Energy and Utilities
White Paper

The future of energy and utilities

An IBM point of view

Contents

Overview

Making predictions is a risky activity. Making predictions in the utility industry can be perilous. History is filled with missed or prematurely exuberant pronouncements of the future of utilities and energy. For example, in the late 20th century, many predicted that the world's oil supply had reached peak production and would become scarce. Instead, shale gas and oil are in abundance. In the 1990s, people predicted that fuel cells and hydrogen would dominate the landscape by 2010, another illustration that predictions can fail to reach their promise.

Notwithstanding the peril, some clear utility trends are emerging on the horizon. They are likely to form the foundation of the industry's future. One can argue about the pace, or even the direction of these trends, but one cannot argue that they will not happen in the next 10 years or so.

The 10-year landscape

The emerging utility trends can be broken into three categories. The first category is a completely changed customer environment that consists of smart appliances, new loads and more sophisticated control technologies. The second is an ever smarter grid that can integrate distributed sources of sustainable energy. And the third is the enabling regulatory and market constructs that are creating the environment for a fundamentally different set of business models than the industry has enjoyed over the last century. The icons in Figure 1 are representative of these trends, broken down into ten representations.

Figure 1: The ten icons of emerging energy and utility trends

New customer environments

Smart appliances will increasingly become ubiquitous in consumer homes. Connected to the Internet, these appliances can be observed and controlled by consumers and by third parties—such as a utility—and can optimize programs such as demand response and energy efficiency. Sophisticated systems such as affordable energy management systems, automated demand response appliances and mobile smartphone applications will offer control. In many cases, the consumer will simply set their preferences, and these systems will respond and learn their patterns and additional preferences.

New grid

The grid itself will fundamentally change. With the increasing percentage of renewable energy sourced from wind and solar, a new pattern of infrastructure deployment and operations will support the unique characteristics of renewable energy. Battery technology, at the grid and consumer level, will become broadly available and affordable. In areas of the world where existing infrastructure is insufficient or the economics for investing large centralized generation and transmission is not feasible, micro-grids will emerge as a reasonable alternative.

New business models

The regulatory environment will increasingly permit new business opportunities and business models—for existing utilities and new entrants—to emerge and thrive. This development will be tempered by a recognition and acceptance that significantly more investment is required to ensure the reliability and resiliency of the grid.

This trend and the others mentioned previously will shape the rapidly evolving utility industry landscape, aided by advances in technology.

Five technology "happenings" are shaping the industry

Although not obvious to the casual observer, the utility industry has always relied heavily on technology. Indeed, for many of the technologies that are currently popular, utilities were, out of necessity, early pioneers. Communication networks, advanced telemetry for reliability and control, and large-scale customer information and billing systems are a few examples. As energy companies embrace advancing technology, the changes continue all around them. Five key advancements are unfolding that will affect their direction.

The Internet of Things

Utilities helped create the Internet of Things. Numerous assets and control devices are spread over their utility operating territories. For more than two decades, they have collected information and used it to benefit their business. Information such as usage patterns and anomalies, device status information and events, and generalized status of the network have all been regularly used. With the advent of smart metering, the information available has become both more detailed and more easily attributed to specific customers. As the Internet of Things expands to include devices numbering in the trillions, the utility's contribution to building the Internet of Things will continue and indeed increase.

IT and operational technology

An interesting phenomenon in the utility industry is unfolding as both the IT and operational technology (OT) networks of the industry undergo the same structural transformation from hierarchal with well-defined interactions to flat with multivariable interactions. In OT, the rapid integration of a larger percentage of renewable and distributed energy sources is replacing the traditional centralized power plant with transmission and distribution networks. Today's IT networks are peer-to-peer and fundamentally not hierarchical. IT and OT environments are both becoming flatter, peer-to-peer and increasingly operating in real time (Figure 2).

