Organisation de Coopération et de Développement Économiques
Organisation for Economic Co-operation and Development

11-Feb-2010

English - Or. English

DIRECTORATE FOR FINANCIAL AND ENTERPRISE AFFAIRS
COMPETITION COMMITTEE

DAF/COMP/WP2/WD(2010)9
For Official Use

Working Party No. 2 on Competition and Regulation

ELECTRICITY: RENEWABLES AND SMART GRIDS

-- United States --

15 February 2010

The attached document is submitted to Working Party No. 2 of the Competition Committee FOR DISCUSSION under item III of the agenda at its forthcoming meeting on 15 February 2010.

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JT03278516

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1. Introduction

1. Smart Grid technologies and advances in renewable electricity generation have the capacity to reshape the United States markets for electric power. The U.S. response to the global economic crisis includes a significant investment in these new technologies,[1] promising to accelerate the pace of these already burgeoning innovations. Such technological leaps have the potential to alter not only the business models of existing firms, but also to enable entry by new firms -- and new *kinds* of firms -- previously unknown in the industry.

2. This paper discusses how these new technologies might change the competitive status quo for American consumers and some of the competition policy issues that this new environment can raise. These include a variety of steps that firms with market power might take to try to limit or delay new entry or the possible dislocations that can arise from wide-scale deployment of the newest technology. In this environment, both antitrust enforcers and regulators need to be mindful of the incentives of incumbent firms. If experience with other industries that underwent similar transformations is a guide, competition agencies should be prepared to take appropriate enforcement action to guard against anticompetitive practices that thwart new entry. Through competition advocacy, competition agencies may also be able to assist regulators in the design of policies that will maximize the competitive potential of smart grid technologies to benefit consumers.

3. This paper proceeds in three parts. First, it explains what is meant by smart grid technology and discusses how smart grid technology and renewable resources might alter the market for electric power. Second, it identifies U.S. programs to support smart grid technology and renewable energy, including provisions from the American Recovery and Reinvestment Act of 2009.[2] Third, it discusses the role antitrust enforcement might play in this context and suggests opportunities for competition advocacy by competition agencies. The paper concludes by identifying areas that may benefit from further research.

2. Understanding the smart grid and its effects

4. Understanding the competitive concerns that could accompany a transition to smart grid technology requires an understanding of what is meant by "smart grid" and how it interacts with the use of renewable generation resources. In general, the term "smart grid" refers to the layering of a telecommunications system on top of the existing power grid. This layering of communications would not only improve operations of the existing network, but also likely would lead to the development of sensors, data measurement tools, control systems, and other devices that have the potential to radically change the competitive landscape of electricity markets. In particular, smart grid technology makes use of two-way information sharing between system administrators and various generation, transmission, and distribution sites throughout the system.[3] In the words of the Electric Power Research Initiative, a smart grid is the "overlaying of a unified communications and control system on the existing power delivery infrastructure to provide the right information to the right entity . . . at the right time to take the right action."[4] As a result, "it is a system that optimizes power supply and delivery, minimizes losses, is self-healing, and enables next-generation energy efficiency and demand response applications."[5]

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1 *See* http://www.oe.energy.gov/american_recovery_reinvestment_act.htm.

2 American Recovery and Reinvestment Act of 2009, Pub. L. 111-5 (2009).

3 *See* ELECTRIC POWER RESEARCH INITIATIVE, THE GREEN GRID 1-1 (2008).

4 *Id.*

5 *Id.*

5. To simplify matters, smart grid technology can be divided into two broad categories. First, it can refer to the use of advanced metering and other technological measures to more accurately monitor, respond to, and affect customer usage. Because these technologies typically require installations at the user end of the wire -- that is, on the lower-voltage, final distribution portion of the supply chain -- regulatory requirements in this realm in the United States are typically subject to the jurisdiction of the several states in the United States.[6] Second, the smart grid concept can refer to infrastructure modernization initiatives that are designed to improve the information sharing capabilities and responsiveness of the broader transmission (or even distribution) systems. Because these networks (particularly, the transmission ones) are higher-voltage, interstate systems, they are usually subject to the jurisdiction of the Federal Energy Regulatory Commission (FERC).[7] This paper will discuss each category of smart grid technology in turn.

