# Smart Grids and Small Utilities
## *A Preliminary Analysis on the Contribution of Utility Size to Successful Smart Grid Deployment*

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Abstract: Modernizing the electric grid and turning the smart grid vision into reality is a complex and multi-decade undertaking presenting significant challenges for utility companies. This paper highlights the particular challenge smaller utilities face as they consider smart grid initiatives. Six key barriers to smart grid implementation are selected and presented here in a qualitative assessment including 1) the need for individually tailored solutions, 2) a questionable value proposition, 3) the lack of communication and information technology (IT) infrastructure, 4) mixed consumer engagement, 5) an aging workforce, and 6) an awkward progression of regulations and standard development. The objective of this effort is to stress the missed opportunity that may exist to promote the early engagement of smaller utilities in national smart grid deployment efforts.

## 1 INTRODUCTION

Implementation of the smart grid vision promises advancements in the areas of energy efficiency, customer visibility, cost savings, reliability, and congestion among many others. Despite these benefits, only small subsets of utilities are implementing smart grid projects to modernize their electric infrastructure. According to the Smart Grid Information Clearinghouse, a project funded by the U.S. Department of Energy (DOE) to populate and maintain a list of smart grid projects, there are only 174 smart grid projects in the country (SGIC, 2012). When compared to the existence of over 3,000 utility companies, this ratio is disappointingly low.

These numbers are especially disappointing in consideration of the efforts made by the federal government to promote investment in the smart grid. A condensed list of these efforts includes 1) creation of the Smart Grid Advisory Committee, the Smart Grid Task Force, the Smart Grid Systems Report, and the Smart Grid Interoperability Framework through the Energy Independence and Security Act, and 2) funding the Smart Grid Investment Program (SGIG), the Smart Grid Demonstration Program (SGDP), the Smart Grid Information Clearinghouse, and the Smartgrid.gov website through the American Reinvestment and Recovery Act (ARRA) funds. Together these efforts represent billions of dollars spent encouraging states and utility companies to begin successful smart grid deployment.

Admittedly, electric grid modernization is expected to be a work in progress that will take 40-50 years and immediate nation-wide results are unrealistic. The heavy reluctance of the majority of utilities to initiate smart grid projects, however, is worth evaluating. Fundamentally, this reluctance is a reflection of multiple barriers of implementation. Not only do smart grid projects require individually tailored solutions and have a questionable value proposition that discourages investment, but also there is a lack of communication and IT infrastructure in the industry, a lack of consumer engagement, an aging workforce, and a difficult progression of regulation and standard development which all contribute to slow progress.

The concern presented in this paper is that while these barriers present significant challenges for the major utilities, smaller utilities are especially discouraged. Operating with a smaller customer base, these utilities have limited resources which lead to their reduced ability to explore emerging technology options, improve cost effectiveness, and promote customer engagement. Consequently, the small utilities may be least successful in attempts to

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engage in smart grid initiatives and may be among the last to move in this direction.

Existing literature pertaining to the progression of smart grid objectives under-recognizes the lack of progress by these stakeholders and overlooks the opportunity there may be to better promote their inclusion in nationwide modernization movements. The objective of this effort is to bring attention to this problem and promote debate that may generate ideas and initiate action to foster the engagement of smart grid projects by the smaller utilities.

To accomplish this objective, six key barriers to implementation are qualitatively accessed and highlighted against the particular disadvantages small utilities face to mitigate each barrier. This list is not exhaustive and additional barriers are left for consideration in future work. Additionally, systematic studies of each barrier against well-defined utility sizes are suggested for future research on this topic.

# 2 BARRIERS OF IMPLEMENTATION

The following sections individually describe barriers to implementation commonly found in existing smart grid literature and relate them to small utilities. For a more detailed description of the technical, business, and financial challenges facing utilities readers are directed to the DOE Smart Grid System Report to Congress in 2012 (USDOE, 2012).

