The value of smarter energy

Making the case for orchestrating the network
Introduction

For most of the past 100 years, the shape of the utility industry has remained fairly stable. It’s been “business as usual.” But today, new pressures and unprecedented changes are creating a mandate for wholesale transformation to business as unusual. Utilities have to cope with much more than the familiar issues of rising fossil fuel costs and aging infrastructures. There is a new marketplace environment and fresh challenges that are in the process of transforming the entire industry—and for which many are unprepared. In coming years, utilities will require much greater flexibility and responsiveness, and action is needed in the near term to position them for what is to come.

The energy value chain is evolving rapidly and becoming more complex. Its traditional, utility-focused structure is already fading, to be replaced with a more dynamic one. There are alternative sources of power in the form of renewables like wind and distributed generation that are fundamentally altering the nature of the network. The rhythm of the 24-hour load cycle will shift as plug-in electric vehicles become more widespread. At the same time, consumers are starting to take a more active role in managing their energy consumption and they are looking to energy providers for help.

There are also threats from new, non-traditional (and unregulated) competitors that are piggybacking on the investments made by the industry. Microsoft, with its Hohm energy management services, is an example, as is Google with its investment in offshore wind energy. To compete, utilities need to think about new revenue streams and services which position them as a true partner, one that is motivated to help their customers achieve their goals as a means to business success.

Maintaining profitability and growth in this shifting landscape is a critical issue. Demand growth in developed markets is slowing as energy efficiency initiatives start to produce results. In the U.S., for example, the growth in consumption in the first decade of the 21st century was less than a quarter of that in the period from 1980 to 1990. This energy conservation limits revenue growth and makes future investments more difficult to justify. Utilities are increasingly challenged to make better, smarter use of existing assets to generate financial return. The transformation from conventional utility networks to much more efficient, smarter grids has become a critical business imperative.

The industry, as a whole, understands that the network needs to be optimized and orchestrated, and that information and insight are essential contributors to this effort. To create a smarter energy value chain, it is necessary to gain a deeper understanding of customers, partners and the network itself. Energy providers need to see what’s happening across the grid and even beyond the meter. This knowledge will allow the industry and consumers alike to make real-time adjustments and better decisions.

But how does one achieve this goal? Most utilities have already taken measures to improve their capabilities, yet still lack the degree of maturity required to make the most of those investments. What steps do they need to take next to achieve full transformation to smarter energy? What needs to be done now and in the near future to achieve success over the long term?

More importantly, are the investments necessary for the utility to rise to the next level truly worthwhile? What are the potential returns? Who are the beneficiaries? Customers and regulators are key stakeholders and utilities must demonstrate that investments will benefit not only themselves, but customers, too.
Utilities need to both understand the necessary transformational steps and quantify the gains that those initiatives can produce. Our research suggests the potential for cost savings and capital expenditure deferral is considerable as compared to the status quo. Indeed, it can measure in the hundreds of millions of dollars, with significant ROI and payback comparable to other typical large infrastructure investments.

**What’s the overall potential for a utility?**

Our detailed modeling of an illustrative, vertically-integrated utility shows that a program of investment in smarter energy could yield:

- **Total benefits:** US$5.9 billion
- **15-year ROI:** 225%
- **Net present value savings:** US$1.5 billion over 15 years
- **Total investment:** US$1.8 billion

Figures based on financial modeling of utility with more than two million customers, assuming average operational maturity and investment in a full range of business capabilities.

**The benefit of going beyond existing smart grid initiatives**

Taking a holistic approach to grid optimization and orchestration produces the greatest benefit for both the utility and its customers. It enables active participation in the network by all parties, including the suppliers and distributors of power, and those who consume it.

