-transition-smart-energy-grid.
120. Press Release, White House Office of the Vice President, Vice President Biden Outlines Funding for Smart Grid Initiatives (Apr. 16, 2009), *available at* http://www.whitehouse.gov/the_press_office/Vice-President-Biden-Outlines-Funding-for-Smart-Grid-Initiatives.
121. *See* Tiernan & Ryser, *supra* note 116, at 1, 32.
122. American Recovery and Reinvestment Act (ARRA) of 2009, Pub. L. No. 111-5, div. A, tit. IV, 123 Stat. 115, 138–39 (2009).
123. *See* Cash et al., *supra* note 118, at 1, 35–36.
124. *See id.*
125. *See* Tom Tiernan, *Co-ops Aim to Identify Customer Benefits as They Deploy Funded Smart Grid Projects*, Electric Util. Wk., Aug. 9, 2010, at 21, 23.
126. Press Release, Midwest Indep. Transmission Sys. Operator, Inc., Grant Helps Install More than 150 Smart Grid Measurement Units in Midwest ISO (Apr. 2, 2010), http://tdworld.com/smart_grid_automation/miso-smart-grid-project-0410/.
127. *See President Obama Awards $2.3 Billion for New Clean-Tech Manufacturing Jobs*, U.S. Dep't Energy, http://www.energy.gov/recovery/48C.htm (last visited July 11, 2011).
128. *See Business & Utilities Tax Incentives*, U.S. Dep't Energy, http://www.energy.gov/utilities_tax_incentives.htm (last visited July 11, 2011); *Business Tax Incentives*, U.S. Dep't Energy, http://www.energy.gov/business_tax_incentives.htm (last visited July 11, 2011); *Government Tax Incentives*, U.S. Dep't Energy, http://www.energy.gov/government_tax_incentives.htm (last visited July 11, 2011).
129. Paul Schwabe et al., Nat'l Renewable Energy Lab., Technical Report NREL/TP-6A2-44930, Renewable Energy Project Financing: Impacts of the Financial Crisis and Federal Legislation 8 (2009), *available at* http://www.nrel.gov/docs/fy09osti/44930.pdf.
130. *Id.*
131. Energy Policy Act of 2005, Pub. L. No. 109-58, § 1303(a), 119 Stat. 594, 991–96 (2005) (codified as amended at I.R.C. § 54 (2006)); *see Business & Utilities Tax Incentives*, *supra* note 128; *Business Tax Incentives*, *supra* note 128; *Government Tax Incentives*, *supra* note 128.

extensions qualify for loan guarantees.[132] The ARRA allocates $6 billion to a loan guarantee program for renewable energy projects, which should support about $60 billion of renewable loans for renewable power and transmission projects.[133] Fourth, the ARRA included $3.25 billion in new borrowing authority for the Western Area Power Administration and the Bonneville Power Administration, both energy utilities, to invest in electric transmission grids.[134] Last, federal bodies are tasked with important policy research initiatives. For example, there exists a smart-grid subcommittee of the National Science and Technology Council, tasked with making recommendations for federal smart-grid policy.[135] The ARRA also required the Department of Energy to conduct a National Electric Transmission Congestion Study to analyze the legal challenges delaying the development of a better grid and to help determine how to allow constrained renewable resources reach the market through better transmission.[136]

ARRA stimulus funding has complemented innovative state programs to help develop metering usage and technology; New York currently offers competitive metering options, California and New York have sophisticated demand-response programs, and Pennsylvania has advanced meter penetration.[137] In Illinois, Commonwealth Edison, a Chicago utility, began an ambitious new smart grid pilot program that would have examined consumer use of smart meters and how their effectiveness changes based on the customer's rate structure.[138] Approximately 131,000 residential households were set to participate, and each household would have received one of twenty-four different combinations of technology and pricing structures.[139] The utility hoped to find the optimal combination of rate structures and smart meters that would provide the most cost-effective usage reductions.[140] However, the program's methods of calculating rates have been successfully challenged in state court,[141] frustrating implementation and development of the program.[142]

Although the Obama Administration devoted more than $3 billion to smart-grid grants,[143] implementation of federally funded projects has been sluggish.[144] FirstEnergy, a utility serving part of Ohio, delayed the roll-out of its smart-grid program when state regulators delayed the inclusion of a cost-recovery mechanism.[145] Additionally, smart-grid investments by utilities may face inaccurate depreciation schedules and controversy with regard to retail-cost allocation;[146] several states are implementing decoupling, rate caps, and other tools to mitigate the risk of utility-revenue loss from encouraging conservative power use.[147]

The sluggish application of federal stimulus funds has also been due in part to the fact that there are several requirements that must be met before a particular project is eligible for such funds. When considering whether or not to release stimulus funds for smart-grid projects, the Federal Energy Regulatory Commission ("FERC") must consider a host of issues, including interoperability with other systems, the security of the project, and whether the project maintains the reliability of the grid.[148] This process does come with some perks, however—a public utility applying for cost recovery will be allowed to undergo a single-issue ratemaking, meaning it will not have to reopen its entire rate base for review by FERC.[149] A public utility may use a single-issue rate proceeding to recover the costs associated with replacing jurisdictional legacy systems with jurisdictional smart-grid technologies.[150] In addition, the interim rate policy allows rate treatments that provide for accelerated depreciation and abandonment authority,[151] the latter of which may allow a public utility to recover the costs of certain abandoned smart-grid projects.[152]

Having generally discussed the flow of public money to certain elements that help comprise a smart grid, it is helpful to discuss in more detail the elements of the smart grid, and to determine just how "smart" it is. The next section addresses these issues.

C. *Exactly How Smart Is a Smart Grid?*

1. Smart-Grid Basics

Encompassing both the distribution and the consumer-spending sides of the utility meter, a "smart" grid has a variety of objectives. First, at the retail level, a smart grid

132. Loan Guarantee Program Office, U.S. Dep't of Energy, Solicitation No. DE-FOA-0000132, Loan Guarantee Solicitation Announcement: Federal Loan Guarantees for Electric Power Transmission Infrastructure Investment Projects 4 (2009), *available at* http://lpo.energy.gov/wp-content/uploads/2010/09/2009-CPLX-TRANS-sol.pdf.
133. Schwabe et al., *supra* note 129.
134. American Recovery and Reinvestment Act (ARRA) of 2009, Pub. L. No. 111-5, §§ 401–02, 123 Stat. 115, 140–41 (2009).
135. *National Science and Technology Council Establishes Subcommittee on Smart Grid*, SmartGrid.gov (July 12, 2010), http://www.smartgrid.gov/news/nstc_subcommittee (discussing establishment and purpose of subcommittee).
136. U.S. Dep't of Energy, National Electric Transmission Congestion Study 2 (2009), *available at* http://congestion09.anl.gov/documents/docs/Congestion_Study_2009.pdf.
137. Brown & Salter, *supra* note 74, at 4.
138. Ben van Gils, *Pushing Ahead with the Smart Revolution*, Util. Unbundled, May 2010, at 8, 11–12.
139. *Id.* at 11.
140. *Id.*
141. Commonwealth Edison Co. v. Ill. Commerce Comm'n, 937 N.E.2d 685, 705 (Ill. App. Ct. 2010).
142. *ComEd Smart Grid Pilot Funding Killed by Appellate Court Ruling*, Transmission & Distribution World (Oct. 20, 2010, 2:30 PM), http://tdworld.com/smart_grid_automation/comed-smart-grid-court-ruling-1010/.
143. Press Release, White House Office of the Press Sec'y, *supra* note 119.
144. *See, e.g.*, Cleveland Electric Illuminating Co., Quarterly Report (Form 10-Q) 67 (2010), *available at* http://google.brand.edgar-online.com/EFX_dll/EDGARpro.dll?FetchFilingHtmlSection1?SectionID=7389749-478922-500169&SessionID=SNHoHeDu1Wnqz77 (discussing delays of one smart-grid program).
145. *See id.*; *see also* Ohio Edison Co., No. 09-1820-EL-ATA, 2010 WL 2715629, at *5–6 (Ohio P.U.C. June 30, 2010) (order approving FirstEnergy's application).
146. *See* Brown & Salter, *supra* note 74, at 4.
147. *Id.*
148. *See* NARUC/FERC Smart Grid Collaborative: Proposed Funding Criteria for the ARRA Smart Grid Matching Grant Program and the ARRA Smart Grid Demonstration Projects, *available at* http://www.ferc.gov/industries/electric/indus-act/smart-grid/FERC-NARUC-collaborative.pdf (last visited July 11, 2011); *State, Federal Regulators Offer Criteria for DOE Smart Grid Stimulus Funding*, Transmission & Distribution World, Mar. 26, 2009, *available at* http://tdworld.com/business/ferc-doe-smart-grid-stimulus-0309/.
149. *See* Smart Grid Policy, 74 Fed. Reg. 37,098, 37,109 (July 27, 2009).
150. *Id.* at 37,114.
151. *Id.* at 37,115.
152. *Id.*

is designed to establish better information flow to consumers regarding electricity consumption and costs.[153] Second, at the distribution level, it is designed to provide a mechanism to make the grid transmit power more efficiently in order to minimize power losses resulting from transmission inefficiencies.[154] Third, it is designed to make the grid capable of moving power over a more diverse area in order to provide redundant sources of supply.[155] This is an important factor because, as the grid is currently operated, power companies are often not aware of a power outage until customers complain, and "[b]etween 5% and 10% of power is lost in transmission."[156] "Because providers [cannot] easily detect demand fluctuations, power plants have to run at full capacity all the time, most burning carbon-emitting fossil fuels."[157] Finally, a smart grid is designed to make the grid as a whole less vulnerable to attack.[158]

The U.S. Department of Energy has stated that a smart grid needs to include five basic elements: (1) integrated communications for real-time information and control; (2) sensors and measurement technologies for monitoring and reporting line conditions; (3) advanced components, such as superconducting power cables; (4) advanced control and monitoring methods that make it possible to solve problems quickly and accurately; and (5) improved interfaces and decision-support tools.[159]

According to the Department of Energy, a smart grid provides a digital quality of power and more efficient use of supply resources.[160] The smart grid involves many pieces, but of particular import is an information-and-control loop at the delivery point of the grid, which then branches off into millions of consumer nodes.[161] Debate continues about whether the smart grid should be centrally controlled or should respond to consumer intervention.[162] Peak shaving of demand, electricity storage, and other similar controls remain among the smart grid's objectives.[163]

While advanced metering infrastructure only accounts for about 4.7% of all electric meters used for demand response,[164] it is projected that approximately 52 million more meters will be installed by 2012,[165] and some states and localities have concertedly pursued smart-grid development in recent years. For example, California has approved utility-system-wide advanced metering deployments for Pacific Gas & Electric ("PG&E"), San Diego Gas & Electric, and Southern California Edison—the three California private utilities.[166] In September 2009, at a time when these utilities had decoupled their rates, the California regulatory commission established an expedited review process for smart-grid funding.[167] Then, in October 2009, California enacted Senate Bill 17 to develop a smart grid.[168] Similarly, in Boulder, Colorado, Xcel Energy and its utility subsidiary, Public Service Company of Colorado, have been working to turn Boulder into a smart-grid city at costs shouldered by ratepayers.[169]

Despite the strength of public and private proponents of smart-grid development, efforts to implement smart metering have led to conflicts with customers.[170] For example, because of consumer resistance,[171] a large number of the meters installed are not being used to establish the billing relationship.[172] A FERC study found that, in 2008, only slightly more than one percent of all customers received a dynamic pricing tariff, nearly all of which were time-of-use tariffs.[173] Customers have put up resistance to smart-grid development across the country. A group of customers in Maine petitioned the Maine Public Utilities Commission to halt smart-meter installation while it investigated health and safety issues associated with smart meters.[174] Additionally, out of concern for consumer impacts and opposition to time-sensitive rates, customers have voiced opposition to smart meters in California,[175] Maryland (where only six percent of customers elected to stay on this option, causing the Public Utilities Commission to stop implementing the smart-grid project entirely),[176] Colorado,[177] Texas,[178] and Connecticut.[179] Maryland has subsequently slowed down the installation of smart meters.[180]

In California, the public anger toward smart meters has created public-relations hurdles for California utilities.[181] The director of PG&E's smart-meter program was forced to resign after it was revealed that he used an alias to participate in online discussions with opponents of the program.[182]

153. *See* Energy Independence and Security Act (EISA) of 2007, 42 U.S.C. § 17,381(8) (Supp. I 2007).
154. *See id.* § 17,381(5).
155. *See id.* § 17,381(3), (4).
156. *See* Russell Kay, *QuickStudy: The Smart Grid*, Computerworld, May 11, 2009, http://www.computerworld.com/s/articles/print/338125/The_Smart_Grid.
157. *Id.*
158. *See* 42 U.S.C. § 17,381(1)–(2).
159. *See, e.g.,* U.S. Dep't of Energy, The Smart Grid: An Introduction 29 (2008), *available at* http://www.oe.energy.gov/SmartGridIntroduction.htm; Kay, *supra* note 156.
160. *See* U.S. Dep't of Energy, *supra* note 159, at 10–13.
161. *See id.*; Kay, *supra* note 156 (discussing the two-way communicative nature of the smart grid).
162. *See* U.S. Dep't of Energy, *supra* note 159, at 12.
163. *See infra* Part III.E.
164. U.S. Dep't of Energy, *supra* note 115, at vi.
165. *Id.*
166. *See* Cal. Pub. Utils. Comm'n, Smart Grid in California 2–3 (2008), *available at* http://www.epa.gov/statelocalclimate/documents/pdf/zafar_presentation_electricity_grid_12-17-2008.pdf (slide presentation).
167. Brown & Salter, *supra* note 74, at 32,.
168. *Id.* at 33.
169. *Id.* at 10.
170. *See, e.g.*, Ethan Howland, *CMP Urges Maine Regulators to Reject Request for Probe of Smart Meter Health Concerns*, Electric Util. Wk., Nov. 22, 2010.
171. *See, e.g.*, AARP et al., The Need for Essential Consumer Protections: Smart Metering Proposals and the Move to Time-Based Pricing (2010), *available at* http://www.nasuca.org/archive/White%20Paper-Final.pdf.
172. U.S. Dep't of Energy, *supra* note 115, at vi.
173. *Id.*
174. AARP et al., *supra* note 171, at 24 n.29.
175. *See The Need to Get Smarter on Smart Grid Projects*, Electricity J., Oct. 2010, at 1, 2.
176. *See* Barbara Alexander, *Dynamic Pricing? Not So Fast! A Residential Consumer Perspective*, Electricity J., July 2010, at 39, 42.
177. *See The Need to Get Smarter on Smart Grid Projects*, *supra* note 175, at 1, 2.
178. *See* Joshua Z. Rokach, *Unlocking the Smart Grid*, Electricity J., Oct 2010, at 63, 68.
179. *Id.*
180. *See* Tom Tiernan, *Slowdown on Meters, Maryland PSC Says, Telling PEPCO 'Education' Plan Needs OK First*, Electric Util. Wk., Jan. 17, 2011.
181. *See* Lisa Weinzimer, *PG&E Photographed Smart Meter Protests, Marking Another Potential Misstep in Program*, Electric Util. Wk., Dec. 20, 2010, at 33.
182. Lisa Weinzimer, *PG&E Smart Meter Director Resigns After Using Alias in Online Chat with Meter Opponents*, Electric Util. Wk., Nov. 15, 2010.

Protests against PG&E's smart-meter program led to questions about the propriety of the program, including concerns about remote disconnections and health impacts.[183] That skepticism spread to lawmakers who held hearings on the smart-meter demonstrations.[184] One consultant concluded that distrust of smart meters had "reached a boiling point in California."[185]

Critics have argued that because a smart grid and time-sensitive dynamic pricing reflect wholesale marginal pricing at peak times, these mechanisms will "expose households to the unregulated prices charged by the most expensive generation supply resource in the wholesale market," and will lead to a "customer revolt against the 'Smart Grid' agenda."[186] Some critics argue that dynamic pricing inappropriately shifts the burden from utilities, which manage supply resources, to residential consumers in order to dampen their demand.[187] Critics in this camp believe that utilities are better able to respond to prices set in an increasingly competitive wholesale market.[188]

Questions remain about whether initial savings from dynamic-pricing programs will continue to motivate consumer behavior after the first year, and whether dynamic pricing results in a savings in total energy use (through either conservation or efficiency), or just a shift in the time of usage.[189] Particular problems may occur for low-income customers who have less flexibility to respond to dynamic price signals by reducing their usage.[190] Yet, even if low-income consumers are not able to purchase newer time-sensitive appliances in response to dynamic rates,[191] inexpensive plug devices are becoming available that are programmed to shift operation in response to various inputs.[192] Moreover, reducing peak-time demand reduces prices for all in the system.[193]

2. Defining the New "Smart" Grid

The regulatory definition of a smart grid is not precise, has varied over time, and has encompassed both sides of the utility meter.[194] The Energy Independence and Security Act ("EISA") of 2007 identified the following ten aspects of a smart grid:

(1) Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid.

(2) Dynamic optimization of grid operations and resources, with full cyber security.

(3) Deployment and integration of distributed resources and generation, including renewable resources.

(4) Development and incorporation of demand response, demand-side resources, and energy-efficiency resources.

(5) Deployment of "smart" technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation.

(6) Integration of "smart" appliances and consumer devices.

(7) Deployment and integration of advanced electricity storage and peak shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.

(8) Provision to consumers of timely information and control options.

(9) Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.

(10) Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.[195]

A year after Congress passed EISA, FERC identified the following "components" of the smart grid in its 2008 staff report on demand-side response and metering: advanced metering technologies, dynamic pricing programs, and demand-response programs (already in place for eight percent of U.S. customers).[196] The 2008 staff report stated that through regulation of regional transmission organizations ("RTO") and ISOs, FERC can ensure comparable treatment of demand-response resources in ancillary service markets, allow these resources to bid into the organized energy market, and reflect the contributions of lost load during an operating reserve shortage.[197] FERC Order 719, issued in October of 2008, requires ISOs and RTOs to accept fees from demand-side management ("DSM") demand-response resources for ancillary services, eliminate certain charges to buyers who voluntarily reduce demand during system emergencies, allow

183. Weinzimer, *supra* note 181.
184. Lisa Weinzimer, *Reappointed CARB Chief Says Agency Faces Intense Pressure over GHG Plan*, Electric Util. Wk., Jan. 10, 2011, at 3, 4.
185. *Id.* at 4.
186. Alexander, *supra* note 176, at 40.
187. *See id.*
188. *Id.*
189. *See* Tex. Comptroller of Pub. Accounts, The Energy Report 311 (2008), *available at* http://www.window.state.tx.us/specialrpt/energy/pdf/96-1266EnergyReport.pdf.
190. Nancy Brockway, Nat'l Regulatory Research Inst., Pub. No. 08-03, Advanced Metering Infrastructure: What Regulators Need to Know about its Value to Residential Customers 30 (2008), *available at* http://sites.energetics.com/MADRI/toolbox/pdfs/vision/Brockway_on_AMI.pdf.
191. *Cf. id.* at 58 (noting that low-use customers "tend not to have or use the high-draw appliances").
192. *See, e.g.*, *GreenPlug Energy Saver*, Amazon.com, http://www.amazon.com/Greenplug-a1-GreenPlug-Energy-Saver/dp/B000FFSLRY (last visited July 14, 2011).
193. *See* Brockway, Nat'l Regulatory Research Inst., *supra* note 190, at 32.
194. *See infra* notes 195–196.
195. Energy Independence and Security Act (EISA) of 2007 § 1301, 42 U.S.C. § 17,381 (Supp. I 2007).
196. *See* Fed. Energy Regulatory Comm'n, 2008 Assessment of Demand Response and Advanced Metering: Staff Report i-ii (2008).
197. *Id.* at ii.

bidders to bid aggregated demand-response measures into the energy markets, and to allow market-rebalancing prices.[198]

In July 2009, FERC issued a policy statement on smart-grid technologies.[199] The statement prioritized the development of interoperability standards[200] and implemented an interim incentive rate policy to recover the costs of deployed smart-grid technologies and certain legacy systems made obsolete by such deployment.[201] The policy states that, even as limited by section 205 of the Federal Power Act,[202] FERC can adopt smart-grid standards for all electric-power facilities, including those facilities serving retail consumers whose service is typically regulated by states.[203]

Until FERC adopts smart-grid interoperability standards, a public utility seeking to recover smart-grid costs must make a filing under section 205 of the Federal Power Act, or it must file an application for a declaratory order, demonstrating four elements: (1) the smart-grid facilities must advance the modernization of the nation's electricity transmission and distribution to securely and reliably meet future demand growth; (2) the deployed technology must maintain compliance with FERC-approved reliability standards such that the grid's cybersecurity will not be compromised; (3) the applicant must have minimized the risk of stranded investment by relying on existing, widely adopted interoperability standards and technologies that are readily and quickly alterable; and (4) the applicant must share information with the Department of Energy Smart Grid Clearinghouse.[204]

Smart-grid plans, however, are not subject solely to the demands of federal standards.[205] Indeed, conflicts are developing between state and federal demands on smart-grid plans.[206] Ideally, there should be distinct state and federal jurisdiction.[207] FERC should control the transmission and sale of wholesale power, regulate the deployment of sensors that monitor power flow in the grid, and control the installation of storage technologies to back up power.[208] State commissions should then be responsible for approving the rates for recovery of meter costs, the rates for power, and whether those power rates are time-sensitive.[209]

In its fundamental meaning, smart distribution technology includes devices that can immediately detect outages on the grid, enable faster responses, reroute electricity as necessary, and improve the efficiency of grid operation.[210] New devices can report on the grid as a whole, instead of requiring controllers to monitor individual transmission-line conditions.[211] One study found that there could be a twenty-seven to forty-four percent reduction in peak demand from the implementation of these technologies accompanied by critical peak-pricing tariffs.[212] A smarter grid can accommodate more distributed resources and intermittent renewable power supplies on the system,[213] assuming those new renewable resources can be reached by the grid. Thus, when examining the benefits the smart grid offers with respect to renewable energy, it is worthwhile to ask whether these renewable sources actually can be reached by the grid.