## 2.1 Individually Tailored Solutions

The first barrier that emphasises the challenge small utilities face to deploy smart grid projects is that by nature smart grid projects require individually tailored solutions. The existing electric infrastructure is a patchwork of interconnected transmission and distribution lines that incorporate multiple sources of energy, include widely varying ages, conditions, capacities, and cross multiple regulatory environments (EDRG, 2011). As a result, there is no one size fits all smart grid solution.

In this respect, each utility must consider its own infrastructure and evaluate the emerging technologies that meet their specific needs. Unfortunately, this makes the effort more time consuming and less affordable during a time that research and development (R&D) efforts have significantly declined in the industry. Before the functional unbundling of the electric industry in the 1990’s there may have been funds available for this purpose, however, R&D became the favorite cost-cutting target as the industry became more competitive. As a result, fewer utilities are investing in long-term projects, especially where those utilities are privately owned (Sterlacchini, 2010).

For this reason, smaller utilities have an incentive to delay their efforts and let the larger utilities go first. Not only do the larger utilities have more resources to research and develop smart grid technologies, but their efforts are much more likely to develop a market for those technologies. The result is that small utilities can then take advantage of these cost reductions as they evaluate the solutions that are most appropriate for their service area. As noted by a manager from a small utility in the state of Massachusetts, “It’s cheaper if you’re one year behind the curve,” (Clamp, 2012).

Herein lays the opportunity for the federal government to make a significant difference in the number of utilities engaged in smart grid projects. By providing general guidance, such as lessons learned, technical and financial analysis on the value of smart grid investments, and communicating information openly across the industry, the R&D burden utilities face may be reduced. For small utilities reducing this burden may be enough to counteract their current tendency to delay initiation of these projects.

## 2.2 Questionable Value Proposition

In light of the individually tailored solutions challenge, the cost effectiveness of a smart grid project is a major hurdle. This is primarily because some of the greatest benefits are to the society at large and are not specific to the utility owner or their investors. Societal benefits may include downward pressure on energy prices, the integration of cleaner distributed generation, and the associated environmental benefits. As energy use during peak demand is reduced by load-shifting designs, for example, the need to build new peak power generation plants and new transmission lines is reduced along with the associated environmental impact of new infrastructure. Unfortunately, measuring these benefits and allocating them to specific benefactors is extremely difficult and they are not likely to be reflected in cost-benefit analysis as companies evaluate smart grid options.

Adding to this problem is that the ability to secure credit is also an issue. Depending on whether or not a utility is in a regulated or unregulated market, investors face a trade-off between funding projects in regulated markets with greater certainty but a reduced incentive to sell less energy, and unregulated markets with greater risk that costs will exceed benefits (SGCR, 2012). Investors are further deterred due to the moving set of possibilities as technology, energy mixes and energy policies are in a constant state of flux, and the cost-benefit analysis are primarily based on research instead of historical or on the ground performance (SGCR, 2012). As mentioned previously, with limited resources small utilities are less able to fund research to support a cost-benefit analysis. Without a well-documented justification, their ability to be issued credit and secure funding is further reduced.

Another consideration is that utility types range from investor-owned, to municipalities, cooperatives, river authorities, aggregators, transmission and distribution, retail, and power generation companies each with their own organizational structure and authority. The difference between these types is important. According to a report by the National Science and Technology Council (NSTC) on the 21st Century Grid, a utility company's motivation to engage in smart grid efforts is impacted by their business model and their level of incentive to sell less energy more efficiently.

Investor-owned utilities (IOU), for example, are profit making enterprises that exist to make a return on investment for their stockholders. Thus an IOU has a strong interest in selling more power and is likely to view smart grid technology less favourably unless it can help avoid building new peaking plants (NSTC, 2011). Rural cooperatives, on the other hand, provide service to their own members and return profits to them directly. These types of utilities are likely to have a greater interest in selling less energy more efficiently and may be particularly attracted to smart grid investments.

The questionable value proposition is magnified for a smaller utility whose lower customer base reduces the cost effectiveness of expensive capital equipment. Some types of smart grid technologies, such as smart meters and transmission line sensors, may be correlated to the number of customers in a service area. Communication and IT infrastructure necessary to collect, maintain, and aggregate data from these systems, however, are a necessary component regardless if utilities are serving a few thousand customers or a hundred thousand customers. Thus smaller utilities with fewer customers are less able to justify the heavy capital investment.

