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### Highlights:

- Shifts in energy policy, technology, and consumer focus are driving transformation throughout the industry, though many organizations are still in the early stages.
  - For most energy and utility companies, success will be achieved through transforming the utility network, improving generation performance, and transforming customer operations.
  - The resulting smarter energy systems will help save tens of billions of dollars in operating costs and reduce the need to build more capacity; anticipate detect, and respond to problems quickly; empower consumers; and help integrate electric vehicles and energy from renewable sources.
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## Transforming the energy value chain

*Taking a smarter approach to the way we produce, distribute, and consume energy*

While the electricity infrastructure that underpinned much of the economic and social development of the 20th Century continues to perform its original functions well, there is widespread consensus that it must be fundamentally transformed in order to meet the needs of the 21st Century. The utilities and energy companies that build, maintain, and operate the world's electric power systems must respond to a number of critical challenges and opportunities, ranging from resource constraints and environmental strictures, to more proactive consumers and potentially disruptive technologies.

The scale of the challenges is significant. For example, the electrical system in the United States is more than 99 percent reliable, but it still experiences power interruptions that cost homes and businesses \$150 billion a year.<sup>1</sup> In some growth markets, the situation is more severe. On the demand side, despite a dip in consumption due to recent economic turmoil and government-imposed restrictions, such as the European Union's "20-20-20" plan, global growth in energy consumption is expected to increase by more than 40 percent over the next 25 years.<sup>2</sup> In some regions of the world, the increase in demand will exceed 100 percent over that same time period. Regardless of the rate of growth in energy demand in a particular market, complexity is certain to increase, driven by societal shifts to more sustainable technologies, such as electric vehicles and distributed and renewable generation.



## Smarter Energy and Utilities

### Point of view

The assumptions that have defined traditional utility operations—mostly one-way flow of power and information, limited competition in distribution, declining costs from increased usage, cost-effective carbon-based generation, and undifferentiated, passive consumers—have been undergoing fundamental change for some time. Shifts in energy policy, technology, and consumer focus are transforming these assumptions, driven by concerns about energy security, environmental sustainability, and economic competitiveness. Meanwhile, against this backdrop of change, energy utilities are still held accountable for delivering reliable power while minimizing costs.

In addition, consumers are becoming more engaged. The access to information and customized services that people have experienced in other industries, such as telecommunications and banking, are setting new expectations for the energy market. For example, people want more immediate and accurate notifications regarding power outages, delivered via their choice of media. At the same time, the rise of technologies that spur more active consumer interplay with electric power systems—electric vehicles, smart meters, “dispatchable” peak load control (e.g., “demand response”), home energy services, and distributed solar generation—is changing the nature of customer interactions from primarily generic, one-way transactions to something more interactive and customized.

As the marketplace becomes more dynamic—even for regulated utilities with little or no competition for core electricity service—the risk of disintermediation grows. Utilities could find themselves in a position similar to that of the companies that invested in building the “backbone” infrastructure of the Internet: they may own the means for

delivery of electric power and related services, but miss the opportunity to capitalize on the new business opportunities it enables, leaving the way open for others to seize the growth opportunities. Furthermore, as customers produce more energy themselves and reduce their consumption through energy efficiency measures, the old pricing models will no longer be enough to pay for reliable grid infrastructure.

Energy and utility organizations around the world have recognized these dramatic changes, and many are taking action to address them. They are making investments to upgrade the capabilities of the grid and to enable consumers to take a more active role in managing their energy use via smart meters, connected appliances, and Web portals. Utilities are installing technologies that improve the efficiency of the grid, and developing new capabilities for integrating renewable energy into the grid. And they will soon install equipment for storing energy, so power can be made available when it is needed, rather than simply when it is produced.

While the industry is making good progress, much remains to be done. Many organizations are only beginning to lay the foundation needed to address the challenges and opportunities ahead. Arguably, even the most advanced organizations are still in the early stages of transformation. And—though there have been notable advances—there is not yet consensus on the technical standards and approaches that are needed to enable the full potential of smart grids and improved generation. The opportunity to transform the industry remains before us.

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### A smarter approach to energy

Much of the public discussion about transforming the electrical system has focused on the idea of “smart grids.” But that term is arguably too confining. A more representative term is, “smarter energy,” denoting an integrated, scalable system that extends from businesses and homes, through the distribution and transmission systems, back to the sources of energy. A smarter energy system is instrumented, with sensors and controls embedded into the fabric of its operations; it is interconnected, enabling the two-way flow of information—including pricing—and energy across the network; and it is intelligent, using analytics and automation to turn data into insights and to manage resources more efficiently.

