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From Distribution To Contribution

Commercializing The Smart Grid

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FROM DISTRIBUTION TO CONTRIBUTION

Commercializing The Smart Grid

Public pressure is growing across Europe for the transformation of the traditional electric grid into an intelligent network—a smart grid. "The electric grid," as one observer recently put it, "is probably the last unintelligent large physical network on the planet." Indeed, this last frontier of underdeveloped space is now finally ready to be explored (see Exhibit 1, page 2). Massive investments in transmission and distribution networks are being planned across Europe—up to €200 billion by 2020, with up to €90 billion directly related to investment in smart grid technology.

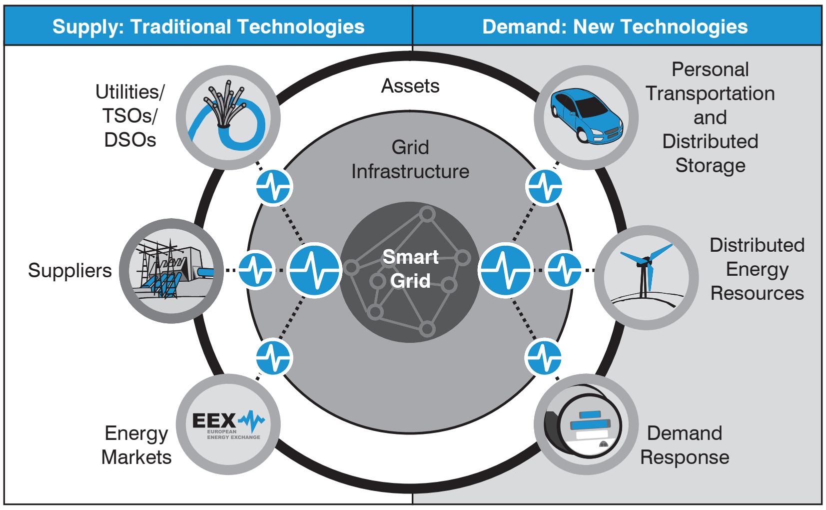
With so much at stake, it would be prudent for the industry to have a plan incorporating a unified mode of approach and a vision. The smart grid has become a touchstone for improving efficiency and for addressing climate change, and utilities are busily responding to recent mandates for smart metering technology in markets where regulators have already issued directives—such as Spain, Italy, the Netherlands, Norway, and Sweden—and in markets that still lack mandates, like Germany—where, for instance, the utility RWE just announced a trial of 100,000 smart meters. However, the question remains: Does the industry as a whole have a vision for the smart grid's emergence and for the commercial opportunities inherent in this revolutionary change in the way utilities will do business?

The Predicament: A Mandate without a Vision

A smart grid would employ digital technology to optimize energy usage, better incorporate intermittent "green" sources of energy, and involve customers through smart metering. Given the significant investment required and the uncertainty around how smart grid technologies could develop, utilities need to take advantage of regulatory enthusiasm and work with regulators to create a strategic, industry-wide plan that will fully reap the benefits of next-generation grid technology and maximize the positive effect on the industry

