The Critical Role of Advanced Metering Technology in Optimizing Energy Delivery and Efficiency

A Report to the U.S. Department of Energy

Itron

Knowledge to Shape Your Future

Today's Real-Time Business Cycle

Imagine the futility of trying to grow an investment portfolio using nothing more than month-old reports of the Dow Jones 30 Industrials Average. Or think of what a recipe for disaster it would be for a manufacturing company to maintain only intermittent monthly contact with its supply chain and distribution network. What a step backward it would be if consumers had to manage their bank accounts today without the aid of automatic teller machines, the Internet or automated telephone banking services? Instead they must rely only on monthly bank statements that arrive in the mail and in-person visits to the branch office between 9 a.m. and 3 p.m. to balance their checkbooks or move money from one account to another.

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In this age of e-commerce, automated transactions and real-time information exchange, scenarios such as those listed above would represent the height of inefficiency and inconvenience, not to mention a clear impediment to economic growth. Yet as absurd as these examples might sound, they represent, by and large, exactly how our country's energy marketplace and infrastructure continue to operate at the beginning of the 21st century.

In fact, though there have been incremental advances in the technologies to improve generation, transmission and distribution of energy over the years, our energy delivery system and information structure doesn't really operate much differently from the time the Public Utility Holding Company Act was passed in 1935, establishing the basic parameters of the vertically integrated, highly regulated utility industry that has defined energy delivery in the U.S. to this day. Specifically, the nation's current metering system — the cash register, data source and link to the customer — is unsuited to meet the dynamic needs of energy providers and energy consumers in the years to come.

While proven and affordable advanced metering and automation technologies have been available on the market for nearly a decade, adoption of the technology by utilities and energy providers has been limited thus far. One of the primary reasons for this slow adoption is that many utilities have been hobbled by regulatory uncertainty and fear of stranded costs.

New Requirements

The times, requirements and stakes are changing. Plans to deregulate and restructure the electricity market are approved or underway in some 34 states. Deregulation of the natural gas market, particularly at the wholesale level, and more recently at the retail level, is well underway and gaining momentum. Energy prices continue to spiral upward — hitting consumers and businesses hard in the pocketbook and undermining economic growth. And the continuing energy crisis in California provides a sobering harbinger of things to come if steps are not taken to re-align — much more precisely — energy supply with demand, and enable market forces to exert their proper influence in stabilizing energy prices.

Despite these clear challenges and recent wake-up calls, neither California nor other areas of the country are well positioned to unleash the true benefits of competition in the energy marketplace. This is because, until now, utilities and energy providers have not had sufficient incentive or need to deploy the necessary data collection and management systems that will be required to ensure that the new energy marketplace functions in an efficient, reliable, safe and less volatile manner. Advanced metering systems and technology will provide the foundation for businesses and consumers to makes choices about their energy supplier and about their energy use on the basis of cost and pricing signals from the marketplace.

Relative to other vital infrastructure systems that have evolved to meet new challenges and requirements in recent years — transportation, banking and finance, telecommunications, law enforcement and emergency services, even national defense — the nation's energy delivery system has not adopted and made use of advanced data collection, data management and communication technologies that will be required to meet the needs of the dynamic energy marketplace. And while no single analogy can adequately capture all the nuance and interdependencies of the nation's energy delivery system, we're driving in the dark with the lights off when it comes to collecting and capturing the full value of timely, accurate and detailed energy usage data. As the crisis in California is showing us, we do so at the imperilment of our economic well-being and consumer needs for safe, reliable and competitively priced energy.

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The Metering Status Quo

The vast majority of utility customers throughout the United States still receive a monthly visit from their utility's meter reader. This meter reader visually reads the electric and/or gas meter, records the amount of energy used for the past month, and

forwards that information to the utility's billing office to generate a monthly consumption bill. If the meter reader is unable to access the meter because it's located in the basement and the consumer is not home, or because the backyard gate is locked and a dog is standing post right behind it, most utilities will proceed to estimate the gas or electricity consumption based on previous usage, recent weather patterns, and then use that estimate as the basis for the next bill.

