Chapter 11
U.S. Energy Ecosystem: Entering a New Era?

Lawrence D. Plumb

The project of modernizing the electricity grid with smart technology has been near the top of the U.S. energy policy agenda for several years.[1] This paper looks in a different direction, however, away from the grid's operation and toward the realm of market transactions between supply and demand. New Federal Energy Regulatory Commission (FERC) rules allow the reduction of end-user loads to be compensated the same as the generation of new electricity. FERC's new rules, coupled with advances in commercial broadband networks, machine-to-machine communications and cloud computing, enable electricity loads to be managed as a sort of asset that can be monetized and can spur innovation and investments in energy efficiency throughout the economy in ways that might not be expected.

Perhaps the most important rule change is contained in something called FERC Order No. 745, which states that "a demand-response resource must be compensated for the service it provides to the energy market at the market price for energy, referred to as the locational marginal price (LMP)."[2] There is absolutely nothing in this jargon that will appeal to consumer imagination. But the impact of the change could be transformative.

[1] See Title XIII of the Energy Independence and Security Act of 2007.

[2] *Demand Response Compensation in Organized Wholesale Energy Markets*, Docket No. RM10-17-000; Order No. 745, U.S. Federal Energy Regulatory Commission, Issued 15 Mar 2011. http://www.ferc.gov/EventCalendar/Files/20110315105757-RM10-17-000.pdf.

L.D. Plumb, Ph.D. (✉)
Verizon, 1300 I Street N.W. Floor 400 West, Washington, DC, 20005, USA
e-mail: lawrence.d.plumb@verizon.com

E.M. Noam et al. (eds.), *Broadband Networks, Smart Grids and Climate Change*, 121
DOI 10.1007/978-1-4614-5266-9_11, © Springer Science+Business Media New York 2013

Importance of Energy Efficiency: Essential Component of a Sustainable Energy Ecosystem

Energy efficiency—the ratio at which the "primary energy" contained in a given fuel stock, like coal, is converted into "useful work," like providing light—plays a critical role in maintaining a robust and growing economy and in addressing national security because the ratio helps determine things like how many barrels of oil must be imported.[3]

Energy efficiency was never a consideration in pre-industrial societies. Sunlight is what fueled agrarian economies, and no one asked how efficiently plants used sunlight to grow and mature. In modern industrial societies, however, most of the energy that drives the economy comes from fossil fuels taken from the ground. The U.S. economy so deeply depends on fossil fuels that even with the most optimistic estimates for the fast growth of wind, solar, and other renewable resources, the economy will still use vast amounts of oil, coal, and natural gas for decades to come. And with reliance on extracted fuel stocks for the energy to make and move things, maintain temperatures in buildings, and to light the night, the question of how efficiently these fuel stocks are used becomes increasingly important.

The U.S. Energy Information Administration (EIA) estimates that by 2035 the U.S. economy will nearly double in size.[4] In making that projection, the EIA presumes a linear extension of today's pattern of energy production and consumption. But developments are looming that could well disrupt the safe and timely production of many energy resources. Perhaps the most obvious risks stem from geopolitical issues that could block the flow of imported oil. But even without factoring in international political challenges, the costs of finding and developing new energy or fuel stock supplies are expected to accelerate faster than inflation.[5] Fuel shortages or high oil prices could impede economic growth if we cannot find ways to increase our energy efficiency. All of this is to say there is a growing need to change our pattern of energy production and use. In fact, a business opportunity is emerging for those who can find ways to improve energy efficiency because its value will only grow as fuel prices rise.

Improvements in energy efficiency, in the ratio at which primary energy is converted into useful work, are possible to achieve. The U.S. economy nearly doubled its energy efficiency between 1950 and 2010, improving from 8 to 14%, by applying capital stock and management know-how to improve energy use.[6] For example, we increased efficiency by insulating homes and buildings, incorporating computer

[3] *The Economic Growth Engine: How Energy and Work Drive Material Prosperity* (Edward Elgar Publishing; 2009), Robert U. Ayres and Benjamin War.

[4] *Annual Energy Outlook 2011 with Projections to 2035,* U.S. Department of Energy: Energy Information Administration, Apr 2011. http://www.eia.gov/forecasts/aeo/pdf/0383(2011).pdf.

[5] *Commodity Markets Outlook and Strategy, Global Commodities Research*, J.P. Morgan, 1 Aug 2011.