Exhibit 1

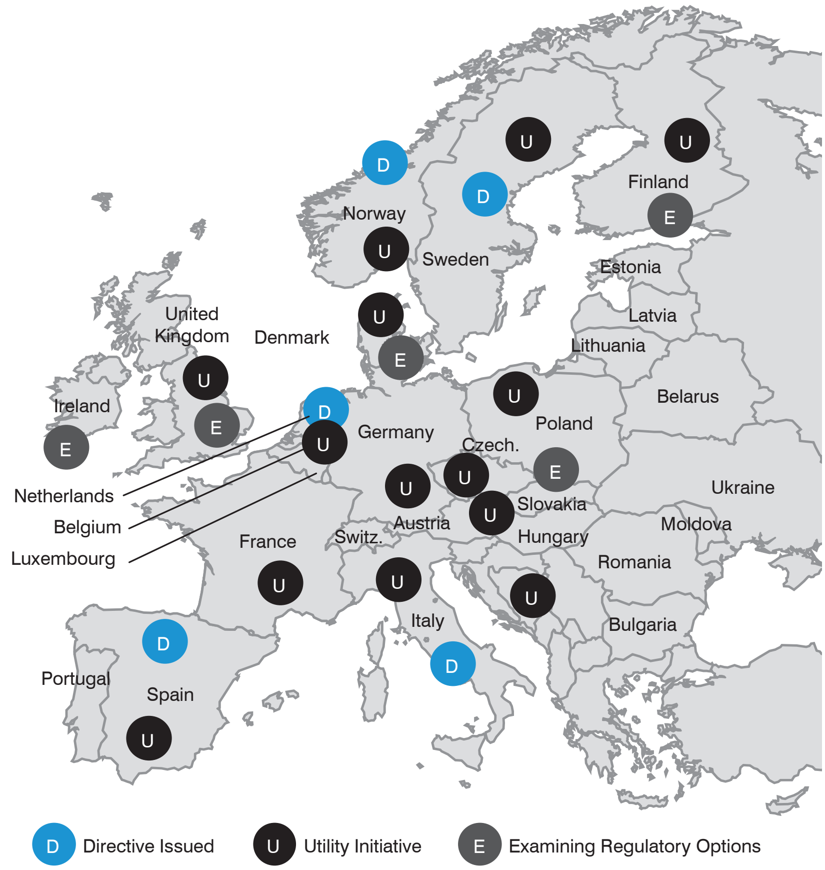
The Future Energy Supply System



Source: Booz & Company

Exhibit 2

Smart Metering Regulation in Europe



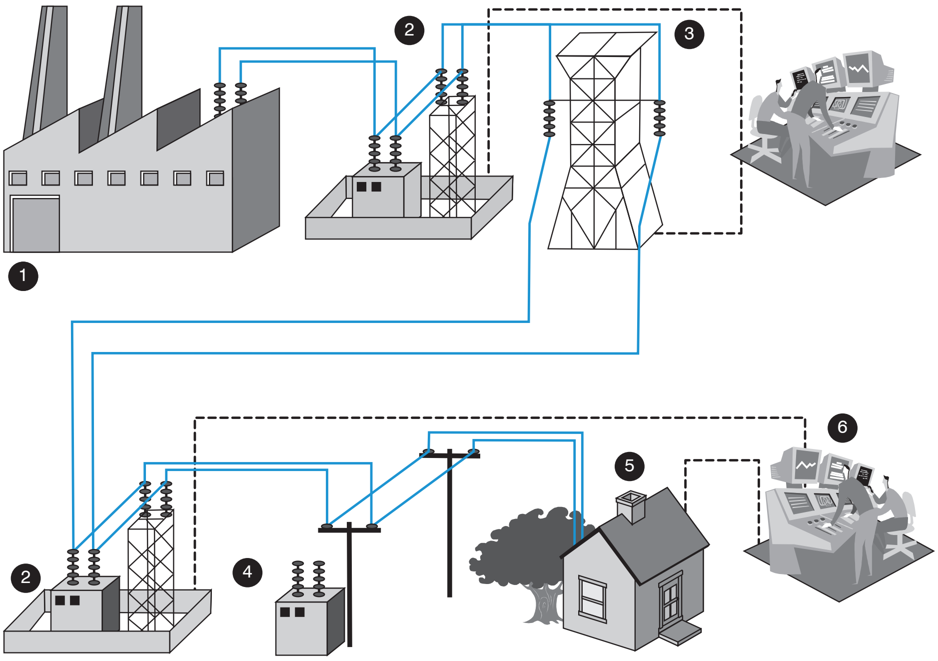
Source: Booz & Company

(see Exhibit 2). A well-defined holistic strategy that takes into account how best to provide value to the customer is the first step in unlocking the commercial possibilities of the smart grid. Only after defining such a strategy should utilities begin to tackle the challenge of choosing the best technology.

The first conceptual hurdle—one that many utility executives understand but have yet to fully act upon—is that the smart grid is not a piece of equipment but a mega-trend. Whatever they want to claim about, for instance, the efficacy of smart meters, many have let the details about such equipment's capabilities distract them from what that equipment truly represents. What it represents is an unstoppable paradigm shift in the way that utilities do business, and a challenge to each utility that wants to keep pace in developing business strategies that will successfully negotiate the shift (see Exhibit 3).

