ENVISIONING THE SMART GRID: NETWORK ARCHITECTURE, INFORMATION CONTROL, AND THE PUBLIC POLICY BALANCING ACT

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While smart grid development promises benefits for utilities and consumers alike, the public policy surrounding its roll-out remains conflicted. Will regulation guide the structure and usability of the smart grid, or will the ways in which the smart grid is already being applied force specific types of regulation? Early decisions by regulators will surely influence the balancing of policy concerns later in the smart grid development process; yet these decisions will be made in a regulatory environment in which utilities may lack the proper incentives to promote energy efficiency and consumer awareness—both functions of the smart grid. This Article examines economic and legal constraints in current utility regulation and describes the policy concerns which impact regulators' decisions. It then studies the interstate market for consumer usage data as a unique source of innovation within the electricity industry, as well as an example of the opposing interests that regulators will need to balance. In this case, such competing interests include consumer privacy protection and information access for edge service providers. Because of the disconnect between parties affected by smart grid development, exemplified by the information marketplace example, regulators need to act quickly and

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knowledgeably to prevent the death of innovation in this emerging field.

INTRODUCTION

The motivations for developing the smart grid are manifold and varied, ranging from environmental concerns to excitement over the potential next big technology boom.[1] Economically, however, the motivations for the project are rooted in both static and dynamic[2] efficiency concerns.[3] First is the static

1. *See, e.g.*, *Technology Quarterly: Building the Smart Grid*, ECONOMIST, June 6, 2009, at 83.

2. We use the term "static efficiency" to refer to energy conservation measures—those actions that reduce the amount of electricity demanded by consumers. But because population continues to grow and more people are demanding more energy services, the best that static efficiency measures can hope to achieve is a

efficiency story of scarce resources in light of global climate change and potential greenhouse gas ("GHG") emissions constraints. As the now-famous McKinsey abatement curve (Figure 1) shows, when it comes to choosing projects to reduce the nation's GHG footprint, conservation measures are simply more cost-effective than efforts to expand renewable electricity generation capacity.

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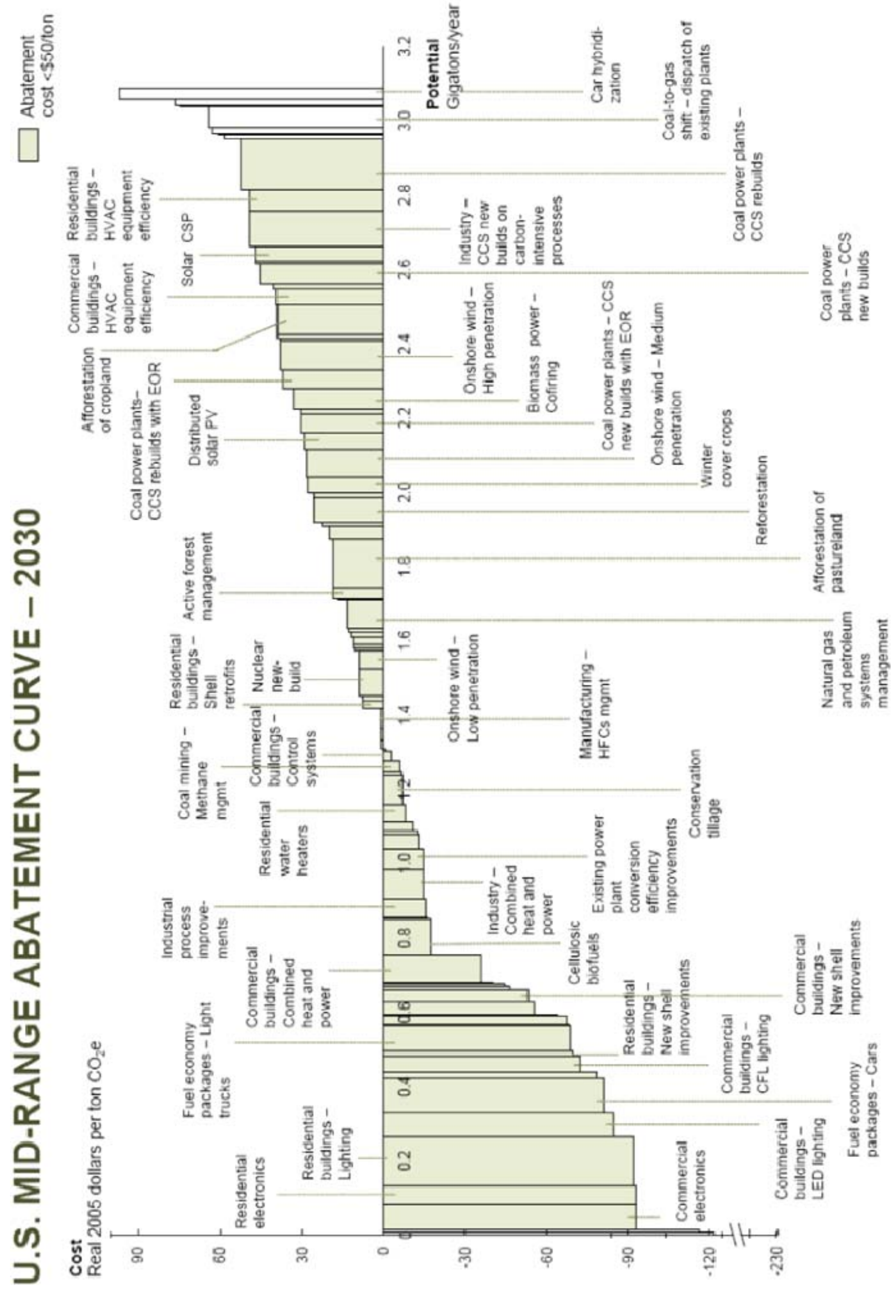
reduced *rate of growth* in electricity demand. We use the term "dynamic efficiency" to refer to functions of the smart grid that enable further integration of renewable energy onto the grid, allowing the system to meet growing demand at progressively lower carbon-intensities. The smart grid is critical in achieving both of these broad objectives. *See infra* notes 7–13.

3. The considerable allocations to the smart grid distributed through the Department of Energy under the American Recovery and Reinvestment Act ("ARRA") are also a major reason for the financial interest in smart grid development. *See* U.S. Department of Energy, American Recovery & Reinvestment Act, http://www.oe.energy.gov/american_recovery_reinvestment_act.htm (last visited Dec. 19, 2009) (discussing funding awards for smart grid development given pursuant to ARRA). However, the other economic *motivations* suggested in this Article both predate those government investments and help explain DOE's decision to invest. *See infra* Part I.

Figure 1: U.S. Mid-Range Abatement Curve—2030[4]



4. *Executive Summary* of MCKINSEY & CO., REDUCING U.S. GREENHOUSE GAS EMISSIONS: HOW MUCH AT WHAT COST?, at ix, xiii (2007), http://www.mckinsey.com/clientservice/ccsi/pdf/Greenhouse_Gas_Emissions_Executive_Summary.pdf.

Although the specific numbers included in Figure 1 are subject to dispute,[5] the figure is "at least qualitatively instructive" insofar as it illustrates that

> [r]eplacing carbon-emitting fossil fuels with most alternative energy sources, including clean-coal (with carbon sequestration), nuclear power, biomass, wind, solar photovoltaics (PV) and concentrated solar power (CSP), costs the economy money (positive bars, expressed in 2005 dollars per ton of CO_2 removed from the emission inventory). But, improving energy efficiency in transportation and buildings generally saves the economy money (negative bars).[6]

Thus, despite the projected cost of developing a national smart grid, the efficiencies it is expected to create should more than compensate for the initial investment, much like the other cost-saving measures illustrated in Figure 1. An upgraded electrical grid is its own source of savings, as the grid would operate more efficiently,[7] would need less maintenance and large-scale infrastructural investment,[8] and would fall victim to fewer "power disturbances" such as outages and overloads that impose significant costs on the U.S. economy.[9] By most accounts,

5. *See*, *e.g.*, Ted Gayer, Op.-Ed., *The EPA Tackles Greenhouse Gases*, FORBES, Dec. 28, 2009, http://www.forbes.com/2009/12/27/epa-greenhouse-gas-climate-opinions-contributors-ted-gayer.html (arguing that McKinsey & Co.'s finding that some pollution abatement actions could come at negative cost "violates the basic principles of economics").

6. AM. PHYSICAL SOC'Y, HOW AMERICA CAN LOOK WITHIN TO ACHIEVE ENERGY SECURITY AND REDUCE GLOBAL WARMING 23 (2008), http://www.aps.org/energyefficiencyreport/report/aps-energyreport.pdf.

7. *See*, *e.g.*, LITOS STRATEGIC COMMC'N, THE SMART GRID: AN INTRODUCTION 17, http://www.oe.energy.gov/DocumentsandMedia/DOE_SG_Book_Single_Pages.pdf [hereinafter LITOS STRATEGIC COMMC'N REPORT] (prepared for U.S. Department of Energy) ("It is estimated that Smart Grid enhancements will ease congestion and increase utilization (of full capacity), sending 50% to 300% more electricity through existing energy corridors.").

8. Maintenance savings of this sort have been estimated to be between $46 and $117 billion over the next twenty years. *See* ELEC. ADVISORY COMM., U.S. DEP'T OF ENERGY, SMART GRID: ENABLER OF THE NEW ENERGY ECONOMY 5 (2008), http://www.oe.energy.gov/DocumentsandMedia/final-smart-grid-report.pdf [hereinafter EAC REPORT].

9. Indeed, the Galvin Electricity Initiative has put a $49 billion annual price tag on such events. *See id*. Another report put the cost at "at least $150 billion each year—about $500 for every man, woman and child." LITOS STRATEGIC COMMC'N REPORT, *supra* note 7, at 5. For other quantitative estimates of smart grid benefits, see generally WALTER S. BAER ET AL., ESTIMATING THE BENEFITS OF THE GRIDWISE INITIATIVE: PHASE I REPORT xi–xiv (2004), http://www.rand.org/pubs/technical_reports/2005/RAND_TR160.pdf (placing present-value estimates of

these efficiency savings swallow smart grid technology costs.[10] Accordingly, investing in efficiency promises more handsome returns than investing in renewable energy generation (to say nothing of its being something of a prerequisite),[11] and the smart grid is a key enabler of a number of efficiency measures.

But in addition to these static efficiency concerns, there is also a dynamic efficiency story to tell. Simply put, the upgraded grid is necessary to facilitate broad-scale renewable electricity generation.[12] Integrating electricity from variable input sources such as wind farms and solar arrays requires accurate, real-time information about the supplies and demands influencing the grid at any given time, as well as mechanisms to balance loads with generation.[13] From this dynamic efficiency perspective, investing in the smart grid is critical to the feasibility and utilization of other energy-related investments.

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nation-wide smart grid benefits for electricity suppliers and end-users between $25 and $130 billion, with a mid-range, "nominal" scenario estimate of just over $80 billion).

10. *See FACTBOX: What is a Smart Grid?*, REUTERS, Jan. 8, 2009, http://www.reuters.com/article/idUSTRE50808B20090109 (estimating the cost for a nationwide smart grid to be $50 billion over ten to twenty years for investor-owned utilities and $65 billion if federally- and locally-owned utilities are included). The article also states that "[s]mart grid advocates say utilities and customers will realize cost savings in the long run, despite the high roll-out costs" and that

> [a]fter [sic] year-long study of smart grid technologies in the Pacific Northwest, U.S. officials and IBM estimated customers saved 10 percent on monthly power bills and cut power use by 15 percent. If those figures could be realized nationwide, it could save between $70 billion and $120 billion in spending on new power plants and transmission lines, the study found.

Id. Presumably, the author was referring to the GridWise Initiative. *See* BAER ET AL., *supra* note 9.

11. *See, e.g.*, AM. PHYSICAL SOC'Y, ENERGY = FUTURE: THINK EFFICIENCY, HOW AMERICA CAN LOOK WITHIN TO ACHIEVE ENERGY SECURITY AND REDUCE GLOBAL WARMING 7 (2008) (stating "[w]hether you want the United States to achieve greater energy security by weaning itself off foreign oil, to sustain strong economic growth in the face of worldwide competition or to reduce global warming by decreasing carbon emissions, energy efficiency is where you need to start").

12. *See*, *e.g.*, David Talbot, *Lifeline for Renewable Power: Without a Radically Expanded and Smarter Electrical Grid, Wind and Solar Will Remain Niche Power Sources*, TECH. REV., Jan.–Feb. 2009, at 40, 47 ("As Gore and other environmental experts warn—and as the engineers at Vattenfall [Europe Transmission, which controls northeastern Germany's electrical grid,] would testify—an explosion in the use of renewables will depend heavily on upgrading the grid.").

13. *See id*. at 44–46; *see also* Steven Andersen, *Trial and Error in Texas*, PUB. UTIL. FORT., Jan. 2009, at 28, 30, http://www.fortnightly.com/article.cfm?p_id=242 (describing technical and economic difficulties of managing highly variable wind energy sources on an electric grid).

The overhaul of the nation's electricity grid[14] and the development of the smart grid may well deserve its reputation as the next great source of innovation and economic growth.[15] However, a lot of work remains between the present state of affairs and the smart grid promised land. This infrastructure will not spring wholly formed from utility installation trucks. Many decisions regarding its network architecture—the actors, physical means, and legal entitlements by which data is collected, aggregated, analyzed, utilized, provided, or sold to interested parties (be they consumers, utilities, data brokers, or others)—are not yet standardized, and in many cases these decisions are almost entirely unformed.

A more pressing question for smart grid proponents is but a new variation on an age-old philosophical conundrum: which comes first, the network or the regulatory controls?[16] The problem of the smart grid's network architecture poses a classic chicken-or-egg dilemma that should be addressed early and head-on in the grid overhaul process. The regulatory structure surrounding the grid will inform how it develops and the shape it takes in the process. Questions as to who controls which parts of the grid, what their rights are, and to whom they answer will inform investment decisions, directing grid development in much the same way zoning influences residential development. However, physical aspects of the network's architecture, such as the data pathway to the first aggregator of consumer usage data, will largely determine which regulatory schemes bear on its operation. Such regulatory schemes would determine whether, for instance, state public utility commissions are the ultimate regulatory authority on the network, or if the federal government's authority may be in play on the grid—be it through the Department of Energy, the Federal Energy Regulatory Commission, the Federal Trade Com-

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14. Our current national electricity grid is a collection of several interstate power grids that are not—or at least not well—connected to one another. An excellent visualization of this can be found at VISUALIZING THE U.S. ELECTRIC GRID, NAT'L PUB. RADIO, http://www.npr.org/templates/story/story.php?storyId=110997398 (last visited Nov. 1, 2009).

15. *See Technology Quarterly: Building the Smart Grid*, *supra* note 1, at 83.

16. *See Symposiacs*, *in* 3 PLUTARCH'S MORALS 197, 242 (William W. Goodwin ed., T.C. trans., Little, Brown, and Co. 1878) ("Soon after he proposed that perplexed question, that plague of the inquisitive, [w]hich was first, the bird or the egg? And my friend Sylla, saying that with this little question, as with an engine, we shook the great and weighty question (whether the world had a beginning), declared his dislike of such problems.").

mission, the Federal Communications Commission, or even some (perhaps synergistic) combination thereof.

This Article analyzes how the regulation of one aspect of the smart grid—information collection and control—may both influence and be influenced by the development of the smart grid as a whole. Of course, with smart grid technology rapidly evolving (and, for that matter, redefining itself),[17] policymakers cannot hope to fully design the grid's network architecture in advance of its development. Nor would such an outcome even be desirable. Rather, the challenge for regulators in the face of such protean technology is the creation of a consistent, multi-jurisdictional regulatory architecture to scaffold the development of network architecture. That regulatory architecture must be determinate enough to support network investment, and yet ought to remain flexible enough to spur continuing innovation. In doing so, it must balance a number of public policy considerations associated with the smart grid: cost savings versus emissions reductions; consumer privacy versus information access and innovation; and improved utility returns versus viable new business models.

Because the regulatory environment may foster network infrastructure and business models with significant life spans, regulatory decisions at this nascent stage of smart grid development will unavoidably widen some avenues of innovation while foreclosing others. In the context of information collection and control, interstate coordination in the regulatory design effort will be crucial to the development of robust data markets, since data collectors, aggregators, and purchasers may well exist across jurisdictional lines.[18] A lock-in of conflicting state regulatory architectures could thwart the development of data markets even if individual state regulatory commissions wished to foster them. Our investigation seeks to illuminate how the emerging network architecture of the smart grid is inextricably bound to regulatory decisions relating to a host of public policy concerns—from energy efficiency and information security to entrepreneurship and business innovation—and to sketch out the various options policymakers

17. *See infra* Part III.B.