The potential benefits of participation are highlighted by smarter energy examples like the successful Olympic Peninsula Project, part of the Pacific Northwest National Laboratory’s GridWise initiative. During the demonstration project, utility customers had remotely controlled thermostats and other appliance controls installed in their homes. Preferences for convenience versus cost were captured via a web portal and used by the utility to adjust thermostats and control clothes dryers and water heating during winter peak periods. In exchange for reduced consumption and slightly cooler homes, customers and the utility avoided the high cost of peak power and bills were reduced. By leveraging information to coordinate demand response and empower consumers, the project yielded a 10 percent reduction in customer electric bills and a reduction in peak grid loads of 15 percent over the course of a year. All parties benefited: consumers used less electricity, the utility was able to increase reliability and avoid interruptions, and local generators were able to better optimize power plant operations. This shows how utilities can take engagement and information to the next level – actions that support both company objectives and societal outcomes.

Many utilities are moving in the direction of smarter energy. Major investments have been and continue to be made in technologies such as smart meters, remote asset monitoring, demand response systems and information portals to instrument and interconnect the grid. These represent large investments and can produce significant returns. In Italy, for example, leading power company Enel installed more than 30 million smart meters at a total cost of €2.1 billion – and is recouping its investment at the rate of €500 million per year, largely through cost savings. Enel’s experience also shows how savings from smarter energy investments often extend beyond the initial scope and expectations. For example, in addition to reducing meter-reading costs, the new equipment helps to identify theft, places sensors on the grid that spot outages and provides data that can be used to assist in capacity planning.

Going beyond technology investments like these, however, can significantly enhance economic gain for all stakeholders. The ultimate goal is to create insight that drives orchestration of the network by its participants. Relatively small additional investments in information management, analysis and optimization create a unified grid that is far more capable and responsive – and at a lower cost than alternatives. This enables all stakeholders to contribute to more efficient and sustainable energy delivery while being better able to achieve their own goals.
The journey towards smarter energy

The path towards a dynamic, optimized and orchestrated utility network has clearly defined transformational steps. The journey begins with infrastructure improvements that lay the groundwork for grid transformation, then builds on those investments to maximize the use of information to create insight.

The foundational step is to monitor and automate the network. Automated control and real-time knowledge have existed for some time in the realm of generation and transmission, through established technologies such as SCADA. Investments in advanced monitoring, sensors and control devices extend these capabilities to the distribution network. This can give full, near-time visibility over all events and devices. This enables more effective management and provides the information needed to support more advanced capabilities, such as the ability to optimize the network.

Next, utilities build on the foundation of visibility by connecting participants to the utility—not only electrically, but also with two-way information flow. Investments in information exchange technologies such as data integration, alerts, portals and dashboards do much more than empower participants with information. They enable distributed generation, storage (for example, using electric vehicles to store energy) and the use of price signals to manage demand. Connecting all participants is a landmark event because it fundamentally changes the relationship of the utility with its customers and value chain partners. This can foster cooperative action beyond the traditional boundaries of the business. Engagement, education and empowerment are important; return on investment is maximized when stakeholder participation is achieved.

Even today, a lack of visibility into the state of the grid hampers many utilities. They are often unaware that a problem exists until a customer calls to report it. Drawing on information from across the value chain and leveraging it through such capabilities as advanced outage management gives the utility the ability to sense and respond in a timely way. For example, live data correlated across multiple sensors located throughout the network can trigger automated alerts about the exact nature and location of a fault. This alone can dramatically improve service thanks to faster recovery from outages.

The ability to proactively analyze and optimize the network by leveraging investments in information aggregation, automation and intelligent agents completes the journey. This leads to full orchestration, where each participant makes decisions based on relevant information and feedback from the actions of others. Consumers can potentially project usage and

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**Figure 1 – The roadmap of development that leads to full network orchestration. With each subsequent step, the network becomes more participatory and transparent.**
establish parameters to manage their consumption and utility bills. On the supply side, generators can determine the optimum level of production in real time, and utilities can configure the network to optimize performance. As more feedback is available, the entire network can be orchestrated to help ensure the best outcome for the system as a whole.