[6] *The Link Between Energy Efficiency, Useful Work and a Robust Economy*, John Laitner, American Council for an Energy-Efficient Economy, Working Paper, Sept 2011.

chips into cars with fuel injection systems, and by deploying better heat exchangers, like replacing tubes with plates in boilers and hot water tanks. The boom in cogenerating power plants in the 1980s, spurred by the Public Utility Regulatory Policies Act of 1978 (PURPA), also helped increase energy efficiency by producing two forms of useful work when burning one fuel stock.[7]

Without these efficiency improvements, the U.S. would have had to import far more oil and burn more coal and natural gas than it actually did in 2011. But even though the economy nearly doubled the efficiency with which it uses energy during the last 50 years, a 14% energy efficiency ratio means that we still lose or waste 86% of the energy we burn, usually in the form of high and low temperature heat that is vented at different stages during the process of manufacturing things, running machines, and heating buildings.[8]

A number of analysts who study energy efficiency question the extent to which improved efficiency can help moderate the pressure for more energy resources. They point to the Jevons paradox, or "rebound effect," which refers to the potential for increased efficiency to lead to increased consumption because new uses are found for energy.[9] For example, consumers might drive longer distances if they know their cars are more efficient and cost less to operate, resulting in a net increase in energy use.

Rebound effects certainly need to be kept in mind, but their impact varies depending on the sector in question. Studies of the building sector, for instance, have found such effects to be minimal: if people light a room with more efficient bulbs, they don't then turn around and light the room more brightly with the new lamps.[10] Meanwhile, recent studies of macroeconomic rebound effects have, indeed, shown that efficiency improvements free up resources that enable people and equipment to amplify their level of economic activity. This allows the economy to expand, which in turn pulls energy use to a higher level to support the additional output. But the increased energy use is at a significantly lower level than it would be when compared to a business-as-usual model of economic growth.[11]

The opportunity for improving energy efficiency while growing the economy is one reason there is so much interest in the idea of making things "smarter" by

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[7] *Small-Scale Cogeneration Handbook*, 4th Edition, Bernard R. Kolanowski (Fairmont Press; 2011), pp 5–6. Relates how the impetus for PURPA started with the struggles of a neighborhood in the Bronx section of New York City, circa 1975, to sell back to Consolidated Edison of NY excess electricity generated by a neighborhood windmill.

[8] *The Long-Term Energy Efficiency Potential: What the Evidence Suggests*, John Laitner, Steve Nadel, Neal Elliot, Harvey Sachs and Siddiq Khan, American Council for an Energy-Efficient Economy, Jan 2012, Report No. E121.

[9] http://en.wikipedia.org/wiki/Jevons_paradox.

[10] *The Take-Back Effect-Fact or Fiction?,* S. Nadel, 1993, American Council for an Energy-Efficient Economy (ACEEE); *Rebound, Technology and People: Mitigating the Rebound Effect with Energy-Resource Management and People-Centered Initiatives*, Karen Ehrhardt-Martinez, University of Colorado; John A. "Skip" Laitner, Aug 2010, ACEEE.

[11] *The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture*, Karen Ehrhardt-Martinez and John A. "Skip" Laitner, May 2008, Report No. E083, ACEEE.

applying information and communications technology (ICT) to cities, systems, and processes. Sensors, communications, and better decisions based on data and information can improve air flows in buildings, traffic flows on highways, and electron flows on power lines. Some economists have projected that the energy efficiency of the U.S. economy can be tripled in the next 20–30 years through the use of ICT, but only if every opportunity to improve energy efficiency is taken, and most importantly if we act on the opportunities for large efficiency gains in buildings and industrial systems as well as in our nation's transportation and power production infrastructure.[12]

The challenge for realizing robust improvement has been that the opportunity tends to be seen either as about reducing or controlling costs or as a problem of economic externalities. Understanding energy efficiency as a problem of externalities is why programs like ENERGY STAR are launched by the Environmental Protection Agency (EPA) and Energy Efficiency Resource Standards (EERS) are developed by state governments.[13] Either way, energy efficiency tends to get less attention and investment than might be considered to be ideal.

This is why FERC's change in how end-use customers can interact with wholesale electricity markets has such profound implications: it turns energy efficiency into an opportunity to add value and generate revenue rather than as just a way to reduce costs or as something mandated by regulation.

