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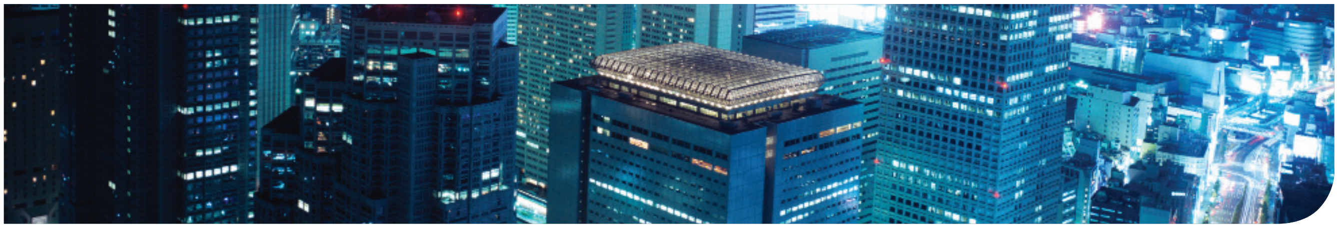
Conference White Paper:
"Utility of the Future"

Abstract

The U.S. electric power industry faces challenges that rival those of any period in its history. Demand growth is requiring generation capacity expansion at a time when generation options pose challenging combinations of costs, risks, and environmental consequences. An aging infrastructure is being pressed into service to meet the demands of a digital society. And this same infrastructure will soon need to accommodate a growing percentage of intermittent renewable resources, distributed generation and storage, energy efficiency and demand response, and plug-in hybrid electric vehicles. Uncertain carbon emission limitations add another dimension. These challenges are likely to result in new forms of utility project financing, new regulatory solutions, and technological advancement, including, but not limited to, the promise of the Smart Grid, renewable/storage synergies, building energy solutions, and many more.

With these issues in mind, nearly 60 utility executives, regulators, industry stakeholders, and senior KEMA consultants met in May 2008 in Dallas not only to discuss these challenges, but also to set in motion an ongoing dialog and identify a path toward precedent-setting solutions.



Executive Summary

“The time is upon us for boldness and a move away from incrementalism. As we look back 20 years from now, history will likely determine that the winners will be those who took bold, action-oriented, but well-informed steps today.”

Hugo van Nispen

President and Managing Director, KEMA, Inc.

“We as a country need to be bold. We as a country have to look at solutions that bring together…national security, climate change, and economic growth. The only area where that happens is in energy.”

George E. Pataki,

Counsel, Chadbourne & Parke LLP,
and former Governor of New York

A Bold Vision: Past and Present

Hugo van Nispen, President and Managing Director, KEMA, Inc., opened KEMA's “Utility of the Future” forum by comparing the challenges the industry faces today with the challenges the early electric power industry faced. “Since the pioneering days of Edison, Westinghouse, and other luminary names in our industry, I believe that our industry has been defined by the willingness of bold visionary thinkers to embrace the challenges that were in front of them. Indeed, if we roll the clock back, the challenges of full electrification must have seemed absolutely overbearing to our forefathers, as they contemplated some of the greatest initiatives ever created by man.”

He summarized the daunting challenges the industry faces today. These include the acceptance of global climate change as a manmade phenomenon, with the attendant cries for significant reduction in carbon emissions, and severe stressing of generation and transmission adequacy in the face of resistance to the construction of fossil or nuclear baseload capacity. Other challenges include inexorably rising costs without the ability to seek full cost recovery, and the inability of the existing power delivery infrastructure to adapt to the demands of the 21st century.

Yet, van Nispen expressed his belief that the bold vision needed to address these challenges has been placed on hold. Citing criticism of the supposedly overbuilt industry's gold plated standard, he characterized the industry as forced to squeeze all possible marginal capability out of the existing system, at the lowest possible cost. During this incrementalism, customers embarked on a digital revolution, exponentially increasing their expectations of quality and service from the industry.

Mr. van Nispen called for a major change in the current environment: “The confluence of major forces directed at our industry no longer enables us to practice the art of incrementalism.” He expressed the hope that this forum and future interactions would help facilitate positive steps toward the decisive action needed.

Energy: The Confluence of Economy, Environment, and National Security

In his keynote address, Governor George Pataki listed three major challenges facing the United States: the economy, the environment, and national security. And he asserted that "the one area where all of this comes together is energy." With regard to the economy, he pointed out that the U.S. will spend about one half of a trillion dollars on foreign oil. This unprecedented transfer of wealth from one society to another, in some cases to "unstable regimes," also results in the combustion of this oil and the consequent emissions of carbon to the atmosphere.

In In the energy area, Pataki explained that three basic policy/political issues will be debated in 2008 and 2009: 1) whether or not to establish a national policy on carbon emission limits, 2) whether or not to establish a national renewable portfolio standard, and 3) whether the U.S. should sign a global climate agreement.

Regarding the first issue, Pataki predicted adoption of a national carbon cap-and-trade law. Cap-and-trade systems and laws are already being adopted (e.g., the Regional Greenhouse Gas Initiative in the Northeast and Mid-Atlantic). Yet "rather than have a hodge-podge of separate cap-and-trade carbon programs across the country, I think there's going to be a desire…to have a uniform law across the country."

With regard to renewable portfolio standard (RPS) legislation, Pataki expressed a preference for state-based standards, rather than a federal one, due to the diversity of renewable capabilities across the states. The diversity of wind, solar, hydroelectric, and geothermal energy across different regions of the country makes a national policy impractical, in his view.

