

# Building a Smart Infrastructure



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*This paper explores the impact of smart initiatives undertaken by a number of utility companies worldwide in response to legislation such as the European Energy End Use Efficiency and Energy Services Directive and the US Energy Policy Act 2005. It also shows how TIBCO is meeting the demands of utility network operators, distributors, and consumers to optimize supply and demand on the grid through a smart infrastructure.*

## 1. Liberalization of the Market

Since the 1990s, the utility industry has seen an increase in government regulation, leading to

- Separation of supply of energy from transmission and distribution
- Break up of state controlled entities in most regulated countries
- Payment of regulated charges by suppliers to generators and distributors to use their delivery networks
- Requirement for supply and demand balancing entities and mechanisms

The deregulation and privatization of utility companies has led to dramatic changes in business models, an increased focus on efficiency of operations, and increased focus on reliability of service. The real-time nature of distribution has driven the development of demand/response mechanisms to manage supply and demand. It has also led to lower prices and more choice for consumers. Legislation mandates that consumers be able to choose their utility supplier and switch from one supplier to another in the same way they are able to switch from one mobile phone operator to another.

Governments are increasingly pushing for intelligent grid technology to address environmental concerns, energy independence, and related security issues. Advanced Metering Infrastructure (AMI) is one of the key components of intelligent or smart grid implementations.

## 2. Smart Initiatives

At the most basic level, we can define two types of “smart” initiative: smart metering, which is the cornerstone technology of AMI, and the smart grid, which focuses on the operations of the physical network.

**A smart meter measures consumption more frequently and allows utility companies to monitor the quality of delivery of energy or water to customers. A smart grid uses communications and sophisticated technology so the grid can operate more efficiently, reliably, and safely.**

Smart meters are advanced electronic meters that identify consumption in more detail than conventional meters; the meter has built-in intelligence and communicates detailed information about consumption via a communications network back to the local utility for monitoring and billing purposes. A smart meter measures consumption more frequently and allows utility companies to monitor the quality of delivery of energy or water to customers.

Key drivers for smart meter initiatives are:

- Bi-directional control of the grid
- Efficient use of energy and cost savings
- Efficient billing
- Effective customer care by providing customized tariffs

A smart grid uses communications and sophisticated technology to upgrade the current electric power grid so it can operate more efficiently, reliably, and safely.

Key drivers for smart grids are:

- Reliability of service – Most grid infrastructure is aging and has not kept up with population and demand growth; hence rolling blackouts<sup>1</sup> and failures are experienced by consumers.
- Efficiency – In the existing grid system, extra generation capacity is kept on “standby” to accommodate load surges.

<sup>1</sup> In a recent article in “Le Monde” on January 9 2009, the CEO of EDF, Pierre Gadonneix, said that the high voltage network in France (RTE) is susceptible to outages at peak consumption times. Consumers in risk areas like Brittany and Provence Côte d’Azur received text messages and emails asking them to reduce consumption on January 7 when a peak national consumption rate of 92 400 MegaWatts occurred during a cold spell.

- Safety – Many governments believe the current grid infrastructure is operationally unsafe and prone to malignant attack.
- Achieving reduced carbon emission targets and using renewable energy sources, some of which will be directly fed into smart grids from locally generated sources.

Countries that have taken the lead in rolling out the Advanced Meter Infrastructure are Italy, the Netherlands, France, some Scandinavian countries, the U.S., Australia, and, more recently, the UK.

### 3. Why TIBCO?

TIBCO solutions, available today, add value to smart initiatives by:

- controlling the rollout of smart meters to homes and businesses in an automated and context-aware fashion
- managing the integration of high volumes of consumption data derived from smart meters with back-end applications
- analyzing consumption information to predict demand and for marketing and commercial purposes
- improving the reliability of service on the grid using real-time information about service delivery and demand

Once consumers are equipped with smart meters, a bi-directional flow of data from and to the grid is enabled, providing information on consumption volumes and periods of consumption. This opens up the potential for energy suppliers to provide attractive and personalized tariff options to consumers and to encourage them to consume energy at off-peak times. The explosion of data derived from consumers provides new opportunities to derive detailed analytical information about consumption patterns. This data can be exploited using TIBCO solutions to derive patterns of energy consumption, which can be applied in many different ways, for example, to detect fraudulent use of electricity or gas. Marketing and product management personnel can leverage the data about consumption patterns to propose new products and services to consumers.