Passive Consumption and Lack of Engagement with the Electricity System: Current State of Play

The U.S. grid's regulated structure and business model still remains largely unchanged from when it was pioneered in the 1920s by Samuel Insull, who led Commonwealth Edison, one of the first utility holding companies.[14] Insull's model focused on achieving economies of scale in the production and distribution of electricity by building centralized generation plants and by connecting these plants to the largest possible number of customers through an interconnected web of power lines. As costs came down and supplies increased, customers were encouraged to consume even more electricity and were provided discounts when they did. There was no active negotiation between supply and demand to set prices. Rather, electricity rates were set through a regulatory process that focused on recovering the costs of providing service.

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[12] Ibid.

[13] See: *Energy Efficiency Resource Standards (EERS): An Overview*, Jeff Brown, EPA—State Climate and Energy Program Technical Forum—19 Jan 2010. http://epa.gov/statelocalclimate/documents/pdf/brown_presentation_1-19-2010.pdf.

[14] *Smartpower: Climate Change, the Smart Grid, and the Future of Electric Utilities*, Peter Fox-Penner (Island Press; 2010), p 2.

Electric utilities historically have had an obligation to serve all customers at any time, an obligation that stemmed from the fact that they are granted exclusive franchises in a given geography. Whenever someone turns on a light or TV in their home, he or she creates a "load" on an electric circuit that must be matched by a corresponding generation of electricity somewhere on the grid. Base-load power plants that often rely on burning coal or nuclear fission are run around the clock to match the aggregate demand for electricity that constantly exists as people go about their daily rounds. Grid operators manage the moment-by-moment marginal changes needed to maintain balance between generation and load with a range of ancillary power options on top of base-load generation. The operators' mission is to make sure enough energy is generated to match the next surge or decline in demand, which they anticipate by using historical data, weather forecasts, and other information that is plugged into sophisticated computer models. The principal ancillary options are designated by how fast they can kick in, with "spinning reserves" the fastest and required to come on line in less than 10 min, then "supplemental," and then "replacement" reserves. The marginal cost of generating the next kilowatt hour varies depending on how efficient is the power station that is called into action, on what fuel sources are used, and on how congested are the transmission lines.

Demand for electricity varies through the day and with the season, but most residential customers and many small business customers pay fixed retail rates that bear little relation to the marginal cost of providing power at any given moment, and the rates they pay certainly bear no relation to the very high cost of providing power at moments of peak demand. So people consume electricity whenever it best suits their needs and desires with little regard to whether their use is "energy efficient": lights on at night, laundry in the morning, air-conditioning in the summer. The manner in which electricity is consumed without regard to its cost of production at any given moment means the supply side of the grid must invest in the generation, transmission, and distribution infrastructure needed to meet demand even when it spikes in the summer on the hottest day of the year.

Building to supply the electricity needed to match extreme peaks in load means that 15–20% of the grid's capacity sits idle more than 9 out of every 10 days, resulting in an over-investment in capacity.[15] Meanwhile, on the demand side of the grid, fixed, flat-rate pricing has contributed to under-investment and less innovation in energy efficiency.

Certainly, there have been changes since the early days of the electric industry. Technological advances in the 1980s increased the efficiency of small-scale electricity generation. Concurrently, the 1970s and 1980s saw cost overruns in the building of traditional, utility-owned, capital-intensive base-load power plants. The technical advances and the cost overruns in combination posed a challenge to the

[15] See: http://www.energyvortex.com—"Regulatory bodies usually require producers and transmission facilities to maintain a constant reserve margin or capacity of 10-20% of normal capacity as insurance against … sudden increases in energy demand." Note: EnergyVortex is an open industry energy site designed to serve as a B2B community and e-commerce center.

assumed economies of scale delivered by large centralized generation plants and eventually led to passage of the Energy Policy Act of 1992.