In the area of global climate agreements, Pataki predicted that "the United States [will] work with the EU [European Union] and Canada and others to try to reach an agreement with countries like China and India where we will set carbon caps for ourselves, maybe not in treaty, maybe in law, in exchange for those countries agreeing to limit not the total emission of carbon, but to limit the energy intensity or the carbon intensity of production as they go forward."

Pataki also indicated a preference for a "national law allowing for the federal licensing and permitting of interstate electrical transmission systems." Citing precedent in the federal permitting of long-distance natural gas pipelines to Gulf Coast, Pataki pointed out that a federal system would eliminate "the hodge-podge Byzantine approach of getting licensed in each state that is uncertain at best." This approach would help meet RPS and help reduce dependence on foreign oil.

The Governor also recommended extending tax credits for wind and solar credits from the current two-year period to 8-10 years, to provide investors the assurance they need during the sometimes lengthy permitting and financing process. And as an alternative to current Corporate Average Fuel Economy (CAFE) standards for vehicle fuel efficiency, Pataki advocated a tax incentive program for manufacturers of very fuel efficient vehicles.

He also recommended further exploration of a concept to sequester carbon dioxide (CO_2) while using it to enhance oil recovery at semi-depleted domes on the Gulf Coast and in Texas. This concept involves converting abandoned natural gas pipelines (such as the one that runs from Louisiana to the Ohio River Valley) to pump CO_2 in the opposite direction. In addition to sequestering CO_2 in the domes, this approach would increase oil recovery, reducing dependence on foreign oil.

Regulatory Perspectives

The Magnitude of the Investment Needed

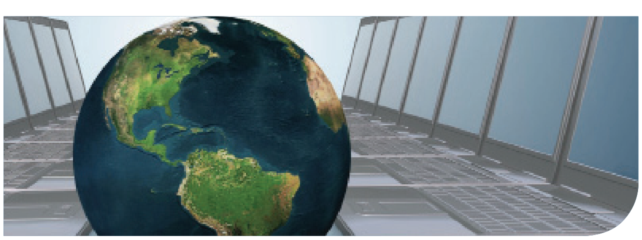
Speakers generally agreed that power delivery infrastructure upgrading is needed as a strategic investment in the future, to maintain a higher level of service, and to enable more rapid service restoration during outages and integration of wind energy into the system, and to accommodate dispersed generation and plug-in hybrid electric vehicles. At the same time, the needed investment to upgrade the power delivery infrastructure on a national level to accommodate the new demands that are, and will be, placed upon it, is very large.

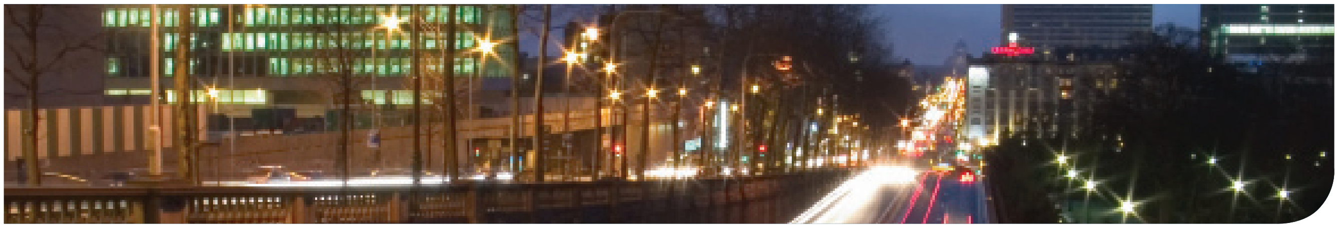
Many of the electric power assets installed in portions of the U.S. are over 80 years old. There is understandable hesitation to replace those assets with technology that is still rapidly evolving. However, customers consider infrastructure development a key component of basic economic development. If the investments are not made, industrial and commercial customers will choose to move their businesses to areas with modern power delivery infrastructure.

As a result of demand growth and accelerated retirement of some power generation, some utilities anticipate investment in capacity expenditures approximately equal to their current market capitalization over the next five-year period. Regulators will be asked to support a high level of investment in generation expansion to meet demand growth and accommodate retirement acceleration, accommodate high fuel prices, allow needed investment in the power delivery infrastructure and renewable generation, and address environmental constraints. The industry-wide needed investment in generation, transmission, and distribution is potentially greater than one trillion dollars.

One challenging question utilities face in winning regulatory support for their initiatives is: “How do you convince [regulators] that putting money into smart grid investments is actually part of the solution to handling the new need for massive capital for generation backbone and transmission and damping the fuel price volatility and spikes that we can see?”

Regulatory discussions also focused on the Regional Greenhouse Gas Initiative (RGGI, often called “ReGGIe”), the first market-based, mandatory cap-and-trade program in the U.S. to reduce greenhouse gas emissions in a simple and constructive way. It will open the first U.S. auction of CO2 allowances on September 25, 2008. Ten Northeast and Mid-Atlantic states pioneered this auction. According to a former Commissioner of a Northeast state environmental department, this project alone will involve a substantial transfer of wealth from the private sector to public sector because of the high value of the emission allowances. This public funding could be used to support the financing for the needed infrastructure.





State and Federal Counter-Control

An important aspect of the regulatory challenge is state and federal counter-control. Calling the problem "a jurisdictional breakdown of authority between the state and federal government," a former FERC Commissioner explained that this problem occurs today in multi-state transmission projects (e.g., where the cost is allocated, who pays citing authorities, etc.). He pointed out that, in the future, this problem will also be faced with any sort of climate change limitation system. He characterized the problem as confusion as to which entity provides leadership and prioritization. His view is that many of these problems cannot be solved on a state-by-state basis.