With these concerns, lawmakers may need to consider more targeted incentive programs. Encouraging investors to fund smart grid projects in specific utility demographics, such as, size or ownership type may help balance the additional funding challenges those utilities face as a result of their customer base and organizational structure.

## 2.3 Lack of Communication and IT Infrastructure

Unfortunately, with a few exceptions by large utilities, the collective electric infrastructure has not been kept up to date with modern technology in the way that other industries such as banking or telecommunications have. As a result, the third barrier to smart grid implementation is the enormous amount of new communications and IT infrastructure required to support smart grid operations with data collection, aggregation, maintenance, and communication.

The Electric Power Research Institute (EPRI) describes, for example, that although many transmission and distribution substations are already equipped with sensors, there is limited bandwidth connecting substations to the enterprise. This means that even if new smart grid sensors are deployed, there is a limited ability to transmit their data back to the utility. As a result, estimates range from \$50,000 - \$70,000 per substation just to build upon communication and IT infrastructure of existing platforms, and these estimates are not including the additional need to build new substations (EPRI, 2011). On the distribution side, costs run over \$500,000 per feeder to incorporate the necessary communications (EPRI, 2011).

Thus although smart meters with demand response, running approximately \$940 per customer (EPRI, 2011), are considered the basic building block of the smart grid (EEI, 2011), funding the smart meter itself is not the only cost. Depending on the legacy system, synchronizing new technology with existing systems may be problematic and may delay deployment.

In this manner, the advantages of smart meters can only be fully realized when the communication network incorporates all appliances and devices in the distribution and metering chain, (Depuru, 2011). The result is that smaller utilities may deploy smart meters without the ability to take full advantage of their capabilities. Unfortunately, this further contributes to the reduced value proposition discussed above and provides additional justification for governments to target incentive programs to smaller utilities and their investors.

## 2.4 Consumer Engagement

Despite advantages in increased visibility of energy use and the associated ability to reduce or shift energy loads and lower energy bills, consumer perceptions and attitudes towards smart grid projects vary. The fourth barrier facing utilities then is the level of customer engagement or opposition. Depending on regional or personal experiences with energy or environmental issues, customer willingness to adopt smart grid technology varies by region (Horst, 2011).

Some areas of the United States, for instance, have experienced significant consumer opposition to smart meters and advanced metering infrastructure (AMI). In the state of Texas the Public Utility Commission (PUC) is considering opt-out rules for customers who are against the installment of smart meters for potential health hazard and privacy concerns (Llorca, 2012). This means that utilities may have to maintain two systems at an additional cost if some of their customers are allowed to opt-out of using a smart meter.

Again, this contributes to the cost-benefit analysis utilities conduct to weigh the pros and cons of initiating a project. In areas where utilities need to mitigate customer opposition, smaller utilities may be much more likely reject smart grid projects that already have minimal direct financial incentive.

This is important because a report by The Edison Foundation concludes that individual, utility, and societal benefits could significantly increase with increased investment and focus on consumer education and engagement (EEI, 2011). Consequently, this is one area where state or regional level education or initiatives to promote customer engagement may be especially beneficial to smaller utilities in their efforts to deploy smart grid initiatives.

## 2.5 Aging Workforce

The fifth barrier to smart grid implementation is that as an industry, electric utilities are facing imminent retirement of much of their workforce without the security of adequate numbers of mid-career level personnel with on-the-job training and experience, or future graduates and professors to fill their positions (Sen, 2012). This is especially challenging as smart grid initiatives have greater demands for personnel with specialized skills. A report from the National Energy Technology Laboratory (NETL) and the Office of Electricity Delivery and Energy Reliability cautions that rebuilding staff reductions and attracting technical talent back to the field is a valid barrier to realizing smart grid initiatives such as AMI deployments (NETL, 2008).

