SMALL IS BIG

THE PROMISE OF MODULAR REACTORS

AMERICA’S NUCLEAR FOCUS

» NRC’S ALLISON MACFARLANE

FUSION’S FUTURE

SALEM SMART GRID

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SMRs IN THE 21st CENTURY

TALK WITH UTILITY EXECUTIVES, AND IT IS NOT LONG BEFORE YOU HEAR them say that they are nervous about their growing dependence on natural gas generation and the abandonment of new nuclear and coal generation.

At the same time, they talk about the rise of distributed generation, microgrids and renewable power and the threats all of that poses to their entrenched ways of doing business.

Our nuclear fleet, largely built many decades ago, is aging and poised for downsizing as units reach the end of their life cycles.

Meanwhile, researchers and engineers for several years have been developing new designs of small modular nuclear reactors that can be factory-assembled, readily transported and economically procured and deployed.

With the recent report of unknown assailants attacking a California substation one year ago and mounting concern about physical and cyber-terrorism as well as severe weather disruptions, there needs to be a robust discussion about the overarching trends in power generation in America.

Public officials are banking on distributed power and microgrids as a path to a more robust energy infrastructure.

How will SMRs fit in? Will they be uniquely vulnerable to hijacking or attack as they are transported down our highways and waterways?

Or, given their size, will they become a less significant target to bad guys than the large baseload nuclear units we now are using?

With power demand flat or declining, utilities may not feel the urgency for pondering these matters in depth.

A couple of new nuclear units are being built. A significant number of coal-fired generation units are being shuttered in response to tightening federal emissions standards. Gas generation is being built. So are renewables, in response to varying incentives and tightening federal emissions standards. Gas generation is being built. So are renewables, in response to varying incentives and consumer demand.

Maybe this is according to some grand design – but that does not seem likely. Rather, it seems haphazard and by default.

We need a national energy policy that clearly lays out what mix of generation resources makes the most sense given our energy needs, financial realities, security threats, climate change and more. What do I mean by “more”?

Generation assets last decades. We must determine what our society, what our communities, what our technologies, what our culture will be like by 2020, 2030 and 2040. Then we must provide the juice.
This is a must-attend event for utilities professionals who are responsible for creating and implementing their organization’s mobile strategy. Walk away with the knowledge and resources required to implement effective mobile solutions.

Maximize the value of your existing back-end systems. Learn how others have discerned which processes to mobilize, aspects of build vs. buy, as well as integration, device management and security strategies.

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Discover how mobile applications can improve communications and productivity, standardize business processes and provide real-time data to and from the field – all while reducing overhead.

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As utilities struggle to reinvent their enterprises and motivate their workforces to embrace change, they are wrestling with major challenges such as threats to power security. Anne Pramaggiore, president and chief executive officer of ComEd, and Ralph Izzo, chairman, president and chief executive officer of PSEG, discussed diverse forces reshaping the industry at the recent EnergyBiz Securing Power Forum. Their comments, edited for style and length, follow.

Energy security from cyberthreats, physical threats and extreme weather is a mounting concern. How are you approaching these issues?

IZZO: I find it fascinating that the question is posed in the context that this is something new we need to do. The hallmark of our industry is it is ready for the extreme event. The nature of the extreme events has been changing over time. Maybe in the past five or eight years it’s been a cybersecurity issue. Maybe in the last two years in the eastern United States, or maybe more broadly than that, it’s been an extreme weather event. Our industry has always focused on being prepared to avoid the catastrophic event through redundancy and resiliency and to respond to the catastrophic event through teamwork, mutual aid, rapid deployment of resources, spare parts and the like. I don’t think this is something that we don’t prepare for routinely.

PRAMAGGIORE: You look at security in nuclear plants. There is very little that is more rigorous than that. The industry has a very solid track record. The culture is there to draw from. We need to shift and adapt a little bit to the new kinds of challenges we have. As an industry, we can be more adaptable. On the cyber side of the equation, things change at lightning speed. You really have to anticipate and be ahead of the game in a little different way than we probably did in the past. We are starting to see machines programmed so they can take data and adjust their own behavior. Those are the sorts of things that we have to think about. We are very good at collaboration within this industry. How do we look outside the industry? We need to collaborate more with technology partners outside the industry in building R&D capacity. Lastly, we have a very fragmented industry in terms of regulation. We all deal with our individual states. We need to consider creating more...
uniformity there. That’s happening through some of the workshops and collaborative efforts through the National Institute of Standards and Technology and other organizations. There is also a call for more distributed intelligence and redundancy. The more you move away from a centralized model to mechanisms like microgrids, you can create some stability and redundancy that you might not have had. There are costs to that. That’s the challenge.

**ENERGYBIZ** What about the culture at utilities as it relates to security issues and the broad question of how you can pursue new business models and opportunities?

**IZZO** Most of us downsized our workforce over the last few decades. We have very much a barbell distribution now in terms of our population demographics – people have been with us 40 years and people who have been with us for 40 days. We didn’t fill that gap in-between as we normally do. What we lose as a result of that is the kind of natural diffusion of knowledge that occurs over time. But there is an opportunity created by new employees with fresh ideas. It’s going to be a quite beneficial in terms of the customer facing part of the business. But it’s going to be a bit of a challenge for us in the more traditional craft and power plant jobs.

**PRAMAGGIORE** One of the biggest challenges we have in the industry is a convergence of less energy usage with a call for higher quality and a more resilient grid. That’s expensive. You are selling fewer units. Yet, you’ve got customers that want higher quality. That’s something that we are going to have to figure out. We’ve got to deal with that in short order. It’s a really tough one and it’s facing us right down the road. We think about that all the time. As for our workforce, I think there is an opportunity. One of the things that we’ve got to think about in our business is this diverse pool of skill sets. With all the challenges we have, with the greening of our industry, with the digitalization of our industry and with the security challenge that digitalization brings, having a broader
mix of skill sets is going to be really important for us. We need an adaptive mindset, with employees able to see around corners. Another factor is the speed of decision-making. We tend to be a pretty hierarchical business. We have to be much speedier at decision-making. The new crop of talent that is coming through tends to have a little bit more of an edge on that front compared with those of us who have been around longer. They will infuse that into the culture. We also need distributed decision-making. I’ve got 11,000 square miles of service territory. There are a couple of hundred jobs going on every day. We rely on people to make good decisions in a very distributed way every day. That’s enhancing in our business. People who have good judgment and a decision-making capacity are at a premium.

ENERGYBIZ | What is the future of your business model? How do you put the culture into your company to support the evolution of that business model?

IZZO | We have an idea for that. Whether it’s protecting against cyberthreats or physical threats or enhancing the resilience of the system, these things cost money. So you have this situation where the product, electricity, is becoming more valuable to people. But they don’t see that value until it disappears. I chose those words carefully. When the price goes up but the product still flows, there’s a visceral negative reaction. So everything is conspiring against you. People are using less and they are more dependent on it. We say the new business model is energy efficiency. We are your full partner, you the customer, in reducing your bill. Forget about the rates. The rates are irrelevant. You don’t know what the rate is on your bill. I don’t know what the rate is on my bill. We are going to come up with an energy efficiency solution that, because it is truly efficient and because it is truly economically justified, creates three winners: the environment, the customer and the shareholder. That is highly motivating to today’s workforce. They not only want a good paycheck and an exciting career, they want to know that they are leaving the world a better place. It is something that our customers will identify with. It will be an opportunity to, basically, reduce the costs associated with fuel purchases and increase the cost associated with the infrastructure that consumes energy. In some cases, that infrastructure is a light bulb. In other cases, it’s a thermal blanket around the water heater. In a third case, it’s a transmission line. We have to get regulators to realize that the meter was an arbitrary boundary that was decided sometime in the past 100 years. If we become full partners in reducing the customers’ bills and let the rate be what the rate is, maybe the fuel supply companies will grumble a little bit, but the utility business model will change. What’s doubly important about that is if we don’t have that conversation, people are going to mistakenly pursue a business model that says, “I can disengage from the grid. I can build my microgrid. I can build my distributed generation.” They would totally ignore the overwhelming economic benefits of having many small people band together and participate in a network, which is the best deal for the small consumer.

PRAMAGGIORE | Those are great points, Ralph. I think that we do have to work with the customer to reduce bills. There’s no question about it. That is what our customers are asking for. I don’t know precisely what the new model will be or precisely what the regulatory solutions will evolve to, but we have to do a better job of tying value to the prices customers pay. In Illinois, the performance-based formula ratemaking process established by the smart grid law enacted in 2011 is enabling us to make the long-term investments needed to upgrade and modernize our system. That’s progress. It’s all about the value that we create for customers. If we can all agree at the front-end that a certain investment looks reasonable if it achieves certain goals, then you start to put together something that is more of a value-focused kind of approach for customers. At the same time, you are driving down bills. There is no question that that’s what customers are looking for.

PRAMAGGIORE | We take the hill. We can solve a problem. We do a great job at recovery. We’ve got a problem, we can send the troops out there and we can bring it back together. What we are less adept at, what we’ve got to do going forward, is become more innovative and more adaptable to get ahead of the issues. With a digital grid we can shift from a reactive culture to a more prognostic culture, predicting problems before they become problems.

IZZO | The one word that would describe us today is “reliable.” We are reliable at our call centers. We are reliable in our nuclear plants. We are reliable everywhere in the business. We need to become more responsive, anticipating where customers are going and responding to that, anticipating where regulation is going and responding to that, and anticipating where society is going and responding to that.
New Security for a New Era

BUSINESS AND GOVERNMENT MUST UNITE // BY MARTIN ROSENBERG

THE FEDERAL GOVERNMENT AND INDUSTRY MUST get more aligned to safeguard vital infrastructure from devastating cyberattacks, according to Mike McConnell, former director of the U.S. National Security Agency. Today’s rules and safeguards are dated and were designed to meet threats that no longer exist, McConnell told EnergyBiz in an exclusive interview.

McConnell explored these issues at the EnergyBiz Securing Power Forum in Washington recently. He is former White House national intelligence director and currently vice chairman of Booz Allen Hamilton. His comments were edited for style and length.

ENERGYBIZ Do utilities or the government take the lead when it comes to securing America’s power sector from cyberattack?

McCONNELL It’s going to take a partnership between businesses sector to sector, intercompany, and also between businesses and the government. That information flow will not occur until it’s required by law. The government has inside access information about cyberthreats, malware, cybertools and tensions that is classified. Congress had to pass legislation signed by the president requiring the intelligence community to share it.

ENERGYBIZ Have you gotten any feedback either from the Obama administration or leaders in Congress that they’re prepared to move on this?

McCONNELL Normally we make decisions crisis to crisis as opposed to planning in advance. Last year there were 14 bills or amendments proposed — several in the U.S. House of Representatives and several in the Senate. There was debate about how to get it exactly right. The Republicans sponsored bills that tended to favor business. The Democratic-sponsored bills tended to favor the government position. They all failed. Probably the most comprehensive bill was drafted by former Sen. Joe Lieberman and Sen. Susan Collins, R-Maine, the two who initially set up the Department of Homeland Security. They focused on putting the Department of Homeland Security into a leadership role. That was objectionable to a lot of the other bureaucracies and government agencies and many in the private sector. They said the department is not yet mature enough to do this. It doesn’t have the capability. That was one of the issues. So the nail in the coffin was the U.S. Chamber of Commerce. It took a position that anything you do would become regulatory for industry. Therefore, they are against it. Republicans got on board with that. It was shut down. I have a point of view about what should be in the legislation. It would require compromise. Government should be forced to provide sensitive classified information to corporate America to help protect it from cyberissues. Companies should be encouraged to exchange information among themselves with regard to cyberincidents or cyberthreats and malware and not be penalized with antitrust considerations. Probably the most important part of that legislation would be that the industry needs to be incentivized to participate and to adopt a higher cybersecurity standard. That incentive could be that if a company...
meets a standard established between the government and the private sector, the company would receive liability protection from frivolous suits.

**ENERGYBIZ** Utility executives have said that their companies do not have enough employees with security clearance at a level high enough to let them learn what the government knows about cyberthreats. Is that a practical problem?

**McCONNELL** It is. The rules that were established to protect classified information were established as a result of World War II. We were breaking Nazi Germany’s codes and we were breaking Japanese codes that facilitated our war effort. That information had to be protected in a very secure way. Many rules were put in place to protect that information. That served us well during World War II and during the Cold War. But we’re at a time in our history when those restrictive rules are not allowing the government, which has a significant capability to protect the country, from in fact protecting the country. The executive order signed by President Barack Obama last February directs the Department of Homeland Security to facilitate clearances for industry. That’s fine. I’m all for giving clearances for industry. But let’s go beyond that to have a way to sanitize sensitive information and provide it directly without the government classification security caveats on it.