The challenge for those contemplating the deep design and business issues that are inherent in the emergence of the smart grid is that the current technological landscape in Europe is a chaotic kaleidoscope of new equipment—smart meters with various degrees of built-in intelligence, for example, in varying states of deployment, under wildly different forms of regulation, and often following needlessly competing or proprietary standards of use. Funding for smart meter programs ranges

Exhibit 3
An Overview of the Smart Grid



1. **From**: Large-scale, centralized power plants
To: Integration of demand response and microgrids
2. **From**: Local substation management
To: Substation automation and remote control
3. **From**: Grid monitoring of load management
To: Grid condition monitoring
4. **From**: Decentralized distribution control
To: Central coordination (banks, transformers, etc.)
5. **From**: Manual meter reading
To: Automatic data collection and demand response
6. **From**: Selective central information and control
To: Full grid perspective and remote control

Source: Booz & Company

between €150 and €500 per customer, with meter hardware accounting for only €100 per customer; the rest goes toward installation, system design, communication infrastructure, program management, and the like. When the operating costs for communication are added in, the negative impact on customer value becomes even more apparent. Now imagine a country like Germany, with more than 600 utilities, or Stadtwerke, each one running its own separate smart meter software, and the scope of the potential problem becomes easy to visualize. And although technological competition is probably healthy, regulatory divergence is not. To avoid creating the smart meter equivalent of a technological Tower of Babel, open standards would be a universal boon.

Toward a Solution: Open Systems and Business Model Competition

In many ways, the situation in utilities today resembles the battle over standards between VHS and Betamax in the 1970s and 1980s video market or even the 19th-century battle between direct current and alternating current. But we think that rather than framing the situation as a battle, utilities should consider this moment an opportunity to design the future together. Everyone will benefit significantly from industry-wide cooperation based on common objectives. Utilities, of course, will need to define how much they want to cooperate, keeping in mind the need to set boundaries to avoid anti-competition issues, but the goal should be clear—to build a common and secure communications standard for the abundant data that will define the smart grid. A utilities task force, for example, could start by laying out recommendations for industry-wide open technology standards and interoperability.

With increased interoperability, utilities will for the first time face critical information security issues, especially as communications infrastructure becomes directly linked to billing and customer account data. Despite these concerns, an interoperable communications backbone is vital for making a bold move forward.The trouble is that many utilities have prioritized investments in metering hardware—or have even considered a move into manufacturing smart meters—when such decisions, in effect, put the cart before the horse. Compared to the overall program costs and complexity of a standardized communications backbone, meters are a minor expense. It's the backbone, one that uses open and standardized technology, that will ultimately make the smart grid live up to its name.

Once the industry achieves open standards, the next step will be to make the right choices about communications infrastructure. The choices are quite diverse: power line communication (PLC), radio frequency (RF), fixed-line mesh, general packet radio service (GPRS), broadband over power line (BPL), and fiber optic. Utilities will need to define how soon they believe a real-time operating environment at the distribution or household level will become relevant. Currently, only advanced solutions like BPL and fiber optic offer truly open, real-time operating capabilties. Because of geographic and population challenges within each utility's service area, most European utilities have varously deployed a combination of PLC and GPRS technologies instead of opting for a standarized, one-size-fits-all solution. Although these technological decisions are crucial, they should not form the basis of a utility's competitive strategy. To paraphrase former French President Francois Mitterrand, these decisions should be made in a way that ensures competition among utilities will be between business models—not between technologies (see Exhibit 4).

Exhibit 4
Smart Grid Initiatives

	Customer Initiatives	Automation Initiatives	Efficiency Initiatives	Monitoring Initiatives
Leading	"Smart" Home/ Building Automation Real-Time Prizing/ Full Advanced Metering Infrastructure	Self-Healing Grids (Configuration/ Management) Distributed Energy Resource-Based Microgrids	Distributed Energy Resource Integration Broadband and Third-Party Enablement	Web Services
Progressive	Advanced Meter Management	Agent Systems Distribution (Feeder) Automation	Advanced Energy Storage Systems Advanced Conductors	Advanced Grid Sensing and Control (2-Way/Real-Time) Advanced Visualization (e.g., Geographic Information System) and Prediction
Conservative	Automated Meter Reading	Substation Automation	Demand Response Demand Management and Control	Outage Management System One-Way Communication with Passive Tracking/ Monitoring
Grid Integration				

Source: Booz & Company

Commercialization: The Next Boom

In order to fully exploit the commercial opportunities at the heart of the smart grid, each utility will have to establish its own business plan, keeping in mind three major opportunities that will come into view in the near term (which can also be viewed as threats). The first is the emerging role of hybrid and electric vehicles in personal transportation, the second is the rise of distributed generation, and the third is changes in demand response (DR). (See Exhibit 5.) These three opportunities cut across the industry's entire value chain. With business strategies and goals in place, the flexibility of the smart grid will seem less confusing, and utilities will stop viewing these features as industry threats and will come to understand, instead, that the smart grid will become a key enabler for future growth.