In fact, in an age of rapidly increasing energy prices, it's not at all uncommon for utilities — particularly those in higher-density urban areas — to estimate 10 percent, 20 percent, even 30 percent or more of the meter reads each month for billing purposes. This practice leads to inaccurate billing, increased customer complaints, and higher costs for utilities to investigate and resolve those complaints. How would consumers feel if their local gas station estimated how much gas they put in their tank when filling up, or if long distance carriers and credit card companies began estimating their customers' usage and bills?

Meter Tampering and Energy Theft

Another area of growing concern for utilities, regulators and consumers (who end up footing the bill) related to metering and meter reading is energy theft. Nationwide, theft of energy services costs utilities, their shareholders and consumers billions of dollars each year. The consensus estimate among most industry groups and analysts is that energy theft in the U.S. stands between .5 percent and 3.5 percent of annual gross revenues. With U.S. electricity revenues at $280 billion in the late 1990s, theft of electricity alone would equate to between $1 billion and $10 billion annually. A recent article in the Wall Street Journal estimated the nationwide electricity theft figure at $4 billion per year. That doesn't include natural gas. And with energy prices increasing sharply nationwide, theft of energy services is only likely to increase as consumers struggle to pay energy bills that have doubled or tripled over the past year.

In addition to costing consumers, meter tampering and theft of electricity and natural gas service create significant public safety issues. A consumer tampering with a gas meter may cause that meter to leak, creating a risk of explosion or fire. An electric meter that is tampered with poses the risk of electrocution or other serious injury. Technology is currently available and in use that is capable of automatically detecting tampering with the meter, which would provide a crucial asset in efforts to improve public safety and deter energy theft.

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If the current crisis in California is any indication, the billing, customer service and theft problems perpetuated by traditional manual meter reading operations today will

pale in comparison to the problems caused by a complete dearth of accurate, timely and reliable information about energy use and demand in the highly dynamic and interdependent energy markets of the 21st century. Without this automated metering technology, energy providers and consumers have no access to detailed and timely energy use data that would allow them to reduce energy consumption and reduce load when available power is in short supply, prices are high or distribution system conditions make it necessary to reduce load.

What is Advanced Metering Technology?

While systems differ from vendor to vendor, most advanced metering solutions involve retrofitting an existing electric, gas or water meter with a data recording and communications device, called a meter module. The meter module is attached to the existing meter or is installed on a new meter. The meter module device automatically monitors and then transmits energy use data to nearby collection devices or communications networks, which in turn forward the information to a database at the utility or energy service provider. The average cost of a meter module, that is attached to an existing meter, is approximately $50 for a meter on a residential home and $500 for commercial or industrial facilities. More than 85% of meters in the U.S. can be retrofitted with these meter modules and not require the purchase and installation of a new meter.

Advanced metering technology's impact on public safety

- Eliminates need to access customer property
- Immediate outage detection
- Automatic meter tamper detection
- Improved energy theft identification
- Enhanced gas leak identification

In addition to more frequent and accurate consumption information, many of these automated advanced metering systems are capable of collecting a variety of other data, such as power outage and restoration alerts, and meter tampering data to detect theft of services. These advanced metering systems also serve as the foundation to enable an array of new content value management applications that will support greater consumer choice and control capabilities with regard to their energy use both now and in the years to come.

Many companies have developed different approaches for their advanced metering technology solutions. Despite the diversity of approaches, the vast majority of systems deployed thus far make use of either public and private wireless communications networks or some combination of the two. These data collection systems, which integrate hardware, software and communications systems, provide a wide range of functionality and sophistication.

The array of systems comprise radio-equipped handheld computers, vehicle-based mobile collection systems and advanced "fixed network" systems that deliver real-time data and are deployed over geographic areas that can range in size from a small neighborhood or apartment complex to a large metropolitan area. Other advanced metering technologies make efficient use of existing telephone and cellular communication networks to communicate with the meter and send the data to the utility. Some systems are better suited for residential metering, while others feature more advanced functionality ideally suited to meeting the more complex needs of larger commercial and industrial energy customers.

Depending on the type of solution deployed, advanced metering technology efficiently and cost-effectively delivers a wealth of critical data to the utility, its energy customers and other players in the deregulated energy market. In addition to automatically delivering basic energy usage data for customer billing, advanced metering systems are capable of gathering and delivering real-time and near real-time energy use data from all types of energy customers in all types of service environments.