**ENERGYBIZ** In April 2013, the Metcalf substation was attacked in California. Would you say the physical threat is higher than the cyberthreat?

**McCONNELL** I’ve focused on the cyber aspect of it for so long I have an appreciation for the dimension of it.

**ENERGYBIZ** What is the likelihood that there will be a malicious cyberattack on U.S. infrastructure in the next five to 10 years?

**McCONNELL** One hundred percent. It’s already happened. The Iranians have been hammering the U.S. banks. They were engaging in distributive denial of service attacks. The reason for it was they were reacting to the sanctions imposed on Iran. From their point of view, they’re retaliating, not attacking. But the point was they went after the top 10 or so top-tier banks. Those banks had to more than double their expenditures on cybersecurity from about $200 million to $400 million. They developed a lot of very sophisticated techniques. If the Iranians would have gone after the tier-two or tier-three banks, they could probably have had a severe impact on global banking there.

**ENERGYBIZ** The smaller banks would not have had the resources that tier-one banks had to prevent it.

**McCONNELL** Exactly. That’s my point. There is a National Council of ISACs or Information Sharing and Analysis Centers. One of the critical infrastructures is in banking. Banking — that’s where the money is; that’s where criminals went early on. Banks had to be early adapters. But I’d say on a scale of 1 to 10, I’d put the Financial Services ISAC at about a 5. It is not large enough, robust enough or fast enough to be able to understand and move quickly. Utilities are starting to set up an ISAC, the Electricity Sector ISAC. How will they share information? What are the reporting requirements? How sophisticated is the organization they set up? As a nation, we’re just starting to grapple with the magnitude of this problem. I was briefing Henry Kissinger a couple of years back. We were going through the details, and he was sitting there, and I wasn’t even sure he was listening. Finally he leaned out of his chair and he said, “Gutenberg.” The point he was making is that Johannes Gutenberg invented the printing press and it took 200 years for it to change the world. With the Internet, he said, you’re talking about a technology that’s changed the world in less than a generation. Our government, our institutions, our policies, our laws and our framework for dealing with it are not mature enough. A relatively small group with some sophisticated understanding could do strategic damage. If you look at our critical infrastructures, most of them could be harmed in a significant way with a sophisticated cyberattack. Now how do I come to this point of view? I was privileged to serve as director of the National Security Agency from 1992 to 1996. We had just been through the first Gulf War. The Soviet Union had collapsed. The Cold War was over. And the Internet exploded. Congress wanted a peace dividend. When you get to the Internet Age, all of a sudden everything is wired. It’s a network. It’s a global infrastructure. I discovered the United States was the most vulnerable country in the world. We’re the most dependent on this digital technology. This is a looming, strategic vulnerability for the nation. We’ve only seen a few samples of what is possible. My concern is, we can do it the easy way by compromise and working through it, or we’ll wait and have a cyber-Pearl Harbor.
Leading in Stormy Times

EXCELLING IN CHICAGO AND WASHINGTON // BY RICHARD SCHLESINGER

WHEN ANNE PRAMAGGIORGE TOOK OVER AS CEO of ComEd in February 2012, she inherited not only Exelon’s largest power company, but also a customer base that had endured outages in the summer of 2011 that left more than 850,000 customers in the dark, often for days on end. They weren’t happy. But in the last quarter of 2013, ComEd’s Customer Service Index hit an all-time high.

In June 2011, Pepco, the Washington-based utility with a long history of outages, scored the biggest decline in customer satisfaction, not just for a utility, but for any company tracked by the American Consumer Satisfaction Index. By the following year, Pepco had virtually reversed its record-breaking decline.

Those are startling reversals, and they may suggest the way forward, not just for ComEd and Pepco, but for the industry as a whole. They certainly reflect the traits that won Anne Pramaggiore and Pepco their recognition as 2014 EnergyBiz KITE Chief Executive of the Year and EnergyBiz KITE Energy Company of the Year.

At first glance one would hardly assume Anne Pramaggiore would become one of the very few women to head a giant energy company. With a B.A. in theater studies, her first jobs were in the retail sector, where she moved into management, but couldn’t sell herself on retail as a lifetime career. She next chose law, graduated from DePaul University’s law school and worked in antitrust law at McDermott Will & Emery, the premier Chicago-based international law firm. ComEd recruited her to its legal department in 1998, and by February 2012, she had risen to CEO.

John Rowe, former Chairman of ComEd’s parent company, Exelon, recalls she had a perfect combination of learning and listening skills. “Anne is someone who never stops learning. That sounds like a compliment you’d give an 8-year-old, but too many people at the CEO level think they know it all. Continuous improvement demands continuous learning, and that’s one of Anne’s great strengths,” he said.

Pramaggiore has taken a vigorous, hands-on approach to the challenges her company faces. Rather than assume a defensive posture, she listened to customer’s complaints and determined to refocus ComEd’s culture to put customer service at the center of every aspect of its business.

But virtually every CEO and every company swears the customer comes first. Pramaggiore took immediate concrete steps to improve customer communication. It might seem counterintuitive, but she directed line workers, even in the midst of major blackouts, to take the time to type into a computer information on where they were, the cause of the outage and when they estimated power might be restored. The focus on customer communication paid off. Customers found out in real time what had happened and when power might come back on. They could text, call, look online or
use a smartphone app to keep abreast of the situation.

The payoff in customer satisfaction was immediate. In 2013, ComEd reliability hit its highest level on record: it achieved an SAIFI of .76, well below the industry average of 1.1 and a CAIDI of 81 minutes. SAIFI is the System Average Interruption Frequency Index, the average number of interruptions a customer might experience. CAIDI is Customer Average Interruption Duration Frequency Index, the average duration a customer might experience. Those numbers reflect an improvement in restoration performance during major storms of 17 percent over 2012.

Responding to emergencies is one thing; preventing them requires serious investment in technology and infrastructure. Pramaggiore sees the modern energy company as the infrastructure that both supports and drives the digital economy and the connected society. ComEd doubled investment in the system under Pramaggiore’s predecessor, Frank Clark Jr. and Exelon’s CEO, John Rowe, but that wasn’t sufficient, according to Rowe. It’s almost impossible to make essential, significant long-term investments without some long-term assurance of funding. During her final months before assuming the chairmanship, Pramaggiore successfully lobbied the Illinois legislature to pass the groundbreaking Energy Infrastructure Modernization Act, which provides guaranteed rate increases for the next 10 years that will fund a $2.6 billion investment to strengthen and modernize the state’s grid. The bill was vetoed by Gov. Pat Quinn, but with further negotiations, the state legislature overrode the veto.

“Anne was able to work out a legislative deal and a working arrangement with the commission that is supporting new investment,” said Rowe. “She was able to combine the sexy new thing of smart grid with the need for more capital for unsexy old things like underground cable and poles and wire to bolster the security of the system. That’s a very big deal.”

Joseph M. Rigby, chairman and CEO of Pepco Holdings, doesn’t try to put a happy face on the company’s dismal performance following storms in 2010 and 2011. “Frankly, even on blue-sky days it
wasn’t great,” he said.

Like Pramaggiore, Rigby recognized that Pepco needed to make the system more reliable by hardening it, while completely overhauling the corporate communications group. But he was careful not to let the PR outstrip the concrete improvements. “We went through a pretty quiet period for about 18 months, despite intense customer and media complaints. We didn’t want to tout our progress before the results were obvious,” Rigby said. Today, if he were the bragging type, which he emphatically is not, he’d have plenty to brag about. “At one point in the midst of a big storm we had in the middle of February of this year, we didn’t have a single outage. I suspect that two or three years ago, under the same conditions, between fifty- and a hundred-thousand customers would have been out. That’s the kind of improvement people can see and really believe in,” he said.

By hardening the system against outages, focusing on customer communications and adopting a new business model, Rigby has largely reshaped Pepco over the past few years.

The company used to be in the generation business, with capacity of 4,200 megawatts. “We made a strategic decision in 2009 that we would focus exclusively on the regulated wire and pipes business,” Rigby said. “We sold the generation side. The credit agencies really liked that we de-risked the business; we completed the sale July 1, 2010, and the next day we got a credit upgrade. That strengthened our balance sheet and made it easier to go out and raise the money we needed to support a $5.8 billion capital plan.”

Some of that money is dedicated to smartening the grid. Pepco is aggressively deploying advanced metering infrastructure with about 2 million customers, it’s already installed 1.4 million smart meters as part of that effort. The work has increased the company’s ability to spot outages, anticipate potential equipment problems and cut the expense of having to physically read meters. But Rigby has again been careful not to oversell the improvements. “We didn’t want to overtake our customers with a lot of hype. The advantages are incremental, and we were careful not to get ahead of our headlights on this,” he said.

Securing the system, against both physical attacks and cyberattacks, is moving to the forefront of industry concerns. “As the biggest energy company in the Washington D.C., area, we’re acutely aware that we could be a prime target for a physical or cyberattack,” Rigby said. “One of the most important things we’ve done is to develop deep relationships with all of the agencies in the federal government involved with these issues to improve the flow of information and to stay right up front with the most advanced defenses.”

Pepco has also broken new ground by forging an innovative public-private partnership with the city of Washington to address the issue of system resiliency. Working quietly to structure a deal over 18 months, Pepco and the city came together to jointly fund a $1 billion project that will bury a number of overhead lines. “It’s amazing what parties can accomplish when they sit down and find common ground,” Rigby said. “The city and Pepco are each putting $500 million into this project, which will result in significant hardening of the system, helping to protect it from future storms.”

The deal that Pepco and the city completed is the first of its kind, though with the increasingly obvious need to protect the nation’s vulnerable grid, it could become a model for energy companies and their communities across the country. ☼
The Beauty of Demand Response

TRANFORMATIONAL PROMISE // BY JON WELLINGHOFF

DURING THE EXTREMELY COLD WEATHER CAUSED by a polar vortex that veered further south than usual in January, utility customers — consumers and corporations — were called upon to curtail their energy use to prevent the nation’s electric grid from crashing from increased heating needs. Demand response, or what I have often called the killer app for a smart grid, alerts consumers and pays them to reduce energy use at times of high stress on the system.

In Texas and in the 13 states in the Mid-Atlantic region, consumers large and small have this ability and effectively use their demand response to enable the system to avert rolling blackouts during periods of unusually extreme warm or cold weather.

Demand response didn’t just prevent blackouts, it also helped put money back into the pockets of consumers. When demand response is structured correctly in the market, consumers benefit by being active participants on the nation’s electric grid. They become not merely consumers of electricity, they act as a resource back to the grid and get paid to do so.

Demand response service will transform our grid and our electric utilities, along with energy efficiency, solar power, energy storage and electric vehicles. The consumer needs to be the primary focus of utilities, not just as a ratepayer, but also as a resource.

Our electric grid is changing because of the proliferation of so-called disruptive technologies. If we could simply capture all of the benefits that these smart apps such as demand response can provide, we could have a more dynamic and resilient electric grid. And consumers could have lower energy costs while also having far more choices to meet their energy needs.

Demand response and the ability for consumers to choose when to use their electricity at the best price can make the grid operate more efficiently, more economically and with less environmental impact from expensive and dirty peaking power plants.

When I was at the Federal Energy Regulatory Commission, the agency assessed the national demand response potential and found that our expensive peak demand could be reduced by as much as 20 percent during the next five years. This is not insignificant given the alternative of building high-cost, polluting power plants. “Negawatts” or planned consumer-driven reductions in use can replace megawatts of generation as consumers proactively choose and get paid not to use electricity a few times each year. Consumers, our grid and our environment all stand to benefit.

Energy users large and small should insist that utility regulators and energy policymakers ensure that options to participate in demand response are available to all consumers. Doing so will ensure that like Olympic athletes, our energy grid performs at maximum efficiency and with winning results for everyone.

BULGARIA RENEWABLES

Bulgaria received 16 percent of its electric power from renewables in 2012, achieving a target that it had set for 2020, according to IntelliNews.

Jon Wellinghoff is strategic counsel to the Advanced Energy Management Alliance, a partner in the law firm of Stoel Rives and the former chairman of the Federal Energy Regulatory Commission.
SMALL MODULAR REACTORS WITH OUTPUTS IN the double- to triple-digit megawatt range increasingly are being eyed as a way to drive down costs, speed deployment and give a boost to nuclear as an energy source going forward.

