Thoughts on Developing the Smart Grid

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Remarks before the GridWise Alliance Annual Membership Meeting

December 6, 2010

Just to set the stage, the United States is the most electricity-hungry developed nation in the world, with twice the electricity consumption per capita vs. Western European nations. New York is among the more efficient states in the U.S. but still has a long ways to go to reach the Western European average. There is much to do in energy efficiency and the Smart Grid has a central role to play.

While there are many different perceptions and interpretations of the "Smart Grid," the phrase most generally describes ubiquitous, communicating and self-optimizing systems of power generation, distribution and consumption. The Grid is intended to be distributed, integrated, optimized, adaptive, secure and self-healing.

The Smart Grid has been coming for a long time and it may take another 10 to 15 years to reach its full potential. The perception that the Grid is stupid and in need of saving through major technology advancement is, in my view, misguided. It is surely true that the Grid cannot do everything we want it to, but it is pretty smart already and getting smarter. The Smart Grid will develop incrementally over time, not through a dramatic paradigm shift.

The motive force behind the Grid's evolution is a set of powerful economics for all stakeholders. In the U.S. alone, McKinsey estimates that Smart Grid technologies could yield societal savings of $130 billion annually by 2020….

- Grid applications could save $63 billion by improving transmission efficiency and reliability.
- Advanced metering infrastructure (AMI) could save another $9 billion.
- Customer applications, such as dynamic pricing programs, in-house displays and direct-load controls, could save as much as $59 billion.

And momentum is building, owing to tightening capacity, growing interest in energy efficiency, expected future rise in energy costs, some (although spotty) government funding for energy infrastructure, and the coming challenge of electric vehicles.

But many of the underlying Smart Grid technologies remain expensive and not fully proven. Issues of cost-effective integration with existing systems, testing emerging technologies at scale, and needed changes in customer behavior are often cited. Indeed, the Smart Grid business model is still evolving as regulators, utilities and third-party product and service providers jockey in their roles, and technology standards are tested and evolve.

So, who stands to benefit from the journey toward a Smart Grid?

Utilities perhaps stand to gain the most. Smart Grid should moderate power demand and flatten peak loads, thus allowing utilities to satisfy growing demand with less expansion of fixed plant, for example by avoiding building highly-inefficient peaking power generation plants. The Grid also offers utilities the possibility of a wide range of new profitable products and services, as well as improved power quality and reduced prospect of power outages. Operational efficiency opportunities are evident, but so is the need for significant capital expenditures to make the Smart Grid a full reality.

The utility industry is making a strategic shift toward delivering more services than simply reliable, low-cost energy. Per-unit energy prices will continue to rise in the future, causing customers and PUCs increasingly to demand more effective tools that will allow consumers to manage their electric bills by managing their electricity use.

Product and service providers also stand to profit handsomely from the Smart Grid journey. McKinsey estimates that Smart Grid deployment by utilities will create $15 to $30 billion in annual revenues by 2015 for grid hardware and IT providers, systems integrators, software firms, telecommunications companies, and semiconductor producers. Legacy product providers will also benefit significantly from increased demand.

In any such journey, there is likely to be a period of confusion as longer term benefits are obscured by near-term disruptions. But Smart Grid momentum is building and the ultimate outcome is increasingly clear.

But, of course, you — as industry players — already know what I have just told you. So, perhaps my remaining remarks should be directed at another perspective on how the Smart Grid is developing: What I call “The-Perspective-From-the-Inside-Out,” with the goal of seeking the biggest improvements with the best economics and the highest likelihood of realization first. Meanwhile, other improvements will continue to be developed and tested, leading toward the Ultimate Grid. But, let’s start by going for the jugular.

Evolution not Revolution

My firm, NewWorld Capital Group, is a private equity investor in the environmental opportunities space, not a venture investor. A lot of buzz has gone into long-lead-time items for the Grid—items that entail tremendous technology, adoption and regulatory risk. We do not want to risk capital on innovations that require reinventing business systems, but prefer innovations that fit into existing business systems, by creating value without being highly disruptive. In that sense, we are a lot like you here this evening in approaching investment and risk.

But interesting resource efficiency investment opportunities do exist under the umbrella of the Smart Grid.

