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Is There a Case for Broadband Utility Communications Networks? Valuing and Pricing Incremental Communications Capacity on Electric Utility Smart Grid Networks

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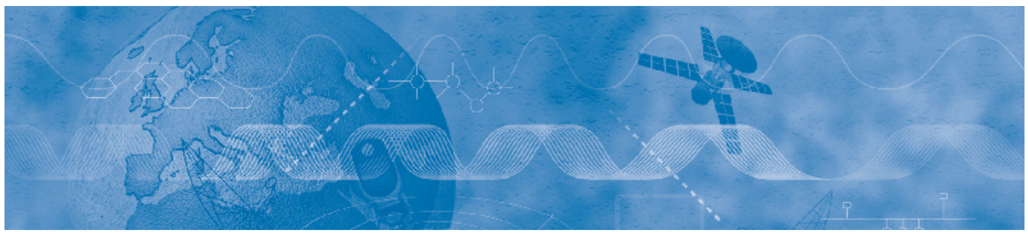

Abstract

Smart Grid and broadband deployment have become national priorities—the American Recovery and Reinvestment Act of 2009 includes a combined total of about $11 billion to fund Smart Grid and broadband projects.[2] In this paper, we explain how the two technologies complement each other and how to assess the incremental costs and benefits of adding Internet access service to utility broadband communications systems. We provide an economic framework for analyzing such investments and highlight regulatory policies that can be used to maximize their net benefits. We explain that: use of broadband communications for Smart Grid networks is likely to generate greater benefits than systems that rely on narrow band communications; utilities can take advantage of economies of scope by using their broadband systems to bring high-speed Internet access to more consumers; regulators can promote more rapid and widespread deployment of broadband-based Smart Grid service and Internet access by allowing integrated provision of these technologies, rather than requiring electric utilities to set up separate subsidiaries; and, regulators should use economically appropriate pricing and (incremental) cost standards to address concerns about cross subsidies.

Introduction

Smart Grid and Automated Metering Infrastructure (AMI) technologies are increasingly seen as a critical component to improving efficiency (e.g., reducing energy use, operating costs, and demand for peaking power plants), increasing the reliability of the electric power delivery system, and improving customer service. These technologies rely on two-way communications systems—either lower capacity/speed narrowband options such as fixed wireless radio frequency (RF) or power line carrier (PLC), or broadband options such as broadband over power lines (BPL) or wireless networks. In the United States, narrowband RF and PLC networks are currently the first and second most common communication systems for AMI. Broadband use is likely to expand because it enables Smart Grid/AMI systems to provide more sophisticated conservation and load management (C&LM) programs, distribution system control, and support for distributed generation technologies.[3] These advantages promise to increase reliability and efficiency, and reduce investment and operating costs.

Utility broadband may also increase competition and availability of broadband Internet services, especially in less densely populated areas.

In this context, it is important to correctly assess the incremental costs/benefits of broadband solutions instead of narrowband communications options. In this paper, we focus on the potential incremental gains from employing broadband as opposed to narrow-band communications technologies. We discuss valuing the incremental costs and benefits of broadband technologies, and the need to consider potential technological innovation in the investment decision. We also highlight the prudence and pricing issues associated with shared use of broadband networks. "Shared use" refers to some combination of Smart Grid/AMI applications and sale of high-speed Internet access service, and/or network capacity to third party energy service providers.

The fundamental economic question from both a financial investment and regulatory prudence perspective is whether the expected incremental benefits (cost savings plus added revenue/value) from using broadband rather than narrow band are large enough to cover the expected incremental costs. If the answer to this question is affirmative and if the project has a positive net present value, then employing increased bandwidth is both prudent and does not result in cross subsidization. The same analytic framework is appropriate for the two types of shared use referenced above. However, use of broadband for communications purposes raises potential competitive issues because other (telecommunications) firms provide or can provide high-speed Internet access.

From a public policy perspective, regulators may find the value of positive externalities associated with broadband—i.e., net gains that would not accrue to the utility—large enough to offset any negative expected financial returns. For example, regulators may wish to reduce pollution, promote competition in distributed generation and energy services, or promote broadband communications in underserved areas. To do so they should consider: allowing broadband investment to be added to the rate base, even if the *utility's own* direct known economic benefits do not exceed the *utility's* incremental costs; and allowing the utility to recover the associated costs, including a reasonable opportunity to recover an appropriate return on and of the capital. In view of the uncertainties and the potential for large economies of scope from joint use of the AMI/Smart Grid communications infrastructure, policymakers should consider allowing electric utilities to own and operate broadband. Given appropriate pricing, cost accounting, and revenue recognition policies, joint use of the communication system is likely to promote more efficient electricity production and use and can advance broadband Internet access availability and competition.