18. For instance, Google, whose corporate mission is "to organize the world's information and make it universally accessible and useful," is based in California but operates around the globe. Google, Corporate Information—Company Overview, http://www.google.com/intl/en/corporate/index.html; Google, Corporate Information—Google Offices, http://www.google.com/intl/en/corporate/address.html.

face when presented with the question of smart grid regulation.[19]

Part I of this Article begins with a brief overview of the regulatory scheme surrounding much of the electric industry today as a basis for understanding the environment in which smart grid decisions will be made. Part II then discusses the public policies and priorities at play in the development of the smart grid, and how early technological and regulatory choices alike will ultimately influence the policy balance between competing and opposed concerns. Finally, Part III proposes, as a thought experiment, the development of an interstate information market ancillary to the smart grid.

Our interest in information markets is twofold. The first is as a tool for inquiry and illustration. Examining information market development provides an insight into the general interplay between regulation and innovation,[20] and illustrates how the smart grid need not be understood as simply a network upgrade for the electricity industry, but rather as a spark igniting entirely new arenas of innovation and as a foundation for the construction of entirely new marketplaces—in all likelihood multi-jurisdictional—for services beyond the provision of electricity. The second interest is a rhetorical one: by examining this aspect of the smart grid, we not only expand the discussion of possible futures in smart grid development, but also hope to illustrate just what is at stake when regulators face early decisions about how the smart grid should be structured and how extant regulations will inform and constrain business activities surrounding the smart grid.

I. THE PLAYING FIELD: THE ELECTRIC UTILITY AND ITS SURROUNDING REGULATORY STRUCTURES

The regulatory environment in which electric utilities operate and its legal underpinnings are as old as—and in some

19. Some residents are already hooked up to the smart grid, *see* FED. ENERGY REGULATORY COMM'N, ASSESSMENT OF DEMAND RESPONSE & ADVANCED METERING 14 (2008), www.ferc.gov/legal/staff-reports/12-08-demand-response.pdf [hereinafter FERC 2008 DEMAND RESPONSE ASSESSMENT], and a few jurisdictions have already regulated in the smart grid space, *see* 16 TEX. ADMIN. CODE § 25.130(j) (2010) ("Access to meter data"). For all intents and purposes, though, the lion's share of smart grid development remains undone, and we treat it as such.

20. *See*, *e.g.*, Lucy Firth & David Mellor, *The Impact of Regulation on Innovation*, 8 EUR. J. L. & ECON. 199, 199 (1999).

cases, older than—the electric utility itself, and the development of the electrical grid has been shaped by the relationship between utilities and regulators.[21] The economic regulation of utilities and the legal principles that govern that system largely determine both the utility's investment decisions and its fundamental identity as, above all else, a generator and seller of electricity. These facets of utility decision-making are critical to the deployment of smart grid technologies for two reasons. First, the smart grid represents a type of investment very different from the investments historically made by utilities, because it attempts to control and shape demand rather than simply satisfying it with generation.[22] Second, many potential functions of the smart grid—such as total demand reduction through in-home feedback displays or the derivation of consumer behavioral trends from detailed usage information—may be seen by utilities as outside their historical role of generating, transmitting, and selling electricity at rates sufficient to recoup costs.[23] Such non-traditional functions may be marginalized in the development of regulations because utilities have a financial interest in promoting a vision of the smart grid that meets their needs while ignoring visions that do not.[24] Thus, absent modifications to the regulatory environment, smart grid functions focusing on cost reduction and load shifting through dynamic pricing, facilitation for plug-in vehicles, and other clearly revenue-positive actions tend to place higher on the list of utility priorities than smart grid functions leading to

21. *See* JOSEPH P. TOMAIN & RICHARD D. CUDAHY, ENERGY LAW IN A NUTSHELL 107–10 (2004). Tomain and Cudahy note that

> [t]he roots of regulation in the public interest may be traced back as far as the 'just price' doctrine of medieval times ascribed to the early Church Fathers and their doctrine of *justus pretium*, which was contrasted with the doctrine of *verum pretium*, or 'natural price,' which the Roman Law had derived from stoic philosophy.

Id. at 107. This medieval notion of pricing for goods common to the public was enunciated as a legal principle through Lord Chief Justice Hale's application of the phrase "affected with the public interest" to common occupations such as innkeepers, bakers, brewers, ferrymen, and many others. *Id.* at 107–08 (citing Lord Chief Justice Hale, DE PORTIBUS MARIS, 1 HARGRAVES LAW TRACTS 78 (1670)).

22. *See infra* Part III.B.

23. *See* FRED BOSSELMAN ET AL., ENERGY, ECONOMICS AND THE ENVIRONMENT 751–56, 778–79 (2d ed. 2006).

24. *See* Adam Reed, Smart Grid, Smart People: Legal and Regulatory Opportunities for Catalyzing Social Change through the Smart Grid 2 (unpublished manuscript, on file with author and with University of Colorado at Boulder Renewable and Sustainable Energy Institute ("RASEI")).

enhanced consumer awareness of environmental footprint, true demand reduction, or opportunities for innovative use of detailed data.[25] This dynamic is captured nicely in Xcel Energy's definition of the smart grid:

> [T]he general definition of a smart grid is an intelligent, auto-balancing, self-monitoring power grid that accepts any source of fuel (coal, sun, wind) and transforms it into a consumer's end use (heat, light, warm water) *with minimal human intervention*.[26]

This statement defines the core of the smart grid, as the utility views it, according to two fundamental characteristics. First, the smart grid's mission is fundamentally about the efficient delivery of electricity, the utility's primary product. Second, the defining methodology of that mission is automation, so as to minimize the need to rely on the actions of people. Yet smart grid functions specifically targeting consumers, like environmental footprint monitoring, may be championed by edge service providers ("ESPs"),[27] provided that the data

25. According to a 2008 Federal Energy Regulatory Commission ("FERC") survey of utilities regarding advanced metering deployment, Home Area Networks ("HAN," technologies that allow consumers to control home loads in response to utility price signals and other events) came in dead-last (under 5 percent of respondents) among reported uses of advanced metering. This result indicates that very few utilities that had deployed advanced meters had also deployed HAN technology that would allow consumers to *do something* with their smart meters other than stare at them. *See* FED. ENERGY REGULATORY COMM'N, ASSESSMENT OF DEMAND RESPONSE & ADVANCED METERING STAFF REPORT 13 (2008), http://www.ferc.gov/legal/staff-reports/12-08-demand-response.pdf.

26. XCEL ENERGY, XCEL ENERGY SMART GRID: A WHITE PAPER 2 (2008), http://smartgridcity.xcelenergy.com/media/pdf/SmartGridWhitePaper.pdf (emphasis added).

27. Edge service providers function at the "edge" of the smart grid as neither providers nor consumers of energy. Rather, ESPs are third-party companies that utilize the information produced by advanced meters and other utility-deployed smart grid technologies in innovative ways. *See* ELIAS LEAKE QUINN, SMART METERING AND PRIVACY: EXISTING LAW AND COMPETING POLICIES, REPORT FOR THE COLORADO PUBLIC UTILITIES COMMISSION iv (2009), http://ssrn.com/abstract=1462285 (discussing "service industries developing at the edge of the electric grid"). ESPs might provide analytical services to consumers regarding their daily or monthly consumption data, or might even provide other technological components (such as HAN technology, *see* discussion *supra* note 25) that offer consumers greater energy control options. ESPs would presumably either charge consumers for equipment or analysis, or would collect valuable consumer energy usage information and sell it, with the consumer's permission, to other interested parties. *See*, *e.g.*, Google PowerMeter, http://www.google.org/powermeter/ (last visited Mar. 26, 2010); Tendril, About Us, http://www.tendrilinc.com/about-us/ (last visited Mar. 26, 2010).

produced could be used as a revenue stream. However, this will only occur if new regulatory approaches both guarantee network access to ESPs and address regulatory concerns about ESP business models, including concerns that these models may infringe on privacy or other important consumer interests, or may conflict with utility interests.

This Part reviews the regulatory systems and rules that govern electric utilities, with particular emphasis on utility investment decisions and business strategies. Section A examines the economics of electric power and the regulatory system that has grown around it. Section B then presents the legal rules that have structured both the behavior and identity of the electric utility. Finally, Section C reviews historical efforts at reform of electric utilities, of which the smart grid is the latest iteration. Together, these economic realities, legal rules, and the legacy of myriad reform attempts are the essential drivers that make utilities and regulators behave in the ways that they do. Making careful policy decisions that will affect the development of smart grid network architecture—and thus determine viable smart grid business models—requires a sober understanding of what utilities, as entrenched stakeholders, stand to gain or lose from those decisions, and what other regulatory needs may be triggered as a result.

A. The Economic Regulation of Centralized Electric Power Service

This Section covers the essential background of the traditional form of economic regulation of investor-owned electric utilities ("IOUs"), primarily from an historical and theoretical perspective.[28] Electric utilities are traditionally considered

28. It is worth noting at the outset that the current reality of economic regulation of utilities is extremely complex, with significant variations between jurisdictions. For example, only half of the states in the United States have retained a traditional, government-granted monopoly regulation structure, wherein a single entity owns the generation, transmission, and distribution assets in a given service territory. The other half of U.S. states have experimented with some form of market restructuring, in which the generation and retail sales components of the system have been opened to competition while transmission and distribution remain traditionally regulated, with varying degrees of success. *See* CHANNELE CARNER, U.S. ENERGY INFO. ADMIN., STATUS OF STATE ELECTRIC INDUSTRY RESTRUCTURING ACTIVITY 1–2 (2003), http://www.eia.doe.gov/cneaf/electricity/chg_str/restructure.pdf. Additionally, large swaths of land are served by rural electric cooperatives, private institutions that either purchase electricity from IOUs and other entities or own generation assets through complex contractual

natural monopolies because they require massive, fixed-cost capital investments (*e.g.*, central power plants, transmission lines, substations, and distribution lines) that make market entry by competing firms not only prohibitively difficult, but also wasteful of societal resources.[29] In the case of an industry described as a natural monopoly, such as water, gas, or electricity, standard economic theory holds that, because of these fixed-cost capital investments, it is more efficient and desirable for a single company to serve a defined geographic area than many.[30]

Because a monopolist will sell a lower quantity of goods at a higher price than would occur in a competitive market, governments regulate natural monopolies in an attempt to approach optimality or to promote other social policies.[31] Thus, the rate that an electric utility may charge its customers for each unit of electricity they consume is set not by the utility itself, but by regulatory bodies at the federal (for interstate and

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agreements with generation and transmission cooperatives ("G&T co-ops"). *See generally* National Rural Electric Cooperative Association ("NRECA"), About Co-ops, http://www.nreca.org/AboutUs/Co-op101.htm (last visited Feb. 26, 2010). Still another type of entity, the public, municipally-owned utility ("MOU"), serves some two thousand cities across the country. *See* NRECA, Co-ops by the Numbers, http://www.nreca.org/AboutUs/Co-op101/CooperativeFacts.htm (last visited Feb. 26, 2010).

This Article focuses primarily on IOUs in regulated markets for two reasons. First, investor-owned utilities serve nearly 75 percent of the electricity customers in the United States, while publicly owned utilities serve only 16 percent and rural cooperatives serve roughly 10 percent. *See id.* Because this Article is concerned ultimately with the regulatory developments that will drive the deployment of smart grids covering most of the U.S. market, we are primarily interested in the investment behaviors and constraints of the larger players—the IOUs. Second, while many IOUs exist in states that have attempted or implemented retail restructuring, these developments have limited relevance to the regulatory environment guiding investment decisions around the smart grid, which is concerned with the demand side (transmission and distribution) of electric power. Even in restructured states, transmission and distribution ("T&D") assets generally remain owned by regulated monopolies, and it is these utility entities that are in a position to invest in smart grid assets. *See* CARNER, *supra* note 28, at 1–2. These T&D companies have essentially the same financial needs as vertically-integrated IOUs—they must sell electricity by the kilowatt-hour in order to cover their capital costs. *See infra* notes 35–37. Thus, T&D companies must still cover capital costs on transmission and distribution investments, even if generation capital now resides with other independent entities. *See* CARNER, *supra* note 28, at 1–2.

29. *See* BOSSELMAN ET AL., *supra* note 23, at 52–57.

30. *See id*. at 52.

31. *See generally* SANFORD BERG, NATURAL MONOPOLY REGULATION: PRINCIPLES AND PRACTICES (1988); KENNETH E. TRAIN, OPTIMAL REGULATION: THE ECONOMIC THEORY OF NATURAL MONOPOLY (1991).

wholesale power sales) and state (for retail power sales) levels.[32] Regulators determine how much the shareholders of an IOU may earn, what expenses the utility may recoup from ratepayers, the levels of rates for certain classes of customers, the degree to which rates may be modified in certain circumstances, and how the utility may expand its capacity to meet future demand projections.[33]

Electricity rates paid by individual consumers are set by state regulators through an administrative process that determines the regulated utility's revenue requirements. Revenue requirements are based on the amount of money the utility must take in annually to maintain its financial integrity and cover all legitimate expenses, including operating expenses and the cost of capital.[34] The rate per kilowatt-hour ("kWh") consumed, P, should equal the revenue requirements of the utility, R, divided by the number of kWh the utility is expected to sell, u. Revenue requirements are the sum of the utility's operating expenses, O, such as fuel costs and labor, and capital assets, B, including the rate of return needed to satisfy its cost of capital, r. Thus,

$P = R/u$, where $R = O+B(r)$[35]

The utility may not earn a return on its fuel costs, but is permitted a rate of return on its capital assets sufficient to both pay its debts and attract further investment capital to purchase generation, transmission, and distribution assets.[36]

These equations indicate that two things affect the price of electricity per unit. First, the rate is directly proportional to the revenue requirements of the utility, meaning that, in practice, rates will increase as investments in capital assets increase. Accordingly, if the regulator determines that the utility's revenue requirements have risen, then it will raise the rate that the utility may recover in the next rate case. Second, the rate is inversely proportional to the units of energy sold, because higher unit sales of electricity allow the utility to cover its preexisting capital investments at a lower rate. Conversely,

32. *See* BOSSELMAN ET AL., *supra* note 23, at 57–58.
33. *See* SCOTT A. SPIEWAK & LARRY WEISS, COGENERATION AND SMALL POWER PRODUCTION MANUAL 3 (5th ed. 1997).
34. *See* BOSSELMAN ET AL., *supra* note 23, at 57–60.
35. *See id.* at 78–79.
36. *See id*. at 93.

if the utility's sales levels drop (due to an energy efficiency program, for example), it requires higher rates in order to capture the same amount of revenue.

However, what the regulator determines at the rate case and what actually happens on the electricity market are likely to diverge. In a given year, due to changes in consumption, the utility may earn more or less revenue than the regulator has determined is required.[37] If the utility consistently makes more revenue than the regulator anticipated, electricity rates are likely to be adjusted downward at the next rate case.[38] If the utility is not meeting its revenue requirements consistently, it is likely to request a rate case to raise electricity rates—likely in the face of consumer opposition.[39]

The implication of this dynamic is far beyond temporary imperfections in the regulatory process: it is the reason utilities do not find it in their best interests to save energy under a traditional rate-setting scheme. Because regulators establish the retail rate of electricity, the rate is held constant between ratemaking dockets.[40] As a result, if the utility sells more power than it anticipated in the ratemaking proceeding, prices cannot decrease accordingly and the utility receives excess revenue. In between rate cases, then, it is generally in the interest of the utility to attempt to maximize sales, in hopes of exceeding its estimates from the rate case. The utility is rewarded for selling more power than it anticipated with windfall revenues.[41]

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37. *See id*. at 94.

38. *Cf. id*. at 149 ("If a regulator or a firm makes a mistake in estimating costs, this could be frozen into utility rates until the next rate determination. While many the ratemaking process may be self-correcting if firms face regular rate evaluation, in many jurisdictions a decade or more will pass between rate adjustments. . . . Rate proceedings also create incentives for firms to exaggerate costs and to engage in strategic manipulation of the types of information presented to regulators. Even if manipulation of the system is not intentional, there is evidence to suggest that rate regulation has led to a higher than optimal capital to labor ratio in the industry.").

39. *See, e.g.*, JAMES A. THROGMORTON, PLANNING AS PERSUASIVE STORYTELLING: THE RHETORICAL CONSTRUCTION OF CHICAGO'S ELECTRIC FUTURE 70–72 (1996).