The Value of Advanced Metering Data

The automated collection of advanced or "interval" energy use data is necessary to enable energy market participants to more closely match energy supply with demand. Balancing energy supply and demand will become increasingly important to making the new competitive energy marketplace work in a cost effective and reliable manner.

To manage the demand-side of the equation, advanced metering and energy data allows energy market participants to more accurately forecast the required energy load, negotiate long-term power purchase contracts, perform proactive energy load management and control, establish demand-side management programs and incentives to reduce energy use, develop more dynamic rate structures to shave peak loads, and put into place knowledge-driven conservation programs and content value management innovations that empower consumers to take charge of and reduce their energy use. By collecting more advanced metering data, a utility can build a body of knowledge to develop an entirely new portfolio of dynamic rate structures and incentive programs, real-time pricing packages and interruptible rates that can be targeted to specific customers to significantly improve load management capabilities and reduce peak demand when distribution system conditions become critical.

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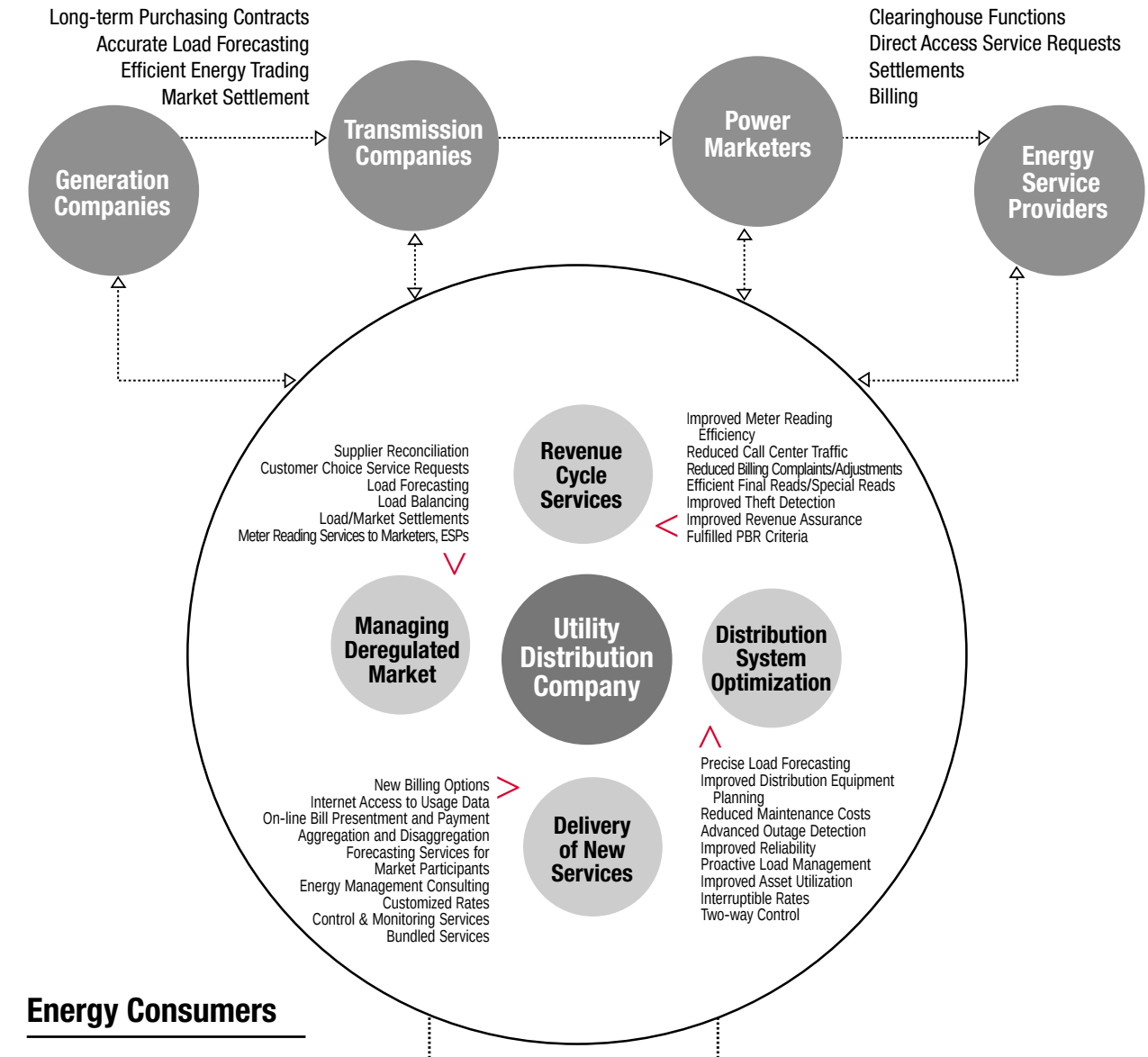
Advanced Metering Data: Enabler in the New Energy Marketplace