About a half-dozen companies are trying to commercialize early-stage ideals and models spawned primarily in academic and government labs. These efforts are being driven by U.S. Department of Energy funding, which recently has backed two of these efforts. For this work to support the development of one or two U.S. light-water reactor designs, the department allocated about $452 million to be spent over five years.

Although small reactors have been used for decades to power nuclear submarines and to produce neutrons for medical and research activities, the envisioned modern small reactors for power generation are different altogether.

The concept is simple. Develop modular reactors with a standardized, approved and certified design. And then make deployment of these reactors less expensive by reducing siting costs and by reaping economies of scale via mass production.

Basic research into such small reactors has been going on for years at DOE-funded labs. Work has now progressed from the lab to address the practical matters to get the units into operation. This is reflected in DOE’s funding of the field over the last several years.

Last December, the DOE announced an award to NuScale Power to support a new project to design, certify and help commercialize innovative small modular reactors in the United States. When the award was announced, Energy Secretary Ernest Moniz noted the importance of the work in this field, saying, “Small modular reactors represent a new generation of safe, reliable, low-carbon nuclear energy technology and provide a strong opportunity for America to lead this emerging global industry.”

The NuScale Power Module reactor is a small, scalable, pressurized water reactor that uses natural forces to operate and cool the plant. Each NuScale Power Module has a 160-megawatt thermal output and can generate 45 megawatts of electrical power.

Through a five-year cost-share agreement, the DOE will invest up to half of the total project cost, with the project’s industry partners matching this investment. The funding for this work comes from the department’s Small Modular Reactor Licensing Technical Support program.

The ultimate aim of this funded work is to help NuScale obtain Nuclear Regulatory Commission design certification and licensing, and achieve commercial operation around 2025. The DOE’s cooperative agreements require that the reactors be built domestically.

Previously, in November 2012, the department awarded support to a project led by Babcock & Wilcox in partnership with the Tennessee Valley Authority and Bechtel. This five-year cost-share agreement was a first-of-a-kind engineering, design certification and licensing for small modular reactors in the United States. The award was given to develop the company’s small modular reactor system, which is a scalable, modular, advanced light-water reactor in which the nuclear core and steam generators are contained in a single vessel. The Babcock & Wilcox Generation III++ small modular reactor mPower system is designed to generate 180 megawatts of electricity.

These funding choices have directly or indirectly caused some changes in the market. In February, Westinghouse opted to scale back work on its 225-megawatt small modular reactor, saying it was reassessing its design certification application schedule. Also in February, TerraPower, a company backed by Bill Gates and others to develop a scalable, sustainable, emission-free and cost-competitive energy source, entered into an agreement with Babcock &
Wilcox. That work will support the joint development of TerraPower’s Generation IV traveling wave reactor.

Outside the United States, work in this arena is accelerating. In China, Chinergy has started work on a demonstration high-temperature pebble bed modular nuclear reactor project. The system will be a gas-cooled reactor with twin reactor modules of 100 megawatts, each driving a single 200-megawatt steam turbine. The goal is to start generating commercial electricity by the end of 2017.

In Europe, Urenco, a company that enriches uranium for use in nuclear power plants, has proposed the development of 5-to-10-megawatt, plug-and-play, inherently safe reactors. It is seeking government support for a prototype uranium-fueled battery that would run for five to 10 years before requiring refueling or servicing.

In addition to these efforts, there are other small modular reactor projects in various stages of development in Russia, Canada and India.

In other parts of the world, such as throughout Africa, organizations are considering small modular reactors as a way to generate electricity. Such reactors are seen as a way to meet exploding electricity demands in regions that have until now been without generation or distribution capacity. The small modular reactors would be able to meet localized power requirements.

Clearly, there is no one design or technology that is a clear favorite to be successful. The promising designs in development through all of these efforts will need to address engineering, costs and licensing challenges before small modular reactors can go into commercial production.
I want to make sure that we continue to make progress on post-Fukishima lessons learned.

ALLISON MACFARLANE
ALL NUCLEAR TECHNOLOGIES — OLD AND NEW — are scrutinized at the U.S. Nuclear Regulatory Commission. Allison Macfarlane, who became chairman of the agency last summer, says all is ready to consider the future of small nuclear reactors. Macfarlane, 50, recently spoke with EnergyBiz about SMRs, nuclear waste and a range of other issues before her commission. Her comments, edited for style and length, follow.

ENERGYBIZ Where does the NRC stand regarding modular nuclear reactors?

MACFARLANE First of all, we need an application. We haven’t gotten one yet. But we have been having lots of discussions with the small modular reactor vendors and the industry in general about them. They understand what they need to do to send in a design certification application. We are expecting a possible design certification application later this year from Babcock & Wilcox for its mPower design. Babcock & Wilcox is working with TVA. We’ll see how it goes. We are ready for them.

ENERGYBIZ The SMRs are really a new animal compared with anything you’ve licensed before.

MACFARLANE Yes and no. They are light water reactors.

ENERGYBIZ What’s your expectation of how long it may take for the whole review process until one is actually in construction?

MACFARLANE I don’t want to give you an exact number. It all depends on the quality of the applications that we get and how many questions are generated from the applications. Whether companies actually decide to go forward and build these things — that’s not a decision that we make or entertain. It will take some years to work through the design certification application, of course. Then these companies will have to see whether they really want to go forward with them.

ENERGYBIZ There’s been a general retrenchment on nuclear construction in this country. How is the NRC using this lull period?

MACFARLANE You may view it as a lull period. But we are not in a lull here. Quite the opposite. It’s a dynamic time. My first and foremost mission here is to maintain and ensure that the operating reactors continue to operate safely and securely. I want to make sure that we continue to make progress on post-Fukushima lessons learned. We are doing that, but it’s going to take some attention to continue to ensure that that moves along pace. I’m personally interested in the back end of the fuel cycle. The timing of my arrival at the NRC and developments in the nuclear world are fortunate. We’ve had a nuclear waste confidence issue that we are tackling here at the NRC. This is something that has been going on for over a year now. The commission will be looking at that later in the spring. The NRC staff is now in the process of dealing with more than 30,000 comments that they received from the public.

ENERGYBIZ The whole waste issue has been heavily politicized. What do you think you can do from a regulatory standpoint to maybe take some of the political heat out of the debate?
MACFARLANE My approach is to deal with the technical issues as they come. I look for technically defensible arguments on these issues. In terms of the back end of the fuel cycle, I don’t think it’s received enough attention.

ENERGYBIZ Are the Europeans and others ahead of America when it comes to dealing with the end of the fuel cycle?

MACFARLANE I’m not sure that some of those countries are much further ahead of the United States. When it comes to waste repositories, that is something that the NRC doesn’t have purview over. We don’t make policy for dealing with siting repositories. But on the repository end, certainly the United States can learn from the experiences of Sweden, Finland and France. All those countries have selected sites. Sweden and Finland are in the process of evaluating the license applications for their sites. France is in the middle of a national debate on its site. There is definitely something to be learned there. There are a lot of open questions on many fronts. What about high burnout fuel? What’s the effect of high burnout fuel on pool performance or on dry cask performance? What about long-term cask life? What do we know about that? What about transport of casks versus storage? What are some of the issues there? Should we really be designing fuel not just for high performance in the reactor but for performance afterward when it’s in the spent form?

ENERGYBIZ Do you have an answer for that last one?

MACFARLANE Yes. From my perspective, from the back end perspective, we should.

ENERGYBIZ How hard will it be to get there?

MACFARLANE I don’t know. I don’t think we’ve looked at that in enough technical detail to answer that question. The answer may be that we don’t really need to do much at all.

ENERGYBIZ Please address the cybersecurity and physical security of our nuclear fleet.

MACFARLANE We are taking it very seriously. It is one place where the United States is way out ahead of other countries. In 2012, we implemented a road map for cybersecurity for nuclear power plants. We required our licensees to complete seven of eight milestones by the end of 2012. They did. We’ve been inspecting the sites to verify implementation of those milestones. The industry has been working with us very well on this issue. Everybody acknowledges that this is a very important issue now. It is something that we are taking very, very seriously here at the NRC.

ENERGYBIZ Are nuclear plants today in America more cybersecure than they were five years ago?

MACFARLANE Yes, absolutely.

ENERGYBIZ Do you see room for improvement ahead?

MACFARLANE Sure. That’s the nature of the cyberthreat. It’s constantly changing. It’s something that we have to invest in keeping up with.

ENERGYBIZ Does it concern you that China is building so many new nuclear units that its nuclear technology will soon eclipse America’s?

MACFARLANE I’m a regulator. I’m interested in ensuring that our operating facilities and our facilities under construction are safe and secure. I’m not concerned about the financial future of nuclear power in the United States. I’m interested in making sure that what we’ve got now works well and works safely.

ENERGYBIZ It’s often said that our nuclear regulation is the model for the world. Do you still maintain that is true?

MACFARLANE We pose a model for the world. Of course, we can also learn from other countries. I don’t think we have cornered the market on nuclear safety. There is always a lot to learn from others. We do that. We spend significant time with our counterparts from other countries, talking with them, learning from them and providing assistance when we can.

ENERGYBIZ What issues are top of mind for you?

MACFARLANE The back end of the fuel cycle is important to me. One issue we did not discuss is decommissioning. Last year, we had five plants that we were decommissioning. I don’t know if that is a trend we will see continue. But it’s something we need to be aware of and work with our licensees on. Globally, you are going to see a lot more decommissioning as a result of German reactors shutting down. Some of the Japanese reactors have announced shutdowns. This is going to be a new growth industry — decommissioning and decontamination.

ENERGYBIZ Have you had to shift resources internally at the NRC as a result?

MACFARLANE No, not yet.

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THE COMMERCIALIZATION OF ANY NEW ENERGY venture depends on passing three fundamental tests. Is it technically feasible? Does it deliver value? Is society willing to pay for that value? Failing any of these three tests is “lights out” for that innovation, which is just as it should be.

It’s helpful to examine the future prospects for small modular nuclear reactors through this lens. From an engineering perspective, the integrated light-water reactor SMR designs are not facing a technical feasibility challenge. The most mature SMR designs are essentially scaled-down versions of current reactor designs. In fact, small nuclear reactors have been around for decades in the form of nuclear-powered submarines and other small-scale applications. Although there are certainly some technical and regulatory issues to be resolved, most agree that the science and engineering paths to commercialization are entirely attainable.

The value proposition for SMRs begins with the rationale for nuclear energy itself. For all its challenges and detractors, nuclear energy remains the only significant source of reliable, carbon-free, baseload generation. If we agree that the primary energy challenge of the 21st century is to increase supply, especially in the developing world, while reducing the carbon emissions, it is difficult to envision a solution that excludes nuclear.

SMRs take this foundational benefit of nuclear energy and diversify its application, bringing it to new customers for more targeted purposes. That is, SMRs are not in conflict with or competition with large-scale nuclear power generation, but instead they expand nuclear power’s reach. SMRs could bring dependable, carbon-free power to sparsely populated areas or regions unattached to a grid. SMRs could serve as distributed-generation solutions to industrial sites such as a desalination plant or other facilities that need a constant and significant amount of clean power. SMRs could bring grid independence to critical facilities such as military bases. SMRs have the potential to work side-by-side with renewable resources to solve the intermittency issue.

With the coming wave of fossil-fuel plant closings, there is an opportunity for SMRs to be sited in the property footprint that already has built-in cooling resources, connections with transmission lines and other important apparatus.

Finally, SMRs have important economic features that address some of the historic and chronic inhibitors of new nuclear. These include lower initial capital investment requirements, shorter construction timelines and more cost-effective safety controls.

Alas, the final test is the most vexing. Can SMRs find customers? That is, even with some promising economic features and even with the significant investment support from the federal government, can SMRs compete in the energy market? The short-term answer may not be optimistic. In the current market environment of low natural gas prices, it will be difficult for SMRs to find their footing. It’s the relative cost of SMRs, as compared with the alternatives, that governs the economic viability of the technology.

So, then, the longer-term question becomes, is that acceptable? Does pure commodity cost trump everything?
else, or does this country need to have a deeper conversation about whether we need to be more sophisticated in valuing and, therefore, pricing our energy resources? With no assigned price for carbon emissions, today’s market structure utterly ignores the environmental value that SMRs deliver. Nor do today’s market structures do an optimal job of rewarding always-on, dispatchable, baseload generation capacity.

The bottom line is that SMRs may be a relatively new idea that is facing some old questions, questions that have dogged development of new large-scale nuclear for decades.