40. *See* BOSSELMAN ET AL., *supra* note 23, at 78–79, 149.

41. Because the additional revenue the utility receives from selling more power than anticipated can be offset by the costs of generating it (i.e., *O* increases), the term "windfall," as used above, may be overly pejorative. The incentive to the utility to produce more power than anticipated in the ratemaking should not be overlooked, however, because of the prevalence of diminishing marginal capital costs associated with the production of additional units of power. Given a fixed amount of capacity, generation of additional units of electricity will often be

By contrast, if the utility's demand-side management ("DSM") program—an attempt to control electricity consumption so as to preclude the need for additional investment in generation—is unexpectedly successful and the utility sells less power than predicted, the utility's revenues will be below its requirements due to the reduction in sales.[42] In this context, DSM puts the utility in a difficult position: it may be ordered by a legislature to implement DSM programs, but it must, perversely, take care that the DSM program performs no better than anticipated, lest its revenues be deficient.[43]

Thus, by using retail rates as the primary cost-recovery mechanism and temporally separating rate-setting from actual sales, traditional economic regulation of utilities creates a revenue-based disincentive for energy conservation. While some smart grid functions provide economic benefits to utilities, such as better balancing for peak usage periods,[44] others pose economic concerns. For example, some smart grid functions

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cheaper than generation of the earlier units, resulting in decreasing average costs over the short term as more power is produced. *See* TOMAIN & CUDAHY, *supra* note 21, at 21. Moreover, because fuel cost volatility may be passed through to consumers via additional rate "riders" approved outside of the normal rate case, marginal costs from the utility's perspective will continue to decrease as consumption rises even if there is a spike in, say, the cost of natural gas. *See*, *e.g.*, Alabama Power, Rates Riders & Adjustments, http://www.alabamapower.com/pricing/al_riders.asp (last visited Feb. 26, 2010) (listing a dizzying array of rate riders for everything from "energy cost recovery" to "volunteer fire department"). In a perfectly competitive market, shifts in costs would be exactly reflected by shifts in the price of electricity (i.e., a reduction in rates that reflected the utility's declining costs). However, because the rate is held constant over the short run by the regulator, this phenomenon does not occur until the regulator re-sets the rate. *Cf.* TOMAIN AND CUDAHY, *supra* note 21, at 21–23 (discussing marginal and average cost concepts in the context of oil production).

42. *Cf.* BOSSELMAN ET AL., *supra* note 23, at 78–79.

43. See *infra* Part I.C, for a discussion of legislative efforts to mitigate this risk, such as a guarantee of higher rates of return on DSM investments than on generation investments to compensate the utility for reduced sales. Such measures do not remove all risk of revenue loss, though, as decreased electricity sales might still outweigh the rate hike.

44. Peak power is the power needed to meet the highest periods of demand on a system, when consumers require the most power. *See, e.g.*, DAN YORK ET AL., AM. COUNCIL FOR AN ENERGY-EFFICIENT ECON., EXAMINING THE PEAK DEMAND IMPACTS OF ENERGY EFFICIENCY: A REVIEW OF PROGRAM EXPERIENCE AND INDUSTRY PRACTICES iii (2007). In some parts of the country, this occurs on exceptionally hot days in the summer. To ensure that there is sufficient power on the system to meet peak demand, utilities invest in quickly dispatchable generation resources that are only used when required. *See id*. Depending on the system, peak resources might be special natural-gas plants, diesel generators, or even hydroelectric generators. These peak resources are very expensive and used irregularly. Utilities have a strong financial incentive in reducing or eliminating peak demand and thus the need for such resources. *See id*.

might alter consumers' relationship with electricity, through increased awareness of environmental footprint or access to improved analysis of energy behavior and investment decisions, such that they reduce their total consumption.[45] But this is only half the story. Legal rules, discussed in the next Section, further constrain serious utility consideration of smart grid development as a way to generate alternative revenue streams apart from the sale of electricity itself.

B. The Legal Basis and Institutional Structure for the Regulation of Utilities

Legal rules relating to the regulation of utilities are a mixture of economic, moral, and political factors. Following Section A's discussion of the economic underpinnings, this Section examines non-economic justifications and positive law developments that have shaped the ways in which electric utility rates, and thus investment and strategic decisions, are determined and modified. These legal constraints on utility investment behavior not only support a system of economic regulation that traditionally disincentivizes demand reduction, but also interact with economic concerns to determine how utilities envision the smart grid. Accordingly, utilities do not view the smart grid as a source of new business opportunities and revenue streams, but as a means of reducing operating costs to incrementally improve profit margins under their legally constituted role as sellers of electricity.

The legal bedrock of utility regulation is the notion, announced by the Supreme Court in *Munn v. Illinois*,[46] that

45. Sarah Darby's review of metering, billing, and direct display feedback found that both instantaneous feedback and sophisticated analytical feedback (e.g., through better and more informative billing) contributed to "the building up of a body of 'tacit knowledge' or know-how about the supply and use of energy." SARAH DARBY, ENVTL. CHANGE INST., THE EFFECTIVENESS OF FEEDBACK ON ENERGY CONSUMPTION: A REVIEW FOR DEFRA OF THE LITERATURE ON METERING, BILLING AND DIRECT DISPLAYS 8 (2006), http://www.eci.ox.ac.uk/research/energy/downloads/smart-metering-report.pdf. Moreover, such feedback was found to result in energy reductions of 5–15 percent for instantaneous feedback and 0–10 percent for processed information, depending on the quality of the information and the context in which it was presented. *Id.* at 3.

46. Munn v. Illinois, 94 U.S. 113, 126 (1877) ("Property does become clothed with a public interest when used in a manner to make it of public consequence, and affect the community at large. When, therefore, one devotes his property to a use in which the public has an interest, he, in effect, grants to the public an interest in that use, and must submit to be controlled by the public for the common good, to the extent of the interest he has thus created.").

certain industries are "clothed with a public interest" and thus obligated to provide equal services to all. The *Munn* ruling upheld the power of a state legislature to prescribe regulations on these industries for the public good, holding that such regulations are not an unconstitutional taking of property *per se* in violation of the Fourteenth Amendment.[47] Moreover, because the early twentieth century Supreme Court took a limited view of federal power under the Commerce Clause, and because local government regulation of utilities resulted in piecemeal approaches and a lack of uniformity, states became—largely due to the desires of utilities themselves—the default utility regulators.[48] Thus, at the state level, utilities are broadly regulated by public utility or service commissions.[49] State regulators have traditionally assigned utilities' territories, set service standards, regulated retail rates, and controlled abandonment.[50] Regulators are also generally afforded wide discretion in the setting of "just and reasonable" rates through their finding of revenue requirements, and courts will not interfere in their decisions unless those decisions result in the utility being unable to pay its bills and finance new construction.[51]

Regulators do, however, face real limits. They must balance the recovery of utility investment costs through rates with the rights of ratepayers in a just manner, "striking . . . a reasonable balance between competing interests."[52] The D.C. Circuit's holding in *Jersey Central Power & Light v. FERC* revealed a partial framework for such balancing.[53] The Federal Energy Regulatory Commission ("FERC") had prohibited the inclusion of an unamortized balance on a $400 million canceled nuclear power plant in a utility's rate base because the plant was not "used and useful," even though the investment was prudent when initially pursued and a failure to recoup its costs

47. *See id.*

48. *See* BOSSELMAN ET AL., *supra* note 23, at 60–61.

49. For example, Colorado's Public Utilities Commission ("CPUC") regulates utilities in the state under the Colorado Constitution and a corresponding enacting statute. *See* COLO. CONST. Art. XXV; COLO. REV. STAT. § 40-3-101 (2009).

50. *See* BOSSELMAN ET. AL, *supra* note 23, at 14–16.

51. Fed. Power Comm'n v. Hope Natural Gas, 320 U.S. 591, 605 (1944) (holding that "[r]ates which enable the company to operate successfully, to maintain its financial integrity, to attract capital, and to compensate its investors for the risks assumed certainly cannot be condemned as invalid, even though they might produce only a meager return on the so-called 'fair value' rate base").

52. Jersey Cent. Power & Light Co. v. Fed. Energy Regulatory Comm'n, 810 F.2d 1168, 1191 (D.C. Cir. 1987) (Starr, J., concurring).

53. *See id.* at 1187.

through the rate base would bankrupt the utility.[54] In *Jersey Central*, the court vacated FERC's decision, announcing that FERC's strict application of the "used and useful" standard for rate base inclusion failed to properly balance utility returns with just and reasonable rates.[55] Judge Starr's concurrence provided further rumination on the dynamics of balancing in rate regulation:

> For me, the prudent investment rule is, taken alone, too weighted for constitutional analysis in favor of the utility. It lacks balance. But so too, the "used and useful" rule, taken alone, is skewed heavily in favor of ratepayers. It also lacks balance. In the modern setting, neither regime, mechanically applied with full rigor, will likely achieve justice among the competing interests of investor and ratepayers so as to avoid confiscation of the utility's property or a taking of the property of ratepayers through unjustifiably exorbitant rates. Each approach, however, provides important insights about the ultimate object of the regulatory process, which is to achieve a just result in rate regulation.[56]

This balancing theme in rate regulation generally is directly related to the rate of return that a utility may earn, because that rate of return, consistent with the holding of *Jersey Central*, may only be high enough to attract sufficient capital to meet the utility's needs for new generation to serve its customers. The Supreme Court held in *Bluefield Water Works & Improvement Co. v. Public Service Commission* that

> [a] public utility is entitled to such rates as will permit it to earn a return on the value of the property which it employs for the convenience of the public equal to that generally being made at the same time and in the same general part of the country on investments in other business undertakings which are attended by corresponding risks and uncertainties; but it has no constitutional right to profits such as are realized or anticipated in highly profitable enterprises or speculative ventures. The return should be reasonably sufficient to assure confidence in the financial soundness of the utility and should be adequate, under efficient and economical management, to maintain and support its credit and

54. *See id.* at 1170–75.
55. *Id.* at 1178.
56. *Id.* at 1191.

> enable it to raise the money necessary for the proper discharge of its public duties.[57]

The reasonable sufficiency and adequacy of the rate of return varies with "changes affecting opportunities for investment, the money market and business conditions generally."[58]

The balancing notion of *Jersey Central* and the public-duties principle of *Bluefield Water Works* are critical to understanding the view of public utilities toward new revenue streams and activities. Utilities are not profit-maximizing firms in the traditional sense. Their returns are largely predetermined (and largely guaranteed) by regulators, and they attract capital by serving as low-risk tranches within capital market portfolios.[59] As such, utilities have very little incentive to examine new business models, products, or ideas outside their core competency of selling electricity to consumers. Indeed, utilities must be careful not to engage in behavior that would be perceived as risky or speculative by regulators or, worse, ratepayers and their advocates, as higher risks and higher costs are ultimately borne by the ratepayer.[60] This risk-intolerance shadows utilities' deployment of smart grids because they represent new investment risks that are not yet fully understood and may affect both investors' perceptions of regulatory and market risk in the electric utility sector and ratepayers' concerns about the effects of smart grid investment on their monthly energy bills.

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57. Bluefield Water Works & Improvement Co. v. Pub. Serv. Comm'n, 262 U.S. 679, 692–93 (1923).

58. *Id.* at 693.

59. Utilities have long been referred to by investors as "widow-and-orphan stocks" because of their steady dividends and extremely low risk, which made them ideal investments for vulnerable persons. *See* Cliff Pletschet, *Judge Utility Stocks on Dividend More Than Share Price*, OAKLAND TRIB.: INSIDE BAY AREA, Mar. 5, 2010, http://www.insidebayarea.com/business/ci_14520609 (stating "utility stocks continue to carry their ages-old label—'suitable for widows and orphans' ").

60. *See, e.g.*, BARBARA ALEXANDER, SMART METERS, REAL TIME PRICING, AND DEMAND RESPONSE PROGRAMS: IMPLICATIONS FOR LOW INCOME ELECTRIC CUSTOMERS 4 (2007), http://www.pulp.tc/Smart_Meters__Real_Time.pdf ("At a minimum, when faced with proposals to promote smart meters or any 'real time' pricing proposal, advocates for limited income and payment troubled customers should call for an analysis of the impacts of the costs and the benefits to residential customers generally and more vulnerable lower income customers specifically. This analysis should reflect a bill impact analysis to pay for the new meters and communication systems at various usage levels, as well as a consideration of the consumer protection policies and programs that presently exist and that rely on personal contact and premise visits as a crucial aspect of the implementation of the notice and attempts to avoid disconnection of service.").

None of this implies that utilities will not invest in smart grid technologies. Rather, the danger is more subtle: that the regulatory and legal architecture that defines the concerns and proper roles of the utility may ultimately define the concerns and proper roles of the smart grid in a way that limits its potential and creates difficulties for non-utility smart grid applications, particularly those focused on consumers rather than utilities. It is not surprising, given this regulatory and legal edifice, that utility-driven conceptions of the core of the smart grid's potential—cost savings from load shifting,[61] reduced administrative costs from replacing meter-readers with automated communication,[62] and improved integration of variable renewable generation assets,[63] to name a few—are overwhelmingly preoccupied with functions that affect the utility's supply-side costs in a favorable manner, with interaction from consumers only where necessary to achieve such objectives.[64]

C. Pre-Smart Grid Regulatory Reform for Energy Efficiency and Conservation

The disincentives to energy conservation and the conceptual limits to the role of the utility created by the regulatory and legal system described above have not gone unnoticed. Policymakers have long understood that traditional utility regulation results in suboptimal utility investment with respect to

61. *See* DAVID J. LEEDS, THE SMART GRID IN 2010: MARKET SEGMENTS, APPLICATIONS AND INDUSTRY PLAYERS 35–36 (2009), http://www.gtmresearch.com/report/smart-grid-in-2010 ("The emergence of smart meters and home area networks (HANs) gives consumers the ability to monitor and adjust their power usage in ways like never before. A small-scale pilot test conducted in 2006 by researchers at Pacific Northwest National Laboratory, which provided homeowners with appliances and displays that monitored and transmitted their energy use, successfully demonstrated an average energy savings of 10 percent per customer (*and a 15 percent reduction in peak load for the utility*)." (emphasis added)).

62. *See* Posting of Michael Graham Richard to Treehugger: A Discovery Company, http://www.treehugger.com/files/2009/11/smart-grids-fewer-utility-trucks-on-roads-reading-meters-truck-rolls.php (Nov. 9, 2009).

63. *See* Talbot, *supra* note 12, at 47.

64. *See*, *e.g.*, AHMAD FARUQUI & RYAN HLEDIK, TRANSITIONING TO DYNAMIC PRICING 1 (2009), http://www.brattle.com/_documents/UploadLibrary/Upload744.pdf ("With the advent of the smart grid, dynamic pricing is receiving increasing interest by state commissions throughout North America *as a means of enhancing economic efficiency by reducing the need for expensive peaking capacity*." (emphasis added)); XCEL ENERGY, *supra* note 26, at 1 (describing the smart grid as "a real-time, automated, 'neural network' that will manage all the variables involved in delivering energy to the consumer").

energy efficiency and conservation, and legislators and regulators at both state and federal levels have made multiple attempts to both adjust utility investment behavior and to require the provision of certain information to consumers so that they may individually adjust their consumption. Because smart grids provide technological and regulatory opportunities for affecting both utility and consumer behavior, any examination of regulatory reform options to promote their deployment is incomplete without a review of the relevant history of regulatory reform prior to the development of smart grid technology. This section will briefly discuss the energy conservation reform efforts of the Public Utility Regulatory Policies Act, the Energy Policy Act of 1992, and a host of state-level policy mechanisms.

The United States Congress undertook to create a policy framework for encouraging energy conservation through reform of the rate structuring process in the 1978 Public Utility Regulatory Policies Act ("PURPA").[65] Among other provisions, the statute encouraged states to adopt six fundamental policies for retail electric power rates:

> 1. Rates ought to reflect the actual cost of electric power generation and distribution.
>
> 2. Declining block rates (where rates decline with increases in power usage) should not be used unless they reflect actual costs.
>
> 3. Rates ought to reflect daily variations in actual generation costs.
>
> 4. Rates ought to reflect seasonal variations in actual generation costs.
>
> 5. Rates should offer an "interruptible" electric power service rate for industrial and commercial customers.
>
> 6. Each electric utility should offer load management techniques to consumers that are predictable, cost-effective, and reliable, as determined by the state PUC.[66]

The PURPA rate structuring reforms contain an underlying conservatism. All of these reforms involved improving the communication of actual cost information to consumers, under

65. 16 U.S.C. §§ 2601–2645 (2006); Fed. Energy Regulatory Comm'n v. Mississippi, 456 U.S. 742 (1982) (holding that constitutionally-challenged portions of PURPA were within Congress' Commerce Clause powers).

