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Hearing on Get Smart on the Smart Grid: How Technology Can Revolutionize Efficiency and Renewable Solutions

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Mr. Chairman and Members of the Committee, thank you for this opportunity to testify before you today on how a smart grid can enable a sustainable energy system with greater energy efficiency, improved reliability, and energy security.

My name is Allan Schurr and I am Vice President of Strategy and Development for IBM's Energy and Utility Business. IBM is proud of its global leadership role in smart grids as it reflects IBM's commitment to a smarter planet that is more instrumented, interconnected, and intelligent – in diverse areas such as transportation systems, water supplies, health care, and, of course, energy. We believe that the application of advanced information and communication technology to energy will revolutionize the way electricity is generated, delivered and consumed across all sectors of the economy.

Opportunities of a Smart Grid

Many begin the discussion of a smart grid with a definition. This approach often focuses on technologies from line sensors to advanced meters, and wireless communication to in-home displays. Unfortunately, this focus frequently omits the primary reasons for investing in an array of smart grid technologies. Namely, the four key interrelated benefits of smart grids:

- More efficient use of energy by consumers
- Lower cost use of renewable energy supplies
- Operational and asset efficiency by utilities
- Improved reliability and quality of electrical service

So let me instead begin with a vision of what providers and consumers alike would experience under a smart grid, with a particular focus on the first two: energy efficiency and renewables.

Imagine a system that helps consumers reduce waste by identifying where and when they use energy; that can automatically manage energy on behalf of consumers based on their lifestyle and economic preferences; that attaches the cost of energy to specific energy consumption patterns or appliances; that facilitates recommendations for deploying best practices and for buying equipment like lighting motion sensors, process control systems, and heating ventilation and cooling; and that enables the use of more efficient electric transportation like plug in cars through consumer-friendly recharging systems.

Or imagine that prices for both central and distributed renewable energy are driven down because the installation and interconnection is faster and cheaper. In this world, the cost and environmental impact of large scale plant transmission interconnection is reduced due to more dynamic loading on existing lines; the process of connecting new rooftop solar systems to the utility grid is as simple as ordering a mobile phone on-line; and the variability of wind, solar and other resources is managed through tighter integration of these supplies with similarly variable loads like dispatchable appliances, grid connected storage, and the timing of plug-in vehicle charging.

Imagine a system that continuously monitors the state of the network, looking for approaching equipment failures by analyzing such things as transient voltage data and transformer oil temperature to predict when equipment may fail so it can be maintained or replaced just in time. Imagine a system that automatically manages maintenance and construction work so that the right crews are sent to the right job with the right materials, thereby reducing costs and repair time for consumers.

Imagine a system that detects an outage, and automatically isolates the problem by rerouting power to affected customers, while simultaneously diagnosing the cause and dispatching the nearest repair crew that has the replacement parts on the truck. Or imagine a system where the utility calls you when there is an outage, rather than the other way around – and even gives you an accurate estimate of when power will be restored so consumers and business can plan accordingly.

Sound far fetched? This world is on our door step and requires no new invention, though it does require new thinking, new business models, new regulatory approaches, and new applications of available technology.

Is It Worth It?

Smart grids encompass a mix of instrumentation, interconnectedness, and intelligence. They are key to ensuring we meet our environmental and energy security goals, and do so cost effectively. Without a coherent approach to leveraging smart grid solutions, the costs to achieve our Nation's goals will unnecessarily divert resources from other productive uses. Let me describe some examples where smart grids help achieve energy efficiency and renewables at the lowest possible cost.

Energy efficiency is widely viewed as the lowest impact and most cost effective resource. In the past, its improvement has relied on efficient equipment selection, improved building shells, and industrial and building control systems. Smart grid technologies will allow improvements in cost and functionality for all customer classes. For example:

- It is not surprising that large enterprises have made substantial progress in reducing energy consumed per unit of output over the past 30 years. Energy price shocks of the 1970's and 1980's fundamentally impacted the profitability of companies, and adversely impacted governments budgets. These enterprises had the scale to support detailed engineering analysis needed to identify waste in their operations and equipment, and they made investments accordingly to improve efficiency. At IBM, we have reduced our operational energy costs by over $310M and reduced CO2 emissions 45% from 1990 levels. But consumers and small businesses cannot afford this level of detailed analysis. However, smart grid technologies in the form of advanced metering infrastructure, data analytics on energy consumption and price data, and peer to peer systems that offer advice and standardized solution delivered over the internet are all facilitated through the smart grid.