As the largest operator of nuclear power plants in the United States, Exelon is obliged to look at the emerging nuclear technologies. Additionally, we envision a role in providing operational services to nonutility owners of SMRs that may not be inclined to operate their units themselves.

We, therefore, have a keen interest and remain engaged inside the SMR development community.

But the long-term viability of SMRs is largely out of the private sector’s hands because the impediments are not technical, but instead are economic- and policy-orientated. The fate of SMRs is not in the hands of engineers and scientists. It’s in the hands of political leaders, market makers and, ultimately, the general public.

It all comes down to a decades-long debate about the role nuclear plays in the 21st-century energy paradigm. It’s about fundamental questions about how we even define the term “uneconomic” when it comes to long-term public infrastructure decision-making. It’s about how serious we are about addressing our energy and environmental challenges.

SMRs have enormous potential to meet growing energy demands in a dependable, carbon-free manner. The question that remains for society to answer is, “What’s it worth?”

Marilyn Kray is vice president of Exelon Nuclear Partners.
As the world searches for affordable, emission-free and carbon-free clean energy, the U.S. Department of Energy projects the electricity demand in the United States alone to increase 21 percent by 2040. That equates to roughly 340 gigawatts of new capacity. Global demand for new electric capacity will outpace the United States by 10-fold in the same period. Further compounding the electrical generation challenge is the rebuilding of aging infrastructure, new environmental regulations, volatility of natural gas pricing, a potential carbon tax and the significant cost to replace retiring baseload generation.

What if there were a way to take the benefits of nuclear
energy — the delivery of safe, clean, reliable and economical power — and make it even safer, fabricate and modularize a majority of the components in a factory, and ship a fully assembled containment and reactor vessel module for site installation? Does that sound attractive?

Small modular nuclear reactors, as defined by the Department of Energy, are 300 megawatts or less, which makes them practical for small electric grids and locales that cannot support large reactors. The option offers utilities the flexibility to add more modules to scale up production if demand increases. Built in factories and transportable to sites, SMRs would be plug-and-play upon arrival, reducing capital costs and construction time. SMRs also offer diverse functionality when compared with large reactors. Our company’s 45-megawatt size SMR and multimodule plant design, for example, permits a high degree of flexibility for deployment in support of both electrical and nonelectrical applications.

Recognition of the value of SMRs in developing a balanced energy policy has escalated recently. Customers tell us they like lowered financial barriers, the ability to safely shut down and self-cool reactors indefinitely with no operator action required, AC or DC power, no additional water requirements and the ability to incrementally add new generation to match load growth. Features such as these provide significant benefits to ratepayers.

The Department of Energy’s cost-sharing program to develop commercial SMR technology included in President Barack Obama’s budget is crucial for attracting investor interest. It also serves the national goal of bringing to market a noncarbon source of baseload energy — that is, energy available 24/7. Nuclear power achieves that goal, and SMRs further it by overcoming financial barriers and by reaching markets not accessible to larger reactor designs.

Since the 2011 Fukushima Daiichi disaster, safety has become a key focus. The use of SMRs greatly reduces the potential hazards presented by natural phenomena. The safety of nuclear power is being taken to a new level, something that is demanded in a post-Fukushima world.

An advanced SMR plant eliminates, by design, modes of failure that must be addressed in larger plants. Tests conducted at a fully instrumented one-third-scale electrically heated test facility confirmed the effectiveness of the NuScale plant’s natural safety features. The plant uses gravity, convection and conduction for normal operations and safe shutdown. The use of natural forces of physics eliminates many of the large and complex systems, such as reactor coolant pumps, motors, valves and large-bore reactor coolant system piping found in today’s nuclear power plants and in other SMR designs.

Two independent expert review panels not only validated our confidence in the safety of this plant, they also made helpful recommendations to improve safety even further.

When the NuScale design was initially developed in 2000, we saw the economic advantages of its simplicity. We saw the economic value of taking essentially the entire nuclear system, including its containment, to a factory where manufacturing could take place under more controlled conditions.

We have heard all the challenges to the economics of small reactors, but we’ve done the estimating on an actual design, starting from the ground up. In 2008, working with our engineering and manufacturing partners, we developed a bottom-up cost estimate. The result shows that we have a plant that will completely change the economic story for nuclear power by not only lowering the financial barriers, but by doing so with a unit cost — meaning dollars per kilowatt — that is actually lower than competitive, larger nuclear plants.

SMRs are attracting the attention of government officials, regulators and energy leaders as a potential addition to the nation’s energy mix. Because of their small size, they have many useful applications, including generating emission-free electricity in remote locations where there is little to no access to the main power grid or to providing process heat to industrial applications.

John Hopkins is chairman and CEO of NuScale Power.
Utilities have more data at their disposal than ever before. Devices like transformers include sensors that record information about system wear and tear, smart meters collect information about energy use, and consumers communicate with utilities by phone, email, online, and social media. Consequently, the volume of data generated is growing rapidly. Market research firm International Data Corporation found that companies created more than 3 zettabytes (3 trillion Gigabytes) of information in 2013. The amount of data is so large that if information were stored on DVDs, the stack would go from the Earth to the Moon and back.
THE RAPIDLY GROWING VOLUME OF COMPANY DATA Utilities have more data at their disposal than ever before. Devices like transformers include sensors that record information about system wear and tear, smart meters collect information about energy use, and consumers communicate with utilities by phone, email, online, and social media. Consequently, the volume of data generated is growing rapidly. Market research firm International Data Corporation found that companies created more than 3 zettabytes (3 trillion Gigabytes) of information in 2013. The amount of data is so large that if information were stored on DVDs, the stack would go from the Earth to the Moon and back three times (about 240,000 miles each way).

Utilities want to use information collected to enhance their business, but face barriers to this goal. One barrier is the fact that information resides in different locations. Traditionally, data has been siloed in autonomous locations — a server in a central data center or machine data from smart devices. Because information is stored in different places, it is not easy to examine.

To unlock data silos and provide employees with the ability to optimize the value of the information across the enterprise, utilities must take two steps. First, they need to utilize a Big Data platform that is an overlay to their data silos and is capable of centrally collecting information. Second, they need a library of data analytics built on utility industry expertise that clearly and easily illustrate information correlations and the impact of managerial decisions on their business. By implementing these steps, utilities can streamline business processes, improve employee productivity, enhance grid reliability and efficiency, generate more revenue, boost profitability, and improve customer satisfaction.

CURRENT DATA CHALLENGES

Data usage has evolved in an arbitrary manner that presents utilities with multiple hurdles. The limitations stem from software application design. Through the years, vendors delivered rich sets of data extraction tools, but they were closely linked to specific solutions like their Enterprise Resource Planning system. Consequently, information was housed in silos, available to employees in select departments, but it was not available to everyone in the enterprise.

There is also a separation between employees who understand how the software systems work and those who recognize the data's value. As a result, management is not able to access, collect, and analyze information quickly and easily.

THE BENEFITS OF DATA ANALYTICS

Data analytics addresses these limitations by bringing information together and providing employees with tools needed to analyze it. Once these steps are completed, utilities realize a number of benefits, including:

**Improved Asset and Resource Utilization**
Utilities gain more insight into their grid operations and assets. They become more proactive and can extend the life of their assets. Loads are shifted to underutilized resources, so energy flows as efficiently as possible. Overall, the utility operates more efficiently.
Cost Reduction
Utilities gain visibility into the performance of work crews by analyzing data from autonomous Distribution Management Systems (DMS) and Outage Management Systems (OMS) to streamline their operations. They are able to extend the life of costly assets, like transformers, because they are a step or two ahead of planned maintenance. Utilities can also determine when physical items do not need to be upgraded, which reduces operating costs, and corporate operating expenses decline.

Fewer Unplanned Events
Utilities gain more insight into grid performance and system maintenance cycles. They see patterns over longer periods of time and are able to decide what proactive steps are needed to keep their networks running.

Restore Service Faster
When emergencies occur, the demands and challenges for support departments rapidly increase. Alarms sound incessantly, making it easier to sort through systems and pinpoint the location of the problems. These systems have a greater ability to perform root cause analysis and deploy work crews to those locations that will quickly bring back service.

Greater Revenue Assurance and Protection
Customers’ energy needs vary greatly. Utilities collect relevant information so they can easily determine usage patterns and develop new programs that promote energy savings and catch energy theft more quickly. By tracking energy saving initiatives, utilities have more insight into consumer usage and respond to them in a timelier manner.

What GE Digital Energy Delivers
GE’s Digital Energy business is a major solutions provider and thought leader in the effort to modernize and optimize how utilities generate, move and consume energy. The company’s global team of more than 5,000 employees are inventing, improving and integrating communications, automation, and power delivery technologies to give the century-old electric infrastructure new capabilities, unheard of just a generation ago.

From deploying solutions that enable consumers to understand and manage energy usage, to championing leading-edge technologies that make clean, renewable energy an everyday reality, GE Digital Energy is delivering the breakthroughs that will power our planet for the next hundred years. Its executives are leading the charge, serving on standards boards, industry task forces and government advisory committees, sharing their unmatched experience and expertise to help overcome the capacity and environmental challenges of an increasingly electrified world. They are building intelligent devices that protect, monitor, control & automate the grid, and visualization software that optimizes the grid. They provide products and services from the Power Plant to the End Power Consumer (Commercial, Industrial and Residential). When evaluating a grid analytics system, Digital Energy is a good place for utilities to start the process.
Utilities find themselves collecting more information, and they want to utilize that data to improve their operations and maximize their asset investments.

Enhanced Customer Satisfaction
Utilities gain more insight into consumer desires by collecting more information when customers contact call centers, allowing them to develop specialized programs to meet their needs.

PUTTING DATA INTO ACTION
The benefits of data analytics are endless, but utilities need to know where to start. Three opportunities that offer rapid returns are GE's Advanced Meter Insight, GE's Reliability Insight and GE’s Outage Insight. Deploying these applications enables utilities to increase revenue, streamline productivity and maximize profitability.

GE’s Advanced Meter Insight benefits include:
• Turning meter data into actionable intelligence
• Identifying usage patterns to avoid false positives
• Protecting revenue from theft and outages
• Discovering new operating efficiencies
• Minimizes equipment issues
• Optimizing voltage levels and loads
• Optimizing supply/demand of electricity with accurate load forecasts

GE's Reliability Insight allows utilities to:
• Monitor asset health and minimize failures before they occur
• Use analysis to optimize vegetation management spend without sacrificing reliability and safety targets
• Determine optimal maintenance program and inspection cycles for systems of assets
• Optimize maintenance, repair, and replacement for entire portfolio of assets

GE’s Outage Insight enables utilities to:
• Minimize outages and their impact on operations and assets
• Proactively optimize and stage resources
• Use triage analysis to optimize restoration sequence
• Playback time-stamped data and view comparative analytics based on similar events
• Improve communication with non-utility service resources
• Minimize the interruption impact of planned network de-energizing

WHAT TO LOOK FOR IN A DATA ANALYTICS SOLUTION?
A utility requires a product that creates relevant and actionable information for every user, including individuals in the control room, at their desks or in the field. Utilities collect a lot of information, and they need a Big Data platform that scales and supports large data models and delivers results quickly. In addition to a technical solution, utilities need a supplier that understands the utility industry. When the supplier knows the business, they are able to identify potential areas of improvement.

CONCLUSION: DATA ANALYTICS STREAMLINE UTILITIES BUSINESS PROCESSES
Utilities find themselves collecting more information, and they want to utilize that data to improve their operations and maximize their asset investments. The task is challenging because data has been sequestered in various departments. Energy providers need a platform to analyze data from across their operational systems and provide managers with insights to confidently take action. The opportunities are endless when utilities deploy the right applications to reduce inefficiencies, maximize use of the grid and dramatically improve customer satisfaction.

Joel Weingarten is the Grid IQ™ Insight Product Line Leader at GE’s Digital Energy business.

1Source: John Ganz and David Reinsel, International Data Corp. Digital Universe Study in 2020, December 2012
FOR MORE THAN 125 YEARS, WESTINGHOUSE HAS been a world leader in technology innovation.

Westinghouse developed the first U.S. commercial nuclear power plant in 1957.

More recently, Westinghouse has led the nuclear industry in developing small modular reactor or SMR technology, a revolutionary approach based on the advanced AP1000 reactor design, which is currently being built in the United States and China.

A major strength of the Westinghouse SMR design is that it leverages the existing licensing of the AP1000 plant, which already has received design certification from the U.S. Nuclear Regulatory Commission. Beyond that, the operational experience from the development of the AP1000 plant would be transferable to the Westinghouse SMR, in effect providing a large-scale prototype.