66. *See* 16 U.S.C. § 2621(d).

the assumption that providing such cost information would shift consumption behavior and improve the economic efficiency—and thus energy efficiency—of power markets, particularly for commercial and industrial consumers.[67] This was not so much an attempt to shift utility investment drivers as it was an attempt to provide better information about the existing dynamics of the market to consumers, and to let enlightened self-interest run its course as consumers responded to more accurate price signals.[68]

The Energy Policy Act of 1992's ("EPACT") additions to PURPA were, by comparison, a more radical attempt to change the behavior of utilities themselves by altering investment incentives through three primary mechanisms:

> 1. "Each electric utility shall employ integrated resource planning. All plans or filings before a State regulatory authority to meet the requirements of this paragraph must be updated on a regular basis, must provide the opportunity for public participation and comment, and contain a requirement that the plan be implemented."[69]
>
> 2. "The rates allowed to be charged . . . shall be such that the utility's investment in and expenditures for . . . demand side management measures are at least as profitable, giving appropriate consideration to income lost from reduced sales . . . as its investments in and expenditures for the construction of new generation, transmission, and distribution equipment."[70]
>
> 3. "The rates charged . . . shall be such that the utility is encouraged to make investments in, and expenditures for, all cost-effective improvements in the energy efficiency of power generation, transmission and distribution."[71]

The EPACT additions to PURPA in 1992 instructed states to consider offering utilities higher rates of return with respect to

67. *See* H.R. REP. NO. 95-543, at 10 (1978), *as reprinted in* 1978 U.S.C.C.A.N. 7673, 7679 ("The bill provides for a method to move the nation's electric utilities toward pricing policies which price electricity at the true cost of providing service to each class of electric consumers, so as to encourage conservation in the production and use of electricity.").

68. *See id.*

69. 16 U.S.C. § 2621(d)(7).

70. *Id.* § 2621(d)(8).

71. *Id.* § 2621(d)(9).

certain kinds of investment over others.[72] Accordingly, these policies were an early push for a shift in the role of electric utilities from the sale of electricity toward the sale of energy services provided by electricity. DSM investments, for example, might receive higher rates of return than investments in additional generation, because the additional return would be needed to make up for the shortfall in electricity sold.[73] Likewise, these policies might provide better rates of return for utilities that improve the efficiency of their existing generation as opposed to those who purchase or build new generation assets.[74] Moreover, by requiring utilities to adopt regulator-approved integrated resource plans ("IRPs"), state regulators could encourage a more holistic view of utility asset growth that both estimated future demand needs and determined the least-cost methods of either meeting or reducing that demand.[75]

Since the enactment of these federal attempts to shape state regulatory reform efforts through different policy approaches, consumer-based in 1978 and utility-based in 1992, state regulators in different jurisdictions have foisted a suite of additional incentive-shifting measures and requirements on electric utilities. These measures attempted, with varying degrees of success, to alter the heuristic structures that drive utility investment and operations as well as electricity consumption behavior. This extensive experimental period led to both incremental and fundamental attempts to alter the structure of the regulatory system. A sampling of incremental measures is presented in Table 1, followed by a discussion of more fundamental alterations to utility regulation.

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72. *See id.*

73. *See, e.g.*, COLO. REV. STAT. § 40-3.2-104 (2009) (requiring that the state public utilities commission allow utility investments in cost-effective DSM to be more profitable than any other utility investment); *see also supra* Part I.A (discussing the economic function of retail rates and their impact on DSM investment decisions).

74. *See supra* note 73.

75. *See* JOEL SWISHER ET AL., UNEP COLLABORATING CTR. ON ENERGY & ENV'T, TOOLS AND METHODS FOR INTEGRATED RESOURCE PLANNING: IMPROVING ENERGY EFFICIENCY AND PROTECTING THE ENVIRONMENT 17–25 (1997), http://uneprisoe.org/IRPManual/IRPmanual.pdf. Integrated resource planning is a process that seeks the least-cost investment pathway for utilities to meet future demand needs, taking into account supply-side expansion costs, demand-side management costs, and environmental and social/distributional concerns. *See id.*

Table 1: Suite of regulatory tools used to adjust incentives and investment decisions within the electricity provision industry.

INCENTIVE- AND DECISION-ADJUSTMENT MECHANISMS [G] = policy tools focusing on shifts in the management, efficiency, and total load of the electric grid. [R] = policies aimed at bringing more renewable-resource generated electricity onto the grid.	
Utility-Focused	**Consumer-Focused**
Rate Decoupling [G] – Attempts to modify regulatory rules, timelines, and methodologies so as to break the link between the electric utility's revenues and the amount of electricity sold. It generally involves a guaranteed recovery of fixed costs, regardless of the amount of electricity sold over a given period. Regulators perform periodic true-ups wherein utility funds are replenished if less than the expected amount of electricity is sold. If the utility sells more than the expected amount of electricity, excess returns are deposited into an account for later true-ups or redistributed to ratepayers.[76]	*Dynamic Rate Structuring* [G] – Design of electricity rates that vary with the time of day and the demands placed on the system, generally making peak electricity costs more expensive and off-peak consumption correspondingly more attractive to consumers. Smart grid technology is thought to improve the ability of utilities to communicate dynamic rate information to consumers through advanced metering infrastruc-ture ("AMI") and the ability of consumers to respond through home automation networks ("HANs") and in-home displays ("IHDs").[77] Forms of quasi-dynamic and dynamic rates include time-of-use pricing, critical peak pricing, peak time rebates, and real-time pricing.[78]
Deregulation [G] – Attempts to introduce competitive market principles into the generation side of utility operations by allowing independent electricity generators to bid energy at differing prices to meet system demand communicated by the utility.[79]	*Demand-Side Bidding* [G] – Allows consumers (usually large commercial/industrial ones, although technologies may expand its availability) to bid reductions in demand on the wholesale power market alongside generation resources, thus being paid for demand-reduction when the system needs it.[80]

76. *See* National Association of Regulatory Utility Commissioners, Decoupling for Electric and Gas Utilities: Frequently Asked Questions 2 (Sept. 2007), http://www.naruc.org/Publications/NARUCDecouplingFAQ9_07.pdf.

77. *See* Ray Bell, *The Smart Home in 2010—From Powerpoints to Pilots*, SMART GRID NEWS, Feb. 9, 2010, http://www.smartgridnews.com/artman/publish/Technologies_Home_Area_Networks_News/The-Smart-Home-in-2010-From-PowerPoints-to-Pilots-1874.html (discussing home area networks); Ahmad Faruqui, Sanem Sergici, and Ahmed Sharif, Household Response to Dynamic Pricing of Electricity—A Survey of the Experimental Evidence 1, Jan. 10, 2009, http://www.hks.harvard.edu/hepg/Papers/2009/The%20Power%20of%20Experimentation%20_01-11-09_.pdf (discussing in-home displays).

78. *See, e.g.*, RYAN HLEDIK & AHMAD FARUQUI, EVALUATING ALTERNATIVE DYNAMIC PRICING DESIGNS 3–7 (2008) http://www.brattle.com/_documents/UploadLibrary/Upload715.pdf.

79. *See infra* notes 90–92 and accompanying text.

Renewable Portfolio Standard [R] – Also called "renewable procurement requirements" or "renewable energy standards," these policies require utilities to meet future demand levels with a specified percentage of renewable energy generation resources or DSM and energy efficiency strategies.[81]	*Net-Metering* [R] – Legal requirement that utilities compensate consumers for energy from on-home energy systems by running the consumer's power meter backwards proportionate to the electricity generated. If the consumer generates electricity beyond what he or she uses on-site, some laws require the utility to pay the consumer for the excess energy generated at market rates.[82]
Smart Technology Deployment [G] – Efforts to deploy any of the many hardware components associated with "smart grid" development. Principal among these are "smart meters" that compile high-resolution electricity usage information and communicate it to the electric utility and the consumer, thereby facilitating better load management—the shifting of electricity demand so as to preclude the need for additional generation.[83]	*Distributed Generation Drivers* [R] – Includes a host of widely varied policy tools designed to drive the diffusion of small-scale, distributed generation technologies, such as roof-top solar photovoltaics ("PV"). The set of such policy tools can be divided into two basic types: (1) Funding mechanisms, *e.g.*, grant, loan, and subsidy programs, as well as accelerated depreciation rates and other tax credits. (2) Legal feasibility measures, *e.g.*, zoning, building codes, and permitting issues, among them invalidating restrictive covenants and exempting homeowners with distributed generation from nuisance liability.[84]

80. For an overview of the economic theory behind demand side bidding, see Robert H. Patrick & Frank A. Wolak, *Real-Time Pricing and Demand-Side Participation in Restructured Electricity Markets*, *in* ELECTRICITY PRICING IN TRANSITION 345 (A. Faruqui & B.K. Eakin eds., 2002).

81. *See* Joshua P. Fershee, *Changing Resources, Changing Market: The Impact of a National Renewable Portfolio Standard on the U.S. Energy Industry*, 29 ENERGY L.J. 49, 49 (2008).

82. *See, e.g.*, COLO. REV. STAT. 40-2-124(1)(c) (2009).

83. FERC reported that, all told, these efforts will result in the deployment of 52 million advanced metering devices over the next five to seven years. FED. ENERGY REG. COMM'N, ASSESSMENT OF DEMAND RESPONSE & ADVANCED METERING 15 (2008), www.ferc.gov/legal/staff-reports/12-08-demand-response.pdf. This estimate predated the stimulus package set forward under the Obama Administration that provided $3.4 billion for investment in smart grids. *See* President Barack Obama, Address at the DeSoto Next Generation Solar Energy Center (Oct. 27, 2009).

84. *See, e.g.*, Colorado Energy Profile: Law & Policy Database, http://www.energyincolorado.org/lpdb (last visited Feb. 16, 2010) (providing a comprehensive relational database of federal, state, and local laws and policies targeted toward the deployment of sustainable energy technologies in the State of Colorado). The database contains 283 federal policies, 110 State of Colorado policies, and some 300 local government policies that aim to aid sustainable energy deployment in the ways described above.

Efficiency Mandates [G] – Quantitative or technological requirements imposed on electric utilities to improve the efficiency of existing generation resources. This may take the form of “recycled energy” technologies such as combined heat and power generation, or requirements that utilities purchase qualifying renewable and cogenerated power from small power producers at rates reflecting the utility’s avoided cost.[85]	*Energy Consumption Displays* [G/R] – These informational portals, which may reside on AMI, appliances, or on a homeowner’s computer or smart phone, aim to provide both descriptive information and normative feedback in an attempt to alter consumer behavior regarding the con-sumption of energy services.[86]
Customer Information Controls [G] – Aimed at protecting consumer privacy in the face of increased data collection concerning home electricity usage, these measures may dramatically impact the development of the smart grid industry by determining who can have access to consumer usage data and what they can do with that data.[87]	

Alongside these incremental modifications came more fundamental changes in the regulatory scheme, as theorists challenged the applicability of natural monopoly theory to the electric utility industry:

> Traditionally it was thought that the [electricity generation] sector displayed natural monopoly characteristics based on the argument that a single firm could achieve output more cheaply than multiple firms and the physics of electricity necessitated system-wide coordination of electricity generation and current flow. . . . Economists later revised their theories as to whether the electricity sector was a true natural monopoly. They argued that the electricity generation and retail sales components of the electricity sector were potentially competitive, while the transmission and distribution components were natural monopolies.[88]

85. *See, e.g.*, 16 U.S.C. § 824a-3 (2006) (known colloquially as “PURPA section 210,” after the title number from the original legislation); COLO. REV. STAT. § 40-2-124(1)(a)(II).

86. *See* Georgina Wood and M. Newborough, *Influencing User Behavior with Energy Information Display Systems for Intelligent Homes*, 31 INT’L J. OF ENERGY RES. 56, 57 (2007); *see also* Reed, *supra* note 24.

87. *See* QUINN, *supra* note 27, at iv–v.

88. Mark A. de Figueiredo, *A Regulatory Framework for Investments in Electricity Transmission Infrastructure,* 26 VA. ENVTL. L.J. 445, 448 (2008) (emphasis added) (citing PAUL L. JOSKOW & RICHARD SCHMALENSEE, MARKETS FOR POWER: AN ANALYSIS OF ELECTRIC UTILITY DEREGULATION 29, 33 (1983); Paul L. Joskow & Roger G. Noll, *The Bell Doctrine: Applications in Telecommunications, Electricity, and Other Network Industries*, 51 STAN. L. REV. 1249, 1292 (1999)).

Technological advancements and the development of sophisticated economic theories shook the early consensus that the nation's electricity sector was populated with natural monopolies.[89] In particular, electricity generation and retail sale were seen to be potentially competitive, while transmission and distribution infrastructure remained monopolistic and regulated.[90]

Despite this early enthusiasm, electricity deregulation—efforts by states to reshape the electricity industry into a competitive market—has become something of a dead letter.[91] In fact, some states that were early adopters on deregulation have since *re*-regulated their electric industries.[92] Even so, the traditional incentives sketched out herein remain the primary drivers of decision-making in the electric utility industry today with respect to transmission and distribution investments (which remain regulated even in markets which have restructured the generation side of the market). Furthermore, many of the regulatory reforms listed in Table 1 function as behavior-shifting modifications that act from within the system rather than as challenges to fundamental regulatory notions.

The upshot of this review of economic regulation of utilities and the legal rules surrounding it is that the regulatory environment provides a two-pronged challenge to deployment of robust, multi-stakeholder smart grids. First, it creates the now-familiar economic disincentives to investing in technologies that inhibit utility profitability. This phenomenon materializes in the development of utility-centric visions of the smart grid that are responsive to utility concerns, but that marginalize potential non-utility applications. Second, and more problemati-

89. *See* Joskow & Noll, *supra* note 88, at 1292.

90. *Id.* ("A new consensus has emerged that sees a much greater role for competition in the [electricity] industry. Virtually all analysts now believe that both generation . . . and retail sales . . . are, and probably always have been, potentially competitive.").

91. *See* Ferdinand Banks, *A Simple Economic Analysis of Electricity Deregulation Failure*, 26 OPEC REV.: ENERGY, ECON. & RELATED ISSUES 169, 169 (2002) (stating "[t]he simple truth is that—in one sense or another—electricity deregulation has failed everywhere, and its failure is fully in line with mainstream economic theory"). Despite his seeming hyperbole, Banks notes at the outset that "[h]ere I am not talking about the spectacular failures in California, Alberta (Canada) or Brazil, but failures in those countries and regions where deregulation failure is not obvious, and, in some cases, where naïve observers have come to the conclusion that deregulation has succeeded." *Id.* at 171.

92. *See, e.g.*, Brian R. Greene & Katherine A. Hart, *Public Utility Law*, 43 U. RICH. L. REV. 295, 296–97 (2008) (describing Virginia's re-regulation of the electric utility industry).

cally, the long-standing relationship between utilities and regulators presents a serious risk that regulators will adopt this utility-centric vision of the smart grid in crafting regulations that have a profound impact on the development of the smart grid's network architecture, and thus on the viability of business models related to the smart grid. A failure to grasp the breadth of potential inherent in the smart grid could result in the development of rules—and consequently informational and network architectures—that permanently and inequitably shut out business models that could drive significant value to the smart grid by way of the vast amounts of data to be collected, analyzed, and used, both in and out of the power sector.

Making smart policy choices regarding the smart grid is not simply a matter of adjusting incentives, but rather centers around addressing the vision and purposes of the network itself, which determine how both vested interests and potential newcomers might situate themselves on the playing field. Indeed, given the historical difficulty of adjusting utility incentives and the limited core competencies of utilities, an alternative solution could be the development of a more edge-service-oriented smart grid—wherein many of its functions are arms-length transactions between third parties and consumers. Such a smart grid would avoid the thorny issues inherent in altering economic regulation of utilities by locating much of the smart grid's intelligence outside of the utility. But, as we shall examine in the next Part, this option is only available if regulators recognize it and act to preserve it as the network develops. Further complicating matters, as Part II explains, is that failing to preserve such an option in multiple jurisdictions could itself pose difficulties for business models utilizing smart-grid-produced information and seeking to enter the stream of interstate commerce.