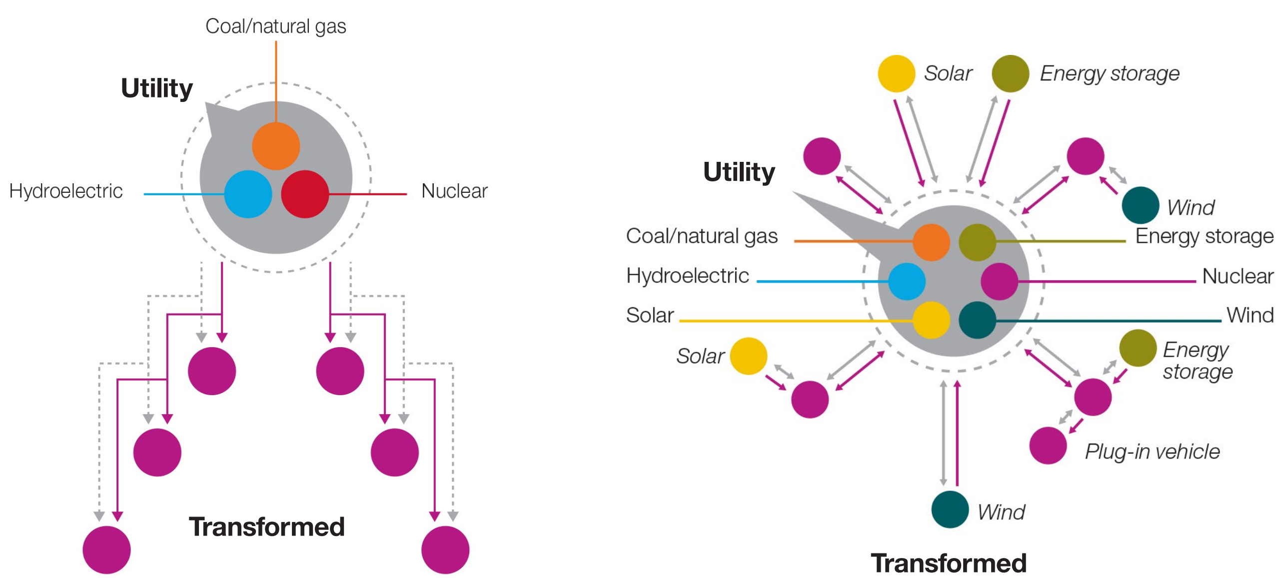

Figure 2: From hierarchical to flat: energy and utility IT and OT

Situational awareness

Situational awareness is a specialized management process that originated from military science. Utilities have used the fundamental management techniques of situational awareness to operate the grid for decades and to manage storm and catastrophe restoration processes. The difference today is that situational awareness has reached popular culture. The world has a continuous feed of videos, photos, blogs, collaboration tools and more that all provide a near instantaneous view of the local and global condition. And indeed, the status of the network, whether it relates to an outage or its level of sustainability, is of interest to the consumer. In the future, utilities must make the support of situational awareness paramount to their customer interaction.

Big data

Conversations about the utility industry commonly include the explosion of available data. The plethora of data sources such as GIS, distribution automation, PMUs and smart meters are diverse. Although this new onslaught of data is massive from the perspective of a utility, it is already manageable from the perspective of other data-intensive industries such as banking and airlines. Big data can seem overwhelming, but in reality it is an opportunity, not a problem. Big data offers greater accuracy and greater depth and can transform utility applications. With the ability of big data technologies to lower cost and provide better customer service, applications that were heretofore impossible, become possible.

Cloud

Along with big data, the cloud is part of conversations about the future of the utility industry. Cloud enables cheaper and easier deployment, testing and growth of new business models with scale and agility. Existing utilities with traditional processes might not deploy cloud technology because they are concerned about privacy and security and operate based on capitalized IT infrastructure; however, new entrants to the utility space are. A number of entrants are aggressively using cloud technology because of its agility and price and the differentiating advantage it offers. The decision of whether to move to the cloud is more than a "what type of IT infrastructure" conversation and should involve understanding that cloud can provide a competitive advantage in an industry where business models are shifting.

IBM's point of view

Given the industry's 10-year landscape and the technology advances shaping its future, IBM has developed a point of view centered on three critical challenges that drive a set of strategic imperatives for the industry.

