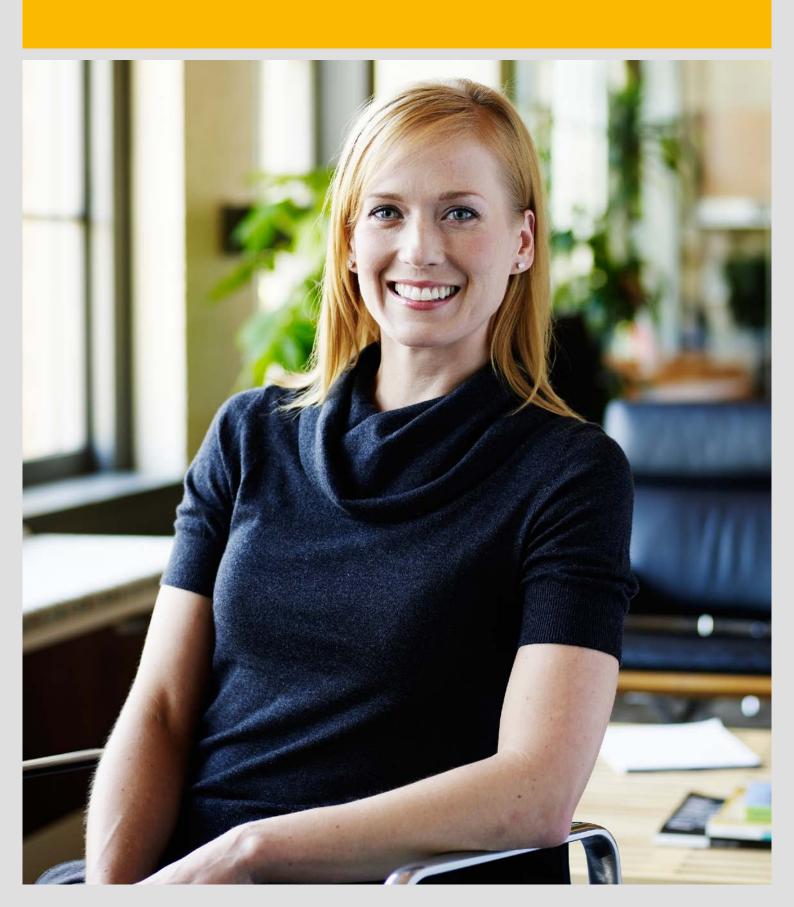# SMART GRID ANALYTICS
UNDERSTANDING THE DATA LATENCY PROBLEM – AND HOW TO SOLVE IT

To make a self-healing smart grid operational, energy retailers will need more than smart meters deployed at customer sites. They will also need a way to predict and communicate consumer demand to power generators and grid operators in advance so they can work together to respond swiftly to changing demand and other events.

CONTENT

EXECUTIVE SUMMARY
SMART GRID SOLUTIONS FOR RETAILERS, GRID OPERATORS, AND INTEGRATED UTILITIES

Smart electricity grids are the way of the future – and the pressure is on to make them a reality across the United States and beyond. As energy demand threatens to exceed supply, costs spiral up, and pressures to reduce carbon emissions increase, smart grids offer a powerful solution to these challenges. These intelligent electricity networks will use digital technology and two-way communications to help deliver electricity from producers to consumers in a more efficient, reliable way. Smart grids are also needed to enable energy retailers to offer customers demand-side management (DSM) programs that will reduce overall energy usage and minimize the need for costly peak capacity.

But it's widely recognized that to be truly transformative, smart grids must be **self-healing**, which means that they can automatically detect, respond to, and solve outages and other problems caused by weather, accidents, or equipment failure. This will require analytics that detect and sense events and fluctuations in demand and respond in seconds. The problem is that until now, this has been technically impossible; collecting the massive amounts of data coming in from retail customers and rendering it available for analysis has required a great deal of time and effort. And data delays of minutes, hours, and even days will render a smart grid as ineffective as today's archaic grid.

This paper explores SAP's vision for a comprehensive, integrated smart grid analytics platform, which will be powered by revolutionary in-memory technology. The platform will encompass IT solutions that support:
- Customer profiling
- Customer event analysis and handling
- Grid-level analytics

SMART GRIDS
TRANSFORMING THE ENERGY INDUSTRY

It's widely recognized that to have a truly transformative smart grid, it must be **self-healing**, which means that it can automatically detect, respond to, and solve outages and other problems caused by weather, accidents, or equipment failure.