The Westinghouse SMR is a 225-megawatt integral pressurized water reactor. Its design, including its passive safety systems, reactor internals, and fuel assemblies, was founded on AP1000 design technology.

Bringing this technology to market requires significant resources and the cooperation of many parties. The energy industry has long-term horizons for technology development and investment. For this reason, the risks of commercialization are high, so public-private partnerships are crucial to drive new technology and product concepts to the marketplace.

That’s why Westinghouse advanced an SMR development program with a utility partnership group, the NexStart SMR Alliance led by Ameren Missouri.

This alliance consists of industry organizations that see the potential in the Westinghouse SMR and its ability to be an important source of emission-free electrical energy both in the U.S. and around the world. Last year, Westinghouse completed manufacturing, assembling and testing of two SMR fuel test assemblies.

When Westinghouse did not receive Department of Energy funding for accelerated development of SMR technology, the company re-prioritized its SMR resources to areas with greater near-term economic potential.

Volatility in the fossil fuel and electricity markets has added to the uncertainty for smaller-scale generation facilities of many types, giving utility executives pause in their long-term capital investment decisions surrounding future capacity. Simply put, an investment in SMR nuclear technology does not compare favorably right now with other options.

That left Westinghouse with two options: continue to invest resources in a market that currently has no
Danny Roderick is president and chief executive officer of Westinghouse Electric Company.

The SMR, Westinghouse will lead the industry again in this new sector.

In the meantime, a team of Westinghouse engineers and business staff remains assigned and committed to the SMR program to ensure that the Westinghouse SMR product investment is protected and available for additional investment and licensing completion when market conditions warrant.

Westinghouse has not abandoned the SMR market. Quite to the contrary, the company has participated, and will continue to participate actively, in the SMR community. When the market demands it, Westinghouse SMR technology will be ready to deploy.

Westinghouse will remain focused on more pressing customer priorities: the successful completion and startup of eight AP1000 plants in the United States and China, new AP1000 plant projects globally and nuclear power plant decommissioning services, which is estimated to be a $1 billion-per-year business.

However, recent history has taught us that fossil fuel prices rise and fall, sometimes significantly. When market conditions make SMR technology more competitive, Westinghouse will be there. When customers do call for the SMR, Westinghouse will lead the industry again in this new sector.

In the meantime, a team of Westinghouse engineers and business staff remains assigned and committed to the SMR program to ensure that the Westinghouse SMR product investment is protected and available for additional investment and licensing completion when market conditions warrant.

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Danny Roderick is president and chief executive officer of Westinghouse Electric Company.
Many uncertainties surround the future of coal. Can other energy sources replace it? When will the related technology be ready? Can we use coal cleanly? One thing is certain about the future of coal: research and innovation in coal and energy, in close collaboration with industry, policymakers and users, will play a key role in shaping the future.

The world’s energy reserves are sufficient to last many years. More than 50 percent of these reserves are in the form of coal and lignite; natural gas, oil, and nuclear are the other non-renewable energy resources. Renewable energy such as wind, solar, geothermal, wave and tides, biomass is abundant and, in practical terms, inexhaustible. The renewable sources are not all equivalent; for example, the solar resource is orders of magnitude larger than all the others combined. Wind energy may be capable of supplying all of the planet’s energy requirements if pushed to a significant portion of its exploitable potential. However, none of the others, most of which are first- and second-order byproducts of the solar resource, is able to satisfy the demand by itself. In general, it is difficult to quantify all renewable energy sources because converting them into useful energy is still costly and requires significant efforts to meet the necessary gains in efficiency.

Because of its broad installed base of users, abundance, and wide availability, coal appears likely to play a continuing role in providing the world with energy. According to the World Coal Association, coal provides around 30 percent of global primary energy needs, generates 41 percent of the world’s electricity and is used in the production of 70 percent of the world’s steel. Coal and lignite reserves are sufficient for more than 100 years at the current rate of production. In December 2012, the International Energy Agency projected coal to come close to surpassing oil as the world’s main energy source by 2017. In addition, unlike oil and gas, coal is widely distributed around the world with large reserves in the United States, Russia and China. Therefore, coal offers a reasonable level of supply security.

Based on various coal forecasts, it can be concluded that there are competing challenges when it comes to securing global energy supply versus reducing global greenhouse gas emissions. This drives us to scenarios in which coal’s role is significantly reduced. For example, the IEA World Energy Outlook 2012 presented several future energy scenarios, including the status quo — energy and climate policy unchanged — or making efforts to limit concentration of CO2 to 450 ppm. One scenario predicts reductions in worldwide growth of global coal consumption from 3.6 percent growth in 2000 to 0.4 percent after 2020; however, as noted, this does not seem likely to be the case. Some nations will see moving away from coal as a politically popular national policy, but others are going to see coal as a reliable way to deliver a secure and politically popular source of energy.

Every energy-generating technology has some degree of environmental impact; coal, of course, is not exempt from this. Environmental impacts associated with coal include pollutant emissions, waste generation, and concerns related to land, water use, public health and safety, all of which are well understood. Without a doubt, coal mining interferes
with the environment, as does the mining or production of any other mineral. To help compensate, ecological impacts are addressed during mine planning, operation and landscape renovation. Emissions from power plants, such as SOx, NOx and dust, are dramatically reduced using state-of-the-art pollution-control equipment.

We need a new generation of coal-to-energy processes that will have the ability to further reduce the emissions of both air pollutants and solids and improve economic efficiency. For example, instead of storage, should we recycle the coal ash, reusing it in construction? Some of the technologies are already available, and others are being developed. The new technological breakthroughs make it possible for both new and older coal-burning power plants to produce power in an economically and environmentally responsible manner. Supercritical or subcritical combustion, oxy-combustion, chemical looping combustion, gasification, and carbon capture and storage present low-emission alternatives. There is a rapidly growing interest in CO2 utilization; chemical recycling of CO2 and its reuse in the production of chemicals and fuels is attractive from both an environmental perspective and in terms of fossil source independence.

For all energy sources, having new technologies is only the first part of the solution. We also have to be realistic about the process of adopting these technologies. Further, the ability to hold fast to any new technology pathway has to be driven by politics and the structure of the industry. Where the future of coal is concerned, although many uncertainties remain, research and innovation will certainly play a key role in finding the optimal path for society. [2]

Tomasz S. Wiltowski is the director of the Coal Research Center at Southern Illinois University.
Innovations in Distributed Energy

RECIPROCATING ENGINES AND MORE // BY MARTIN ROSENBERG

GE, A GIANT IN MANY SECTORS OF ENERGY, plans to lay claim to the burgeoning business of distributed generation. EnergyBiz recently sat down with Mark M. Little, GE chief technology officer and senior vice president, to discuss the trend. His comments, edited for style and length, follow.

ENERGYBIZ As more distributed generation is used and the grid becomes more complex, what opportunities are created?

LITTLE We think distributed power is a very interesting opportunity. We’ve actually built a business around distributed power. It’s part of our overall power and water business, which is the single biggest business GE has put forward. We want to create solutions that are small in scale, so people can use them locally, and still very efficient. So a core piece of this would be reciprocating natural gas engines that are very good for distributed energy.

ENERGYBIZ What are reciprocating engines?

LITTLE A reciprocating engine is an engine like the one in your car. The engines we produce use natural gas instead of gasoline for a commercial site. In India and Africa, they have a distributed telecommunications grid that doesn’t have a very firm electrical supply. They use these systems quite often where they have smaller local demands.

ENERGYBIZ Are you producing this now or is it on the horizon?

LITTLE No, this is a business we have today. And we’re innovating around that. One very interesting innovation is around solid oxide fuel cells. We are looking at hybrid systems. We put in a fuel cell first that runs on, say, natural gas, or it could be diesel fuel. We extract electricity from that. We then take the residual fuel and put it through a reciprocating engine or maybe even a turbine engine, and extract electricity from that. Today’s central plants are 60 percent efficient. These systems could be 70 percent efficient at a local level. That’s a real breakthrough.

ENERGYBIZ What other innovations do you see for distributed generation?

LITTLE Renewable energy varies with the flow of the wind or the clouds going by the sun. Grids have to adapt to that kind of variability. We’ve learned how to enable grids to sustain those kinds of fluctuations in a significant way. As a result, for instance, in Hawaii we can put up to 30 percent renewables on the grid. That kind of resilience is applicable for distributed power, where you have power flows coming from consumers or from industry back into a grid. The grid system needs to be able to handle these kinds of power flows. We have the technology to do that. We are building a battery business that will enable producers to moderate the power flows. Imagine a wind supplier today who wants to bid into a grid at a firm level for, say, 15 minutes. They never know how the wind is going to blow, so they have to discount the capacity and underbid what they could produce with strong winds. If you put a battery with that system, they can firm up their energy commitment and build to full capacity all the time, enabling our customers to make more money and our users to have a more stable and resilient supply.

ENERGYBIZ Energy storage will be a game changer. What kind of new technologies do you see on the horizon?

LITTLE We’re building out an energy business. It’s an interesting thing from my perspective. We wanted to build a hybrid locomotive as a flagship thing for our transportation business. It would be a diesel-driven locomotive engine with a battery system to back it up. A Prius kind of battery is not the right kind of battery for our locomotive because when you put the brakes on a locomotive you’re going to store a lot more energy than when you put the brakes on a Prius. We looked around the world for the right kind of battery for our locomotive because when you put the brakes on a locomotive you’re going to store a lot more energy than when you put the brakes on a Prius. We looked around the world for the right kind of battery system for that application, and we couldn’t find it. So our researchers invented their own technology. We liked it so much we’re actually building a business out of it. We’ve hollowed out an old steam turbine manufacturing building and put in a world-class facility that’s making batteries. The early applications are for grid support and for telecommunications backup. The locomotive will come later.
Utility Analytics Institute utility members include:

Solution Provider members include:
Extreme weather is the leading cause of disturbances to the U.S. electric grid, and has grown rapidly over the last two decades. The fraction of all grid disturbances caused by weather-related phenomena has more than tripled from roughly 20 percent in the early 1990s to 65 percent in recent years. Throughout the world, power systems have been severely damaged by hurricanes, storm surge, winter storms, and other extreme events. Climate change is expected to lead to changes in the frequency, intensity, spatial extent, duration, and timing of extreme weather and climate events, and may result in unprecedented extreme weather and climate events.

DNV GL has developed a probabilistic risk-cost-benefit framework, ADAPT-POWER, for analyzing power system investments to mitigate extreme weather and climate change damages.

ADAPT-POWER provides a unique ability to:
- Assess power system exposure and risks associated with extreme weather and climate change
- Evaluate the risk reduction potential of management measures such as adaptations to enhance infrastructure resilience, as well as preparing, responding, and recovering from climatic events
Do you want to determine appropriate measures to prudently manage risks associated with extreme weather and climate change?

ADAPT-POWER gives electricity providers, regulators, and other stakeholders involved with power systems a methodology for conducting probabilistic risk assessments and cost-benefit analyses.

- State-of-the-art methodology that explicitly incorporates consideration of multiple uncertainties
- Establishes a quantitative basis for selecting optimal adaptation strategies and demonstrating the prudency of making investments to enhance power system resiliency

Unlike any other existing methodology, ADAPT-POWER combines a set of scientific, engineering, and risk assessment approaches that enable DNV GL to deliver unsurpassed consulting services that maximize the value of investments—often in the hundreds of millions to billions of dollar range—in being better prepared to meet the hazards associated with extreme weather and climate change.

- Perform a cost-benefit analysis that allows customers and other stakeholders to understand the degree of risk reduction accomplished by various adaptation investments.

Operators of electricity power generation and delivery are faced with multiple hazards associated with extreme weather, including hurricanes, tornadoes, winter storms, flooding, heat waves, and more, which have the potential to wreak damage across large swaths of electric power systems.

Consider, for example, Hurricane Sandy, which struck the New York City metropolitan area on October 29, 2012. More than 8 million customers across 21 states lost power, leaving electrical and other infrastructure damaged in its wake. Utilities reported damage to over 7,000 transformers and 15,200 poles throughout the affected region.

While we have good information about the extent of damage and costs involved with these events, we can't predict with certainty what the impact will be in the future. What we do know is that climate scientists expect climate change to increase the frequency and severity of extreme weather events. ADAPT-POWER provides the framework to analyze both near-term and longer-term expectations, taking into account the many uncertainties involved in a quantitative manner.