Background

In the last decade, electric utilities have evaluated communication services as a means to diversify and grow earnings by utilizing the utility's "last-mile" wires into consumers' homes. In general, the efforts of investor-owned utilities to diversify into communication services were not very successful. However, some publicly owned utilities have successfully set up broadband communication services in conjunction with utility use. Some public and private utility efforts to gain legal/regulatory approval to offer broadband services have been challenged by potential competitors. Consequently, significant competitive and economic issues have arisen in conjunction with utilities assessing whether to implement advanced metering and communications systems and whether to invest in higher bandwidth systems rather than the minimum required network.

Broadband enabled Smart Grid/AMI systems tend to be in an experimental phase. BPL was identified as one of the promising technologies to deliver these services.[4] For example, Xcel Energy has begun constructing an extensive, experimental smart grid project for Boulder, Colorado.[5] "Nearly 90 percent of the city will be connected with BPL; however, Xcel Energy will also test wireless capabilities…."[6] As of year-end 2007, the United Power Line Council "BPL Deployment Map" showed 10 commercial BPL deployments and 24 BPL trials in the US.[7] Utilities are also using advanced wireless technologies—e.g., Hydro One is deploying a high-speed (250 Kbps) wireless mesh as part of its extensive AMI system,[8] and Texas New Mexico Power (TNMP) is using AT&T's digital wireless cellular network to connect to 10,000 residential smart meters.

Thus far, use of utility broadband for Internet access appears to be limited.[9] IBM, an early BPL proponent, recently argued that retail Internet access service is best suited to rural areas where utilities would face little competition because cable modem and DSL would cost too much to build.[10] However, BPL Internet access could eventually find a broader market if BPL providers can close the gap in communications speed and/or lower their costs. This could occur if BPL finds greater use in AMI/Smart Grid networks.[11] In any case, a utility considering the sale of Internet services to its customers needs to keep in mind that a number of these ventures were not successful and in some cases shareholders were punished for ill-advised or unsuccessful ventures.[12] Thus, utilities are cautious about moving beyond their core business. This is evidenced by the recent Oncor purchase of Current Group's BPL network and Oncor's subsequent decision to use the network for utility purposes only—i.e., not to sell Internet access. In addition to the business risk, utilities also have to evaluate the regulatory risks associated with the allocation of costs and revenues and whether there is any incentive to shareholders. We address these issues below.

Justification of Incremental Smart Grid Communications Investment

It is often noted that the current vintage of distribution SCADA, meter reading, outage management services, and load-control devices for demand-side management applications do not *require* broadband technology. However, forward-looking applications of Smart Grid technologies (such as energy storage, plug-in hybrids, distributed generation, and home automation) will require greater degrees of integration, and hence bandwidth. Moreover, Smart Grid/AMI deployments require a significant capital expenditure,[13] and may involve significant operating costs. Thus, the key issue is whether the net benefits from using broadband for Smart Grid/AMI applications (possibly in combination with provision of Internet access) are sufficient to justify the added costs. The potential incremental gains from broadband should be incorporated into the assessment.
Assessing whether Smart Grid/AMI (or other) capital investments are prudent and should be included in rate bases is generally done by comparing the expected net present value of benefits from an investment (cost savings plus incremental service revenues) with the expected net present value of the associated costs. Some of the benefits commonly quantified—e.g., reduced meter reading costs and reduced costs for services such as connection/disconnection—are relatively easy to measure. Other more difficult to measure benefits that may be enhanced by using broadband enabled Smart Grid/AMI networks should also be evaluated. These include:

- Power cost savings attributed to the ability to offer rates with better price signals
- Increased penetration of DSM programs enabled by more sophisticated control strategies
- Increased customer participation in innovative rates and C&LM programs as a result of providing customers with interactive controls and home energy automation tools
- The potential to avoid or delay future distribution system investments through targeted programs to reduce demand at critical times
- Use of condition-based maintenance to lower costs, increase reliability, and improve service restoration times
- The ability to reconfigure the system in real time, manage voltage and reactive power, and better utilize existing capacity of the distribution/transmission system
- The potential to implement new programs in the future
- Reduction in externalities, including the benefits of reduced emissions

We outline strategies for assessing a subset of these benefits below.