While public attention has focused on end-user components of the Smart Grid, there has been and will continue to be more meaningful change occurring at the Grid's center, namely in transmission and distribution. Largely invisible to consumers, this part of the Grid represents the "lowest hanging fruit" in the system. It is also necessarily more impactful — a feeder in the Grid touches tens of thousands of end users, as opposed to end user components which impact only individual consumers.

Focusing on resource efficiency opportunities—getting more power distributed though the same system and doing more with that power—is a pragmatic approach. Near-term adoption and impact enhances the value proposition.

So, how smart does the Grid really need to be and by when?

Will the Real Grid Please Stand Up?

The current Grid gets power from generators-to-consumers reliably, at low cost, with a wide range of technologies and wide variability in demand. And it is repairable and upgradable without needing to be shut down. Remember that between 1910 and 1990, power plants got larger and were moved further from urban centers both to reduce costs and improve local air quality. The challenge in the past of delivering power from generators to users cheaply and reliably was not an easy one.

The current Grid has a number of tools available to help it do its job. Among them:

- Long, high-voltage transmission systems
- Radial and network distribution systems
- Demand Response for industrial customers
- Remote control of generation and switching assets

- Time-of-use pricing
- Capacity and supply auction markets
- Large storage systems, such as provided in NYS by the 1 GW Gilboa pump hydro station near Albany (built for "load shifting" back in the 1970s).

So, what does the future Grid look like? It will have many of the characteristics of the current Grid, plus a lot more. Prime examples are integration for highly-intermittent renewable energy sources and distributed generation and provision of pricing signals to incent more efficient end-user behavior. The tools to support the emerging Grid are:

- Dynamic pricing
- Fully-inclusive Demand Response
- Two-way broadcast of energy
- Advanced storage (all sizes, cheap, easy to permit and control)

Once again, today's Grid is not a simplistic set of wires connecting power plants to home appliances, but instead is a dynamic smart network with storage and real-time adaptability as well as complex pricing signals to drive more optimal behavior by stakeholders. The evolution is in driving down costs and increasing the deployment of tools which spread these capabilities from large industrial stakeholders down to ubiquitous, autonomous small components (ultimately right down to your dishwasher).

So what are the functionality gaps in the Grid today?

- Distributed generation, where we have made a beginning but have a long ways to go
- Two-way energy broadcast capability, again just beginning but with real potential
- Ability to deal with highly-intermittent energy sources
- Self-healing (the current Grid can isolate faults; in the future, technologies like distribution automation switches, beginning to be used now, can get power from where it is to where it is needed).

Here are a few anecdotes from New York on what is working well. The Empire State is leading an effort with end-to-end cooperation among OEM's, government agencies, and utilities based on using modeling and economic evaluation to identify and facilitate the highest NPV rollout opportunities. The surprise for many observers and investors is that the biggest impacts tend to come (early on at least) deep inside the invisible workings of the systems. For example:

- *NYSERDA-commissioned wind integration studies by GE and AWS showed that forecasting and small market changes will allow wind integration for the next decade* with only marginal investment in transmission equipment. The measures identified in

the study are already being implemented by NYISO. FERC has recommended that the rest of the U.S. emulate New York in this approach.

- *Phasor Measuring Units (PMUs) are a technology that facilitates the above integration* and also allows significantly higher throughput in existing Grid hardware. Implementation is ongoing by NYISO, with support from NYSERDA.

- *The Variable Frequency Transformer (VFT) in New Jersey and the coming transmission line to New York City will bring in 610 MW of incremental capacity from PJM*. In the short run, this may appear to be a simple price arbitrage, which is increasing the burning of coal in order to feed high-speed trading data centers on Wall Street. Actually, however, it adds significant flexibility and efficiency to the market for electrons, which will foster investment in cleaner generation in PJM because it creates a larger market for power.