ADAPT-POWER is applicable to electric systems throughout the world; can be applied to virtually any meteorological or hydrological event; and can be used to inform a variety of customer types—utilities, utility regulators, insurance companies, investors, etc. Moreover, the ADAPT-POWER methodology lends itself to other issues, such as electromagnetic disturbances, geophysical hazards, and energy security.
Long Island Case Study
The ADAPT-POWER framework was applied in a 2013 case study in Long Island, New York. The Long Island Power Authority (LIPA) provided DNV GL with information about selected circuits to use in the study. Projections of severe weather were derived from scenarios of climate change provided to DNV GL by the U.S. National Center for Atmospheric Research (NCAR). Parameters such as wind speed, precipitation, and storm surge were then used to evaluate the exposure of infrastructure to hazardous conditions, defined by a series of fragility curves for each type of equipment and hazard. The framework uses novel methods developed to determine the survivability of T&D grid components delivering electricity to end users. The effectiveness of mitigation measures, such as physical grid hardening, were then assessed.

NCAR reproduced the conditions under which Sandy formed in their weather research and forecasting (WRF) model, creating a control simulation. The control simulation was then perturbed to predict what a similar storm would look like in a world where climate change has increased the temperatures of air, soil, and sea surface. Scenarios were examined corresponding to warming estimates for 2020, 2050, and 2100. Results showed that increased temperatures force the simulated storm along a more northerly track than the actual Sandy, delaying landfall. Relative to the control simulation, surface winds were somewhat increased, precipitation increased significantly, and storm surge was higher.

The vulnerability of selected power system components on Long Island was evaluated, and measures to mitigate losses were examined. Apparatus fragility models used to model failure due to wind, flood level, and soil moisture were extended to consider future Sandy scenarios. These were used to analyze the LIPA transmission system for probabilistic “N-M” multiple failures and to perform a similar analysis on two distribution circuits (the “Route 110 corridor” provided by LIPA). Vegetation fragility models were developed to assess likelihood of circuit damage from falling trees.

Key Findings:
- The simulation methodology that takes probabilistic weather data to drive probabilities of apparatus failure as the basis for N-M contingency analysis was demonstrated. The transmission N-M methodology was successfully demonstrated and its value can be seen. It also lays the groundwork for “maximized load served” as an operational paradigm for severe weather disruption.
- The distribution N-M methodology was demonstrated but the circuits chosen and data simulated are not as immediately compelling as the transmission modelling.
- Twelve transmission substations were affected by storm surge in the actual Sandy event. Storm surge in the future Sandy scenarios is projected to be substantially higher than in the actual event, increasing the exposure of the twelve substations and potentially affecting numerous additional substations. A methodology was developed to optimize measures needed to ensure that each substation is able to continue to serve load.

An Integrated Defense Plan (IDP) for Resiliency against Multiple Threats
A state’s electricity infrastructure is clearly one of its most important assets as it is the engine of its economic well-being. In general, the electric sector has successfully managed day-to-day reliability risk to the system. However, rare risks to the system are present, with the potential to cause long-term, catastrophic damage to the bulk power system as well as its economy. Examples of these risks include:
- Coordinated malicious physical attacks
- Extreme weather (and climate change)
- Geomagnetic disturbances (GMD)
- High-altitude detonation of a nuclear weapon leading to electromagnetic pulse (EMP) threat

EMP and GMD may have never occurred in a region, and the probability of future occurrence and impact can be difficult to measure. But by virtue of their mammoth impacts, they need to be analyzed in a systematic and comprehensive fashion. Also, as mitigating options are considered for each of these threats, individually, or in common (e.g., protecting for GMD and for the late effect EMP, E3 can have similar traits) it is important to note that it is impossible to fully protect the system from every threat. Therefore, sound management of these risks to the electricity sectors involves a holistic approach, with specific focus on determining the appropriate risk-based balance of Protection (hardening), resilience, and restoration.

ADAPT-POWER begins by identifying the threat environment and protection goals for the system and balancing expected outcomes against the costs associated with proposed mitigations to obtain a level of system resiliency. With an IDP based on ADAPT-POWER you will define targeted actions that the public and private sectors must take to ensure appropriate protections are in place to enhance resiliency and response capabilities for electricity infrastructure bulk power system in the face of these threats.

Malicious Physical Attacks
The risk of a coordinated physical against a state is more important today, as resource optimization in recent years have allowed some inherent physical redundancy within the system to be reduced. The specific concern with respect to this threat is the targeting of multiple key nodes (e.g., substations) on the system that, if damaged/destroyed, or interrupted in a coordinated fashion, could bring the system outside...
the traditional planning and operating criteria, as well as its protection.

**Use of ADAPT-POWER for Malicious Physical Attacks**

To defend an electric grid, first learn how to attack it! The attack scenarios are comprised of:

1. Targeted attacks against the most critical nodes (substations)
2. Random attacks against substations
3. Random attacks against sets transmission lines
   - Investigate vulnerability to multiple, coordinated failures (N–M)
   - Identify worst-case attacks to the grid (most “disruptive”)
   - Use optimal power flow model (minimize load shedding)

**Geomagnetic Disturbances (GMD)**

Large solar flares, and the resulting coronal mass ejection’s solar wind plasma, interact with Earth’s magnetosphere to cause rapid changes in the configuration of its magnetic field. These changes in the magnetic field induce quasi-DC currents over wide geographical regions in the HV, EHV and UHV transmission lines. The quasi-DC currents, also known as geomagnetically-induced currents (GIC), can also lead to half cycle saturation of the magnetic core of electrical transformers, which leads to internal heating brought on by the associated stray flux. Saturation of the transformer cores leads to higher reactive losses. Reactive power absorption (or losses) from saturated transformers leads to lower system voltages, which can lead to system voltage regulation concerns. Saturation of the transformer cores leads to the generation of harmonic currents on the systems. Harmonics can lead to the tripping of capacitor banks which may exacerbate the system voltage regulation issues.

Other potential effects of GMD include overheating of auxiliary transformers, improper operation of relays, and heating of generator stators, along with potential damage to reactive power devices and filters for high voltage DC lines. These reactive power devices are very critical to maintaining system stability during GMD events when reactive power demand is high, due the saturation of many transformers.

GMD effects happen very rapidly and can result in widespread and simultaneous impacts to many points on a power grid which is not designed to operate through the concurrent loss of many key assets, typically large power transformers. As such, GMDs can quickly bring the grid outside the protection provided by traditional planning and operating reliability criteria, resulting in potential system instability and widespread outages. Restoration times from the system collapse due to voltage instability can be a matter of hours to days, while replacing transformers requires long lead times (months) to replace or move spares into place.

Certain system operators have adopted operating practices to address GMD events. In addition, mitigation measures have been implemented by some utilities. Hardening system components, or applying specifically designed operating measures, if done in a non-coordinated fashion, can result in undesirable consequences to the overall interconnections and can lead to the forced separation of the overall interconnected grid into several non-synchronous electrical islands.

**Use of ADAPT-POWER for GMD**

Based on latitude, geology and voltage class, the geographic impact of GMD can be defined. ADAPT-POWER can be used to:

- Determine the magnitudes of GICs in different parts of the affected grid
- Evaluate load/generation balance scenarios in the islands
- Define appropriate system separation points to be able to stitch the system back together
- Identify the transmission lines to be opened in case of an imminent GMD
- Identify lines for reduced loading in anticipation of increased flows due to GMD induced currents
- Identify GMD protective settings and permissible operating limits of equipment
- Identify generating units that can act as synchronous condensers on line to provide additional reactive power
- Identify generators that can be brought on line to provide additional reserve power and reactive capacity
- Determine dispatch and operating modes tolerant of tie loading and operating reserve margins, and that anticipate any contingencies likely in the GMD

Assessments must be completed on a regional and multi-regional scale to effectively model the effects of GMD events. Effective response and restoration from GMD events requires initiation and mobilization exercised through thorough prior planning.

DNV GL has a long heritage in helping the Energy industry turn risk into reward. Let us help you enhance your power system resilience to extreme events, while optimizing your electricity infrastructure investments.

Contact us today at energyadvisory.energy@dnvgl.com or +1 781 273 5700. Learn more about our leading global energy advisory services, thought leadership, innovation and client successes at www.dnvgl.com/energy.

DNV KEMA is now DNV GL
GETTING ENERGY FROM CONTROLLED NUCLEAR fusion may not quite be the Holy Grail, but it is a quest far from complete despite a major step forward at a U.S. research laboratory.

Physicists at the National Ignition Facility at the Lawrence Livermore National Laboratory outside San Francisco earlier this year reported the first-ever successful laboratory effort to generate more energy than that invested in the fuel — the first step toward reaching the elusive goal of ignition, when fusion becomes a self-sustaining process producing carbon-free energy.

“It’s an important step on the way,” said Omar Hurricane, one of the physicists conducting the experiment. “It’s a first for facility-based fusion.”

Hurricane quickly added, however, that this basic research still has a long way to go before any consideration can be given to practical applications. “It’s far too early to talk power plants,” he said.

Nonetheless, it is a big incentive for the team at Lawrence Livermore to continue its quest for nuclear energy through what is called inertial confinement fusion. This means causing the pressure for the fusion with a barrage of laser beams, resulting in fusion cre-
ating a burst of energy that lasts for the tiniest fraction of a second.

Hurricane notes that although the energy released slightly exceeded the energy input of the fuel, the huge amount of energy needed for the lasers meant there was a net deficit of energy in the experiment. However, when fusion can be self-sustaining, that laser energy would only be needed once to start the process. "One metaphor is a match that you use to light a piece of wood, which then burns on its own," Hurricane said.

The research at Lawrence Livermore parallels that being conducted at the International Thermonuclear Experimental Reactor facility in southern France, a joint project of the European Union, the United States and several other countries. That research is based on magnetic confinement fusion, which relies on a "magnetic bottle" to apply a smaller amount of pressure for a longer period of time.

A variation of the inertial confinement method is also being studied at the Sandia National Laboratories in Albuquerque, N.M., where a complex process known as Z-pinch creates the pressure needed for fusion.

“They all have pros and cons,” Hurricane said of the different approaches. He said that fusion research has been going on for decades, so it makes sense to explore as many avenues as possible. “It’s like spreading your money across the stock market,” he said.

Fusion is seen as a noncarbon polluting form of energy that avoids the hazards and radioactive waste of the nuclear fission currently used in power plants. “A fusion power plant would produce no greenhouse gas or other noxious emissions, operate continuously to meet demand, and would not require geological disposal of radioactive waste,” the NIF website explains. “A fusion power plant would also present no danger of a meltdown.”

Nuclear fission power plants rely on the splitting of heavy atoms such as uranium to release energy for electricity. A fusion power plant would generate energy by fusing atoms of deuterium and tritium, two isotopes of hydrogen.

Fusion that is uncontrolled, as most of us learned in school, is what produces the much more powerful explosion of an H-bomb, as opposed to the fission of an atomic bomb.

While progress in controlled fusion research has been steady, Hurricane said, and the latest success moves things forward, it could well be decades before scientists can produce the self-sustaining fusion they are seeking.

The laboratory-scale experiment is quite small, even though the NIF building is the size of three football fields and 10 stories high.

But Hurricane is optimistic that once the ignition process is developed, practical applications will quickly follow. “Once you demonstrate that something can be done and what it takes to do it, you see an acceleration of inputs,” he said.
ONE YEAR INTO OUR smart grid demonstration project, Portland General Electric and its partners are demonstrating new technologies that hold promise for building a more efficient, sustainable and reliable grid. These technologies provide the opportunity to reshape not only the infrastructure that makes up the grid, but also the approach utilities take to meeting the needs of our customers, the economy and the environment.

A partner in the Pacific Northwest Smart Grid Demonstration Project, PGE is testing several technologies at our Salem Smart Power Center, which opened in May 2013. The key feature of the 8,000-square-foot center is a 5-megawatt lithium-ion battery-inverter system. The bank of batteries stores 1.25 megawatt-hours of energy, which allows PGE engineers and planners to demonstrate high-reliability strategies involving intentional islanding of the feeder, distribution automation using smart switches, demand response, renewable energy integration and automatic economic dispatch.

As a result, we’re learning how to better integrate variable renewable energy resources into the grid. We’re also finding ways to take better advantage of demand response opportunities. What’s more, we’re testing software that uses a Transactive Node to alert us to store energy when market prices are low and pull from battery storage, rather than buying power when prices are high. PGE is testing this tool to see how it might help ensure customers receive the most benefit from energy resources for the least cost.