II. THE GAME: BALANCING POLICY INTERESTS

While it is easy enough to make the case for smart grid development, it is harder to lay out a plan for its actual deployment in any specific region or jurisdiction, and, as everywhere, the devil is in the details. Precisely who should pay for the grid's development and how they should be allowed to earn their returns are difficult questions, the answers to which require the navigation of myriad interests and public policies that often lie in tension with one another. Further complicating matters, these answers, as often as not, become embedded within the very technological and regulatory architecture that will scaffold the network. This means that the choices made now, at the early stage of the network's development, will have a profound impact on the efficiency, efficacy, and equity of the smart grid going forward.

This Part aims to make clear just what is at stake in smart grid network architecture development, and who the stakeholders are. Importantly, one key player in the development of the smart grid and its regulatory architecture—the electric utility—has an enormous preexisting presence in the regulatory space. Its position affords it the opportunity to shape early network development in ways that competing players cannot. Regulators can act to preserve opportunities for a multitude of players on the smart grid field, but only if they recognize who else is playing. Section A examines how different network architectures may implicate different regulatory bodies, and how those outcomes in turn affect later network development. Section B then explores the many substantive policies that regulators must balance in formulating the rules of the smart grid.

A. *The Importance of Architecture: Competing for Control Over Smart Grid Development*

Network architecture is both policy and politics.[93] The design of a network—its points of access, whether network protocols are proprietary or open in their standards, and the path that information takes as it travels on the network—embeds within it such policy decisions as which parties on the network enjoy control over information flows and how competitive the regional market in data services will be.[94] Equally important

93. *See* LAWRENCE LESSIG, CODE VERSION 2.0 24 (2006), *available at* http://pdf.codev2.cc/Lessig-Codev2.pdf (citing, *inter alia*, Mitchell Kapor, *The Software Design Manifesto*, *in* BRINGING DESIGN TO SOFTWARE (Terry Winograd ed., 1996), *available at* http://codev2.cc/links (follow "Link # 9" hyperlink), and noting that the Electronic Frontier Foundation has updated Kapor's aphorism "architecture is politics" to "architecture is policy"); *see also* Paul L. Joskow, *Incentive Regulation and its Application to Electricity Networks*, 7 REV. OF NETWORK ECON. 547 (2008) (describing the impact of incentive regulations on industry development and performance).

94. Subsequent regulation could work contrary to the network's natural state by, for example, making the data collector servant to some other party on the network, thereby granting a superior right of control over the data to a downstream recipient of that data. While the history of regulated utilities is in many

to the technological architecture, though, is the regulatory architecture erected in parallel. Regulations such as "information [privacy] controls that govern which parties have access to smart grid information when, and what they can do with it, will . . . inform—and constrain—viable business models for edge services."[95]

Architectural decisions will also have an impact on the ability to regulate the smart grid space. For example, if high-resolution information about consumer electricity usage is gathered only by a smart meter—which was likely installed by an electric utility as a part of an infrastructure build-out overseen by the state public utility commission—then it is likely that the data trade would be subject to whatever PUC regulations the agency decides to put in place. If, however, the information is collected without touching the infrastructure of a regulated utility (perhaps a measurement device purchased by a consumer and attached to her home's circuit box),[96] then the

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ways the history of granting post hoc a better bargaining position to ratepayers, the context of the smart grid is somewhat unique. Much of the network development is yet to be done, and so in many ways participants face a chicken-or-egg problem: network developers are looking to regulators to make certain initial decisions about architecture, or to give their imprimatur to project proposals, while many regulators hesitate to step into the space until the markets are better developed and the item of regulation—the smart grid—is something more of a known commodity.

95. QUINN, *supra* note 27 (research report used as a framing document for the Colorado Public Utilities Commission's high profile Docket No. 09I-593EG, Investigation of Privacy Issues Associated With the Deployment of Smart Grid Technologies, http://www.dora.state.co.us/puc/DocketsDecisions/HighprofileDockets/09I-593EG.htm); *see also* Ethan Howland, *Colo. Regulators Eye Privacy Issues, Smart Grid*, ELEC. POWER DAILY, Sept. 10, 2009, at 6 ("Bottlenecks in customer information could reduce innovation and bar market entry . . . ."). Ontario's Information and Privacy Commissioner, Ann Cavoukian, has long advocated that privacy protections be "baked into" the network design through her "Privacy by Design" initiative. See Privacy By Design, http://www.privacybydesign.ca/papers.htm (last visited Dec. 19, 2009), for papers outlining principal architectural decisions that can protect privacy in the smart grid context as well as more generally.

96. Collecting information in this way—privately and at or beyond the edge of the grid—challenges our notions of just what crafting a smart grid entails: while these individual actions might make for a smart house or a smart consumer, they lack the coordinated economic and environmental incentive systems that are the hallmark of the conventional conception of the smart grid. However, visions of the smart grid that do not consider independent conservation efforts ultimately constrain its development. If enough private entities began collecting information about their electricity consumption in this way (imagine every Google-searcher also looking into their electricity consumption), those individual efforts could nonetheless galvanize a paradigm shift in electricity management and sale. This is not to say the motivation is there to drive consumers to such large-scale private investigation in the first instance, but it would be wrong to assume that economic

state PUC's jurisdiction over the data trade would be somewhat more questionable, while the federal government's (assuming the device was sold in interstate commerce) would seem stronger.[97]

These are not merely academic concerns, but real differences in vision among smart grid developers. In the application process for Stimulus Act dollars for smart grid development,[98] some parties submitted plans for large-scale retail projects that would sell smart grid equipment directly to the consumer through big-box, national electronic stores.[99] Others, meanwhile, sought grant money for traditional, utility-centric proposals where the electricity supply infrastructure would house the technological expansion and excess costs would likely be incorporated into the rate base.[100] Such a schism in the architectural vision will be attended by a divide in regulatory

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incentives—as provided by utility regulators—are the only place from which such motivations might come. *See* SARAH DARBY, ENVTL. CHANGE INST., THE EFFECTIVENESS OF FEEDBACK ON ENERGY CONSUMPTION: A REVIEW FOR DEFRA OF THE LITERATURE ON METERING, BILLING AND DIRECT DISPLAYS 3 (2006), http://www.auburn.edu/projects/sustainability/SAB/resources/Sustain-A-Bowl_2009/topicalReading/energyconsump-feedback.pdf (reviewing literature on consumer interactions with usage data and concluding that more information generally enables better energy management).

97. Of course, not all information collected on the grid is of equal value to all envisioned purposes. Information at the consumer level may help manage consumer usage and support efforts targeting certain kinds of network efficiencies and reliability goals, while information collected at switching stations or along the distribution network (as opposed to at its edge) helps inform other network efficiency efforts. As such, the division in approach need not be seen as dichotomous, but rather as different efforts striving for different ends. However, developing the smart grid from all sides poses a quandary for regulators, industrialists, and consumers alike as they face a hydra of technological innovation, capability, and purpose.

98. The funding for these projects was established under the ARRA. American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5 § 405, 123 Stat. 143 (2009) (amending Title XIII of the Energy Independence and Security Act of 2007). For an overview of the funding opportunities as implemented by the Department of Energy's Office of Electricity Delivery and Energy Reliability, see Department of Energy, OE Recovery Act - Funding Opportunities, http://www.oe.energy.gov/recovery/1272.htm (last visited Mar. 5, 2010).

99. Interview with Cameron Brooks, Senior Director of Market Development and Policy Strategy, Tendril Inc., in Boulder, Colo. (Sept. 1, 2009); *see also Google and Partner Offer Home Energy Management Without Smart Meters*, SMART GRID NEWS, Oct. 6, 2009, http://www.smartgridnews.com/artman/publish/News_News/Google-and-Partner-Offer-Home-Energy-Management-Without-Smart-Meters-1254.html.

100. A number of the smart grid investment grant awards were ultimately of this type. For a list of the awards, see Department of Energy, Smart Grid Investment Grant Awards, http://www.oe.energy.gov/recovery/1249.htm (last visited Mar. 5, 2010) (follow "Go >" hyperlink next to "View Smart Grid List by Topic").

response, and perhaps even a competition of sorts for jurisdiction.

The jurisdictional question is not merely one of local, state, or federal scale, but also one of matching smart grid regulation to a particular agency's area of expertise. For example, as part of its SmartGridCity project in Boulder, Colorado, Xcel Energy laid its own fiber to facilitate the transmission of metering information back to the utility and, eventually, the sending of dynamic price signals (potentially as often as every five seconds) to the consumer (or at least, the consumer's energy automation system).[101] The last mile of this network utilizes broadband over power line transmission ("BPL") with a fiber back-haul network. Xcel's future deployments of smart grid technologies will likely rely on wireless data transmission for the last mile in order to cut down on installation costs.[102] But this project looks awfully similar to the development of a traditional communications network, which may prompt traditional communications-network regulation:

> As long as smart grid information management and trade remain ancillary to the purpose of electricity provision for an electric utility, such networks are likely to be viewed as private networks facilitating the utility's operations. However, were the business models of electric utilities to undergo a paradigm shift toward one of information management (say, even electricity network switch became decentralized and the principle purpose of the electric utility was to facilitate information transfer and so efficient management), there is at least a colorable argument that such activities would fall under the Federal Communication Commission's Title I—or even Title II—authority under the Communications Act of 1934 to regulate the collection an[d] disclosure of personal information related to information or telecommunication services, and even be *subject to* the [FCC's]

101. Interview with Roy Palmer, former Executive Director of Government and Regulatory Affairs, Xcel Energy, in Denver, Colo. (Mar. 5, 2009).

102. *See* Roy Palmer, *SmartGridCity: Xcel Energy's Bold Step Toward a Next-Gen Grid*, ELECTRIC LIGHT & POWER, http://www.elp.com/index/display/article-display/339011/articles/utility-automation-engineering-td/volume-13/issue-9/features/smartgridcity-xcel-energyrsquos-bold-step-toward-a-next-gen-grid.html (last visited Mar. 5, 2010) (" 'The primary means of communication across SmartGridCity will be broadband over power lines, or BPL . . . . Nearly 90 percent of the city will be connected with BPL, although the company also plans to test wireless capabilities in parts of the network as well.' ") (quoting Randy Huston, SmartGridCity Project Delivery Executive, Xcel Energy)).

> CPNI [consumer proprietary network information] rules themselves.[103]

Though originally considered but an academic "thought experiment,"[104] there is now more reason to focus on just how network architectures may influence jurisdictional decisions. Duke Energy's application for development of a smart grid project in Indiana was challenged by the local telecommunications provider, which argued that Duke's smart grid would be positioned to improperly compete with a telecommunications network already regulated as a monopoly.[105] Moreover, the FCC, citing its authority under the ARRA to develop a national broadband plan,[106] has in fact expressed some interest in entering the smart grid space and is considering how its regu-

103. Quinn, *supra* note 27, at 25 n.80 (citing 47 U.S.C. § 153 (defining "telecommunications service" and other relevant terms in determining jurisdictional scope), § 222 (setting out guidelines and definitions for the protection of customer proprietary network information ("CPNI"))); *see also* Nat'l Cable & Telecomm. Ass'n. v. Brand X Internet Servs., 545 U.S. 967, 996–99 (2005) (interpreting "telecommunications" as defined in the Communications Act of 1934 and focusing on the "transparency" or unprocessed nature of the information transmission); Mark F. Foley, *Data Privacy and Security Issues for Advanced Metering Systems (Part 2)*, SMART GRID NEWS, July 1, 2008, http://www.smartgridnews.com/artman/publish/industry/Data_Privacy_and_Security_Issues_for_Advanced_Metering_Systems_Part_2.html ("[I]f a utility collects and transmits AMI data via BPL and also offers consumers internet access, the utility may be subject to rules governing telecommunications service providers.").

104. Quinn, *supra* note 27, at 25 n.80.

105. The Indiana Utility Regulatory Commission described the thrust of the intervention in its final order:

> The Indiana Telecommunication Association ("ITA") filed the testimony of Mr. Alan I. Matsumoto employed by Embarq Corporation as Regulatory Manager. Mr. Matsumoto recommended certain competitive safeguards to protect against [Duke Energy's] anti-competitive behavior. He indicated that Duke Energy Indiana's SmartGrid Initiative may allow the Company to offer communications services, and therefore competitive safeguards may be required. Mr. Matsumoto stated that such competitive safeguards could include: (1) divestiture of communications operations into a separate company; (2) functional separation of communications operations; or (3) separate books, records and accounts and a cost allocation methodology. Mr. Matsumoto specifically recommended that, at a minimum, the third method be implemented with respect to Duke Energy Indiana's SmartGrid Initiative.

Verified Petition of Duke Energy Indiana, Inc. Requesting the Indiana Utility Regulatory Commission to Approve an Alternative Regulatory Plan, Order on Settlement, Cause No. 43501 at 9–10 (Nov. 4, 2009), *available at* http://www.in.gov/iurc/files/43501order_110409.pdf.

106. *See* American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5 § 6001(k)(2)(D), 123 Stat. 115 (2009) (directing the FCC to develop a National Broadband Plan that included "a plan for the use of broadband infrastructure and services in advancing . . . energy independence and efficiency").

latory authority might extend into the development of the nation's next electricity infrastructure.[107]

The FCC is perhaps the least intuitive home of federal jurisdiction over the developing smart grid, but it is far from the only contender for development control. The FERC issued a policy statement asserting its jurisdiction over the arena as well, stating that the Energy Independence and Security Act of 2007 ("EISA")[108]

> give[s] the [FERC] new responsibilities for the adoption of standards needed to insure smart grid functionality and interoperability. The legislation specifically directs the Commission to institute rulemaking proceedings to adopt standards necessary to insure "functionality and interoperability in interstate transmission of electric power, and regional and wholesale electricity markets." The Commission understands this mandate to mean that the Commission has the authority to adopt a standard that will be applicable to all electric power facilities and devices with smart grid features, including those at the local distribution level and those used directly by retail customers so long as the standard is necessary for the purpose just stated.[109]

In a footnote concluding this section, FERC explained:

> [T]wo-way communications are a distinguishing characteristic of smart grid devices on both the transmission and distribution systems. This two-way communications capability is essential to the smart grid vision of interoperability, allowing the transmission and distribution systems to communicate with each other. They also affect the security and functionality of each other.[110]

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107. *See* FCC Public Notice, Implementation of Smart Grid Technology, DA 09-2017 (Sept. 4, 2009), http://hraunfoss.fcc.gov/edocs_public/attachmatch/DA-09-2017A1.pdf (seeking comments on smart grid technology and the ways in which consumer electricity usage data will be collected and transmitted between interested parties); *see also* FCC Public Notice, FCC Requests Nominations by May 8, 2009 for Membership on the Technological Advisory Council, DA 09-796 (Apr. 8, 2009), http://fjallfoss.fcc.gov/edocs_public/attachmatch/DA-09-796A1.pdf (stating that the reestablished Technology Advisory Council might be tasked with advising the FCC on the communications infrastructure needed to support smart grid development).

108. Pub. L. No. 110-140, 121 Stat. 1492 (2007).

109. Policy Statement, 74 Fed. Reg. 37,098 at 14 (July 16, 2009), *available at* http://www.ferc.gov/whats-new/comm-meet/2009/071609/E-3.pdf (quoting EISA §§ 1301, 1305(d)).

110. *Id.* at 14 n.42.

The Department of Energy is another arguable home for some jurisdiction and oversight over the smart grid, after overseeing the disbursement of over $4 billion of stimulus funds under the ARRA for smart grid development.[111] Even the Federal Trade Commission—the typical privacy watchdog—has a claim to control at least those aspects of the smart grid's development that relate to information collection and dissemination.[112]

Additionally, the locus of regulation will select who among a cadre of now-competing protocols and devices emerges as the industry (and regulatory model) standard: "[a]s to how best to make grids 'smarter,' a fiercely competitive struggle is underway among multiple vendors with huge proprietary stakes in the outcome."[113] For example, the communications protocols and information security measures mentioned in the FERC policy statement, if made standard, could well be king-making of those companies that developed the standards or guessed right when designing their systems. The technological and regulatory architectures of the smart grid are inextricably intertwined; their symbiotic development will be driven by policy decisions and will in turn drive policy outcomes.

But just as the design of the smart grid will help decide the question of how it is regulated, developers await the answers to the regulation question before they sit down at the design table. Whether smart grid information is to be controlled under the relatively weak CPNI rules of the FCC,[114] or rather under some new consumer protection scheme developed piecemeal by the state PUCs,[115] will very likely influence the value of the

111. *See supra* note 98.