The 1992 law opened wholesale electricity markets to competition under FERC jurisdiction and to the formation of Independent System Operators (ISOs) and Regional Transmission Organizations (RTOs) that manage deregulated wholesale electricity transactions. ISOs and RTOs also manage the flow of electricity across the transmission lines in their region because of the perpetual need for system balancing and coordination between multiple generators and end-user loads. Two-thirds of the U.S. economy is now served by electricity generated and transmitted in deregulated wholesale electricity transactions.[16]

Starting in 1998, 24 states had also passed laws opening their retail markets to competition in hopes that retail competition, coupled with wholesale power generation competition, would lead to lower prices and new electric service options.[17] The emergence of competitive retail markets, however, has not developed as anticipated. By 2006, eight states had repealed or delayed the deregulation laws in response to the California energy crisis of 2000–2001, and most other states maintained some element of price control to ensure residential customers were protected from huge price increases.[18]

Thus while the law deregulated wholesale electricity markets, these markets have—until developments in the last decade that culminated in FERC's rule changes—generally remained supply focused, in the sense that there is little to no negotiation between generation and consumption that might result in less demand. Rather, power suppliers submit bids for the right to sell their capacity to meet a level of demand that is accepted as a given. It is certainly true that utilities have long been in the practice of calling upon large commercial and industrial customers to power down equipment for a few hours to help maintain the balance between generation and load, usually by making a phone call to a business or factory enrolled in a "load management" program. But it is only in the last 10 years or so that it has become possible to reduce electricity use in the controlled manner needed to dynamically balance generation and load.

The absence of active negotiation between electricity supply and demand can be seen in the relatively unreflective way in which most consumers use energy. For generations, consumers have not had to think about their consumption of electricity and the price they pay for it. Rather, people have come to expect low, stable prices for highly reliable power to be almost an entitlement.[19]

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[16] *The Future of the Electric Grid: An Interdisciplinary MIT Study*, Massachusetts Institute of Technology, 2011. http://web.mit.edu/mitei/research/studies/documents/electric-grid-2011/Electric_Grid_Full_Report.pdf.

[17] *The Failure of Electricity Deregulation: History, Status and Needed Reforms*, Tyson Slocum, Director—Public Citizen's Energy Program, Mar 2007, p 5.

[18] Ibid, p 5.

[19] *A Market-Based Model for ISO-Sponsored Demand Response Programs*, Vernon Smith and Lynne Kiesling, Center for the Advancement of Energy Markets and Distributed Energy Financial Corp., Aug 2005.

The way in which most take the availability of electricity for granted and give little thought to its use is a mark of the success of the industry launched by Samuel Insull and his “gospel of consumption” early in the twentieth century.[20] But today, the lack of consumer engagement has become a barrier to the sector’s advance and digital transformation. If state regulators agree to replace fixed rates with dynamic pricing in order to encourage energy conservation and avoid spikes in peak-use demand, for instance, and yet consumers fail to embrace dynamic rates with informed participation, then they will be hit with much higher bills when they don’t cut back on use during times of peak load, and political backlash against smart grid deployments will result.

The standard response to this dilemma has been to call upon utilities to educate their customers about the value and benefits of the utility infrastructure called the “smart grid,” so that customers will accept any rate increases and changes its construction might require and to help prepare them to become more informed consumers of electricity. A recent review of dynamic pricing pilots has found that energy use behaviors can, in fact, be changed in response to changing electricity prices.[21] Dynamic pricing pilots or programs in California,[22] Maryland,[23] and Washington, DC,[24] also have demonstrated that customers will modify their consumption in response to information and new pricing regimes.

Certainly, education is worthwhile and needed to help people understand developments in a critical infrastructure that they generally take for granted and to help them appreciate how the changes will affect them and can improve their lives and their communities. But leading state utility commissioners have cautioned that a shift toward dynamic pricing for retail electricity rates is expected to come only very slowly.[25]

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[20] *The Electric City: Energy and Growth of the Chicago Area, 1880–1930*, Harold L. Platt (University of Chicago Press; 1991), pp 88–89.

[21] Ahmad Faruqui, Ph.D. “Dynamic Pricing: The Top 10 Myths.” The Brattle Group, 7 Apr 2011. The full report can be downloaded from http://www.brattle.com/_documents/UploadLibrary/Upload936.pdf.

[22] California Statewide Pricing Pilot (SPP). Pacific Gas & Electric (PG&E), Southern California Edison (SCE) and San Diego Gas & Electric (SDG&E), “Impact Evaluation of the California Statewide Pricing Pilot.” Charles River Associates (2005). The full report can be downloaded from http://sites.energetics.com/madri/toolbox/pdfs/pricing/cra_2005_impact_eval_ca_pricing_pilot.pdf.