Benefits from Providing a Better Price Signal

Providing a better price signal to customers—i.e., prices that better match power costs–is a primary tenet of rate design and mechanisms to encourage the efficient use of resources. While approaches such as time-of-use rates do not require AMI, the use of real-time pricing and critical peak pricing do require a more sophisticated metering system and two-way customer communication system. Implementation of dynamic pricing in conjunction with smart grids and home area networks is often assumed to increase the penetration of these programs as a result of transferring tools and controls from the utility to the consumers. The envisioned improvements are still subject to evaluation. Based on our experience, we believe that estimates of savings associated with price elasticity and cross-period elasticities can be derived by applying econometric analysis to data from prior utility programs. That is, price response data combined with demographic information and system characteristics—e.g., type of customer equipment and pricing method used in the prior trials—can be used to statistically estimate the incremental effects of different price signals and network control options.

Improved Service Reliability

Improving power quality and reducing the frequency and duration of outages is very valuable to many customers. However, valuing such benefits is a significant challenge. Previous work suggests that surveys to assess willingness to pay for improved power quality and reduced outages tend to overstate the value as measurable by a customer's willingness to buy backup power or improvements to the distribution system that will increase reliability (i.e., redundant feeders and transformers, switches, and SCADA controls). Therefore, sophisticated survey techniques are required to quantify value-of-service. For example, rather than asking direct questions regarding willingness to pay for enhanced service quality, we have used an approach that requires respondents to make tradeoffs among price, service characteristics, and service quality to estimate the value of increased reliability—i.e., reduced frequency and duration of outages.[14]

Technological Potential

Broadband communication networks used to support Smart Grid/AMI may have future value arising from currently speculative or unanticipated applications. The long list of potential benefits centers around infrastructure to optimize charging electric vehicles, integrating large amounts of environmentally benign distributed generating resources, and elimination of future peaking generation and T&D improvements. For example, use of broadband-enabled smart grid technology could allow faster activation of standby power and limit the extent and duration of blackouts. A brief filed by the County of Maui regarding "the potential gains from emerging DSM technologies, when enabled with emerging [BPL] and other 'smart grid' technologies" argues that by allowing better coordination of distributed generation and storage of electricity via plug-in hybrid electric vehicles, such technologies could reduce the chance for a blackout or enable faster restoration and/or reduce the number of locations affected by a blackout attributable to an earthquake for example.[15]

The costs and characteristics of alternative technologies will influence the value and timing of deploying broadband. Major cellular service companies—AT&T, Verizon, and T-Mobile—have begun to compete aggressively to provide connections to residential AMI equipment. "To win smart-grid business from utilities, wireless companies are slashing the monthly fee they charge to provide the communications link, providing that service, in some cases, for pennies a month for each meter."[16] These options allow the utilities to avoid investments in last-mile communications links, and they appear to provide substantial flexibility without broadband. For example, TNMP will use communications equipment provided by SmartSynch and AT&T's existing general packet radio service (GPRS) to provide AMI service to 10,000 residential customer locations. GPRS operates at speeds of 30-40 Kbps (up to 80 Kbps), compared to about 700 Kbps and above for residential broadband services.[17] However, the arrangement will "… allow TNMP to read meters frequently, receive alerts about outages, and terminate or restore service remotely….The meters will be programmed to upload data to the utility once a day, most likely during off-peak times…." Customers will be able to "…sign up for rate plans with peak and off-peak prices, or set appliances and lighting to turn on and off with the help of controllers installed on appliances or electric outlets."[18] Customers will also be able to use their own Internet connections, as opposed to the AT&T link, to log onto the TNMP website to check their usage pattern and compare it with other customers' patterns. In addition, the SmartSynch option allows utilities to migrate to higher-speed communications links over time. Thus, if the costs for the current cellular options are as low as implied in the article cited above, utilities could find it prudent to wait and to upgrade to faster wireless or to install their own broadband connections until they have gauged the demand for and benefits of AMI-enabled services.

Real options theory and probabilistic tools can be used to assess the value of implementing a network with the capacity to support possible anticipated technological innovations. Conceptually, the investment in "more" network than is immediately needed creates a call option for the utility's customers and investors. The value of this option is determined by a number of factors including the anticipated life of the network, and the value of delaying incremental investment decisions (anticipated technology improvements, greater certainty on environmental regulations). Real options are only one approach to decision-making under uncertainty but they provide a framework for assessing the time pattern for investments and the benefit and costs of delaying investments with uncertain future benefits.

Of course, applying these principles to determine the prudence of investments in broadband options must be done on a case-by-case basis depending on a given utility's network configuration and customer base.