D. Legal and Technological Challenges: Cost-Effectively Reaching Renewable-Power Systems

1. The Chicken and the Egg of Renewable Power

There is a chicken-and-egg problem concerning whether remote renewable power sources can be created without the construction of new transmission infrastructure to connect them to the grid.[214] This poses new challenges for the existing power grid.[215] The public is under pressure to pay for or subsidize some of these connection costs.[216] Issues of transmission infrastructure have existed ever since U.S. utility companies first chose to construct large baseload facilities—often located away from load centers—after World War II.[217] Extensive transmission infrastructure was necessary to move this power.[218]

Although renewable resources are distributed across the United States and the world, they are not distributed evenly,[219] requiring construction of new transmission corridors between areas that are rich and poor in renewable energy resources.[220] For example, many states east of the Mississippi River do not have any subregions with abundant wind resources.[221] Six states in the eastern United States have no subregions with at least 250,000 metric tons of currently available biomass

198. Wholesale Competition in Regions with Organized Electric Markets, 18 C.F.R. § 35 (2008).
199. Smart Grid Policy, 74 Fed. Reg. 37,098 (July 27, 2009)
200. *Id.* at 37,102.
201. *Id.* at 37,114.
202. Federal Power Act § 205, 16 U.S.C. § 824d (2006).
203. Smart Grid Policy, 74 Fed. Reg. at 37,102.
204. *Id.* at 37,112–13.
205. *See* Tom Tiernan, *Smart Grid Catch-22: Utilities Must Have Plans Even as Vital Standards Still Being Developed*, Electric Util. Wk., Nov. 22, 2010, at 2 (noting that there are both federal and state regulations relating to smart-grid development).
206. *See id.*
207. *Cf.* Rokach, supra note 178, at 63, 71 (discussing such an arrangement).
208. *See id.*
209. *See id.*
210. U.S. Dep't of Energy, *supra* note 159, at 3, 17, 29.
211. Matthew L. Wald, *For the Smart Grid, a "Synchrophasor"*, N.Y. Times (Apr. 1, 2010, 8:21 a.m.), http://green.blogs.nytimes.com/2010/04/01/for-the-smart-grid-a-synchophasor/.
212. Ahmad Faruqui & Sanem Sergici, Household Response to Dynamic Pricing of Electricity: A Survey of the Empirical Evidence 48 (2010), *available at* http://papers.ssrn.com/so13/papers.cfm?abstract_id=1134132.
213. U.S. Dep't of Energy, *supra* note 159, at 21.
214. Richard Piwko et al., *What Comes First?*, IEEE Power & Energy Mag., Nov.–Dec. 2007, at 69.
215. *See id.*
216. *Id.*
217. *What Is the Electric Power Grid, and What Are Some Challenges It Faces?*, U.S. Energy Info. Admin., http://tonto.eia.doe.gov/energy_in_brief/power_grid.cfm (last updated Oct. 20, 2009).
218. *Id.*
219. *See* Charles F. Kutscher, *Overview and Summary of the Studies, in* Tackling Climate Change in the U.S. 7, 20, 22, 25, 30 (Charles F. Kutscher ed., 2007).
220. *Cf.* Richard Piwko et al., *supra* note 214, at 69 ("[Wind developers] find it necessary to locate wind plants in less-attractive wind regions that are closer to existing transmission lines with available capacity.").
221. Kutscher, *supra* note 219, at 22.

annually.[222] These states have relatively dense populations[223] and significant electricity demand.[224] In theory, such states could rely on energy efficiency to meet energy needs instead of creating additional generation capacity.[225] Yet, unless this potential is achieved to a sufficient degree, incorporation of remote renewable energy into the grid will require new transmission corridors between resource-rich generation sites and load centers.[226]

Major electrical-power companies have already begun to invest in transmission construction to connect renewable energy to the grid. For example, Southern California Edison looked to spend approximately $5.5 billion on transmission projects between 2008 and 2013 in order to add about 7,000 megawatts of renewable generation to its system.[227] Texas utilities spent a similar amount to bring their competitive renewable energy resources to market.[228]

As for who should pay for such new corridors, transmission-cost allocation depends on whether policymakers view energy transmission as a private or public good,[229] and whether the cost to be allocated is large.[230] The Joint Coordinated System Plan, representing several ISOs and reliability councils in the United States, found that achieving five percent wind generation by 2024 would require approximately 10,000 miles of additional high-voltage transmission lines at an estimated cost of $50 billion.[231] Achieving twenty percent wind generation would require 15,000 miles of transmission lines costing approximately $80 billion.[232]

2. Jurisdictional Challenges and Other Conflicts and Obstacles that Hinder the Connection of Renewable Power to the Grid

Energy transmission is subject to federal, rather than state, jurisdiction.[233] "[F]ederal regulation of intrastate power transmission may be proper because of the interstate nature of the generation and supply of electric power."[234] Federal jurisdiction controls the interconnection between the transmission and the distribution systems.[235]

Yet despite this historically clear realm of federal jurisdiction, state challenges to it are developing.[236] While states are making demands for smart-grid plans, the federal government is simultaneously making different demands and developing national smart-grid standards at the National Institute of Standards and Technology.[237]

FERC Order No. 2003-A recognizes that some general rules for bringing sources of power onto the grid do not work for location-constrained resources.[238] FERC acknowledges that power generators seeking to transmit or sell energy at wholesale prices in interstate commerce have often been able to choose where to interconnect and will do so in an economically efficient manner that minimizes the costs of interconnection.[239] In contrast, location-constrained renewable resources, like wind- and solar-based generation sources, "have an immobile fuel source, are small in size relative to the necessary interconnection facilities, tend to come on line incrementally over time, and are often remotely located from loads."[240] "Location constrained resources therefore have a limited ability to minimize their interconnection costs and, moreover, these factors can, in certain circumstances, impede the development of such resources altogether."[241] As FERC implicitly recognized, a transmission solution is necessary to efficiently bring these renewable, location-constrained resources onto the grid in accordance with public-policy initiatives.[242]

In July 2011, FERC issued Order No. 1000, which requires that state public-policy determinations, including energy efficiency and renewable portfolio standards, be incorporated into regional transmission planning by RTOs and ISOs.[243] It requires that "generation, demand resources, and transmission be treated comparably in the regional transmission planning process."[244] Order No. 1000 concludes that the issue of cost recovery for nontransmission alternatives (such as demand response) is beyond the scope of the transmission-cost-allocation reforms for new facilities adopted in the Order.[245] Order No. 1000 goes beyond prior Order No. 890 by requiring public-utility-transmission owners to amend

222. *Id.* at 20, 25. These resources include agricultural residues, crops, wood residues, municipal discarded materials, and methane from landfills. Anelia Milbrandt, Nat'l Renewable Energy Lab., NREL/TP-560-39181, A Geographic Perspective on the Current Biomass Resource Availability in the United States 11 (2005), *available at* http://www.nrel.gov/docs/fy06osti/39181.pdf. With the exception of Florida, the eastern half of the United States is devoid of subregions capable of producing 6.0 kilowatt–hours per square meter per day with solar photovoltaic resources on south-facing structures and surfaces. *See* Paul Denholm, Robert M. Margolis & Ken Zweibel, *Potential Carbon Emissions Reductions from Solar Photovoltaics by 2030*, *in* Tackling Climate Change in the U.S., *supra* note 219, at 91, 94.

223. *See U.S. Population Density (By Counties)*, U.S. Census Bureau, http://www.census.gov/dmd/www/pdf/512popdn.pdf (last visited July 14, 2011).

224. U.S. Energy Info. Admin., State Energy Consumption Estimates 15 (2010), *available at* http://www.eia.doe.gov/states/sep_sum/html/pdf/rank_use.pdf.

225. *See generally infra* Part III.

226. *Cf.* Piwko et al., *supra* note 214, at 69.

227. Tom Tiernan, *Transmission Boom Calls for Reconsidering Cost Allocation Methods, Some Officials Say*, Power Markets Wkly., July 28, 2008.

228. *Id.*

229. Adrienne M. Ohler & Kristi Radusewicz, *Indirect Impacts in Illinois from a Renewable Portfolio Standard*, Electricity J., Aug.–Sept. 2010, at 65, 72.

230. *See* William F. Henze II, *Electricity: If We Want It Clean, Firm, and Cheap, We're Going to Have to Pick Two*, Electricity J., Nov. 2009, at 81, 85.

231. *Id.*

232. *Id.*

233. *See* FERC v. Mississippi, 456 U.S. 742, 755 (1982).

234. *Id.*

235. S. Cal. Edison Co. v. Pub. Utils. Comm'n, 124 Cal. Rptr. 2d 281, 285 (Ct. App. 2002).

236. *See* Tiernan, *supra* note 205, at 2 (discussing the varying state smart-grid plans).

237. *Id.*

238. *See* Cal. Indep. Sys. Operator Corp., 119 FERC ¶ 61,061, paras. 2, 64 (2007) (granting declaratory order).

239. Standardization of Generator Interconnection Agreements & Procedures, 69 Fed. Reg. 15,932, 15,985 (Mar. 26, 2004).

240. *See* Cal. Indep. Sys. Operator Corp., 119 FERC ¶ 61,061 at para. 64.

241. *Id.*

242. Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities, 75 Fed. Reg. 62,023 (Oct. 7, 2010) (to be codified at 18 C.F.R. pt. 35).

243. Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities, 76 Fed. Reg. 49,842, 49,845 (Aug. 11, 2011).

244. *Id.* at 49,956.

245. *Id.*

their open-access-transmission tariffs to consider transmission needs reflecting local public policy.[246]

This need for a transmission solution raises the question of whether it is the federal government or the states that can better regulate multistate energy projects. When renewable power from remote sources moves in interstate commerce, it justifies cooperation between regional and state regulators.[247] Constitutional concerns arise, however, if states form legal compacts to promote energy planning.[248] The Interstate Compact Clause of the U.S. Constitution provides that "[n]o State shall, without the Consent of Congress . . . enter into any Agreement or Compact with another State, or with a foreign Power."[249] Therefore, Congress must approve multistate compacts concerning power regulation in order for such agreements to be constitutional.[250]

Obtaining approval from Congress for a multistate compact, however, transforms state action into federal law,[251] which has its own legal consequences. Once the multistate compact becomes federal law, it can preempt state law, even if it discriminates against states or state programs, or conflicts with the state constitution.[252] A multistate compact that has become federal law is immunized against the dormant Commerce Clause, which prevents discriminatory state, but not federal, action.[253] Such multistate agreements can thus expose the states involved to potential suits in federal court regarding any disputed acts under the compact, because those acts would not be the act of a single sovereign state and the states' sovereign immunity would therefore not be implicated.[254]

Federal authority, like state authority, also has its legal limits. Environmental groups, for example, filed multiple suits against the federal government for failure to adequately assess greenhouse-gas impacts under the National Environmental Policy Act.[255] Similar challenges under the Endangered Species Act could follow.[256] In addition, the federal push for National Interest Energy Transmission Corridors under the Energy Policy Act of 2005[257] faced criticism for turning environmentally sensitive areas into energy corridors and for running what amounted to a giant extension cord to existing coal sources.[258] In one dispute, a federal appeals court blocked FERC from acting as a backstop and granting a federal permit for a new transmission line when the state had already denied a permit application within the applicable twelve-month deadline.[259] According to the court, so long as the state took some action, including denying the permit, FERC could not intervene.[260]

Aside from jurisdictional disputes, there are conflicts and differences of opinion regarding the division of costs for this expensive and extensive transmission infrastructure.[261] Texas, for example, allows cost recovery for transmission connections within Competitive Renewable Energy Zones at the expense of all consumers on the grid.[262] In the Midwest, a federal circuit court struck down a FERC order requiring all RTO members to equally share the costs for any large transmission lines, whether or not they benefited from the investment.[263] The court held that local utilities should not have to pay for transmission lines to transport power outside the region, a result that would widely socialize costs to all ratepayers, including those who would not directly reap the benefits of the investment.[264]

Differences in prices of renewable power between states have also sometimes posed a challenge to the adaptation of the grid to incorporate renewable power.[265] California offers special cost-sharing for transmission projects in "locationally constrained" or remote areas.[266] The California Power Utili-

246. *Id.* at 49,964 (to be codified at 18 C.F.R. § 35.28(c)(3)).

247. Steven Ferrey, *Goblets of Fire: Constitutional Impediments to the Regulation of Global Warming*, 35 Ecology L.Q. 835, 900–902 (2008).

248. *Id.*

249. U.S. Const. art. I, § 10, cl. 3.

250. Ferrey, *supra* note 247, at 900–901.

251. *See* Cuyler v. Adams, 449 U.S. 433, 440 (1981) ("[W]here Congress has authorized the States to enter into a cooperative agreement, and where the subject matter of that agreement is an appropriate subject for congressional legislation, the consent of Congress transforms the States' agreement into federal law under the Compact Clause.")

252. *See* Stephans v. Tahoe Reg'l Planning Agency, 697 F. Supp. 1149, 1152 (D. Nev. 1988) (dismissing plaintiff's takings claim based on the Nevada Constitution because the multistate compact as federal law preempted both state law and state constitutional provisions).

253. Prudential Ins. Co. v. Benjamin, 328 U.S. 408, 434 (1946); *see also* Hillside Dairy, Inc. v. Lyons, 539
U.S. 59, 66 (2003) (noting that Congress can also authorize states to discriminate against interstate commerce if it does so clearly enough); New York v. United States, 505 U.S. 144, 171 (1992) (noting the same); N.Y. State Dairy Foods, Inc. v. Ne. Dairy Compact Comm'n, 198 F.3d 1, 12 (1st Cir. 1999); Cent. Midwest Interstate Low-Level Radioactive Waste Comm'n v. Pena, 113 F.3d 1468, 1470 (7th Cir. 1997).

254. *See* Hess v. Port Auth. Trans-Hudson Corp., 513 U.S. 30, 52 (1994).

255. *See, e.g.*, Ctr. for Biological Diversity v. Nat'l Highway Traffic Safety Admin., 538 F.3d 1172, 1181 (9th Cir. 2008) (arguing that the final rules setting corporate average fuel economy standards for light trucks is arbitrary, capricious, and contrary to the Energy Policy and Conservation Act of 1975 because the benefit of carbon dioxide ("CO_2") emissions reduction was assigned zero value in the calculation of the costs and benefits of alternative fuel economy standards); Mid-States Coal. for Progress v. Surface Transp. Bd., 345 F.3d 520, 548–550 (8th Cir. 2003) (arguing that the environmental assessment failed to consider the effects on air quality that an increase in the supply of low-sulfur coal to power plants would produce); Border Power Working Grp. v. U.S. Dep't of Energy, 260 F. Supp. 2d 997, 1028 (S.D. Cal. 2003) (arguing that the environmental assessment failed to consider emissions of CO_2 and ammonia).

256. *See, e.g.*, Pac. Coast Fed'n of Fishermen's Ass'ns v. Gutierrez, 660 F. Supp. 2d 1122, 1183 (E.D. Cal. 2008) (contending that the biological opinion did not take into account data concerning global climate change); Natural Res. Def. Council v. Kempthorne, 506 F. Supp. 2d 322 (E.D. Cal. 2007) (same).

257. Energy Policy Act of 2005 § 1221, 16 U.S.C. § 824 (2006).

258. *See* Nada Culver, Wilderness Soc'y, West-Wide Energy Corridors: Overview/Key Points 2–3 (2009), *available at* http://wilderness.org/content/west-wide-energy-corridors-key-points (identifying major concerns with the West-wide Energy Corridors which include sources of renewable energy not being prioritized, the effects on adjacent lands being ignored, and sensitive species habitat and other vulnerable places being endangered).

259. Piedmont Envtl. Council v. FERC, 558 F.3d 304, 309–10 (4th Cir. 2009).

260. *Id.*

261. David Bloom, J. Paul Forrester & Nadav Klugman, *Current Conflicts in U.S. Electric Transmission Planning, Cost Allocation and Renewable Energy Policies: More Heat than Light?*, Electricity J., Dec. 2010, at 8, 9.

262. *See* Alborz Nowamooz, *Inadequacy of Transmission Lines: A Major Barrier to the Development of Renewable Energy*, 3 Envtl. & Energy L. & Pol'y J. 176, 178–79 (2008).

263. Ill. Commerce Comm'n v. FERC, 576 F.3d 470, 476–77 (7th Cir. 2009).

264. *Id.*

265. Press Release, Ariz. Corp. Comm'n, Regulators Reject "Extension Cord for California": Commissioners Reject Palo Verde to Devers II Power Line (May 30, 2007), http://energylegalblog.com/files/ACC_Press_Release_Devers_II_Vote.pdf.

266. Cal. Indep. Sys. Operator Corp., 2008 Summer Loads and Resources Operations Preparedness Assessment 9 (2008) (noting connection of remote resources).

ties Commission has estimated that requiring Californians to obtain thirty-three percent of their power from renewable resources by 2020 will necessitate an expenditure of roughly $115 billion for new transmission infrastructure.[267] The California Public Utilities Commission allowed Southern California Edison to spend $4.5 million of ratepayer money to identify renewable-resource zones and develop transmission plans to access resources in those zones in order to deliver power to load centers.[268] According to Southern California Edison's findings, these zones would tend to be in Nevada, Arizona, and southern California.[269] The Arizona Corporation Commission, however, rejected Southern California Edison's proposal to build a 230-mile power line to provide southern California with access to cheaper Arizona power, fearing that the exported power would increase costs to Arizona consumers.[270]

Another obstacle to development of interstate transmission lines to connect renewable power to the grid has also arisen over which states should pay for what. Traditionally, it has been the responsibility of the generator to construct the interconnection from generators to the existing transmission lines.[271] Yet this responsibility is not a given. For example, there is a plan to construct additional wind turbines in remote areas of Northern Maine and in Canada, where there is a robust wind regime and sparse population settlement, and therefore little resistance to the siting of power generation resources.[272] Massachusetts regulators, however, have shown skepticism about paying for new interconnections and power lines to Maine, despite the fact that these infrastructure developments would also transport wind power southward.[273] Reciprocally, the Maine Public Advocate opposed the new transmission line from Maine to load centers in southern New England states.[274] Maine utilities have also requested adders (allowed increases in rates) to their base return on equity for transmission facilities to move new renewable power from northern Maine.[275] In addition, there are ongoing disputes between states over whether new capacity on transmission lines must be made available on a competitive, open-access basis.[276]

Opposition to smart-grid plans within a particular state has also developed from within the state itself. In 2010, Maryland's Utility Regulatory Commission rejected the Baltimore Gas & Electric smart-grid plan as "untenable" and not "cost-effective or serv[ing] the public interest."[277] The plan involved almost $1 billion of proposed ratepayer-assessed expenditures for universal smart meters, two-way communication, and time-of-use pricing.[278] The Commission concluded that the plan would guarantee profit for the company and its shareholders and was motivated by the availability of funding from the American Recovery and Reinvestment Act.[279] The president of the Electric Consumers Resource Council, an industrial consumer group, commented on the Maryland decision, stating that governments should not "write a blank check, signed by ratepayers, to every utility in the nation . . . [for] a very costly smart grid, funded by immediately raising consumers' rates."[280]

The smart-grid rollout is encountering some legal and public-policy barriers in several places.[281] Even if the smart grid geographically reaches where it seeks to go, it remains questionable whether the combination of new and old power-generation resources will achieve the flexibility and balance to work together effectively—an issue explored in the section that follows.