**Once consumers are equipped with smart meters, it enables a bidirectional flow of data from and to the grid, providing information on consumption volumes and periods of consumption.**

**ENEL was the first utility company in the world to roll out smart meters to its 30 million customers. The company has reportedly achieved €500 million per year in operational savings from this move.**

The Italian utility company ENEL, a TIBCO customer, implemented AMI for its customers between 2000 and 2005 at a cost of €2.1 billion and was the first utility company in the world to roll out smart meters to its 30 million customers. The company is understood to have achieved €500 million per year in operational savings from this move.<sup>2</sup>

Utility companies can significantly reduce labor costs associated with meter reading through AMI deployments. Smart meters can accurately measure and collect consumption data to generate bills without visiting homes through remote meter-reading. Other operational benefits include remote control of systems and remote sensing of meter tampering and service outages.

Utility companies require solutions that can integrate the data collected from the smart meters seamlessly with their back-end systems, effectively manage increased volumes of data derived from more frequent meter readings, and perform advanced data manipulation in real time.

Distribution networks are already equipped with sensors that make them somewhat "smart." Historically, however, this information has not been correlated and aggregated across the operational and commercial aspects of the business. In the future, network operators will be utilizing more advanced software technologies to act on the information provided by these sensors to optimize the operation of the grid in areas such as Emergency Management and Distribution Automation.

Transforming the physical power distribution network into a two-way communication system is still a long way off and comes at a prohibitive cost. In the meantime, information and technologies exist that can provide some of this transformation and optimize the flow of power for greater efficiency of existing assets.

<sup>2</sup> Source : Dataquest Insight : Smart Meters for Intelligent Grids to Drive Semiconductor Growth 12 December 2008

## 4. TIBCO's Advanced Meter Infrastructure

Advanced Meter Infrastructures (AMI) involve not only the physical deployment of meters, but also a sophisticated communications network and IT infrastructure that can handle the forecasted volume of messages and information required to service millions of commercial and residential customers. AMI solutions have, so far, primarily focused on the physical deployment of meters to end users. As part of this deployment, many companies have turned to business process management (BPM) technologies. In parallel, most companies realize that in addition to deploying meters, they must also focus on what to do with the data that is received once the meters are in place. This requires a messaging infrastructure and integration technologies to tie existing systems together.

With complex event processing (CEP) technologies becoming widely understood, many AMI deployments are also considering the use of this technology for managing the "state" of meters throughout the lifecycle.

The roll out of smart meters to business and private premises is a multi-faceted task that presents a number of challenges:

- high volume of devices
- highly complex
- high cost of deployment (any failure in deployment will be expensive)
- high business impact
- integration challenges between central system and deployment system

The logistical complexity of rolling out millions of devices to businesses and homes can be reduced by automating and orchestrating business processes that manage the roll out, thus providing management with visibility into progress of the end-to-end processes through analytical dashboards.

**A Netherlands-based utility company solved the issue of meter allocation by detailing and automating the business process at all levels from initiating a work order through to billing.**

### **NETHERLANDS-BASED UTILITY COMPANY**

A forward thinking Dutch energy company formed in 1995 focuses on providing sustainable energy supply to its customers either in the form of electricity, gas, or heating. With a history in energy generation, it seeks to implement a program of sustainable energy supply by 2020. This includes wind, biomass, and clean gas-fired power plants. The company is active in all links of the supply chain from generation to distribution.

In the early period of deregulation, the company's process for allocating and installing meters was in chaos. Spreadsheets "controlled" the meter allocation process and, consequently, installed meters went unnoticed, faulty meters were never detected, and customer invoicing was not profitable.

