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State Regulatory Opportunities and Impediments to Smart Grid

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Executive Summary

On August 25, 2010, the Silicon Flatirons Center brought together a number of experts in the fields of economics, technology and policy, including public utility commissioners, economics professors, financial analysts, and policy advisors, to discuss regulatory issues facing smart grid deployment in the United States. The discussion was held at the University of Colorado School of Law and touched upon the economics of the smart grid, incentives for the variety of stakeholders in the smart grid effort, the technological challenges of implementing a "smart" electricity generation and distribution system and its constituent technologies, and the policy implications at both state and federal levels.

The theory of New Institutional Economics – an emerging area of economic thought that gives greater weight to the role institutions play in the operation of economic systems – may have significant relevance in this area. As cost of service regulated entities, utilities are not currently incentivized properly to increase efficiency through innovation, while state regulators face the real risk that at this stage smart grid technologies are not yet a proven investment, so for early adopters the costs could outweigh the benefits.

In terms of the technologies involved in the smart grid, one question is whether they should be open or closed and the implications this may have for near- and long-term competition, innovation and policymaking. There are also important privacy questions as to how to approach the large amount of personal data involved.

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[*] The *State Regulatory Opportunities and Impediments to Smart Grid* event is part of the Silicon Flatirons Roundtable Series on Entrepreneurship, Innovation and Public Policy. Special thanks to Brad Feld, Managing Director of the Foundry Group, who sponsors the Roundtable Series. *Smart Grid* is the tenth installment in the series, following earlier discussions on: (1) Law 2.0; (2) Government 3.0; (3) Open Standards, Open Innovation, and the Rollout of IMS; (4) The Social, Ethical, and Legal Implications of Social Networking; (5) The Promise and Limits of Social Entrepreneurship; (6) The Private Equity Boom; (7) The Entrepreneurial University; (8) Rethinking Software Patents; and (9) The Unintended Consequences of Sarbanes-Oxley. The reports from those discussions can be found at http://www.siliconflatirons.org/publications.php?id=report.

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The smart grid effort will require both state and federal agencies to work together in a form of cooperative federalism to ensure effective implementation. While state governments are taking the leadership role in actually building out the grid, the federal government has an important role to play in both the funding and analysis necessary to support and promote the efficient development of a truly nationwide system. This is especially true within the broader context of global concerns like climate change, economic development and national security.

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Introduction and Overview

As issues of climate change, economic growth and energy security become more important, the "smart grid" and implementation of smart grid technologies look to be an increasingly important part of addressing these challenges. Recovery Act funding available for smart grid projects in the United States makes this an especially opportune time to invest in energy infrastructure,[1] with policymakers playing a critically important role in determining how these funds can be most efficiently used to correctly incentivize stakeholders in the smart grid system.

In an effort to address some of these issues, on August 25, 2010 the Silicon Flatirons Center brought together a number of economic, technology, and policy experts to discuss issues facing the U.S. smart grid effort.[2] The discussion was held at the University of Colorado School of Law and touched upon the economics of the smart grid, incentives for the variety of stakeholders in the smart grid space, the technological challenges of implementing a smart grid, and the policy implications at both state and federal levels. The roundtable was a continuation of earlier discussions, but with an added focus on the issues regulators will need to address in order for the smart grid to "actually happen."

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[1] Vice President Joe Biden announced almost $4 billion of stimulus act funding for smart grid projects in April 2009, as detailed in this government press release: http://www.energy.gov/7282.htm (last visited Jan. 23, 2011)

[2] The Roundtable was jointly sponsored by Silicon Flatirons and the Institute for Regulatory Law & Economics (IRLE). The discussion was also held according to the Chatham House Rule, which is used at meetings or discussions to encourage openness and the sharing of information. The Rule itself reads, "When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed." For more information, see the Chatham House website at http://www.chathamhouse.org.uk/about/chathamhouserule/ (last visited Jan. 23, 2011). In Silicon Flatirons roundtable discussions and the resulting report or summary, the list of attendees and their affiliations is customarily published. Of note, in this discussion the participants were asked to indicate when the comments started to infringe on open proceedings that may be in front of the various government officials so as to protect against any potential *ex parte* requirements.

This report, tracking the structure of the roundtable itself, will proceed in three parts. Part I will discuss the economics of the smart grid effort, including incentives within the pricing system and what effect these can have on innovation and policy. Part II will discuss the technological challenges of implementing a smart grid and related issues. Part III will focus on the federal policy considerations and how these interact with state policy.

Part I – The Economics of Smart Grid

The theory of New Institutional Economics (NIE) is an emerging area of economic thought that gives greater weight to the role institutions play in the operation of economic systems.[3] In the body of writings that has become synonymous with NIE, writers have generally sought to extend neoclassical economic theory by examining how property-rights structures and transaction costs affect economic incentives and behaviors.[4] The NIE model has built up over time as greater institutional detail has been injected into economic models where economic theory may previously have been too abstract to deal with more modern questions.[5]

Viewing smart grid through the NIE lens, much of the initial discussion revolved around the institutions and incentives related to smart grid and its various stakeholders. Although these stakeholders include utilities, vendors, consumers, standards setting organizations, and both federal and state regulators, here the group focused primarily on

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[3] *See* Eirik G. Furubotn & Rudolf Richter, *The New Institutional Economics: An Assessment*, 1-32, in THE NEW INSTITUTIONAL ECONOMICS: A COLLECTION OF ARTICLES FROM THE JOURNAL OF INSTITUTIONAL AND THEORETICAL ECONOMICS (1991) (introducing and describing New Institutional Economics).

[4] *Id*. at 1. The NIE literature includes, among many other writings: RONALD H. COASE, THE FIRM, THE MARKET AND THE LAW (1988); DOUGLASS C. NORTH, INSTITUTIONS, INSTITUTIONAL CHANGE AND ECONOMIC PERFORMANCE (1990); AND OLIVER E. WILLIAMSON, THE MECHANISMS OF GOVERNANCE (1996).

[5] *Id*. One way to define NIE is in contrast to neo-classical economic analysis,

> While it would be incorrect to say that traditional analysis abstracted completely from institutional structure, there can be little doubt that the usual treatment of institutions was superficial. The existence of political, legal, monetary and other systems was certainly recognized; but either these systems were regarded as neutral in their effect on economic events and ignored, or they were taken as given and then specified in so perfunctory a way as to suggest that institutional influence was not of much importance. By contrast, the new institutional economics seeks, at a minimum, to demonstrate that institutions truly matter. Each distinct organizational structure is said to affect incentives and behavior but, beyond this, the institutions themselves are regarded as legitimate objects of economic analysis. As Coase has argued, it is possible to use theory to analyze institutions so that their operation is explained and made an integral part of the economic model.

Id. at 2 (internal citations omitted).

utilities and state regulators. One theme that emerged was how significant economic challenges will need to be resolved in order to create an incentive structure that works to encourage prudent investment in smart grid development.

A. New Institutional Economics and the Incentives of Different Smart Grid Stakeholders

The roundtable began with a presentation by Ray Gifford, Senior Adjunct Fellow at Silicon Flatirons and a Partner at the law firm of Wilkinson Barker Knauer LLP, on the economics and incentives of regulated utility companies. He started with how the theory of New Institutional Economics applies to smart grid and smart grid technologies, focusing on the impact that institutions can have on economic decisions.

According to Gifford, New Institutional Economics (NIE) brings a different focus and level of sophistication to the micro-analytic questions that face institutions and regulators involved in smart grid policy. NIE shows that institutions and incentives matter, he said, while the smart grid itself confronts institutions, utilities and regulators with the question of how each will address technical innovation in the electric grid. Importantly then, the innovation that smart grid *may* represent – not necessarily an unqualified good – is the need for regulators and utilities to realize there will be different incentives for each stakeholder moving forward. Along these lines, he felt that one goal might be for regulators to adapt and change the incentives presented to utilities.