The roadmap shown in Figure 1 describes investments that build on one another to deliver a complementary series of enhanced capabilities. It is not a single, “one size fits all” approach; the details may vary according to the utility’s particular circumstances, existing assets and initiatives, and priorities. It should be noted that achieving a smarter energy future is a process that takes time to come to fruition, which emphasizes the importance of action in the near term. Utilities that begin to transform today will be in an advantageous position in the coming decade, and should be better equipped to counter emerging competitive and market threats.

As shown in the model Figure 2, there is a high degree of synergy and added benefit to the utility as one progresses along the path. The financial gains accelerate over time, with returns starting early in the journey. Monitoring and automation, for example, are mostly complete and already beginning to deliver tangible results by the end of the second year, assuming an eight-year course of investment in accordance with the roadmap.

The full scale of benefits, however, can be realized as the more advanced steps leverage the earlier capabilities. So, while investments can be made in a different sequence or in parallel, it is still important to address all of the steps.

**How financial gains are realized**

The discussion to this point has centered on investment steps and their resulting business capabilities. Making the economic case for investment, however, requires consideration of exactly how those capabilities yield quantifiable financial gain. How does gaining better control of the grid help the utility avoid capital investment, for example? What are the financial implications? How do customers realize additional gains? Our research and quantitative analysis that underlies this paper was undertaken specifically to help answer these questions.

### Annual benefit at year 10 for an illustrative utility

More than two million customers

<table>
<thead>
<tr>
<th>Monitor and automate</th>
<th>Correct participants</th>
<th>Sense and respond</th>
<th>Analyze and optimize</th>
<th>Total economic benefit</th>
</tr>
</thead>
</table>

*Figure 2—While benefits accelerate with more advanced capabilities, early-step investments can produce significant gains of their own.*

### How we put a value on “smart”

The information and projections contained in this paper are based on research conducted by the IBM Center for Applied Insights among energy and utility industry leaders around the world. Case studies of 15 utilities were conducted to estimate potential benefits, addressing smart grid, transmission and distribution operations and regulatory policy. The team supplemented this primary research with data from more than 100 academic and industry studies and sources, combining all the input with their own experiences and perspectives.

The model for smarter energy investment that emerged from this research, along with the hypothetical value projections, is designed to help companies gauge their potential returns from their own, similar investments. The model can be scaled for different industry segments and corporate maturity profiles to produce individually tailored assessments and estimates directly applicable to your business.
Transmission and distribution capital expenditure

Facing an impending need for network infrastructure investment, the illustrative utility is able to leverage enhanced information and better management to defer those expenditures for approximately five years. By proactively optimizing line voltage, managing demand, forecasting capacity and maintaining assets more effectively, the company can use its existing infrastructure to meet growth in customer needs.

Benefits could include:
- A five percent reduction in peak demand through demand response and direct customer feedback.
- A 2.5 percent savings in capacity cost and a 15 percent reduction in equipment failure through better asset management and planning.
- A two percent reduction in peak load through voltage/VAR optimization.

It is acknowledged that capital expenditures will eventually have to be made. The longer the investment can be deferred, the more the utility will save on capital carrying charges.
Generation capital expenditure
The illustrative utility also generates its own power. As with capital expenditures on transmission and distribution, it is possible to delay building new generation capacity by managing existing assets more effectively and fully understanding capacity requirements. In addition, the ability to incorporate alternative sources of power can have a major impact on the ability to defer generation capital expenditures.

Annual estimated benefit:
US$135 million\(^3\)
23% of total benefits

Investment returns by capability:
- Monitor and automate
- Connect participants
- Sense and respond
- Analyze and optimize

Environmental gains
There is a major opportunity for the illustrative utility, in the form of direct financial incentives, to reduce CO\(_2\) emissions. But even where formal incentive programs or other carbon market mechanisms are not in effect, greenhouse gas emissions are of great interest to regulators and, increasingly, to customers and investors. This makes emissions reduction an important factor in investment planning.