PGE has combined several of the energy storage features we’re testing to create a microgrid within our system that is capable of serving business and residential customers on a specific feeder in Salem, Ore. By intentionally islanding the entire feeder under certain system conditions, PGE can use the batteries to keep electricity flowing for all the commercial and residential customers on that circuit for up to 30 minutes. This is more than adequate time to start the six customer-owned standby generators on the circuit and synchronize them to the line. These generators, owned by the state of Oregon, have a combined capacity of more than 5 megawatts and can maintain service on the grid as long as there is fuel to power the generators.

The ability to create a microgrid in partnership with a utility could benefit large customers with continuous needs for high system resilience and reliability during extreme conditions. Although our demonstration efforts show promise for the viability of these technologies, they are too costly for widespread use. As with other emerging technologies, we expect costs to come down as research and development continues and, if they become cost-effective, we look forward to sharing the benefits with a broader set of customers.

PGE has been working for more than 10 years to establish cooperative microgrids with customers.
that own standby generation. We believe this type of partnership will be the predominant form of microgrid in the future. We use a real-time control system to use the backup generators at 49 projects to meet most of our nonspinning reserve requirement. These generators also improve reliability for customers that need to exceed PGE’s system reliability of 99.99 percent.

To continue to be their trusted energy partner, utilities need to support customers in their efforts to be more competitive and to grow our economy. Large customers are beginning to explore microgrids and other nontraditional ways to serve their increasingly sophisticated energy needs. More than ever, their success is our success, and we have the opportunity to engage with them to become part of the solution.

Creating a microgrid is just one of many smart grid technologies that can benefit our customers. Smart grid technologies represent an opportunity to enhance the value customers receive from the electric system. This transition will be a significant challenge – one that involves not only leveraging new technology, but also making major changes in the way electricity is provided and used. For our part, PGE is eager to engage in the research and development needed to bring our local and regional grid into the 21st century.

Jim Piro is president and CEO of Portland General Electric.
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Entergy’s Growth Story

FOCUSING ON LESSONS LEARNED // BY MARTIN ROSENBERG

Entrezy is uniquely poised to capitalize on a growing regional economy and its increasing demand for electricity. Even so, all has not been smooth sailing for the venerable company, which last year passed the century mark in longevity. A couple of big deals in recent years did not transpire as envisioned by company leaders. Leo Denault, 54, became chairman and chief executive officer of Entergy in early 2013. He recently talked with EnergyBiz about where the utility has been and where it’s headed. His comments, edited for style and length, follow.

Leo Denault, center, confers with others at a generation project. Photo courtesy of Entergy
What is the state of Entergy today? What gives you the most anxiety and what gives you the most hope?

I’ll start with the exciting parts. We had a really busy 2013. We had a lot of initiatives in place. We got a large chunk of really complicated and difficult work behind us as it relates to our entrance into MISO, which is great for our customers. The design and implementation of our human capital management program is going to make us a more efficient company. We have an opportunity to earn our allowed rate of returns in our jurisdictions and keep our costs and rates low, which is good for our customers.

We were fighting through the ITC Holdings transaction and the regulatory process. Although we were not successful in pulling that off, we did get resolution. We also took a good hard look at our EWC fleet and each of the facilities and other businesses related to that.

What is the EWC fleet?

That’s the Entergy Wholesale Commodities business. That’s primarily the nuclear fleet in the Northeast, but it also includes fossil fuel plants. It did include a district energy business, but we sold that because it wasn’t core to our business. We made a difficult decision about Vermont Yankee. Even though we were being successful in all the regulatory and political avenues, it wasn’t a good economic environment for the plant, and we made the decision to shut that plant down at the end of 2014. But we also made a decision that we are going to own Indian Point. So, in sum, we had a really active 2013 that was designed to get us to the point at which from 2014 and beyond we can focus on a lot fewer initiatives that are going to profitably grow the business and we can manage risk.

What is the effect of the shale gas revolution?

We’ve got this unique situation in our service territory at the moment that is driven by the differential in North American natural gas prices versus international natural gas and oil prices. Anyone who has a manufacturing process that utilizes natural gas and competes worldwide has a competitive advantage locating their manufacturing facilities in the United States. Our service territory is the perfect place to locate, given its energy infrastructure. We have people constructing large LNG export and other types of facilities in our service territory. They’re going to use hundreds of megawatts of electricity. Gas-to-liquids facilities have announced that they are going to locate in our service territory. Again, that could be several hundred megawatts of new load for our system. There’s been an announcement about approximately $65 billion worth of investment in those types of facilities and others within our service territory. If all of them showed up, there would be about 2,400 megawatts of additional load.

How does that benefit Entergy?

They are significant electrical loads. They’re going to use hundreds of megawatts of electricity. Gas-to-liquids facilities have announced that they are going to locate in our service territory. Again, that could be several hundred megawatts of new load for our system. There’s been an announcement about approximately $65 billion worth of investment in those types of facilities and others within our service territory. If all of them showed up, there would be about 2,400 megawatts of additional load.

How do you get these new industrial companies to buy power from Entergy instead of producing it for themselves?

The co-generation risk is real. What our team is focused on is trying to convince those customers that we have a better solution. Because we are managing a system, it would make sense that we, logically, could provide that power. We’ve actually had some companies start down the path of co-generation and our team has been able to work with them to provide a better solution. I’d like our CFO to talk to the CFO of the guys building those plants so they can have a cost of capital discussion. Traditionally, that isn’t what happens. That’s one of the major things that we have to accomplish.

Much of the industry is facing the situation of flat to declining electricity revenues.

We have an opportunity to overcome that. Over the next five years, you might see our annual load grow by about 1 to 1.25 percent. In November, when we gave our outlook for the next several years to investors, we pegged our annual load growth at 2 to 2.25 percent.

How do you deal with the risk of that growth not materializing? Are you planning to ramp up generation?

Obviously that’s a risk, but we already have contracts in place for more than 1,000 megawatts of new load, about 450 megawatts of which is now under construction. And we just entered the MISO regional transmission organization, which expanded our market footprint. It allows the market to get planned access to more generation than just the Entergy generation. The region has excess generation. Depending on location, system reliability issues and grid stability issues, we are likely to source the power from the market.
**ENERGYBIZ** Is there adequate transmission?

**DENAULT** There is adequate transmission in the market. But there will be a need for more transmission to hook these people up and to maintain stability of the grid. That will start to show up if they construct the facilities. There might be the need for incremental generation, even in the MISO market. But we will have time to plan for that.

**ENERGYBIZ** How have you rebounded from Hurricane Katrina?

**DENAULT** With Hurricane Katrina, the biggest impact was really on the city of New Orleans. It was devastating in ways well beyond anything that happened to us. New Orleans is our smallest subsidiary. The rest of Louisiana was impacted as well. We are 80 percent back to where we were in New Orleans. But overall we’re as big or bigger than we were at that point in time.

**ENERGYBIZ** Entergy had two major deals it tried to do. One was to spin off transmission assets tied to ITC. And a few years ago, you tried to spin off your nuclear assets. Both efforts floundered. It seems as though you are not driving the train the way that the industry thinks you want to. Discuss those setbacks and what you’ve learned from them.

**DENAULT** Sure. The first thing we need to say is that they were unique. We believed both provided a significant amount of value for our customers, for the markets and certainly for the people who own the company. Where we didn’t succeed is in the regulatory process around trying to do a couple of highly complicated, unique transactions. In the case of ITC, we were trying to spin and merge using a Reverse Morris Trust transaction, which I don’t believe was ever done before in the utility industry. As part of the transaction, there was a change in regulatory construct from state to federal regulation. We couldn’t garner enough support from our state jurisdictions. It was a big public policy decision. It was a very complicated transaction. It was a big change in the way the world works. We still believe our customers, the communities we serve, our employees and our shareholders would all be better off if we had done the ITC transaction. We continue to own the transmission business and will invest in it. Owning, operating and managing that is not a bad thing. In fact, for Entergy, that’s obviously going to be a major growth piece of the business. There are a lot of lessons we learned about that, particularly given the nature of the change we were asking people to make. As far as the spinoff of the nuclear business back in 2007, we really got caught up in a series of events. We were trying to make a stand-alone company around the nuclear business at the same time that a financial crisis hit the country. New York state regulators were uncomfortable with anything they perceived could jeopardize the financial strength and stability of Indian Point. They said Indian Point was too important to the grid, to the environment and to the community to fail. The merchant nuclear business was not an investment-grade business. The mortgage crisis hit. The collateralized debt obligation crisis hit. The banks were going under. It was bad timing. Still, we were able to raise money. We actually were able to get credit facilities for that business and everything put in place, should it have happened. But we were the victims of unfortunate timing.

**ENERGYBIZ** What challenges are ahead for the utility business model?

**DENAULT** There’s a lot of activity in the energy efficiency space, the distributed generation space, with microgrids, demand side management and different regulatory structures. You see a lot of interesting dynamics as relates to the industry. Our view is that we need to be proactively looking at what the threat to the business model and the monopoly will be. That is wise technologically and from the standpoints of public policy and regulation, both at the federal and state level. We need to find solutions as opposed to putting up barriers. We need to be the ones that determine what the future business model ought to be and whether it includes what we traditionally do or not. Then we need to be able to find a way to participate in that future model in ways that are different from what we’ve done in the past.

**ENERGYBIZ** How do you guard against your team getting gun shy after these last two forays?

**DENAULT** We have to continually focus on lessons learned. We need to be a lot more proactive with our regulators around what that future holds. We have to be a lot more constructive with our regulators around the different ways that it can be accomplished long before we go to them with a transaction.

**ENERGYBIZ** Do state regulators understand the changes in the utility business?

**DENAULT** There is a lot of education that the industry has to get, period. Then, the regulators will get it as well. It’s not going to be one single technology
that wins out over all. There’s going to be a combination of factors that go into what’s next and the industry has to figure that out, and we haven’t yet. A lot of things are public policy driven. Technology choices are mandated. It may not make all the economic sense in the world, but once it’s subsidized and once the programs are put in place, it happens. We have to deal with productivity enhancements that are occurring outside of our business, whether it’s in solar panels, windmills, microgrids, battery technology or electric vehicles. How do we understand the real energy economics of all that? How do we find the right solution set for our customers that will be economically sound, environmentally sound, a good choice for reliability and a good choice for cost structure? And it should not shift burdens from one customer class to another or be regressive.

ENERGYBIZ | As you sit down with regulators in Arkansas, Louisiana, Texas and Mississippi in the next six months, what will you be telling them about deals that you hope to consummate five years from now?

DENAULT | Whatever those deals might be, they’ve got to be lined up, first and foremost, with our mission: to create sustainable value for our owners, our customers, our employees and the communities we serve. Beyond that, I’d be getting out in front of myself if I started talking about deals we might do.

(GUEST OPINION)

Funding Upgrades

AGING INFRASTRUCTURE // BY COLETTE HONORABLE

OUR NATION’S ENERGY INFRASTRUCTURE IS AGING. We know work is needed so consumers can enjoy safer, cleaner and more efficient utility services.

Under our regulatory system, every penny utilities spend on building, updating, and maintaining their infrastructure eventually gets passed through to consumers. For more than 100 years, this regulatory compact has served our nation well. Electricity, telecommunications, water, and natural gas utilities have, for the most part, provided safe and reliable service at affordable rates. Through rate cases designed to ensure that ratepayer money is well spent, utilities are able to maintain their systems and provide reliable service almost 100 percent of the time.

Unfortunately, it only takes one prolonged outage for the public to question this system, just as it only takes one devastating accident to raise doubts about the safety of our natural gas pipelines. When something goes wrong, the public asks questions and deserves answers. Indeed, as I’ve said many times, we are all responsible for providing safe and reliable service.

With extreme weather like this year’s polar vortex or the 2012 derecho seemingly more frequent, our utility infrastructure’s ability to withstand these events is being tested far more often than in the past. As a result, utilities are proposing infrastructure replacement and modernization plans with the aim of building a more resilient system. And as the regulatory compact requires, the costs of these plans, if deemed in the public interest by their regulators, will fall onto consumers.

Many utility sector observers expect that modernizing our electricity, gas, and water infrastructure will cost more than $4 trillion over the next 20 years. And because these expenses will likely be shouldered by ratepayers, regulators must find ways to ensure consumers are not overburdened by these expensive yet necessary investments. At the same time, we cannot always predict when the next natural or manmade disaster will hit, so we must also prioritize and invest in the most vulnerable elements of the system proactively.