The New Institutional Economics' analytic premises, as Gifford related, include three fundamental assumptions: (1) bounded rationality – the concept of how humans do not behave in a perfectly logical or rational manner, both on an individual and institutional level; (2) opportunism – players in a market or a regulatory situation are opportunistic and the challenge for regulation is how to plan for that opportunism and think about how to channel it into a more beneficial form; and (3) asset specificity – once capital has been dedicated, especially to electric and communications infrastructure, those assets are not easily changeable and are committed for a significant period of time, on the order of decades and often up to half a century.[6]

Regulators must carefully consider asset specificity when making decisions about the proper time to authorize projects or approve construction in order to avoid costly mistakes, he said, especially if investments are made in a technology that is later abandoned. As a negative example, Gifford pointed to electricity generation "overbuilding" in the 1970's and said that in modern times no stakeholder wanted to be the first to deploy or build the "Commodore 64" of smart grid.

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[6] *See* Oliver E. Williamson, *The New Institutional Economics: Taking Stock, Looking Ahead*, 38 J. ECON. LIT. 595 (2000), *available at* http://www.jstor.org/stable/2565421.

Comparing smart grid to another industry, Gifford felt the profound innovation cycles the communications industry has gone through might shed some light on the challenges facing smart grid. This comparison could be especially useful, he said, as policymakers move forward and face the challenge of implementing and regulating smart grid technologies in the face of innovation, uncertain information, and unclear benefits.

B. The Institutional Players

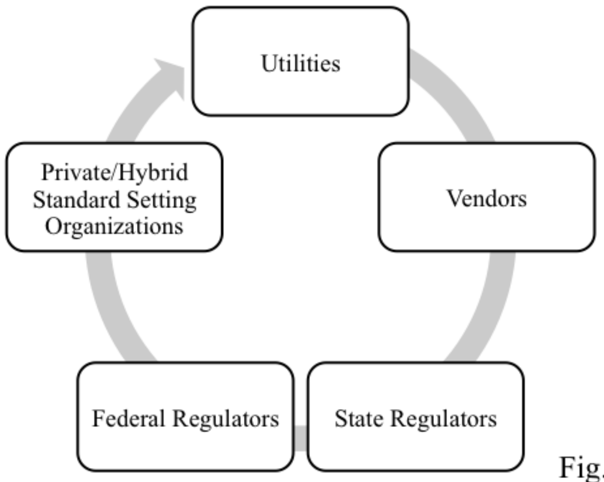

Fig. 1

New Institutional Economics is a helpful lens through which to analyze smart grid because it allows policymakers to examine the incentives and behaviors of all the stakeholders in the ecosystem, for example utilities, vendors, private and hybrid standards setting organizations, and both federal and state regulators alike (see Fig. 1).[7] Gifford analyzed the incentives of each in turn.

Utilities

For utilities, they have some incentives to innovate and change their business models when it comes to smart grid technologies, he said, which is a positive outcome and allows for new business opportunities. Additionally, the regulatory "wind" looks to be favoring smart grid efforts, so utilities have incentives to participate and ensure a guaranteed recovery of their costs.[8]

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[7] For a more detailed analysis of the different stakeholders and vendors involved in the United States' smart grid "ecosystem," see DAVID CHENG ET AL., 2010 U.S. SMART GRID VENDOR ECOSYSTEM (2010), *available at* http://www.energy.gov/news/documents/Smart-Grid-Vendor.pdf.

[8] For example, the Federal Communications Commission's recent National Broadband Plan devotes its entire Chapter 12 to energy and the environment, and, among many other recommendations concerning smart grid, recommends

On the negative side, Gifford pointed out how most electricity utilities in the U.S. are currently regulated under a cost of service regime and as a result do not have strong incentives to invest in smart grid technologies or innovate in this area.[9] Despite the positive nature of what innovation and new business models could do for utilities generally, he said, most utility companies have corporate cultures that do not see innovation or changed business models as positive outcomes. Utilities may be motivated by the perception that the industry as a whole is moving towards innovation in the smart grid space, deciding to participate in order to avoid being left behind, but otherwise there are no real incentives to innovate in a cost of service regulated environment. As long as the new business model remains unclear, he said, utilities are not encouraged to change their existing systems.

Utilities are also facing the challenge of addressing the sunk costs – or in other words asset specificity[10] – associated with building out a smart grid. Continual iteration would be a helpful method of determining which particular smart grid technology is the most effective or efficient, but in the utility industry many construction and infrastructure decisions are in place for up to 50 years. This long horizon makes experimentation difficult and costly.

Along these lines, state regulators looking to create investment requirements in new technologies with long payback horizons or depreciation schedules should look to the standards that have already been adopted in leading smart grid states such as Texas and California. One participant mentioned that in California, for example, regulators may require each utility to file a smart grid "plan," which could help keep standards well-defined and maintained across the state.[11] In contrast

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that "States should reduce impediments and financial disincentives to using commercial service providers for Smart Grid communications." *See* FCC, NATIONAL BROADBAND PLAN (2010), *available at* http://www.broadband.gov/plan/12-energy-and-the-environment/.

[9] While not discussed in depth, Gifford mentioned that there may be distinctions and differences in the incentives faced by utilities regulated under a cost of services regime versus those regulated under a performance- based regime.

[10] Asset specificity refers to physical investments that are specialized and unique to a task, or in other words are not easily redeployed elsewhere. *See* OLIVER WILLIAMSON, THE ECONOMIC INSTITUTIONS OF CAPITALISM (1985). This can be contrasted with an asset's "plasticity" or the range of uses to which an asset may be put. *See* Armen A. Alchian & Susan Woodward, *The Firm is Dead; Long Live the Firm*, 24 J. ECON. LIT. 65, 69 (1988), *available at* http://www.jstor.org/stable/2726609.

[11] The proposed regulation in California to review each smart grid plan individually was eventually modified to stipulate that all proposed plans would be reviewed in a single proceeding held twice annually, in order to improve efficiency and "help ensure some congruity." *See* California Public Utilities Commission, Decision Adopting Requirements For Smart Grid Deployment Plans Pursuant To Senate Bill 17 (Padilla), Chapter 327, Statutes Of 2009 (June 24, 2010) (quoting DRA Comments at 7), *available at* http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/119902-03.htm#P773_139554 (last visited Jan. 23, 2011).

to these state-mandated guidelines and plans, utilities may also wish to define their own. Although some companies may opt for lower-cost plans while others choose a more gold-plated “Cadillac” version, participants felt that both can be accommodated as long as the standards are flexible and applicable to a wide variety of technologies.

Vendors

Vendors are also an important stakeholder, but Gifford pointed out they currently are not sure whether their customers are the utility or the end-user. If the proper incentive structure was in place, he said, the smart grid market could function more like the solar market with eager involvement of third party vendors. Additionally, smart grid vendors are approaching what looks like a potential “standards war,” involving traditional information technology standards-setting issues found in computer operating systems, smart phones, and other technologies.

State Regulators

Returning to the theme of New Institutional Economics, Gifford asked whether the current state regulatory incentives are adequate for the more efficient energy consumption that smart grid represents and, importantly, how can those incentives be modified to accommodate improved outcomes? There are real and compelling reasons to encourage smart grid, he said, including net system savings and environmental benefits. However, there are also risks to pioneering new technologies and no state has yet emerged as the clear leader in innovation and deployment, albeit California appears to have a head start. The city of Boulder, Colorado is also participating in a smart grid project, but some of the recent negative press it has received may call into question the intelligence of pioneering these technologies. As Gifford pointed out, the smart grid does not necessarily meet the “proven investment test” and it is unclear that the costs outweigh the benefits for early adopters. One potential solution, he said, might be price cap plans, which have been successful in other parts of the world.[12]

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[12] According to one academic,

> Price cap regulation allows the operator to change its price level according to an index that is typically comprised of an inflation measure, I, and a "productivity offset," which is more commonly called the X-factor. Typically with price cap regulation, the regulator groups services into price or service baskets and establishes an I - X index, called a price cap index, for each basket. Establishing price baskets allows the operator to change prices within the basket as the operator sees fit as long as the average percentage change in prices for the services in the basket does not exceed the price cap index for the basket.

See Mark A. Jamison, *Regulation: Price Cap and Revenue Cap*, in ENCYCLOPEDIA OF ENERGY ENGINEERING AND TECHNOLOGY, VOL. 3, Barney Capehart, ed., pp. 1245-51 (2007), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=959684.