Installing energy efficient equipment, however, is only the start of the process. Again, large enterprises know that continuous monitoring and control of energy systems is key to realizing the benefits of energy efficiency. If the lighting runs on an empty shop floor, or office occupants change the temperature, or a pump operates at a higher pressure than specified, even highly efficient equipment is wasteful. Once again, consumers and small businesses have not been afforded the same opportunity to be as aware and effective at reducing unnecessary energy consumption. Smart grid technologies can also help track, analyze, and control energy consumption at the whole premise level, and on specific appliances, such as connected thermostats for a home air conditioner. Think of this as an intelligent home automation system, but utilizing internet technology and in some cases utility scale economies, to dramatically reduce costs.

- Finally, electric transportation offers a substantial opportunity to simultaneously improve energy efficiency and energy security. And as ubiquitous as the electric grid is, its role as a seamless and user friendly electric refueling network will require investment and coordination between drivers, automakers, utilities, and public charging providers. Especially for the emerging area of plug-in vehicles, smart grid technologies are critical to ensuring interoperability and off peak charging – whether at the system level or to avoid local distribution feeder overloads.

Renewable energy technology is a growing part of a portfolio of generating technologies that can reduce environmental impacts. Whether in a utility scale configuration or in wholly distributed installations, the integration of renewables with traditional grid operations requires special consideration and smart grids can reduce this cost of assimilation. For example:

- Transmission access is often cited as a constraint to more renewable energy development. This constraint is a combination of the lack of transmission lines to interconnect the utility scale wind or solar plant, as well as lack of available capacity on the existing transmission assets downstream of the interconnection point. If smart grid technologies can allow transmission operators to capture additional capacity through more dynamic loading, asset risk assessments, new market designs, and reduced spinning reserve that is otherwise contracting for transmission capacity, the costs and lead time of constructing new capacity can be reduced.

- To achieve the maximum penetration of renewable energy sources, utility scale systems must be supplemented with distributed systems located at the point of energy consumption. In addition to roof top solar, micro-wind and combined heat and power (CHP) systems need to be encouraged. Systems to provision these technologies through automation also are needed to reduce the cost and time of contracting for interconnection, ensuring safe operation, and monitoring the network. Smart grid technologies can simplify these processes through business process automation, communication standards, and system discovery and monitoring – much like the way the internet itself manages devices that constantly are connected and disconnected.
- The variability or intermittency of renewable energy output is often cited as a significant objection to growing the portion of renewable energy sources. To the degree that variable supply can be matched in time, quantity and location to variable loads, this concern is significantly mitigated. Smart grid technology can address this supply/demand imbalance by connecting

the current and forecasted renewable output to available variable load. Such load control has been available for years. Utilizing these same techniques to modulate loads, as well as dispatching charge and discharge cycles is one strategy for reducing the need for spinning reserve to support renewables. IBM is currently involved in related efforts in Europe to integrate wind generation to the smart charging of plug-in vehicles so that the on-board battery storage can absorb excess wind energy during controlled charge cycles.

Can We Do It?

The Desire for the Smart Grid

One important actor in the future I am describing here today is the consumer. Many industry leaders openly wonder if consumers are ready for this new world. Two recent IBM surveys demonstrate that consumers do want more control over their energy usage. The historical view of residential and small commercial customers as uniform and like-minded is not sustainable in the long run and is already outdated in most places. As utilities prepare for a period of major new infrastructure investments, consumers worldwide are reconsidering their role in the electric power value chain because of a combination of environmental, economic, and technology-driven factors. New consumer behaviors are emerging based on discretionary income, desire for control, ability to take control, and how successfully these new investments can be leveraged.