Market Participants



Energy Consumers

Dynamic Rate Options
Internet Access to Usage Data
Distributed Generation/Control
Choice of Energy Suppliers
Aggregated Energy Purchases
Improved Outage Detection/Power Quality
Improved Energy Cost Management
Customized Billing via E-mail, Internet

Commercial & Industrial Customers

Residential Customers

Accurate, Timely Billing
Improved Customer Service
No Need for Utility to Access Property
Selectable Billing Dates
Choice of Energy Suppliers
On-line Service Options
Monitoring Services
Improved Service & Reliability

These energy management and load control capabilities would help prevent extreme crisis management measures such as the costly rolling blackouts initiated by the California Independent System Operator (ISO) earlier this year. These blackouts are hugely disruptive and costly to consumers and businesses; they also pose a serious threat to public safety. These data-driven capabilities can also insulate utilities and their customers from the volatile whims of today's wholesale energy market by providing the means to forecast future demand more precisely. The utility or energy service provider can then use this knowledge to negotiate longer-term power purchasing contracts at much more competitive prices. Without detailed, real-time energy usage delivered by advanced metering systems, this type of precise planning, management and control is unachievable.

By combining advanced metering technology with the Internet and new load management and demand side management technologies, businesses and consumers can take charge of their energy consumption to reduce their costs. Businesses can monitor their energy consumption much more closely, and alter production schedules or equipment start-up sequences to take advantage of off-peak hours. Consumers can adjust their thermostats while they're away from home, or use the data in concert with new technologies from the home automation and control sector to monitor energy consumption by appliance to create a new model for home energy efficiency in the 21st century. For small businesses owners, large increases in energy costs can put their business in jeopardy, while the ability of American companies to compete in the global economy is undermined. Ultimately, increased energy costs are passed on to consumers and with the current metering infrastructure, they have little or no means and little or no knowledge to do anything about it.

Advanced metering technology's impact on system reliability

- Data to match system capacity to load requirements
- Immediate outage detection and restoration notification
- Accurate load forecasting
- Proactive load management & control capability
- Enhanced distribution system optimization

Furthermore, by using automated metering systems to collect advanced energy usage data from strategic numbers and segments of energy customers on a daily, hourly or 15-minute interval basis, utilities and energy service providers gain knowledge necessary to optimize their own load forecasting accuracy, which reduces the risk of hugely expensive spot-market energy purchases that have led at least two large California utilities to the brink of bankruptcy.

On the supply-side of the equation, accurate energy use forecasting supports the precise planning of supply or generation requirements, which reduces frantic and costly searches for available power supply when energy reserves are near emergency levels.

Safety and Reliability

In addition to delivering real-time consumption data, many advanced metering systems provide other types of information that improve energy delivery while also improving consumer safety and distribution system reliability. Even today, customer phone calls continue to be the utility's primary source of information about power outages. Many advanced metering systems provide immediate outage detection and restoration notification capability to remove the guesswork and inference from the outage management equation. The systems provide precise, immediate and reliable data — all the way down to individual customers' homes and businesses — that enable utilities to reduce the duration of power outages and improve the reliability of their distribution system. Furthermore, automatic outage detection, improved outage response and restoration times, and improved system reliability have significant economic ramifications. As we saw during the recent rolling blackouts in California, outages cost businesses large amounts of money in ruined product and lost productivity. According to the Department of Energy's own figures, power outages and fluctuations cost U.S. businesses and consumers $30 billion each year. Yet that estimate may be very conservative in today's information- and technology-driven economy. As this year's energy crisis in California revealed, power outages at large, high-tech manufacturing companies with energy-sensitive production methods can cost just a single company millions of dollars per hour.