Valuing Incremental Benefits from Shared Use of Broadband Capacity

To this point, our discussion has focused on incremental benefits from using broadband to enhance network control, monitoring, AMI, energy pricing, and energy efficiency. We turn now to the potential benefits of third party energy-related and non-utility uses of the communications network. Third party energy-related uses include access to the communications system to support DSM programs and distributed generation investments by others besides the owner of the wires. The potential for such uses is exemplified by the role of non-utilities in providing significant amounts of demand-side resources in the Northeast capacity auctions as well as the recently announced GE and Google Smart Grid Alliance.[19] Third party non-utility uses also include meter reading by other utilities and consumer high-speed Internet access. The realization of incremental benefits from third-party uses might involve the utility's investment in a business that it otherwise would not venture into. However, from a societal perspective, third party benefits should be considered for efficient allocation of resources. This is because third party benefits are associated with economies of scope which could make the incremental expenditure for broadband communications capability cost effective even if the benefits from the utility's own Smart Grid/AMI applications are insufficient to justify the costs. Thus, we provide a framework for evaluating the benefits associated with third party services.

Broadband Communications Benefits

Assessing the added benefits from broadband communications services involves estimating the potential demand for the service and the associated incremental revenue. There is a well established market for broadband Internet access, thus the value per customer can be estimated based on actual market prices for various speeds of service sold in markets similar to those in which the service is to be provided. Forecasting demand is more difficult because it hinges on the availability of competing services—e.g., cable modem, DSL, fixed and mobile wireless, and satellite services. Hence, demand forecasting requires two steps: (a) forecasting total potential market size and (b) forecasting market share. The first step can be based on the trajectory of demand that has occurred in other similar markets. FCC state-level, time-series data on broadband penetration provide one rough but readily available benchmark.[20] More detailed data are available from market research companies. The second step can be accomplished using econometric techniques based on penetration and demographic data obtained from prior deployments of utility broadband services. If such data are not available we would apply the survey techniques we describe above.

Other considerations must be taken into account to assess the incremental gains from deploying broadband. First, the utility must determine based on costs, potential future developments, and current communications capacity whether other communications options are more appropriate for the company's service area. For example, wireless networks may be more efficient and may offer greater potential gains from unforeseen technological capabilities. For example Hydro One, which is using wireless connections for its AMI system, describes its service area as "predominantly rural."[21] Wireless could also prove more robust for emergencies such as an earthquake in which wired networks could be more susceptible to interruption. Second, in rural areas with limited broadband service, governmental funding could be used to stimulate deployment of various forms of broadband. Third, notwithstanding the FCC's approval of BPL, there is considerable debate as to whether the radio frequency interference with the amateur radio spectrum is a fatal flaw for BPL.

Sale of Broadband Capacity to Other Utilities for Smart Grid/AMI Use

A utility installing broadband capacity for its own use could also benefit from and realize added revenues by selling capacity on its communications network to another utility. The seller in a free market would then compare the incremental costs associated with providing the added capacity with the potential revenues.

The potential added revenues from providing communications capacity hinge on the cost of available substitutes for use by the other utility—e.g., a natural gas company or a retail competitor for electric service. Presumably the potential revenues would be determined by estimating the net benefits that the other firm could realize if it used another communications network. The same approaches we describe above would be used to estimate this value.

The incremental costs would be best estimated using engineering estimates for the added bandwidth and added terminal equipment.

In addition to these economic/business factors, the utility faces regulatory issues that affect the net economic value of investments in broadband technology. We discuss these issues in the next section.

Regulatory Issues Associated With Combined Utility and Non-Utility Use of Broadband Networks

Utility investments in communication infrastructure for both regulated-utility and unregulated purposes raise several interrelated issues, including asset ownership and affiliate transactions, cost allocation, cost recovery, and cross-subsidization. Regulators concerned about cross-subsidization may consider separation of the regulated and unregulated businesses. However, the need for integrated management of the infrastructure makes it difficult to find an economically efficient way to structurally separate the business of selling communication capacity from a Smart Grid/AMI system. Third party use of a utility communication network and the associated terms and conditions are reasonably likely to be litigated in regulatory proceedings. As we discuss below, much of the discussion centers on pricing and allocation of common costs.

Ownership and Affiliate Transactions

When the broadband communications system is used solely for AMI/Smart Grid applications, ownership structure is not a major concern and the utility typically earns a return of and on the infrastructure. In contrast, when investor-owned utilities (IOUs) seek to provide both regulated and unregulated service, such as Internet access, the issue arises whether the unregulated service should be provided by a separate subsidiary.[22] In this context, the tradeoff to be considered by regulators is whether the benefits—i.e., the reduced risk that a utility could fund below cost pricing of the competitive service using revenues from its regulated utility service—outweigh the direct and indirect costs of structural separation.