[23] Baltimore Gas & Electric Company’s Smart Energy Pricing Pilot. Baltimore Gas & Electric Company. “BGE’s Smart Energy Pricing Pilot Summer 2008 Impact Evaluation” The Brattle Group (2009). The full report can be downloaded from http://www.brattle.com/_documents/uploadlibrary/upload768.pdf.

[24] Smart Meter Pilot Project, Inc. (SMPPI), Pepco, “PowerCentsDC™ Program Final Report.” eMeter Strategic Consulting (2010). The full report can be downloaded from http://www.powercentsdc.org/ESC%2010-09-08%20PCDC%20Final%20Report%20-%20FINAL.pdf.

[25] “*Dynamic Pricing Alert: Best Practices Courtesy of Two PUC Chairmen*,” Phil Carson, Intelligent Utility, 17 Mar 2011. http://www.intelligentutility.com/article/11/03/dynamic-pricing-alert.

Given the slow pace of change in retail pricing, it is very possible that 5–10 years from now FERC Order No. 745, aimed at *wholesale* transactions between supply and demand, will be seen as the seminal event that truly launched America's electric grid and energy system into a new paradigm of efficiency and use. FERC's changes in how to compensate the timely reduction of loads in the wholesale market could well spur dynamic competition among existing and new entrants who provide energy services that entail measuring and managing electricity use. The development of new apps for smart phones and tablets by these competitors and perhaps new gadgets like thermostats, and their investment in advertising and the creation of buzz through social media as they struggle to recruit end-use customers whose loads they can aggregate, would do far more to change how consumers engage with their energy consumption than will education about a utility infrastructure.

FERC Orders 719 and 745: Enter a New Dawn for the Electric Grid

The FERC opened a new market opportunity for "demand-response resources" in 2008 with Order 719, which required grid operators in all six organized wholesale electricity markets to accept bids from demand-response resources for ancillary services like "spinning," "supplemental," and "replacement" reserves on a basis comparable to power generation resources.[26] A "demand-response resource" is one that can stop using a given amount of electricity at the right moment in time needed to ensure that generation and load remain matched on the grid.

FERC noted that Order 719 advances the national policy of fostering competition in wholesale electric power markets that had been reaffirmed by the Energy Policy Act of 2005.[27] FERC's real breakthrough in enabling demand-response resources to compete in wholesale markets, however, came on March 15, 2011, when it issued Order 745. This Order required grid operators in the wholesale markets to pay the same price to demand-response providers who take load off the grid as they do to power generators who provide electricity to put on the grid.[28] This is a big step forward in putting investments in energy efficiency on par with investments in generation. The order establishes that electric utilities will have to pay demand-response resources the market price for energy, which is known as the LMP. It is a

[26] FERC Order 719: http://www.ferc.gov/whats-new/comm-meet/2008/101608/E-1.pdf.

[27] See: Energy Policy Act of 2005. Section 1815 calls for a study of wholesale and retail competition for electricity.

[28] Op Cit, FERC Order 745.

recognition that a "negawatt" of load reduction serves as an equal alternative to a megawatt of power generation in order to keep the system in balance.[29]

FERC's effort to bring demand-response resources into play in wholesale market competition is not without controversy. Due to concerns about the possible disruption of utility retail demand-response programs and related issues, a number of states either have prohibited third-party aggregation of customer demand response into organized wholesale markets while still allowing aggregation by and through utilities or have ongoing proceedings examining the third-party aggregation that is a component of Order 719. For example, see proceedings in Indiana, Iowa, Michigan, Minnesota, Missouri, North Dakota, South Dakota, and Wisconsin—all states with vertically integrated utilities.[30]

Meanwhile, power generators have challenged Order 745 in court.[31] They will lose a lot of revenue if megawatts are forced to compete directly with negawatts. For somewhat different reasons, the Edison Electric Institute (EEI) and the California Public Utilities Commission have filed for a court review of Order 745.[32] EEI has argued that FERC's proposal represents an "unduly preferential payment" for demand response if the LMP is not adjusted for the retail price that customers save by curtailing their use.