E. *Intermittency of Renewable Power and Grid Reliability*

1. Balancing the Grid

To keep the grid in balance and operational, officials must find the proper mix of resources, not only for the primary production of power, but also to respond to the intermittency of a system dependent on renewable resources.[282] Renewable power introduces to the modern grid an "unparalleled degree of intermittency of power supply."[283] Furthermore, the new sources of renewable power are not going to be located where the traditional sources of centralized power have been located.[284] A slight mismatch in the supply and demand of electric power in California caused brownouts, billions of dollars of extra expense to consumers, and the recall of the Governor.[285] Thus, the failure to find the proper balance of

267. Lisa Weinzimer, *Let's Level with Ratepayers About High Costs of Renewables, California Regulator Says*, Electric Util. Wk., Nov. 16, 2009, at 25.
268. *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), www.docs.cpuc.ca.gov/published/NEWS_RELEASE/71776.htm.
269. *Id.*
270. Press Release, Ariz. Corp. Comm'n, *supra* note 265.
271. *See* Pub. Serv. Enter. Grp., The Role of Transmission in the Clean Energy Economy 1, 4 (2009) *available at* http://www.pseg.com/info/media/pdf/clean_energy_wp.pdf.
272. *See* D.L. Elliott et al., U.S. Dep't of Energy, DOE/CH 10093-4, Wind Energy Resource Atlas of the United States ch. 3 (1986), http://rredc.nrel.gov/wind/pubs/atlas/chp3.html; Governor's Office of Energy Independence & Sec., State of Maine Comprehensive Energy Plan 2008–2009, at 17, 18, 78 (2009), *available at* http://www.maine.gov/oeis/docs/OEIS%20Comp%20Energy%20Plan.pdf; *Canada*, Global Wind Energy Council, http://www.gwec.net/index.php?id=120 (last visited July 15, 2011); *see also* Beth Quimby, *$2 Billion Power Grid Upgrade Proposed*, Portland Press Herald (Me.), Aug. 3, 2008, at A1 (reporting Maine wind-farming project).
273. Jason Fordney & Lisa Wood, *Northeast Transmission Projects Embody Arguments About Who Should Pay for What*, Electric Util. Wk., Aug. 18, 2008, at 7.
274. Lisa Wood, *Solar Company Proposes Unique Project to Displace Need for 350 MW Maine Line*, Electric Util. Wk., Feb. 2, 2009, at 11.
275. *See* Cent. Me. Power Co., 135 FERC ¶ 61,153 (2009) (granting motion to lodge and dismissing rehearing requests).
276. Pub. Serv. Enter. Grp., *supra* note 271 at 1–2.
277. Tom Tiernan & Mary Powers, *Maryland Turns Down BGE Smart Grid Plan, Stirring Surprise and Concern, and Cheers*, Electric Util. Wk., June 28, 2010, at 1.
278. *Id.* at 24.
279. *Id.* at 25.
280. *Id.* at 25.
281. *See, eg.*, *id.*
282. Steven Ferrey, *Greening the Grid: Building a Legal Framework for Carbon Neutrality*, 39 Envtl. L. 977, 986 (2009).
283. *Id.* at 986.
284. Many renewable power resources, such as wind power, are located far from the load for power. See Piwko et al., *supra* note 214, at 69.
285. Steven Ferrey, *Soft Paths, Hard Choices: Environmental Lessons in the Aftermath of California's Electric Deregulation Debacle,* 23 Va. Envtl. L.J. 251, 262, 298

energy supply—including the implementation of new energy sources—and energy demand has major repercussions.[286]

Many renewable-power projects deployed today are wind or solar photovoltaic ("PV"), which, as previously noted, tend to supply intermittent power.[287] Such renewable sources are difficult to control in order to guarantee precise amounts of power.[288] A study by Cambridge Energy Research Associates found that wind-farm production does not strongly correlate with peak summer demand, and wind capacity is typically valued at only ten to twenty percent of its maximum rated capacity.[289] Renewable energy has also led to other concerns; when addressing FERC's proposal on interregional transmission planning and coordination, Exelon Corporation alleged that a joint ISO agreement "'caus[ed] a marked deterioration of operations at the seam' due to an influx of wind during off-peak periods."[290]

According to the U.S. Department of Energy, the technologies that constitute renewable power in the near and intermediate terms will be wind power and, to a lesser degree, solar power[291]—both of which are inherently intermittent.[292] Some commentators project that biomass and geothermal renewable-energy sources, which are not intermittent, could also play a role over time in diversifying the U.S. energy portfolio.[293] The U.S. Department of Energy forecasts that the United States could achieve twenty percent of its electricity from wind power by 2030.[294] New wind installations reached record highs in 2008 and 2009, in excess of 8,000 megawatts each year, or forty-two percent of all new generation additions.[295] As of 2010, there were 35,000 megawatts of wind-generator capacity installed in the United States.[296]

In 2011, the FERC Reliability Office director concluded the following about the ability of the current system to handle wind power: "[W]e can do 3% in the West, we can do 1% in the East and we can do 10% in Texas."[297] Due to their intermittent operation, wind- and solar-power projects (which do not have electric-storage capability) do not use transmission capacity of the grid efficiently across all hours of the day, thereby increasing transmission costs.[298] Such a growth of renewable resources puts pressure on grid electric-supply reliability and transmission costs.[299]

According to the North American Electric Reliability Corporation ("NERC"), which is responsible for overseeing the U.S. electricity-transmission grid, in the future, carbon regulation will also compromise grid reliability.[300] There is real debate about the extent to which sustainable resources could negatively affect reliability.[301] NERC has concluded that the renewable portfolio standards ("RPS") in the United States and Canada could cause early substitution from traditional coal-fired power to renewable power and simultaneously decrease grid reliability.[302]

With greater reliance on solar and wind power, unexpected disruptions in those resources impose new challenges on quickly starting conventional-peaking power-generation units.[303] The impact on existing systems is already manifest. For example, in Texas, ERCOT was unable to compensate for an unexpected drop of more than eighty percent in wind-power production with sufficient backup power resources.[304] "If the ambitious levels of renewable generation (mainly wind) established by RPS mandates are to be successfully integrated into electricity markets, policymakers and regulators will have to make sure that fast up- and-down-ramping generation resources are available as operating reserves to the grid operator."[305]

2. How Solar and Wind Renewable Power Fit in the Grid

Power can perform as baseload power or backup peaking power.[306] Intermittent renewable resources cannot sup-

(2004) [hereinafter Ferrey, *Soft Paths, Hard Choices*]; *see also* Ferrey, *supra* note 247, at 855.

286. *See* Ferrey, *Soft Paths, Hard Choices*, *supra* note 285.

287. Ferrey, *supra* note 282, at 986.

288. *See* Jennifer DeCesaro et al., *Wind Energy and Power System Operations: A Review of Wind Integration Studies to Date*, Electricity J., Dec. 2009, at 34–35.

289. *See* Jeffrey Ryser, *With Wind Power at Their Back, 13,000 at Conference Weigh Pros and Cons*, Electric Util. Wk., June 9, 2008, at 1, 32.

290. Reply Comments of PJM Interconnection, L.L.C. at 6, Transmission Planning and Cost Allocation by Transmission Owning and Operating Public Utilities, No. RM10-23-000 (FERC Nov. 12, 2010) (citation omitted), *available at* http://www.pjm.com/~/media/documents/ferc/2010-filings/20101112-rm10-23-000%20TX.ashx.

291. *See* U.S. Energy Info. Admin. DOE/EIA-0348(2009), Electric Power Annual 2009, at 2–4 (2011) *available at* http://www.eia.doe.gov/cneaf/electricity/epa/epa.pdf; Ferrey, *supra* note 282, at 987.

292. See U.S. Energy Info. Admin., DOE/EIA-0383(2006), Annual Energy Outlook 2006 with Projections to 2030, at 80 (2006), *available at* http://www.scag.ca.gov/rcp/pdf/publications/1_2006AnnualEnergyOutlook.pdf.

293. *See id.* at 56.

294. U.S. Dep't of Energy, DOE/GO-102008-2567, 20% Wind Energy by 2030: Increasing Wind Energy's Contribution to U.S. Electricity Supply (2008), *available at* http://www1.eere.energy.gov/windandhydro/pdfs/41869.pdf.

295. Housley Carr, *AWEA Reports a Record 8,358 MW of US Wind Capacity added in 2008*, Electric Util. Wk., Feb. 2, 2009, at 12.

296. *See* Timothy Gardner, *Wind Power Capacity Up in 2009*, Reuters, Jan. 26, 2010, *available at* http://www.reuters.com/article/2010/01/26/us-wind-power-capacity-up-in-idUSTRE60P36020100126.

297. Martin Coyne, *FERC Reliability Director Details Limits of FERC/NERV Process on Cybersecurity*, Inside FERC, June 27, 2011, at 9.

298. *See* Robert Mendick, *Firms Paid to Shut Down Wind Farms when the Wind is Blowing*, Daily Telegraph (London), June 19, 2010, *available at*, http://www.telegraph.co.uk/earth/energy/windpower/7840035/Firms-paid-to-shut-down-wind-farms-when-the-wind-is-blowing.html.

299. *See id.*; *see also* Ferrey, *supra* note 282, at 986.

300. *Public Utilities Fear that GHG Cuts Might Threaten Electricity Supply, Reliability*, Carbon Control News, July 28, 2008.

301. *See, e.g.*, Jeff Postelwait, *California Voters Reject Two Renewable Energy Propositions*, Power Engineering (Nov. 10, 2008), http://www.power-eng.com/articles/2008/11/california-voters-reject-two-renewable-energy-propositions.html.

302. *See* N. Am. Electric Reliability Corp., 2010 Long-Term Reliability Assessment 41 (2010), *available at* http://www.nerc.com/files/2010%20LTRA.pdf.

303. Ferrey, *supra* note 282, at 986.

304. *How Renewables Can Be Undermined by Intermittency*, Electricity J., June 2008, at 5, 6.

305. J. Nicolas Puga, *The Importance of Combined Cycle Generating Plants in Integrating Large Levels of Wind Power Generation*, Electricity J., Aug.–Sept. 2010, at 33, 42; *see also* Adrienne M. Ohler & Kristi Radusewicz, *Indirect Impacts in Illinois from a Renewable Portfolio Standard*, Electricity J., Aug.–Sept. 2010, at 65, 70–72 (discussing Illinois's RPS policy implemented in 2008).

306. *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).

ply reliable baseload power, because they are generally only available thirty to forty percent of the time.[307] Correspondingly, intermittent renewable resources are not valuable as reliable backup peaking power resources because they are frequently unavailable to fill a need or supplement peak power demand.[308] Yet, system operators will run intermittent renewable resources as much as possible, when available, "because their marginal cost of operation, with no fuel costs, is near zero."[309] Most ISOs, which dispatch the regional generation resources, dispatch these resources in an order that prefers the lowest cost of operation per unit.[310]

Wind and solar power will tend to replace different kinds of traditional, nonrenewable sources of energy. Wind power, not always available during peak hours,[311] will tend to displace typical coal baseload power. Solar PV units, which only generate energy during roughly twenty percent of the hours of the year,[312] will tend to displace typical on-peak, gas-fired, peaking-generation units.[313]

An expected increased share of U.S. power in the form of intermittent resources will reduce the reliability of the power grid as a system unless there are advances in power-storage technology.[314] The U.S. Department of Energy calculated that use of wind power for approximately twenty percent of total power generation can be accommodated on the grid without requiring additional storage or other mechanisms to accommodate intermittency;[315] this roughly equals the amount of backup reserve margin in regional power systems.[316] If system resource availability and reliability decreases, volatility and fluctuation of system operation will increase.[317] Consequently, there will be greater demand for backup power-generation resources.[318]

The electric-power grid must constantly balance supply with demand in order to keep the grid operational,[319] but such balance is not always possibly given current technology, leading to serious consequences.[320] If power supply does not respond and is deficient to instantaneous demand, the grid can shut down and black out large areas, as happened in the northeastern United States on August 14, 2003.[321] Moreover, the current grid configuration in the United States already features a significant shortfall of existing modern backup power resources, particularly backup resources that are either capable of operating on dual-fuel inputs or have quick-start capability.[322] During the past decade, peak demand has been growing more quickly than total electric demand.[323] Each of these factors will prove critical in a period when, as in recent periods, both the market-clearing price and the availability of sufficient generating capacity of fossil-fuel resources have been less reliable and more volatile.[324]

The New England grid-control area provides an interesting example of these phenomena. In 2008, New England's grid operator, ISO New England, had about 31,024 megawatts of rated summer generating capacity to serve a peak demand of 27,970 megawatts.[325] This, however, did not allow for the recommended fifteen to twenty percent surplus for equipment repairs and unit unavailability.[326] Moreover, the peak power demand has been increasing over time as a percentage of average demand.[327] In 1980, New England peak capacity was 154% of average load, which increased to 159% in 1990, and further increased to 175% in 2000.[328] Commentators predict that this peak will continue its upward trend.[329]

In New England, peak power resources amount to less than ten percent of total supply, even before the implementa-

307. Ryser, *supra* note 289, at 1, 32.
308. Ferrey, *supra* note 282, at 986.
309. *Id.*
310. *Id.* at 987–88. For a discussion of ISOs, see Steven Ferrey, Law of Independent Power: Development, Cogeneration, Utility Regulation § 10:87 (2011).
311. DeCesaro et al., *supra* note 288, at 34.
312. Thomas Casten & Jeffrey Smith, *Finding the Cheapest Clean Power Options*, Electricity J., Dec. 2009, at 71.
313. *See e.g.*, Ed Feo & Josh Ludmir, *Challenges in the Development and Financing of Offshore Wind Energy*, 14 Roger Williams U. L. Rev. 672, 676 (2009) (noting the current reliance on conventional generating plants as backup sources for offshore wind farms); Patrick R. Jacobi, Note, *Renewable Portfolio Standard Generator Applicability Requirements: How States Can Stop Worrying and Learn to Love the Dormant Commerce Clause*, 30 Vt. L. Rev. 1079, 1084–85 (2006) (noting that the intermittent nature of renewable energy sources necessitates the need for backup from facilities using fossil fuels).
314. *Cf.* Ferrey, *supra* note 310, § 2:20 (discussing the benefits of storage technologies to "overall system efficiency").
315. DeCesaro et al., *supra* note 288, at 34.
316. *Reliability Indicators: Planning Reserve Margin,* N. Am. Electric Reliability Corp., http://www.nerc.com/page.php?cid=4|331|373 (last visited July 15, 2011). Power systems typically operate with about a fifteen percent active reserve margin. *Id.*
317. *See* Ferrey, *supra* note 310, § 2:20. By not requiring the input of fossil fuels, commentators have suggested that renewables act as energy hedge instruments. Frank Graves & Julia Litvinova, *Hedging Effect Of Wind On Retail Electric Supply Costs*, Electricity J., Dec. 2009, at 44. As a conventional energy hedge instrument, however, the most deployed renewable resources do not fare well. *See id.* Wind resources are uncertain as to volume and timing, and they are also unreliable at peak times. *Id.* Wind becomes a more valuable hedge strategy when CO_2 and gas prices rise. *Id.*
318. *Cf.* Ferrey, *supra* note 310, § 2:20.
319. *Cf.* Ferrey, *supra* note 106, at 570 (discussing the widespread impact of the California electric grid in 2001 when supply failed to meet demand).
320. *See, e.g.*, Matthew L. Wald, Richard Perez-Pena & Neela Banerjee, *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 the northeastern United States).
321. *See generally id.*
322. *See* Ferrey, *supra* note 310, § 2:20.
323. Electric Power Research Inst., Assessment of Achievable Potential from Energy Efficiency and Demand Response Programs in the U.S. (2010–2030), at ix–x (2009).
324. *See, e.g.*, *NYMEX Settlement History*, Hess, https://www.hessenergy.com/reports/NymexSettlementReport.aspx (last visited July 15, 2011) (providing comparisons of monthly settlement prices for natural gas over a ten-year period).
325. FERC, New England Electric Market: Overview and Focal Points 5 (2009), *available at* http://www.ferc.gov/market-oversight/mkt-electric/new-england/elec-ne-reg-des.pdf.
326. *Id.* For current data on generating capability and demand, see *Generation and Resources*, ISO New Eng., http://www.iso-ne.com/genrtion_resrcs/index.html (last visited July 15, 2011).
327. *See* Braintree Electric Light Dep't, No. EFSB 07-1/D.T.E./D.P.U. 07-5, at 77 (Mass. Energy Facilities Siting Board Feb. 29, 2008), *available at* http://www.env.state.ma.us/dpu/docs/electric/07-5/efsb07-1/22908findec.pdf.
328. *See* Gordon van Welie, ISO New Eng., Ensuring Long Term Reliability of New England's Regional Electricity System 15 (2006), *available at* http://www.iso-ne.com/pubs/pubcomm/pres_spchs/2006/iso-ne_platts_gvw.pdf.
329. *See* ISO New Eng., 2006–2015 Forecast Report of Capacity, Energy, Loads, and Transmission 1–2 (2006), *available at* http://www.iso-ne.com/trans/celt/report/2006/2006_CELT_Report.pdf.

tion of renewable resources,[330] and this supply of peak power resources represents more than a fifty percent deficiency between peak need and supply.[331] The need for peak power resources in New England is 7,000 megawatts,[332] but only about 1,500 megawatts of non-pumped-storage peaking resources are available.[333] Counting pumped storage, there are about 3,000 megawatts of peak power resources.[334]

The source of New England's limited available peak power resources is also environmentally troublesome. They rely strictly on fossil fuel when dual-fuel capability is unavailable; only twenty percent of this peak power resource has dual-fuel capability.[335] More than half of the remaining eighty percent of power is generated by oil and gas fuel acting alone.[336] This is problematic because oil is more responsible for carbon dioxide ("CO_2") emissions per unit of power generated than is natural gas.[337]

The existing modern backup peaking capacity is dramatically short of where it needs to be, despite the fact that the system has enough resources in gross.[338] This shortfall is compounded by a lack of either dual-fuel or less-polluting gas-fuel alternatives.[339] After analyzing this situation, ISO New England concluded 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."[340]

Quick-start capability of backup peaking resources is important in an age of renewable power and carbon control. Most of the existing backup peaking capacity currently installed in the grid is not the newer aeroderivative quick-start technology.[341] Quick-start technology allows the generator to go from a cold start to full power production in less than ten minutes,[342] which falls within the shortest category for start time maintained by system operators.[343] Power is therefore nearly instantaneously available, avoiding the need to spin and operate the generator before consumers demand that power.[344] Conventional, non-aeroderivative generators take hours to bring their temperatures up gradually from a cold start, and similarly must slowly ramp down their temperatures when they shut down.[345] These "spinning," non-quick-start reserve units also expel a less contained profile of environmental emissions when operating at partial capacity.[346] One analysis of coal-plant cycling against intermittent renewable power's hourly variations found that emissions during cycling were eight percent higher for sulfur dioxide and ten percent higher for nitrogen oxides than emissions of the same compounds during constant operation.[347] Moreover, while generators spin to increase their temperatures to their design values, the power that these units produce may or may not be used by the grid, thus incurring power "uplift" costs to the grid.[348] The grid (and, ultimately, power consumers) incurs this multiple loss whether or not these units are ever required to supply power during the peak time of the day.[349]

