

Electric Energy Delivery

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The electricity transmission and distribution (T&D) system serves to collect electrical power and energy from generating plant and delivers it to customers. The T&D system is a part of a just-in-time system – power is produced, transmitted and received in an amount equal to the ‘demand’ of the customer. This power system is in the midst of unprecedented changes. Public policy, the electric utility industry and market innovations are determined to transform the grid into an ‘energy delivery system’.

This presentation speculates on several aspects of this transformation - ‘speculates’ because, the complex interactions between legislation, public policy, private and public financing, socialization of costs, environmental and engineering considerations, and public perception tend to obscure the path forward with numerous detours.

The electric power delivery system – aka the power grid – evolved to connect large generating stations, which afforded economies of scale, to load centers. This grid expanded rapidly and demonstrated excellent reliability. However, in the eighties and

nineties investment in the grid as well as in new generation resources came to a grinding halt. Through the turn of the century, the challenge became one of pushing existing resources to the limit and the perception has grown that disinvestment has led to a collapse of reliability. It is likely true that the stressed grid is more vulnerable to low probability events leading to service disruptions of a larger scale. Electric energy is such an important factor in economic development and competitiveness that reliability becomes a major driver for the development of the grid. A second set of drivers come from environmental concerns and the related desire to use renewable and alternative energy resources. Finally, in addition to reliability, economic competitiveness requires affordable and secure energy supply. We cannot, however, ignore the fact that electric energy has become a basic necessity that needs to be fairly economical and fairly reliable for all.

The USDOE vision for the modern grid states *“This smart grid supports the best and most secure electric services available in the world and connects everyone to abundant, affordable, high quality, environmentally conscious, efficient, and reliable electric power. By 2030, the power grid has evolved into an intelligent **energy** delivery system that supports plug-and-play integration of dispatchable and intermittent low-carbon energy sources, and provides a platform for consumer engagement in load management, national energy independence, innovation, entrepreneurship, and economic security”*. What will this new grid look like?

Energy Resources

Central station generation will continue to play an important role and (re)development of Nuclear power is a grand challenge. In the interim it appears that gas and renewables will continue to grow. The business case for gas-fired generation is reasonably clear.

However, renewables are growing fastest using purchase power agreements but the case for these remains tenuous as the interactions between RPS and renewable energy credits is dynamic. A major challenge in renewables integration is that their capacity must be firmed if the benefits of generation capacity deferral are to be achieved. Absent capacity deferral the economic benefits erode and environmental considerations become the major

driver. Concerns over socializing cost of PPAs as well as residential and small-commercial installations, as well as access to renewable across the customer base challenge the penetration of renewables. Distributed generation, renewable and conventional, developed as microgrids holds promise to make power supply more robust.

Changing Load Demand

Energy consumption is increasing but at a lower rate as in the last decade. Incentives for energy efficiency have had a major impact. This can lead to mild price escalation because the fixed costs still accrue. Peak demand reduction can have a much more significant impact and this has led to the implementation of successful Demand Response programs. All of this will change dramatically as Electric Vehicle penetration increases. EVs bring substantial economic benefits to the transportation sector, they can stabilize utility revenue, and provide environmental benefits. However, they will require significant investment in electric distribution systems and perhaps in transmission as well. It may well be that these technologies might allow demand to follow generation , particularly if energy storage devices were available.

Wires

There remains a serious need to increase transmission capacity by building new transmission.

Smart Grid

The smart grid concept refers to devices, software and processes that use extensive communication and control capability with the goal of using the components in a system to their full capability. Simply stated, the grid is operated on the basis of risk – if risk can be better quantified resources can be utilized better. Smart grid components will have inherently better response times thus contributing to better control and protection. Smart grid concepts also bring the promise of greater customer involvement. The smart grid is a means to the end- the end, perhaps, that is described in the DOE vision.

Energy Storage

Electric Energy Storage (or any form of storage that can be readily converted to electricity) may be the closest thing to a silver bullet, but is still elusive in the multi-MWH ratings – e.g., in sizes that could support a community for several hours. Obvious applications include firming renewable resources and supporting transmission and distribution systems. However, very large scale storage truly turns the power system into an *energy delivery* system. Blocks of energy would be moved around the grid and power would then be supplied to loads at the most appropriate time and at the appropriate level. It may well be that financial instrument may become possible to provide capital needed to truly advance the grid.

Creating this energy delivery system will require a significant conversation between public policy leaders, the business community, the engineering community, and the customer.