The company solved the issue of meter allocation by detailing the business process at all levels from initiating a work order through to billing. TIBCO's business process management suite was implemented to track both the automated and manual parts of the process and give visibility into the processes across organizations. When an installer was assigned a work order, the meter was picked up from the warehouse by the installer and tracked through to installation and testing. Further remote auditing is performed for faulty meters and meter readings are now fed directly to billing systems.

The benefits of automating the e-meter allocation are more than just financial. The company now has visibility into a process that was previously unpredictable. Work orders can now be assigned to installers in a more equitable fashion avoiding work overload. The proper function or malfunction of meters is continually monitored and customer service has improved dramatically.

## **5. Orchestrating Smart Meter Roll-Out Using BPM**

**TIBCO's BPM solution, combined with complex event processing capability, provides a context aware environment to orchestrate meter roll-out.**

Ensuring that all the steps and dependencies in smart meter installation are respected and that data collection and aggregation are properly orchestrated requires a "context aware" solution that, in addition to automating a maximum number of tasks, is able to manage the tasks on the critical path according to a high level execution plan. The execution plan can be changed dynamically at any time in response to time-related dependencies or unpredictable events such as a delay or an outage in communications. Unpredictable events that influence the roll-out take place in an asynchronous fashion; to interpret these events, a powerful rules engine applies different algorithms to event correlation and is

able to associate related events to a specific rollout sector. The sequence and priority of tasks are dynamically recalculated based on the real-time information provided by the events detected on the enterprise service bus (TIBCO's or another standards-based platform), which acts as a high volume and secure transport mechanism for transporting data and business events.

Some key technology components are necessary in order to benefit from a context-aware solution to orchestrate smart meter roll-out. TIBCO's BPM solution, combined with complex event processing capability, provides a context-aware environment to orchestrate meter roll-out.

Utility companies need to be able to respond to multiple environmental factors such as unavailability of components, people, modified deadlines, etc. during meter roll-out. A unique feature of TIBCO's BPM solution enables the detailed plans for meter deployment, including dependencies between tasks to be encapsulated in rules and to be represented in a Gantt chart interface. At process execution time, a visual representation of progress is visible through this interface, and tasks in "jeopardy" are highlighted in real time, enabling steps to be dynamically rescheduled according to their priority. The orchestration engine responds to the context and to events external to the process detected on the enterpriseservice bus to update deployment progress.

TIBCO's out-of-the-box solution provides utility companies with the operational nsight and flexibility to accommodate changes and confidence in their ability to process fast flowingand high volume data across a secure transport mechanism – the enterprise service bus.

A business activity monitoring capability, to track the progress of the overall process and to raise alerts when service level agreements (SLAs) may be at risk, is a key component of controlling the smart meter roll-out.

Figure 1. Sample tasks on the critical path of the smart meter rollout plan for specific geographical zones