Today, as one attempts to transform the grid to accommodate more intermittent renewable power, the reality is that the power-generation grid is lacking the much-needed quick-start backup peaking power resources.[350]

F. Cybersecurity

Grid cybersecurity and data privacy are of increasing importance, especially in an age in which electronic hackers dominate the news, with stories of WikiLeaks,[351] hackers who have stolen merchants' electronic credit-card records,[352] and

330. Montgomery Energy Billerica Power Partners, No. EFSB 07-02, 2009 WL 1532821, at *16 (Mass. Energy Facilities Siting Board Mar. 3, 2009).
331. *Id.*
332. *See* Braintree Electric Light Dep't, No. EFSB 07-1/D.T.E./D/P.U. 07-5 at 77.
333. Montgomery Energy Billerica Power Partners, 2009 WL 1532821 at *10.
334. *Id.*
335. *Id.* Indeed, in 2005, ISO New England found that it needed to convert 400 megawatts of gas-fired generation to dual-fuel capacity and then nearly quadruple that capacity by the winter of 2009–2010. *See* ISO New Eng., 2005 Regional System Plan, at ES-2 (2005), *available at* http://iso-ne.com/trans/rsp/2005/05rsp.pdf.
336. ISO New Eng., *supra* note 335, at 8.
337. *See Combustion Fuels—Carbon Dioxide Emission*, The Engineering ToolBox, http://www.engineeringtoolbox.com/co2-emission-fuels-d_1085.html (last visited July 15, 2011) (showing oil emitting about fifteen percent more CO_2 than natural gas, and coal emitting more than fifty percent more CO_2 than natural gas).
338. *Cf.* ISO New Eng., 2006 Regional System Plan 5 (2006) (noting that a system needs more than just a certain level of resources to meet demand for electricity; it also needs certain types of resources).
339. *See id.*
340. *Id.*
341. Regarding the small amount of peaking or backup generation in systems, see, e.g., Montgomery Energy Billerica Power Partners, EFSB No. 07-2, 2009 WL 1532821, at *10, *13 (Mass. Energy Facilities Siting Board Mar. 3, 2009). The bulk of fossil-fueled power generation was built prior to 1990, when aeroderivative quick-start technology began to be used for power generation. U.S. Energy Info. Admin., Existing Electric Generating Units by Energy Source, 2008 (2008), *available at* http://www.eia.gov/cneaf/electricity/page/capacity/capacity.html. 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. *US Energy Consumption,* Maxwell Sch. of Syracuse Univ., http://wilcoxen.maxwell.insightworks.com/pages/804.html (last updated Apr. 10, 2006).
342. Braintree Electric Light Dep't, No. EFSB 07-1/D.T.E./D.P.U. 07-5, at 94 n.67 (Mass. Energy Facilities Siting Board Feb. 29, 2008), *available at* http://www.env.state.ma.us/dpu/docs/electric/07-5/efsb07-1/22908findec.pdf.
343. *Id.* at 94. ISO New England has separate reserve markets for ten-minute nonspinning reserve capacity and thirty-minute operating reserves. ISO New Eng., Ancillary Services Market Enhancements White Paper 3 (2004), *available at* http://www.iso-ne.com/pubs/whtpprs/asm_wht_paper.pdf. Many units have to "spin" to meet either of these criteria. Michael Milligan & Brendan Kirby, Nat'l Renewable Energy Lab., NREL/CP-550-48247, Utilizing Load Response for Wind and Solar Integration and Power System Reliability 7 (2010), *available at* http://www.nrel.gov/docs/fy10osti/48247.pdf.
344. *Cf.* Braintree Electric Light Dep't, No. EFSB 07-1/D.T.E./D.P.U. 07-5 at 79 (explaining that the reserve market serves as a "real-time backup supply to ensure continuity of service to system customers even in the event of an unexpected outage or other system contingency").
345. *See id.* at 97.
346. Montgomery Billerica Energy Power Partners, No. EFSB 07-02, 2009 WL 1532821 at *12 (Mass. Energy Facilities Siting Board Mar. 3, 2009).
347. Puga, *supra* note 305, at 38.
348. *See id.* at 34.
349. *See id.*
350. *See, e.g.*, ISO New Eng., *supra* note 343.
351. *See* Jill Dougherty, *State Department Relocating People Identified in WikiLeaks Releases*, CNN (Jan. 7, 2011), http://www.cnn.com/2011/US/01/07/wikileaks.relocations/ (discussing one issue associated with WikiLeaks release of classified State Department documents).
352. *See* Mark Jewell, *TJX Thieves Had Time to Steal, Trip Up: Duration May Be Unprecedented Among Large Data Thefts Involving Hackers*, MSNBC (Apr. 13, 2007), http://www.msnbc.msn.com/id/18095321/ns/technology_and_science-security/.

hackers who have invaded U.S. military databases.[353] Because power companies sell power through the Supervisory Control and Data Acquisition system ("SCADA") over an internet connection, one can access the grid by hacking into this system.[354] One security expert indicated that he could get into the SCADA system of a power company as a consultant with less than a day's effort.[355]

Correspondingly, NERC is taking steps to guard against potential electronic attacks on the new, smarter grid.[356] This includes establishing critical infrastructure protection, working with other countries, and engaging in a process to set a national standard of grid cybersecurity.[357] The current system of electricity transmissions in vulnerable to national security attacks, according to Joe McClelland, director of FERC's Office of Electric Reliability.[358] The NERC system "can't work for national security issues because it was not designed for national security issues. . . . The process is too slow, it's too open and it's too unpredictable for us, the commission, to assure a national security result. . . . Anytime there's two-way communication, there's a chance for exploit."[359]

The National Institute of Standards and Technology has established a set of operations standards for utility smart-grid plans, addressing cybersecurity and privacy when devices communicate with each other.[360] Curiously, FERC excluded nuclear facilities from its reliability standards for cybersecurity.[361] In the view of one authority on these issues, this omission makes the entire power network "incredibly vulnerable."[362]

All customer-specific data should be within the control of the customer, while aggregate system data should be considered public information.[363] With the bidirectional communication of data between customers and suppliers, ideal customer protections would protect and promote the confidentiality of personal information, ownership of information, real-time price information, appliance control, net metering, and the ability to choose a level of service quality.[364] California, Texas, Pennsylvania, Massachusetts, Ohio, and New York have codes of utility conduct that generally include rules for the "handling of customer information in a competitive environment."[365] California, Colorado, Pennsylvania, and Ohio protect customers by requiring utilities to obtain a customer's consent before providing information about that customer to third parties.[366] Securing the new smart grid, however, is still a work in progress.[367]

III. Promotion of Energy Efficiency and Conservation in the United States

The political and infrastructure-related challenges associated with integrating renewable energy-generation sources into the grid may make such integration a longer-term goal than originally anticipated.[368] In the interim, energy-efficiency and conservation investments provide an immediately implementable and cost-effective opportunity to reduce greenhouse-gas emissions and the use of fossil-fuel resources.[369] Moreover, conservation and efficiency improve grid reliability and functionality in the short term, helping to create a more efficient infrastructure.[370] Energy-efficiency measures can improve the system on the customer side of the meter, and, in the process, save the consumer the cost of purchasing the conserved amount of energy.[371]

A. *Where Do We Stand?*

The United States holds a distinctive position in energy; in 2005, the average American consumed 340 million Btu of energy,[372] making the United States the world's largest consumer of energy.[373] By comparison, if the United States were to use energy as efficiently as Japan does, it would lower the U.S. national fuel bill by more than $200 billion per year,[374] which the United States could invest in other competitive opportunities. While the United States devoted 10% of its GNP to buying fuel in 1986, Japan only devoted 4% of its GNP to that use that year.[375] As a result, the average Japanese product then had an automatic cost advantage of about 6% in the U.S. market.[376] Japan was not only richer for its efficiency; it also had positioned itself to be more competitive in the world market for many high-efficiency technologies.[377] It also became a leader in certain innovative technologies.

353. Sean Alfano, *U.S. Military Databases Hacked*, CBS News, (Aug. 23, 2005), http://www.cbsnews.com/stories/2005/08/23/tech/main792304.shtml.
354. *See* Riptech, Understanding SCADA System Security Vulnerabilities 1 (2001), http://www.iwar.org.uk/cip/resources/utilities/SCADAWhitepaperfinal1.pdf.
355. Tim Greene, *Experts Hack Power Grid in No Time*, Network World (Apr. 9, 2008), www.networkworld.com/news/2008/040908-rsa-hack-power-grid.html.
356. *See* N. Am. Electric Reliability Corp., Smart Grid Task Force Scope 1 (Dec. 8, 2010), *available at* http://www.nerc.com/docs/pc/sgtf/SGTF_Scope_Approved_12-08-10.pdf.
357. *See id.*
358. Coyne, *supra* note 297, at 9.
359. *Id.*
360. *See generally* Nat'l Inst. of Standards & Tech., U.S. Dep't of Commerce, NIST Special Pub. 1108, Framework and Roadmap for Smart Grid Interoperability Standards (2010), *available at* http://www.nist.gov/smartgrid/upload/FinalSGDoc2010019-corr010411-2.pdf.
361. Esther Whieldon, *Agencies Tackle Gap in Nuclear Cybersecurity; Expert Speaks of 'Incredible' Plant Vulnerability,* Electric Util. Wk., Apr. 14, 2008, at 1.
362. *Id.*
363. *See* Brown & Salter, *supra* note 74, at 29.
364. *Id.* at 6.
365. *Id*. at 4.
366. *Id*. at 13.
367. *Id.* at 3.
368. *See supra* text accompanying notes 238–264.
369. *See infra* text accompanying note 411.
370. *See infra* text accompanying notes 412–423.
371. *See infra* text accompanying note 663.
372. Lester B. Love, *The Potential of Energy Efficiency*, The Bridge, Summer 2009, at 5, 6.
373. Maxine Savitz, *Expanding Opportunities for Energy Efficiency*, The Bridge, Summer 2009, at 3.
374. Christopher Flavin & Alan Durning, Worldwatch Inst., Worldwatch Paper 82, Building on Success: The Age of Energy Efficiency 9 (1988), *available at* http://www.eric.ed.gov/PDFS/ED292621.pdf.
375. *Id.*; Ellyn R. Weiss & James Salzman, *The Greening of American Energy Policy*, 63 St. John's L. Rev. 691, 700 n.44 (1989).
376. *See* Weiss & Salzman, *supra* note 375.
377. *See id.*

The trends in energy use are not consistent across the United States.[378] Since the 1970s, electricity use per capita in the United States has increased by about fifty percent, while in California, with aggressive energy-conservation programs, it has remained relatively flat.[379] In 2009, a report by the American Council for an Energy Efficient Economy ("ACEEE") ranked California, Massachusetts, and Connecticut as the top three states in energy-efficiency efforts.[380] The lowest-ranked states were located predominantly in the South.[381] Electricity use has also been inconsistent across sectors of the economy.[382] In 2009, demand for electricity by industrial users decreased 9.1% from the previous year, reaching its lowest level since 1987 and "account[ing] for most of the decline in overall electricity consumption" that year.[383] Residential energy demand also decreased in 2009.[384]

Twenty-six states have energy-efficiency standards or goals to reach certain levels of energy efficiency,[385] and the pursuit of such gains in energy efficiency can be a long-term, costless investment. The investment in electric efficiency equipment would cost between one-quarter and one-half of the price of power supplied from the construction of new power plants.[386] "Energy and energy efficiency services should be viewed as a comprehensive system 'from production all the way to the end use, and everything in between.'"[387]

B. *Following the Money to Energy Conservation and Efficiency Measures*

First, some historical context: Expenditures on energy-efficiency programs in the United States peaked at $1.7 billion from 1993 to 1994 and then began a steep decline in April 1994 after the California Public Utilities Commission announced that it intended to restructure California's electric industry.[388] It did so, and more than a dozen other states followed.[389] By 1998, efficiency expenditures had decreased by half.[390]

According to commentators, that restructuring was not based on intellectually transparent or sound premises and came up short in yielding the most cost-effective future for power supply:

> Restructuring electricity came after a debate that can, in almost every jurisdiction, charitably be described as less than intellectually honest. Advocates on all sides of the debate were frequently oversimplifying issues, making false promises, inaccurately characterizing existing and prospective circumstances, and failing to educate both policymakers and the public. The question of how to reconfigure a core infrastructure industry, perhaps society's most capital-intensive one, was not debated with the attention and thought that the gravity of the subject merited. In fact, there are several examples of the debate showing flawed results with negative repercussions. There was, as noted, the naked assertion that competition would drive prices down, as if Newton's Laws of Physics somehow applied to the economics of electricity. In many states, prices were arbitrarily frozen (e.g. California) or even lowered by simply deferring cost recovery and calling it a "decrease" (e.g. Massachusetts). These were, in essence, artificial contrivances employed to "prove" that competition would lower prices.[391]

The ARRA included a significant incentive package for the electric sector,[392] pouring billions of dollars in both new spending and tax breaks into renewable energy and energy efficiency.[393] The stimulus funding included $12.35 billion for energy-efficiency improvements through low-income weatherization, state block grants, public-housing efficiency, and Department of Defense efficiency.[394] In addition, in 2009, the Department of Energy awarded more than $155 million in stimulus funds to forty-one industrial energy-efficiency projects, including district energy systems and combined-heat-and-power facilities.[395]

But the ARRA did more than work to stimulate development of renewable energy and improve energy efficiency; it also provided states and municipalities with approximately $10.8 billion in funding for energy-conservation measures.[396] New York has ninety energy-efficiency programs and is spending $600 million over three years as part of a larger effort to reduce energy use 15% by 2015.[397] In fact, some areas of the country received so much more conserva-

378. *See, e.g.*, *California*, Climate Group, http://www.theclimategroup.org/programs/policy/states-and-regions/california/ (last visited July 17, 2011).
379. *See id.*
380. *See The 2009 State Energy Efficiency Scorecard*, Am. Council for an Energy-Efficient Econ. (Oct. 20, 2009), http://www.aceee.org/blog/2009/10/2009-state-energy-efficiency-scorecard.
381. *See id.*
382. *See Electric Power Industry 2009: Year In Review*, U.S. Energy Info. Admin. (last updated April 2011), *available at* http://www.eia.doe.gov/cneaf/electricity/epa/epa_sum.html.
383. *Id.* (explaining that industrial users' 9.1% decrease in electricity use in 2009 "reflected the 9.3-percent drop in industrial output, as measured by the Federal Reserve Bank's index of industrial production").
384. I*d.*
385. Tom Tiernan, *26 States Have Energy Efficiency Resources Standards; the States Are 65% of US Demand*, Electric Util. Wk., Jan. 3, 2011, at 22.
386. *Id.* (quoting ACEEE researcher who said that "[i]t costs far less to save a [kilowatt–hour] than to generate one").
387. Cano, *supra* note 92, at 18.
388. Carl Blumstein, Charles Goldman & Galen Barbose, Ernest Orlando Lawrence Berkeley Nat'l Lab., LBNL-53597, Who Should Administer Energy Efficiency Programs? 6 (2003), *available at* http://eetd.lbl.gov/ea/ems/reports/53597.pdf.
389. *Id.*
390. *See* Clark Gellings, Greg Wikler & Debyani Ghosh, *Assessment of U.S. Electric End-Use Energy Efficiency Potential*, Electricity J., Nov. 2006, at 64–65 (citing Keystone Ctr., The Keystone Dialogue on Global Climate Change (2003), *available at* http://keystone.org/files/file/about/publications/FINAL-REPORTGLOBALCLIMATE.pdf; U.S. Energy Info. Admin., *supra* note 292).
391. Brown & Salter, *supra* note 74, at 23.
392. American Recovery and Reinvestment Act (ARRA) of 2009, Pub. L. No. 111-5, 123 Stat. 115 (2009).
393. David M. Herszenhorn, *A Smaller, Faster Stimulus Plan, but Still with a Lot of Money*, N.Y. Times, Feb. 14, 2009, at A14, *available at* http://www.nytimes.com/2009/02/14/us/politics/14stimintro.ready.html?_r=1.
394. Steven Ferrey, *Restructuring a Green Grid: Legal Challenges to Accommodate New Renewable Energy Infrastructure*, 39 Envtl. L. 977, 983 (2009).
395. *DOE Awards $155 Million to 41 Industrial Energy Efficiency Projects*, U.S. Dep't Energy (Nov. 4, 2009), http://www1.eere.energy.gov/solar/news_detail.html?news_id=15600.
396. Derek Sands, *Report Documents Growing Number of State Efficiency Programs; Now 27 Have Standards*, Electric Util. Wk., Oct. 18, 2010, at 12–13.
397. *See* Lisa Wood, *New York Regulators Want Accountability for Spending on 90 Energy Efficiency Programs*, Electric Util. Wk., Oct. 18, 2010, at 11.

tion funding than usual in 2010 that there were worries that there possibly were "not . . . enough contractors trained up to actually spend the money . . . coming out of the federal government and [the] utilities."[398] One New York regulator described the state's ninety energy efficiency programs as a "spaghetti pile."[399]

Additionally, the ARRA provided federal tax credits for efficiency investments, including a thirty percent credit for the purchase of qualified energy-efficiency improvements[400] to the envelope components of an existing home,[401] "qualified natural gas, propane, or oil furnace or hot water boilers," "energy efficient building property," and "an advanced main air circulating fan."[402]

Congress also updated and extended through 2011 the § 25C credit for energy-efficient improvements to existing homes, reinstating the credit as it existed prior to the ARRA.[403] Under I.R.C. § 179D, a taxpayer may take an additional deduction of $1.80 per square foot of commercial property that exceeds certain energy-efficiency standards,[404] as set forth in Table 1. Although President Obama's initial call in 2011 for a new "clean energy" goal did not include a specific mention of conservation or energy efficiency,[405] later that year, President Obama proposed additional tax incentives to help increase the efficiency of commercial buildings by twenty percent, including changing the tax deduction to a tax credit.[406]

Although stimulus grants and tax-incentive programs garner the most attention, there is another, less visible—but still significant—incentive system: the rate-based incentive system. Over the past twenty years, utility ratepayers have indirectly funded investments in energy efficiency at the state and local levels.[407] In the most recent year surveyed, thirty-five states implemented ratepayer-funded energy-efficiency programs that totaled $3.1 billion.[408] Budget levels have risen to 1% of revenues from utility retail sales, with annual savings of about 0.5% of retail sales.[409] These savings are expected to rise to a level of between $5.4 billion and $12 billion annually by 2020.[410]

What makes all of these various energy-efficiency investments cost-effective? The U.S. Environmental Protection Agency ("EPA") determined that reductions in energy use via energy efficiency can be made at approximately half the cost of creating new sources of power generation, making energy efficiency a cost-effective solution for utilities looking to reduce their system costs or greenhouse-gas emissions.[411] Estimating even greater cost efficiency, ISO New England concluded that the $10 million paid to demand-response programs yielded savings of more than three times that amount in lower energy costs.[412] McKinsey & Company, a global consulting firm,[413] estimated that full realization of energy efficiency by 2020 would save the industrial sector $442 billion in energy expenses and reduce CO_2-equivalent ("CO_2e") emissions by 300 megatons.[414] Furthermore, in both the residential and commercial sectors, fully realized energy efficiency would save between $290 billion and $395 billion in energy expenses and reduce CO_2e emissions by 360 megatons.[415] Yet, these savings to the industrial, residential, and commercial sectors would only cost around $470 billion in new investments.[416]

Yet, there remains significant disagreement about the true degree of the cost efficiency of energy conservation. In 2009, ACEEE reported that the cost of energy conservation had continued over several decades to be available, on average, at about $0.025 per kilowatt–hour.[417] Amory Lovins, chairman of the Rocky Mountain Institute, argues that the cost of energy conservation is less than $.01 per kilowatt–hour saved, while analysis by the Electric Power Research Institute puts the amount closer to $.04 per kilowatt–hour saved.[418] In response, Professor Paul Joskow argues that estimates like these, on average, may understate the true cost of kilowatt–hours saved by a factor of two.[419] Some point out that the prevalence of "free riders" in energy-conservation programs