Whether an organization is well along the path to smarter energy or just putting together business-case scenarios for an initial project, there is much to do—and much to be gained. Those utilities that have already deployed smart meters can invest in making grid infrastructure more intelligent and efficient. Generation companies that have invested in optimizing individual plant operations can deploy more sophisticated analytics and real-time management tools that enable integration and optimization across the more diverse generation fleet. And almost every organization needs to invest in expanding its ability to serve customers and to work on transitioning utility cultures to be more customer-driven.

In our work with hundreds of energy and utilities organizations around the world, we have identified the three key imperatives to develop smarter energy systems that address the challenges and opportunities facing the industry:

- Transform the utility network
- Improve generation performance
- Transform customer operations

### Transform the utility network

As described above, the objective of this imperative is to transform electric, gas, and water infrastructures to dynamic, automated, and more reliable networks. To do so, various functional areas within the energy ecosystem must be engaged: consumers, business customers, energy providers, regulators, and the utility’s own operations (both “IT” and “OT”). Key elements of the transformation include smart meters, grid operations, work and asset management, communications, and the integration of distributed resources.

Transforming the utility network can also be viewed as a progression of capabilities—though there is no set order of steps to be taken—beginning with infrastructure improvements that lay the groundwork for network visibility and automation, and then moving into integration and collaboration among participants (organizations, people, and things). Capitalizing on those investments and the data they generate allows utilities to develop a more responsive network, one in which conditions are analyzed proactively and used to optimize the network. Finally, the network and all its participants can be orchestrated continuously, balancing the various complex needs and parameters—such as supply, demand, service quality, cost, and regulatory and environmental compliance—for the best outcome for the system as a whole.

### Improve generation performance

By applying instrumentation, automation, and analytics, the generation portfolio can be optimized to meet contractual and regulatory requirements while continuously improving efficiency and maintaining financial viability (as with the first imperative, these principles also apply to gas and water infrastructures). To begin with, control systems are applied to automate and standardize operations, and assets are monitored and managed to provide a consolidated view of

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plant operations, on demand. To gain economies of scale and manage the overall supply chain and workforce more effectively, plant-level optimization can be extended across the generation fleet. With automated performance reporting available across the fleet in real-time, maintenance can be coordinated centrally and analytics applied to enable a more predictive approach, and fleet generation can be optimized.

The addition of highly accurate weather and load prediction and dynamic management allows plant dispatch also to be optimized, even with large-scale intermittent generation from renewable sources. As analysis and forecasting capabilities become more sophisticated, utilities can optimize their generation strategies, balancing factors such as fuel and emissions costs against electricity price—while taking into account other factors, such as planned outages, transmission constraints, and market forecasts. With a more adaptive portfolio, generators are able to meet demand, control production costs, reduce emissions, and increase profit in their current operations, while developing a more agile generation portfolio to meet future market requirements.

### Transform customer operations

Transforming customer operations requires that a foundation of technical capabilities and new skills for managing customer relationships be put in place. For example, while many utilities have invested in upgrading their customer systems over the past several years, many still lack a “single view” of the customer and the ability to support time-specific pricing and tailored services. Once the foundational capabilities are in place, energy and utility organizations can start to engage customers across various channels (with customized messaging and targeted offers), better understand customer preferences and behavior, and track the effectiveness of customer programs.

Insights gained from analyses of customer-related data can then be applied to improve the customer experience and gain new operational efficiencies. More sophisticated segmentation of customers can help boost the performance of specific programs and incentives designed to improve customer retention or to help consumers contribute to achieving broader energy goals. And more collaborative relationships with customers can be used to develop new revenue streams, via platforms that enable services (offered directly or together with partners) in areas such as information exchange—relating to energy use, for example—energy management, distributed generation, or demand integration.

### Elements for success

There are common elements to every stage of the transformation to smarter energy. The most pervasive is **collaboration**. Given the complexity of the energy ecosystem, consensus on policy, facilitated by cross-industry groups such as the GridWise Alliance and the Global Smart Grid Federation, is critical. So, too, are common standards that enable choice and integration across a range of technologies and systems. For highly complex smarter energy projects, it's important to work with partners who have experience in integrating complex “systems of systems,” and in developing a plan and roadmap to guide the process across the entire enterprise.