A state public utility commissioner stated that "this idea that states should take an approach where every single state is on the bleeding edge of each different type of technological change is a mistake. Each of us can play a role in educating the other about the particular areas of risk that we are taking on as a regulatory body." Characterizing the "fragmented industry" with over 3,300 different entities serving customers in the U.S., he called for utilities to educate regulators about activities occurring across jurisdictions. Pointing out that customers are starting to demand innovation and that new players are entering the market with reputations of quickly developing products, he emphasized the opportunity for rapid innovation, including innovation in vertically integrated entities. He called for an end to "regulatory tentativeness." He also recommended "fact-based advocacy and education" at public utility commissions by groups that support distributed resources, plug-in hybrid electric vehicles, renewable energy, energy efficiency, and others. Instead of considering the regulator "the enemy," he encouraged stakeholders to "engage the regulator."

A utility Chief Technology Officer characterized the challenge as a "need to rethink…the regulatory value proposition." He recommended careful consideration of "what policies and regulatory frameworks are going to be needed to incent utilities, customers, and investors to aggressively pursue energy efficiency…to address the need for modernization of critical infrastructure, and to support the technological innovation that will be required to address CO2 and give energy consumers more control over how they use energy." He also pointed out the need for redesigned business models for energy companies, utilities, and suppliers. It also involves identifying the regulatory frameworks and policies that will "balance the needs of our customers, our communities, our regional economies, and our investors."

Any regulatory solution requires commitment from the top, according to another panelist, a former state environmental department Commissioner. "At the end of the day, it really comes down to the Governor of the state providing the leadership and saying that this is important. This is where the state has to go. We need to address our infrastructure. We need to invest in technology. In the long term, the state's going to reap the benefits."

Perspectives on Carbon

A carbon constrained world is rapidly approaching. Some analysts believe that carbon emissions will need to be reduced between 60 percent and 70 percent from today's baseline levels by mid-century. The G8 international conference listed a stated objective of reducing greenhouse (GHG) emissions by 50 percent by mid century. This objective may seem overwhelming; to meet demand growth, electric generating capacity will need to increase by 40 percent by 2030 alone, according to the U.S. Department of Energy. And transportation demand is forecasted to double by mid century.

In the coming decades, the level of transformation required in energy production, transportation, and use will be dramatic. Regulators, utilities, and society will use CO2 sequestration, limiting of coal generation, cap and trade systems, and other mechanisms and approaches to manage environmental concerns. Meeting the challenges of a carbon-constrained world will probably require a combination of solutions, including energy efficiency, nuclear power, renewable energy, carbon capture and sequestration, and others.

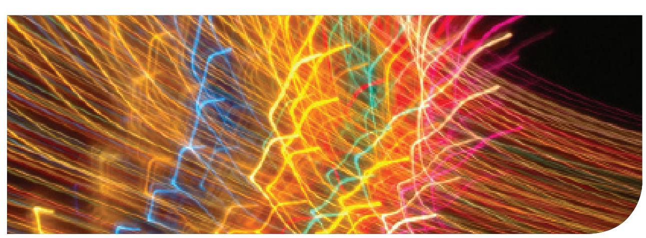
The cost of technologies (e.g., renewable energy systems, carbon sequestration systems, and distributed generation systems) and regulations (e.g., cap and trade) are not known, but will probably be passed on to consumers through rates or some other mechanism. In other words, carbon regulation may be reflected in the costs of coal and gas generation. This will effectively incentivize renewables such as solar and wind energy, which do not emit greenhouse gases.

A Dow Jones public opinion poll showed that 63 percent of those surveyed said that they are concerned about global climate change. However, when those same respondents were asked how much they would be willing to pay on their electricity bills to help reduce CO2 emissions, only about one-half were willing to pay more than their current bill. Only 18 percent were willing to see their bills increase by 10 percent or more and 3 percent were willing to pay 20 percent or more. Responses like these indicate a potential backlash if significant environmental costs are integrated into rates.

According to a research and development (R&D) executive at publicly traded energy production company, the industry can rely upon carbon capture and sequestration. He explained that "all of the components for carbon capture and sequestration are out there. We've been doing enhanced oil recovery for years now. We know how to capture carbon. The real issue is integrating it together and then bolting it onto the back end of a power plant. And it's that integration issue that we need to focus our time and attention on."

The R&D executive also pointed out the need for measurement, monitoring, and verification (MMV) of the CO2 plume in long-term sequestration. This involves identification of leakage, migration, and other issues, which requires an aggressive MMV program in the U.S.

One vision includes using the existing natural gas pipeline infrastructure to transport CO2 to depleted oil and gas fields. However, enhanced oil recovery may not be able to use all of the CO2 that may be captured from fossil-fueled generating stations. Therefore, deep saline formations will also be needed.



The apprehension over pending carbon legislation often prevents or delays construction of new generation facilities. Some coal-fired generating plants are being cancelled, and the number of new coal plant proposals has decreased. For example, in late 2007, Kansas declined to authorize construction of a new coal plant primarily due to its CO_2 emissions.

Because regions of the country vary widely in their ability to access renewable energy, such as hydroelectric, solar, and wind, federal legislators may not establish national renewable portfolio standards. However, some believe that the current and anticipated political climate will support national cap-and-trade policies, due to the emergence of regional cap-and-trade systems.