Federal Regulators

One of the major issues facing federal regulators is their lack of jurisdiction over electricity distribution systems, something which is clearly more in the domain of the states. Although the federal government can play an important "convening" and "bully pulpit" role, Gifford felt that the costs and the benefits of smart grid implementation are not uniform across distribution systems (as these can vary according to where the utility sits in its life cycle of assets and what the utilities load profile looks like). Finally, an additional challenge for the federal government is that most utilities are "long" on generation with significant excess capacity, meaning that efforts or technologies that make electricity generation more efficient – and thus reduce customer demand – are not necessarily attractive.

Standard Setting Organizations (SSOs)

Related to both federal and state regulatory issues is the question of standard setting, as it can be one of the important precursors to widespread deployment of smart grid and smart grid technologies. According to Gifford, both utilities and regulators feel the industry is beginning to congregate around a certain set of standards. California, for example, has trended towards generally more open standards, which from both a consumer and regulatory perspective is "safer" overall than closed proprietary standards. Outside of California, he said, utilities seem to generally have a preference for closed proprietary standards, but momentum towards open standards is building and should likely continue.

Gifford concluded his presentation with a comparison to the Ptolemaic astronomy model. He pointed out how Ptolemy theorized the Earth was at the center of the universe and the retrograde motion of the planets in the sky could be explained by epicycles, or in other words a series of nested spheres; this turned out to be an interesting but extremely complicated model.[13] Creating a similarly complex structure for the smart grid, according to Gifford, would result in unnecessary challenges for all stakeholders involved. It is essential that policymakers seriously examine incentive structures that encourage the utility to become the center of the smart grid system. On the one hand then, regulators should give utilities the freedom to make those decisions, while on the other hand remain vigilant in ensuring the incentives faced by utilities in other areas do not "fall apart."

Finally, as the group moved into more broad discussion, Gifford posed a series of questions. First, how can the relevant institutions (utilities, regulators and vendors) be incentivized to invest prudently?

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[13] Ptolemy was largely responsible for the "geocentric cosmology" of ancient times, though he was not the first to propose such a model. For more on the life of Ptolemy and the Ptolemaic cosmological model see, Encyclopedia Britannica, *Ptolemy*, ENCYCLOPEDIA BRITANNICA ACADEMIC EDITION, http://www.britannica.com/EBchecked/topic/482098/Ptolemy (last visited Jan. 23, 2011).

Second, how can the closely regulated electricity market accommodate experimentation, failure, and other difficulties in creating standards? Third, how can utilities move away from the engineering model where institutions have centralized control to one of a more loosely distributed network of transactions between generators, distributors, and customers? Finally, how must regulatory institutions adapt to internalize the cost to utilities of smart grid investment and allow both utilities and customers to realize the potential benefits?

C. Discussion

The general discussion started off with one participant asking whether customers, or "end-users," should be included as relevant stakeholders in the smart grid decision-making process. Many other participants thought efforts in this space might not have credibility without the consumer as a main focus. Here, Gifford felt it essential to stop treating consumers as "passive agents" during the regulatory process, instead encouraging them to become more engaged at a transactional level, where he felt their preferences are crucial.[14] A critical part of engagement, he said, will be consumer education, so they can easily understand what has changed and make informed decisions. Considering the different degrees of consumer sophistication, Gifford quipped that the end result of smart grid efforts might actually be the "Smart *Enough* Grid," which would allow different levels of engagement.[15] For example, a very sophisticated consumer might be an entity like Wal-Mart, who will want to take advantage of every available option in order to reduce their electricity costs, while some individual consumers may be less interested in learning about and using some of the more complicated technologies and pricing regimes, but more concerned with stability and ease of use.

The participants generally agreed that any incentive structure failing to consider the needs of the consumer or end user would necessarily be incomplete. One participant wondered if there would ultimately be enough economic benefit for consumers to see value in the smart grid, while another pointed out that even if there was no real

[14] For more on customer participation in the smart grid and how this relates to end-use pricing, see Christopher Russo & Richard Tabors, *Does a Smart Grid Need Smart Customers? The Debate Over End Use Pricing*, Smart Grid News, http://www.smartgridnews.com/artman/publish/Business_Markets_Pricing_News/Does-a-Smart-Grid-Need-Smart-Customers-The-Debate-Over-End-Use-Pricing-1249.html (last visited Jan. 23, 2011).

[15] Here, Gifford was referring to what some have called the "good enough revolution" where over the past decade as the technology and features of products have reached a certain threshold level consumers have begun to prefer "flexibility over high fidelity, convenience over features, quick and dirty over slow and polished" and "[h]aving it here and now is more important than having it perfect." *See* Robert Capps, *The Good Enough Revolution: When Cheap and Simple is Just Fine*, WIRED MAGAZINE, http://www.wired.com/gadgets/miscellaneous/magazine/17-09/ff_goodenough (last visited Jan. 23, 2011).

economic benefit, there may be strong enough prevailing social norms to motivate responsible citizens to participate in smart grid anyway. There may also be new performance capabilities that influence adoption, as economics should not be the only consideration in terms of creating new markets and policies. Further discussion centered around the idea of some kind of benefit or tax credit that could be offered to consumers who switched to smart grid, with the Saver's Switch program in Colorado mentioned as an example.[16] Here though, there were some concerns with introducing potential distortions to the marketplace, which according to some could discourage innovation stemming from the price of electricity being brought to the level of the actual costs of the system.

Another participant wondered if approaching the smart grid analytically and breaking it down segment-by-segment would change the incentives. For example, what if the entire electricity grid was divided into transmission, distribution, and generation rather than divided by individual stakeholder. The group agreed that incentives were complex and that analytically, a middle-mile and last-mile smart grid are different propositions, with many seeing the middle-mile as less difficult from a regulatory perspective.

One participant reiterated that utilities need to be incentivized to internalize the investment proposition, pointing out that currently we have exactly the opposite: in a regulated cost of service environment, the utilities would actually lose money if they became more efficient. For example, he said, currently if a utility sees a 5% efficiency gain through investment in better and more efficient equipment or infrastructure, they actually lose money on that particular capital expenditure, even though there are long run gains in efficiency. Here, one participant thought the driving incentive, at least in California, is whether investment in smart grid technologies is included in the rate base of the utility.[17] Often, according to the participant, if it is in the rate base, the actual performance of the technology is less relevant. In Boulder, he said, the smart grid investment was not in the rate base of the utility.[18]

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[16] The Saver's Switch program in Colorado operates during the summer and allows the utility, during peak times and by remote control, to "cycle a customer's central air-conditioner compressor units on and off at 15-minute intervals." Those customers who are part of the program receive bill credits from the utility for helping it to "avoid purchasing high-priced electricity from other utilities during peak-use periods or building new power plants." Xcel Energy, Press Release, http://www.xcelenergy.com/Minnesota/Company/Newsroom/News%20Releases/Pages/Denver_Xcel_Energy_to_boost_Saver_s_Switch_participation.aspx (last visited Jan. 23, 2011).

[17] The rate base is very important in determining the profitability of a utility. It is defined as the "total fair value of public utility property that is used in rendering services and that comprises the investment on which a fair rate of return is based in setting utility rates." *See* Miriam-Webster's Dictionary of Law (1996), *available at* http://dictionary.reference.com/browse/rate+base.

[18] Though Xcel Energy has sought further reimbursements for the project and some critics have contended that any additional payments to the utility are

In addition to the rate base, participants mentioned several other regulatory solutions for managing incentives and encouraging innovation, including dynamic pricing,[19] bottom-up pricing,[20] price caps, experimental economics,[21] and a suite of applications designed to allow the utility to provide a number of basic services built around ultra-efficient homes and appliances or devices. Price caps were of significant interest to the participants and were seen as allowing utilities to keep their current profit margins while at the same time incentivizing efficiency. However, there was concern that incentivizing too much efficiency could create a shift to "starving the network" rather than some of the current incentives to "gold plate" it, and thus could require regulations to ensure quality control. One participant pointed out how there may be lessons in other countries' experience with price caps.