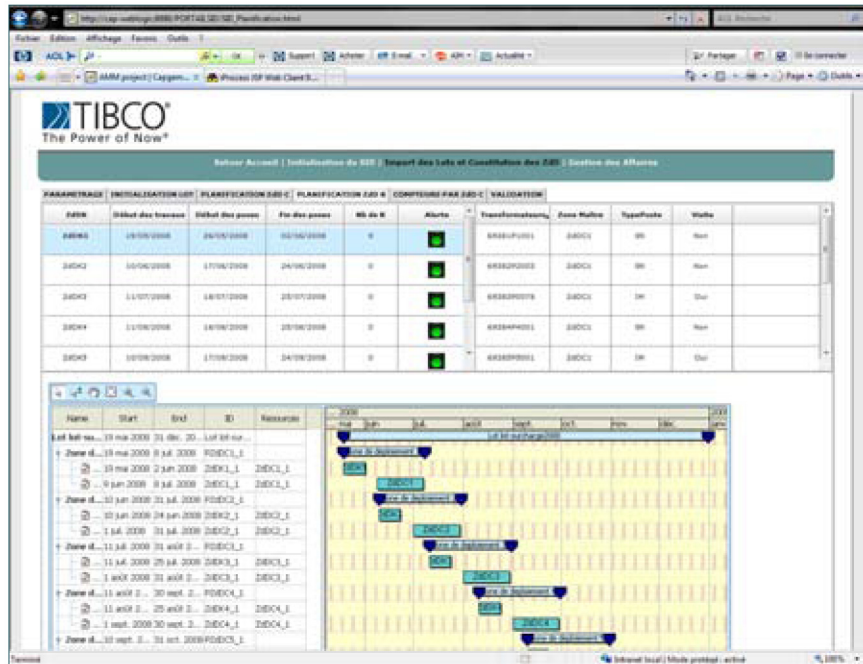
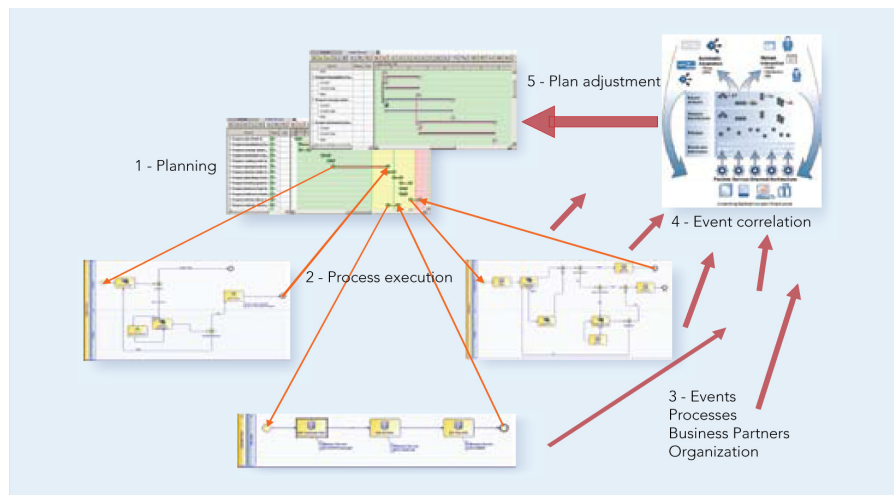


Figure 2. Context-aware solution for smart meter roll-out



## 6. Freedom to Switch Supplier – Improving Customer Retention

Utility companies are required to give consumers the freedom to go to their supplier of choice for energy and water supply; consumers subsequently benefit from more competitive pricing. A disconnect and connect process needs to be in place for customer switching along with the ability to provide the new supplier with all the relevant customer and billing information. A number of utility companies have implemented their customer switching processes based on TIBCO solutions including ACEA, Essent Energie and EnergyAustralia.

### **ENABLING CUSTOMER SWITCHING AT ACEA**

In Italy, the last step in the liberalization of the energy market was accomplished in July 2007. From this date onwards, all consumers are able to choose their preferred energy provider. The legislation also determines that, if explicitly requested by the customer, the provider is obliged to use renewable energy sources.

Energy generated by distributed network operators is placed in the National Distribution Network controlled by a government body. Delivery of energy to the consumer is managed by a local distributor, which provides the energy through a local distribution network. At least 2% of the total energy distributed by the local distributor must be produced by renewable energy sources.

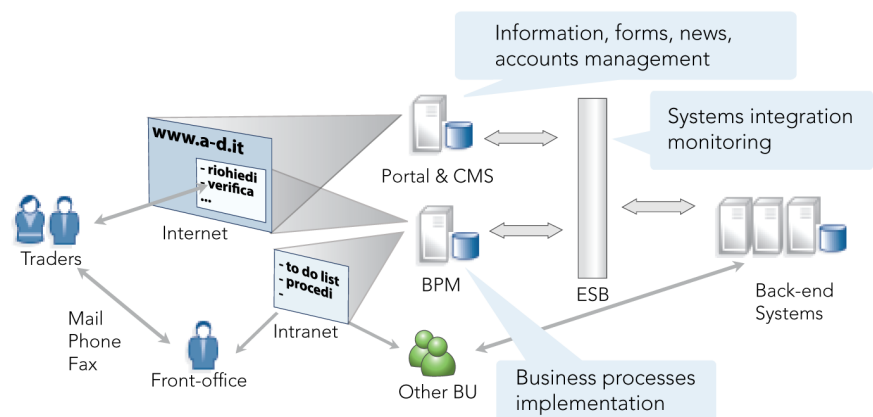
ACEA, a public utility leader in Italy, is focused on the development of water and energy services. A listed company since 1999, ACEA operates in the production, sales, and distribution of power, public lighting, decorative, and architectural lighting and the management of integrated water services. ACEA has 13% of market share in Italy. It provides 7 million residential customers with water and over 2.7 million residential customers with power in the Rome area.