This barrier is especially important to small utilities in rural versus suburban areas, as they are less likely to attract technical staff or new college graduates. While some movement of college graduates has been tracked increasingly to the suburbs of metropolitan areas (Forbes, 2011), college graduates still tend to migrate to cities of greater density than rural areas. Thus smaller utilities in outlying and rural areas may be especially vulnerable to the ability to attract the technical talent they need to deploy and maintain new smart grid systems.

Again, this may be an opportunity for state or federal initiatives to balance the greater challenges facing small utilities. Governments, utilities, and universities are already taking action to increase participation in the energy industry (Sen, 2012), thus it is likely that there is an opportunity to add to this effort through additional incentives for technical graduates to seek employment in lower density areas. In doing so they may promote a faster deployment of smart grid efforts by small utilities that will help broad policy initiatives to improve energy efficiency and realize the smart grid vision.

## 2.6 Regulation and Standard Development

Finally, the sixth key challenge facing utilities is the uneven progression of regulations and standards in an industry that is not fully regulated, nor fully deregulated. While developing regulations that encourage interoperability, cyber, reliability, and interconnection standards, policy-makers struggle to balance the need to provide a lower risk environment for investors while allowing for flexibility that may promote innovation in the new energy market (SGSR, 2012). Monitoring the action of government authorities to move in this direction, however, is especially tough for small utilities with less staff to keep track of regulatory change.

Additionally, small utilities by design have less ability to influence these regulatory changes. Not only are they more restricted by their influence from the perspective of their smaller customer base and fewer resources for lobbying, but as discussed above they are moving slower than their larger counterparts towards smart grid deployment. This means they are less likely to identify and vocalize their preferences to decision-makers in time to pre-empt or confront the preferences larger utilities have already promoted in the path forward to standards development.

To balance these challenges, federal authorities should take deliberate care to better communicate the status of regulatory change, and assist states in developing and implementing their policies with greater confidence and fewer delays. Furthermore, both authority levels are encouraged to specifically solicit input from small utilities in public workshops as they weigh pros and cons of various regulatory options.

# 3 CONCLUSIONS

Exploring the vast array of smart grid technical solutions, analyzing cost-effectiveness, evaluating cost-recovery options, securing funding, and gauging customer support are challenging steps for any utility. Conducting these steps on a limited budget, with limited staff, limited credit, and a small customer base, the effort may be overwhelming. The intent of this paper is to show how specific barriers to smart grid integration are particularly challenging for smaller utilities and explain why targeted government efforts are needed to promote their involvement.

First, the high cost of individually tailored solutions driven by the complexity of the electric infrastructure is especially problematic for small utilities that have fewer resources committed to R&D. These costs may be mitigated by government efforts to provide general guidance, technical and financial analysis and improve communication across the industry, thereby alleviating some of the R&D burden.

Second, the questionable value proposition of smart grid projects is exacerbated for small utilities with reduced abilities to secure funding and fewer customers to spread out costs of expensive capital equipment. This is especially true considering the lack of existing communication and IT infrastructure common across the industry. Targeting incentives for investment in small utility smart grid projects may balance the additional challenges they face to improve affordability.

Next, regional and local consumer opposition to smart grid projects is especially troublesome for small utilities due to their reduced ability to fund consumer education programs. Thus by increasing awareness of societal and individual benefits of the smart grid vision, federal or state level consumer education programs may be especially helpful to smaller utilities.

Additionally, in the face of a national aging energy workforce, smaller utilities are more vulnerable due to their locations in areas of less population which typically receive fewer college graduates. Thus federal level programs that encourage energy and electric technical professionals and college graduates to migrate to areas of less dense populations may reduce the impact on smaller utilities located in these areas.

Finally, the awkward progression of federal level regulation and standard development is more troublesome for smaller utilities with less ability to monitor and influence these requirements. To improve their participation federal efforts to engage diverse stakeholders from all utility types and sizes in public workshops may improve the participation rate of these utilities.

In conclusion, by exploring each barrier to smart grid implementation this paper seeks to highlight the particular susceptibility of small utilities. By suggesting additional federal or state level involvement specifically targeted to promoting their engagement and fostering debate on measures that may be taken to dampen these obstacles, the final objective is to achieve a greater ratio of utilities initiating smart grid projects.

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