Finally, the conversation turned to consumer benefits, where one participant felt there is no demonstrated business case for smart grid technologies. It is hard to "anticipate" consumer benefits, he said, and there is a bit of a chicken and egg problem. Incremental steps are being taken, but there may need to be some sort of "idealism" that helps to provide momentum behind the development of the platform. In order to realize the benefits, he said, it is necessary to open up the network and allow broad innovation on the platform, and this should set the stage for a wide range of unexpected benefits. As an example, he pointed to the Internet and how it has provided an enormous amount of consumer benefit that a regulator would not have been able to predict *ex ante*, or before the innovation on the open platform actually occurred.

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unwise as the smart grid project in Boulder is "a research-and-development project and its full costs should be borne by Xcel shareholders, not ratepayers." See Mark Jaffe, *Xcel, critics await Colorado PUC's smart-grid rate ruling*, Denver Post (Nov. 28, 2010), http://www.denverpost.com/business/ci_16721011 (last visited Jan. 23, 2011).

[19] Under dynamic pricing, utilities pass through the wholesale costs of electricity to consumers on an ongoing basis by letting retails prices fluctuate based upon wholesale costs. Moving to a system of this nature may require significant and costly changes in the metering infrastructure nationwide, but should lead to reductions in household electricity demand. *See* AHMAD FARUQUI AND SANEM SERGICI, HOUSEHOLD RESPONSE TO DYNAMIC PRICING OF ELECTRICITY—A SURVEY OF THE EXPERIMENTAL EVIDENCE (2009) (describing the results of fifteen different dynamic pricing experiments), *available at* http://www.hks.harvard.edu/hepg/.

[20] Bottom up pricing is where the rate maker considers "all [the] components of a utility rate for possible competition, including transmission, distribution, customer service, metering, marketing, taxes, etc. as well as the energy component (which is generally considered the "top" of the rate)," whereas in contrast a top-down approach "involves an examination in the reverse order and typically results in only the energy component becoming subject to competition, instead of all aspects of the utility rate." *See* Glossary of Energy Market Terms, http://www.energybuyer.org/glossaryAB.htm (last visited Jan. 23, 2011).

[21] Experimental economics is a somewhat recent development in the field of economics and focuses on "the systematic evaluation of economics theories under controlled laboratory conditions." *SEE* DOUGLAS D. DAVIS & CHARLES A. HOLT, EXPERIMENTAL ECONOMICS (1992).

One participant felt that many benefits of smart grid are "upstream" and difficult to quantify. He pointed to improved "smart" appliances and how many of them require "smart rates" for their full efficiency benefits to be realized. In this area though, he said, manufacturers are having trouble deciding whether the utilities or the consumer is their market. Another participant felt that if overall efficiency was the goal, investment should be in overall system efficiency rather than in individual smart grid technologies because of the potentially greater benefits to this approach. He thought that retrofitting utility customer facilities or buildings would have a larger effect than simply installing smart appliances. Additionally, participants voiced some concern that appliance manufacturers were hindering the smart grid effort at the state level by not being as active in state proceedings as they are at the national level, and in this respect not helping to create the evidentiary record necessary for changes at the state level.

Consumer backlash was another concern. As one participant related, in California and other places there has been resistance and consumers have "opted out" of pricing structures, with some voters turning against smart meters and inverted block rates.[22] One reason might be that consumers can sometimes distrust change generally, but another reason might also be that consumers often end up paying more for smart grid technologies, at least in the short run. Additionally, the new systems might be too complicated for consumers who want a simple, consistent solution. But not all consumers are the same, so while some may enjoy the added choice that smart grid can offer, others may prefer to stick with the system they are already using. This is part of both the value and the cost of the smart grid: the ability to segment consumers – both businesses and individuals – and move from a one-size-fits-all mentality to an understanding of how the value may vary significantly based on the type of consumer.

Speaking again to the business case, one participant pointed out one significant benefit of smart grid technologies, which is reducing the need to build new electricity generation facilities. Some participants felt this was not a tangible or large enough benefit to change perceptions. Also, some participants were concerned there may be less of a savings in this area – or at least the savings would be spread out over a longer time horizon and be less impactful – since most utilities are currently "long" on electricity generation and have excess capacity as is.[23]

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[22] The consumer backlash in California has been broad and sustained. *See* Tom Zeller Jr., *Smart Meters Draw Complaints of Inaccuracy*, NEW YORK TIMES (Nov. 12, 2010), http://www.nytimes.com/2010/11/13/business/13meter.html?_r=1&ref=business (describing how California residents have turned against smart meters because of inaccurate measurements of power usage and the resulting increase in utility bills) (last visited Jan. 23, 2011).

[23] Although most utilities may have excess capacity for normal demand cycles, they are not necessarily long on "peak" generation – the additional and at times significant electricity generation requirements at times of peak demand. Smart

From the discussion of the benefits and business case for smart grid technologies, the conversation then moved to the technology considerations.

Part II – Technology Considerations of Smart Grid

The technologies used in building out the smart grid will have significant implications for its architecture, both in terms of capabilities *and* limitations. Since electricity is an integral part of almost all citizens' daily lives – from charging a cell phone to surfing the Internet to viewing television and listening to music – and as more and more of our civic lives and the governmental process move online and onto devices that require electricity to operate, where and how electricity is delivered is becoming vitally important. How we choose to architect the technology will have significant implications in other areas as well, such as policymaking.

A. Signaling Networks in Smart Grid Distribution Systems

The second segment of the discussion began with a presentation by Dale Hatfield, Executive Director of the Silicon Flatirons Center, Adjunct Professor at the University of Colorado, and former Chief Technologist at the Federal Communications Commission, where his self-acknowledged goal was to place the smart grid effort into a larger historical and technological context.

Hatfield began by giving some background on smart grid and some general information on the electricity grid. He pointed out that there were four major components in the electricity grid: (1) electricity generation; (2) transmission; (3) distribution; and (4) the customer premises' network and devices. He said there was no single or formal definition of smart grid, as it is sometimes used as a generic term that describes applying computer intelligence and networking to otherwise "dumb" electricity systems, and other times it is used to describe a modernized grid that enables "bidirectional flows of energy and uses two-way communication and control capabilities that will lead to an array of functionalities and applications."[24] Some of the goals of the smart grid, according to Hatfield, are to improve the "reliability, security, and efficiency" of the electric system, by improving the delivery systems

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grid may help to better balance the high demand that can cause blackouts. *See* Mike Orcutt, *How a Smarter Grid Can Prevent Blackouts*, POPULAR MECHANICS (Aug. 6, 2010), http://www.popularmechanics.com/science/energy/efficiency/how-a-smarter-grid-can-prevent-blackouts (last visited Jan. 23, 2011).

[24] *See* NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, FRAMEWORK AND ROADMAP FOR SMART GRID INTEROPERABILITY STANDARDS, RELEASE 1.0 AT 13 FN. 6 (2010), *available at* http://collaborate.nist.gov/twiki-sggrid/pub/SmartGrid/IKBFramework/NISTFrameworkAndRoadmapForSmartGridInteroperability_Release1final.pdf.

of large electricity generation systems and by improvements and innovations in distributed-generation and storage.

Hatfield explained that although there are islands of intelligence within the electricity network today, the distribution component of the grid has been largely lacking, making it necessary for power companies to rely on customer-reported outages when a disruption in service occurs rather than on automatic alerts by the network itself. In order to better illustrate how this distribution component could become more intelligent, Hatfield felt some examples from other industries might be helpful.