Furthermore, utility pricing and demand response studies demonstrate that consumers respond proactively to increased energy information and feedback that results from advanced metering and in-home displays. In short, consumers save money as they learn when and where their energy spending goes.

Innovation that matters to the world – is paraphrased from part of IBM's core values. As one measure of innovation, the Cleantech category has attracted substantial investment from the venture community covering everything from biofuels to solar to energy efficiency. But while biofuel and solar investing has stabilized, smart grid related investments have been growing. For example, the third quarter of 2008 saw venture capital investments in energy efficiency and smart grid grow to $272 million, overtaking biofuels' $150 million to capture second-place behind solar power companies in green technology VC investment rankings.

In addition, IBM's experience with both our own investments in smart grid and our work with technology partners of all sizes is that the modernization of the grid and grid connected systems is attracting substantial innovation: innovation through the application of technologies originally developed for other industries, innovation with new business models, and innovation of new vendor to vendor integration through specialization. The resulting landscape is dynamic, to say the least, and utilities are modifying their risk tolerance in some cases to be more comfortable acquiring less than fully mature technologies and solutions, through the insistence on standards and integration platforms. Today, we see new technologies emerging that are supported by both strong corporate balance sheets as well as venture funded startups.

Interoperability

Historically, progress occurs when many entities communicate, share information, and together create something that no one entity could do alone. When people talk about the smart grid, interoperability is a necessary foundation of that concept, and good progress is being made. Within the electricity system, interoperability means the seamless, end-to-end connectivity of hardware and software from the customers' appliances all the way through the transmission and distribution system to the power source, enhancing the coordination of energy flows with real-time flows of information and analysis.

There are three types of interoperability, and all are relevant to our objective. Technical interoperability covers the physical and communications connections between and among devices or systems (e.g., 120V power plugs and USB ports on a PC). Informational interoperability covers the content, semantics and format for data or instructions flows (such as the accepted meanings of human or computer languages and common symbols). Organizational interoperability covers the relationships between organizations and individuals and their parts of the system, including business relationships (such as contracts, ownership, and market structures) and legal relationships (e.g., regulatory structures and requirements, and protection of physical and intellectual property). All three types must be addressed to achieve effective interoperability in any system.

Privacy

One of the perceived hurdles to smart grids has to do with consumer privacy -- particularly voiced by consumer groups about the privacy of real-time meter data that is identifiable with household activities (such as that which could be associated with smart appliances). IBM has just completed a global utility consumer survey in late 2008 in which we asked people in twelve countries a variety of questions about their energy usage and goals for managing energy in the future. In anticipation of such concerns, our question set included several that dealt with consumers' desire for more information about their usage of energy and how they would use personally use that data, as well as some specific questions about making data available to outside parties and trusted privacy models for such data.

In the US, 65% of consumers we surveyed stated that they would be willing to make their usage data available to energy providers if it could be used to identify better deals for them. Only 9% said they would not (the remainder were unsure or neutral). These numbers are virtually identical to the global averages, and were consistent across all age and income levels. Most of those customers also want to leverage that data themselves; 54% in the US (58% globally) said that they want to obtain more information about their usage, such as its cost at any given time or its environmental impact.

To get a sense for what a privacy structure that would provide consumers with the most confidence that their data was being handled securely, we also asked about other industry models for handling sensitive personal data. Two industry models emerged with a majority of customers being comfortable: banking and medical offices (doctors, hospitals, and pharmacies). Given the somewhat unique nature of the privacy regulations and laws around medical records in the United States, we believe that providing a data security and privacy infrastructure along the lines of the consumer banking system would make the most sense to give people confidence that their data was being handled securely.