Structural separation need only be considered for companies operating under rate of return regulation. Investor-owned rate-of-return-regulated utilities have a *theoretical* incentive to try to subsidize competitive services by seeking to raise regulated rates. In theory, they could increase their profits if they were able to recover Internet access investments (or operating costs) by adding them to the rate base (or costs) for utility services. Both of these possibilities can be dealt with using proper costing and pricing rules. In contrast, structural separation would provide little if any benefit for utilities operating under price caps, because the utility could not recoup losses associated with below-cost rates for an unregulated service by raising regulated rates above the price ceiling.[23] Moreover, in markets in which it faced competition for Internet access service, the utility could not subsequently raise rates for that competitive service because competing, facilities-based providers such as cable companies and telephone companies are not likely to be driven out of the market. This means that a utility Internet provider has little if any ability or incentive to charge predatory (low) prices.

Potential benefits from structural separation

Proponents of structural separation argue that it protects regulated service customers, who might otherwise see their rates increased to subsidize utility entry into an unregulated broadband business, and competitors who could be artificially disadvantaged if the utility's rates for the unregulated broadband service were held below incremental costs. They argue that structural separation deters excessive prices for the regulated utility service that would constrain demand for the regulated services and lead customers to make less efficient choices. They also point out that subsidization of broadband prices would constrain demand for the competing communications services while broadband consumption was uneconomically expanded by the subsidized prices.

Potential costs of structural separation

The costs of structural separation include the direct costs of setting up and maintaining a separate subsidiary, including costs for creating and maintaining management, sales, and operations teams and systems, and purchasing or leasing building space and equipment. The indirect costs include those associated with reduced economies of scope and constraints on broadband for Internet access and possibly on deployment of broadband for AMI/Smart Grid. Indeed, the indirect costs could include foregone benefits that would arise if structural separation made AMI/Smart Grid and/or broadband Internet access service uneconomic to pursue. The costs depend on whether the broadband system is operated by a fully separate entity—e.g., a subsidiary, an unaffiliated company that deploys and sells communications capacity to both the utility's AMI/Smart grid operation and to retail Internet customers—or the utility, which could set up the broadband system for its AMI/Smart Grid function and sell capacity to an independent retail Internet operation. A quantitative analysis of these costs is beyond the scope of this paper. The nature and composition of these costs, however, suggests that they will be quite large.

Maximizing net benefits of utility broadband communications networks

The benefits of allowing integrated provision of utility AMI/Smart Grid and Internet service are essentially the mirror image of the costs of mandating structural separation—allowing integration avoids the direct and indirect costs of structural separation and lower transactions costs for the provider and for customers. Integrated development and deployment of AMI/Smart Grid and Internet access would also be likely to speed service availability, reduce administrative costs such as customer service and billing costs, and thus permit somewhat lower prices for consumers. Providing customers with one point of contact for electric, AMI, and Internet access services would likely lower consumers' transactions costs, and could increase the use these services. Doing so would yield greater savings from AMI services, and would promote diffusion of broadband services.

Despite these considerations, a number of states require structural separation of non-utility lines of business. To minimize the potential costs of this requirement, we recommend that the utility be allowed (but not required) to develop and operate the broadband infrastructure used to provide both AMI/Smart Grid and Internet access, and that only the retail Internet business be operated as a separate entity. (If allowed by law, for reasons summarized above, we also recommend joint marketing of AMI and Internet access services.)

First, given that the primary purpose of the infrastructure is to benefit utility customers via more efficient electricity distribution, production, and consumption, it would be problematic to shift ownership to an unregulated affiliate and sell access to the utility because the AMI/Smart Grid system needs to be integrated with regulated infrastructure and operations. In addition, if structural separation required allocation of investment costs for the common facilities used for both AMI and Internet access, this would of necessity involve arbitrary allocations. The same limitation arises for functional or non-structural separation based upon accounting rules. As we explain below, incremental costs should be used as the basis for pricing.

Second, the specific costs for retail Internet access service such as Internet connections to ISPs, communications modem equipment and distribution, and retailing costs, are sufficiently discrete to facilitate use of incremental costs as the price floor for the Internet service. Similarly, efficient use of the utility's infrastructure should also be promoted by using incremental costs as the basis for compensating the utility for use of its infrastructure. For example, the incremental cost of using the utility's wires is close to zero, although there may be some initial cost for granting access to the broadband network for retail businesses—e.g., the cost of personnel time needed to coordinate with the broadband operation when equipment is installed or maintained to allow the signal to be transmitted. It is important to avoid a fully allocated cost approach that assigns excessive costs to the unregulated part of the business. Regulators concerned about protecting rate payers from cross-subsidizing the competitive service should ensure that utility rates do not increase beyond the level that would prevail in the absence of the utility's entry into a competitive market, but they should not go further than that. See our discussion of cost recovery and cost allocation below.