Hybrids, plug-in hybrids, electric vehicles, and hydrogen fuel cell vehicles are all becoming viable options, and they represent a grand shift in personal transportation that will have widespread consequences for the energy sector as consumers move away from gasoline and diesel fuels and toward electricity. The transition is already happening—electric vehicles are well beyond the experimental stage and are now approaching mass production—and the opportunity for growth is enormous. In Germany, which many view as representative of what is likely to happen in the rest of Europe, transportation is the only sector of energy

Exhibit 5
Demand-Side Applications for the Smart Grid

	Personal Transportation and Distributed Storage	Distributed Energy Resources	Demand Response
Overview	• Design with mass market appeal • Battery performance (speed and durability) sufficient for personal transportation requirements • Lifetime costs lower than internal combustion engine cars • Electric vehicles introducing high loads at the household level (number one in household load and demand) • Battery capacity with real option value for storage/replacement to power plants	• Mass market introduction of household size applications reaching beyond solar • Evolution of applications from pure heat to electricity-driven combined heat and power by 2009 • Growth driven by regular replacement cycles of heat installations and deteriorating asset maturity • Increasing challenges to the distribution network with increased market penetration	• Extending load management from industry to commercial and retail customers • As of today, limited relevance in Central Europe in the mass market due to the lack of sizable load • Electric vehicles and distributed energy resources introduce high load to and from the grid at the household level • Demand response will play a key role in managing the customer interface
Opportunities	• Demand growth potential of new applications • Introduction of substantial load at the household level • Increase in baseload demand levels and load smoothing	• Customer investment in 2020 renewable energy obligations • Smoothing of load disruptions caused by large-scale wind capacity through distributed clusters of multi-technology distributed energy resources • Service business opportunity	• De-commoditization and differentiation of electricity pricing • New product offerings including hardware, software and services • Increased customer intimacy
Threats	• "Mobile load" with distributed and irregular offtake and feed-in patterns • Increase in technical, meter data management, and accounting complexity • Load aggregators as potential new competitors	• Increased distribution network management challenges given irregular offtake and feed-in patterns • Unclear distribution system operator (DSO) reimbursement for increased grid investment requirements • Negative impact on generation business	• Market dynamics and regulation do not compensate for investments in energy saving • Negative impact on generation (reduced demand) and trading (reduced volatility) business