Challenges

Despite the many benefits that a smart grid offers, business model challenges still exist in making a fully integrated smart grid a reality. Today's utility business models are based upon the utility earning an authorized rate of return on capital investments. Utilities responsible for making these investments focus on minimizing risk and consequently, utilities are often slow to adopt new technologies that have not been extensively proven on a large installed-base. In addition, the many faceted value of smart grid technologies has been difficult to quantify in a simple cost-benefit analysis, thus making comparative financial metrics difficult to achieve. Existing electric rate structures create further complications since state public utility commissions (PUCs) are responsible for ensuring that electric utilities under their jurisdiction provide service at a cost effective price. Investments are often evaluated based upon actual and realizable benefits, and while societal benefits may be considered, they must be evaluated appropriately.

Another challenge is the lack of a coherent national smart grid strategy. The efficient evolution to a smart grid will require a coordinated strategy that relies upon building an appropriate electric infrastructure foundation to maximize utilization of the existing system. A smart grid is a new integrated operational and conceptual model for utilities. Among other things, it envisions the real-time monitoring of utility transformers, transmission and distribution line segments, generation units, and consumer usage, along with the ability to change the performance of each monitored device. This will require significant planning for implementing a system-wide network of monitoring devices (including monitoring devices at the consumer level), and for installing the equipment necessary to enable parts of the system to "talk" with other components and reroute power, self-heal configurations, and take other actions automatically. Developing such an integrated system requires a multi-year, phased installation of smart grid devices and upgraded computer and communication capabilities.

The lack of smart rates is also an issue. Per the Brattle Group, a smart rate provides "cost-based, forward looking information on the price of electricity that allows consumers to make wise decisions about how much electricity to purchase and when to purchase it. A review of default rate designs across North America reveals that prices paid by customers do not reflect the scarcity of capacity to produce energy at various times of day.

There is a lack of recognition that the default rates embody a hedging or risk premium which insulates customers from price volatility and eliminates any incentive that they would otherwise have for moving to dynamic pricing tariffs. In addition, customers lack the information to become smart shoppers. Policy makers have bought into a viewpoint espoused by defenders of the status quo that customers are averse to being placed on dynamic pricing tariffs, since not only will they face price volatility but they may also pay higher bills. This is contradicted by evidence from fifteen recent pilots with dynamic pricing, which clearly showed that once customers experienced a dynamic tariff, not only did they understand and respond to the price signals, they also overwhelming preferred dynamic tariffs to their conventional hedged rate form. The experiments also showed that a well-thought out customer education program is needed to sustain customer response.

To achieve the benefits of smart grids, industry must embark on and complete scale deployments of their selected solutions. While there are numerous, and sometimes overlapping pre-deployment pilots being conducted on various elements of the smart grid architecture, there have been few full scale projects.

However, things are changing and projects are beginning, and they are utilizing proven methodologies for managing similar large scale projects to define, design, develop and launch complex smart grid. IBM's extensive experience in complex projects has allowed us to apply skills, tools, and technologies to ensure that program functional and budget objectives are met and all constituencies are addressed. Installing technology is of course necessary, but insufficient for a successful outcome. Rather, significant technology integration, process redesign, and change management are all elements that ensure success. This proven approach is one way to reduce the hurdles of getting smart grid projects off the ground. As both utility executives and regulators see a disciplined, risk based program management approach, many of the concerns of this new frontier are alleviated.

This undertaking also will require significant investment and access to capital is a major hurdle to making these investments. A smart grid is a complex, comprehensive, and orchestrated utility operating system; it will provide publicly observable benefits only after substantial investments have been made in upgrading the infrastructure of the nation's utilities. Investing in equipment and personnel training, for which there are few short-term benefits, creates operating costs that may be difficult to justify without policy direction and support from government agencies

Conclusion

Smart grid has become a topic of keen interest to parties across the technology, energy, and regulatory spectrum. Its benefits to energy efficiency and renewables are well documented alongside reliability and operating efficiencies. So what is the hurdle to achieving these benefits? We believe smart grid advancement is now dependent on overcoming the institutional inertia of the existing regulatory models and utility business. Necessary technologies and solutions are available today, awaiting only the orders for scale deployments to drive costs out and benefits up. We believe our nation is ready to break out from this inertia and, to dramatically alter the energy value chain. By doing so we will help the US achieve its energy efficiency and energy security goals.

Thank you very much and I look forward to answering your questions.