Viable substitutes rise

The rise of viable energy substitutes introduces a set of business and technical challenges such as supply intermittency, demand response dispatchability and business disintermediation. Photovoltaic solar at grid parity, the mainstreaming of renewable and storage technologies, and the increasing ability for demand response to replace supply in the power dispatch balancing process are formidable alternatives in the value chain of the traditional utility model.

In almost every case, these technologies and methods have been used experimentally for decades but were not viable for mass deployment until recently. Better technology, more liberal public policy, lower costs and new industry entrants now challenge the future of the traditional utility business model.

This challenge drives the first strategic imperative: Successful energy companies will *assume the role of energy integrators*. Energy integrators, commonly known as trusted energy providers, assume the business and technical responsibility of providing all sources of energy supply safely and reliably to a customer. It encompasses both demand-side and supply-side technology and associated business models. And, it requires IT and OT infrastructure that is substantially more sophisticated and complex than today's typical utility environment.

Customer engagement deepens

As the future utility framework evolves, rich and instant customer interactions delivered primarily from social and mobile apps are required. Why? For one, per capita demand of energy is rising. However, energy intensity, which is the measure of energy input required for a fixed economic output typically measured in BTUs per dollar of gross domestic product, is falling. Given the intent of energy efficiency programs, the result is not surprising and now the same functional outcome, for example lighting or heating, is increasingly less expensive on a unit basis to provide.

As a result, it will be difficult for utilities to generate the same revenue per customer as they have in the past. The implications are onerous as growth opportunities not only dwindle, but in some situations, actually reverse. Along with this loss of revenue, utilities face customers who are evolving. As the ability to generate electricity onsite becomes more accessible, some customers are turning into "prosumers".

Revenue losses and prosumers mean that the traditional method of interacting with customers once a month in a bill by mail or during a telephone call to inquire about service interruption is no longer sufficient or cost-effective. A much more instantaneous and fulfilling method of interaction is required.

This new customer engagement interaction drives the second strategic imperative: Utilities must *deliver a 360-degree "customer-of-one" experience*. This is fundamentally a retail customer engagement model and one that the vast majority of utilities globally are not yet delivering. Just as with the challenge of viable substitutes, this new way of engaging with customers will require investment in technologies that are fundamentally new to the utility industry.

Core expectations persist

Despite the changes in the industry, the core expectations to deliver safe, reliable, affordable and sustainable energy remain. No one is expecting less safe or less reliable or less sustainable energy at higher cost nor will global regulatory processes allow it. However, the new entrants in the industry are much more agile and not bound by the limitations of traditional utility regulated economics. These entrants challenge the very necessity of the grid in the first place and argue that customers can deploy technologies that enable them to disconnect from the grid and their utility. And in many places, that is exactly what they are doing.

For utilities to compete in this new environment successfully and ensure safe, reliable, affordable and sustainable energy, they will have to fundamentally transform their current business processes. This leads to the third strategic imperative of this point of view: utilities need to *disruptively innovate business processes through analytics driven operational excellence*. If the 1980s and early 1990s were all about labor arbitrage, and the late 1990s and early 2000s were all about business reengineering, the future of the industry is all about using advanced analytics to eliminate unnecessary processes.

Substantively more sophisticated analytics technologies are just the beginning of what can be accomplished in terms of disruptive innovative business processes. For example, in the area of storm restoration, advanced forecasting techniques can be used to forecast not only the weather but also a damage profile. This profile would enable the optimum positioning of restoration resources and material before the event and is a good example of where a current manual (albeit refined) process can be replaced in its entirety with advanced analytics. Another example is the use of advanced forecasting to predict the actual power output of a wind farm or solar installation, which could significantly reduce the level of additional services that must be provided. Other examples in the areas of customer, finance, and even IT operations also abound.

Figure 3 summarizes IBM's point of view, shifts in the industry, and the three imperatives.