ACEA has transformed its front office processes using TIBCO solutions to comply with new energy regulations that require it to have a supply arm separate from its distribution arm and to enable customer switching. The ACEA Distribution entity (Distribuzione) has implemented a front office portal that improves communications with providers and automates and simplifies the connect and disconnect processes for new and existing customers.

The providers use the portal to submit switching requests – the consumer wanting to change provider sends a request to the preferred provider, the provider sends the switching request to ACEA Distribuzione, incorporating commercial services requests such as contract changes, commercial offers for products and services, and technical service requests. The same portal is also accessible to ACEA Distribution back office operators who process requests to switch coming in from other channels (phone, fax, mail).

The ACEA portal includes a portal framework, a TIBCO BPM solution, and an enterprise service bus that provides all the necessary integration to the back-end systems.

**Figure 3. Front office portal to manage customer switching**



## 7. Exploiting the Incoming Data from Smart Meters

Once the smart meters are installed, the applications infrastructure needs to be capable of managing very high volumes of data coming in from the customer end points and to integrate the data in real time with existing front- and back-end applications such as CRM and billing. The high frequency of smart meter reads can generate in excess of 800% increase in volume of billing data alone. The applications infrastructure also needs to be capable of providing billing

information to consumers either on demand or at much more frequent intervals (at least monthly).

Many utility companies, including Essent Energie, EnergyAustralia, Constellation Energy, and ATEL, depend on TIBCO's application integration infrastructure and the messaging capabilities provided by the enterprise service bus for enabling integration with CRM, ERP, and billing applications.

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### **ESSENT ENERGIE**

Essent is a Dutch energy company that specializes in the generation, transport, trade, and supply of gas and electricity. While the Netherlands is its primary market, Essent also operates in Germany and Belgium and is the northwestern Europe market leader for energy. In the Netherlands, Essent has over 2.6 million consumer and business customers.

The 1997 European Electricity Directive set a binding timetable for the liberalization of electricity generation, distribution, and supply across Europe. The Netherlands soon adopted the directive and Dutch utilities undertook one of the most ambitious and far reaching liberalization programs in Europe.

Essent needed to prepare to compete effectively for customers in this new market. Their current customer care handling was inefficient. Detailed customer information was not recorded, meter data was missing or of bad quality and billing information was often incorrect. This obviously had a negative impact on customer satisfaction.

Essent had a requirement to collect metering data from multiple sources to effectively monitor and manage power consumption.

Essent needed to put in place a system to enable its retail operation to expand and provide access to information both internally and to partners. Over a 3 year period, Essent rationalized their applications environment and integrated multiple applications to create a real-time infrastructure based on TIBCO.

TIBCO's business integration solution integrates accounting, sales, billing, and metering systems and enables real-time data sharing and straight through processing of transactions. By the close of 2003, Essent's customers had access to a customer self-service portal for managing billing and payments.

**Essent reduced invoicing errors by linking transaction systems to customer service, metering, and billing systems.**

Benefitting from the greater agility provided by TIBCO solutions, Essent became the first Dutch energy utility to manage billing and issue invoices by the deregulation deadline. Essent reduced invoicing errors by linking transaction systems to customer service, metering, and billing systems. The customer self-service environment enhances customer loyalty and decreases operational costs. At the infrastructure level, Essent was able to reduce the number of applications by 37% and the number of interfaces by 32% by adopting the TIBCO integration platform.