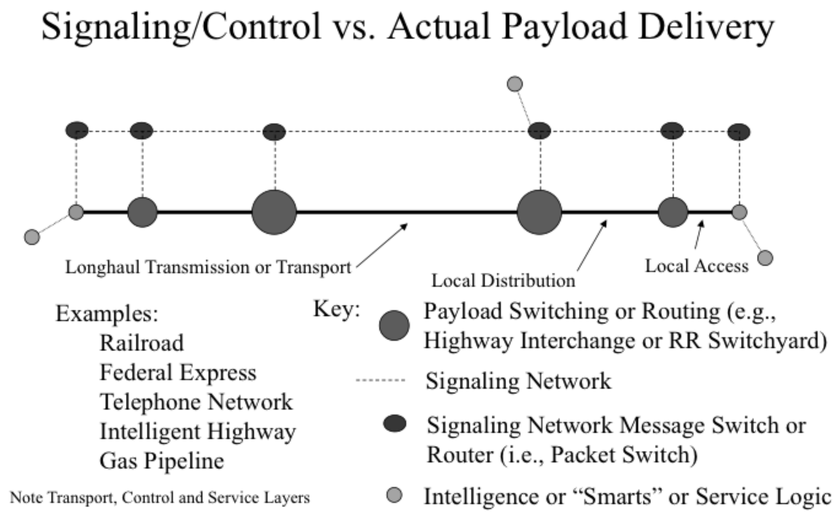

Fig. 2

Along these lines, Hatfield said it is important to distinguish between the two core elements of any network: the signaling and control system versus the actual payload delivery system (see Fig. 2). For instance, in the railroad industry and its railroad track network there are the rails themselves, which are for the purpose of actually moving the trains – or in other words the payload delivery system – and there are the parallel telegraph lines that run along beside the rails to coordinate communications concerning which train should go where and at what time – or in other words the signaling system.

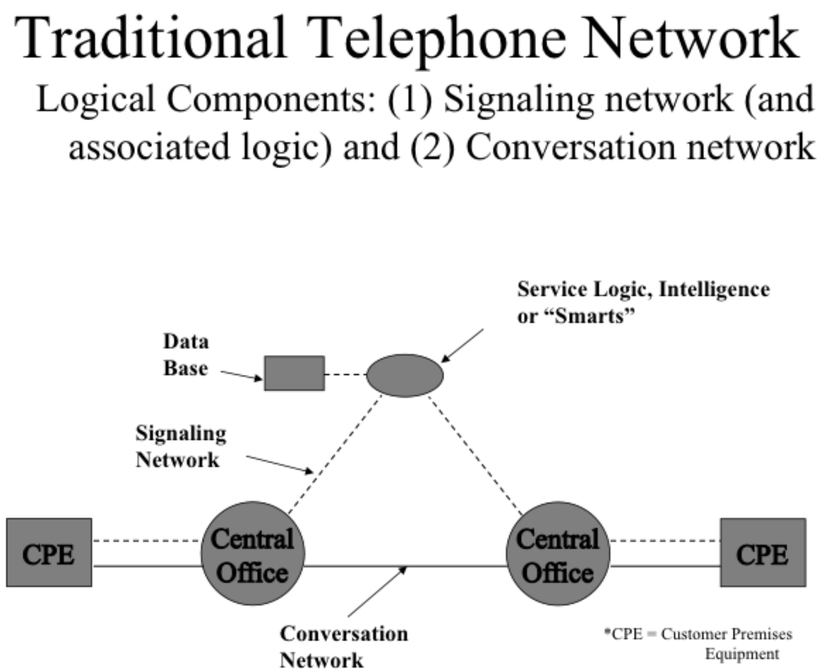

Fig. 3

The telephone network operates similarly, he said, and has lines in place to both carry actual phone calls and the attendant signaling network that determines where the call should go (see Fig. 3). This signaling network, according to Hatfield, is really the nervous system of the whole organization and determines the ability of the network to deliver calls intelligently and efficiently. As Hatfield related, the signaling network and its associated assets were key strategic assets of the traditional telephone industry prior to the rise of the Internet. The phone network is a good example of a relatively intelligent system that is able to accomplish complex tasks. Introducing computer power to the telephone database made the network even more powerful and allowed the routing of calls to the correct geographic location, time zone, and even language depending on how much information is known about the caller.

According to Hatfield, the intelligence of the signaling network is a critical component of any system's efficiency and competitiveness, which has important implications when deciding whether to use a closed proprietary signaling system versus an open platform that many different operators can use to freely develop innovations. Policy that allows open access to the signaling network for the smart grid would encourage strong innovation and competition in the industry. In Hatfield's opinion, the electric industry is comparatively late to the game in terms of adding signaling capability to their system, considering how railroad engineers were able to add this critical element to their network more than a century ago.

Another industry that is ahead of the power grid in terms of signaling capability, Hatfield related, is the mail and package delivery business, where FedEx arguably revolutionized overnight package delivery services by introducing a dedicated signaling network. This parallel signaling and control network dramatically improved the efficiency and reliability of a physical payload delivery network that had existed for decades. The increased efficiency gave FedEx a competitive edge that forced UPS to quickly adapt by making deals with cellular network providers to create its own improvised signaling network.[25]

Turning back to the main topic, Hatfield pointed out how the electric power industry has been slow to fully adopt the notion of a parallel signaling and control network, especially in terms of distribution. The extension of a parallel digital communications (or signaling) network from power generators to individual end users – or in other words the smart grid – has the potential to revolutionize the electric industry.

Working with existing signaling networks to bring intelligence to an unrelated content delivery system, as UPS did with cellular phone network providers, is a strategy that could prove useful to the electric industry as well. Existing networks like cable, Internet and cellular are already in place connecting US homes, and utilities could leverage these networks to improve intelligence and efficiency in the electric grid.[26]

When implementing a signaling network to gain increased efficiency in a delivery network, Hatfield said that a key consideration is

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[25] As described in their corporate history, UPS added tracking through wireless networks in 2000. *See* United Parcel Service, Company History 2000-2007, http://www.ups.com/content/us/en/about/history/2007.html (last visited Jan. 23, 2011).

[26] As an aside, Hatfield felt that there were some other networks in the U.S. that might be able to use this same technique. For example, the U.S. highway system could utilize existing communications networks to bring greater intelligence to their transportation grid, creating wireless alert systems for accidents or congested traffic ahead so drivers are able to reroute their path or adjust their speed accordingly. Of course, the notion of an intelligent highway system has been around for quite some time and the subject of a large of amount of research by the US Department of Transportation and others, see e.g., U.S. Department of Transportation, Research and Innovative Technology Administration, Intelligent Transportation Systems, http://www.its.dot.gov/ (last visited Jan. 23, 2011). There is still plenty of room for improvement though, see Joyce Wenger, et al., *The Smart Highway: A Smart Idea?*, Strategy and Business, Feb. 26, 2008, http://www.strategy-business.com/article/li00064?gko=9148d (last visited Jan. 23, 2011. Just like with the electric grid, Hatfield felt this limited highway network intelligence is rather conspicuously behind the sophistication of other networks such as the gas pipeline system that alerts oil companies automatically if there is a rupture in the pipe anywhere along the thousands of miles that it runs through sometimes harsh and remote environments. Another pipeline system that is considering implementing network intelligence is the water utility industry. For more on the smart *water* grid, see Devin Coldewey, *i2O: An Intelligent Grid For Water Systems That Could Save Millions Of Gallons*, TECH CRUNCH (Oct. 15, 2010) http://techcrunch.com/2010/10/15/i2o-an-intelligent-grid-for-water-systems-that-could-save-millions-of-gallons/ (last visited Jan. 23, 2011).

where the intelligence of the system is located: in the center, at the edge, or within the devices that are actually part of the network itself. For the electric grid, this means that, with suitable instrumentation in the house, monitoring and control of power usage could occur: (1) at the power company itself; (2) at each individual home; (3) or within each individual appliance . The question of where the intelligence or control functionality is located is important because it relates to competitive situations where one entity may have an advantage in terms of controlling the signaling network data.

Concluding his presentation, Hatfield described where some of the trends for locating intelligence within the smart grid are going and how, moving forward, policy makers can help work towardsan optimized and efficient system architecture. He pointed out how, similar to the way in which the intelligence in communications networks has migrated over time from inside the network to, in the case of the Internet, the edge of the system and into each individual computing devices, the trend in the electric grid may also be moving intelligence towards the edge and into houses and appliances, rather than towards a central operating station. Moving forward, he said, the task for policymakers will be to apply the historical lessons of parallel intelligence network systems to best define the interfaces and protocols that will work for the smart grid system.

According to Hatfield, how the U.S. goes about defining this network will have enormous consequences and whether it is either open or closed, proprietary or "open source," and centralized or with intelligence located at the edge will have a tremendous impact on future innovation.[27] He said it is critical that the system architecture is optimized for efficiency in the future.