Our point of view 1.	Our point of view 2.	Our point of view 3.
Viable substitutes rise, introducing the business and technical challenges of intermittency, dispatchability and disintermediation.	**Customer engagement deepens,** requiring interactions delivered primarily from social and mobile apps.	**Core expectations persist** requiring the continued delivery of safe, reliable and low cost energy with sustainablility embedded.
What we see shifting Alternatives reach grid parity while renewables and storage mainstream and demand response increasingly balances supply.	**What we see shifting** Per capita demand is rising but enegy intensity is sinking. Prosumer supply is expanding, thereby driving a more sophisticated and economically challenging customer interaction.	**What we see shifting** Grid essentiality is challenged with OPEX agile new entrants emerging and growth stunted by #1 and #2.
Strategic imperative Assume the role of energy integrator.	**Strategic imperative** Deliver a 360-degree "customer-of-one" experience.	**Strategic imperative** Disruptively innovate business processes by using analytics-driven operational excellence.

Figure 3: A summary of IBM's point of view

What are the next steps?

The strategic imperatives establish a baseline for what energy providers will need to address as the industry transforms itself. But, what are the next steps? What can be done and what things are needed to deal with the imperatives of the industry in the future?

For the energy integrator role, utility operations will have to become more integrated with the other parts of the utility business. This involves deploying advance distribution management systems (ADMs) that use the telemetry of monitored assets in the utility network. The information from ADMs should be combined with customer data derived from advanced meters and more sophisticated analytics to enable demand response that can be dispatched. Forecasting technologies can be deployed to provide more accurate forecasting of power output from renewable sources such as wind and solar. To this end, the reliability and sustainability expected by customers will be fulfilled.

Customer expectations can be managed with the methods used by industries that depend on understanding and engaging customers effectively. Industries such as retail, insurance, finance and banking are good strategic proxies for the type of systems and methods that utilities will undoubtedly have to invest in during the coming years and decades. A monthly paper bill and webpage no longer define the customer interaction. Instead, the interface is social and mobile and delivered by an app on the customer's smartphone. While these technologies and methods are not exactly new to the industry, greater investment is needed in both the technology and the talent that knows how to exploit it to satisfy the customer of the future.

Disruptively innovating business processes with advanced analytics requires an analytics solution that addresses three primary objectives.

Disruptively innovate business processes with analytics-driven operational excellence

A single foundation for analytics in the energy enterprise

Whether your utility is a veteran or new to the industry, operational excellence with silo-breaking analytics capability is key to innovation.

With the flood of big data from grid instrumentation, meters and connected consumers, utilities increasingly are applying analytics to unlock the value of the data. Analytics can enable utilities not only to improve current business processes, but sometimes to transform them altogether. Success in analytics is best achieved by using a foundation of common capabilities that can be applied to various utility domains and systems and can help integrate them.

Built from world-class IBM business analytics technology, IBM Insights Foundation for Energy brings together in one solution a core set of capabilities and building blocks for new analytic applications. IBM Insights Foundation for Energy enables operational excellence improvements such as reducing asset failures, improving asset utilization, optimizing network availability, decreasing loss of service and potentially reducing costs.

IBM Insights Foundation for Energy is a data management, visualization and analytics software solution that includes a broad range of pre-integrated analytic technologies. It also is a foundation for an ecosystem of new analytic applications from IBM and partners.

First, the solution must cross the lines of business in the utility enterprise. Much of the value of analytics is derived from synthesizing new relationships of data that come from more than one line of the utility business. The consistency, structure and discipline of an enterprise-wide platform are critical. Second, the solution must apply and enable best practices from other industries. Condition-based maintenance best practices, for example, come not from the utility industry, but from avionics. And as already noted, best practices for customer engagement originate from an industry such as retail. Third, enabling business outcomes to become the primary metric of success is fundamental. Measuring an outcome is profoundly more effective than measuring inputs such as schedules, budget or objectives not tied to the bottom line.

"What are the next steps?" is a call to action. It is a call to embrace the new technologies and the new business approaches that are now viable and to embrace that which is desirable from a customer, policy, and in the end, from a business sustainability perspective. The utility industry enjoys a unique position of providing a product and service that is essential to the well-being of its customers and the world economy. Recognizing the opportunities provided by the three strategic imperatives can help ensure that this position endures.

For more information

To learn more about IBM solutions for the energy and utilities industry, please visit: **ibm.com**/energy

IBM Corporation
New Orchard Road
Armonk, NY 10504

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