2.1 Advanced metering, demand response, and distributed generation

6. One major set of smart grid initiatives involves the installation of smart meters at the end of the distribution system. Large-scale industrial customers have begun using such meters, seeking to identify strategies for conserving their electricity usage and saving costs in the process. Such meters can be used to obtain real-time price information from utilities and to allow utilities to get specific information about how much electricity particular consumers are using rather than just the amount of general demand. As these technologies become more sophisticated, they can be connected to major home and industrial appliances, allowing them to be programmed for use only when electricity rates are low or even allowing utilities to control them -- for a fee or in exchange for reduced electricity rates -- during periods when demand is extremely high relative to supply. A few utilities currently use meters that are “smart enough” to allow some of their customers to take advantage of strategies like time-of-day pricing or other forms of more nuanced measurement than a mere tally of the number of kilowatt hours used each month. But increasing the penetration of the most innovative and “smartest” meters, with their two-way, digital communications capability, would enable a much broader set of programs that might vastly alter the shape of electricity markets.

7. The principal impact of smart meters is to better enable the set of changes collectively known as “demand response.” Because there is no efficient way as yet to store large amounts of electricity, generation must constantly be matched with consumption. At the same time, short run demand for electricity is extremely inelastic. Consumers may not be aware of when electricity is most expensive and when it is cheapest; at least in the short run, they therefore may use all the electricity necessary to meet their preferences. This means that utilities must constantly monitor demand and must have generating capacity ready for very large peaks -- sometimes called “needle peaks” -- even if they occur infrequently.[8] This “peaking” generation is typically older, costlier, and more harmful to the environment. Indeed, a significant portion of electricity costs comes from maintaining rarely used excess capacity for the purpose of meeting peaks that are few and far between.

8. With respect to smart meters, the use of “demand response” can take at least four important forms. First, simply exposing end users to more real-time prices often will be sufficient to cause them to refrain from using high-energy appliances when prices are high, deferring their use to less costly times of

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6 FERC also plays a role in this area pursuant to the Energy Independence and Security Act of 2007, 42 U.S.C. §§ 17001-17386 (2007).

7 The states are primarily responsible for many siting issues.

8 Approximately 10% of California’s generation capacity is used less than .65% of the time annually. *See* ELECTRICITY ADVISORY COMMITTEE, SMART GRID: ENABLER OF THE NEW ENERGY ECONOMY 7 (2008).

the day.[9] Because smart meters with digital displays or connections to cellular phones and home computers can communicate this kind of real-time pricing information to customers, they have the capacity to introduce significantly more short-run elasticity into the demand for electric power. In the longer run, smart metering technology could lead to increases in demand elasticity as consumers invest in technologies that preserve convenience but shift consumption to off-peak demand periods. For example, smart meters could even be linked to appliances that would tailor their own peak usage to electricity costs -- say, a dryer that is told when electric power is cheap and is turned on automatically at that time. Similarly, with efficient price signals, consumers may decide to invest in distributed generation that can further increase demand response by such consumers.

9. Second, many studies indicate that simply exposing consumers to information about their energy usage is sufficient to cause them to consume less power overall.[10] Reflecting this development, a number of diverse players, including information companies like Google, are interested in assisting consumers by tracking their electricity usage and enabling them to better manage their overall demand.[11] Third, smart meters that are connected to appliances could be linked to the utility company, which could – for example, in exchange for discounted rates -- turn off certain non-essential devices to save power during peak demand periods and thereby avoid the possibility of "brownouts."[12] Moreover, because utility control over demand during peaks is essentially a substitute for installing new peaking generation (or new transmission), firms capable of pooling this kind of demand response could bid it into reserve capacity markets, provide a form of competition (*i.e.*, an alternative to new generation and/or transmission), and reduce the need to maintain environmentally and economically costly generation reserves. Finally, smart meters that operate in conjunction with recharging systems for electric vehicles of the future could help channel this new demand into off-peak periods and potentially facilitate access to the energy stored in vehicle batteries for system reserves (provided, of course, that such technologies continue to develop and are practical to implement).