A planning executive with a publicly-owned Northwest utility explained that his company is believed to be the first greenhouse gas neutral U.S. utility – they are a net zero emitting electric utility. The utility is meeting all of its load growth with renewables and conservation. Through conservation programs that began 30 years ago, they reduced system load by 11 percent and avoided emitting 600,000 metric tons of CO2 in 2007. Their renewables program currently includes purchases of large amounts of wind power, and their integrated resource plan includes landfill gas, additional wind, and distributed generation in the form of solar and microturbines. Their program also includes purchase of local offsets, the cost of which is rising rapidly.

Perspectives on Renewables

Central Station Wind and Solar

Even as investment dollars are shying away from nuclear and coal generation, they are flooding to renewable generation, especially wind and solar. Driven by state RPS standards, many regions of the country are oversubscribed with applications for new wind generation siting, licensing, and transmission interconnection. The Midwest ISO, for instance, has 60,000 MW of wind generation interconnection requests pending. Almost daily, some state, municipality, utility, or independent power producer announces plans for major investments in renewables. Also, "behind the meter" or distributed solar (and to some extent wind) implementations are growing rapidly. Today, these systems appear in utility planning as net decreases in metered load growth, but as distributed solar and wind resources become more significant, they will represent a significant amount of generation resource that must be accommodated on the grid via careful planning and engineering.

Increased renewable resources implies increased variability (due to the intermittent nature of solar and wind energy) and decreased capacity factors. In some areas, the wind increases in the evening hours. In other areas, wind can exhibit a diurnal effect or a shoreline oceanic effect that provides two daily peaks – in early morning and late evening. Like hydroelectric power, wind generation cannot necessarily be built close to load centers or existing transmission – it must be built where the wind blows. Around the country, transmission access limits wind development. Texas and California have both taken steps to ensure that the needed transmission is sited, funded, and built before the windmills are committed, as a way to remove this obstacle and assure the wind development community that their energy will reach loads.

Despite the growth in wind generation, it still represents less than 1 percent of total U.S. generation. However, approximately 6,000 megawatts of renewable capacity will come on line over the next several years to meet the 2015 RPS targets, representing an unprecedented ramp up in renewable generation development.

Investors are willing to finance regulated and unregulated renewable generation projects when they can see the potential for a return. Today, that potential remains, and will probably continue to remain for several years, dependent upon Production Tax Credits (PTCs) or other subsidies. Making existing PTCs permanent would stimulate greater investment and production of wind generation. A 2007 study showed a 73-93 percent decrease in new wind capacity following years in which the PTC was not extended (2000, 2002 and 2004). The same study forecasted that without a PTC extension, 2009 wind installations could fall from an estimated 6,500 megawatts to as low as 500 megawatts. Another limitation to renewables that vexes regulators and utilities is public arguments against the installation of new transmission lines to bring the renewable energy to load centers (the “not in my backyard” concern), as well as concerns with avian (bird) mortality as a result of turbine operation.

Behind the Meter

The role of the electric utility in the build out of distributed generation, increased energy efficiency and demand response, and the integration of these technologies (and storage) with the grid is unclear. Utilities have traditionally worked with customers on a variety of programs, such as direct load control of conditioning units, pool pumps, and water heaters. More recently, utilities have supported energy efficient appliances and lighting (e.g., compact fluorescent bulbs). A natural extension of these activities would be participation in other activities “behind the meter.”

In the utility of the future, utilities will benefit from advantages borne of their traditional business model and brand equity. They have the resources and institutional experience to accomplish integration; access to long-term financing; and the ability to leverage their well-recognized brands. The utility of the future may also offer customers such options as their own microgrids and storage, separating them from a central utility’s services – if poor reliability and high tariffs push them in that direction.

Areas in which utilities may need to strengthen their position include public communications, gaining knowledge of and acting on customer needs, and creating a greater sense of urgency with public utility commissions. In order to succeed behind the meter, utilities will need to forge new relationships with customers based on information and value that extends beyond delivering a commodity. While utilities send regular communications to customers, they are not as practiced at understanding whether the message is understood and acted upon. To that end, utilities would benefit from greater market research on their customer base to understand the evolution of customer needs, so that utility services would be created at the right time to meet emerging needs.

In today's society, electricity supports an expectation or entitlement of 24/7 access. Regulators and utilities will need to explain to consumers that improvements will cost them money. The message should persuasively explain the benefits of applying smart grid enabling technologies. Without a focused message and a coherent and consistent value proposition, public backlash is possible.

Although the paths to solutions are not clear, utilities may need to overcome regulatory decision cycles that handicap them competitively. More generally, a new compact with regulators is probably needed for utilities to participate behind the meter. With new technologies, new business models, and greater utility exposure to customers in the form of new services, commissions may become tolerant of "intelligent mistakes." Utilities will need to become more skilled at public and political outreach and fact-based advocacy in order to influence regulatory decisions.

Interdependence of Renewables and Energy Storage

No longer can the discourse over clean energy sources separate wind and other renewables from energy storage. Instead, renewables and storage need to be part of an integrated discussion. In fact, the overall contribution of renewables is dependent on energy storage systems. Storage potentially resolves the issues of matching renewable resources to demand more effectively than any other technology. The rapid advance of storage technology is likely to increase its role to a significant part of the energy infrastructure. However, for energy storage to be feasible on a large scale, additional research and testing is needed.

Uncertainty remains as to the optimal locations for storage. Storage located at remote wind farms can capture and store energy for later transmission. Storage located at the load can serve that load as needed, as well as provide local voltage support and other benefits to the local distribution system. Some storage systems can be relocated as needed, providing additional flexibility. As technical improvements in lithium batteries advance, home energy storage devices become feasible.