398. *Id.* at 13.
399. *Id.* at 11.
400. American Recovery and Reinvestment Act (ARRA) of 2009 § 1121, I.R.C. § 25C (Supp. III 2009). A qualified nonrefundable "energy efficiency improvement" is any energy efficiency building envelope component (1) that meets or exceeds the prescriptive criteria for such a component established by the 2000 International Energy Conservation Code as in effect on August 8, 2005, (2) in a taxpayer's principal residence, and (3) that reasonably can be expected to remain in use for at least five years. *Id.*
401. "Building envelope components" are: (1) insulation materials or systems that are specifically and primarily designed to reduce the heat loss or gain of a dwelling and that meet the prescriptive criteria for such material or systems established by the 2009 International Energy Conservation Code in effect on the date of the enactment of the American Recovery and Reinvestment Act of 2009; (2) exterior windows (including skylights) and doors ; and (3) roofs with appropriate pigmented coatings or cooling granules that are specifically and primarily designed to reduce the heat gain for a dwelling. I.R.C. § 25C(c)(2)(A)–(D).
402. *Id.* § 25C(d)(2)(A). For examples of and limits on federal tax credits for energy-efficiency investments that existed in 2011 after several congressional enactments amended the tax-code provisions that ARRA created, see *id.* §§ 25C–D, 45L–M (2006 & Supp. V 2011).
403. Tax Relief, Unemployment Insurance Reauthorization, and Job Creation Act of 2010 § 710, I.R.C. § 25C(g)(2) (Supp. IV 2010).
404. I.R.C. § 179D (2006).
405. Kathy Larsen, *Various Interests Heard From as Jockeying Begins on Possible 'Clean Energy' Package*, Electric Util. Wk., Jan. 31, 2011, at 5.
406. Cheryl Bolen, *Obama Proposes Buildings Initiative to Save Energy, Cut Pollution, Create Jobs*, 23 World Climate Change Rep. (BNA) (Feb. 3, 2011).
407. *See* Galen Barbose, Charles Goldman & Jeff Schlegel, *The Shifting Landscape of Ratepayer-Funded Energy Efficiency in the U.S.*, Electricity J., Oct. 2009, at 29.
408. *Id.*
409. *Id.* at 30–31.
410. *See id.* at 30.
411. U.S. Dep't. of Energy & EPA, National Action Plan for Energy Efficiency 6-5 (2006), *available at* http://www.epa.gov/cleanenergy/documents/suca/napee_report.pdf.
412. *See* Craig Cano, *Load Response Programs Save Three Times More Than They Cost, ISO-NE Report Says*, Electric Util. Wk., Jan. 10, 2010, at 23.
413. *See About Us*, McKinsey & Company, http://www.mckinsey.com/en/About_us.aspx (last visited July 17, 2011).
414. Hannah Choi Granade et al., McKinsey & Co., Unlocking Energy Efficiency in the U.S. Economy 75 (2009), *available at* http://www.greenbuildinglawblog.com/uploads/file/mckinseyUS_energy_efficiency_full_report.pdf.
415. *Id.* at 29, 55.
416. *See id.* at 29, 55, 75.
417. Geoffrey Keith et al., Civil Soc'y Inst., Beyond Business as Usual: Investigating a Future without Coal and Nuclear Power in the U.S. 62–63 (2010), *available at* http://www.civilsocietyinstitute.org/media/pdfs/Beyond%20BAU%205-11-10.pdf.
418. Gellings, Wikler & Ghosh, *supra* note 390, at 64–65.
419. *Id.*

Table 1. Examples of Capital-Cost-Recovery Tax-Code Provisions

Eligible Activity	Description of Provision	Expiration
Pollution-control facilities[a]	A taxpayer may elect to recover the cost of any certified pollution control facility over a period of 60 months. A corporate taxpayer must reduce the amount of the amortizable basis otherwise eligible for the 60-month recovery by 20%.	None
Energy-efficient commercial buildings deduction[b]	A taxpayer may be eligible to take an additional deduction of $1.80 per square foot of commercial property that exceeds certain energy efficiency standards.	December 31, 2013

[a] I.R.C. §§ 169, 291(a)(4) (2006 & Supp. III 2009).
[b] *Id.* § 179D (2006 & Supp. III 2009).

obscures the true cost efficiency of such programs; commentators Loughran and Kulick estimated in 2004 that the cost of energy conservation actually achieved by a particular conservation-financing incentive was between $0.146 and $0.229 per kilowatt–hour in 2002 dollars after factoring out the "free rider" subsidy from the realized benefit attributable to the incentive.[420]

If energy conservation is cost effective, what is the potential magnitude of energy savings that could be achieved through this avenue? One ambitious estimate is that if all cost-effective energy-efficiency measures were implemented by 2025, these measures alone would address fifty percent of the expected load growth of energy demand and would achieve more than $500 billion in net cost savings.421 A report by FERC in 2009 indicated that by using demand-response resources, peak electric demand in the United States could be cut by 38 to 188 gigawatts.422 This significant decrease would occur if all customers had advanced metering and the ability to respond to price incentives.[423]

C. Defining Modern Energy Efficiency

The importance of the electricity sector to the modern industrial economy is reflected in the sector's changing role in, and impact on, society. In 1949, only about twenty percent of greenhouse gases in the United States came from the electric-power sector; today, more than two-thirds comes from the electric-power sector.[424] In 2008, the Energy Information Administration concluded that the electric-power sector, not the transportation sector, offered the most cost-effective opportunities to reduce CO_2 emissions.[425] Therefore, it stands to reason that policymakers should focus on the electric-power sector as they aim to reduce CO_2 emissions.

Energy efficiency and conservation reduce the amount of energy consumed.[426] To this end, DSM strategies shift the time at which power is consumed to off-peak times, when the electric-generation system can operate more efficiently.[427] Focusing solely on the energy used by buildings in urban areas and individual energy-conservation measures, the congressional Office of Technology Assessment ("OTA") forecast that by using existing technologies more efficiently and making feasible investments, the United States could save seven quads of energy annually.[428] This efficiency savings would equal more than half the current energy consumed by buildings in urban areas.[429] Utility-system load shaping, also known as DSM, could even further reduce the demand for delivered energy.[430] The OTA report projected, however, that about sixty percent of this energy-savings potential might not be realized because there exists a variety of practical barriers to cost-effective energy decisionmaking.[431]

1. New Conservation Standards: LEED

Federal law and state and local codes regulate the energy efficiency of new buildings and new major appliances.[432] Most of the energy-efficiency funding discussed in this subsection is applied to existing buildings that were constructed before more stringent efficiency standards were in place. For the most part, preexisting nongovernment buildings are exempt from new federal standards.[433] Although permits for new construction implicate energy-efficiency standards, most

420. *Id.* at 65.
421. U.S. Dep't of Energy & EPA, National Action Plan for Energy Efficiency: Vision for 2025: A Framework for Change, at ES-2 (2008), *available at* http://www.epa.gov/cleanenergy/documents/suca/vision.pdf.
422. FERC, 2009 Assessment of Demand Response and Advanced Metering: Staff Report 3 (2009), *available at* http://www.ferc.gov/legal/staff-reports/06-09-demand-response.pdf.
423. *See supra* Part II.C.1.
424. *See* U.S. Energy Info. Admin., Energy-Related Carbon Dioxide Emissions from the Residential and Commercial Sectors, by Fuel Type, 1949–2007 (2007), *available at* http://www.eia.doe.gov/oiaf/1605/ggrpt/excel/historical_co2.xls.
425. *See Energy Estimates Show Rise in CO_2 Emissions, Offer Mitigation Options*, Carbon Control News, June 30, 2008, at 20.
426. Richard Munson, *The Missing Efficiency*, Electricity J., June 2010, at 79.
427. *See* Eric Hirst, Oak Ridge Nat'l Lab., ORNL/CON-285, Electric Utility Energy-Efficiency and Load-Management Programs: Resources for the 1990s, at 1 (1989).
428. Gellings, Wikler & Ghosh, *supra* note 390, at 66. However, it may be noted that OTA's forecast was not a recent one, as that office was defunded in the mid-1990s. Keith Bradsher, *To Last Hour, Agency Staff is on the Job*, The N.Y. Times, Oct. 1, 1995, at § 1, at 19; Amanda Peterka, *Scientists Scramble to Bridge the Uncertainty Gap*, Greenwire, Nov. 9, 2010, http://www.eenews.net/public/Greenwire/2010/11/09/3.
429. *Conservation and Efficiency*, Energy Justice Network, http://www.energyjustice.net/solutions/c_and_e (last visited July 18, 2011).
430. *See* Regulatory Assistance Project, Revenue Decoupling Standards and Criteria: Report to the Minnesota Public Utilities Commission 5 (2008).
431. *See generally* U.S. Office of Tech. Assessment, NTIS Order #PB82-200346, Energy Efficiency of Buildings in Cities 4, (1982), *available at* http://www.fas.org/ota/reports/8206.pdf.
432. Electric Power Research Inst., *supra* note 323, at 9 (2009), *available at* http://www.edisonfoundation.net/iee/reports/EPRI_AssessmentAchievableEEPotential0109.pdf.
433. *See* Energy Policy Act of 1992, Pub. L. No. 102-486, § 101, 106 Stat. 2776, 2782–87 (codified as amended at 42 U.S.C. §§ 6832–35 (2006)) (requiring standards for new construction).

standards do not impact preexisting buildings unless those buildings undergo rehabilitation requiring new permits.[434] Therefore, the energy efficiency (or lack thereof) of existing buildings is not regulated, although there are various tax and other stimulus incentives for improving existing building efficiency.[435]

In the field of new building construction, the U.S. Department of Energy is responsible for overseeing the development of guidelines related to energy conservation[436] and the implementation and enforcement of existing energy statutes.[437] Although no longer the source of federal energy-efficiency standards for buildings,[438] for a period, the Energy Policy Act of 1992[439] provided the energy building codes that the Department of Energy was expected to implement and enforce.[440] Section 101 of the 1992 Act required that any given energy-code standard would improve upon the then-existing relevant levels of efficiency.[441] Whenever the Secretary of Energy sets new standards under section 101 of the 1992 Act, within two years after the date of publication of that standard, states must certify that they have reviewed and updated their respective residential and commercial building codes to either meet or exceed the most current standards imposed.[442]

Ultimately, however, standards issued by the International Code Council ("ICC") and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers ("ASHRAE") replaced the standards established under the 1992 Act.[443] The ASHRAE standards are simply commercial-building energy codes.[444] The International Energy Conservation Code ("IECC") is a model energy code for residential buildings developed and published by the ICC, and it has been incorporated into the Energy Policy and Conservation Act by the Department of Energy.[445] Yet, the Department of Energy still plays a role, albeit a broad one, in the process of developing standards, ensuring that standards for commercial and residential buildings are current, reasonable, and enforceable.[446]

The IECC and ASHRAE standards function as baseline energy codes for buildings; many states and municipalities implement codes that are significantly stricter than the federally mandated standards.[447] For example, the Leadership in Energy and Environmental Design ("LEED") standards, established by the U.S. Green Building Council, are green building standards for the construction of new buildings.[448] The LEED Green Building Rating System operates as a checklist of elements that can earn the building points for ratings in six areas: "sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environments quality, and innovation and design process."[449]

Some government authorities in the United States have chosen to adopt the LEED standards.[450] As of 2008, 134 mandatory government green-building programs and 85 voluntary programs in 118 counties, municipalities, and districts have been established in the United States.[451] Some states, including Rhode Island, Connecticut, Maryland, Nevada, and Hawaii, have enacted statewide green-building codes requiring LEED Silver certification or higher on certain new projects.[452]

2. Wasted-Energy Recapture

Equally important as improving the energy efficiency of buildings is improving the ability of the American grid to capture wasted dispersed energy sources. In late 2010, after the demise of climate-control legislative proposals, energy-efficiency advocates shifted their strategy from promoting efficiency as a way to cut greenhouse gases and boost renewable energy, to focusing on efficiency's ability to cut waste.[453] For example, the industrial sector expels a significant amount of energy as waste heat.[454] Capturing that waste heat before it exits the stack and converting it to electric power can sub-

434. *See Public Policies Adopting or Referencing LEED: State and Local Initiatives*, U.S. Green Building Council, http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1852#state (last visited July 18, 2011).
435. *See supra* Tables 1–2.
436. 42 U.S.C. § 6372a (2006) (dealing only with guidelines applicable to buildings "owned by units of local government and public care institutions").
437. *Cf. Laws the Department of Energy Administers*, U.S. Dep't Energy, http://energy.gov/gc/laws-doe-administers (last visited Aug. 17, 2011) (providing an example of the Department of Energy determining whether regulations will enhance the energy efficiency of commercial buildings).
438. *See Building Energy Codes Program*, U.S Dep't Energy, http://www.energycodes.gov/status/all_about_determinations.stm (last updated Mar. 22, 2011) (discussing Department of Energy code determinations).
439. *See Chronology of Federal Legislation*, U.S. Dep't Energy, http://www.afdc.energy.gov/afdc/laws/key_legislation (last updated June 15, 2010) (discussing key legislation and its intended purpose).
440. *See* Energy Policy Act of 1992, Pub. L. No. 102-486, § 101, 106 Stat. 2776, 2782–87 (codified as amended at 42 U.S.C. §§ 6832–35 (2006)).
441. *Id.*
442. *Id.*; *Building Energy Codes Program, supra* note 438 (discussing Department of Energy code determinations).
443. *See Building Energy Codes Program*, *supra* note 438 (discussing Department of Energy code determinations).
444. *See Types of Codes*, U.S. Dep't Energy, http://www.energycodes.gov/why_codes/types.stm (last updated Feb. 11, 2011); *see also* Preliminary Determination Regarding Energy Efficiency Improvements, 75 Fed. Reg. 54,117 (Sept. 3, 2010).
445. Energy Policy and Conservation Act (EPCA), 42 U.S.C. §§ 6201–6422 (2006); *Laws the Department of Energy Administers*, *supra* note 437; *see also* Updating State Residential Building Energy Efficiency Codes, 75 Fed. Reg. 54,131 (Sept. 3, 2010).
446. *See Building Energy Codes Program*, *supra* note 438; *Types of Codes*, *supra* note 444.
447. *See Types of Codes*, *supra* note 444.
448. *See About USGBC*, U.S. Green Building Council, http://www.usgbc.org/DisplayPage.aspx?CMSPageID=124 (last visited July 18, 2011); *What LEED Is*, U.S. Green Building Council, http://www.usgbc.org/DisplayPage.aspx?CMSPageID=1988 (last visited July 18, 2011).
449. Kate Bowers & Leah Cohen, The Green Building Revolution: Addressing and Managing Legal Risks and Liabilities 2 (2009), *available at* http://www.mgkflaw.com/Green%20Building%20Revolution.pdf.
450. *Id.* at 4–5.
451. *Id.*
452. *Public Policies Adopting or Referencing LEED: State and Local Initiatives*, *supra* note 434. The Electricity Policy Research Institute ("EPRI") estimates that energy-efficiency programs have the potential to reduce the annual electricity-use growth rate by twenty-two percent from 2008 to 2030, yielding an approximate five percent reduction in total U.S. electricity consumption by 2030. Electric Power Research Inst., *supra* note 323, at x, xx. The EPRI also forecast that efficiency measures can reduce summer peak electric demand by fourteen percent. *Id.* at xi.
453. Bobby McMahon, *Advocates May Shift Strategy To Tout Energy Efficiency In Cutting Waste*, Clean Energy Rep., Dec. 10, 2010.
454. *See* Tom Casten & Phil Schewe, *Getting the Most from Energy*, Am. Scientist, Jan.–Feb. 2009, at 26, 30, *available at* http://www.americanscientist.org/issues/id.76/past.aspx.

stantially create and disperse power into the grid.[455] This capture would change the basic flow of power on the particular grid,[456] but the ability to capture waste heat as usable energy is an essential part of an efficient and smart grid.[457]

Energy and industrial officials can achieve the benefits of capturing this waste heat both by tapping a manufacturer's exhaustion of waste heat and by converting conventional power production into cogeneration of electricity and useful thermal energy.[458] Even facilities nearing the end of their assumed useful lifetimes can realize this waste-heat capture. In 2011, the small Kendall power station, not far from the Harvard University campus, took advantage of such an opportunity.[459] The facility, built in 1949 and originally running on oil, had outlasted its expected useful life and was repowered to run on cleaner natural gas.[460] Traditionally, this facility used up to 70 million gallons of cooling water from the Charles River per day, but it then discharged the heated water into the river, which EPA alleged damaged fish populations.[461] Now, the plant has committed itself to reducing discharges of heated water into the river by ninety-five percent, instead converting the water into steam, which a newly constructed pipe carries into Boston to heat other buildings.[462] In essence, a sixty-year-old, independent, fossil-fuel-fired power-generation facility became a cogeneration facility, thus increasing its energy efficiency by about fifteen percent.[463] This is possible wherever power generation is sited relatively close to large users of heating and cooling technologies.[464]

A 2007 study by the U.S. Department of Energy found the potential for 135,000 megawatts of additional cogeneration at industrial facilities, while the National Renewable Energy Laboratory found an additional 64,000 megawatts.[465] Much more efficiency could be captured in the industrial sector than in the residential sector, but it is the residential sector that attracts more attention.[466] Trade competitors, including Japan, Germany, France, Russia, and Denmark, recycle a much larger percentage of their energy than does the United States.[467]

In addition to cogeneration efforts, new load-control software offers the ability to control building-management systems remotely, capture real-time energy data, and accurately compute baselines of customer energy use.[468] Moreover, a newly developed plug-in device will allow a computer to remotely cycle off connected appliances, such as air conditioners, for any number of minutes when the system needs additional resources connected to or disconnected from the grid.[469]

Yet, despite all of this potential to be more efficient, cut consumer costs, and provide competitive advantages, the recession of 2008 and 2009 was the first time that consumers have responded to a recession by cutting total power consumption.[470] Industrial demand for electricity decreased 9.1%.[471] Next, this article will consider specific regulatory techniques to decouple economic incentives perceived by utilities supplying power or efficiency, and later time-sensitive pricing of the final sale of power to consumers using smart meters, as well as certain growing resistance to the implementation of these regulatory options.

D. *Decoupling Energy Consumption from Utility Revenues*

The U.S. utility sector is beginning to be regulated in a way that encourages "decoupling" of revenues from quantity of power sold in order to address environmentally contradictory incentives. The amount of revenue earned by regulated utilities is a function, in large part traditionally, of the number of kilowatt–hours a utility can sell.[472] In this regard, monetary cost breaks for larger consumers can increase the quantity of electricity sold and the revenues garnered by utilities, but such discounts may be in conflict with other environmental or policy objectives.[473] When utilities' greenhouse-gas emissions are identified as a major environmental cause of global warming and ambient-air-pollutant levels, and when those levels of emissions are directly correlated with the amount of electricity produced and sold, incentives that reward additional production and sale of power are not aligned with carbon-limiting environmental policy.[474] The Energy Policy Act of 1992 tried to remedy these environmentally contradictory incentives, providing:

> The rates allowed to be charged by a State regulated electric utility shall be such that the utility's investment in and expenditures for energy conservation, energy efficiency resources, and other demand side management measures are *at least as profitable*, giving appropriate consideration to *income lost from reduced sales* due to investments in and expenditures for conservation and efficiency, as its investments in and expenditures for the construction of new generation, transmission, and distribution equipment. Such energy conservation, energy efficiency resources and other demand side management measures shall be appropriately monitored and evaluated.[475]

455. *Id.* at 32.
456. *Id.* at 28.
457. *Id.* at 30.
458. *Id.*
459. Beth Daley, *Agreement to Cut Power Plant Discharge, Send Heat to Boston*, Bos. Globe, Feb. 2, 2011, at A1.
460. *Id.*
461. *Id.*
462. *Id.*
463. *Id.*
464. United Nations Env't Programme, Energy Technology Fact Sheet: Cogeneration 1, *available at* http://www.unep.fr/energy/information/publications/factsheets/pdf/cogeneration.pdf (last visited July 19, 2011).
465. Richard Munson, *The Missing Efficiency*, Electricity J., June 2010, at 79.
466. *Id.*
467. *Id.* at 80.
468. Ferrey, *supra* note 310, § 3:68 n.6 (discussing capabilities of software).
469. *See Omni Home Control Systems*, Home Automation, Inc., http://www.homeauto.com/Products/HAISystems/OmniOverview.asp (last visited July 19, 2011).
470. *See* Scott DiSavino & Eileen O'Grady, *U.S. Power Use Tumbling with Recession*, Reuters, Mar. 20, 2009, *available at* http://www.reuters.com/article/idUSTRE52T7OE20090330.
471. U.S. Energy Info. Admin., *supra* note 291, at 6.
472. *See* Ferrey, *supra* note 106, at 556–557.
473. *See* Regulatory Assistance Project, *supra* note 430, at 4–5 (2008).
474. *See id.*
475. Energy Policy Act of 1992, Pub.L. 102-486, § 111(a), 106 Stat. 2776, 2795 (codified as amended at 16 U.S.C. § 2621 (2006)) (emphasis added).