112. *See* Pamela Jones Harbour, Commissioner, FTC, Remarks Before FTC Exploring Privacy Roundtable, at 5 (Dec. 7, 2009), www.ftc.gov/speeches/harbour/091207privacyroundtable.pdf ("As firms continue to develop new data-based markets—including, for example, cloud computing and smart grid services—we must engage in more serious inquiries regarding both the privacy and competition issues that affect consumers.").

113. Ralph Cavanagh, *Electricity Grids, Energy Efficiency and Renewable Energy: An Integrated Agenda*, ELECTRICITY J., Jan.–Feb. 2009, at 99.

114. For a discussion of this possibility, see Quinn, *supra* note 27, at 25–26.

115. Some PUCs have at least shown interest in such regulation, and a few have begun it in earnest already. *See, e.g.,* Investigation of Privacy Issues Associated with the Deployment of Smart Grid Technologies, Colo. Pub. Utilities Comm'n, Docket No. 09I-593EG (Sept. 15, 2009), http://www.dora.state.co.us/puc/DocketsDecisions/HighprofileDockets/09I-593EG.htm; Order Instituting Rulemaking to Consider Smart Grid Technologies, Cal. Pub. Utilities Comm'n, Rulemaking 08-12-009 (May 1, 2009), http://docs.cpuc.ca.gov/efile/RULC/100533.pdf (indicating that California's "Regulatory Approach" to the smart grid should consider "[c]yber-security issues including policies to ensure customer privacy"); 16

data[116] and so too a number of smart grid players' bottom lines. It is a game of chicken involving innovation, with each side taking steps toward their desired result—the regulators holding hearings to consider their oversight authorities, the developers deploying test programs and beginning the process of network overhaul—but with each really waiting for the other to flinch and clear the pathway.

From this conflict must emerge a coherent and reasonably integrated network, and a great many of the public policies that drive the smart grid will be influenced, and perhaps even wholly determined, in the process. To better understand just how these decisions—made throughout the development process by both regulators and smart grid developers—will influence the efficiency and efficacy of the grid that results, Section B turns to a description of the integrated set of public policy questions that will be answered (at least in part) during network construction.

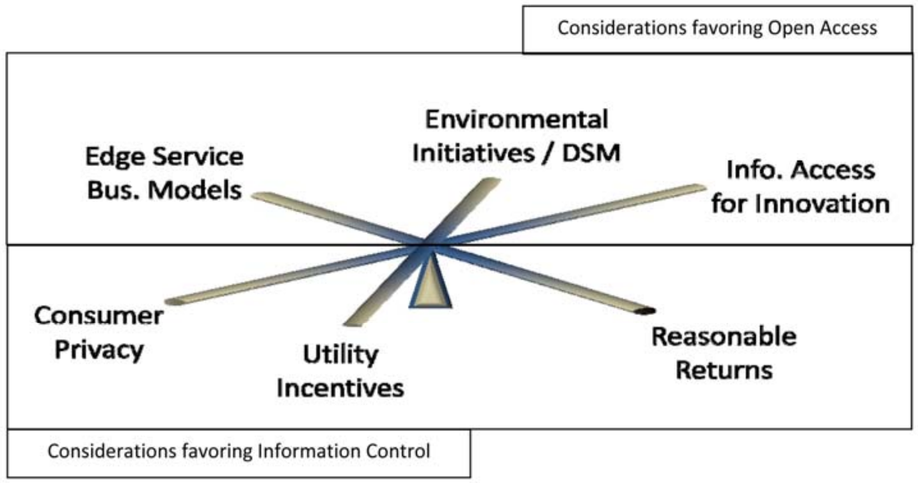
B. Competing Policies and their Architectural Consequences

Network development is akin to a balancing act in which a plethora of public policy concerns must be weighed against one another and taken into account in a way that does not unduly favor one to the exclusion of another. Here we set out six key considerations at issue in the development of the smart grid, and attempt to illustrate the ways in which these interrelated and sometimes overlapping policy concerns affect one another and are affected by network and regulatory architecture decisions. Each of these six considerations will be addressed in turn.

TEX. ADMIN. CODE § 25.130(j) (2010) (Texas PUC regulations concerning "Access to Meter Data").

116. Those who control the data and what they can do with it speaks to the very heart of the data's utility and influences the transaction costs surrounding data collection. Consider, for example, the difference between entitlement regimes that require usage information to be collected directly from each consumer (or at least that require the affirmative consent of each consumer before the information can be disclosed to a third party), and a structure where the electric utility acts as an information clearing house for its service area.

Figure 2: The Smart Grid Policy Balancing Act[117]



1. Environmental Initiatives & Demand-Side Management

Environmental advocates view the smart grid as a means of reducing the environmental footprint of electricity consumption by improving system emissions profiles and reducing demand.[118] The provision of information and other signals to modify social norms and prompt pro-environmental behavior related to energy use and demand-side appliance and energy efficiency investment are seen as effective means of drawing down demand.[119] Higher resolution data, presented in the

117. The pairings and placement of these policies here is deliberate, as is the order of their description in the following pages. Were each of these policies considered in isolation, it would drive network architecture decisions in many ways antithetical to those decisions that might be motivated by the policy lying on the other end of the balance beam.

118. *See* Rebecca R. Johnson, Smart Grid, PHEVs, and Wind: A Colorado Case Study, presented to the American Wind Energy Association (Nov. 20, 2009) (modeling environmental benefits of shifting consumption away from traditional peaks through smart grid-enabled dynamic and time-of-use pricing); K.C. Jones, *Smart Grids to Get Jolt From IT*, INFORMATIONWEEK, Mar. 23, 2009, at 18, 18 (discussing Duke Energy's smart meters in Charlotte, N.C., which provide "business and residential consumers with real-time information on their energy use, as well as data on how much their appliances cost to operate, letting them save money by cutting back usage during high-rate peak times or by replacing inefficient appliances").

119. *See generally* SARAH DARBY, ENVTL. CHANGE INST., THE EFFECTIVENESS OF FEEDBACK ON ENERGY CONSUMPTION: A REVIEW FOR DEFRA [DEP'T OF ENV'T, FOODS & RURAL AFFAIRS] OF THE LITERATURE ON METERING, BILLING AND

right manner, tends to result in more effective consumer empowerment, prompting alterations in daily demand and investment in more efficient appliances.[120]

To this end, these efforts would be best supported by technologies that provide targeted, real-time information to electricity customers, and measured usage in relatively small time slices so that electricity consumers are aware of specific appliance loads and can react in an informed way to either price signals or environmental directives and information.[121] Naturally, smart grid applications that reduce consumer demand for electricity are opposed to the traditional utility bottom line, which is dependent on the sale of a minimum quantity of electricity in order to meet the utility's costs of capital and attract continued capital for new expansion.[122] Thus, electric utilities may have little incentive to provide their customers with the kind of high-value data needed to reform usage habits. But such information remains valuable to consumers for a number of reasons: personal desires to reduce environmental footprints, economically driven needs to make smarter appliance investment decisions, and, of course, social desires to signal personal convictions and socio-economic status.[123] This is to say nothing of the import of achieving greater social and environmental goals.

DIRECT DISPLAYS 3 (2006), http://www.auburn.edu/projects/sustainability/SAB/resources/Sustain-A-Bowl_2009/topicalReading/energyconsump-feedback.pdf (reviewing literature on consumer interactions with usage data and concluding that more information generally enables better energy management).

120. *See id*. Of course, information by itself is not enough. Rather, information of a fine-enough resolution is a necessary but far from sufficient condition to engage consumers actively in electricity management efforts.

121. *See, e.g.*, Georgina Wood & M. Newborough, *Influencing User Behavior with Energy Information Display Systems for Intelligent Homes*, 31 INT'L J. ENERGY RES. 56, 57 (2007).

122. *See supra* Part I.A. Consumer behavior to merely time-shift, rather than reduce, electricity use would not interfere with the utility bottom line, and could result in utility cost savings as well as potential emissions reductions by reducing the need for peak power. But limiting consumer response in such a way would simultaneously limit the potential environmental benefits: there is no demand as green as the absence of demand.

123. *Cf.* Paul C. Stern, *Blind Spots in Policy Analysis: What Economics Doesn't Say about Energy Use*, 5 J. POL'Y. ANALYSIS & MGMT. 200, 207–17 (1986) (explaining that consumer choices regarding energy efficiency investments are not governed solely by rational economic decision-making, but rather by a spectrum of psychological processes, including perceived actions of others, organizational parameters, desire to avoid cognitive dissonance, advertising and marketing, and signaling between persons).

If utilities would rather not provide this information, non-utility actors are eager to give people what they want. Such edge service providers might sell their equipment directly to consumers through retail outlets,[124] might provide equipment free of charge and profit from the sale of consumer usage data into data markets, or some combination of the two. Still another possibility arises if the utility were to sell consumer usage information to edge service providers engaged in environmentally based analysis in an attempt to offset sales losses.

2. Traditional Utility Incentives

As discussed earlier,[125] electric utility incentives under traditional regulatory schemes could be described as the balance point between rate structures (including rate-setting) and directed mandates (such as those regarding quality of service or universal service).[126] In defining how electric utilities garnered the return on their investment and the population a utility was commanded to serve, legislators and regulators laid out the incentives that drove the industry's growth—incentives that were directly tied to the management and sale of electricity.[127]

This incentive landscape has unfortunate consequences, and can stall progress toward the industry's reform: "[a] number of technologies need to be put in place to make the power grid smarter, notably more automation within the network and tools to give end users better information. But utilities are 'grossly risk-averse and grossly hesitant to adopt new technology.' "[128] This is not an isolated opinion. The Department of

124. *See* Tendril Inc., http://tendrilinc.com (last visited Feb. 26, 2010).

125. *See supra* Part I.

126. *See generally* Paul L. Joskow, *Incentive Regulation and its Application to Electricity Networks*, 7 REV. NETWORK ECON. 547 (2008) (describing incentive regulation as the application of price cap mechanisms, service quality incentives, and performance measurement). Of course, there are questions of institutional design for both regulatory bodies and electric utilities at play in the incentive landscape, but these go more to *how* the balance is struck than to the factors placed on the scales.

127. When Paul Joskow described the "theoretical considerations" at play in electricity incentive regulation, he did so under the implicit assumption that the principle—indeed exclusive—source of incentive leverage stems from pricing and regulating the product distributed by the network, namely electricity. *See id.* at 550.

128. Martin LaMonica, *Will Anyone Pay for the 'Smart' Power Grid?*, CNET NEWS, May 16, 2007, http://news.cnet.com/Will-anyone-pay-for-the-smart-power-grid/2100-11392_3-6184046.html (quoting Alison Silverstein).

Energy's Electric Advisory Committee also recognized utilities' risk-averse behavior as a barrier to the adoption of new technologies:

> Many of today's utility business models are based upon the utility earning a negotiated return on prudent capital investments. It is not surprising, therefore, that the utilities responsible for making prudent investments focus on minimizing risk. Consequently, utilities are often slow to adopt new technologies that have not been extensively proven outside of a laboratory.[129]

Moreover, traditional rate-of-return regulation creates incentives in many ways antithetical to the modern project of electricity reform.[130] Especially when framed as a means to reduce electricity consumption, a smart grid is, under the existing regulatory lens, hardly more than a huge capital expense focused on minimizing profits. For a utility to hasten to deploy such smart grid technologies is, therefore, economically irrational under existing incentive structures. Of course, existing incentives could prompt utilities to deploy some smart grid components—for example, advanced metering and home automation for time-shifting of demand—that reduce costs while otherwise maintaining existing sales levels.[131] But demand-reducing smart grid technologies that are less friendly to utility profitability may be marginalized in the process unless utilities are compensated in some way for the lost electricity sales.

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129. EAC REPORT, *supra* note 8, at 14.

130. *See supra* Part I.A; *see also* Daniel J. Weiss & Kalen Pruss, *Harvesting Low-Hanging Energy Savings*, CTR. FOR AM. PROGRESS, Mar. 10, 2009, http://www.americanprogress.org/issues/2009/03/eers_efficiency.html ("[T]he profits of most utility companies are tied to the amount of electricity sold, not to some other measure of service. Therefore, electricity suppliers have little incentive to reduce their generation because that would reduce profits.").

131. Other motivations may play a role in driving utility action in this area. To the extent that smart grid development is treated as a foregone conclusion, strategies may differ as to how to approach the issue. On the one hand, it seems reasonable to try to obstruct such progress: it may be better to drag one's feet in smart grid development and thus postpone the erosion of electricity sales through conservation efforts and DSM. On the other hand, there may be an early-mover advantage to be had. Gaining expertise in the new technologies and methods of electricity management may give utilities a head start in shifting its practices to the new business environment. However, this latter view is mitigated by two counterpoints. First, utilities do not generally compete with one another, and so just who the early-mover advantage would be over is not obvious. Second, it is quite possible that later regulatory efforts may moot early development in favor of a single technical standard. This cautionary hypothetical disfavoring early action is often summarized by the twisted adage that no good deed goes unpunished.

Moreover, because utilities have an extensive pre-existing relationship with regulators, a failure to deliberately account for the needs of other players in the emerging smart grid marketplace may result in a "default" regulatory and network architecture for a smart grid that is excessively utility-centric.

3. Consumer Privacy

The backbone of the smart grid is the collection of information. Depending on the grid architecture, information about customer electricity consumption could be collected in a number of ways, and at many levels of granularity. Early smart metering systems collected information about usage in half-hour increments. Newer models often default to five-minute collection, but can in fact be used to measure usage at resolutions of less than a second. The available information determines the kinds of analysis that are available: with finer-grained information, specific appliance events can be deciphered from the user's load profile and a consumer's daily activities can be determined with surprising (and potentially disturbing) levels of detail.[132] This information could be of interest to a host of potential actors, some relatively benign (market researchers interested in the number of times a person makes tea throughout the workday), some more questionable (insurance companies using intimate personal information to identify risky behavior and thus adjust premiums), and some downright monstrous (criminals examining usage information to determine when the user is not home—or is home alone).[133]

Protecting consumers from dangerous and unauthorized disclosure of their personal information requires careful thinking about who may collect the information, who owns the information, how the physical network collecting the information is protected against attack, and how to ensure that users authorized by consumers to use the data guard it from inadvertent disclosure to unauthorized parties.[134]

132. *See* Quinn, *supra* note 27, at 1−3 & app. A.

133. *See id.* at 9–11; *see also* Susan L. Lyon, *Privacy Challenges Could Stall Smart Grid*, MATTERNETWORK, June 1, 2009, http://featured.matternetwork.com/2009/6/privacy-challenges-could-stall-smart.cfm.

134. *See* Quinn*, supra* note 27, at 28–34.

4. Information Access as Fuel for Innovation

While consumer privacy protection is vital, regulations to protect the flow of information against unauthorized disclosure present potential conflicts with the development of innovative uses of the valuable data produced by the smart grid, whether it be for the development of new utility revenue streams or for the development of edge service provider markets. Many see open access to information as crucial for spurring competition and innovation.[135] Likewise, edge service innovators such as Tendril Networks have expressed concerns that "information control regimes that centralize smart grid information disclosures will likely hamper innovation."[136] However, innovation firms are not necessarily cavalier or unsympathetic to privacy concerns. Rather, such firms suggest that the locus of information control should reside with consumers, so that willing participants could sign access to their usage information over to third party data analysts and other edge service providers.[137]

5. Reasonable Returns

Detailed electricity usage information has always been thought of as a source for improving the existing electricity infrastructure—managing assets, dispatching resources, integrating distributed generation, and generally increasing efficiency. To that end, a number of electric utilities conceive of collected usage information as *theirs*—a resource they use in providing a service to their customers.[138] In this light, it is

135. *See*, *e.g.*, Written Ex Parte of Professor Mark A. Lemley and Professor Lawrence Lessig, In the Matter of Application for Consent to the Transfer of Control of Licenses MediaOne Group, Inc. to AT&T Corp., Federal Communications Commission, CS Docket No. 99-251 ¶ 1, *available at* http://cyber.law.harvard.edu/works/lessig/lem-lesd.pdf(arguing that changing the Internet's "open access" architecture might in turn "threaten . . . innovation and growth").

136. Comments of Tendril Networks, Inc., In the Matter of the Investigation of Security and Privacy Concerns Regarding the Deployment of Smart Grid Technology, Colo. Pub. Util. Comm'n 2, No. 09I-593EG (Sept. 21, 2009), https://www.dora.state.co.us/pls/efi/EFI.Show_Docket?p_session_id=&p_docket_id=09I-593EG.