New regulatory philosophies for addressing storage as a generation, transmission, or distributed resource as appropriate to different applications will be needed. For example, paying for storage would vary according to the application. If the storage is a transmission asset, then the transmission company could collect from T&D budgets and incorporate it into rates. If the storage is a generation asset, the storage could be treated like merchant generation – bought and sold as energy and delivery services at the Independent System Operator (ISO).

Perspectives on Financing

Introduction

From the financer's seat, the challenges the industry faces translate into a series of financial questions. What will this cost us? What do current and prospector investors seek? And how can we insure capital availability as we collectively pursue what will amount to substantive infrastructure projects?

A former FERC Commissioner estimated the needed investment in transmission, distribution, and generation at potentially greater than one trillion dollars. Costs for critical building materials such as cement, concrete products, steel, and copper are also escalating, with no expectations as to when these costs will reverse or at least stabilize. One significant contributing factor is the rapid and sustained growth of economies supported by new generation in India and China, which are creating a shortage of and higher cost for generation equipment. Even if technology issues and cost estimation risks could be overcome, offshore vendors essential to nuclear plant supply today typically insist on passing these commodity cost exposures on to the plant owner.

If utilities were to invest in nuclear generation, the capital expenditures could approach a significant percentage of their market capitalization, which translates into high risk, obvious rate increases, and potential share dilutions. Even assuming that licensing and siting issues were resolved, other unforeseen roadblocks to their full use could present utilities with adverse financial scenarios including bankruptcy, creating further energy sustainability issues for customers, as well as consequences for the economy in general.

Funding Sources

In light of growing capacity needs, utilities in the United States will require an unprecedented supply of funding. Traditionally, financing has originated from small fixed-income oriented investors or pension funds, insurance companies, and others seeking low risk investments with returns somewhat better than government bonds. Such sources of financing will continue to be available for utilities seeking to finance transmission projects once siting is approved. Investors will see a continuation of the classic utility fixed return model. In this model, utilities have an obligation to serve and to make needed investments; and regulators (the ultimate customer and investor) have an obligation to allow prudent investments and provide a sufficient rate of return.

These traditional sources of funding may see new nuclear plants and possibly new coal plants in a different light. Well aware of the licensing problems and cost overruns of the last round of nuclear plant construction, investors will not view new nuclear plants as low risk. Ongoing uncertainties about carbon regimes and the technology of carbon sequestration could lead to similar risk aversion attitudes towards new coal plants. Even with initial siting and licensing apparently approved, some investors may see risk in these ventures. Some regulators may also be risk adverse.

Utilities seeking their portion of huge generation investments will face two problems. The first problem is the inevitable impact of such expensive capital investment on the rate structure and the potential for share value dilution or a lowering of ratings. The second problem is the outright lack of traditional fixed income investors willing to face an unknown regulatory and technology cost risk.

To fill this void, some speakers at the KEMA forum predicted that private equity, hedge funds, and sovereign wealth funds will provide financing for higher risk situations (e.g., nuclear and coal plant projects) where they see the potential for a commensurate return. Accustomed to large infrastructure project financing, these investors will believe in their ability to judge the cost and technology risks of a major project.

New Regulatory Compact

The presence of these investors, however, may change the regulatory compact. These investors have no obligation to serve and will simply not finance the project without protection against regulatory risk. Regulators may find that the price of obtaining the needed investments in new and replacement baseload nuclear and coal generation is a combination of allowing market-based rates, higher than normal returns, and risk shifting back to the consumer. This paradigm shift has the potential to stress the regulatory compact in the U.S. at a level similar to the stresses endured during the final phase of the nuclear plant overruns or California deregulation.

These challenges to business-as-usual utility earnings growth via ongoing capital expansion in nuclear and fossil-fired generation pose a potential threat to utility credit ratings and a greater potential stress on the regulatory compact over allowable rates of return.

Oil and Natural Gas

Historically, natural gas-fired combustion turbine plants have been relatively easy to site, license, and finance. These plants have been the new generation of choice in much of the country (and the world) in the past decade. However, the U.S. natural gas supply and transportation infrastructure may not be able to continue to supply a growing share of the generation expansion needed. Liquified natural gas (LNG) also faces issues in terms of global pricing dynamics and terminal siting.

Fuel prices have increased to unprecedented levels, particularly in the last six months. In the first half of 2008, Goldman-Sachs foresaw a probability of a $200 per barrel price between the end of 2008 and 2010. These prices, while not directly impacting electric generation, affect the psychology and actions of the commodities fuel markets. Even pure wires companies face rate pressure to fund investments as consumers react to the overall utility bill (with its fuel cost adders) and regulators bend to pressure to minimize total bill increases. When regulators lose the ability to control the fuel costs component, they may react by squeezing the T&D capacity expenditure and operating expense allowances.

Advanced Metering and Smart Grid

Investments have been flowing to the promising technology of advanced metering, which is not associated with the nuclear, carbon, and fuels availability issues that plague generation. And, the venture capital community is familiar with the technology, which consists of communications, electronics, and information technology. According to an investment banking executive the public market valuation of the smart grid technology market capitalizations from 2005 to 2007 has more than doubled. However, the absence of full-scale deployments demonstrating the technology works in significant numbers has been slowing the rate of investment lately.