The electricity industry has made huge progress toward enabling the smart grid vision: the deployment of an intelligent electricity network that employs digital technology to deliver electricity from energy producers to consumers using two-way digital communications. These digital communications are expected to make the nation's electricity grid operate far more efficiently than it currently does. With a smart grid, for example, grid operators will have more granular, real-time visibility into demand so they can control loads in a way that truly balances production and demand.

At the same time, energy retailers will be able to engage consumers to participate in demand-side management and energy-efficiency programs that will reduce overall energy usage and minimize the need for costly, traditional peak capacity. (For instance, they can encourage customers to install energy-efficient appliances, run washers and dryers at night, and set air conditioners at a higher temperature during predetermined times of day). They will also be able to accurately predict demand on a given day and time and share this insight with power producers and grid operators so no generated power needs to be off-loaded and wasted.

Given current and projected trends in energy demand, enabling the smart grid across the United States is critical to the future of the country. First, demand is rapidly exceeding supply. According to the Department of Energy, "Since 1982, growth in peak demand for electricity – driven by population growth, bigger houses, bigger TVs, more air conditioners, and more computers – has exceeded transmission growth by almost 25% every year."[1] At the same time, the United States has chronically underinvested in transmission and distribution; this is contributing to more frequent outages and power quality issues that are estimated to cost American business more than $100 billion (on average) each year.[2] Research confirms that effective use of the smart grid can both substantially reduce demand and optimize transmission and distribution by aligning demand with supply in near-real time. And finally, as the world's largest energy consumer, the United States must find ways to reduce its overall carbon footprint.

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1. *The Smart Grid: An Introduction.* Prepared for the U.S. Department of Energy by Litos Strategic Communication under contract No. DE-AC26-04NT41817, Subtask 560.01.04. Available online at www.oe.energy.gov/DocumentsandMedia/DOE_SG_Book_Single_Pages(1).pdf.
2. Ibid.

The Ultimate Goal: A Self-Healing Energy Grid

It's widely recognized that to have a truly transformative smart grid, it must be **self-healing**, which means that it can automatically detect, respond to, and solve outages and other problems caused by weather, accidents, or equipment failure. Using sophisticated, automated distribution capabilities, for example, a typical outage could be avoided altogether by a self-healing smart grid, as it could detect grid issues and proactively reroute energy to avoid problem areas. And in the event that an outage does manage to occur, a self-healing smart grid could automatically detect when it occurs, identify its root cause, and instantly reroute transmissions so that consumers regain power in minutes or even seconds. This is a significant improvement over the hours and even days required to detect and fix outages when utilities rely on conventional equipment and processes to find and repair downed lines.

This self-healing capability – considered "smart grid nirvana" – is only possible when data about grid conditions and consumer demand are instantly available to the digital technology at the heart of the smart grid. This technology must be able to sense events and fluctuations in demand and respond in seconds. Data delays of minutes, hours, and even days render the smart grid as ineffective as our current grid.

Until now, this has been technically impossible. Collecting the massive amounts of data coming in from retail customers – both consumers and businesses – and rendering it available for analysis has required significant amounts of time and effort. Some early smart meter architectures take 24 hours to render received smart meter data available for analysis. That's hardly fast enough to enable a self-healing grid; such delays prohibit the grid's automatic "sense and respond" capability. As a result, the self-healing grid has remained a concept – not reality.

Technology Requirements for Retailers

To make a self-healing smart grid operational, energy retailers will need more than smart meters deployed at customer sites. They will also need a way to predict and communicate consumer demand to power generators and grid operators in advance so they can work together to respond swiftly to changing demand and other events. And they will need to be able to detect outages and other customer issues instantly and address root causes proactively. At the same time, retailers must be able to create and manage data-driven DSM programs that enable a higher percentage of customers to reduce overall energy usage and their carbon footprint, thereby minimizing the need for costly peak capacity.

To address these needs, energy retailers in particular will have to invest in enabling technologies such as:
- A way to aggregate, cleanse, and make massive amounts of streaming customer data available for analysis almost instantly, so that they can react quickly to events (for example, by alerting a third-party outage management system that can instantly reroute transmissions and prevent a blackout)
- Analytics to run reports and detect trends and issues quickly and early
- DSM software that leverages analytical insights about customers and empowers retailers to manage programs that influence customer behavior in ways that reduce usage and carbon emissions and balance energy demand and supply
- A billing system that's capable of billing in different time intervals

It's All About the Data

It's important to note that the common thread through all of these technical enablers is **data and the analysis of data**. Data-driven analytics – and customer and business intelligence – are foundational to enabling transmission optimization and effective demand-side management. As noted by Gartner Inc., "Near-real-time data sources (for example, smart meters or power quality sensors) will support new key performance indicators (KPIs) and enable more-discrete measurement of power delivery and customer service performance. Utilities will be required to dramatically increase their investment in real-time business intelligence systems resulting from smart grid development."[3]

Data-driven analytics – and customer and business intelligence – are foundational to enabling transmission optimization and effective demand-side management.