Annual estimated benefit:
US$165 million\(^3\)
27% of total benefits

Investment returns by capability:
- Monitor and automate
- Connect participants
- Sense and respond
- Analyze and optimize

Distributed generation and renewables help increase capacity and sustainability without building extremely costly new conventional plants. Successfully integrating these new sources, however, does require investments in connecting grid participants to manage energy exchange in real time.

Benefits could include:
- A 6.5 percent reduction in peak demand through demand response and direct feedback.\(^7\)
- A further two percent reduction in peak demand through voltage/VAR optimization.\(^8\)

The primary mode of achieving emission reduction is by promoting customer energy conservation. This emphasizes the importance of information sharing and investments in customer enablement such as information portals, consumption analytics and advanced metering. Initiatives that reduce line losses and create customer energy efficiency also lessen the need for additional generation with its associated emissions.

Benefits could include:
- A 0.2 percent reduction in supply needs through reduced line losses, with a further 0.8 percent through conservation voltage reduction.\(^9\)
- A seven percent reduction in carbon emissions through efforts to promote energy efficiency.\(^9\)
Transmission and distribution operations and maintenance

Compared to the returns on capital expenditure and environment, this value driver generates a relatively small portion of the overall gain. Nevertheless, it is still considerable, contributing US$65 million in the illustrative case. Its importance can be much greater. Any company that attributes much of its costs to activities like field operations, service restoration and customer service can achieve major gains in the course of making them more efficient.

The goal here is to control the scope and severity of outages and reduce the amount of physical intervention needed. For some operations that require field trips, the same outcome can be achieved remotely, and far less expensively, through automated outage management, advanced metering and similar investments.

Energy costs

In some markets, theft and unaccounted-for power are significant contributors to the cost of energy for utilities. Here, a combination of visibility created by technology such as advanced metering and analytics can help spot unusual trends in usage. This is responsible for approximately half of the US$45 million estimated annual benefit. Reduced line losses through active control of line voltage – a capability dependent on investments in information connectivity, integration and analytics – accounts for the remainder.

Controlling the cost of energy requires making sense of the data on the network. That, in turn, requires a robust analytic and optimization capability.

Better management of outages, assets and distribution, along with advanced metering, could yield a broad range of benefits:

- A 10 percent reduction in restoration cost, through improved fault monitoring, outage management and self-healing grid capabilities.\(^{10}\)
- A 10 percent reduction in outage call handling time through remote monitoring of conditions on the grid.\(^ {11}\)
- A four percent reduction in field trips through remote control of equipment.\(^ {8}\)
- A 90 percent reduction in the cost of connecting and reading meters, through remote meter operations.\(^ {12}\)
- A 10 percent reduction in maintenance costs, driven by improved, analytics-based asset management.\(^ {13}\)

The key is to understand where, when and how power is being lost, so the root causes can be addressed.

Benefits could include:

- A 0.2 percent reduction in supply needs through reduced line losses – which coincidentally also provide part of the environmental benefit cited earlier.\(^ {8}\)
- A 25 percent reduction in spending on power generated to compensate for commercial losses, including theft, lost meters and meter inaccuracy.\(^ {3}\)
Making the case for all stakeholders

The utility industry is unique, because customers and regulators are key stakeholders with a vested interest in the investments made by utilities. For this reason, it is necessary to make a good business case for audiences beyond the company and its investors.

The good news is that investment in smarter energy is beneficial for all concerned. The illustrative scenario shows that the financial benefit for customers is significantly greater than it is for the utility itself—more than 60 percent higher, as shown in Figure 4. Also notable is how early in the journey these benefits are realized.