From a regulatory perspective, new ways of persuading transmission providers to decouple their rates and earnings exclusively from the total volume of power handled, and thus reflecting various rate-recovery mechanisms tied to explicit policy incentives, is gaining support.[476] Therefore, several states have moved to "decouple" the amount of revenue earned by their regulated utilities from the amount of power they can produce and sell.[477] The purpose of decoupling is to make utilities financially indifferent to whether they meet energy demand with greater energy production or more cost-side options.[478] Traditional, vertically integrated utilities have no incentives to decrease capacity and sales "because the scale of their capital investment and the source of their profits are tipped heavily toward their investment in generation."[479] To counter this, decoupling typically rewards the utility for doing things that the regulators suggest, apart from adjusting the volume of power produced and sold.[480]

State and local governments can implement decoupling using a variety of tools. States can create decoupled incentives by applying surcharges to approved rate tariffs, offering rate-of-return incentives decoupled from electricity sales, adjusting mechanisms for utilities' lost revenues from reduced power sales, or providing other performance incentives.[481] The names used for decoupling mechanisms include "billing determinant adjustment," "volume balancing adjustment," and "bill stabilization rider."[482]

The smart grid will require implementing some type of dynamic retail pricing and energy-management services.[483] Some states have already begun to recognize this.[484] Approximately eighteen states have adopted some type of retail competition for the sale of power.[485]

States have also moved to decouple utility revenues from sales. In late 2008, FERC reported that ten states had adopted polices, if not requirements, to decouple changes in utility revenue from changes in utility sales volume.[486] Three states—California, Connecticut, and Massachusetts—have fully decoupled electric-utility rates from the quantity of electricity sold.[487] Six other states require at least one utility within their jurisdiction to decouple rates.[488] Connecticut, California, Illinois, New York, and Pennsylvania have mandated real-time pricing.[489] Standard & Poor's rating downgraded the corporate credit rating of utilities in Hawaii because of uncertainty regarding rate decoupling and revenue recovery.[490] The states leading decoupling efforts are the same states that led electric-utility restructuring and retail deregulation a decade ago,[491] led the development of renewable-portfolio standards and renewable system-benefit charges over the past decade,[492] and have been leaders in state carbon regulation.[493]

In 2009, various environmental groups urged Congress, as part of its economic stimulus legislation, to provide additional federal incentives for states to decouple electric-utility revenues from utility-sales volume.[494] Originally, Congress included a revenue-decoupling provision in the 2009 stimulus proposal that would have required states to decouple utility rate-of-return determinations from the volume of power sales.[495] Congress, however, significantly weakened this provision in the final version of the bill, only requiring states to indicate that they are moving toward decoupling.[496] The debate over incentives for utility revenues pits consumer groups, state regulators, and some industrial groups—which are concerned about cost increases resulting from various incentives—against environmental groups that want to increase the conservation incentives provided to utilities. According to one observer, "It's consumers versus utilities and environmentalists."[497]

Amory Lovins of the Rocky Mountain Institute claims that changing the role of a utility is essentially "turning the utility inside out."[498] Under a decoupled system, utilities become energy-services providers, with energy efficiency being just one facet of their service, instead of simply being merchants of electrons for power.[499] By recasting the role of the utility and decoupling utility sales from profits, regulators can then put incentives behind energy-efficiency measures in a manner that makes sense to both shareholders and utility executives.[500] Such decoupling substitutes for financial and accounting experts responsible for tracking utility rev-

476. For an in-depth proposal on decoupling, see, e.g., Regulatory Assistance Project, *supra* note 430, at 4–5.
477. For a discussion of one such effort, see Donald Simon, *Green Building Carbon Credits*, Wendel Rosen Black & Dean LLP (Sept. 16, 2008), http://www.wendel.com/index.cfm?fuseaction=content.contentDetail&ID=9012.
478. *See* Regulatory Assistance Project, *supra* note 430, at 4–5.
479. Brown & Salter, *supra* note 74, at 8.
480. *See* Regulatory Assistance Project, *supra* note 430, at 5.
481. Pamela Lesh, *Rate Impacts and Key Design Elements of Gas and Electric Decoupling: A Comprehensive Review*, Electricity J., Oct. 2009, 66–67.
482. *See id.*
483. *Cf.* Brown & Salter, *supra* note 74.
484. *See* Ferrey, *supra* note 106, at 567.
485. *Id.*
486. Ferrey, *supra* note 394, at 1002; Lesh, *supra* 481.
487. *Decoupling in Detail*, Pew Center on Global Climate Change, http://www.pewclimate.org/what_s_being_done/in_the_states/decoupling_detail (last visited July 19, 2011).
488. *Id.*
489. Brown & Salter, *supra* note 74, at 13.
490. Paul Carlsen, *S&P Downgrades Hawaiian Electric Industries, Finding Decoupling 'in Regulatory Limbo' at PUC*, Electric Util. Wk., Nov. 22, 2010.
491. Ferrey, *supra* note 310, §§ 10:6–10:12.1.
492. Ferrey, *supra* note 53, at 508.
493. *See* Ferrey, *supra* note 247, at 855–56 (discussing California's efforts to reduce greenhouse gas emissions).
494. Cathy Cash, *Decoupling Mandate Keeps the Pot Stirred as Congress Advances Stimulus Package*, Electric Util. Wk., Feb. 2, 2009, at 1.
495. American Recovery and Reinvestment Act (ARRA) of 2009, I.R.C. § 48 (Supp. III 2009); see Cash, *supra* note 494, at 2.
496. *See* Katherine Ling, *Stimulus Doesn't Require Utility Decoupling, Key Democrat Says*, N.Y. Times, Feb. 24, 2009, *available at* http://www.nytimes.com/gwire/2009/02/24/24greenwire-stimulus-does-not-require-decoupling--markey-9846.html.
497. Cash, *supra* note 494, at 2.
498. Katherine Ling, *Rising Temps Melt Electric Utilities' Business Models*, N.Y. Times, Sept. 10, 2009, *available at* http://www.nytimes.com/gwire/2009/09/10/10greenwire-rising-temps-melt-electric-utilities-business-72148.html.
499. *See id.* (quoting David Owens, executive vice president of business operations at the Edison Electric Institute: "The utility will not be a passive entity as it is today . . . . Folks believe a utility exists to sell kilowatt–hours; that is not going to be the model of the future. The model of the future is 'Let me look at how I can improve efficiency, how I can reduce greenhouse gas emissions.' That is what the utility is going to be focused on.").
500. *See id.*

enues with regulatory-relations staff who justify returns for the company by following regulators' directives.[501]

For various utilities, decoupling has resulted in a mixture of increases in electricity costs and refunds to customers.[502] Decoupling tends to affect utility returns one to two percent when applied to the base of total retail rates.[503] One commentator argues that decoupling works as expected when the allowed rates of return are kept close to a utility's cost of capital, but it does not work well when utility rates of return exceed the utility's cost of capital.[504] When a utility's rate of return exceeds its cost of capital, its stock price exceeds its book value.[505] The rate of return is multiplied by the utility ratebase to generate revenues that can be used, in part, to pay dividends to shareholders.[506] When rate of return exceeds the cost of raising capital, the dividend yield and the stock price increase. Most utility stocks traditionally have traded at prices substantially in excess of their book values, and about half of utility stocks do so today.[507]

Critics have attacked decoupling and alternative pricing on a variety of other grounds. First, some critics argue that alternative pricing mechanisms that shift the timing of electric usage ignore the wishes of consumers, consequently dooming these mechanisms.[508] Second, critics claim that onlookers have been "wowed" by the prospects of implementing smart technology,[509] but that decoupling rates encourages utilities to engage in conservation and demand-shifting as a way to increase returns.[510] Third, utility rates have traditionally reflected the average cost of transmission and generation of power of the entire service territory,[511] and critics have raised concerns that resources freed up by dynamic pricing in one area will not serve that area, but will instead flow to adjacent service areas.[512] Fourth, critics maintain that because utilities will shift loads to off-peak times, decoupling efforts will yield no net energy conservation.[513] Ralph Cavanagh of the Natural Resources Defense Council stated that, unlike energy conservation, it is not clear that demand-shifting necessarily reduces energy usage, and it could actually increase CO_2 emissions by curtailing the use of cleaner natural-gas fossil fuels.[514] Ultimately, Connecticut rejected full decoupling of retail rates.[515] In 2010, the state Attorney General, industrial companies, Wal-Mart, and others moved to stall decoupling, saying that it could lead to higher utility rates.[516]

1. California Initiatives

Beginning in 1978, California started experimenting with decoupling, hoping that energy efficiency could prevent the construction of new power plants.[517] By creating a robust energy-efficiency industry and various incentives, California has managed to keep per capita electricity usage nearly the same as it was almost thirty years ago, while per capita usage in the rest of the country has increased over fifty percent.[518] The California Public Utilities Commission also reported that its energy-efficiency programs saved enough energy between 2004 and 2007 to prevent the construction of two new 500-megawatt power plants.[519]

During 2001, when California had an energy crisis that prevented it from supplying enough electricity to consumers, consumers voluntarily engaged in aggressive energy conservation.[520] One-third of all residential customers in California reduced their demand by at least twenty percent of their usage in 2000 and qualified for the state's 20/20 rebate program.[521] It is estimated that this conservation saved the equivalent of between 50 and 160 hours of rolling blackouts during the summer of 2001.[522] In August 2001, California ratepayers used 8.4% less electricity during peak periods of the day than during August of the previous year.[523] Almost half of the conservation savings initiated by ratepayers in 2001 persisted through the next year.[524]

In 2007, California worked with four investor-owned utilities to create and implement a risk–reward incentive mechanism ("RRIM") that provides rewards to utilities that make certain energy-efficiency investments.[525] The amount of these rewards is determined by the energy costs avoided by energy-

501. *See id.* ("So utilities see an opportunity to generate electricity and meet renewable electricity standards—possibly even getting emission-offset credits—by renting rooftop spaces, installing their own equipment and owning the electricity that is generated.").
502. Lesh, *supra* note 481 at, 65.
503. *Id.* at 67.
504. Steve Kihm, Energy Ctr. of Wis., When Revenue Decoupling Will Work . . . and When It Won't 2 (2009), *available at* http://www.virtualcap.org/downloads/CIF/Kihm_Decoupling_2009.pdf.
505. *Id.* at 3
506. Ferrey, *supra* note 106 at 556.
507. *Id.*
508. Stefanie A. Brand, *Dynamic Pricing for Residential Electric Customers: A Ratepayer Advocate's Perspective*, Electricity J., July 2010, at 50.
509. *Id.* at 51.
510. Tom Tiernan, *IEE Report Prompts Debate on Efficiency, and Value of Demand Response Distinction*, Electric Util. Wk., Jan. 17, 2011, at 30, 31–32.
511. *See* Brand, *supra* note 508, at 51.
512. *Id.* at 54–55.
513. *Id.*
514. Tiernan, *supra* note 510, at 30–31.
515. Lisa Wood, *Connecticut Regulators Reject Full Decoupling, Slash CL&P's Rate Increase Request by 42.7%*, Electric Util. Wk., July 5, 2010, at 11.
516. Lisa Wood, *Decoupling Foes in Connecticut on the Attack as State Diverts Funds to Close Budget Gap*, Electric Util. Wk., June 28, 2010, at 8.
517. *See* Ronald Brownstein, *The California Experiment*, The Atlantic, Oct. 2009, at 3-11 to 4-11, *available at* http://www.theatlantic.com/magazine/archive/2009/10/the-california-experiment/7666/.
518. Howard Geller et al., *Policies for Increasing Energy Efficiency: Thirty Years of Experience in OECD Countries*, 34 Energy Pol'y 556, 569 (2006).
519. Cal. Pub. Utils. Comm'n, Energy Efficiency and Conservation Programs: Progress Report to the Legislature 5 (2009), *available at* http://docs.cpuc.ca.gov/PUBLISHED/GRAPHICS/104470.PDF.
520. *See* Charles A. Goldman, Joseph H. Eto & Galen L. Barbose, Ernest Orlando Lawrence Berkeley Nat'l Lab., LBNL-49733, California Customer Load Reductions During the Electricity Crisis: Did They Help to Keep the Lights On? 13 &rdquo(2002), *available at* http://eetd.lbl.gov/ea/EMS/reports/49733.pdf.
521. *Id.*
522. *Id.* “at 6.
523. *Id.* at 23.
524. Cal. Energy Comm'n, Revised Energy Conservation Impact Assessment 1 (2003), *available at* http://www.energyarchive.ca.gov/electricity/peak_demand/2002_REVISED_CONSERVATION.DOC.
525. *CPUC Approves Energy Efficiency Incentives for California's Utilities*, Electric Energy Online (Dec. 17, 2010), http://www.electricenergyonline.com/?page=show_news&id=146331.

efficiency measures.[526] The RRIM allows utilities to recover a percentage of the net benefits they achieve through implementation of energy-efficiency measures, so long as the utilities reach a minimum of 85% of the RRIM's goals for saving energy.[527] Furthermore, the program subjects utilities to a penalty if their energy-savings performance falls below 65% of the program's goals.[528] If the utilities achieve between 65% and 85% of the program's goals, then the utilities receive neither penalties nor rewards.[529]

In California in 2004, there were 215 separate energy-efficiency programs, which cost approximately $2.2 billion.[530] Some California utilities are participating in shared-savings plans through which participating utilities that achieve more than the expected baseline conservation earn nine to twelve percent of the savings.[531] Under these programs, if the utilities fail to achieve the baseline goals, there are penalties for each kilowatt–hour sold.[532] Utilities may even have to pay back the capital cost of conservation programs to customers, as opposed to billing the customers for the conservation investments.[533] By 2009, the California Public Utilities Commission had allocated just over $3 billion for the California utilities' efficiency programs,[534] from which the Commission predicted peak savings of approximately 3,500 megawatts.[535] The Commission also projected that these programs would save nearly 7,000 gigawatts of total electricity use[536] and obviate the need to construct three new 500-megawatt power plants for the 2010–12 program cycle.[537]

In February 2008, the California utilities filed their first earnings claim.[538] A draft verification report from the Commission indicated that the utilities owed a penalty of almost $18 million.[539] In August 2008, the utilities petitioned the Commission to authorize the utilities to recover an incentive award from ratepayers totaling $152 million.[540] In late 2008, an administrative-law judge issued two proposed decisions: one called for no incentive rewards to the utilities, and the other reduced the utilities' proposed reward to $108 million.[541] In December 2008, the Commission authorized combined incentive payments of $82 million to the California utilities.[542] Because of the major controversies surrounding the delays, concerns over methodologies used in the verification reports, and the wide range of claimed results of energy-efficiency programs, the Commission opened a new rulemaking proceeding regarding RRIM.[543] The new rulemaking will consider changes to the current RRIM, as well as deliver a final review of program activities from 2006 to 2008.[544]

2. Various Other States

States other than California have also taken significant steps to achieve greater energy efficiency and conservation. One such state is Massachusetts. The Massachusetts Green Communities Act of 2008 requires each utility to prepare an efficiency-investment plan every three years, according to which it will acquire "[a]ll available energy efficiency and demand reduction resources that are cost-effective or less expensive than supply."[545] In addition, the Massachusetts Department of Public Utilities issued an order that established a new base-rate-adjustment mechanism that decouples utility-company revenues from electricity sales.[546] Yet, the Massachusetts Attorney General has argued that adopting decoupling as a rate-adjustment mechanism would effectively render all existing utility-ratemaking incentives superfluous.[547] Arizona also adopted rate decoupling, at the end of 2010.[548] Other states have provided utilities a bonus return on equity for conservation investments.[549] The bonus is tied to a utility's spending on conservation, rather than to power-product sales.[550] This provides incentives for utilities to spend their customers' money when those customers have not elected to spend it themselves.[551]

Rhode Island uses a different mechanism to increase the rate of return to the utility, allowing a utility to earn an incentive profit of 2.75% of annual contract payments under a long-term contract, in addition to its normal rate

526. Comm'n's Energy Efficiency Risk/Reward Incentive Mechanism, No. 10-12-049, 2010 WL 5650685, at *5 (Cal. P.U.C. Dec. 16, 2010).
527. *Id.*
528. *Id.*
529. *Id.*
530. Cal. Pub. Utils. Comm'n, *supra* note 519, at 1.
531. Edward Comer, *Transforming the Role of Energy Efficiency*, 23 Nat. Resources & Env't 34 (2008).
532. *Id.* at 36.
533. *Id.*
534. *See* Cal. Pub. Utils. Comm'n, Fact Sheet: California's Long-Term Energy Efficiency Strategic Plan 1 (2009), *available at* http://www.cpuc.ca.gov/PUC/energy/Energy+Efficiency/eesp/.
535. S. Cal. Edison Co., No. 09-09-047, 2009 WL 3229397, at *23 (Cal. P.U.C. Sept. 24, 2009).
536. *Id.*
537. Cal. Pub. Utils. Comm'n, *supra* note 534.
538. *See* Energy Div., Cal. Pub. Utils. Comm'n, Energy Efficiency 2006–2007 Verification Report 5 (2008), *available at* http://www.cpuc.ca.gov/NR/rdonlyres/D0943818-BF3E-4E17-839A-B2802C16217A/0/EE_Verification_Report_Final_020509.pdf.
539. *Id.* at 65.
540. Tom Roberts, Cal. Pub. Utils. Comm'n, California's Shareholder Incentive Mechanism—a Ratepayer Perspective 4 (2009), *available at* http://www.dra.ca.gov/NR/rdonlyres/A69928B3-DEC3-4FC9-BBB7-3E73C9063DCF/0/TomRoberts2009ACEEEpaperFinalMay292009.pdf.
541. *Update on Regulatory Approaches to Promoting Energy Efficiency*, Nat. Gas Rate Round-Up (Am. Gas Ass'n, D.C.), May 2009, at 6, *available at* http://www.aga.org/SiteCollectionDocuments/RatesReg/RateDesign/0905RegulatoryApproachesPromoting%20EE.pdf.
542. *Id.*
543. Cal. Pub. Utils. Comm'n, White Paper: Proposed Energy Efficiency Risk–Reward Incentive Mechanism and EM&V Activities 3 (2009), *available at* http://www.cpuc.ca.gov/NR/rdonlyres/A51D61E2-DF03-4D9B-BFDB-221109638165/0/ProposedEnergyEfficiencyRiskRewardIncentiveMechandEM_VActivities.pdf%29.
544. *See id.* at 3, 25–26.
545. Massachusetts Green Communities Act of 2008, Mass. Gen. Laws ch. 25, § 21 (2008).
546. *See* Mass. Dep't of Pub. Utils., D.P.U. 07-50-A, Investigation by the Department of Public Utilities on Its Own Motion into Rate Structures That Will Promote Efficient Deployment of Demand Resources 1 (2008), *available at* http://www.ceadvisors.com/publications/Testimony/Ratemaking%20and%20Utility%20Regulation_John%20J.%20Reed%20Decoupling%20Comments%20MA%20DPU.pdf.
547. *Id.* at 34–35.
548. Ethan Howland, *Arizona Regulators Adopt Decoupling Policy Plan to Review Programs After Three Years*, Electric Util. Wk., Dec. 20, 2010, at 29.
549. *Id.*
550. *Id.*
551. *Id.*

of return.[552] Rhode Island eliminates stranded costs for the purchasing utility by allowing it to immediately resell such long-term renewable power in the wholesale spot market.[553]

The Idaho Public Utility Commission in 2007 approved a three-year pilot decoupling program for Idaho's largest power generator, Idaho Power.[554] Under the pilot agreement, Idaho Power's rates for residential and small commercial customers are determined by a fixed cost adjustment that serves, in part, as a "true-up" mechanism.[555] This arrangement helps ensure that Idaho Power recovers its actual fixed costs based upon the number of customers it has in each class, and simultaneously discourages the sale of electricity at prices above the baseline rate.[556] If actual costs exceed expected baseline costs, Idaho Power increases consumer rates; likewise, if true fixed costs are less than the baseline rates collected, Idaho Power rewards its consumers with lower rates.[557]

After the first year, Idaho Power reported a slight overcollection from the baseline-rate case and, accordingly, Idaho Power slightly lowered rates for both of its consumer classes.[558] In the second year, actual revenues were below anticipated levels.[559] As a result, Idaho Power applied for, and received permission for, a 0.82% rate increase to be spread between both customer classes.[560] Although the Idaho Public Utility Commission achieved the reduction in power usage that it sought, it remains to be seen whether this is attributable to the economy or to Idaho Power's energy-efficiency initiatives.

