Journal of Advances and Scholarly Researches in Allied Education
Vol. 13, Issue No. 1, April-2017, ISSN 2230-7540

Smart Grid: A Review

Indrajit N. Yadav*

Dept. of Chemical Engineering, Bharati Vidyapeeth College of Engineering, Navi Mumbai, (MS) India

Abstract – The idea has been beaten around for years, but now the money and the will are converging to turn the old analog electric grid into the next big digital network. The smart grid starts its transformation from an overhyped and ill defined concept to a set of clearly articulated pieces and working prototypes. A Smart Grid is an electricity grid equipped with modern computer systems and communication networks. The primary goal of a Smart Grid is controlling the distribution of electricity as optimal as possible. All sides agree that today's aging analog and mechanical electric grid needs to be dragged into the era of digital networks. The promises are compelling. Moving to a smarter electrical grid is imperative not only for the nation but also for the planet. However, we must be realistic about the risks and anticipate and mitigate the security and privacy problems they introduce in term of barrier. As this paper focus on barriers in Smart Grid and its possible solution.

Key words: Barriers Smart Grid, Smart Grid Challenges, Barriers Modern Grid, Smart Grid Solution.

---------------------------------x---------------------------------

1. INTRODUCTION

In moving to the smart grid, we replace a physical infrastructure with a digital one. A similar transition in other infrastructures hasn't always been easy, and we must expect that some problems will occur. How we deal with these problems will make the difference between a smooth transition to a less costly and more environmentally sound future, or the lights going out. The smart grid is a network of computers and power infrastructure that monitor and manage energy usage. Although deploying the smart grid has enormous social and technical benefits, several security and privacy concerns arise. Customers work closely with the utility to manage energy usage in the smart grid, requiring that they share more information about how they use energy and thus exposing them to privacy invasions. Moreover, because grid customers are connected over a vast network of computerized meters and infrastructure, they and the infrastructure itself become vulnerable to scalable network-borne attacks. Here, we look at several securities and privacy issues resulting from this new infrastructure and identify initiatives that might help reduce exposure to these ill effects. One of the smart grid's most attractive features is its ability to support widespread customer energy generation. A broad national effort is needed to investigate smart grid security and privacy. We can't wait to determine whether current laws and technology sufficiently protects users, utilities, and the nation's interests. Security and privacy failures in first generation technology deployments of electronic voting and medical device. As in brief characteristics of Smart Grid

1. Enable active participation by consumers.
2. Accommodate all generation and storage options.
3. Enable new products, services and markets.
4. Provide power quality for the digital economy.
5. Optimize asset utilization and operate efficiently.
6. Anticipate & respond to system disturbances.
7. Operate resiliently against attack and natural disaster

2. CHALLENGES

- High capital and operating costs – Capital and operating costs include large, fixed costs attributable to the ubiquitous communications network. Hardware costs do not factor in significant improvements in economies of scale and production innovation, and software integration assumes significant delivery and integration risks.
- Benefits are constrained by the regulatory framework – When assessing the benefits, business case modelers tend to be conservative in what they can realize as cash benefits to the shareholder.

2.1 Overcoming such challenges

- Regulatory Refresh – There is an urgent need to refresh the utility regulatory regimes that oversee the governance and economics of the power industry. No longer is it the sole purpose of this industry to provide energy to the masses at cost-competitive prices; there now exists a set of competing imperatives which centre on the provision of infrastructure to support a low-carbon economy while maintaining security of supply and quality of service to the end consumer. The regulatory regimes worldwide need to be restructured to reflect these new imperatives. Governments and regulators should provide clear profit motives to utilities to place value on energy efficiency, encouraging utilities to produce and deliver as efficiently and clean electricity as possible, without compromising security of supply. In both vertically integrated and competitive utility value chains, utilities should be rewarded for helping achieve this mission.