Cost and Pricing Issues

Common costs—costs incurred in common for the retail communications services and for Smart Grid/AMI, such as communications links from a central location to substations—will be a factor in regulatory debates regarding non-utility use of broadband because third party services involve sharing of fixed network components. The economically appropriate approach to pricing and cost recovery in the presence of common costs relies on incremental or marginal costs and market conditions. However, regulatory determinations of the cost of providing third party services may consider approaches ranging from fully allocated costs to marginal costs. These methods, as well as alternative methods, involve implementation decisions that can dramatically change the analytic results. For example, allocation of common costs in a fully allocated cost model can be done many ways. This is why economists reject fully allocated costs for pricing. Thus, it is useful to examine the costs and benefits of the smart grid technology needed for network control and monitoring, and then examine the incremental costs and benefits of third party services.

Pricing issues for third party use of communication services

Possible standards for pricing communication bandwidth for third party uses include: incremental costs, incremental costs with allocated overhead, comparative value, and fully allocated costs. From an economic perspective, if the network control functions were being sold to outside parties, the incremental cost test would require that both that function and the communications services cover their incremental costs and that the total revenues from the two services must cover the incremental costs and the common costs caused by the two services. The allocation and recovery of common costs is typically a subject of contention. Non-economic schemes are likely to be inappropriate for numerous reasons. For example, the amount of common cost that can be incorporated into the retail price will be constrained by the market price for the communications services. Too much allocation of common costs may lead to the circumstance where sales of communications services are foregone that otherwise would be beneficial. The result is that sales that would contribute to the common costs are foregone because the price at which those sales could occur is below the price floor but above the incremental cost.

Price Floor—incremental costs

The issue of price floors often arises when a regulated firm uses common facilities to provide both regulated services and competitive services. Indeed, competitors of municipal utilities have challenged the prices they charge for communications services. The economic price floor for broadband Internet access is the incremental cost for that service, i.e., the added cost of higher capacity transmission plus any additional infrastructure to connect to the Internet, and—if voice services are to be provided—the added cost to connect to the public switched telephone network needed for communications functions rather than for Smart Grid/AMI.

The incremental costs may include added costs for billing, potentially different modems, and differences in central office software and equipment. To determine the incremental infrastructure cost it may be possible to rely on the original cost estimates from vendors for providing the alternative systems, i.e., to request bids for each type of network and use those bids to calculate the incremental costs. Econometric analyses based on available data from previously implemented systems would provide a reasonableness check on such engineering cost estimates, provided enough information about system characteristics, scale, and operating company service area characteristics are available to allow the analyst to adjust the results for use in a given situation.

In the scenario where the incremental costs include additional capital necessary to build a system with extra bandwidth, it is necessary to also consider the appropriate cost of capital. The incremental cost of capital should match the risk of the incremental project and that risk may be different than the utility's cost of capital. The cost of capital issue is particularly difficult in the case of public power entities. If the area is either unserved or underserved by high-speed Internet service, it can be argued that use of a lower cost of capital is appropriate to provide an essential service that the private sector is not willing to provide. Alternatively, use of a lower cost of capital may result in a subsidy by a group of taxpayers that may undermine private investment without serving any legitimate purpose.

Pricing at comparative value

While incremental cost is the floor for pricing, this price floor may be below the market value of the service. The value of broadband service is discernable from the mass market price, since there are many markets where there is effective competition from cable and ADSL service as well as fixed wireless providers. In rural areas without competition from these two options, comparable value would be more difficult to estimate. Benchmarks could include satellite broadband or prices for BPL in markets in which it has been offered for sale.

Fully allocated cost pricing

It is likely that some interveners may be interested in pricing third party use at fully allocated costs as an approach for avoiding cross subsidies. However, the fully allocated cost approach is problematic and is unlikely to result in efficient economic decisions. One of the problems with fully allocated costs is the tenuous relationship between the assignment of indirect costs and the actual or incremental costs of providing the service. The impact of potentially arbitrary allocations of indirect cost—i.e., setting excessively high price floors—could lead to the inefficient duplication of infrastructure and potentially result in lost revenues and leave the electric utility customers worse off.