3. *Market Trends: U.S. Energy and Utilities Market Sustains IT Interest in Business Intelligence and CRM*, Gartner Research, by Cynthia Moore, 20 December 2010, ID Number: G00209615.

SAP'S VISION: COMPREHENSIVE SMART GRID ANALYTICS

INTEGRATED SOLUTIONS THAT SOLVE DATA LATENCY ISSUES

Three Key Components

SAP offers a long-term vision of the analytical capabilities that energy retailers and grid operators will need to realize the full value of the smart grid and bring scalable, effective DSM programs into operation. This vision, as illustrated in the figure, involves the deployment of an integrated platform for smart grid analytics that will encompass IT solutions supporting:
- Customer profiling
- Customer event analysis and handling
- Grid-level analytics

enable them to profile customers, neighborhoods, businesses, regions, and other customer segments and understand trends. For example, if a cold snap happens, one customer's pattern may be to use more power, but another customer in the same area may use a woodstove to heat and not need as much energy. This trend data is needed to forecast energy requirements during cold weather events.

Examples of questions that analytical tools would address include:
- What are typical load profile patterns over a given day for different customers

are well covered by synthetic load profiles, and which others are not?
- How consistently are customers sticking to a certain usage pattern?
- How do these trends change as the seasons change?
- Which customers deviate from their peer groups significantly? What is the consumption benchmark in a specific segment?

All players in the energy ecosystem will need this kind of trend data so they can plan ahead for required energy generation and transmission, solve transmission problems swiftly, and offer targeted DSM packages or energy services based on actual customer usage patterns.

Customer Event Analysis and Handling

The energy ecosystem will also require analytics that can tell them almost instantly about anything that happens on the grid that impacts a customer – for example, if a meter goes offline, when a customer experiences an outage or even a minor interruption, or if an incident of fraud or tampering occurs. Solutions will also need to include integrated functionality for tracking when and where these interruptions occur so retailers and grid operators can handle them more proactively.

Grid-Level Analytics

In the future, the energy ecosystem will require grid-level analytics to monitor and analyze events at power plants and on transmission and distribution lines. This will enable all participants to optimize grid reliability, as well as support decision making regarding asset maintenance priorities and capital planning for network expansion.
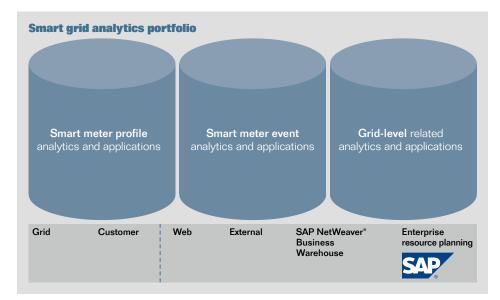

Figure: SAP's Vision for Smart Grid Analytics

Customer Profiling

Members of the energy ecosystem (which includes retailers, grid operators, and power producers) will not only need smart meters and a way to automatically collect data from smart meters. They will also need powerful analytical tools that will

and segments? How many customers (and customer days) match each of these patterns?
- Which load patterns are well defined, and which have large variability?
- How do actual load patterns compare to synthetic load profiles? Which segments

Tackling the Data Latency Problem

As noted previously, the self-healing smart grid vision can't be made operational if transmission and distribution companies can't solve the looming data-processing latency problem that currently prohibits timely analytical processes. As noted by Gartner, "The expansion of smart grid initiatives will yield unprecedented amounts of data."[4] As customer and transmission data pours into retailer IT systems, it must be processed by billing and analytical software in near-real time to make a self-healing grid operational.

Moreover, the need for real-time analytical processing will only increase over time. For example, according to Gartner, "New investments will expand for business intelligence [BI] software – linked to real-time and near-real-time data sources and accompanied by visualization capabilities – for managing an increasingly complex

Many countries are challenging energy providers to make significant changes in operations by 2020. For example, the EU's 20/20/20 legislation mandates that energy companies produce 20% of their power from renewable sources and reduce greenhouse gases by 20% by the year 2020.