Smart metering and the associated communications also expose utilities and their regulators to another new conundrum of rapid technology obsolescence. Utility assets have traditionally been depreciated at 40 years or more (up to 75 year schedules for some transmission lines). Smart metering technologies are exposed to technology obsolescence, and regulators are facing the need for 10- and 15-year schedules, which increase the consumer's monthly bill adder for advanced metering infrastructure (AMI).

While utilities will need to be creative and diverse in their financing, they might also look to another class of investor, Socially Responsible Investment funds. Fund managers evaluate investments in sustainability initiatives, but have specific criteria. Smart grid improvements could be seen as supporting a clean and green alternative.

Prioritization

End-to-end infrastructure costs will encompass generation, transmission, and distribution improvements, including smart metering. Utilities will be asking regulators to approve the replacement and expansion of generation (to address spiking fuel costs), and to invest in the grid's backbone, renewable technologies, and environmental protection. If utilities request these simultaneously, regulators are likely to ask utilities to prioritize their requests – further complicating the challenges that utilities face.

Perspectives on PHEVs

Electric vehicle transportation has been attempted in the United States three times in its history – once in the early 1900s, then in the 1990s and now today. In the first two attempts, electric vehicles failed because gasoline vehicles were cheaper to operate, cheaper to buy, and better served customers' needs. Today, plug-in electric vehicles (PHEVs) reduce CO2 emissions by 30 percent. Assuming the national average of 300 grams of CO2 emitted per mile for conventional vehicles, if 60 percent of the cars were PHEVs by 2050, the U.S. could save 3 to 4 million barrels of oil per day and avoid emission of 450 million metric tons of CO2 per year - the equivalent of taking 82 million cars off the road.

With regard to the net impact of CO2 emissions from PHEVs, an automotive industry technology executive pointed out the need to consider the source of electricity to fuel the PHEVs, which, at least in the near term, cannot be expected to be exclusively renewable energy sources. In terms of PHEV to gasoline-powered vehicles, the automotive technology executive explained that based on analysis figures alone that assumed a national average of 8 cents per kWh for electricity to recharge the vehicle, electricity is about one quarter of the price of using gasoline. However, then assuming a $5000 cost for the vehicle's batteries, the real cost is closer to $3.00 a gallon. "There's no reason on earth why a customer should pay for this thing. When you include the discounted cost of money, it goes from being barely a breakeven to an absolute disaster." From this perspective, the automotive technology executive explained the need for funding from some other source besides OEMs and customers to make widespread adoption of PHEVs a reality. “If we all want this to happen, somebody has to help. The OEMs and their customers cannot make this happen…There’s got to be a huge change in the financials around this to make it happen.”

To make PHEVs a reality, one utility director of electric transportation recommended more collaboration between the utility industry and auto industry: “The utility industry and the auto industry are not really talking to each other. They’re talking at each other.” He explained that the goal of a partnership between his utility and a US automotive company is “to collaborate to accelerate the introduction of PHEVs and to develop data knowledge leading to new business models.” PHEV technical challenges cited include batteries designed to accommodate both driving cycles and utility discharging cycles; bi-directional invertors with two voltage levels; intelligent charging; energy storage; and improved value propositions.

The utility electric transportation director further characterized integration of advanced batteries into energy systems in stationary applications as “the single greatest contribution that we can make to help this industry come to market.” He explained that the latter can be done using a “home energy storage device” that helps meet air conditioning load, is integrated into the utility system, and is combined with a photovoltaics system. With regard to the cost of PHEVs, he explained that “no auto maker is going to bring this technology to market if they’re losing money on every single unit they make and hoping they’re going to make it up in volume. We wouldn’t do it in our business. Why are we asking them to do it in their business?”

On developing PHEV technology and supporting infrastructure, the program manager of a university PHEV research center summarized six primary research areas: power trains, power train modeling and analysis, batteries, impacts on infrastructure in the utility grid, impacts on consumers, and environmental and lifecycle impacts. The Center is preparing a PHEV research roadmap for the state of California, with the goal of developing a productive PHEV market. In the key research area of infrastructure, the Center is examining the effectiveness of time-of-use rates at shifting charging times to off-peak periods, evaluating the role of smart meters with PHEVs, and identifying how PHEVs might contribute to load leveling. The Center is also examining battery use in utility or grid storage applications as a second use after initial vehicle lifetime; examining synergism between PHEVs and renewable energy resources; and conducting a consumer survey of vehicle driving/parking habits and consumer PHEV desires.

An advanced technology manger for a regional transmission organization, described the Mid-Atlantic Grid Interactive Car Consortium (sometimes called “MAGIC”) formed “to develop a full two-way communications capability to a vehicle to provide that vehicle with price or auxiliary service signals and to have that vehicle actually participate in the [RTO] market.” Using a full electric vehicle, not a hybrid, the project involves proving the technology, developing a business case and business entity, and incenting stakeholders to mass produce the vehicle. Due to the fast response capability of the vehicle, as well as other attributes, “the best opportunity for participation is certainly in the regulation market,” presenting a business opportunity for an aggregator entity to manage a fleet of these vehicles.

From a business use perspective, a project manager for Google, summarized the company’s Recharger Initiative, which began as a demonstration of PHEVs to identify current capabilities, expanded to include education via their Web site, and funding in terms of grants. Google also operates the Renewable Energy Cheaper than Coal (RE less than C) Initiative, which aims to develop renewable energy technology that is cost competitive with coal-based technology, and the Climate Savers Computing Initiative, which involves companies across the computer industry that aim to improve computer power supply efficiency. In addition, Google itself has pledged to be carbon neutral. The Google executive also articulated the need for improved business models and/or cooperation between the utility industry and auto industry. “The automakers really don’t see a way forward in terms of how do we integrate with the grid…They’re just designing a car that works…So we need to think about what kind of business models need to be in place to succeed with these vehicles.”