What's new and at issue with the FERC Orders is the opening of an opportunity for demand response in wholesale market competition that will exist in parallel with retail demand-response programs.[33] Retail demand-response programs have been used by distribution utilities for the past few decades as a management tool for shaving loads during periods of peak use. These programs have consisted of utilities gaining direct control over equipment in some homes and businesses, like the ability to moderate the settings on air-conditioners during very hot days. Participating consumers receive some benefit in exchange for allowing the utility to have this control, such as a special rate during the summer months or a monthly or yearly credit. But except for the few instances where pilot programs for time-based pricing have been implemented, there generally is no market negotiation between supply and demand in these load management programs. Rather, the utility is very much in control of the action and of the monetary benefit that

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[29] The term "negawatt" was coined by Amory Lovins during his keynote address at the Green Energy Conference in Montreal, in 1989. See: "The Negawatt Revolution: Solving the CO2 Problem." http://www.ccnr.org/amory.html.

[30] *Assessment of Demand Response and Advanced Metering; Sixth Annual Report Pursuant to Energy Policy Act of 2005, Section 1252(e)(3)*, FERC Staff Report, Nov 2011. http://www.ferc.gov/legal/staff-reports/11-07-11-demand-response.pdf.

[31] "*Energy Power Supply Association Seeks Federal Court Review of FERC's Demand Response Final Rules*," EPSA News Release, 23 Dec 2011.

[32] *EEI, California PUC File for Court Review of FERC DR Compensation Order*, 15 Feb 2012, Restructuring Today.

[33] See: *FERC Policy on Demand Response and Order 719*, Jason R. Salmi Klotz, GridInterop 2009. http://www.gridwiseac.org/pdfs/forum_papers09/klotz.pdf. Klotz recognized that FERC was developing a wholesale demand-response market that operates in parallel with retail demand-response programs. He was critical of how FERC was approaching the effort, but not necessarily of FERC's intent.

is given to the end-use consumer. The needs of the supplier are what determine the "response" required on the demand side of the transaction.

The utility use of demand response as a load management tool under state regulatory authority will not disappear. But with FERC Orders 719 and 745, the value of shedding electricity loads moves to a whole new realm. As just one example, consider "economic demand response." Economic demand response involves curtailing load when the wholesale price makes it worthwhile for the participant to avoid using electricity, rather than consuming it. The amount a demand-response program participant can earn by curtailing electricity use is determined by the threshold price chosen by the participant, times the number of hours set by the market. To illustrate, assume a business or operator who manages the use of electricity in New York City selected a threshold of $74 per megawatt hour (MWH) and then agreed to participate in the "day-ahead demand-response" program managed by the New York ISO, in which a business or operator agrees to curtail load "tomorrow." In 2011, the participant would have been called upon to avoid electricity use during 945 h, and he or she would have earned $182,000. Prior to Order 745, the operator would have earned about half that amount.[34]

If FERC's Orders continue to be upheld, it will mean demand response will have the same value as generation, an idea that the renowned economist Alfred Kahn strongly endorsed as the Order was being developed.[35] Judging from the progress with ISOs and RTOs filing tariffs that are compliant with the FERC Orders, it appears that about 75% of the electricity generated in the organized wholesale markets overseen by FERC will be open to competition from demand-response resources, or about one-half the country's electricity, despite the controversy and pushback from some quarters.[36]

Furthermore, depending on the shape of the final rules, a business with a solar rooftop system and a storage battery may be able to use that energy during high peak demand times, reduce its load on the grid and get compensated as a demand-response resource at the full wholesale price of generation. Small, distributed generation systems, like a micro grid at a shopping mall or on a military base, will begin to have value in energy markets under Order 745. Electric vehicles, batteries, and energy storage will become even more relevant in the mix of electricity resources.[37]

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[34] Example provided in email by Howard Feibus, with Innoventive Power, 16 Apr 2012.

[35] *Renowned Regulatory Economist Supports Federal Energy Regulatory Commission Proposal for Demand Response Parity*, 30 Aug 2011, NERA Economic Consulting news release. See: http://www.nera.com/nera-files/FERC_Reply_Comments_Kahn_08.30.10.pdf.

[36] See for example: Whieldon, Esther, "On Order 745 proposals, SPP sent back to drawing board, ISO-NE told tweaks needed." *Inside F.E.R.C.*, 23 Jan 2012. Factiva. 19 Mar 2012; Whieldon, Esther, "Comments on ISOs' demand response plans target cost allocation, measurement." *Inside F.E.R.C.*, 22 Aug 2011. Factiva. 19 Mar 2012; Whieldon, Esther, "Some RTOs, ISOs tweak tariffs to comply with FERC's new demand response rule." *Inside F.E.R.C.*, 1 Aug 2011. Factiva. 19 Mar 2012.