- Public Private Partnerships and Societal Value Propositions – The limitations need to be recognized of either the utility or the city/region acting in isolation. A wealth of smart grid benefits sit across the boundary between the utility and society as a whole. It is unrealistic to expect the utility shareholder to take on the full risk of investment in this instance. Public-private partnerships are required for this technology to reach its full potential. A new era of collaboration is essential. It is necessary to move away from purely financial business cases to develop broader societal value propositions, which are reflective of more than financial benefits and consider positive effects on citizens and businesses from clean, reliable energy supply. They can then be used as a tool with which to appropriately allocate smart grid cost benefit. Despite the clear benefits case for smarter electricity infrastructure, there are a number of barriers, which are acting as a brake on investment.

3. BARRIERS

1. Lack of Awareness – Consumers and policy makers are becoming increasingly aware of the challenges posed by climate change and the role of greenhouse gas emissions in creating the problem. In some cases, they are aware of the role of renewable generation and energy efficiency in combating climate change. It is much less common that they are also aware of the way that power is delivered to the home and the role of smart grids in enabling a low carbon future.

2. Skills and Knowledge – In the longer term, a shortfall is expected in critical skills that will be required to architect and build smart grids. As experienced power system engineers approach retirement, companies will need to transition the pool of engineering skills to include power electronics, communications and data management and mining. System operators will need to manage networks at different levels of transition and learn to operate using advanced visualization and decision support.

3. Policy and Regulation – In many cases, utilities do not get as far as a business case for the smart grid as there are regulatory and policy barriers in place that either create reverse incentives or fail to create sufficient positive incentives for private sector investment.

4. Technology Maturity and Delivery Risk – A smart grid brings together a number of technologies (communications, power electronics, software, etc.) at different stages of the technology maturity lifecycle. In some cases, these technologies have significant technology risks associated with them because defector or agreed standards have not emerged.

5. Access to Affordable Capital – Utility companies are generally adept at tapping the capital markets; however, where delivery risks are high and economic frameworks are variable, the relative cost of capital may be higher than normal, which acts as a deterrent to investment. Stable frameworks and optimum allocation of risk between the customer, the utility and government will be the key to accessing the cheapest capital possible. In the case of municipalities and cooperatives, this challenge may become amplified as the ability to manage delivery risk is reduced.

6. Business Case – Where policy makers and utility executives are aware of the role that smart grids can play, they are often unable to make the business case for smart grid investments. Within the business case, two factors operate: first, the capital and operating costs are too high, as suppliers have not been able to achieve scale economies in production and delivery risk is priced in; and second, only those benefits that are economically tangible are factored in, while other ancillary and non-financial

benefits are not included (e.g. the carbon benefits) or are aligned to the appropriate value chain players.

7. Cyber Security and Data Privacy – Digital communication networks and more granular and frequent information on consumption patterns raise concerns in some quarters of cyber insecurity and potential for misuse of private data. These issues are not unique to smart grids but are cause for concern on what is a critical network infrastructure. The Smart Grids is aware of the realities facing the development of a new electricity supply network. Since grids are highly complex with multiple connection points, it is recognized that isolated developments will be ineffective in such complex value chains. The realization of such active distribution network technologies will allow radically new system concepts to be implemented.

3.1 Solutions to the Barriers

1. Output Based Regulation – As regulators and policymakers consider the best frameworks for smart grid investment, it is worth considering a greater level of output regulation. If it is assumed that similar regulated return models will be used in the future, it is worth considering linking bonus/penalty mechanisms to the rate of return to encourage delivery of the outcomes defined in the smart grid vision (those outcomes specified during the design and architecting phase). In principle, the utilities that are able to deliver the most efficient network per unit of electricity generated should get the highest rate of return.

2. Improved Allocation of Risk – As the technological and delivery risk associated with smart grid implementation is significant, although it will decrease over time as more issues arise and are addressed. In the meantime, it is important that the regulatory frameworks are structured to allocate risk to the parties that are best able to manage it and diversify it. Every party in the value chain should shoulder some of the risk to align incentives, but some parties are more able than others to manage the risk. When designing the frameworks for delivery of the smart grid and awarding contracts, it should be clear that utility shareholders must hold some of the risk, but only sufficient risk to make them act in a way that aligns their interests to those of the consumer, and to a level that is material but not so severe that it is a disincentive to engaging in the project. By balancing bonus/penalty mechanisms at a material level, there will be improved alignment of incentives. In addition to creating the right incentives for the utility, there should be careful consideration of how much of that risk the utilities can pass on to the suppliers and contractors. If the risks are simply passed through to the suppliers and contractors but the benefits are kept by the utility, the alignment breaks down. All parties should have positive and negative incentives in the framework for delivery.