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When outages and system reliability issues do arise, advanced metering systems enable a utility to quickly identify and isolate the problem, efficiently dispatch maintenance resources with pinpoint precision, and they can provide customers with much more reliable and timely information concerning restoration of service. More frequent data collection of advanced metering combined with outage information also enables utilities to identify trouble spots in their distribution system, replace or resize equipment, improve outage response and restoration times and overall distribution system reliability and safety. These safety benefits are not limited to electricity delivery. By recording and reporting abnormal gas consumption patterns, the technology also helps to identify potential gas leaks before they turn into safety hazards that threaten property and consumer safety.

Adoption of Technology Has Been Slow

While proven and affordable advanced metering and automation technologies have been available on the market for nearly a decade, adoption of the technology by energy providers has been limited thus far. According to recent statistics compiled by Chartwell,

a leading energy industry research group and publisher, more than half of utilities nationwide are installing or piloting advanced metering technology. However, the majority of those are doing so only on a limited basis to this point. Overall penetration of advanced metering and automation technology currently stands at about 8 percent of electric, gas and water meters in the U.S., according to the most recent industry statistics available. More than nine out of every 10 electric, gas and water meters nationwide are still read manually once each month by a meter reader who must physically access the customer's house and property.

One of the primary reasons for the slow adoption of advanced metering technology is that many utilities have been hobbled by regulatory uncertainty and fear of stranded costs. Stranded costs and investments refer to assets that were purchased to serve customers under the traditional regulated model and their costs were recovered in the utility's ratebase. Those assets may become "stranded" if regulatory decisions "unbundle" those assets from utility ownership before their cost is recovered, or if asset cost exceeds its market-driven value in a deregulated market. With one foot forward in a new business model of a competitive marketplace, and one foot stuck fulfilling the obligations of the traditional business model, investments in advanced metering and automation technology and other infrastructure improvements still seem risky to many utilities. As a result, some utilities have postponed, delayed, downsized or altogether shelved their plans for investment in advanced metering technologies until this cloud of uncertainty clears.

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In the end, those delays cost everyone: utilities, their shareholders, businesses, consumers, and they delay further our nation's ability to move toward an efficient energy delivery model that is characterized by consumer choice among energy providers, competitively priced energy and energy services, and a highly efficient and reliable energy delivery system that enhances consumer safety and provides a strong foundation economic growth.

Lack of Enterprise-Wide Perspective

To this point, virtually all utilities have appraised advanced meter reading technology in relative isolation. In the view of most utilities thus far, the technology delivers value merely by automating meter reading and reducing or eliminating many of the operations costs associated with a manual meter reading operation. Advanced metering technology delivers some further value to utilities by eliminating meter access prob-

lems, estimated reads and improving meter reading accuracy, which results in improved billing accuracy, fewer customer complaints, reduced call center traffic and improved customer service. Because they eliminate the need for large utility vehicle fleets associated with traditional meter reading operations, automated metering systems also reduce gas consumption, and vehicle emissions.

As mentioned earlier, many systems on the market today also feature automatic meter tampering detection to detect and deter theft of services and improve revenue assurance. That's about as far as many utility project teams will take their business case. And this limited view has made it very challenging, many industry experts say, to develop a compelling business case to justify the technology's widespread deployment.

However, when comparing the operational costs associated with meter reading and revenue cycle services to the overall cost of delivering energy, there's a persuasive case to be made that meter data collection technology, by virtue of the information it delivers, provides an even stronger return on investment to the utility's distribution system operations and business development initiatives. Yet many utilities, for many different reasons, have difficulty seeing the value of advanced metering technology beyond automation of the meter reading function.

Performance-based Drivers

Some electric and natural gas utilities are working with regulators to implement an innovative new regime of Performance-Based Regulation (PBR) aimed at providing utilities with strong financial incentives to ensure that consumer needs for reliable and competitively priced energy services are maintained.