10. In sum, demand response strategies that use smart meters (or even "smart enough" meters) have the potential to improve the functioning of competitive electricity markets. As FERC recently stated, demand response "can provide competitive pressure to reduce wholesale electric prices, increase awareness of energy usage, provide for more efficient operation of markets, mitigate market power, enhance reliability, and, in combination with certain new technologies, support the use of renewable energy resources and distributed generation."[13]

11. Smart grids, through both demand response and other capabilities, also have the capacity to facilitate better integration of renewable energy sources and other new generation technologies into the

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9 *See, e.g.*, PACIFIC NORTHWEST NATIONAL LABORATORY, PACIFIC NORTHWEST GRIDWISE TESTBED DEMONSTRATION PROJECTS (2007); *see also* DEMAND RESPONSE AND SMART GRID COALITION, TIME-BASED PRICING FOR RESIDENTIAL CUSTOMERS: QUESTIONS & ANSWERS (2007), *available at* http://www.smartgridnews.com/artman/uploads/1/Time-Based_Pricing_for_Residential_Customers.pdf.

10 Although there is significant research remaining to be done on the designs that best promote consumer awareness and reaction to price and usage information, diverse studies do indicate that consumers who receive information about high levels of consumption do choose to consume less energy. *See, e.g.*, CASS SUNSTEIN & RICHARD THALER, NUDGE 193-194 (2009) (describing Southern California Edison Ambient Orb project); http://sites.energetics.com/madri/pdfs/ChartwellHydroOneMonitoringProgram.pdf (describing Hydro One pilot program with PowerCost Monitor).

11 http://www.google.org/powermeter.

12 *See, e.g.*, Dan Charles, *Renewables Test IQ of Grid*, SCIENCE 172-175 (Apr. 2009).

13 FED. ENERGY REGULATORY COMM'N, THE STRATEGIC PLAN: FY 2009–2014, at 8 (2009), *available at* http://www.ferc.gov/about/strat-docs/FY-09-14-strat-plan-print.pdf.

system. The increasing reliance on renewable energy sources, such as wind and solar, introduces greater variability into the supply chain. This is because, unlike traditional fossil fuel generation, wind and solar generators cannot balance increased demand by burning more fuel, *i.e.,* their output is dependent on variable weather conditions.[14] Smart grids could potentially offset such variation with demand response or could allow system operators to balance them more rapidly with calls on less expensive reserve generators, making large-scale renewable generation both easier and more cost-effective.[15] The two-way communications capabilities of smart grid technology also facilitate competition in electricity generation by allowing for greater use of "distributed generation" and "distributed storage," where multiple, small-scale generation and storage sites – such as rooftop solar panels or plug-in hybrid vehicles -- can sell electricity back to the grid.[16] Significantly, this has the capacity to introduce an entirely new competitor into the market for electric generation -- namely, the consumer.

2.2 Infrastructure improvement

12. The other important segment of smart grid initiatives is the modernization and expansion of the existing transmission system. This interstate system of long-distance, high-voltage wires is the principal system to which most large-scale generation resources (both traditional and renewable) are connected. It is often analogized to the interstate highway system -- a series of higher-volume, longer-distance pathways carrying traffic to lower-volume, local streets -- except that the engineering complexities of electricity require every "highway" in the system to be kept in constant balance. Notably, improving the communications network along the grid allows it to balance itself automatically – and much more quickly -- by enabling the system to carry much less reserve capacity to balance unexpected drops or surges in supply. It also allows the grid to "heal" itself by automatically detecting failures and thus allows the grid to respond better to emergencies. Significantly, smart grid technology offers the opportunity to address the special demands placed on the system by some forms of renewable resources whose output can be more variable.[17] In general, a smarter transmission system will be able to get much greater use out of existing generation and transmission capacity, making the operation and continued maintenance of the grid less costly.

3. U.S. Smart Grid and Renewable Investment

13. As part of the response to the global financial crisis, the United States invested in infrastructure spending in the American Recovery and Reinvestment Act (ARRA).[18] Notably, the Act allocated $16.8 billion for efficiency and renewable programs and another $4.5 for grid modernization.[19] In addition to these investments, the government has established various programs to foster progress in these areas. These include, for example, the Federal Smart Grid Task Force established under Title XIII of the Energy

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14 *See* Charles, *supra* note 9, at 172-175.