137. *See*, *e.g.*, Comments of Google Inc. on Proposed Policies and Findings Pertaining to the Smart Grid Policies Established by the Energy Information and Security Act of 2007, Cal. Pub. Util. Comm'n, No. R08-12-009 (Oct. 26, 2009), http://www.google.org/powermeter/cpuc.html#_edn3.

138. *See*, *e.g.*, Public Service Company of Colorado's Initial Comments in Response to Decision, In the Matter of the Investigation of Security and Privacy

understandable that incumbent utilities might perceive the information to be a resource from which *they* should benefit. Contrary to the notion that they should provide "rights of access" to the information, these utilities may want to control the disclosure of the information themselves, either to garner revenues from it or to gain some competitive advantage.[139]

Additionally, several electric utilities have already invested heavily in the roll-out of smart metering infrastructure.[140] Any decisions that might threaten their ability to reap reasonable returns on that investment—through, for instance, revenue from data sales or analysis services—will likely be vigorously opposed. As a general matter, though, public utility commissions are comfortable reviewing—and righting—alleged wrongs done to the utility on this front. Protecting early-action investments in the smart grid space could thus be done on a case-by-case basis and need not weigh heavily on fundamental architectural concerns. An opposing possibility arises from the utility's customary boundaries and its traditional, risk-averse behavior: utilities may not be interested at all in data sales revenues because of higher market risks as compared to their traditional core competencies.[141]

6. Edge Service Business Models

A growing number of edge service providers have cropped up to manipulate and present electricity usage data at the edge of the electricity network. Among the ranks of these providers are relatively young companies such as Tendril Networks,[142] Comverge,[143] and Grid Point,[144] as well as older giants branch-

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Concerns Regarding the Deployment of Smart Grid Technology, Colo. Pub. Util. Comm'n 5, Docket No. 09I-593EG (Sept. 14, 2009), https://www.dora.state.co.us/pls/efi/efi_p2_v2_demo.show_document?p_session_id=&p_docket_id=09I-593EG (listing the many uses to which the electric utility could put smart meter data, arguing they are crucial to their business, and stating that "the Company disagrees that it should be compelled, other than when a customer requests that his or her own information be disclosed to a third party, to provide access to the energy usage information that it collects to further the commercial interests of third parties such as the emerging 'edge service' providers").

139. *See id*.

140. *See,* FERC 2008 DEMAND RESPONSE ASSESSMENT, *supra* note 19, at 14.

141. *See* EAC REPORT, *supra* note 8, at 6–9 (describing the smart grid's benefits to electric utilities entirely in terms of electricity provision and concerns about reliability and security).

142. Tendril Inc., http://www.tendrilinc.com (last visited Feb. 26, 2010).

143. Comverge Inc., http://www.comverge.com (last visited Feb. 26, 2010).

144. GridPoint Inc., http://gridpoint.com (last visited Feb. 26, 2010).

ing out into this new area such as Microsoft,[145] IBM,[146] and Google.[147] This is a growing industry attracting large amounts of venture capital and stimulus fund dollars, and driving the assessment of the smart grid space as the next silicon-valley-type tech boom.[148]

However, despite early success, there remains a palpable dissonance among the business models of edge service providers. The critical divide concerns exactly who providers perceive to be the principal beneficiary of intelligence instilled in the electric grid. In many early developments, the target customers of edge services were the electric utilities themselves. This focus on utilities led the edge service providers to promise dispatchable load savings through the installation of remote-controlled "saver-switches" as well as enhanced reliability and network efficiencies to attract the network managers.[149] Utilities could even save money simply by eliminating the need to send meter-readers in trucks into neighborhoods. Such projects might be thought of as developing the smart grid from the utility out.

In contrast, other models such as Google Powermeter, Microsoft Hohm, Tendril TREE, and OpenPeak target electricity consumers as their primary customers. These efforts promise load analysis and management to individual electricity consumers, as well as the information backbone required for home- or plant-automation systems. This might be considered development from the edge in.

There are shades of gray between the two options of utility- versus consumer-centered business models for edge services. However, the two models would drive the construction of quite different data collection and management systems. In the case of the former, data would likely be collected by utili-

145. Microsoft Corp., http://www.microsoft-hohm.com (last visited Feb. 26, 2010).

146. IBM, Smarter Planet, http://www.ibm.com/smarterplanet/us/en/ (last visited Feb. 26, 2010).

147. Google, Google PowerMeter, http://www.google.org/powermeter/ (last visited Feb. 26, 2010).

148. *See, e.g.*, *Technology Quarterly: Building the Smart Grid*, *supra* note 1.

149. Comverge presented some impressive savings, as demonstrated by its use of saver-switch operations with PacifiCorp in Salt Lake City, Utah, to the Colorado Public Utilities Commission in April of 2009. *See* Tom Van Denover, Senior Vice President, Comverge Inc., Comverge: Leadership in Demand Response for Utilities and Consumers, Presentation at the Colorado Public Utility Commission's Informational Meeting 17 (Apr. 9, 2009), http://www.dora.state.co.us/puc/presentations/InformationMeetings/SmartGrid/04-09-09CIM_Comverge.pdf.

ties—probably through smart meters—who would then play the role of gatekeeper, distributing the information to various users and edge service providers in accordance with pertinent privacy and security regulations. In the case of the latter, information would be collected outside and beyond the utility's network—for example, within the homes of electricity consumers—and then provided by the consumer to whomever she desired. While there is no reason that these models could not coexist, duplicity in the data collection infrastructure would come at a huge expense. Furthermore, because regulatory schemes controlling privacy and security are likely to impinge on information collection, analysis, and storage models, such regulation is likely to influence which model appears most appropriate and thus most viable. Not surprisingly, the physical deployment of smart metering technologies has not necessarily decided the matter. Smart meter installation programs distributing millions of smart meters across the country have already begun, and millions more smart meters are on their way as a result of ARRA funding.[150] But the meter lies at the outer boundary of the electric grid, and its status as a collection tool for the utility and its contractors, or as an open-access tool for multiple edge service providers, is far from clear.

Although utilities seem to assume they will receive proprietary rights over data produced by the smart grid as a result of their entrenched dominance in the electricity space, there are good reasons to question the wisdom of assuming that utilities should be the default recipients of the data. As a threshold matter, there is no compelling policy reason why the analysis of energy usage data, or the sale of that data into data markets, is an appropriate area for operation of the monopoly-style regulation to which utilities are subject. Indeed, such activities do not exhibit the characteristics of a natural monopoly, provided the data is neutrally available to competing analytical services.[151] Rather, competition among edge service providers might be the ideal driver toward better analytical services, both in the provision of accurate information and in the communication of information in a manner that engages energy consumers to take real action. Edge service providers thus

150. *See* Department of Energy, Recovery Act Selections for Smart Grid Investment Grant Awards - By Category, http://www.energy.gov/recovery/smartgrid_maps/SGIGSelections_Category.pdf (listing the numerous grants awarded for smart grid projects under the ARRA).

151. *See* BOSSELMAN, *supra* note 23, at 52.

have a strong argument that the creation of a regulatory architecture that views the utility as the natural space for analysis services unnecessarily straitjackets innovation in the smart grid.

Finally, there is no reason to think that utilities would be especially skilled in developing analysis and behavior modification applications, given their traditional supply-side concerns. Utilities have always thought of demand as something of a giant in the hillside, whose movements are to be predicted in integrated resource plans, and whose needs are to be met through least-cost investments in generation assets. Only legislative mandates have forced utilities to incorporate increasing amounts of demand-side management into their planning processes.[152] Edge service companies might find it counterintuitive, to say the least, to suggest that a wizened electric utility could design sophisticated applications to spur consumer attention to something that they have happily ignored for over a hundred years.

C. *Whither the Balance?*

The competing concerns implicated in smart grid technological and regulatory architecture design, while compelling, probably are not equally weighted. Interestingly, privacy concerns in Colorado seem to have struck a nerve with regulators that emissions reduction, utility profitability, and edge service market development have not.[153] As a result, many of the decisions that affect the latter issues may be determined, for better or worse, with privacy as the dominant framework for discussion. Indeed, the usage restrictions placed on data streams in

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152. *See, e.g.*, COLO. REV. STAT. § 40-3.2-104 (2009).

153. *See, e.g.*, Investigation of Security and Privacy Concerns Regarding the Deployment of Smart Grid Technology, Colo. Pub. Util. Comm'n, Docket No. 09I-593EG (Sept. 15, 2009), *available at* http://www.dora.state.co.us/puc/DocketsDecisions/HighprofileDockets/09I-593EG.htm (subsuming all of these other issues under the privacy heading). Additionally, during the final editing stage of this paper, the California Legislature began considering Senate Bill No. 837, a state bill that would impose data sharing restrictions on both electric utilities and third-party data service providers. *See* California S.B. 837, 2010 Leg. (Cal. 2010) (as amended Apr. 27, 2010), *available at* http://www.leginfo.ca.gov/pub/09-10/bill/sen/sb_0801-0850/sb_837_bill_20100427_amended_sen_v96.pdf. The proposed Bill deals with many of the issues raised in this paper through the lens of consumer privacy, and appears to adopt an approach to data management developed in the comments and framing papers of the Colorado PUC's investigatory docket.

the name of privacy protection could have profound effects on competing business models' ability to leverage the value of smart grid data.

At the moment, there are few coherent visions that comprehensively balance these competing policy concerns. Rather, the conversation tends to progress piecemeal. However, CableLabs recently proposed a policy balance that came down on the side of open access and spurring innovation.[154] The research and development consortium argued that, "[w]ithout an open market for residential energy management, there will be minimal private investment and new product development, leaving the promise of a ubiquitous national Smart Grid unrealized."[155] The paper definitively concludes that

> [t]he need for a robust market for residential energy management is clear. What remains unclear is how the government will allow, even encourage, this market to develop. Without the ability for consumers to choose their own solutions, the ability to read their own meter directly, and the ability to control their own usage, this market will not reach its potential.
>
> At risk is the success of the Smart Grid in this country. In order to realize the maximum benefits from residential energy management, the federal government must recognize:
>
> 1. An open market for residential energy management is required to achieve real interoperability and economies of scale on a national basis. Adopting these principles would ensure the market for home energy management systems and services would be open to all potential entrants.
>
> 2. An open market requires that utilities allow direct access to real time meter data and real time pricing and pricing signals. This will prevent the market from being Balkanized into islands of utility-specific solutions.
>
> 3. An open market requires competition to stimulate the greatest innovation and greatest investment and maximize the probability of a sustainable market. The rich diversity of solutions that are being developed now and in the future

154. ROY PERRY & KENNETH WACKS, CABLELABS, CREATING A ROBUST MARKET FOR RESIDENTIAL ENERGY MANAGEMENT THROUGH AN OPEN ENERGY MANAGEMENT ARCHITECTURE 12–13 (2010), http://www.cablelabs.com/downloads/pubs/residential_energy_management.pdf.

155. *Id.* at 1.

> should be allowed to connect to the Smart Grid, as long as they do not harm the grid.[156]

Interestingly, the CableLabs paper does not expressly recognize the way in which its answer marginalizes consumer privacy problems[157] or undermines utilities' arguments that they have a superior right to develop and garnish returns in this arena.[158] However, in emphasizing the need for real-time access to information for all players on the network, it does set forth a coherent vision of smart grid development that would strike a balance among the policies at play.

Whether that balance is a livable one for the other interests surrounding smart grid development—consumer protection and utility business flexibility among them—is a different matter, and one that this Article does not purport to solve. However, it is important to recognize that CableLabs' vision is not the only reasonable one. Part III provides a counterpoint to the CableLabs option, one that favors centralizing information control at the electric utility rather than emphasizing edge-in development vectors. This counterpoint is suggested not as a superior option, but only as a different choice to help expand notions of information regulation on the grid.

III. PONDERING STRATEGIES: THE POTENTIAL FOR A SMART GRID INFORMATION MARKETPLACE

The complexity of managing competing policy concerns in the development of smart grid architecture within a single jurisdiction is daunting. But bigger problems lurk on the horizon, particularly if different sets of state regulators reach drastically different conclusions about the proper regulatory architecture of the smart grid. A patchwork of regulatory architectures—some built around utility-based models of smart

156. *Id.* at 12–13.

157. The paper notes that service providers "must protect consumer data as private customer-owned data and use these data only to deliver the contracted services," but the point is simply thrust forward as a matter of principle. *Id*. at 8. CableLabs does not appear sensitive to the fact that requiring the collection of more information, and open access to that information, will heighten privacy risks. *See generally id*.

158. While this point is not necessarily incorrect, neither is it self-evident based on the industry's history or the regulatory practices in effect. Indeed, the paper simply notes, as if axiomatic, that "[p]olicy should allow a competitive EMSP market with a level playing field for utilities and third parties alike." *Id.* at 8.

grid analytics and informational controls, others built around edge service providers with very little utility input—could frustrate the development of information markets driving smart grid adoption and development, especially where market actors wish to engage in interstate commerce.

Interstate coordination of decisions affecting smart grid information flows could prove critical both to the growth of some emerging industries and to the smart grid itself, as these industries have the potential to drive significant value to the smart grid. To illustrate the potential of these industries, this section develops and explores a thus-far underdeveloped side of the smart grid possibility: the data market. The information produced by the smart grid is a heretofore unmatched library of personal information, and could provide a unique insight into consumers' in-home activities.[159] As such, it is potentially of great interest—and great value—to a wide range of service providers and end consumers.[160] In particular, smart grid data is unique as an information commodity because it is of value to the very person about whom it is being collected.[161] Additionally, utilities themselves—pressured to find new revenue streams under the looming shadow of greenhouse gas emissions constraints—could well seek to capture rents on the information's use. As Roger Duncan, Deputy General Manager at Austin Energy, noted: "We haven't figured out the business models . . . [that] work well for the utility and the city government and the citizens . . . . Austin Energy has to figure out how to diversify its revenue sources."[162]

One possible result is that utilities could enter the information trade in addition to their business of electricity provision, provided both that data sales offset electricity sales reductions from better consumer energy management, and that utilities find the impetus to engage in data aggregation and sale. Smart meters and other smart grid technologies allow for

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159. *See supra* notes 106–08 and accompanying text.

160. *See* Andrew Maykuth, *Utilities' Smart Meters Save Money, but Erode Privacy*, PHILA. INQUIRER, Sept. 6, 2009, *available at* http://www.philly.com/inquirer/business/20090906_Utilities__smart_meters_save_money__but_erode_privacy.html (quoting Rick Brakken, CEO of DataRakker Inc., as saying that "[t]he real value of smart meters is the information").

161. Compare, for example, the information about search histories or click-through habits collected by search engine companies or aggregated for online advertising.

162. Martin LaMonica, *Will Anyone Pay for the 'Smart' Power Grid?*, CNET NEWS, May 16, 2007, http://news.cnet.com/Will-anyone-pay-for-the-smart-power-grid/2100-11392_3-6184046.html.

the collection of a great deal of historically unavailable data about all kinds of things, ranging from market penetration data on certain electric appliances to individual consumers' daily routines. Electric utilities could bundle the electricity usage information pouring in from their consumers into data streams. The content of these data streams could be varied in a number of ways to suit a diverse set of potential subscribers. The following sections first discuss the basics of information economics pertinent to the argument and then apply those lessons in the context of the smart grid information market in order to expand visions of just what is possible with the smart grid's development.

A. Pertinent Lessons of Information Economics[163]

Information economics concerns itself with the market dynamics particular to trade in information goods, such as news stories and entertainment content. These goods display characteristics somewhat different than those in other markets. First, "[i]nformation goods . . . often exhibit *both* demand-side and supply-side economies of scale."[164] Like any other information good, smart grid information exhibits these characteristics. On the supply side, information collection and aggregation costs less per added customer as the smart grid continues to expand. Returns on technology development investments can be spread over a wider pool of customers and new customers can be integrated into an existing smart grid with relatively little expense. For example, the communication and management network needs no alteration to accommodate a new customer; rather, the customer just needs a smart meter to communicate usage information to the grid and to enable various fringe services.