Striking the appropriate balance is one of the most pressing challenges regulators now face. Many states have adopted alternative rate-recovery mechanisms such as riders and surcharges that let utilities charge a slight amount to consumers now for broad infra-
structure upgrades that can occur immediately. This allows the utility to make immediate investments into its system without having to go through a lengthy rate case. For consumers, this not only ensures a more resilient system, but also will keep the ultimate costs of these investments lower because of access to cheaper financing.

NARUC passed a resolution last July encouraging our members to consider such approaches when appropriate. Alternative rate-recovery mechanisms may help expedite the replacement and expansion of the pipeline systems by promoting timely rate recovery for investments in infrastructure, safety and reliability. Moreover, these policies can be very effective for advancing critical safety and reliability infrastructure upgrades.

Let’s also be clear that an accelerated rate-recovery mechanism is subject to the same regulatory scrutiny as a typical rate case. The difference is these costs can be addressed in a more accelerated fashion and not every several years like a normal rate case.

But accelerated recovery mechanisms are not substitutes for performing maintenance and upkeep. As our resolution makes clear, utilities own and operate their systems. They know those systems best, or at least they should.

Because we agree that our utility system is aging, one can assume companies have recovered their investments in these systems from consumers. This means utilities are likely profiting on the pipes already in the ground and the power lines in operation. A prudent utility should reinvest these profits into system infrastructure. In fact, most recognize that if infrastructure is not upgraded regularly, any efforts to catch up may not be possible if an extreme weather event hits. This poses a significant risk to the public. Simply put, delayed infrastructure investment is a reliability and safety risk.

Surcharges and other kinds of mechanisms can have a positive effect on infrastructure resilience and reliability. Proactive utilities, that is, those that have already made investments with or without these treatments, should be applauded for their efforts. Those that have not should not sit back and wait.

政府发起的项目被视作研发费用而不是资本投资。

The two key interrelated risks recognized by stakeholders are technological risks associated with early equipment failure and political risks associated with higher costs to customers to replace failed equipment.

One avenue to mitigating these perceived risks is some third-party insurance or guarantee backstopping the asset. The insurance industry is in the business of risk assessment and pricing insurance; however, for a new technology or new application of an existing technology there is a lack of data to provide a basis for underwriting. Consequently, coverage may be unavailable or may be offered at rates that reflect the underwriter’s inability to assess potential losses.
There are examples of government programs that provide backstop insurance or assurances for technologies and businesses where the private markets cannot or will not assume the risks. The U.S. Department of Energy’s loan guarantees for large nuclear plants and the U.S. Department of Agriculture’s crop insurance program are examples of financial assurance and shared risk management.

There are several policy steps that can help mitigate the risk barrier to utility and regulatory adoption of new technologies.

The DOE, academics, businesses and the financial community can collaboratively develop risk assessment models for new technologies to enable development of financial insurance or assurance options.

Research into life span and failure modes at an accelerated level can reduce risk faster than the simple passage of time.

We should acknowledge that early adopters of new technologies assume greater risks and that such risk-taking should be rewarded, within reason, because of the societal benefits resulting from advancing knowledge. The technological, economic and political risks associated with deploying new technologies that have been tested in pilot studies should be shared among the utilities, consumers, vendors, manufacturers and government. We learn by trying — sometimes succeeding, sometimes failing, and sometimes by not fully succeeding.

We can determine what replacement options exist for a new technology that does not fully meet expectations and at what cost. For example, if a battery fails prematurely or does not fully perform to expectations, the utility has to replace it — but perhaps with peaking power or some type of substitute supply or technology. Collaboration among the DOE, members of the financial community, utilities and regulators to determine the replacement of function options and costs will facilitate development of financial instruments to protect the interests of consumers, regulators, manufacturers, utilities and the DOE.

If we can figure out the value of new technologies to the electric system, it will also help identify the ultimate value of those technologies to system operational efficiency. This knowledge would permit the DOE and the financial community to develop financial instruments to reduce the perceived risk to utilities, regulators and consumers. For example, the use of electric storage to mitigate fluctuations in voltage may be less expensive than building increased generating capacity. If the DOE and the financial community establish the relationship between the two costs, it may provide a path for developing the necessary financial insurance or assurance options.

A broader understanding of how utilities, the financial community, infrastructure investors and regulators view technology risk and possible mitigations might serve DOE and other policymaking organizations well in helping the financial community and government develop insurance and assurance incentives and guarantees so as to remove perceived barriers and lower risk mitigation costs. The development of such technological and financial risk-and-reward models should be relatively inexpensive, and they could greatly improve the likelihood that new technologies or the application of existing technologies in new ways will be perceived as viable and responsible investments. Such financial packages are vital for early adoption of new technologies until a basis for actually determining life-cycle system performance is established.

We learn by trying new things, but the political reality is that risk-taking is not rewarded. It is time that policymakers and other stakeholders develop the knowledge and financial instruments necessary to responsibly advance greater innovation within the electric system.

Tom Sloan is a member of the Kansas House of Representatives.
Cheaper Ways to Power America

THIS IS EASY // BY REED HUNDT

LIBERALS AND CONSERVATIVES NO LONGER HAVE any reason to disagree about how to power America. Thanks to big data, financial innovation and technological advances, we have suddenly arrived at a point in time that is magical. The entire economy can move to cleaner energy and at the same time everyone can pay less for that energy.

Big data describes the way Netflix and Amazon tell you what you want to buy. As we have demonstrated at the state-created Connecticut Green Bank (I’m a board member), big data also can tell every homeowner whether their roof is suitable for solar panels that would lower their electricity bill. Soon we will be able to link homeowners on the shady side of a street with those on the sunny side, so they can share panels and both get a better deal.

A Brookings conference in February addressed how states can loan homeowners all the upfront costs for solar and efficiency installations. Rates will be low enough for homeowners both to save money on energy bills every month and also to pay back the loans in total over time. If consumers can buy cars and furniture and smartphones with cheap finance, why not buy clean energy the same way?

Meanwhile, solar install costs continue to fall like semiconductor chips adhering to Moore’s Law. When and where solar install costs hit less than $3 per watt, everyone not living in a cave can get at least three-quarters of their electricity from their roof at a price lower than grid-supplied electricity. This is the reason investors put more than $10 billion into solar last year.

Wind power and natural gas offer ample sources to provide cheaper and cleaner electricity at night or for industrial purposes.

To expedite the shift to electric vehicles, state and local governments can borrow money to build charging station grids. Private firms are already pitching this deal in many states. The loans to build the charging stations can be paid back by modest surcharges on the electricity. As consumers leap to avoid paying at the gas pump, utilities will earn new revenue from the new charging networks, turning them into passionate advocates of the new power platform.

Because sun, wind and natural gas are widely available around the world, this trio of cleaner, cheaper energy sources can simultaneously drive economic growth in developing nations, including today’s dirty coal-burning China. Already the World Bank, the Export-Import Bank of the United States, and the Overseas Private Investment Corp. are developing expertise in this area even in much maligned Washington. Their efforts should be combined in a new institution and expanded to join with private capital that builds a brand new power platform for the global economy. The administration can take this step using executive authority alone.

The United States can propose border duties on carbon imports, which would have the effect of keeping coal in the ground unless it is burned in plants that capture all dangerous emissions. These duties would suppress the dirty coal trade and also level the global playing field for American manufacturing. The United States Trade Representative should launch this initiative right away. There’s no need to wait for the liberal-conservative fracture in Congress to heal.

Conservatives have to understand that even if global warming really weren’t a scientific fact, the free fuel of the sun still makes consumers better off.

Liberals have to understand that consumers can be better off right away and still be saving tomorrow’s world.

And even if elected officials in Washington still find a way to disagree, the rest of us can move into a cheaper and cleaner energy future without them.

Reed Hundt, former chairman of the Federal Communications Commission, is CEO of the Coalition for Green Capital.
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Utilities need to consider expanding the range of services that they provide.

Tariff reform is one area to look to to address industry challenges. If properly structured, it would allow for the utility to recover the costs that are being covered, right now, on a volumetric basis and try to move them to the consumers that are benefiting from the grid, including distributed generation customers.

**ENERGYBIZ**: How would it look?

**KIND**: One of the things you could do is institute a fixed charge so that more of the costs are recovered without having to be concerned about volume sold. Distributed resource customers could be charged a fixed fee for their usage of the network and the option of being connected to the network.

**ENERGYBIZ**: What about the idea of getting utilities to re-imagine the business they are in and going after revenue that’s not tied to volume sales?

**KIND**: Yes. Agreed. One of the conclusions that I’ve reached is this isn’t just about tariff reform. The costs of things like solar and energy efficiency are dropping. Ultimately, regardless of whether you fix the tariffs, in many markets these technologies will achieve parity with utility generation. Utilities need to consider expanding the range of services they provide in order to identify new revenue sources.

**ENERGYBIZ**: Are the implications of that understood by the industry?

**KIND**: They are not clear as to what those services may yet be. They’ve installed smart meters but they are not being efficiently utilized. Ultimately, a utility can’t get involved in new services without its regulator supporting it. There needs to be an open dialogue about what are these services? Why are they needed? Why should the utility provide them?

**ENERGYBIZ**: If there are distributed generation and renewables closer to the user, will the industry spend less on transmission?

**KIND**: That’s what I’m hearing from the experts. With more distributed resources there is less of a need for transmission and centralized generating stations.
FROM AN INTIMATE GATHERING OF SOME 50 KEY customers in 2007 to a highly anticipated meeting of more than 200 utilities this year, the Itron Africa Users’ Conference welcomed senior executives from across the continent to discuss the unique challenges and opportunities facing the African utility industry today.

In the past, electricity powered the conference’s agenda. Over the past several years, however, Itron has added water and gas to the mix, reflecting an increased focus on resource conservation and demand for all three commodities.

Why the change? For one thing, Itron has expanded its repertoire to reflect a growing hunger on the part of its African customers and partners — and their customers — for more resourceful ways to use water and energy. But the company’s presence, much like Africa’s urgency for a strategy to efficiently manage scarce
resources, has grown, especially in recent years.

The issues are complex and growing rapidly.

Infrastructure, including power generation and distribution, is lacking across the region. Combine this with large numbers of the population migrating to larger cities, and you have an issue of both growing infrastructure requirements in some areas and increased usage demands in others. Water, too, is scarce in many places, requiring an increased emphasis on conservation, in many cases this begins with measuring the water supply to ensure that the water distributed equals water delivered. Energy theft is a challenge in Africa. It causes significant losses in revenue to utilities and contributes to overloaded networks.

The skills needed to address these issues and bring water and energy to all Africans while helping manage these resources wisely can be difficult to find. Utilities and municipalities often have strategies in place to expand power and water services — they know where they need to be and how to get there — but they may lack the capacity and the access to trained, skilled workers required to reach their goals. African utilities need flexible solutions and long-term partnerships in order to deliver the right solutions based on their unique regional needs.

During the users conference, many discussions focused on recent solutions deployed in Africa and how these efforts may be duplicated in other regions. Key utility leaders and industry experts discussed a variety of projects that have taken place on the continent in recent years as a way to exchange best practices and share a common vision for future infrastructure improvements.

One example is a $130 million large-scale smart meter contract in South Africa calling for the installation of world-class, cutting-edge technology throughout Johannesburg for City Power. The smart meter solution will empower City Power’s customers to better manage their electricity use and save money on power bills in a country where energy costs are on the rise. It will help the city reach its energy-efficiency goals. Itron, Edison Power Group and City Power have been working hand in hand to complete this crucial project that will benefit the city for decades to come.

On the gas side, a project is underway to deploy more than 2,000 gas meters and an online prepayment vending system for alternative energy provider EnviroFuel. Although much of South Africa’s focus has historically been on prepaid electricity technologies, this project will enable residents of Waterfall Country Estate, an environmentally friendly residential development in Johannesburg, to also use these technologies in gas installations. In addition to installing the system, Itron has trained EnviroFuel employees manage the vending network. This is just one example of the new models for developing businesses in Africa.

In the Sol Plaatje Municipality, a revenue assurance approach has produced significant financial and operational benefits, which in turn has led to improved controls within the municipality.

A prepayment system has been deployed in Zimbabwe, and work is ongoing with customers in Angola, Zambia, Kenya, Tanzania and Mozambique, among others.

Although much progress has been made to reliably deliver electricity, gas and water to citizens across Africa, more is still needed. After spending an invigorating week with Africa’s energy and water leaders, I am confident that together we’ll create a more resourceful world for generations to come.

Damian Padachi is managing director of Itron, South Africa.
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