B. Discussion

Following the presentation, the floor was opened to discussion. Picking up where Hatfield had left off, the first question asked where the best place to house the intelligence in the smart grid network might be. Hatfield replied it was difficult to say with certainty where the "best" location is, but that he felt flexibility was a key consideration to allow for

[27] By statute the development of a smart grid has been made a national policy goal in the U.S., and Energy Independence and Security Act of 2007 specifies that:

> [T]he interoperability framework should be "flexible, uniform, and technology neutral." The law also instructs that the framework should accommodate "traditional, centralized generation and distribution resources" while also facilitating incorporation of new, innovative Smart Grid technologies, such as distributed renewable energy resources and energy storage.

NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY, FRAMEWORK AND ROADMAP FOR SMART GRID INTEROPERABILITY STANDARDS, RELEASE 1.0 (2010), *available at*: http://www.nist.gov/public_affairs/releases/upload/smartgrid_interoperability_final.pdf.

adjustments or the possibility of a combination of locations in the future.[28] Another benefit of increased intelligence in the grid would be to link electricity demand to the distribution and generation systems in real time with the attendant rate schedules. Some participants felt the main challenge boils down to a question of timing: the new rate schedules are only beginning to develop, so the first order of business will be to implement the technology and then the rates can be passed on to consumers (with the hoped-for result of shifting consumption from high-cost to lower-cost times of the day). There is money on the table here, according to some participants, especially if these rate schedules can be properly managed through consumer education and the changes in consumption patterns actually occur. One difficulty is the number of bigger players making significant profits with the current energy-pricing regime, leading some participants to comment that there may be pushback to the rate schedule idea.

The discussion then turned to the architecture of the signaling network, focusing on what structures are already in place that could be utilized as part of the smart grid system. One participant mentioned the cable network, focusing on how it is a nationwide communications network with broad penetration. Participants also mentioned the use of wireless technologies and radio frequencies, though using radio spectrum for smart grid technologies would require working with the Federal Communications Commission (FCC). Referring back to the concept of system architecture as policy, one participant wondered how regulators would unbundle the services each network offers to the extent necessary to support innovation and healthy competition, and of course to make sure that these stayed unbundled.

There was also some discussion as to how to best organize the business arrangements and agreements on some of the existing networks to overcome potential regulatory and economic challenges. Here, there were questions as to the economic incentives inherent in the way these partnerships are structured. Unlike innovative markets where first movers stand to gain from additional rents, for example in the smart phone industry where early adopter customers are willing to pay premiums for the first models, utility regulation does not permit discrimination in rate classes and it reduces the economic incentive to innovate.

There may be different incentives for the consumer and utility companies as well, with some questions around who will ultimately pay for the smart grid effort and whether the horizons of the different stakeholders are in sync. Here, one participant felt the near term benefits and business case are mostly on the side of the utility companies, but that consumers and the federal government are the ones being forced to pay the upfront costs. He wondered if this was one cause for the consumer backlash that had been seen, and if the utility companies should be

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[28] As a clarification, Hatfield said that when using the word "intelligence" he was primarily referring to "routing" and the ability to quickly and automatically redirect electricity around a failure in the grid.

forced to justify the increases in the rates charged to customers. Another participant agreed that there might be more benefit on the side of utility companies and felt there should be a way for the utility to pass this benefit on to the consumer. One possible solution, mentioned previously in the roundtable, is price caps.[29] In comparison to cost of service regulation, according to one participant, price caps have shown successful results in the UK and Canada, suggesting that US regulators would do well to consider them.[30] One final comment pointed out that there might be differences in the incentives of the regulated versus deregulated utility companies, and that innovation may come first in the deregulated areas.

In addition to the economic incentives around innovation, participants felt the ownership model for the smart grid signaling system may be important as well. Once the intelligence network is in place, it can also serve other uses, for example connecting the elderly to a medical alert network in case they need assistance. If the utility is the owner of a proprietary, closed signaling network, they may or may not allow the system to be used for these other purposes, which is why an open platform would be preferable for purposes of innovation and maximizing the benefits to society generally.

Another participant pointed out how utilities have been conditioned over decades to favor stability over innovation in their corporate culture, adding a further challenge to regulators. Along these lines, some participants thought that collaboration among government agencies involved in the smart grid might be helpful. Here, many thought the Federal Energy Regulatory Commission (FERC) might have a role in generally helping utility companies to develop a new culture that is more supportive of innovation.[31]

Finally, one participant asked if separating out the intelligence in the signaling network versus the payload delivery system was a proper goal. He said the intelligence seems to be focused on the information collected and used for the routing decision, whereas the information and intelligence as to the payload is really the customer's decision at the edge of the network. Possibly, he said, this means that what is needed first is more of a smart *information* system and that any upgrade to the physical facilities should come later. The participant thought the proper focus instead might be building out an information system through the use of smart meters and other similar technologies.

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[29] Though one participant thought that price caps would require the regulator to "vigilantly" enforce quality of service requirements.

[30] For more information on price caps in the UK, see Richard Green, Has Price Cap Regulation of UK Utilities Been a Success?, Public Policy For The Private Sector (The World Bank Group) (Nov. 1997), *available at*: http://cdi.mecon.gov.ar/biblio/docelec/bm/ppps/N132.pdf.

[31] The Federal Energy Regulatory Commission's general mission is to "[a]ssist consumers in obtaining reliable, efficient and sustainable energy services at a reasonable cost through appropriate regulatory and market means." *See* Federal Energy Regulatory Commission, http://www.ferc.gov/about/about.asp (last visited Jan. 23, 2011).

There was a final brief discussion concerning smart meters that focused on the difference between implementing Advanced Metering Infrastructure (AMI), which enables two-way communications with the meter, versus the existing system of Automatic Meter Reading (AMR).[32] Participants felt that utility companies would like the ability to communicate with meters using AMI to control energy use, which could result in real operational savings, but the downstream consumer benefits are not yet clear.

Part III – Federal Policy Implications

The third and final part of the discussion examined the federal and state policy considerations of the smart grid, where there may be an opportunity for both levels of government to work together in a form of cooperative federalism that should result in the optimized implementation of new technologies. While state governments are taking the leadership role in actually building out the grid, the federal government plays an important role in providing both the analysis and funding necessary to support efficient development of the system nationwide, and also placing the smart grid effort within the context of the larger global concerns of climate change, economic development and national security. Additionally, consumer participation in the smart grid implementation process is a critical component.

A. Roles for Federal versus State Governments in Smart Grid Implementation

There is no question that the energy industry is behind others as far as using information to become more efficient. According to Phil Weiser, Senior Advisor to the Director for Technology and Innovation at the National Economic Council, the Department of Energy is positioned to help shape the evolution of these technologies. However, in Weiser's

[32] According to the Electric Power Research Institute:

> Advanced metering systems are comprised of state-of-the-art electronic/digital hardware and software, which combine interval data measurement with continuously available remote communications. These systems enable measurement of detailed, time-based information and frequent collection and transmittal of such information to various parties. AMI or Advanced Metering Infrastructure typically refers to the full measurement and collection system that includes meters at the customer site, communication networks between the customer and a service provider, such as an electric, gas, or water utility, and data reception and management systems that make the information available to the service provider.

See ELECTRIC POWER RESEARCH INSTITUTE ADVANCED METERING INFRASTRUCTURE (AMI) (2007), *available at* http://www.ferc.gov/eventcalendar/Files/20070423091846-EPRI%20-%20Advanced%20Metering.pdf.

opinion, there are a couple of principal substantive challenges to implementing the technology.

First, the smart grid needs to be viewed in an appropriate context; it will not, for example, revolutionize society on the order of the Internet. Referring to any new technology as the "next Internet," he said, is an unfair comparison, as the Internet revolutionized everything from banking to entertainment and it is therefore unlikely that any new technology will soon appear and have such a dramatic impact on human social realities. Second, Weiser also pointed out that the term "smart grid" often ill defined or at least under-defined. Referring to the smart grid as a precisely defined concept is imprecise, as there are actually many different components that are not necessarily equal when it comes to the cost benefit analysis. At a minimum, smart grid includes transmission, distribution, and customer premise devices, and more broadly includes a set of smart grid technologies. Smart grid technologies are not, stated simply, merely smart meters, as sometimes is depicted. Finally, despite the issues with expectations and definitions for smart grid, the promise of smart grid technology is real and critical to the electricity network of the future, which will face challenges such as the increased use of renewable energy sources, management of peak demand, and the accommodation of electric vehicles.