[37] See blog post by Katherine Hamilton, director of the clean energy practice at Quinn Gillespie & Associates: https://idc-insights-community.com/energy/smart-grid/ferc-order-745-and-clean-tech-really-this-is-not-b?author=khamilton6.

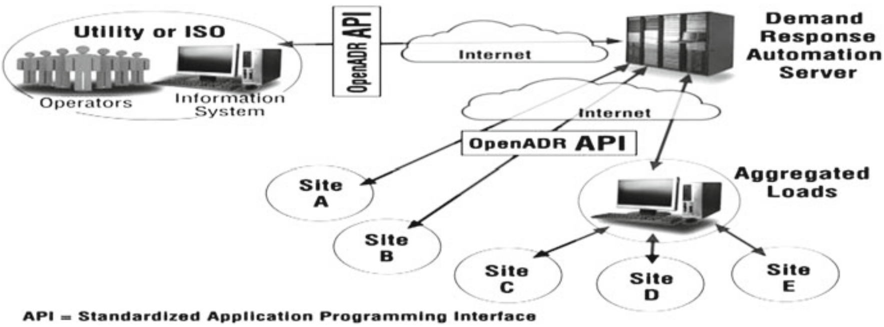

Fig. 11.1 OpenADR communication architecture (*Smart Grid Standards and Systems Interoperability: A Precedent with OpenADR*, Girish Ghatikar and Rolf Bienert, Lawrence Berkeley National Laboratory, The OpenADR Alliance, Dec 2011)

Advances in broadband wireless and wireline communications and cloud computing in the last decade, coupled with a machine-to-machine communications standard called OpenADR, are what make it possible for end-users to transact directly with wholesale electricity markets.[38] The technological key is the ability for servers and devices to communicate with each other quickly and efficiently as is illustrated in Fig. 11.1. In fact, at least one demand-response firm has incorporated the acronym for Network Operations Center into its name: "EnerNOC." The economic or market triggers are Orders 719 and 745, which put load reduction and power generation on equal footing.

Order 745 can be expected to accelerate the development and adoption of smart home energy management solutions, without waiting for a utility smart meter to be deployed. A smart meter is needed to improve the delivery of retail service and to communicate retail price changes; it is not necessary for wholesale transactions. Certainly, a smart meter can be used to help consummate a wholesale transaction, but other devices like home gateways also can accurately measure and document reductions in a building's electricity use. A single household or small business may not be able to participate as a demand-response service provider in wholesale electricity markets. But with the aid of a "curtailment service provider," the load of a thousand households or a hundred small businesses can be effectively aggregated with the use of cloud computing and broadband wireless or wireline communications in order to "generate" negawatts that can be bid into wholesale markets.[39]

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[38] *Smart Grid Standards and Systems Interoperability: A Precedent with OpenADR*, Girish Ghatikar and Rolf Bienert, Lawrence Berkeley National Laboratory, The OpenADR Alliance, Dec 2011.

[39] FERC does recognize that there may be instances when the laws or regulations of a relevant electric retail regulatory authority do not permit a retail customer to participate in an "Aggregated Retail Customer" Demand-Response program. See, for instance, FERC's decision affirming Order 719, issued on 16 July 2009, after a rehearing proceeding. http://www.ferc.gov/whats-new/comm-meet/2009/071609/E-1.pdf.

Advances in cloud computing and machine-to-machine communications already are being used by start-up firms like Nest[40] and EcoFactor to provide smart thermostat solutions on a subscription basis to individual homeowners.[41] EcoFactor, for instance, remotely manages a home's digitally connected thermostat from its data center, tweaking the settings throughout the day in a way that reduces energy waste while keeping the temperature comfortable. Through sophisticated algorithms that take into account outside temperatures, the physical makeup of the house, and input from the owner, an EcoFactor thermostat can usually cut energy consumption while maintaining comfort levels for the residents. Once these firms gain a critical mass of subscribers in a town or neighborhood, the ability to bid demand-response services into the wholesale market will open a new revenue stream for them.