On the demand side, as more customers purchase the information, the demand may well increase while the availability of the information to the customer becomes standard.[165] This is a kind of network value to smart grid information that is rare among traditional information goods—though not so rare

163. For a much-abbreviated version of this discussion, see Quinn, *supra* note 27, at 5–7.

164. CARL SHAPIRO & HAL R. VARIAN, INFORMATION RULES: A STRATEGIC GUIDE TO THE NETWORK ECONOMY 189 (1999).

165. *See* Jay Kaplan, Unit 14 – Networks and Positive Feedback, http://spot.colorado.edu/~kaplan/econ2010/section14/section14-main.html (last visited Apr. 3, 2009).

for information technologies, such as operating systems.[166] Moreover, personal use information is more valuable to customers if those customers are able to compare electricity usage statistics with one another. According to Adrian Tuck, CEO of Tendril Networks, people want three things from the smart grid: they want to see their consumption, they want to manage it, and, most importantly, they want to compete with other people by seeing how much more energy they saved than did their neighbors.[167] As such, the information gains value to the customer[168] simply through the expansion of the information network and corresponding dissemination.[169]

Furthermore, information goods occur where the fixed costs of product development are rather high, and the marginal costs of creating copies are negligible. Smart grid information is no different than other information goods in this respect. The installation of advanced metering infrastructure and the network development required for data collection and analysis

166. To illustrate, consider the difference between, say, a new file-sharing software that requires users on either end of the file share to be using the same platform and a specific file—the chart-topping song of the week, for example. The more people who use the file-sharing software, the greater the value it has to each user, as it allows access and sharing among a greater community with a collectively larger library. Thus, each new person who subscribes to the file-sharing software makes each previous copy that much more valuable to its respective previous user. On the other hand, copies of the song do not bring their listeners greater value as they proliferate throughout the network. Copying the song does not bestow on each copy more value to its owner; the song is still only as good—or as worthless—to its listener as it ever was.

167. Adrian Tuck, Comments at Center for Energy & Environmental Security Smart Grid Symposium (Mar. 30, 2009). See Center for Energy & Environmental Security, Colorado Clean Energy Solutions Series, http://cees.colorado.edu/smartgridevent.html (last visited Apr. 2, 2009), for information about the roundtable discussion. Other commentators on the issue have made similar points about the relative value of being able to compare performance. *See* John Tierney, *Are We Ready to Track Carbon Footprints?*, N.Y. TIMES, Mar. 25, 2008, http://www.nytimes.com/2008/03/25/science/25tier.html (discussing how studies have shown that, when information is provided as relative to the performance of others, combined with a normative assessment of which results are more desirable (e.g., a smiley face next to low electricity consumers and a frowny face next to excessive consumers), reductions can be both deep and sustained, and further describing research discussed in CASS SUNSTEIN & RICHARD THALER, NUDGE (2008)).

168. Yet there is likely a point of diminishing returns: unlike networks such as telephone service, there may be regional boundaries to the interests of smart grid electricity customers. The fact that electricity usage patterns of Seattle residents are dramatically different from those of Denver residents is likely to limit the value to the end-use customer of availability of one region's information to customers in the other region.

169. For an excellent discussion of this kind of network value, *see* SHAPIRO & VARIAN, *supra* note 164.

comprise huge capital expenses. Indeed, Xcel Energy's SmartGridCity experiment in Boulder, Colorado comes with a price tag of over $100 million to network a humble 50,000 buildings into the smart grid.[170] Yet the information made available through that technology roll-out is just as copy-able and manipulable as any other set of electronic information.

Finally, information goods share two characteristics with public goods. First, information is a non-rivalrous good: the consumption of information by one party does not prevent its consumption or use by another, because copies retain all the value of originals and can be made at very low costs. Second, the prevalence of copying technologies makes it difficult to exclude individuals from the use of information goods once they have been disseminated.[171] The non-excludable nature of the good raises some immediate concerns for information markets. Absent excludability,

> the flow of money through the [information] market will not serve its primary purpose of registering the utility of the commodity being produced. There is no reason to think *ex ante* that the commodities that generate the most attractive revenue streams paid by advertisers or by ancillary others will be the commodities that ultimate consumers would wish to see produced.[172]

In many ways, this leads to the conflicting policy concerns surrounding market regulation.[173] For example, the information market is likely to undervalue customer privacy since the individual customers whose information is monetized in such a market are involved in the market in only tangential ways. Of course, excludability can be artificially constructed through disclosure regulations, contracts, or technological protections, but without implementing and enforcing such controls, infor-

170. *See* Press Release, Xcel Energy, Xcel Energy Begins Work on SmartGridCity in Boulder (May 15, 2008), http://smartgridcity.xcelenergy.com/news/releases/05-15-2008.html.

171. *See* Yannis Bakos & Erik Brynjolfsson, Bundling Information Goods: Pricing, Profits and Efficiency 1, 1 (Apr. 1998) (unpublished manuscript), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=11488 [hereinafter Bakos & Brynjolfsson, Bundling Information Goods] ("Digital copies of information goods are indistinguishable from the originals and can be created and distributed almost costlessly via the emerging information infrastructure.").

172. J. Bradford DeLong & A. Michael Froomkin, *Speculative Microeconomics for Tomorrow's Economy*, FIRST MONDAY, Feb. 7, 2000, http://firstmonday.org/htbin/cgiwrap/bin/ojs/index.php/fm/article/ view/726/635.

173. *See* discussion *supra* Part II.

mation goods naturally tend toward public dissemination. Absent such controls, however, information production cannot be channeled into a revenue stream.

The question for decision-makers across the multiple jurisdictions through which the information is likely to flow thus becomes one of just how the information should be packaged and sold in order to recover the substantial fixed costs of its collection and development. Over the last two decades, information-economy theorists have settled on a dominant strategy which may be applicable to smart grid developers as well: product bundling.[174] Product bundling is the grouping of separate goods together in a single salable package.[175] Bundling is especially appropriate in the context of information goods because of the very low marginal cost of the product.[176] Mixed bundling becomes the strategy of choice when customers value only subsets of an available information resource,[177] or when information customers vary widely in their valuation of bundles:

> [W]hen different market segments of [information] consumers differ systematically in their valuations for goods, simple bundling will no longer be optimal. However, by offering a *menu* of different bundles aimed at each market segment, a monopolist can generally earn substantially higher profits than would be possible without bundling.[178]

Essentially, effective bundling techniques can facilitate price discrimination, which in turn allows for value extraction in

174. *See*, *e.g.*, Bakos & Brynjolfsson, Bundling Information Goods, *supra* note 171, at 1 ("[I]n a variety of circumstances, a multiproduct monopolist will extract substantially higher profits by offering one or more bundles of information goods than by offering the same goods separately.").

175. *See id.*

176. *See* HAL R. VARIAN, JOSEPH FARRELL, & CARL SHAPIRO, THE ECONOMICS OF INFORMATION TECHNOLOGY: AN INTRODUCTION 19 (2004) ("[Bundling] is particularly attractive for information goods since the marginal cost of adding an extra good to a bundle is negligible.").

177. *See* ARYYA GANGOPADHYAY, MANAGING BUSINESS WITH ELECTRONIC COMMERCE 107 (2002) (citing John Chung-I Chuang & Marvin A. Sirbu, *Optimal Bundling Strategy for Digital Information Goods: Network Delivery of Articles and Subscriptions*, 11 INFO. ECON. & POL'Y 147 (1999); Vincenzo Denicolo, *Compatibility and Bundling with Generalist and Specialist Firms*, 48 J. OF INDUS. ECON. 177 (2000)).

178. *Abstract to* Bakos & Brynjolfsson, Bundling Information Goods, *supra* note 171.

contexts where individual product sales might otherwise be unprofitable.[179]

After an extensive investigation of bundling techniques and competition effects surrounding information products, Yannis Bakos and Erik Brynjolfsson concluded that bundling information goods can have significant advantages for those companies able to engage in the practice.[180] Apropos to this discussion are their conclusions that:

> 1. Bundling information goods for sale to down-stream users "makes an incumbent seem 'tougher' to competitors and potential entrants;"[181] and
>
> 2. "Bundling can reduce the incentives for competitors to innovate, while it can increase bundlers' incentives to innovate."[182]

From these conclusions, we can extract lessons for electric utilities that illustrate that the development of smart grids might not be as contrary to the existing incentive structures as we intimated in Part I. Drawing from the first of these conclusions, it would seem that if electric utilities can, from the beginning, effectively bundle customer information into profitable data streams, the data market will insulate itself from other information providers that might seek to enter the market to collect and disseminate customer information. As to the second conclusion, bundling smart grid information into products for various kinds of service providers can incent the utility to innovate around its data acquisition and analytic techniques. As natural a consequence as this may seem—new revenue streams

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179. *See* Yannis Bakos & Erik Brynjolfsson, *Bundling and Competition on the Internet*, 19 MARKETING SCI. 63, 65 (2000) [hereinafter Bakos & Brynjolfsson, *Bundling and Competition*] (citing R. Preston McAfee, John McMillan, & Michael D. Whinston, *Multiproduct Monopoly, Commodity Bundling, and Correction of Values*, 114 Q. J. OF ECON. 71 (1989); Richard L. Schmalensee, *Gaussian Demand and Commodity Bundling*, 57 J. OF BUS. S211 (1984)).

180. *See* Bakos & Brynjolfsson, *Bundling and Competition*, *supra* note 179, at 63, 78. While the focus of this reference was limited to traditional information content such as news threads and entertainment products, nothing in the authors' assumptions or model construction would limit their results to that context. *See* Chuang & Sirbu, *supra* note 177.

181. Bakos & Brynjolfsson, *Bundling and Competition*, *supra* note 179, at 78–79; *see also* VARIAN, FARRELL, & SHAPIRO, *supra* note 176, at 19 ("There are two distinct economic effects involved [in bundling]: reduced dispersion of willingness to pay, which is a form of price discrimination, and increased barriers to entry . . . .").

182. Bakos & Brynjolfsson, *Bundling and Competition*, *supra* note 179, at 79.

bring new focus on developing ways to expand them—this result is significant in the context of electricity provision: it is a new incentive for electric utilities, one more closely tied to electricity management than to electricity sale, and one that may suggest significant changes to the utility cost-recovery regulations.

B. *Bundling Smart Grid Information*

The smart grid information space offers information providers with a number of choices as to how to bundle the information in order to tap into specific information needs and so construct information markets. The principle bundling choices are outlined in Table 2 below.

Table 2: Summary of smart grid information bundling dimensions.

Smart Grid Bundling Choices	
Dimension	**Description**
Aggregation	Electricity usage information could be provided to interested parties on the individual usage level, or the information could be aggregated on various scales—city block, region, community, county, grid—depending on the needs of the information consumer.
Resolution	Subject to the physical constraints of the smart meter at a given home, electricity usage information could be collected and disclosed at a number of intervals, ranging from monthly or daily usage totals down to usage patterns in five- and one-minute intervals.
Time-Delayed Distribution	Usage information could be provided to information customers either subject to some delay—say the month or week after the data was collected—or in real-time.

Appliance Event Identification	Optimizing electricity management on a smart grid means knowing what is putting power on the grid and when, and what uses the produced power can be directed toward. This means the utility will likely have to identify at least some personal appliance uses in order to know how long a consumer's demand is likely to last (is it a toaster or a washing machine?), what quality power would best suit her need, or how dependable a provider of power she is (solar panels, stored power in a PHEV battery, home-scale wind, etc.). Information customers could potentially purchase usage information in which large appliance events have already been identified, or they could purchase the raw usage information itself to analyze individually as seen fit.
Consumption Preferences	The deployment of HANs means electricity consumers will be able to set consumption preferences and automate appliances to respond to price or environmental signals sent out by the utility. These preferences provide an additional source of useful data points for information consumers.

These various dimensions for information bundling provide electric utilities ample room to bundle the information in ways targeted toward specific information markets, and thus the ability to extract value that may be spread unevenly across a number of information customer-types. Rather than ability, however, one of the biggest obstacles to this utilities-as-information-bundlers approach is the requisite shift in thinking. As it stands, many of these fringe services are packaged as services provided to *utilities* for load management and maintenance cost reduction. As such, electric utilities are the customers paying for technology and service support, not the providers of a service in support of these nascent fringe industries.[183]

FERC's 2008 Demand Response Assessment is illustrative of this obstacle of conception. In the report, FERC sets out the results of an extensive survey that included questions to smart meter users about their uses of the information.[184] Of the six-

183. *See* Michael Kanellos, *Tendril Expands Its Reach in Smart Homes*, GREENTECHMEDIA, Nov. 24, 2008, http://www.greentechmedia.com/articles/tendril-expands-its-reach-in-smart-homes-5248.html (discussing Tendril's growing number of contracts with electric utilities). The company "charges around $1 per month per consumer to the utility. The actual hardware costs an additional fee, but you can plug in non-Tendril hardware into the system." *Id.*

184. FERC 2008 DEMAND RESPONSE ASSESSMENT, *supra* note 19, at 13–14.

teen possible responses to this survey question, only three—"enhanced customer service," "price responsive demand response," and use with home area networks—focus on benefits provided to the customer.[185] The lion's share of fringe services discussed earlier would be lumped into the category of "enhanced customer service," if counted at all. The rest of the possible answers—including such uses as outage detection and restoration, load forecasting, and asset management—focused on benefits to the electric utility.[186] This conceptualization of the edge service industry makes extracting value from the personal usage information stream difficult for electric utilities, since they are already the customers of those services. Transitioning edge services to direct their service to end-use electricity customers would not only enable electric utilities to capture revenues from smart grid information, but may also ensure that fringe service market values help capture the "utility" of the provided service.[187]

Of course, from the perspective of the edge of the grid, the view is quite different. Electric utilities' role as the first collectors of information from utility-deployed smart meters in service territories where they face no competition creates enormous barriers to entry for non-utility actors that would seek to bundle smart grid information themselves. If information flows by default to utilities thanks to the architecture of the smart grid, other actors must then purchase the information from the utility. Such actors might argue that the policy justifications for directing information first to the utility are unclear, given the historical role of the utility as a regulated natural monopoly for the provision of electricity, not information.[188]

Either way, the possibility of such a market brings into focus not only architectural concerns—who collects the infor-

185. *See id*.
186. *See id*.
187. *Cf. supra* note 183 and accompanying text.
188. Currently, customer usage information is generally given to customers as a courtesy rather than a requirement. Electric utilities often consider themselves the proper owner of information generated in conjunction with service provision. *See supra* note 113. While many customers have, at least on paper if not in reality, some ability to request their own usage data and to allow third parties to access that data, it is fair to query whether such courtesies are likely to continue—even to the limited extent they do now—in the event that the data is found to be valuable, and a consumer's gifting of the information is seen as doing an end-run around what might otherwise be a revenue-port for the utility. *See* discussion *supra* Part II.

mation, who analyzes it, who distributes it, and who consumes it—but also meta-concerns about competitiveness, antitrust, and interstate operation. Would regulatory architectures directing information to utilities as a default matter set them up to corner a market that does not display natural monopoly characteristics? How will trade in information across state lines cope with the interoperability of consumer protection requirements and other architectural decisions made by different states? Regulator decisions regarding the direction of information flow and the nature of access points to that information will have wide-ranging impacts on the determination of winners and losers in the smart grid data market, and even on the ability of the regulators themselves to continue to oversee the development of the market.

CONCLUSION

The historical relationship between utilities and regulators should not be overlooked in the kinds of architectural decisions discussed here, for two opposing reasons. Making utilities the initial collectors and bundlers of information would implicate state utility regulators as the obvious permanent parties to regulate the flow of information. Such a role suggests that information could be an excellent tool to move the electric utility away from its reliance on the sale of electricity units and could be the means by which the smart grid helps utilities make money, rather than hinders their existing business models. On the other hand, that same relationship suggests that binding the smart grid to the utility so closely, such that its value is seen primarily as a driver of utility revenue, will hamper its growth in other directions and could prevent the smart grid from reaching its full potential, to say nothing of constraining the development of competitive, non-utility industries around the edge.

Moreover, the interstate nature of information markets suggests that coordination between state utility regulators could be terribly inefficient compared to the capacity of a federal information or trade regulator to provide uniform guidance and confidence to emerging information markets. The location of jurisdiction over smart grid information in federal regulators would be more certain were the majority of intelligence in the grid developed and managed by edge companies outside of the state-regulated utility. Yet such a decision, made for the expediency of information market development, would leave the utility as aged and ill-incentivized as ever, and would leave the smart grid's promise of modernization as empty as the ghost towns left behind when the coal miners moved on.

The central challenge of deploying the smart grid is a problem not of method, but of vision. Incentives can be adjusted, technologies standardized, and rules developed. But realizing such changes is impossible without an understanding of the ends at which we aim. The potential data market discussed in Section III is but one track among many along which the smart grid might develop. But all development tracks related to the flow of information in the smart grid are dependent on network-architecture decisions regarding the path and direction of that information. This Article aims not to make a normative argument as to how the smart grid ought to develop, but rather to provoke utilities, regulators, and emerging businesses to consider the full spectrum of possibility that the smart grid represents, and to deliberate carefully and with an eye toward other jurisdictions before making decisions that could be difficult to reverse.