**Ensuring security and privacy** is another essential aspect of the move to smarter energy. Security has always been a fundamental element of energy systems, but the convergence of operations technology and information technology demands a more integrated approach that encompasses both physical and cyber-security. Critical information systems that increasingly serve a primary operations role must have integral protections and backup and recovery capabilities, and be compliant with regulations. And the availability of new data about customer energy consumption and consumer behavior requires privacy protections that meet both legal requirements and customer expectations—while allowing maximum value for cost, service, and sustainability goals.

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A third consideration is **culture change**. While regulators will continue to play an important role in energy and utility markets, the balance of influence is shifting toward consumers. In response, energy and utility organizations must increase customer focus in their operations and culture. Businesses that traditionally have been focused on physical assets will need to make new investments in human capital.

Organizations will also need to develop a performance-based culture that uses analysis of the ever-increasing volumes of data from instrumented and intelligent operations to deepen their insight and continually improve outcomes. Long-established processes will need to become more flexible and responsive to more dynamic conditions driven by highly variable factors like renewable energy and electric vehicles. And as organizations develop new business models, corporate cultures will need to become more dynamic and flexible, with leaders who understand and articulate a clear set of operating principles that drive organizational behavior for success.

### Smarter energy systems

Improved efficiencies in utility transmission and distribution systems could save tens of billions of dollars in operating costs and dramatically reduce the need to build more capacity. And while price increases are likely as any system modernizes, they could come more gradually in a smarter energy system than they would under the regime of traditional expenditures needed to maintain or replace older systems. Smarter grids also stand to be more resistant to attack and natural disasters.

A next-generation grid that anticipates, detects, and responds to problems quickly has the potential to reduce wide-area outages to near zero, and at a lower cost. Consumers empowered with better information can make smarter choices about how they use energy. And by integrating energy from renewable sources like solar and wind onto the grid, overall impact on the environment can be curtailed, and regions can be more self-sufficient in energy.

The following are just a few examples of forward-thinking energy and utility organizations that are helping to define the future of the industry, and paving the way for smarter energy:

#### **DONG Energy**

Denmark's largest energy company added intelligence to their electricity distribution system that allows them to identify problems quickly, so power can be rerouted and repair crews can be dispatched more effectively. With the new systems, they expect to reduce the minutes of power lost by up to 50 percent, and cut the time it takes to locate faults by one third. Armed with new knowledge gathered from its network sensors, DONG expects to be able to drive up the utilization rates on its existing equipment, avoiding costly upgrades. As a result, the company believes it can forego as much as 90 percent of the system upgrades it now has on the drawing boards.

#### **Ausgrid (formerly EnergyAustralia)**

Ausgrid was the first utility in the world to build and operate a two-way communications network using carrier-grade Internet protocol technology. In the past, to monitor electricity traffic patterns on the network, a crew had to go into the field and attach a data logger to the network, leaving it for a few days or weeks, and then retrieve it. Data managers then had to examine and interpret the data. Ausgrid invested in a new system for monitoring and evaluating data every 10 minutes. With more information about what's happening on its network, Ausgrid can quickly dispatch repair people to fix the causes of outages and interruptions.

## Pacific Northwest Smart Grid Demonstration Project

An original project gave homeowners on the Olympic Peninsula in Washington State more information about their energy use and its cost as an incentive to reduce their power consumption at peak times and during emergencies. The additional information and automation helped homeowners change how they used energy. The results were very compelling: On average, consumers saved approximately 10 percent on electricity bills over the year prior. Peak demand was reduced by an average of 15 percent, and, over one period of 40 hours during severe weather, demand was reduced by up to 50 percent. That first Pacific Northwest project is now being expanded in scope to span five different U.S. states, 11 utilities, and 60,000 homes—the largest regional smart grid demonstration project in the U.S.

## Smarter energy for a smarter planet

IBM is working with these organizations and hundreds of others to develop smarter energy systems.

## For more information

To learn more about smarter energy and how IBM can help your organization, please visit: [ibm.com/energy](http://ibm.com/energy).



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- 1 *Galvin Electricity Initiative*; U.S. Department of Energy, “*The Smart Grid: An Introduction*”
- 2 International Energy Outlook 2011 by the US Energy Information Administration (EIA)



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