15 *Id.*; *see also Trade Winds*, THE ECONOMIST (Jun. 21, 2008) at 6-12.

16 *See, e.g.*, Dep't of Energy, The Potential Benefits of Distributed Generation and the Rate-Related Issues That May Impede Its Expansion at 6, *available at http://www.oe.energy.gov/DocumentsandMedia/1817_Report_-final.pdf* (explaining that the viability of distributed generation depends on state implementation of "provisions that promote smart metering, time-based rates . . . demand response, net metering, and fossil fuel generation efficiency.").

17 *See* David Talbot, *Lifeline for Renewable Power*, TECH. REV. (Jan./Feb. 2009) at 41-47, *available at* http://www.technologyreview.com/energy/21747/ (describing German experience and major challenges facing the U.S. grid).

18 Pub.L. 111-5, Feb. 17, 2009, 123 Stat. 115 (2009).

19 *See* http://www.energy.gov/recovery.htm.

Independence and Security Act of 2007,[20] and a number of efforts by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy.[21] These programs create grant and loan opportunities for businesses interested in investing in smart grid and renewable technologies. These government incentives – which represent environmental, security, and economic priorities – may foster even faster growth in these already burgeoning sectors.[22]

14. In 2008, the Department of Energy released an exhaustive report chronicling the various policy steps that state and federal entities had taken to encourage the growth of smart grid technology.[23] For present purposes, it is sufficient to say that federal programs range from requiring deployment of advanced metering in federal buildings[24] to requirements for planning, reports, or smart grid demonstration projects.[25] Meanwhile, in conjunction with federal direction, some states have enacted standards requiring time-based metering,[26] and the National Institute of Standards and Technology is in the process of developing standards for interoperability of smart grid technologies.[27] Together with the recent financial appropriations, these and other programs help to structure and create the incentives for major investment in smart grid technology.

15. On the renewables side, many U.S. states have recently enacted guidelines that require utilities to provide a fixed percentage of their total load from renewable resources (generally from 10-30 percent).[28] The U.S. Congress is considering proposals for a similar federal requirement.[29] In many of these "RPS programs," states provide for renewable energy credits or certificates called "RECs," which are not energy purchases as such, but rather "tradable commodity certificate[s] representing the environmental aspect of electricity generated by renewable energy."[30] Due in significant part to RPS programs, the development of renewable sources of energy generation are growing rapidly with, for example, wind-powered generation constituting 42 percent of all new generation built in the United States in 2008 (according to the American Wind Energy Association).[31] As noted above, the development of smart grid technology can operate in tandem with an increased reliance on renewable energy sources and facilitate its use.

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20 Pub.L. 110-140, 121 Stat. 1492 (2007).

21 *See* http://www.eere.energy.gov.htm.

22 *See* FEDERAL ENERGY REGULATORY COMMISSION, ASSESSMENT OF DEMAND RESPONSE AND ADVANCED METERING (2008); *see also* http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=12209 (noting major increases in utility investment in smart grid technology).

23 *See* NATIONAL COUNCIL ON ELECTRICITY POLICY, DEMAND RESPONSE AND SMART METERING POLICY ACTIONS SINCE THE ENERGY POLICY ACT OF 2005: A SUMMARY FOR STATE OFFICIALS (2008).

24 *Id.* at 3.

25 *Id.* at 4-10.

26 *Id.*

27 *Id.* at 5-6.

28 29 states and the District of Columbia have set RPS targets; another 5 states have set non-binding targets. *See* RYAN WISER & GALEN BARBOSE, STATE OF THE STATES: UPDATE ON RPS POLICIES AND PROGRESS 6 (Nov. 18, 2009).

29 *See* American Clean Energy Leadership Act of 2009, S. 1462, 111th Cong. (2009); American Clean Energy and Security Act of 2009, H.R. 2454, 111th Cong. (2009).