3. Decoupling – In most cases around the world, utility revenues are a function of the commodity price and volume of that commodity sold. In these cases, there is a negative incentive to reduce consumption. In some cases, regulators have introduced specific energy efficiency incentives; some regulators have gone further and decoupled utility rates from the volume of the commodity that they are selling. By guaranteeing a rate of return on the installed asset base independent of the consumption levels, the incentive to drive sales is reduced. The utility is still remunerated on asset base installed. However, this is not a new issue and regulators have developed methods to address this. In some cases, regulators may also want to create stronger incentives for volume reduction in the domestic market or flattening of peak load. However, decoupling is only intended as a transitionary measure to manage the transition from a commodity based business model to a service-based business model. In the long-run, regulators, policy-makers and utilities will need to transition towards a model that rewards efficiency, low carbon generation and flexibility for the consumer.

4. Dealing With Stranded Assets – In some cases, there will be a significant legacy of installed assets that may become stranded by the transition to a smarter grid. In deregulated markets, this may mean that some players in the value chain will lose out significantly from this technology. While this could be considered to be a natural risk of doing business, there will be calls for mechanisms to smooth the transition. If some stakeholders are set to lose significant sums from the process of modernization, there will be strong incentives for them to delay the transition. Whether this is dealt with through the regulatory mechanism or allowed to play out without interference will be a political decision, but it could put significant stress on the transition. and reduce This issue has been faced a number of times already in other areas, and the same mechanism would apply but should be considered on a case by case basis.

5. Managing Telecoms Investments – Telecoms infrastructure will form a significant proportion of the total investment in smart grids and has potential overlap with other aspects of the broader economy. In many developing and developed economies, the growth of a high-speed data and voice infrastructure (both wired and wireless) is a fundamental aspect of their future economic growth plans. The roll-out of these networks will cover similar footprints and may present opportunities to drive economies of scale and scope. Customers should not have to bear the burden of multiple coincident communications networks unless it is strictly necessary for reasons of security. Furthermore, by piggy backing the existing communications infrastructure where possible, it will improve the business case for marginal improvements in smart grid functionality. In many cases, telecommunications and energy regulators have separate remits. Going forward, these regulators will have to work more closely together to agree on spectrum allocation, standards and cost/risk allocation. The same is true of policy makers who will be responsible to consumers and taxpayers for delivering telecommunications and energy infrastructure at the lowest total cost of ownership.

6. Migrating Value Across the Value Chain in a Deregulated Market – Although the process of deregulation has delivered significant cost savings for the consumer in many deregulated markets, it does tend to make the process of transition to a smart grid more complex as there are multiple private sector parties involved with varying potential to win and lose. In each deregulated market, it is important to look at the entire length of the value chain and understand where investments will need to be made and where benefits will accrue. It will then be down to the economists to work out how best to migrate the cost and benefit across the value chain to make sure there is an equal alignment of incentives and delivery of benefits to the consumer. As with the private sector, if consumers are being asked to shoulder significant elements of the risk, they should also see the greatest percentage of the reward.

7. Funding of Pilots – If smart grids are to move forward at a rate that will help society deliver its ambitions to reduce greenhouse gas emissions, there will be a need for many, coordinated smart grid pilots, which then move quickly via effective dissemination of best practice to full scale implementation. These pilots will need to vary in size and scope to ensure a broad spectrum of understanding of the risks and mitigations that need to be addressed to make smart grid value cases more attractive. At present, pilots such as that at Smart Grid City in Boulder have been reliant on the investment of private sector companies and have been conducted at significant risk. There has been a rapid increase in the level of interest in smart grids and potential trials. To get best value for money for the consumer and taxpayer, these pilots will need to coordinate scope and size. They will need to be funded or underwritten by either taxpayers or consumers with incentives placed on the parties engaged to share outputs and learning's so that consumers can mutually benefit from investments made elsewhere. Recently, a number of strategies have been adopted by utilities to encourage regulators and policy makers to agree to pilots.