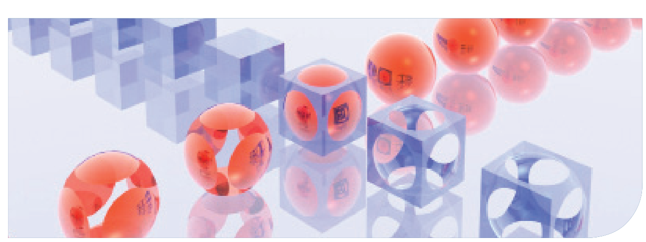
Hugo van Nispen, President and Managing Director of KEMA, captured the essence of the issue: “The automakers have a business model that they’re pursuing that requires cars to be affordable to the consumer. The power industry is looking to improve reliability, capacity, throughput, stability and all of those good things. The reality is that if the two industries continue to focus upon their core business models, things won’t change or they will but they’ll change incrementally. So I think the real excitement, at least to me, about this panel is the conversations around the perimeters that start talking about what happens if we lock [the utility] and [automotive industries] up in a room for a month. And say you can’t leave until you’ve got a new business model that supports both of your financial needs.”

Perspectives on Building Automation

According to Architecture 2030, buildings account for three quarters of all U.S. electricity consumption and over 40 percent of total U.S. CO_2 emissions. Building architects and managers only recently have been turning their attention to energy consumption and carbon impacts. Nascent building automation technologies will need to be supported by a coordinated system of sensor networks, smart devices, business logic integration, and price signals.

Many buildings currently in use were constructed when energy and environmental concerns were not as pronounced as today. Buildings were not designed with certain types of efficiencies in mind. For example, in typical HVAC systems, cooler outside air is drawn into air handlers, mixed with the warmer interior air, and reheated and pumped into the space. This approach is similar to driving a car with one foot on the accelerator and the other foot on the brake.

Building automation systems are not usually tuned to one another. Building buyers see a structure as a single edifice that serves a commercial purpose. The building uses many different systems, including electrical, heating and cooling, security, lighting, chillers, boilers, emergency back up, elevator, escalator, fire, and smoke exhaust systems. Because building systems operate independently – many using their own networks, installers, methodologies, specification, and contracting – building system coordination becomes a kind of puzzle.



The real estate industry is fragmented and short term in its orientation. Vertical markets such as healthcare, education, government, and commercial building are typical classifications in the buildings industry. Healthcare, education, and government buildings are quite different than commercial buildings in one important respect. The former are typically owner-occupied buildings, while the latter are typically leased. Because average ownership by commercial building enterprises is less than five years, these owners have little interest in energy consumption. They are usually not interested in investing in energy efficiency or building automation systems that can cost a quarter of a million dollars, because the payback period may be longer than the typical ownership period. The economics of integrating these systems into existing buildings show that the benefit accrues to the tenant and not the owner.

Further dampening integration of commercial buildings with utilities is the complexity of building automation systems. Most building owners and managers do not employ skilled in-house professionals to manage these systems. Without resident monitoring and support, these systems could quickly fall into disrepair. An alternative resource is the system integrator who originally installed the system.

Commercial buildings can be subdivided into offices and retail. Retail space is basic but ubiquitous. Typical current energy efficiency measures are limited to the thermostat or "on-off" switch, which means the potential energy savings from automation systems is significant. The retail space is large and particularly suited to energy information systems, and retail building owners are typically energy conscious. Demand response is also a practical application in the retail space because the building automation system itself is typically fairly basic.

Perspectives on the Smart Grid

Many in the utility industry have embraced the concept of the "Smart Grid," which promises to ultimately enable real-time pricing, improved demand response, enhanced reliability, and better asset management. The Smart Grid may also ultimately lead to new paradigms of behind-the-meter management of electric appliances, HVAC, and other devices with the electric supply system. However, most of the Smart Grid emphasis today is on residential advanced metering infrastructure (AMI), rather than on larger commercial and industrial facilities with significant opportunities for energy efficiency and distributed resources, or on broader power delivery system management, operation, and planning benefits.

Hugo van Nispen, President and Managing Director of KEMA, Inc., explained the challenge facing the industry. Compared to the ability, using online consumer tools, to locate a coffee shop on the nearest corner, industry capabilities are quite antiquated and limited. For example, many utilities are not able to quickly identify fault locations, nor are they even aware that faults have occurred until customers contact them. "In an era of severe labor stress caused by an aging work force, we literally cannot afford to use our best talent for routine maintenance tasks. We need an intelligent network capable of self-diagnosis. Limited siting of new facilities suggests that we will need a grid capable of managing large-scale, centrally managed distributed generation."

One utility executive and technology strategist emphasized the need to increase the number of investors and participants in the market to design, test, and implement products and services for the smart grid. Increasing the number of competitors that develop products needed for the smart grid will help ensure that they are competitively priced, becoming commodities. Investors can also become involved to arbitrage transactions between consumers in a trading business. He also identified a range of capabilities of the smart grid, each of which presents investment opportunities for a variety of stakeholders. He views the smart grid as beginning at the customer meter, encompassing a smart metering infrastructure, and including a "smart home." The smart home can include home security services, geographic information systems, home healthcare monitoring services, and others, through a portal of some kind. It also includes network management (management of the network of sensors, meters, and other data collection devices), system integration, outage management and distribution management, condition-based maintenance, and other functions.