Implementing an efficient smart grid will be critical in managing these challenges and others. Initially, Weiser pointed out that renewable energy supplies are variable in their supply characteristics as compared to coal or natural gas. Renewables are highly sensitive to weather conditions and other factors that can vary drastically – sometimes on a daily basis – so for stability purposes the United States will likely need to continue to use more reliable sources in the generation mix. The use of renewables could increase significantly if there were better storage technologies capable of capturing the renewable energy supply, but unfortunately the technology has not quite reached that threshold yet.

One of the things smart grid technology can do is to help stabilize the energy supply by helping to clarify the size and extent of demand so that the supply can respond appropriately. These new technologies may also serve as a final means of quantifying exactly how much capacity is necessary in regions where additional generation capacity still needs to be constructed. One looming challenge is electric vehicles; there will be a large number of people charging their vehicles at the same time of day, for example when they return home from work, creating new and excessive demand on the grid during peak times.[33]

[33] A University of California Berkeley study models the effects of plug-in vehicle charging on the grid under a number of different scenarios and assumptions, with most scenarios showing significant stress on current electricity generation and distribution systems. *See* NICHOLAS DEFOREST, ET AL., IMPACT OF WIDESPREAD ELECTRIC VEHICLE ADOPTION ON THE ELECTRIC UTILITY BUSINESS – THREATS AND OPPORTUNITIES 9-15 (2009), *available at* http://cet.berkeley.edu/dl/Utilities_Final_8-31-09.pdf.

The challenges of smart grid are certainly significant, and the federal government will need to work closely with state governments to meet those challenges. According to Weiser, there are three primary institutional issues that will impact the approach to smart grid implementation. First, state governments are in a leadership position in terms of actually implementing smart grid policies, while the federal government is in a position to provide the states with better research and analytics to understand what is working and what is not. He said that one significant obstacle states will face is a legacy regulatory system that values stability and constancy rather than innovation and change, which as discussed previously is part of a culture that is reflected in the utilities themselves. As California deals with the challenges of implementing a statewide smart grid and the city of Boulder, Colorado deals with similar obstacles at the municipal level, he said it is important to recognize the importance of learning from lessons that comes from early experiences.

Second, according to Weiser the federal government can catalyze innovation by providing funding.[34] Pointing to some of the lessons learned in the energy projects funded as part of the Recovery Act stimulus package, he felt the federal government should be able to: (1) take leadership in standard setting; (2) develop recommendations for best practices; (3) provide encouragement for experimentation; and (4) create a structure to analyze technological and marketplace developments. Working together on smart grid, he said, the state and federal actors can develop a form of cooperative federalism that both respects and embraces state authority and the opportunities for experimentation, but also benefits from federal guidance and support where there is a comparative advantage at that level. Weiser felt this type of cooperative federalism will be essential for finding the optimal approach to smart grid technology.

Federal and state regulators may also be able to work together on smart grid by using a funding sequence similar to the stages that venture capital firms use when investing in start-up companies, with the first round of funding coming from the federal government followed by later rounds by the states.

Consumer participation in the smart grid implementation process is also critical. Weiser felt that dynamic pricing does not have to be real-time, but utilities do need to provide some degree of signaling and an opportunity for consumers to react to those signals. One technique is giving customers the opportunity to "set it and forget it" when it comes to their power usage settings. Approaches such as this are critical to engaging the consumer and evaluating what technologies are most cost

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[34] For example, as part of the American Recovery and Reinvestment Act of 2009, Congress set aside $300 Million in tax credits for expenditures associated with investment in plug-in electric vehicles in order to support and promote that technology. *See* NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION, RELIABILITY IMPACTS OF CLIMATE CHANGE INITIATIVES: TECHNOLOGY ASSESSMENT AND SCENARIO DEVELOPMENT 77 (2010), *available at* http://www.nerc.com/files/RICCI_2010.pdf.

effective. Implementation of smart grid should examine the use of less expensive and simpler technologies such as smart meters and automated thermostats to avoid causing consumer distrust through excessive expense. Weiser felt the technology should put a premium on being easily adaptable to meet the needs of a wide range of consumers.

Weiser concluded with four "animating" questions, including: (1) how do consumers view smart grid technologies and how can the smart grid revolution be more consumer friendly; (2) how to place a structure around ongoing experimentation, evaluation of different successes or failures, and assess what really constitutes a cost effective grid; (3) how to define the role for federal government policy moving forward, including the structure for research and development funding and ongoing evaluation; and (4) evaluating what areas can benefit from defining best practices, for example privacy standards for the data involved in smart grid operations, as well as cyber security issues.

B. Discussion

Starting off the discussion, one participant felt that global and national issues – such as greenhouse gas emissions, economic development, and energy security – are what drive the discussion at the federal level, but that what is actually needed is a more incremental approach, and this "gradualism" should lower the cost impact on consumers. Along these lines, one participant thought that the focus for policy makers in Washington, D.C. should be where there is a pending "paradigm shift" that will provide an opportunity for significant movement in an area where otherwise, using an incremental approach, the US would not be able to reach its goals.

Another participant felt there needed to be a more holistic long-term view of the smart grid effort, and that this should be a multi-step and extended effort involving integrated resource planning processes. The goal, he said, should be getting to a smart grid "formula" and it might be that the key is in requiring utilities to give communities and states an annual business plan of sorts that addresses the electricity generation mix.

Most agreed that the federal and state governments are "in this together" but that the difficulty is in framing the challenge so as to increase engagement by all the stakeholders. Here, participants thought that education might be the key – for example through educating the consumers and then giving them the tools to automate their consumption. This way consumers would understand more about what their consumption means in terms of electricity production and distribution, and would have the ability to sync pricing (reflecting actual system conditions) with their own demand, moving the consumer from a passive to an active role. One participant thought that many other countries have more advanced regulators and regulation systems for their electricity grids, and getting the international perspective may help inform new models. As an aside, another participant thought that New Institutional

Economics (NIE) might help the US find new regulatory institutions that both support innovation and solve some of these regulatory conundrums.

There were some questions as to what the "killer app" in the smart grid space might be. One participant pointed to the telecommunications sector and how it transformed over time. While historically there had been some speculation as to what the killer app in that space might be – the one to break up the Bell telephone system – that app turned out to be the Internet and cell phones. The thought here was that for things in the smart grid space to shake out in a natural and sustainable way, like the changes in telecommunications, finding the killer app may take time. Looking at the current state of smart grid, some participants thought that things were moving pretty fast, especially from the consumer's perspective, and that utilities and policy makers should be careful and avoid assuming that all consumers will buy into the same things.

Highlighting the consumer perspective, one participant felt that California might end up as an example of what *not* to do when it comes to implementing smart grid technologies. In California, they related, there have been significant "hiccups," for example when some wrong technologies were installed and then needed to be replaced by correct technology – at a significant cost to the rate-paying customers. Along these lines, there have been numerous changes to the rates, increases in consumer education, and more, but now many cities are "refusing" the new smart meters. With all of this, and especially with only marginal savings to consumers on their bills – with at times short -term increases to achieve long-term savings – it is becoming more difficult to convince consumers that smart grid is something helpful. In order to address some of these issues it may be helpful to start talking to consumer groups at the federal level.

Privacy questions when it comes to third-party access to data

In terms of getting information to the consumers of electricity and the innovators in the smart grid space, one participant wondered if there was an opportunity to accomplish some of the consumer education at the edge of the network, and asked how the innovators on the supply side were getting their information. He pointed out that often utilities do not share the type of information necessary for third parties to innovate, and that for smart grid to work the people at the edge need access to the appropriate information. There was some discussion of groups working to provide consumers with this kind of information, and one participant anecdotally pointed to an effort by Google to gain access to this data through private agreements with utilities.[35]

[35] Currently only available to utility customers in San Diego, California, the project is called the Google Power Meter. It is an online tool that uses the "information provided by utility smart meters" to allow the consumer to view their "home's energy consumption from anywhere online." *See* Google Power Meter, http://www.google.com/powermeter/about/about.html (last visited Jan. 23, 2011).