- *Targeted Energy Efficiency programs pioneered by Con Edison are allowing much higher return on investment in energy efficiency*. The adoption of such programs is facilitated by sophisticated matching of the incentives to action that create the most system benefits. Con Ed is able to offset infrastructure investment by targeting energy efficiency programs at the most stressed nodes. (Con Ed may be one of the few utilities in the nation doing this.) The methodology created and implemented by Con Ed exemplifies the unique nature of the highly-dense New York City network distribution system and foreshadows further first-in-the-nation initiatives needed in the City. The unique challenges of the City (infrastructure is underground, requires tearing up streets, tall buildings interfere with radio communication, and buildings of different ages) have driven innovation.

- *New York State has drastically expanded its Demand Response programs*. Demand response resources in the NYISO markets have grown from fewer than 300 end-use locations providing about 700 MW in 2001, to more than 4,000 end-users providing nearly 2,400 MW of demand-response resources in 2009.

What is not working so well in the Grid? Hype and lack of economic prioritization has done a disservice to many Smart Grid innovations. Too-rapid rollout of immature technologies without context can create skepticism and delay good changes. Here are a few negative anecdotes:

- *Disappointing impact of smart meter and residential, end-user Smart Grid pilots*. Price signals are not very effective in changing consumer behavior, consumer education is generally inadequate, and consumer costs are often grossly underestimated.

- Colorado's Xcel's SmartGridCity program was supposed to be a model for Smart Grid, including the ability to remotely read electric meters, detect outages, move power around congested transmission lines, and give consumers real-time information to enable them to make decisions on how to conserve power. In 2008, the project cost was projected at $15.3 million; the estimated cost has been revised to $44.8 million, not including the cost of running and maintaining the Grid. In total, the project will likely cost more than $100 million. Ballooning costs are largely due to building the new Grid's fiber network, which proved more daunting than expected. Cost overruns resulted in a rate hike and consequent consumer pushback. Consumer buy-in has been limited and fewer in-home benefits have resulted than anticipated.

- California's pilot programs created a lot of buzz but have ultimately resulted in public disappointment and anger from consumers who have not seen the value creation they had anticipated.

- *Demand response aggregation and participation*. So far, the opt-in rate has been very low—generally at around 10% of program potential in traditional Demand Response programs

- *Efficiency program validation*. Deep skepticism from failed programs, such as construction being completed with incandescents, so that they can be switched out for CFLs later on to earn a participation credit

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The reality is that today's Grid is pretty smart and works reasonably well. And the disciplining fact is that consumers are not willing to pay more for their power.

Some best practices in New York State based on broad stakeholder consultation, combined with flexible demonstration and evaluation programs, have quietly kept the New York Grid reliable and flexible, despite strong growth of in-state industries, a major oil shock, and transitions from coal to hydro, gas, and nuclear power over the past century. So far in this decade, New York has implemented dynamic pricing markets, importation of renewable energy from Canada, substantial wind integration, and connection to other grids for improved market efficiency—and it is well on its way to properly-incented energy efficiency, Demand Response, and a self-optimizing Grid.

Investment opportunities for people like us in energy efficiency, distributed generation, Demand Response, and HVAC are attractive because of energy inefficiency in the American economy and growing sophistication in the marketplace. We will continue to look for pragmatic solutions to move toward greater energy efficiency in step with the incremental improvements that will continue to move us toward a Smarter Grid.

In closing, here are few broader thoughts on life as an investor in the space. Adoption of new Smart Grid products and services has been slower than expected, in part because of the recent economic downturn and in part because many utilities have simply been slow to buy. Many utilities do not have incentives to be more efficient, since savings generally go to ratepayers, so the sales cycle can be long and frustrating with slow uptakes and low margins. Utilities themselves face slow demand growth, together with the need to replace obsolete capacity as well as raise large amounts of compliance capital. To make matters worse, the industry faces an uncertain regulatory environment.

These are ingredients that favor larger companies with strong balance sheets and can kill smaller companies who often provide innovative solutions. The conditions are certainly not friendly to new ventures.

With the death of Federal climate change legislation, significant assistance from government is less likely going forward unless the energy efficiency argument can prove effective in the political economy. Energy efficiency in the Smart Grid context does offer a net benefit to the economy and creates jobs, so perhaps it can win bi-partisan support in a highly-partisan world. Such support would be a welcome boost for the Smart Grid.

The net is that the situation continues to be uncertain and evolving and we will have to watch it closely for opportunities.