30 SECTION OF ANTITRUST LAW, AM. BAR ASS'N, ENERGY ANTITRUST HANDBOOK 251 (2d ed. 2009).

31 AMERICAN WIND ENERGY ASSOCIATION, WINDPOWER OUTLOOK 2009, at 1 (2009), *available at* http://awea.org/pubs/documents/outlook_2009.pdf.

16. Moreover, as described above, the advent of large-scale, distant, renewable generation itself creates pressure for grid modernization. This is because a more modern grid would be able to compensate for these variable resources by balancing out rapid drops in generation with calls on other resources (including demand response), rather than by requiring the wind farm or solar plant to have its own conventional fuel generation (or energy storage devices) to offset such dips.[32] Thus, the policy initiatives in favor of renewables and smart grid technology work together to create significant incentives for modernizing and transforming the business of electricity generation, transmission, and delivery.

4. Antitrust enforcement and competition advocacy

17. The incentives that face today's market participants are complex and may vary widely depending on local market characteristics. These characteristics include the relevant regulatory framework, the availability of installed generation capacity, the integration of generators and distributors, the types of fuels and generators available, and the shape and frequency of load peaks. Indeed, it is impossible to determine in the abstract whether incumbent firms will be better or worse off in the wake of the deployment of smart grid technology. It is quite possible, moreover, that different firms will react to incentives facing them in different ways, employing a variety of different strategies. Many utilities, recognizing that smart grid technologies can provide significant cost savings, already are experimenting with smart metering initiatives, time-of-day and real-time pricing, and other programs using demand management to reduce costly peaks. On the other hand, because of the potential of this new technology to disrupt their existing business models, some incumbent firms may resist the deployment of this technology. Given the potential significance of this technology, policymakers are likely to be interested in evaluating the reasons for resistance to its adoption.

4.1 Antitrust experience in electricity and related markets

18. Appreciation of the potential role of antitrust *vis-à-vis* smart grid technology can be aided by an evaluation of how the U.S. antitrust agencies have addressed analogous markets. Notably, antitrust enforcement played an important role in ensuring open access to competing electricity providers in the past. Consider, for example, the seminal case *Otter Tail Power Company v. United States*.[33] In that case, the Supreme Court held that Otter Tail had violated the Sherman Act by refusing to sell wholesale power or to wheel power from another source to a municipal power system that sought to compete with Otter Tail in the retail electricity market. In particular, the Court concluded that Otter Tail had monopoly power in retail sales of electric power in its service area and that it had used its dominance in transmission to foreclose potential competition for retail sales. Although the FERC has since taken the lead in ensuring open access to facilities by regulation,[34] the courts have historically played an important role in enforcing antitrust claims based on a denial of access.[35] Although each market is structured differently – both within and outside the United States – both regulators and enforcers should be aware that incumbent electricity firms may be able to impede entry of not only generation sources but also of new technologies that have the potential to facilitate new forms of competition. To address this possibility, competition authorities

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32 *Id.*

33 *Otter Tail Power Company v. United States*, 410 U.S. 366 (1973).

34 *See* FERC Order No. 888, Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities; Recovery of Stranded Costs by Public Utilities and Transmitting Utilities, 61 Fed. Reg. 21,540 (May 10, 1996).

35 *See, e.g.*, City of Vernon v. So. California Edison Co., 955 F.2d 1361 (9th Cir. 1992), *cert. denied*, 506 U.S. 908 (1992); City of Anaheim v. So. California Edison Co., 955 F.2d 1373 (9th Cir. 1992), *cert. denied*, 506 U.S. 908 (1992); City of Malden v. Union Elec. Co., 887 F.2d 157 (8th Cir. 1989).

should evaluate whether such efforts reflect legitimate business purposes or an effort to exclude competition on the merits.