CONCLUSION

Although the long term vision for the smart grid involves global energy management and home area networks that can control smart appliances, current deployments evolve around the deployment of onsite smart meters. It will tackle the issue of an insufficient availability of skilled staff, particularly to achieve the development and deployment of innovative technologies. These are not fixed, discrete or unique solutions. The two considerable examples are:

1. Microgrids: They are generally defined as low voltage networks with DG sources, together with local storage devices and controllable loads (e.g. water heaters and air conditioning). They have a total installed capacity in the range of between a few hundred kilowatts and a couple of megawatts. The unique feature of Microgrids is that, although they operate mostly connected to the distribution network, they can be automatically transferred to islanded mode, in case of faults in the upstream network and can be resynchronized after restoration of the upstream network voltage. Within the main grid, Microgrids can be regarded as a controlled entity which can be operated as a single aggregated load or generator and, given attractive remuneration, as a small source of power or as ancillary services supporting the network.

2. Virtual electricity market: It adopts the structure of the internet like model and its information and trading capability, rather than any hardware. Power is purchased

and delivered to agreed points or nodes. Its source, whether a conventional generator, RES or from energy storage is determined by the supplier. The system is enabled by modern information technology, advanced power electronic components and efficient storage.

REFERENCES

Christian Feisst et.al, (2008). Smart Grid: The Role of Electricity Infrastructure in Reducing Greenhouse Gas Emissions Researcher Promises Smart Grid, (2009). Network Security, (6), pp. 2-20

David P. Chassin, (2010). What Can the Smart Grid Do for You? And What Can You Do for the Smart Grid?, The Electricity Journal, 23(5), pp. 57-63

Directorate-General for Research, (2006) Sustainable Energy Systems, European Technology Platform Smart Grid, EUR 22040

Eric Miller, (2009). Renewables and the smart grid, Renewable Energy Focus, 10(2), pp. 67-69

Information and Privacy Commissioner, (2009). Ontario, Canada, Smart Privacy for the Smart Grid: Embedding Privacy into the Design of Electricity Conservation.

Jean-Philippe(2010). Smart Grid Interconnecting Smart Objects with IP, pp. 305-324

Joe Miller, (2008). What is the Smart Grid? , Modern Grid Strategy Team, Litos, the Smart grid: An introduction, Prepared for the U.S. Department of Energy by Strategic Communication under contract No. DE-AC26-04NT41817, Subtask 560.01.04

M. Granger Morgan et.al. (2009). The many meanings of "Smart Grid", At Carnegie Mellon, and research on the electricity system is being conducted by the campus wide Electricity Industry Center and by the Electric Energy Systems Group in Electrical and Computer Engineering, Research on information system security is conducted in CyLab SMB Smart Grid Strategic Group, (2010). IEC Smart Grid Standardization Roadmap, Edition 1.0

Peter Crossley (2010). Smart energy systems: Transitioning renewables onto the grid , Renewable Energy Focus, 11(5), pp. 54-56.

Renewable Energy Focus, (2009). Smart grids – a smart idea? 10(5), pp. 62-67

Rick Merritt, (2009). Switching on the smart grid, Electronic Engineering Times

Roger N. Anderson, (2009)The Distributed Storage-Generation “Smart” Electric Grid of the Future, from workshop proceedings, The 10-50 Solution: Technologies and Policies for a Low-Carbon Future, The Pew Center on Global Climate Change and the National Commission on Energy Policy.

Ryan Hledik, (2009). How Green Is the Smart Grid?, The Electricity Journal, 22(3), pp. 29-41

Tony Flick, (2010). Smart Grid: What Is It?, Securing the Smart Grid, pp. 1-18

World economic forum, (2009). Accelerating smart grid investments.

Corresponding Author

Indrajit N. Yadav*

Dept. of Chemical Engineering, Bharati Vidyapeeth College of Engineering, Navi Mumbai, (MS) India

E-Mail – indrajityadavpatil@gmail.com