Applying economic pricing and costing methods—i.e., applying the incremental-cost price floor we described above—will assure that neither consumers nor competition are harmed by such ventures.

Conclusions

A combined emphasis on increased service reliability, cost control, promotion of EE/DSM programs, and anticipated advances in distributed generation technologies is likely to result in greater use of broadband communication systems to control US electric distribution. This will also be driven by state and federal initiatives and tax policies. Smart Grid programs are also likely to increase as the industry attempts to improve the efficient use of electric generation and delivery, and provide an improved customer interface to manage electricity use with interconnected home networks. These developments provide the opportunity to increase the efficient use of more advanced utility communications networks through access by third party energy and non-energy applications. Decisions whether to build/sell excess bandwidth require assessments of business risk/benefits, regulatory treatment, and consumer/societal benefits, including analyses of the following key factors:

- Potential customer/societal benefits associated with building out and using excess bandwidth to provide high speed Internet service in under-served areas
- The option value of excess capacity
- The likelihood of developing a regulatory structure that provides a reasonable risk/reward structure for providing non-utility communication services while non-cross-subsidizing the service with revenues from regulated utility services.

Analysis of the potential for selling non-utility uses of broadband capability constructed in conjunction with Smart Grid/AMI deserves careful consideration. These services can be provided in a manner that neither creates unfair competition nor results in cross-subsidization of unregulated services by regulated services.

End notes

1 James Heidell and Harold Ware are Vice Presidents with NERA Economic Consulting's Energy, Environment, and Network Industries Practice.

2 It includes $4.5 billion to improve electricity delivery and energy reliability, including funds "to modernize the electric grid, to include demand responsive equipment, enhance security and reliability of the energy infrastructure… and facilitate recovery from disruptions to the energy…"; billions of dollars more for "Energy Efficiency and Renewable Energy" and "Innovative Technology Loan Guarantees," which could be used in part to fund Smart Grid projects; and about $7 billion to expand broadband service availability in "unserved" and "underserved" areas.

3 We estimate that the type of communications system is "to be determined" for 14 utility AMI projects that account for about 23.4 million of roughly 50 million meters covered in FERC data on large AMI deployments "announced [beginning in 1996] or … expected with some level of confidence by the end of 2008." Federal Energy Regulatory Commission Staff, *2007 Assessment of Demand Response and Advanced Metering Staff Report*, September 2007, Table F-1.

4 At the risk of significant oversimplification, a brief description of a BPL system follows. BPL relies on the utility fiber optic system that is frequently installed with transmission systems for supervisory control and data acquisition (SCADA). The fiber system is used to deliver the signal from and to distribution substations. The communication signal is injected into the utility distribution system on the low side of the distribution transformer. Depending on the specific technology, that signal either passes through or around the line transformer and can be received at any electric outlet on a 110/220-volt home distribution system.

5 The Xcel Energy program is called SmartGridCity and the construction of the first phase of the project began in April 2008. See "Xcel Energy begins work on SmartGridCity in Boulder," Xcel news release, 15 May 2008, in which Xcel announced: "The design phase is complete, equipment is ordered and construction has started on SmartGridCity….In May, the company began implementation of the smart grid network and construction on the SmartGridCity Control and Operations Center." http://www.xcelenergy.com/Company/Newsroom/Pages/200805015-DenverXcelEnergyBeginsWorkonSmartGridCityinBoulder.aspx

6 Xcel Energy, SmartGridCity: Design Plan for Boulder, Colo. http://smartgridcity.xcelenergy.com/media/pdf/SmartGridCityDesignPlan.pdf

7 See: http://www.uplc.org/fileshare/files/38/Legal_Regulatory_Issues/Industry_Issues/BPL_Deployment_Map_12-31-07.pdf.

8 According to "The Hydro One Smart Network: The Future Has Arrived," Hydro One's AMI architecture is a mesh network "based on the global 2.4 GHz IEEE 802.15.4 standard." See:http://www.trilliantinc.com/1_Abt/_PDFs/HydroOne.pdf. That standard operates at 250 Kbps. Other mesh networks could use higher or lower bandwidths. Depending on the network configuration, e.g., speed and number of network nodes, mesh networks may trade off some network latency for lower cost achieved by using more intermediate nodes. See: http://www.smartgridnews.com/artman/publish/grid_automation/Trilliant_s_SecureMesh_Great_Interoperability_but_Can_It_Scale-478.html.