19. The technological changes in the telecommunications industry and the landmark case of *U.S. v. AT&T* may also be relevant to the emerging technological developments in the smart grid environment.[36] In that case, the Justice Department focused on the efforts of AT&T to protect its legacy business model from would-be rivals in the equipment manufacturing and long distance markets. In both markets, AT&T used its control over the interface to the telephone network to forestall competition and the emergence of new technologies.[37] Without an antitrust remedy, AT&T's refusal to open its interfaces to new technologies produced by competitors would have slowed the deployment of new equipment, including modems. An incumbent's use of its control over existing networks and interfaces to exclude competitors is hardly unique to AT&T. Indeed, the DOJ's case against *Microsoft* involved similar interoperability concerns.[38]

20. The DOJ and FTC's experience with standard-setting bodies is also highly relevant in this context. As in the *Allied Tube* case, there is a risk in such technology-heavy markets that incumbents will try to influence the vote of a standards setting organization to ensure that rival technologies will be viewed as unsafe, suspect, or otherwise disfavored.[39] As the Supreme Court recognized, such standards can make all the difference in whether rivals will be able to compete with existing technology.[40] Going forward, standard setting will play a crucially important role in creating smart meters and smart devices that can successfully connect to each other and to the broader network.

21. In the smart grid context, government regulators will take the lead in cultivating and endorsing the relevant standards. Even so, experience teaches that this is a particularly important realm for antitrust and regulatory vigilance. Notably, standard setting organizations should insist on openness regarding existing intellectual property rights to prevent hold-up,[41] take care that the standards are not so onerous as to prevent entry, and seek to ensure that standardized technology is advanced enough to allow maximal use of expanding technological opportunities. Indeed, the U.S. Department of Commerce's National Institute of Standards and Technology (NIST) is already doing important work in this area.[42] Given their experience in this area, antitrust authorities can be particularly effective advocates in these endeavors.

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36 *United States v. AT&T Co.*, 552 F. Supp. 131, 224 (D.D.C. 1982), aff'd sub nom. *Maryland v. United States*, 460 U.S. 1001 (1983).

37 Philip J. Weiser, Deputy Assistant Attorney General, Antitrust Division, U.S. Department of Justice, INNOVATION, ENTREPRENEURSHIP AND THE INFORMATION AGE, Remarks as Prepared for Silicon Flatirons Center Digital Broadband Migration Conference: Examining the Internet's Ecosystem, University of Colorado at Boulder, January 31, 2010, *available at* http://www.justice.gov/atr/public/speeches/254806.htm.

38 *See United States v. Microsoft,* 84 F. Supp. 2d 9 (1999).

39 *Allied Tube & Conduit Corp. v. Indian Head, Inc.*, 486 U.S. 492 (1988); *see also* Philip J. Weiser, *Regulating Interoperability, available at* http://papers.ssrn.com/so13/papers.cfm13abstract_id=1344828.

40 *Id.*

41 Philip J. Weiser, *Making the World Safe for Standard Setting* (March 13, 2008), *available at* http://papers.ssrn.com/so13/papers.cfm?abstract_id=100342.

images/stories/file/iprstrust/Making%20the%20World%20Safe%20for%20Standard%20Setting.pdf. For an example of how standard setting processes can enable patent holders to engage in holdup-type behavior, *see Rambus Inc. v. Infineon Techs. AG*, 318 F.3d 1081, 1100-01 (Fed. Cir. 2003).

42 Under the Energy Independence and Security Act of 2007, NIST is assigned "primary responsibility to coordinate development of a framework that includes protocols and model standards for information

4.2 The role for competition advocacy

22. Competition agencies may have a similarly important role to play in the competition advocacy arena. In particular, in designing effective regulatory polices with respect to smart meters and demand response, there are a number of specific kinds of possible behavior to which regulators and antitrust enforcers should be sensitive. Incumbents may have much to lose from efficient demand response, and they may try to use regulatory actions to limit deployment of smart meters and residential-scale demand response by, for example:

- Resisting deployment of smart meter technology;
- Supporting deployment of less sophisticated, proprietary, or closed architecture equipment so that access to information is difficult and expensive;
- Supporting imposition of utility-type regulation on new entrants to raise their costs and discourage entry; and
- Supporting strict and inflexible interconnection criteria for variable resources, like rooftop solar.