Another participant pointed out that the incentives for utilities on this issue are all wrong, because providing access to this data would in essence make utilities the primary motivator behind reducing their own customers' demand. Because of the respective incentives, participants thought one focus might be on federally mandated data sharing. This brought up the question of data access versus data ownership. The group generally felt that consumers owned their electricity usage data and there was unanimous agreement that consumers should have access to it.[36] One participant pointed out that there might be a chicken and egg problem, because how does a regulator mandate access to certain types of data if they are not even being captured? There were many questions around what data is being captured currently, how to capture more data, whether this simply meant better meters, and who or what entities should be considered third parties.

Another major issue surrounded the privacy implications of sharing consumer energy usage data. Here, the discussion began by asking what it meant to allow access to user data. Paul Ohm, Associate Professor of Law at the University of Colorado Law School, felt that data can either be useful or private, but not both.[37] For example, if you have a powerful enough computer and a sufficient number of unique variables, then data anonymization is practically impossible, or at least easily "re-individualized." Currently, he said, most privacy laws have some sort of safe harbor for anonymized data that has been "stripped" of personally identifiable information, but with increases in computing power this anonymization is mostly illusory. There needs to be a new approach to privacy, especially when looking at information that might show such things as what appliance is used in the home at what time of day and for how long.[38]

Ohm said that one approach might be a notice and consent regime wherein the utility gives notice to the consumer as to what information it gathers and disseminates, but he pointed out that many privacy experts have given up on this model because the average consumer does not rationally understand the risks involved. Thus, he said, the government may need to become paternalistic at some point and give people the level of privacy they "deserve" and not the level to which

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[36] One participant pointed out that there was pending California legislation on this point, which has now been passed into law. It addresses such things as third party disclosure policies, data security and protection, and liability. *See* California Senate Bill 1476, http://www.leginfo.ca.gov/pub/09-10/bill/sen/sb_1451-1500/sb_1476_bill_20100929_chaptered.html (last visited Jan. 23, 2011).

[37] For a more thorough discussion of Professor Ohm's views on privacy, see Paul Ohm, *Broken Promises of Privacy: Responding to the Surprising Failure of Anonymization*, 57 UCLA L. REV. 701, *available at* http://uclalawreview.org/?p=1353.

[38] It is possible to get at this type of information through more detailed knowledge of electricity use combined/compared against databases of the current draws of different appliances and electrical devices. *See* Jon Beyea, *The Smart Electricity Grid and Scientific Research*, SCIENCE (May 2010), p. 979, *available at* http://www.sciencemag.org/content/328/5981/979.full.pdf.

they agree. Maybe the answer is legislation or procedures that "nudge" consumers in certain directions on privacy choices for a set number of years until there is more experience and a better culture of privacy in the populace.

There is also a motive problem, according to Ohm, because there will be a treasure trove of personal information on electricity usage in the smart grid data that companies will want to monetize, from personal information in the home to business information in the workplace.[39] This raises a host of questions. For example, who within the organization has access to the information? What happens if it is "leaked"? What procedures should be taken, or can be required to be taken, to prevent leaks? Must the owner of a building give consent to sharing the energy usage of a building or can the tenants give consent? Ohm felt that drawing bright lines on these issues would be very difficult.

Other participants highlighted how privacy issues are not specific to smart grid, and pointed out how the same issue is involved in the information tracked through customer discount cards at supermarkets and other personalized coupons. The difference though, according to other participants, is that many people do not look favorably on their utility company and there is generally no competition or choice at the consumer level; people cannot choose their utility company and they are "forced" to pay many regulatory fees. Another participant pointed out that this bridge had already been crossed in the telecommunication space by granting access to customer consumption information, and that there were processes and procedures there that could be applied to the smart grid data. Another useful model might be the protection of medical information through the Health Insurance Portability and Accountability Act (HIPAA)[40] because personal medical information is arguably more sensitive than energy usage, and is highly regulated, but is still open to use by researchers.[41] An added wrinkle, according to Ohm, is that there is significant judicial precedent that makes gathering information about what goes on inside someone's home uniquely invasive.[42]

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[39] One participant called this "Google envy."

[40] 42 U.S.C. § 1320d (2010).

[41] For a list of the privacy rules for HIPPA compliant researchers, see the National Institute of Health website at http://privacyruleandresearch.nih.gov/faq.asp (last visited Jan. 23, 2011).

[42] The Supreme Court has recently upheld the relatively high expectations of privacy in the home by prohibiting the use of a thermal imager to gather details about the home that would have been previously inaccessible without a physical trespass—at least until such time as the technology to do so becomes widely available to the general public. *See* Kyllo v. United States, 533 U.S. 27 (2001). But there seems to be some tension with the generally lower expectations of privacy in the information contained in common business records that most utilities gather as a matter of course. *See* Jack L Lerner & Deirdre K. Mulligan, *Taking the "Long View" on the Fourth Amendment: Stored Records and the Sanctity of the Home*, STAN. TECH. L. REV. 3 (2008), *available at* http://stlr.stanford.edu/pdf/lerner-mulligan-long-view.pdf.

Some participants felt that the privacy discussion might be overcomplicating what smart grid is. They pointed out how on the Internet many people give out vast amounts of significantly personal information every day, whereas smart grid technologies are at their core only about giving and receiving electricity price and demand data. Some participants felt there would be vendors who would offer various levels of data protection along with their services and that this would end up being a market decision by consumers.

Conclusion

Implementation of smart grid technologies in the United States faces many challenges, from economic, technological and policy standpoints. As cost of service regulated entities, utilities are not currently well incentivized to increase efficiency through innovation, while state regulators face the real risk that at this stage, the smart grid is not a proven investment. Architectural concerns of whether the signaling network will be open or closed and where the intelligence will be located are critical for ensuring that the smart grid design is optimized to allow for the greatest efficiency moving forward. Finally, state and federal governments will likely need to work together in a form of cooperative federalism to ensure the optimized implementation of new smart grid technologies.

Attachment A – Smart Grid Roundtable

(Alphabetical by Last Name)

Srihna Apridee	University of Colorado, Interdisciplinary Telecommunications Program, *Student*
Rimvydas Baltaduonis	Gettysburg College, *Assistant Professor, Economics*
Frank Barnes	University of Colorado, *Professor of Electrical Engineering*
Brad Bernthal	Silicon Flatirons, CU Law, *Director of EI, Professor*
Tim Brown	University of Colorado, Interdisciplinary Telecommunications Program, Electrical and Computer Engineering, Computer Science, *Professor*
John Colgan	Illinois Commerce Commission, *Commissioner*
Kelly Crandall	University of Colorado Law School, *Alumnus*
Jeffery Earl	Indiana Regulatory Commission, *Law Judge*
Sherman Elliott	Illinois Commerce Commission, *Commissioner*
Giancarlo Estrada	Arizona, *Policy Advisor to Chairman Kris Mayes*
Manuel Flores	Illinois Commerce Commission, *Chairman*
Ray Gifford	Silicon Flatirons Center, *Senior Adjunct Fellow*
Dian Grueneich	California Public Utilities Commission, *Commissioner*
Eric Gunning	Wilkinson Barker Knauer, LLP, *Associate*
Mark Handschy	U.S. Department of Energy, *Senior Advisor*
Dale Hatfield	Silicon Flatirons Center, *Executive Director*
Steven Hauser	Grid Integration National Renewable Energy Laboratory, *Vice President*
Bill Levis	Colorado Department of Regulatory Agencies, *Consumer Counsel*
Maureen McLaughlin	U.S. Department of Energy, *Senior Legal Advisor*
Paul Ohm	University of Colorado Law School, *Associate Professor*
Preston Padden	Silicon Flatirons Center, *Senior Fellow*
Kaleb Sieh	Silicon Flatirons Center, *Research Fellow*
Gregory Sopkin	Colorado Public Utilities Commission, *Former Chairman*
Jess Totten	Competitive Markets Division Public Utility Commission of Texas, *Director*
Bob Veneck	Technical Operations Indiana Utility Regulatory Commission, *Executive Director*
Phil Weiser	National Economic Council, The White House, *Senior Advisor to the Director for Technology and Innovation*