An independent utility industry consultant and former FERC advisor envisioned two intertwined networks – the electricity network and the network that serves data and communications. She predicted that the intelligent communications network will leverage "network automation, analytics in conjunction with grid data devices like smart meters, sensors, phasors, and automated monitoring of all kinds." Devices will include "meter data management, SCADA, EMS, and a ton of information that includes prices, grid conditions, asset conditions, customer choices, generator actions, and the like. And very importantly, different pieces of information are going to be delivered to different customers, different players, and different devices in ways that they can use and act on."

The independent consultant also emphasized the importance of interoperability, which Gridwise defines as "the capability of systems or units to provide and receive services and information between each other and to use that information and services exchanged to operate effectively together in predictable ways." Providing this capability without significant user intervention, this means "seamless end-to-end connectivity of hardware and software from customers' devices through the meter, through the T&D system, all the way up to the power sources, including through whomever it is who is busy operating or coordinating this grid, and coordinating the energy flows with real time flows of information and services." An important part of this is industry-wide adoption of protocols and standards, which will provide "significant improvement of competition between equipment suppliers and increased innovation of technology and applications."

Customers increasingly seek interactivity with the utility, including green energy, energy efficiency, distributed generation, and billing control options. As a result, one panelist predicted that "the relationship between the customer and the utility [will] become much more customized and optimized around the customer's needs and capabilities."

Perspectives on Technology R&D

Throughout the KEMA forum, discussions of technology R&D needs emerged. These R&D needs are linked by a common problem: they have been significantly underfunded in the last 25 years at the government, industry, and applied research levels. This section summarizes the major technology areas discussed at the forum, but does not attempt to cover all areas that require technology R&D, or to prioritize these needs.

Despite some experience with carbon sequestration in enhanced oil recovery operations, significant R&D technology needs exist to make large-scale carbon capture and sequestration a practical, cost-effective reality. In addition to developing and demonstrating these technologies, research is needed to examine the potential safety hazards of sequestering carbon over a 50- to 100-year timeframe.

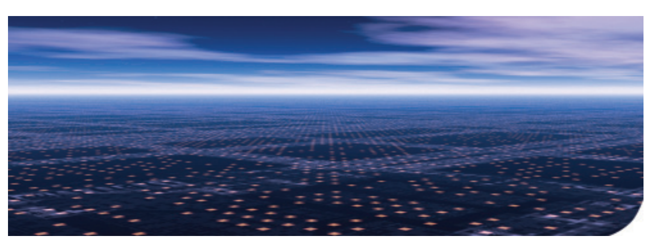
The unprecedented ramp up in renewable generation development and deployment, primarily driven by state renewable portfolio standards, will pose challenges for the power delivery system. R&D technology is needed to ensure that the power delivery infrastructure can accommodate the rapid growth of this generation source, with its intermittency, distance from load centers, and other challenges. R&D is also needed to advance energy storage technologies, both as an enabler of renewables and as a bulk storage capability to reduce emissions from fossil-fuel-fired generation sources.

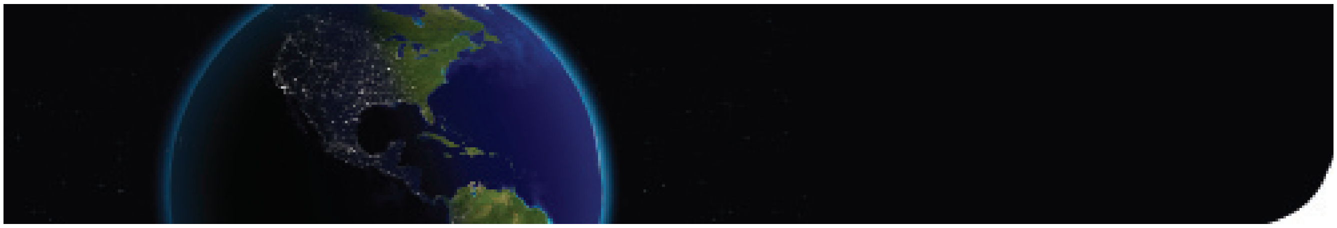
Successfully integrating PHEVs and the grid will require a considerable amount of planning, testing, dialogue, and communication between the auto and utility industries. The first step will be to learn each other's language because each industry strategizes and operates differently. Opening subjects of discussion between the two will be their objectives, business models, and integration standards. Requirements will need to be developed that enable accepted protocols between electric vehicles and the grid.

Technology R&D needs in the area of the Smart Grid are many and varied, and a thorough accounting of these needs is beyond the scope of this document. These needs are perhaps best summarized by recapping key capabilities of the Smart Grid that forum participants envisioned. These include an intelligent network capable of self-diagnosis; a network that supports a plethora of consumer services; an intertwined data and communications network; an interoperable network that supports industry-wide adopted protocols and standards; and a network that accommodates distributed generation, PHEVs, renewables, storage, energy efficiency, demand response, and other advances.

About KEMA:

KEMA specializes in business and technical consulting, operational support, measurement and inspection, testing and certification. With 80 years of experience in serving energy and utility clients, KEMA has developed a reputation for integrating deep technical and functional capabilities with management expertise to provide solutions that deliver profitable, reliable, sustainable results. More than 500 energy and utility clients in over 70 countries rely on KEMA's impartial, objective and expert consulting services to plan, build and maintain their strategies for growth.





For more information, please contact:

KEMA
67 South Bedford Street
Burlington, MA 01803
United States of America
T (800) 892 2006
utilityofthefuture@kema.com
www.kema.com/utility_future

KEMA