As energy markets "regionalize" and become increasingly interdependent, the efficacy of a federal mechanism establishing basic performance-based regulation increases significantly. This innovative and proven regulatory approach would provide utilities and energy service providers with clear financial incentives to ensure that consumer needs for safe, reliable and competitively priced energy services are maintained.

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This approach strikes a desirable balance between the benefits of competition and the vital interests of consumers, and is gaining significant momentum in the energy industry as it transitions from a highly regulated, monopolized model to a competitive one. With these incentives in place, energy providers would have a strong opportunity to mitigate risk and achieve a higher return on investment in advanced metering technology while meeting the vital needs of businesses and consumers.

These important objectives can be achieved with minimal government intrusion and regulation by instituting a new regime of performance-based incentive programs at the federal level that will provide utilities nationwide with the impetus to invest in new technology to optimize energy delivery. These performance-based incentives should focus on critical distribution and customer service functions such as system reliability; outage response and restoration times; meter reading, estimated reads and billing accuracy; as well as call center operations and customer complaint resolution. These incentives could also focus on conservation and demand-side management programs to trim overall demand for energy. With reliability, energy costs and customer service high on the minds of regulators nationwide, uniform performance-based regulation has opened a window of opportunity to address critical energy distribution issues and consumer needs through automation technology in a manner that minimizes costs and strengthens shareholder value.

The California Crisis

When it comes to issues facing the energy and utility industry, the California energy crisis rightly deserves top-of-mind billing for both state and federal policymakers. The California energy crisis is a multidimensional problem that doesn't lend itself to easy answers. Blaming "deregulation" is overly simplistic. While there are important lessons to be learned from California's early deregulation initiative, the fundamental premise that competition in the energy industry will ultimately benefit consumers is hardly disproved. Deregulation of electricity markets in other states is proceeding without the price volatility and supply problems seen in California. Instead, it is a mosaic of circumstances that have put the power supply in California so wildly out of step with rapidly increasing demand. Many in the industry have dubbed California's energy crisis "the perfect storm," and they're right.

What if advanced metering technology were in place in California?

- Real-time data to balance supply and demand
- Enhanced load management and control capability
- Accurate demand forecasts for long-term power purchases
- Proactive demand reduction to avoid rolling blackouts
- Data for businesses, consumers to manage energy use
- Empowerment of conservation measures

"Some predict a deficit of 4,000 to 8,000 megawatts during peak summer load, or enough energy to power approximately 800,000 homes"

Most industry experts predict that the state will be unable to muster the necessary mega wattage to make it through the summer without persistent service interruptions and widespread rolling blackouts. Some predict a deficit of 4,000 to 8,000 megawatts during peak summer load, or enough energy to power approximately 800,000 homes.

The stakes are huge. California represents the sixth largest economy in the world and is home to many of the high-tech companies that are driving the new economy. When the power goes out, it can cost large companies with energy-sensitive operations and production methods millions of dollars an hour in lost productivity, not to mention the impact rising energy prices have on the overall cost of doing business. Many of these companies have already made it clear to the state's politicians that they have no intention of expanding their presence in the state without being assured of a reliable supply of competitively priced power. Add in the costs, difficulties and uncertainties for the state's agriculture, manufacturing and tourism sectors, and the adverse economic effects of a protracted power crisis will likely ripple far beyond the California border.

Yet this seemingly dark period in the evolution of the competitive energy marketplace will likely be looked back upon on as a trial-and-error period, a time in which utilities, regulators, politicians and other market participants corrected the course and trimmed the sails. At the same time consumers, despite current regulatory rate caps that insulate them from the law of supply and demand in California, are slowly coming to grips with the fact that electricity is not an inexhaustible resource.

The ultimate solution to the problems plaguing California is to balance — much more precisely — the supply of electricity with overall demand. This, of course, can be achieved in two ways: increase supply or decrease demand. Ultimately, as new power plants are constructed, more portable or "distributed generation" technology proliferates (such as back-up generators and fuel cells), and existing power plants that are currently idle return to service, supply shortages will ease. Despite expedited efforts to speed up power plant siting, approval and start-up, it will take three to five years before appreciable generations assets to serve the California market will go on line, and it could be nearly a decade before generation capacity catches up with California's again-booming economy, which has brought with it a 25 percent increase in energy demand over the past five years that no one seemed to anticipate. Cleary, addressing this problem on the supply side of this unbalanced equation represents a longer-term and very expensive strategy.