Source: Booz & Company

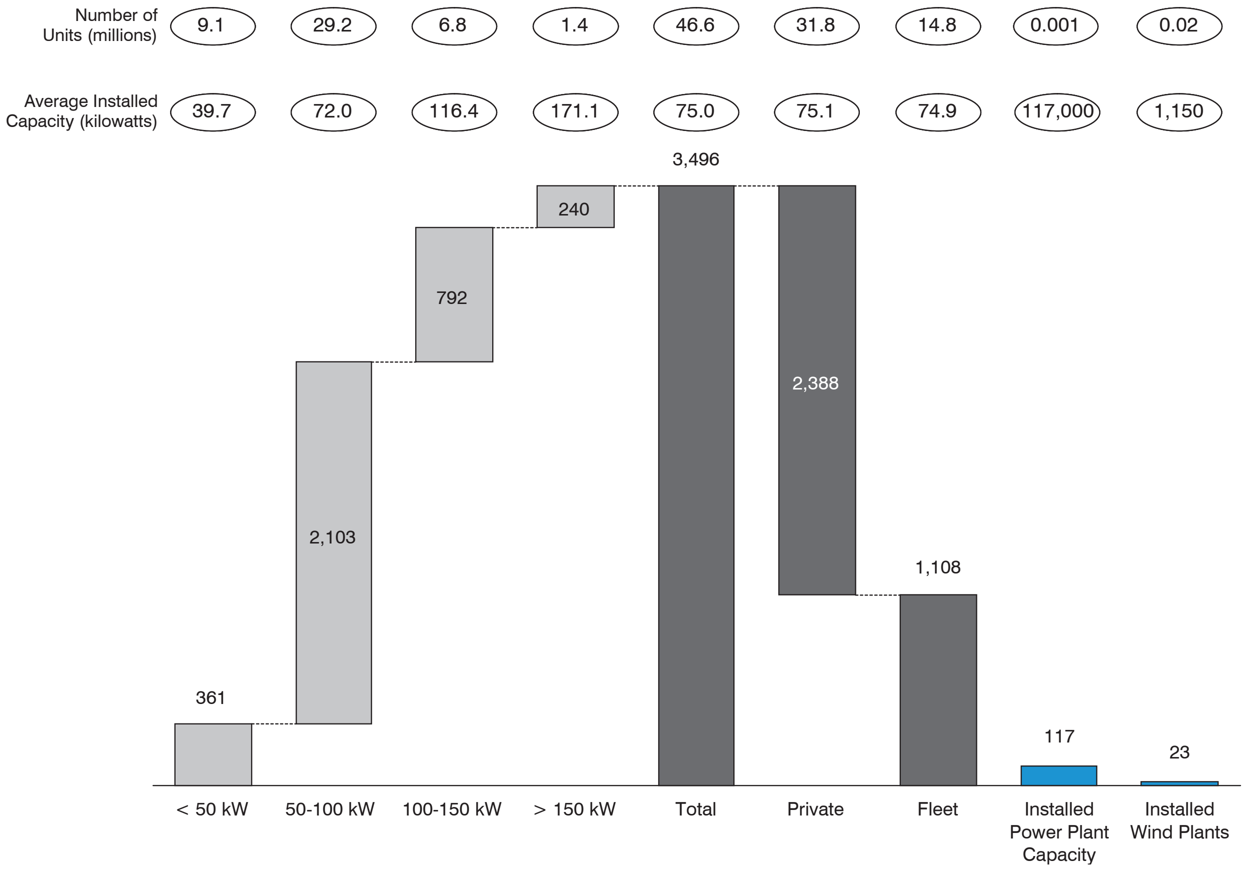
use to offer significant growth potential for electricity. Market penetration for electric vehicles in Germany is expected to reach 4 percent by 2015, with several million electric vehicles expected to be on the road, and some suggest that those numbers could double by 2025. New, well-financed companies with mature management are rolling out electric vehicles, targeting the fleet business that captures 20 to 30 percent of the German car and light truck market. To offer a sense of perspective—and an indication of the emerging opportunity that electric vehicles represent for the utility industry—consider that an electric vehicle market penetration of approximately 5 percent in Germany will result in electric vehicles having roughly the same inherent battery capacity as the entirety of the installed generation capacity on a national level (see Exhibit 6).

Clearly, this shift will present increased challenges for utilities in keeping pace, but it will create tremendous growth opportunities as well. In the trading space, utilities will enjoy reduced peak supply requirements and a variety of trading opportunities. And with so many people using the grid to support how they get from Point A to Point B, the retail space will experience an increase in customer retention—customer value patterns will change and competition in the retail space will increase as retail customers become, in effect, more valuable.

The second perceived threat to utilities lies in the rising phenomenon of distributed generation—

Exhibit 6

Comparison of Installed Capacity in Germany, 2006



Note: Analysis based on assumptions of average engine size per car type
Sources: Shell; Global Insight; VDEW "Stromzahlen 2007"; Booz & Company

the small but growing share of industrials and households that produce their own electricity using solar photovoltaic, wind, micro-CHP (combined heat and power), or some other source of electrical power generated independently from the grid. The idea of millions of European homes with their own power plants; thousands of microgrids or semi-autonomous electricity networks; and thousands of businesses, schools, and retail outlets with similar setups strikes many as a utility's nightmare. The grid was designed on the basis of distribution, not contribution. However, utilities are expected to lead and support this widespread shift. Again, the challenge will be to determine how to benefit from the change. Utilities can do so by offering retail innovation—tariffs and value-added services that will enable these home- and business-owned "micro-generators" to hook up to the grid. Millions of such homes and businesses producing electricity at critical times, moreover, will add levels of redundancy, making a smart grid more robust, allowing for peak shaving, and eliminating expensive coal-fired or gas-fired generators that utilities now rely on to provide extra intermediate-load electricity.

The impact of demand response is the third and perhaps the most worrisome feature of the emerging smart grid era. With demand response, customers will learn to control their energy usage, making informed trade-offs to facilitate conservation. Demand response will thus take volatility out of the market as consumption patterns stabilize. The key to success for utilities adjusting to this change will lie in mitigating losses on the generating side and advocating for new tariff structures that, once in place, will allow utilities to invest in demand response capabilities, decreasing their capital investment exposure on the unregulated side of the business. Utilities that anticipate the way demand response will affect the market will benefit by offering demand response services and providing an attractive stable pricing environment for a new—and growing—customer base.