Before moving one additional step along the power transaction to examine time-sensitive retail pricing of power for consumers, the next section looks at other mechanisms that can shift the time of day consumers use electricity, given that electricity is one of the few cost-efficient, non-storable energy sources.[561]

552. R.I. Gen. Laws § 39-26.1-4 (2008).
553. *See id.* § 39-26.1-5(b).
554. *See* Idaho Power Co., 275 Pub. Util. Rep. 4th (PUR) 177 (Idaho P.U.C. May 29, 2009).
555. *See id.*
556. *Id.* To determine rates under this arrangement, the company's fixed-cost portion of its revenue requirement for each customer class is first determined through a general rate case. *See* Idaho Power Co., No. IPC-E-11-03, 2011 WL 2176878, at *1 (Idaho P.U.C. May 31, 2011). This procedure sets the baseline for prospective fixed-cost recovery. *See* Idaho Power Co., 256 Pub. Util. Rep. 4th (PUR) 322 (Idaho P.U.C. Mar 12, 2007). Once actual fixed costs per customer are determined, the true-up mechanism is implemented to determine the difference between the baseline and the true fixed costs. *See id.*
557. *See id.*
558. Idaho Power Co., Demand-Side Management Annual Report 2008, at 71 (2009), *available at* http://www.idahopower.com/pdfs/EnergyEfficiency/Reports/2008DSMAnnualReport.pdf.
559. *Id.*
560. *See* Idaho Power Co., 275 Pub. Util. Rep. 4th (PUR) 177 (Idaho P.U.C. May 29, 2009).
561. Ferrey, *supra* note 106, at 542.

E. *Demand-Side Management as a Conservation Mechanism*

1. A Tool to Complement Storage

DSM is an umbrella term used to encompass the efforts of power suppliers to influence the timing and scope of the demand for their power supplies.[562] DSM with regard to electric power is a unique issue because electricity cannot be stored efficiently and will be lost if not used immediately.[563] Because access to solar and wind resources is not uniform across the country,[564] DSM techniques play an important role in locally disbursing the impacts of conservation of fossil-fuel resources used in power generation.[565]

Although it is possible to store electric power in batteries, is not particularly cost-effective to do so.[566] To run a laptop computer, a flashlight, or other tool, stored electricity is worth its premium cost.[567] For day-to-day storage of power, however, bulk battery storage has not yet proven to be cost-effective when compared to traditional supply.[568]

Common DSM load-shape objectives include so-called peak clipping, to reduce demand at peak times;[569] valley-filling, which encompasses increasing off-peak loads;[570] load-shifting, or shifting loads from on-peak to off-peak periods;[571] conservation, the load-shape change that results from a reduction in sales as well as a change in the pattern of use;[572] and flexible load-shaping, which is related to reliability.[573]

DSM's effects on consumer use differ in the residential sector and the commercial sector. Residential DSM savings will

562. Charles River Assocs., World Bank, CRA No. D06090, Primer on Demand-Side Management with an Emphasis on Price-Responsive Programs 6 (2005), *available at* http://siteresources.worldbank.org/INTENERGY/Resources/PrimeronDemand-SideManagement.pdf.
563. Ferrey, *supra* note 106, at 542.
564. *See* David C. Hoppock and Dalia Patiño-Echeverri, *Cost of Wind Energy: Comparing Distant Wind Resources to Local Resources in the Midwestern United States*, 44 Envtl. Sci. & Tech. 8758, 8758 (2010); *supra* Part II.D.1.
565. *See* Charles River Assocs., *supra* note 562, at 7–9.
566. Ferrey, *supra* note 310, § 2:20.
567. Sidney A. Shapiro & Joseph P. Tomain, *Rethinking Reform of Electricity Markets*, 40 Wake Forest L. Rev. 497, 505 (2005) (discussing high cost of producing electricity and the difficulty in storing it).
568. Ferrey, *supra* note 310, § 2:20.
569. *Id.* § 3:23 n.2 ("Peak clipping reduces demand at peak times . . . .").
570. *Id.* § 3:23 n.3 ("Valley filling is a classic form of load management. Valley filling encompasses increasing off-peak loads. This may be particularly desirable where the long-run incremental cost is less than the average price of electricity. Adding properly priced off-peak load under those circumstances decreases the average price.").
571. *Id.* § 3:23 n.4 ("Load shifting also is a classic form of load management. This involves shifting load from on-peak to off-peak periods. Applications include use of storage water heating, coolness storage, and customer load shifts.").
572. *Id.* § 3:23 n.5 ("Conservation is the load shape change that results from a reduction in sales as well as a change in the pattern of use. In employing energy conservation, the utility planner must consider what conservation actions would occur naturally and then evaluate the cost-effectiveness of possible intended utility programs to accelerate or stimulate those actions. Examples include weatherization and appliance efficiency improvement.").
573. *Id.* § 3:23 n.6 ("Flexible load shaping is a concept related to reliability. Load shape can be flexible if customers are presented with options as to the variations in quality of service that they are willing to allow in exchange for various incentives. The programs involved can be variations of interruptible or curtailable load concepts of pooled, integrated energy management systems or individual customer load control devices offering service constraints.").

be concentrated in the space-heating, water-heating, space-cooling, and lighting end uses, as well as heating-equipment tune-ups.[574] Commercial-sector DSM energy impacts are concentrated in indoor-lighting, heating, space-cooling, and whole-building end uses.[575]

The cost of implementing DSM programs is less than the cost of building new generating facilities to supply additional power.[576] For example, weatherization as a conservation measure returns fifty percent more in energy-related benefits than the cost of the investment, according to a study by the U.S. Department of Energy's Oak Ridge National Laboratory.[577] Similarly, in one region, power supplied through installation of high-efficiency equipment cost between one-quarter to one-half the price of power supplied from new power plants, on average.[578] These savings in the cost of power supply, which is only an input to the provision of societal goods and services, have significant secondary effects, including reducing the national debt and controlling costs.[579] Power-supply cost-controlling strategies free investment dollars for other opportunities[580] and promote national security by reducing reliance on imported oil.[581]

There has already been a substantial reduction in energy use per unit of GDP produced in the United States over the past decades.[582] Residential electricity use per customer, however, has generally continued to increase over the past sixty years.[583]

2. Storage of Electric Energy Equivalents

In addition to storing electricity in batteries, discussed above,[584] there are other ways to store power—in nonelectric equivalents, including through chemical storage, compressed air, or spinning flywheels.[585] As for spinning flywheels, in 2010, the U.S. Department of Energy provided a $43 million loan guarantee for a Treasury Department loan to acquire a twenty-megawatt flywheel energy-storage application owned by Beacon Power.[586] Although the technology is maturing, regulatory issues remain.[587] For example, several energy-systems operators nationwide treat all electricity-storage systems identically, categorically excluding them from the definition of "station power," in part for accounting purposes.[588]

As for storing potential electricity, "[p]umped storage is the largest-capacity and most cost-effective form of grid energy storage available."[589] With an ordinary dam, one can hold water behind the dam until peak times of power demand, typically on afternoons when most electric appliances are operating, and then release the water through hydroelectric water turbines to produce power.[590] Power has more value, and the retail cost of power can be more expensive, at peak times.[591]

A pumped-storage hydroelectric-power-generation facility is a special type of dam that has added benefits in terms of addressing consumer demand without construction of additional generation units. This type of facility, which was invented in the 1930s,[592] has an elevated reservoir connected to a lower reservoir by a long tunnel through which the water falls, turning generators at the bottom.[593] At times of low demand and low value of power, the facility operators can reverse the tunnel pumps to move the water from the lower

574. Ahmad Faruqui et al., *Clouds in the Future of DSM,* Electricity J., July–Aug. 1994, at 58.

575. *Id.* at 60. Industrial-sector DSM energy impacts are concentrated in motor-drive improvements and whole-plant innovations. *Id.* at 62.

576. *See* Douglas Norland, *Comprehensive Assessment of a Conservation and Load Reduction Program: Results of the General Public Utilities Case Study*, 6 ACEEE 1988 Summer Study on Energy Efficiency Buildings 6.166, 6.175– (1988). ("The Cost to [General Public Utilities] of a rebate program producing the greatest reduction in revenue requirements is $272 million, of which $21 million is for administrative costs and $251 million is for rebate payments (all in 1985 dollars). . . . This cost is less than that of constructing a comparable power plant (estimated at $525 million for 350 MW at $1500 per kW). It, however, covers the cost of operation (which is not reflected in the power plant construction cost). It also is recoverable immediately (assuming expensing), produces immediate net benefits, and reduces revenue requirements on a net basis rather than increasing them.").

577. *Low-Income Energy Efficiency Programs are Revenue Builders, Experts Suggest,*” Electric Util. Wk., June 12, 2006, at 18.

578. *See* Florentin Krause et al., Ernest Orlando Lawrence Berkeley Nat'l Lab., LBNL-30797, 1 Incorporating Global Warming Risks in Power Sector Planning: A Case Study of the New England Region, at ES-4 to -5 (1992).

579. *See* Flavin & Durning, *supra* note 374, at 9.

580. An efficiency improvement strategy would lower costs and increase the predictability and stability of rates in New England. *See* New Eng. Energy Policy Council, Power to Spare, A Plan for Increasing New England's Competitiveness Through Energy Efficiency 15 (1987). Unlike conventional power plants, efficiency improvements need not be purchased in large, indivisible "chunks," but can rather be purchased in kilowatt increments. This means that a region need not commit itself to enormous long lead time capital investments subject to radical swings in demand, interest rates, construction costs, regulatory requirements, and other factors that inflate costs and may ultimately lead to plant abandonment. *Id.*

581. Flavin & Durning, *supra* note 374 at 45 ("Relying on imported oil entails a national security cost that is not included in market prices. In recognition of this, industrial countries have wisely spent billions of dollars building 'strategic petroleum reserves.' The U.S. has filled salt caverns in Louisiana with stockpiled oil, while Japan has a fully loaded tanker fleet in Tokyo Bay. More dubiously, the U.S. alone spent $47 billion to defend the Middle East region in fiscal year 1985. This comes to $26 per barrel of oil shipped through the Strait of Hormuz.").

582. *See Daily Chart: Power Slide*, Economist (Jan. 19, 2011), http://www.economist.com/blogs/dailychart/2011/01/energy_use/print. For an explanation of the energy use per unit of GDP statistic, see *Consumption and Production Patterns*, United Nations Dep't Econ. & Soc. Aff. (Mar. 24, 2003), http://www.un.org/esa/sustdev/sdissues/consumption/cpp1224m2.htm.

583. U.S. Energy Info. Admin., DOE/EIA-0384(2009), Annual Energy Review 2009, at 41 (2010), *available at* http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf.

584. *See supra* notes 566–568 and accompanying text.

585. *See* Ferrey, *supra* note 310, § 2:20.

586. Herman Wang, *DOE Completes $43 Million Loan Guarantee with Beacon for 20-MW Flywheel Storage System*, Electric Util. Wk., Aug. 16, 2010.

587. *See, e.g.*, Craig Cano, *PJM Changes Would Treat Rapid-Response Storage Devices like Other Storage Resources*, Electric Util. Wk., July 19, 2010.

588. *See id.*

589. *See* Richard Winters & Maureen Miller, *Opportunities for Pumped Storage: Supporting Renewable Energy Goals*, Hydro Rev., July 2009, *available at* http://www.hydroworld.com/index/display/article-display/366365/articles/hydro-review/volume-28/issue-5/Featured_Articles/energy-storage-opportunities-for-pumped-storage-supporting-renewable-energy-goals.html.

590. *See id.*

591. *See* Ahmad Faruqui et al., Inst. for Electric Efficiency, Moving Toward Utility-Scale Deployment of Dynamic Pricing in Mass Markets 3 (2009), *available at* http://www.brattle.com/_documents/uploadlibrary/upload779.pdf.

592. *See Developing Hydro: Pumped Storage*, Nat'l Hydropower Ass'n, http://hydro.org/tech-and-policy/developing-hydro/pumped-storage/ (last visited July 20, 2011).

593. *See id.*

reservoir back to the upper reservoir.[594] Water is heavy to lift, so this consumes significant amounts of electric power to run the pumps.[595] Yet, if this is done when the off-peak demand for power is low and the price is relatively low, with the goal of producing additional electricity during peak-demand periods, then this process essentially arbitrages the position of the water to convert low-value power to high-value power, and to meet consumer demand without constructing additional generation units.[596] There are thirty-nine pumped-storage projects operating in the United States, which provide more than twenty gigawatts of power, or nearly two percent of the capacity of our nation's energy-supply system.[597] The combined energy capacity of pumped-storage and conventional hydroelectric plants accounts for seventy-seven percent of our nation's renewable-energy capacity, and represents the greatest capacity and most cost-effective form of grid-energy storage currently available.[598] Pumped-storage systems also provide ancillary electrical-grid services for frequency control and reserve generation.[599]

A developer recently sought permits to construct four pumped-storage facilities that would create an additional 2,100 megawatts of pumped-storage capacity in or near four different states,[600] and there are examples of this sort of development in several states. Massachusetts has two significant pumped-storage facilities on the Deerfield and Connecticut rivers in the western part of the state. The Bear Swamp facility on the Deerfield River is an approximately 625-megawatt facility,[601] while the Northfield Mountain facility generates more than 1,000 megawatts.[602] Northfield Mountain was the largest pumped-storage facility in the world when it went into service in 1972.[603]

Hydroelectric facilities are exclusively subject to FERC licensing for their operation, because they are located on "navigable" waters as defined in the Federal Power Act.[604] Federal licenses can last for 50 years[605] and may be renewed.[606]

3. Potential Extent of Energy Conservation Through DSM

Although reductions in energy use due to DSM techniques may seem small when viewed from the level of individual consumers, such small differences add up to make a significant difference. The Keystone Center, a nonprofit organization headquartered in Keystone, Colorado,[607] estimated that the DSM possibilities between 2007 and 2010 were over 230 terawatt–hours, or the equivalent of 5.5% of the forecasted electric-power requirements in 2010.[608] This total DSM potential could trim 7.5% of peak electric consumption.[609] NERC estimates that interruptible-load and direct-control-load management reduces national summer peak consumption by about 2.5%.[610] In 2006, FERC assessed the demand-response potential within the United States and found that it was 37,500 megawatts.[611] Although this potential may seem small, a few percentage points of reduction, if they are available when needed, can make a significant difference in the operation of a power system.[612]

DSM can also benefit the U.S. power system as a whole in several other ways. Reducing peak demand can have more than a merely proportional decrease in consumer costs.[613] Some have suggested that demand-response resources might be able to reduce or fill the power-supply gap when intermittent solar PV resources are not available.[614] In the 2008 ISO New England forward-capacity auction, new demand-response-resource bids totaled 1,188 megawatts, and existing demand-response-resource bids totaled 1,366 megawatts.[615] These demand-response and DSM bids to reduce power demand totaled almost eight percent of total current peak load in the region.[616] Correspondingly, NERC has recommended that "[p]olicymakers and regulators . . . consider the impacts on bulk power system reliability as part of their development of legislation and regulation processes," requiring more certainty of DSM contributions and remaining present generation resources.[617]

594. *See id.*
595. *See id.*
596. *See id.*
597. Paul Denholm et al., Nat'l Renewable Energy Lab., NREL/TP-6A2-47187, The Role of Energy Storage with Renewable Electricity Generation 8 n.14, 43 & n.78 (2010), *available at* http://www.nrel.gov/docs/fy10osti/47187.pdf; *see also* Winters & Miller, *supra* note 589.
598. *See* Winters & Miller, *supra* note 589.
599. *Id.*
600. Esther Whieldon, *GridFlex Seeks Permits for Pumped Storage Projects to Help Balance Wind, Solar Output*, Electric Util. Wk., Oct. 18, 2010, at 25.
601. *Bear Swamp Project*, BerkshireWeb, http://www.berkshireweb.com/sports/comp/bearswamp.html (last visited July 21, 2011).
602. *An NU Timeline*, Northeast Util., http://www.nu.com/aboutnu/timeline.asp (last visited July 21, 2011) (discussing Northfield Mountain in Northeast Utilities plan).
603. *Northfield Mountain Station*, FirstLight Power Resources, http://www.firstlightpower.com/generation/north.asp (last visited July 21, 2011).
604. Ferrey, *supra* note 310, § 5:48.
605. Federal Power Act, 16 U.S.C. § 808(e) (2006).
606. *Id.* § 808(a).
607. *See About Us*, Keystone Center, http://www.keystone.org/about-us (last visited July 21, 2011).
608. Gellings, Wikler & Ghosh, *supra* note 390, at 55.
609. *Id.* at 56.
610. N. Am. Electric Reliability Corp., 2009/2010 Winter Reliability Assessment 154 (2009), *available at* http://www.nerc.com/files/Winter2009-10.pdf.
611. Jon Wellinghoff et al., FERC, *Creating Regulatory Structures for Robust Demand Response Participation in Organized Wholesale Electric Markets*, 5 ACEEE Summer Study on Energy Efficiency Buildings 5-342 (2008).
612. *See id.* at 5-339 ("[I]f U.S. peak demand were to be reduced by 5 percent, the long-term benefits to consumers over a twenty-year horizon would have a net present value of $35 billion.").
613. *See id.*
614. Aimee E. Curtright & Jay Apt, *The Character of Power Output from Utility-Scale Photovoltaic Systems*, 16 Progress Photovoltaics: Res. & Applications 241, 245 (2008).
615. *See* Press Release, ISO New Eng., Wholesale Marketplace Helping to Achieve Long-Term Power System Reliability Goals (Feb. 13, 2008), http://www.iso-ne.com/nwsiss/pr/2008/press_release_fcm_auction_results_02_13_08.pdf.
616. *See id.*
617. N. Am. Electric Reliability Corp., Reliability Impacts of Climate Change Initiatives: Technology Assessment and Scenario Development, at II (2010), *available at* http://www.nerc.com/files/RICCI_2010.pdf.