Similarly, firms providing whole-house energy management solutions will have a new way to monetize their investments by expanding into the role of a curtailment service provider that is a demand-response resource to the wholesale electricity markets. More than 46% of U.S. households already have installed a home area network as a result of broadband connectivity.[42] Home area network adoption has been driven primarily by the desire to share entertainment-related content between devices, to connect multiple devices to the Internet and to connect from anywhere in the home, and to increase the productive use of things like home printers.[43] By adding a bit of software and hardware to these home networks, firms like Comcast and Verizon are extending them to connect with sensors on outlets, switches, or electrical wires and with appliances and heating and cooling systems to enable home monitoring and energy management services that also are connected to cloud-based data centers. These whole-house solution providers will be able to aggregate loads into a demand-response resource that can be bid into wholesale electricity markets, the same as can be done by smart thermostat companies.

Firms like Comverge,[44] Consert,[45] EnerNOC,[46] Innoventive Power,[47] and Viridity[48] that already provide demand-response services and/or smart building solutions to commercial and industrial customers will almost certainly take advantage of Order 745 to bring additional strength to the value propositions they offer. And they will be joined by entrants attracted by the new revenue opportunities.

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[40] http://www.nest.com/.

[41] http://www.ecofactor.com/for_homeowners.php.

[42] *The State of Consumers and Technology Benchmark 2010, US*, Sept 2010, Forrester Research, Inc.

[43] *Connected Home: Global Outlook: 2009*, Parks Associates.

[44] http://www.comverge.com/.

[45] http://www.consert.com/.

[46] http://www.enernoc.com/.

[47] http://www.innoventivepower.com/.

[48] http://viridityenergy.com/.

Broadband and Information Technology: Providing a Platform for Energy Services Innovation

The Federal Communication Commission's National Broadband Plan, published in 2010, asserted that "broadband and advanced communications infrastructure will play an important role in achieving [the] national goals of energy independence and efficiency."[49] The plan envisioned two ways in which this would happen:

- First, commercial service providers could become vendors to utilities and deploy the communications and control networks needed to make operation of the power lines that deliver electrons more efficient and nimble.
- Second, commercial broadband providers would "provide a platform for innovation in smart homes and buildings that will enable and encourage the more efficient use of electricity by customers."[50]

Much has been written and discussed with regard to the first question of whether, when, and how electric utilities should enlist the aid of commercial service providers as they go about the project of modernizing the grid.[51] At issue are the sophisticated industrial control systems needed to enable operators to spot and avoid potential outages before they happen, more effectively address rapid fluctuations in wind and solar generation, and implement new pricing structures and peak-load shaving programs that reduce pressure to invest in costly new generation. Factors to consider in the deployment of a hi-tech industrial control system that makes the grid "smart" include security, reliability, and cost. Some utilities have chosen to build and own these control networks themselves. Others have chosen to buy solutions from commercial wireless and broadband providers, and some utilities have taken a hybrid approach and are doing both. Which approach is chosen depends upon the particular requirements and circumstances of any given utility.

The second question, however, is ultimately the more interesting one: how can the commercial broadband applications and services industry provide a "platform" for innovation and the more efficient use of electricity?

With Order 745 the way forward now is clearer: investments in energy efficiency offer a way to create assets that add value and generate revenue, rather than just a way to reduce or control costs. With the application of machine-to-machine communications and cloud computing to the challenge of managing end-use electricity loads, these loads become an asset that can be monetized.

[49] *National Broadband Plan,* Chapter 12, p 247.

[50] Ibid, p 247.

[51] *A Study of Utility Communications Needs: Key Factors That Impact Utility Communications Network,* Utilities Telecom Council, Sept 2010.

The ability to control and reduce electricity loads nearly instantaneously, on command, turns load reduction into an asset that competes directly with the generation of electricity. As the costs of new generation increase, whether due to EPA Clean Air regulations or because of the increasing marginal costs of drilling for the next barrel of oil, the value created by effectively managing loads increases as well.

The measurement and control of load that is enabled by ICT means building- and home-energy management systems can be treated as improvements that increase the value of a piece of real estate and which can be monetized in mortgage transactions. ICT-enabled control of load and the ability to use negawatts to compete with megawatts opens the door wider to the practice of performance contracting, another way to monetize load as an asset.

Conclusion

As companies pursue energy efficiency as a promising new market and not just something firms do to control their costs, the prospect for innovation and substantial improvements in our economy's energy efficiency greatly improves. As energy efficiency evolves to compete directly as an alternative to finding and developing new energy resources, then a greater emphasis on the more efficient use of energy can indeed be expected to be an important feature of a robust future U.S. economy.