Demand response will play an important role in changing the dynamics of the utility industry, but the perceived threats to the industry—reduced revenues because of reductions in peak load and in total demand—will challenge the profitability of particularly large-scale baseload power plants benefiting from peak load prices and price volatility. The result of this shift will be a reshaping of the "merit order curve," at the cost of peak load capacity. The smart grid also implies an eventual shift to "load-based" pricing, whereby customers will pay a premium at high-load energy consumption times, like a congestion charge on a toll road during rush hour. This is something that utilities in most E.U. countries will need to take up with regulators, because load-based pricing is typically not permitted.

The Road Ahead

Ideally, each utility will develop a smart grid strategy with a focus on making its smart grid investments a commercial success (see Exhibit 7, page 8). This will require that each utility understand the national regulatory environment and the implications of the regulatory situation on its end-to-end value chain. Each utility must fully understand its customer requirements and develop a long-term smart grid technology strategy, defining key differentiators and developing superior business models that reflect the true cost of the smart grid expenditures and their impact on the value chain as well as the expected benefits of such investments. After all this groundwork has been laid, utilities can then proceed to define the underlying technology strategy they wish to use. We believe that only with the regulatory groundwork and the proper business strategies in place can smart grid technology be fully—and intelligently—deployed.

Much of this preparation will require a general, industry-wide level of orchestration and planning, with utilities leading the way. They will need to align smart grid technologies and identify the need for broader industry-wide agreements and partnerships with vendors and other players in the space. We understand that a coordinated approach may prove difficult, especially considering the size of the task at hand and the

Exhibit 7

Smart Grid Value Proposition

Benefit Sources	Operating Costs		Capital Costs		Revenues		Operations		Societal
	Reduction	Avoidance	Reduction	Avoidance	Creation	Protection	Performance	Security	
Resource levels	■	■							
Employee productivity	■	■							
Work simplification	■	■	■	■					
Outage reduction/duration	■	■	■	■		■	■	■	
Restoration timing	■	■	■	■		■	■		
Asset utilization	■	■	■	■			■	■	
Power quality	■	■	■	■	■	■		■	
Asset protection	■	■	■	■		■			■
Energy conservation	■	■	■	■					
Load control	■	■	■	■	■	■			
Regulatory compliance	■	■			■	■			
Local generation	■	■	■	■	■	■	■	■	
Congestion management	■	■	■	■	■	■	■	■	■
Avoided generation	■	■	■	■					■
Environmental quality			■	■			■		■
Job creation					■				■
Innovation					■				■
Local GDP					■				■
Energy products and services					■				
Telecom products and services					■				

Source: Booz & Company

regulatory pressures that are even now coming to bear. But we maintain that the scope of the change taking place in the industry is so unprecedented that coordination, however difficult, must be undertaken. By proactively planning and designing a vision of the future, with business models, investment scenarios, and roll-out timetables, utilities will place themselves to great advantage when it comes to the all-important point of persuading regulators to join forces with the industry's vision.

The ideal regulatory environment will support and encourage the massive investments that are to come. Currently missing from the equation are the very sorts of regulatory schemes that will shape an orderly, cohesive smart grid deployment. Here the utility industry as a whole must take the initiative and, with the assistance of neutral advisors who have the proper technical and market acumen, form a multilateral task force. The task force should poll its members across Europe, each of whom will have devised its own business plan, and then spell out a comprehensive, industry-wide agenda describing what laws and regulations will best help the industry develop and deploy a smart grid. State regulatory policies should clearly outline the way utility investment in the grid will be recovered, for example, and laws should be revised or put in place so that a truly “decoupled” electricity marketplace exists whereby utilities will be compensated for lost revenue resulting from the smart grid’s improvements in energy efficiency and customer empowerment.

The right regulatory policies will encourage important and innovative retail offerings that will, for instance, allow utilities to further recoup lost value as the old grid shifts to the new. New regulations might allow utilities to offer an array of services: microgrid solutions for customers, demand response implementation, distributed generation technologies for home use, hookup capabilities for electric vehicles, and financing for all of the above. As yet, there are no such comprehensive examples in the market, and so this remains a significant growth opportunity for first movers in the retail space. Each utility, in the end, will face specific challenges based on its unique regional profile, its exposures, and its energy portfolio. But we believe the industry can chart a successful and profitable course as it makes its passage through these turbulent waters.

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