DSM has few negative implications for utility systems if implemented cost-effectively. The extent of utility DSM efforts is positively correlated with the support of state regulators for energy conservation.[618] There is also a positive correlation between the near-term need for additional peaking capacity and support for DSM.[619] Finally, when utilities are directly rewarded for DSM activities by state regulators, or allowed to share in the savings earned by DSM investments, utilities invest more in DSM initiatives.[620] Regarding the accuracy of estimation and reward, FERC is investigating four industrial demand-response participants— including two paper manufacturers in New England that were being paid to provide demand reductions to the grid in times of shortage—for having inflated their load levels to make it appear that they had reduced their demand from higher levels in order to earn greater payments.[621]

F. *Time-Sensitive, Time-of-Use Pricing for Electricity*

Time-sensitive power pricing to retail consumers is the primary mechanism by which incentives and smart meters are employed to implement DSM. This practice has also caused some disputes among consumers.[622]

Electricity is a unique commodity in the world in two special regards. First, energy is a unique force in the universe. This is more than $E = mc^2$. Energy is critical, whether in the form of coal, which powered the industrial revolution,[623] oil, which powers modern transportation and special land-use development patterns,[624] or electricity, the essential energy source for the information age and operation of modern electronic equipment.[625] Electricity is the signature technology of the modern era.[626]

Second, electricity, unlike all other forms of energy, cannot be efficiently stored for more than a second without being lost as waste heat.[627] Therefore, the supply of electricity must match the demand for electricity over the centralized utility grid of a nation on an instantaneous basis, or else the electric system shuts down or expensive equipment is damaged.[628]

The cost of producing electricity varies greatly hour by hour.[629] Yet, this volatile price is not instantaneously reflected in rates perceived or paid by most consumers.[630] The current rate structure in most states for residential consumers is flat, meaning these consumers pay the same for the kilowatt–hour of electricity purchased during a hot midsummer day as they do for the kilowatt–hour consumed at 4:00 a.m. [631]

While the retail cost to the consumer stays the same under a flat-rate structure, the cost to the utility to produce the power is dramatically time-sensitive.[632] Baseload generation is usually provided by a coal-fired plant, and these plants run continuously because they have long startup and cooldown periods.[633] When demand for electricity rises, more plants must come online to meet that demand, and those secondary generators are typically natural-gas- or oil-fired generators.[634] Such secondary generators are expensive to build and run, but they may only be online for about one percent of the total operating hours of the year.[635] Thus, if peak demand can be lowered significantly enough to prevent the construction of these facilities, then customers can avoid bearing the bill for the construction of generators whose purpose will only be to meet peak demand.

This model may change. Now, electricity can be priced at the actual time-sensitive cost of its production and delivery.[636] In the Energy Policy Act of 2005, Congress supplemented the measures that states were required to consider with a requirement that electric utilities offer customers a "time-based rate schedule under which the rate charged by the electric utility varies during different time periods and reflects the variance, if any, in the utility's costs of generating and purchasing electricity at the wholesale level."[637] Congress also required electric utilities to "enable the electric consumer to manage energy use and cost through advanced metering and communications technology."[638] This billing method would track and pass on the higher costs during peak times to the consumer, who could then adjust his or her consumption accordingly or adopt conservation practices to defer discretionary consumption during high-price peak times.[639] Note that states are not required to implement time-based rate schedules or any of the other standards listed in the Energy Policy Act, but merely to consider them and to determine whether their implementation is appropriate to further the purpose of the statute.[640]

Discretionary consumption typically includes the use of air conditioning, clothes washing and drying, dishwasher operation, and the use of certain consumer appliances and lighting.[641] Peak-load pricing or time-of-day pricing is typically voluntary under current state regulations,[642] affecting few

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618. *See* Martin Schweitzer & Timothy R. Young, *The Effects of State Regulation on the Use of DSM Resources by Electric Utilities*, Electricity J., Oct. 1995, at 37, 38–.
619. *See id.* at 39.
620. *See id.* at 40.
621. *See* Esther Whieldon, *After Clarifying Investigation Procedures, FERC Reveals Five Ongoing Investigations*, Electric Util. Wk., Jan. 31, 2011, at 6, 6–7.
622. *See Welcome, Smart Meters*, *supra* note 70, at 3.
623. *See A Brief History of Coal Use*, U.S. Dep't Energy, *available at* http://fossil.energy.gov/education/energylessons/coal/coal_history.html (last visited July 21, 2011) (discussing role of coal in the industrial revolution).
624. *See* Ferrey, *supra* note 106, at 538, 541.
625. *See id.* at 539–43.
626. *See id.* at 541.
627. *Id.* at 542.
628. *See* Ferrey, *supra* note 75, at 149–50.
629. *See Welcome, Smart Meters, supra* note 70.
630. *Id.*
631. *Id.*
632. *Id.*
633. *See* U.S. Energy Info. Admin., DOE/EIA-0562(00), The Changing Structure of the Electric Power Industry 2000: An Update 8–13 (2000), *available at* http://www.eia.gov/cneaf/electricity/chg_stru_update/update2000.pdf (discussing the difficulty of bringing baseload generators online and offline, and discussing coal as the primary source for U.S. generation because of its use as a baseload-generation fuel).
634. *Id.*
635. Faruqui et al., Inst. for Electric Efficiency, *supra* note 591, at 2.
636. *See id.* at 5.
637. Energy Policy Act of 2005 § 1252(a), 16 U.S.C. § 2621(d)(14) (2006).
638. *Id.*
639. *See* Faruqui et al., Inst. for Electric Efficiency, *supra* note 591, at 8.
640. Energy Policy Act of 2005 § 1252(a).
641. *See* Catherine McDonough & Robert Kraus, *Does Dynamic Pricing Make Sense for Mass Market Customers*, Electricity J., Aug.–Sept. 2007, at 30.
642. *See* Alexander, *supra* note 176, at 42–43.

retail residential consumers despite its rational approach.[643] Several states also shield certain classes of consumers from the real cost of power by issuing discounts to low-income consumers or elderly consumers.[644] The case for real-time or time-of-day pricing to achieve conservation in the residential sector is still being tested.[645]

Officials are exploring peak-load pricing as one type of real-time pricing designed to help meet peak demand.[646] This billing method would pass on the higher costs during peak times to consumers, who could then adjust their behavior accordingly.[647] Participating consumers could then respond by cutting their usage during the peak time.[648] By combining peak-load pricing with smart-grid applications, consumers would be able to adjust their energy usage according to real-time prices.[649] Ideally, a consumer would put off energy-intensive tasks until utility rates reached lower levels.[650] Another positive outcome of this prospective method of real-time pricing would be that consumers could choose to turn off appliances when rates were at their highest.[651]

Connecticut, California, Illinois, New York, and Pennsylvania have mandated real-time pricing.[652] Chicago experimented with real-time pricing for residential consumers through its Energy Smart Pricing Plan.[653] One study of this program determined that savings per consumer household would be only one to two percent of the household's annual electricity expenditure, or approximately $10.[654] The study also determined that, for the test group of residential consumers, the elasticity of consumer demand improved when the consumers had access to real-time price signals.[655] What remains to be demonstrated in practice is whether these usage reductions make the high up-front investment in smart meters cost-effective.[656]

Commonwealth Edison, a Chicago utility, is experimenting with equipping 100 different households with rooftop solar panels, a smart meter, and real-time pricing based on the wholesale electricity market.[657] Its consumers will be able to sell their excess electricity back to the grid at wholesale rates.[658] The experiment is partly funded by a $5 million stimulus grant from the U.S. Department of Energy and a $3 million investment by the utility and its subsidiaries.[659]

In California, utilities have experimented with critical-peak pricing ("CPP"), which sets a new rate structure when market conditions meet certain thresholds.[660] The three investor-owned utilities in the state conducted a statewide pricing pilot from July 2003 to December 2004.[661] About 2,500 residential and small and medium commercial and industrial customers participated in the program. The statewide average reduction in electricity use amounted to 13.1% on critical days and 4.7% on noncritical days.[662] Households that had sophisticated end-use controls were able to cut their baseload by 41% during these critical periods; household consumers with varied incomes and electricity demands all responded positively to CPP by lowering their peak demand and, in turn, their monthly bills.[663]

Idaho Power has been experimenting with peak-load management by working with farmers to cut their power

643. *Id.*
644. Ferrey, *supra* note 310, § 10:12.1.
645. *See* Hunt Alcott, *Rethinking Real-Time Electricity Pricing* 18 (MIT Ctr. for Energy & Envtl. Policy Research, Working Paper No. 2009-015, 2010), *available at* http://web.mit.edu/allcott/www/Allcott%202010%20-%20Rethinking%20Real-Time%20Electricity%20Pricing.pdf (discussing the fact that although one study of residential real-time pricing showed promise, there were several variables that cautioned against a conclusion that similar results could apply to the residential population as a whole).
646. Michael A. Crew, Chitru S. Fernando & Paul R. Kleindorfer, *The Theory of Peak-Load Pricing: A Survey*, 8 J. Regulatory Econ. 215, *passim* (1995).
647. *Critical-peak pricing* involves a high peak-demand electricity rate that can replace a lower base rate during a small, predetermined number (typically on the order of one hundred) of critical hours on a predetermined number of days within a year. *See Time-of-Use and Critical Peak Pricing,* Energy Insights, *available at* http://www.aeic.org/load_research/docs/12_Time-of-Use_and_Critical_Peak_Pricing.pdf (last visited July 21, 2011). *Peak-time rebate* programs are a variation of CPP programs; instead of paying a higher rate during peak hours, customers receive a rebate if they reduce their electricity use during peak hours with respect to a pre-determined baseline. *Id.*

Real-time pricing is the ideal form of dynamic pricing from a price-signal perspective. Severin Borenstein, *Electricity Pricing that Reflects Its Real-Time Cost*, NBER Reporter (Nat'l Bureau of Econ. Research, Cambridge, Mass.), 2009, at 9, 9, *available at* http://www.nber.org/reporter/2009number1/2009number1.pdf. Real-time pricing links retail prices directly to wholesale prices on an hourly basis or on even shorter time scales. *Id.*

Time-of-use ("TOU") rate structures assign different electricity prices to different periods during the day and year based on estimates of the actual electricity demand during these time periods that are derived from statistical data previously gathered. *See Time-of-Use and Critical Peak Pricing*, Energy Insights, *available at* http://www.aeic.org/load_research/docs/12_Time-of-Use_and_Critical_Peak_Pricing.pdf (last visited July 21, 2011). In a strict sense, TOU pricing is not dynamic, as it does not depend on the actual, real-time system load. *Id.* However, it provides a reasonable approximation of actual energy cost at given times and generally incentivizes load shifting to off-peak hours, which, in turn, can result in reduced peak capacity. *Id.* TOU does not require advanced metering technology, and has been in use for about three decades. *Id.*
648. *See* Faruqui et al., Inst. for Electric Efficiency, *supra* note 591, at 3.
649. *See* Alcott, *supra* note 645, at 2.
650. *See id.*
651. *See id.*
652. Brown & Salter, *supra* note 74, at 13.
653. Alcott, *supra* note 645, at 18.
654. *Id.* at 18–19.
655. *Id.* at 18.
656. *See id.* (discussing ways in which test group may not reflect the practices of residential consumers as a whole).
657. Sandra Guy, *ComEd Puts Solar to the Test*, Chi. Sun-Times, March 1, 2010, at News 20.
658. *Id.*
659. *Id.*
660. Karen Herter, *Residential Implementation of Critical-Peak Pricing of Electricity,* 35 Energy Pol'y 2122 (2007).
661. Faruqui et al., Inst. for Electric Efficiency, *supra* note 591, at 13. The participants were divided into three groups, which were charged electricity rates according to three respective pricing schemes: TOU pricing, CPP with a fixed peak price on critical days, and CPP with a variable peak price. *Id.* Under the TOU rate, the average peak-period price was about $0.22 per kilowatt–hour, and the average off-peak rate was about $0.09 per kilowatt–hour. *Id.* at 14. While customers responded to the higher peak price during the summer months of 2003 by reducing their electricity use during peak hours by about 5.9%, no similar impact was found during 2004. *Id.* Customers participating in CPP were notified of critical hours a day in advance (for fixed peak pricing) or the day of (for variable peak pricing). *Id.* at 13. On noncritical days, they were charged TOU rates. *Id.* Under the fixed CPP rates, electricity cost $0.59 per kilowatt–hour during peak periods on critical days, $0.22 per kilowatt–hour during peak periods on noncritical days, and $0.09 per kilowatt–hour during off-peak times. *Id.* at 13-14.
662. *Id.* at 13. The variable peak price was, on average, $0.65 per kilowatt–hour, and the off-peak price was $0.10 per kilowatt–hour. Peak energy-use reductions were sixteen percent among customers who had not participated in the prior pilot, and twenty-seven percent among those who had. *See id.* at 14.
663. Herter, *supra* note 660, at 2122, 2127–28.

usage during peak times.[664] In Idaho, the water pumps used by farmers to pull water from nearby rivers to irrigate their crops use a large amount of electricity.[665] Crop irrigation is responsible for twelve percent of Idaho Power's electricity consumption and can account for up to twenty-three percent of the load during peak hours.[666] The utility arrangement allowed farmers who participated in the program and agreed to let Idaho Power shut off their pumps during peak demand hours to realize savings of close to thirty percent on their utility bills.[667] By using these demand management programs, Idaho Power has been better able to meet peak demand, although it has not been able to completely avoid building new power plants.[668]

Consumer acceptance of dynamic pricing is not assured. An April 2010 report by Accenture revealed that 52% of respondents in the United States were concerned about higher bills resulting from utilities' management of consumers' energy usage, 40% were concerned that the utility would arbitrage their power at a profit to the utility, and 38% were concerned about data privacy.[669] 32% expressed concern over decreased comfort in their homes.[670]

If presented correctly, the concept of time-of-use pricing is not alien in the modern utility context. People are quite used to telephone service being priced at peak and off-peak times. Likewise, "[e]nergy prices vary. Oil prices go up and down, as do natural-gas prices, especially during cold winter spells. . . . But when it comes to electricity, prices fluctuate a *lot,* and not just daily or seasonally but hourly."[671] So the concept of time-of-use power pricing has analogies with other key modern utilities, offered today in an unregulated market. To the extent that power is deemed a service rather than a commodity,[672] peak-time services are familiar to consumers.

IV. Conclusion

A nation's policy and investment choices are especially important when they relate to critical electricity infrastructure that will last for a century. There are recent major congressional and administration initiatives for a "smarter" grid and more reliance on energy efficiency as a means to change the energy infrastructure of the nation and address emissions of greenhouse gases.[673] The federal government is pouring billions of stimulus dollars into these energy investments.[674] Yet:

- On the utility side of the meter, lack of federal or regional power-transmission authority to reach new, renewable power supplies impedes the construction of a "new" integrated national grid, as do state differences of opinion on transmission infrastructure.[675]
- Whether producers or all consumers bear the cost of grid extensions to reach often-remote renewable power has been a substantial, ongoing policy dispute.[676]
- The current grid configuration cannot yet adequately address and backstop the intermittency of many of the new renewable power-generation resources because of a lack of reliable quick-start power-supply resources.[677]
- Critics are skeptical of certain expensive new initiatives because power-sector restructuring and retail power competition will not necessarily result in substantial decreases in consumers' residential power bills.[678]

Energy-efficiency and conservation efforts have not encountered similar barriers.[679] Energy efficiency and conservation are not subject to the legal challenges that have beset the regulatory promotion of renewable energy and the new grid, for several reasons related to implementation on the consumer side of the retail meter and lack of coverage in the Federal Power Act.[680]

First, subsidies or requirements for energy efficiency do not attempt to regulate the price or terms of power-market sales and do not implicate the Federal Power Act.[681] Second, energy efficiency is less controversial because it delivers the capital investment on the ratepayer's side of the meter,[682] while grid incentives deliver subsidies to private companies that then charge ratepayers for their power-supply services.[683] Third, energy efficiency is dispersed; the expenditures per installation for energy efficiency tend to be less than the larger expenditures per installation for power and grid improvements.[684] Moreover, the winners and losers of public subsidies for efficiency are not as clearly demarcated as they are with selective, subsidized power-supply investments.[685]

664. Kate Galbraith, *Why Is a Utility Paying Customers?*, N.Y. Times, Jan. 23, 2010, at BU1, *available at* http://www.nytimes.com/2010/01/24/business/energy-environment/24idaho.html?pagewanted=2&_r=1&sq=Kate%20Galbraith,%20Why%20is%20a%20Utility%20Paying%20Customers?&st=cse&scp=3.
665. *Id.*
666. *Id.*
667. *Id.*
668. *See id.*
669. Tom Tiernan, *Accenture: Consumers Will Drive A Hard Bargain in Exchange for Giving Up Control of Their Usage*, Electric Util. Wk., April 26, 2010, at 30. The report also revealed that consumers trust academic organizations most, consumer associations second, environmental associations third, their utilities fourth, and government organizations last when comparing consumer trust in those five groups to advise consumers on efficiency and conservation plans. *Id.*
670. *Id.*
671. *Welcome, Smart Meters*, *supra* note 70, at 3.
672. On the distinction between services and goods in characterizing power, see Ferrey, *supra* note 84, *passim*.
673. *See, e.g.*, *supra* notes 127–130, 406 and accompanying text.
674. *See, e.g.*, Press Release, White House Office of the Press Sec'y, *supra* note 119 (discussing the U.S. Department of Energy's $3.4 billion in grant awards for smart-grid projects—awards that are part of the American Recovery and Reinvestment Act of 2009); *supra* notes 116–126, 131–136, 392–396 and accompanying text.
675. *See supra* Part II.D.2.
676. *See supra* Part II.D.1–2.
677. *See supra* Part II.E.1–2.
678. *See supra* notes 186–188 and accompanying text.
679. *See supra* Part I.B.
680. *See* Ferrey et al., *supra* note 10, at 125.
681. *See supra* notes 199–204 and accompanying text.
682. *See supra* Part I.B..
683. Ferrey et al., *supra* note 10, at 135.
684. For treatment of the politics of climate-control and renewable-energy incentives comparing the European Union and the United States, see Cameron Ferrey & Steven Ferrey, *Past is Prologue: Recent Carbon Regulation Disputes in Europe Shape the U.S. Carbon Future*, 16 Mo. Envtl. L. & Pol'y Rev. 650 (2009).
685. *See supra* Part III.B.

Fourth, there is a history of shared federal and state legal authority over energy efficiency and the power grid, precisely because the grid is dispersed and efficiency is on the customer side of the grid meter and not on the regulated side of the meter.[686] The Federal Power Act of 1935 covers power sale and transmission[687] but does not cover or restrict conservation.[688] Conservation on the customer side of the meter is neither the wholesale nor interstate sale of power, and no jurisdictional provisions of the Federal Power Act are triggered.[689]

This is not true with renewable-power incentives enacted at the state level. Incentive tariffs to procure renewable power at the state level risk the type of constitutional challenges[690] that were recently successful against California programs[691] and New York climate-control programs.[692] Incentive credits at the state level for renewable-power generation cannot discriminate in favor of in-state power generators, as many states do.[693] Promoting certain generation technologies through state regulation of climate change also risks legal challenge.[694] Energy-conservation measures confront none of these legal challenges when implemented at the state level.[695] Therefore, not only is it more cost-effective than alternatives, but it also avoids potential legal minefields under the American constitutional system. It becomes an obvious state option.

With aspects of renewable-energy promotion and the "new" grid tied up in Congress, the courts, or state–federal jurisdictional conflicts,[696] efficiency measures are a very cost-effective option that faces fewer roadblocks. There will likely be more court challenges to existing statutes and regulations, with recent suits in New Jersey, Massachusetts, Missouri, Rhode Island, and Colorado, and continued disagreement in Congress on federal energy legislation affecting renewable-energy options and mechanisms for their promotion. Yet, it will be through the resolution of these legal issues—not technological issues—that our country will sculpt its own energy future.

686. *See supra* notes 178, 207 and accompanying text.
687. Federal Power Act of 2005, 16 U.S.C. § 824 (2006).
688. *See id.*
689. *Id.*
690. Ferrey et al., *supra* note 10, at 180–95.
691. *Id.* at 195–200; S. Cal. Edison Co., 133 FERC ¶ 61,059 (Oct. 21, 2010).
692. *See* Indeck Corinth, L.P. v. Paterson, No. 10-E-0025, 2010 WL 2021947, (N.Y.P.S.C. May 18, 2010) (order approving tariff filing); *see also* Steven Ferrey, *Legal Barriers to Sub-National Governance Techniques by U.S. States for Renewable Energy Promotion and GHG Control*, Second UNITAR-Yale Conference on Environmental Governance and Democracy (2010), *available at* http://conference.unitar.org/yale/sites/conference.unitar.org.yale/files/Paper_Ferrey_0.pdf.
693. Ferrey, Ferrey & Laurent, *supra* note 10, at 158–60.
694. Ferrey, *supra* note 247, at 883–99.
695. *See* Ferrey, Ferrey & Laurent, *supra* note 10; text accompanying note 47.
696. Ferrey, *supra* note 75, at 133–66.