23. Similarly, regulators and antitrust enforcers should be sensitive to the following types of behavior with respect to infrastructure modernization:

- Refusing to update grids, even when it makes economic sense to do so, in order to foreclose entry by renewable generation sources;
- Attempting to convince regulatory bodies to force inordinate costs for connection and modernization onto new entrants, including renewable generation; and
- Other attempts to raise costly barriers to entry for new generation (or limit it entirely), including attempts to foreclose renewable resources from capacity markets and attempts to impose excessive charges for backup power on customers with distributed generation.

24. To be sure, not every one of these types of actions is necessarily harmful to competition, unwarranted, or unjustified. There are undoubtedly substantial costs involved in the coming technological transition and incumbent firms may have legitimate concerns about whether the benefits of a transition to a new generation of technology outweigh the costs of that transition, particularly when environmental and other social costs have not fully been internalized in price. This question makes it all the more important for regulators to be able to carefully and intelligently evaluate the incentives of firms and consider the claims of those who comment on their proposals. Antitrust agencies may be particularly well-equipped to assist in this endeavor. Given their institutional expertise, antitrust enforcers can help highlight for regulators the positive dynamic effects of increased competition in the face of competing arguments about its ultimate economic impact.

4.3 Areas for further research

25. Because smart grid technology and widespread integration of renewable generation resources are both still nascent, much remains to be learned about optimal implementation, best industry practices, key

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management to achieve interoperability of Smart Grid devices and systems." 42 U.S.C. §1305 (2007). NIST has already published a framework and roadmap for smart grid interoperability standards, *available at* http://www.nist.gov/public_affairs/releases/smartgrid_interoperability_final.pdf.

regulatory issues, and the incentives of entrants and incumbents. This is itself an important point for enforcers and regulators: where the technology – and experience with it – is still developing, any governmental approach must be flexible and subject to revision so that it can accommodate creative and unexpected advances by consumers, producers, and new entrants. In other words, regulation should take a dynamic view of the market and endeavor to find approaches that facilitate technological change, experimentation, and the possibility of disruptive business models that defy the classic approaches of incumbents. As the technology evolves, the following issues merit further evaluation and study.

4.3.1 How smart is smart enough?

26. Many of the programs and initiatives described above might be capable of implementation with meters that are less advanced – and, perhaps, less costly – than the latest technology. It merits investigation whether there are less expensive alternatives that could provide nearly equal benefits. At the same time, existing firms may have incentives to deploy second-best technology that provides essential benefits to themselves without enabling entry by newer players. What appear to be the most essential technologies? Do existing firms have incentives to deploy them? Do others? Does the existing regulatory structure spread the costs of technological investment in ways that provide incentives for that investment when it is or could be socially beneficial? If not, what regulatory design would do so? What are the experiences of other countries in these areas?

4.3.2 How will consumers respond?

27. Energy markets, like many others, implicate questions of human behavior. The issue is not only whether certain programs create incentives for consumers to conserve energy and save money, but also whether those incentives are salient so that consumers actually act on them. Which technologies best enable consumer response? How have consumers actually responded to test and pilot programs in various jurisdictions? Do programs that enable utilities to control home appliances work best because they are automatic or do consumers find this option unpalatable? What kind of grid architecture will best enable consumers to find and make the choices that they would themselves regard as welfare maximizing?

4.3.3 What investment structures work best?

28. Many of the possible benefits of smart grid technology lie with consumers, but consumers may be unwilling or unable to make large, up-front investments to realize these benefits, especially where the benefits will come only if others do the same. Are consumers likely to invest in smart grid technologies? Under what conditions? Are incumbents or entrants better poised to make initial investments? What regulatory changes would be necessary to provide the right incentives for initial investment? To the extent that smart grid technologies facilitate non-economic goals such as environmental conservation or electric reliability, should governments be expected to invest? What have been the results where governments have done so?

5. Conclusion

29. Smart grid technology continues to develop and is only in its incipient stages. Utility regulators still have a lot to learn about this technology, how it will work, and what regulatory strategies are optimal in this area. As regulators proceed to encourage the development and adoption of this technology, it is important that they are mindful of the relevant competition policy issues that it raises. Similarly, for antitrust enforcers, the development of new technologies and the potential blocking position of incumbent monopolists—as evidenced in the *Otter Tail* and *AT&T* cases -- raise concerns that merit attention as well.