Empowered with information and programs that promote energy efficiency, customers can willingly change their behavior and reduce consumption—saving billions in the process. At the same time, customer satisfaction can increase due to more reliable service, faster recovery from outages and the potential for lower utility bills. There is also the intangible benefit of goodwill—the knowledge that customers are taking an active role in creating a sustainable energy future.

From the point of view of the utility itself, as well as investors concerned with cash flow, it is important to consider not only the direct benefits described above, but also the implications of not investing in smarter energy. Because of the long-term impact on rates, this too is of interest to consumers and regulators.

As shown in Figure 5, a traditional investment strategy is considerably more expensive over time. While expenditures for the first two years are higher with the new approach, the payoffs should be dramatic. As time passes and more advanced capabilities are put in place, the illustrative example indicates that savings of nearly US$2 billion each year can be achieved.

Looking deeper reveals why investment in smarter energy is so important. Staying with the tried-and-tested approach that focuses on major investments in infrastructure can accommodate growth and provide reliability if enough money is spent. However, the traditional approach can not only be far more expensive over time, it will likely fail to address uncertainty, risk and the growing need for flexibility.

Additional potential customer benefits

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<th>Year</th>
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<td>14,000</td>
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<tr>
<td>7</td>
<td>13,500</td>
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</tbody>
</table>

Note: This is based on a comparison of the yearly costs for our illustrative utility with > 2 million customers.

Comparing investment approaches

- Traditional asset investment
  - Grid reinforcement for reliability
  - Centralized wind energy for renewables
  - Traditional demand management

- Smarter energy investment
  - Monitoring and grid automation
  - Smart metering
  - Advanced distribution management
  - Advanced outage management
  - Grid optimization analytics

Note: This is the annual benefit at Year 10 (steady state) for this illustrative utility and their customers.

Figure 4 – The potential benefit to customers easily outstrips that obtained by the utility, with most of the benefit coming early.

Figure 5 – Investment in smarter energy is initially more costly, but it positions the utility for significant savings over time.
With traditional investment, the utility remains fundamentally inflexible. It cannot engage easily with new entrants into the market, manage distributed energy sources that are becoming increasingly prevalent or facilitate greater customer participation. Taking a smarter approach to energy investment helps meet these new challenges head-on and positions the utility to survive today and thrive in the future.

**Continue the journey**

Our research has shown the rationale for investment in smarter energy and offers a view of the potential financial gains that can be achieved. It demonstrates the need to act and make the investments required to put your utility where it needs to be a decade from now. The path is not only clear, but achievable and could also prove to be profitable.

It is time to take the next step and make the case for your own stakeholders, laying out your specific investment strategy and why, compared to business as usual, it is the best way forward. The same research that lies behind this paper can be applied to your company, showing you in detail what is possible and what benefits the right course of investment can bring. If you would like to continue the conversation about how and where you can start, we invite you to contact the author.

**About the author**

*Bridget Meckley* is the IBM Center for Applied Insights Industry Champion for Energy and Utilities. She has 30 years of experience in the industry, leading transformation and business strategy engagements and providing operational guidance for system implementations with many electricity and gas utility clients. She brings this unique perspective to her current role of helping utilities explore the benefits of improving their operational capabilities and expanding their definition of value. She can be reached at bmeckley@us.ibm.com.

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The IBM Center for Applied Insights integrates deep industry and analytical expertise to chart the course to new value for clients. The Center develops research and tools with pragmatic guidance and tangible outcomes to provoke organizations to action.


3 All financial results cited in this paper are for an illustrative utility with over 2 million customers. The model used to arrive at these estimated figures is highly dynamic and customizable, and makes a number of assumptions about the sample company including overall maturity and investments made. The modelling methodology is based on extensive primary and secondary research including interviews and data from more than 100 industry and academic sources. Individual results for other company profiles will vary and the model can be tailored to accurately reflect individual circumstances. Figures shown have been rounded for clarity.


5 Unlocking the €53 Billion Savings from Smart Meters in the EU. The Brattle Group, 2009.