Members of the energy ecosystem will not only need smart meters and a way to automatically collect data from smart meters. They will also need powerful analytical tools that will enable them to profile customers, neighborhoods, businesses, regions, and other customer segments and understand trends.

transmission and distribution grid. In addition, within wholesale energy operations, BI can be used to analyze and report collective or cross-commodity positions where multiple energy trading and risk management (ETRM) trading platforms are used for individual commodities."[5]

The Solution: A High-Performance Analytics Environment

To solve the data latency problem, what's needed is a high-performance analytics environment that includes:

- **In-memory technology for analyzing "cold" data:** In-memory technology enables participants in the energy ecosystem to process large volumes of cold data – for example, smart meter data stored in a database – and provide results in seconds or minutes, not hours or days. It does this by enabling very fast query response times to large, stored data sets; rather than storing data on a hard drive, data stays in-memory (similar to random access memory, or RAM) and available for analysis with minimal time delay. This enables energy retailers, for example, to detect issues in near-real time and respond to them swiftly with a predetermined action. These actions can also be automated as part of a self-healing grid.
- **Real-time event monitoring of "hot" data:** True real-time event monitoring provides operational business intelligence as events occur. But it requires a way to analyze data as it streams in from smart meters – before it is stored in-memory.

Both of these capabilities are essential to becoming a real-time utility, because they shrink the time from incident and response from days or hours to minutes and even seconds.

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4. *Market Trends: U.S. Energy and Utilities Market Sustains IT Interest in Business Intelligence and CRM*, Gartner Research, by Cynthia Moore, 20 December 2010, ID Number: G00209615.
5. Ibid.

SAP: PAVING THE WAY TO THE FUTURE
EXECUTING ON A CLEARLY DEFINED ANALYTICS ROAD MAP

SAP is already well on the way to realizing its vision of an integrated smart grid analytics platform that simultaneously addresses data latency issues. SAP expects to launch the first of its three solutions – a customer profiling solution – in 2011. Customer event analysis and handling software is planned to follow shortly after, after which a grid-level analytics solution is in mind. These solutions will be optimized for energy retailers and grid operators and will make it easier for them to share trend data with the broader energy ecosystem so all players can work together to optimize supply, demand, and reliability.

The grid analytics platform from SAP is part of its longer-term solution road map, as summarized in the paper Demand Side Management Solution from SAP: Statement of Direction for 2011 - 2013.

All three of these solutions will leverage a single source of trusted data that's collected from smart meters and other sensors. In-memory technology – specifically, SAP HANA™ appliance software – will enable timely reporting (in seconds rather than days) on massive volumes of cold data so that retailers can analyze consumption patterns, predict consumption over the next few days, and more. This kind of reporting will be combined with true real-time reporting enabled by software such as SAP® BusinessObjects™

Event Insight software, which allows retailers to identify events in real time, correlate algorithms and "fixes," identify when consumption expectations are "off," and more – all with zero data latency.

Once SAP's integrated smart grid analytics platform is fully deployed, the possibilities will be limitless for utilities. For example, retailers, grid operators, and power generators will be able to:

- Support customer event management (for example, a power outage) by analyzing the flow of energy across transformers, identifying issues and their cause, notifying the appropriate grid operator instantly, and sharing details about the exact location and root cause. This will enable repair teams to bring the right parts and tools and fix problems more quickly and at a lower cost.
- Profile customers in detail and design more targeted demand-side management energy packages that will help customers use power more efficiently
- Capture trend data to enable the smart grid and empower customers to compare their energy use relative to their neighbors
- Provide benchmarking services for various customer segments
- Use grid analytics to monitor the flow of energy along the grid
- Enable customers with solar systems to sell back power to the power company

Bottom-Line Benefits

With integrated smart grid analytics solutions from SAP, retailers, grid operators, and power generators will be able to achieve the vision of a self-healing smart grid and realize benefits such as:

- **Improved customer service** – for example, by minimizing outages and offering data-driven DSM programs that lower costs and energy consumption
- **Maximized operational excellence and efficiency** – for example, by reducing demand for peak energy and shifting consumption to lower-demand periods, as well as eliminating production of costly excess capacity that must be shed from transmission networks
- **More effective risk management** – for example, by detecting outages more quickly and diagnosing and fixing root causes more efficiently
- **Effective balancing of energy demand and supply** – for example, by having granular, real-time visibility into demand so they can control loads with pinpoint accuracy

Learn More

To learn more about the SAP for Utilities solution portfolio and SAP's development of smart grid analytics solutions, please visit www.sap.com/industries/utilities/index.epx.

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