9 Even optimistic market research reports show BPL accounts for only about 0.3 percent (135,000) of 40 million US broadband users. See Judy Motti, "IBM Aims to Electrify Rural Broadband Access: Big Blue partners to bring broadband networking via electrical power lines to millions without Internet access," 12 November 2008. http://www.internetnews.com/hardware/article.php/3784656/IBM+Aims+to+Electrify+Rural+Broadband+Access.htm, accessed 19 November 2008. The FCC shows about 5,400 BPL lines in mid-2007. *High-Speed Services for Internet Access Status as of June 30, 2007*, FCC, Industry Analysis and Technology Division Wireline Competition Bureau, March 2008.

10 http://ap.google.com/article/ALeqM5h34ExZwCNNQ6JAorv-5jiHL3l_TwD94DI2R81

11 See "United States Department of Justice, Voice, Video and Broadband: The Changing Competitive Landscape and Its Impact on Consumers," November 2008, p. 29.

12 Montana Power's strategy to transform itself into a telecommunications company, Touch America, was ultimately a key factor in the bankruptcy of Montana Power. Less spectacular value destruction occurred at other utilities, including Dominion's sale of Dominion Telecom and, more recently, the publicly funded Manassas Virginia's takeover of the BPL system operated by ComTek when that company's deal to sell the system fell through. Manassas is now considering whether to use the BPL infrastructure for an AMI project. Similarly, Current has refocused its efforts on Smart Grid/AMI applications of its BPL, although "…it is still offering BPL to … 50,000 of the 700,000-home network in Cincinnati through its own brand name…." See: Vandana Sinha, "Current Group retools its tech to focus on smart grids," *Washington Business Journal*, 6 June 2008, http://washington.bizjournals.com/washington/stories/2008/06/09/story10.html, accessed 18 November 2008.

13 For example, the three major California investor-owned utilities are anticipating a combined AMI investment of over $4 billion to install almost 17 million advanced meters for gas and electric customers. California's Advanced Metering Infrastructure Initiatives, Energy Division, January 2008.

14 More specifically, we create a large set of perhaps 50 to 100 realistic choices that are characterized by different fixed monthly charges, variable energy prices, billing options, expected frequency of outages, and duration of outages. We send randomly selected sets of perhaps four of these options (depicted on cards), none of which is clearly superior to the others (i.e., if price is lower then outages would be more frequent on the option). Then, based on customers rankings, we estimate an equation or equations that shows the incremental values that respondents place on each characteristic.

15 See County of Maui, Post Hearing Brief of the County of Maui and Certificate of Service, In the Matter of Hawaiian Electric Company, Inc. For Approval and/or Modification of Demand-Side and Load Management Programs and Recovery of Program Costs and DSM Utility Incentives DOCKET NO. 05-0069 23 October 2006. http://hawaii.gov/budget/puc/dockets/05-0069_young_2006-10-24.pdf

16 Rebecca Smith, "Wireless Firms Eye 'Smart Grids': Cellphone Carriers Cut Prices in Aggressive Push for Deals With Utilities," *The Wall Street Journal*, 17 April 2009, p. B5.

17 "Advanced Communication Network," SmartSynch website.

18 "Wireless Firms Eye 'Smart Grids'."

19 In September 2008, Google and GE announced an alliance to bring new information and renewable energy technologies to customers in order to influence public policy and create a 21st century distribution grid.

20 See, for example, *High-Speed Services for Internet Access Status as of June 30, 2007*, FCC, Industry Analysis and Technology Division Wireline Competition Bureau, March 2008.

21 See "Hydro One Leverages Smart Grid for Multiple Customer and Business Applications," Hydro One news release, 16 June 2008.

22 The issue of structural separation may be an issue for publicly owned companies. For example, communications providers may be concerned that BPL Internet access services could be subsidized by a municipal utility's electric customers. In principle, a municipal utility concerned with the welfare of its customers would have an incentive to price its services efficiently. However, the utility's managers can be driven by other incentives—e.g., seeking to expand the size and scope of their enterprise.

23 As Professor Alfred Kahn explains, under price cap regulation, as long as rates for the utility service are not allowed to increase when a competitive service is introduced, the utility customers' rates cannot be used to subsidize rates for competitive services. See Alfred E. Kahn, "How To Treat The Costs Of Shared Voice And Video Networks In A Post Age," Cato Policy Analysis No. 264, 27 November 1996, in which Professor Kahn concludes: "…the Commission should *stop allocating* the costs of the multipurpose facilities and *not change the prices of regulated services*—up or down—in response to them. That is the way to see that purchasers of the regulated services are neither burdened nor benefited by them—which, as we have seen, is another way of saying that it is the way to put on the companies the entire burden of the additional costs to weigh against all the anticipated benefits."

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