An Opportunity in Disguise

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That leads us to the demand side of the equation, where, through the application of advanced metering systems and technology, we find dramatic opportunities to put a big dent in this problem in the near term. To manage demand more effectively and empower a new regime of conservation and demand management efforts, utility distribution companies and their

customers need access to much more timely and detailed energy usage data that empowers them to manage energy distribution and consumption much more effectively. What's required to solve today's energy problems in California and meet tomorrow's requirements is an infrastructure that empowers businesses and people to take control of their energy use and costs. What a golden opportunity California has to establish a new model of effective load management, energy efficiency and conservation for the 21st century.

But to meet this challenge, energy providers require better data, which they can turn into valuable knowledge for themselves and their customers. As previously discussed, the automated collection of advanced metering data would enable utilities and energy service providers in California to more closely match energy supply with demand through precision load forecasting, effective load management and control, demand-side management programs and incentives, development of more dynamic rate structures, and knowledge-driven conservation programs. For example, if the large utilities in California were to move aggressively to deploy advanced meter data collection capability for their commercial and industrial customers, they could conceivably have the data collection and management infrastructure in place to proactively manage as much as 60 percent of their load in relatively short order. Whether it could happen in time to provide some relief from the looming summer crisis would depend on a number of variables. But the technology is there and ready to go.

Policy Solutions

"enact tax incentives and/or asset recovery mechanisms to encourage all forms of investment in this country's energy infrastructure as part of a comprehensive national energy policy"

One of the most cost-effective, potent and yet measured public policy solutions to these problems in the near term would be for regulators and legislators, at both the state and federal levels, to enact tax incentives and/or asset recovery mechanisms to encourage all forms of investment in this country's energy infrastructure as part of a comprehensive national energy policy.

This public policy effort should not only include new generation facilities and energy exploration to increase energy supply and reduce our dependence on foreign energy sources, but should also include advanced metering systems and data management technology to increase distribution system efficiency and reliability while empowering businesses and consumers to take control of their energy consumption in response to market forces and price signals. It's time to remove uncertainty. Remove obstacles. Remove risk. But this calls for nothing less than a revolutionary retooling of the energy infrastructure at a level and sense of purpose comparable to what the Interstate Highway System did for transportation and commerce in the 1950s and the 1960s.

Conclusion

In the long-term, the solution to the problem posed by volatile energy markets requires a carefully balanced prescription of increased energy supply and reduced demand. If we focus only on increasing supply through expanded generation capacity, the solution to our problems will be much more expensive than it needs to be. We will achieve our energy management objectives most cost-effectively if we also deploy the technology to collect reliable, timely and detailed knowledge about how much energy people need, how much they use, when they use it, and most importantly, how much can be saved if people are given incentives and the means to do so. The economic upside to renewing our energy information infrastructure by putting the power of technology to work through advanced metering systems is tremendous; the downside is very steep.

"advanced metering technology is vital to keeping the lights on and keeping energy prices affordable"

In that light, the crisis before us in California is really an opportunity. It is an opportunity to invest in new technology that will enable us to put the power of information to work in our energy delivery infrastructure. The result will be improved public safety, improved reliability and greater price stability. An affordable, reliable energy supply is critical to economic growth in our knowledge-driven economy of the 21st century. Increasing energy supply is part of the answer to the nation's energy needs. Stimulating investment in technology and information that empower utilities, businesses and consumers to more effectively manage the demand side of the equation is an equally important component to any long-term energy policy. In the end, advanced metering technology is vital to keeping the lights on and keeping energy prices affordable. Incentives to implement this technology and make full use of the data it delivers offer the fastest, most cost-effective way to restore balance between energy supply and demand. Ultimately that capability will enable the nation's energy providers to deliver safer, more reliable and competitively priced supply of energy to businesses and consumers today, and well into the future.

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