Previously, it took call center agents at Essent 15 minutes to process a new customer location. Leveraging the capabilities of TIBCO's integration platform, they were able to significantly reduce this time, thus improving the quality of the customer interaction.

#### **ENERGYAUSTRALIA**

EnergyAustralia is one of the largest energy suppliers in Australia. With over 1.5 million business and residential customers, EnergyAustralia operates an electricity network of around 22,275 square kilometres. Their operations include purchasing and supplying energy, electrical contracting, customer connections, emergency restoration and local repairs, and major capital works. Customer service has always been EnergyAustralia's priority.

When the Australian utilities market was liberalized in the 1990s EnergyAustralia chose TIBCO to meet its long term requirements to transform its enterprise application environment and business processes for greater business agility.

EnergyAustralia, like many utility companies, has a large deployment of SAP primarily used in Finance, HR, Purchasing and its retail line of business. Little integration existed between these applications, resulting in re-keying data and manual rework.

In order to become an active participant in the new National Electricity Market, EnergyAustralia needed to connect to these new systems. With the need to support 1.5 million customers on the retail side of the business, turnover of households from service order to connect/disconnect was a labor intensive process and fraught with errors.

EnergyAustralia met these challenges by integrating its SAP domains with other critical applications. Over 150 SAP interfaces were implemented using TIBCO. Many of these interfaces provided business critical connections such as feeding

data about consumption from the metering system to billing which is captured in SAP.

TIBCO also was used to integrate internal systems to the National Energy Market systems allowing EnergyAustralia to be an active participant in buying and selling of power.

Finally, TIBCO BPM software was implemented to automate the manual process of managing service orders and connecting and disconnecting customers as they relocate.

EnergyAustralia has been able to increase its service agility by automating processes, thus allowing it to be more responsive to the market. In addition, by developing core TIBCO components in-house, the company is able to re-use these components from project to project, saving time and money.

## 8. Improving Customer Service Levels

One of the objectives of legislation in liberalizing utility companies is to enable consumers to go to the provider of their choice for energy and water supply. Utility companies have a much greater stake than previously in customer retention by improving customer service levels. One way to prevent customer churn is to provide attractive tariff packages to consumers, tailored to their needs and consumption patterns, in much the same way as mobile phone operators offer tailored rate plans to mobile phone subscribers. The opportunity to read consumption data from the smart meters at frequent, sub-hourly intervals enables tariffs to be adjusted dynamically to reward off-peak energy consumption and to communicate special offers via smart meters in real time.

The rich information derived from smart meter readings can be manipulated and analyzed using sophisticated event processing software from TIBCO that enables behavioral patterns to emerge from seemingly unrelated events correlated by a rules engine.

In order to fine-tune the product and services offerings from utility companies, it is important for them to understand in detail how energy and water are being consumed, in what quantities and at what times of the day. It is also important for them to receive detailed feedback about the quality of service delivered. Event processing software can correlate data about micro events that have been

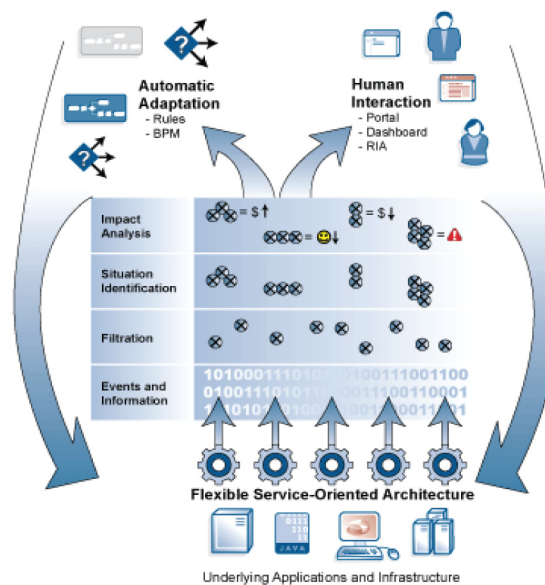
**The rich information derived from smart meter readings can be manipulated and analyzed using sophisticated event processing software from TIBCO that enables behavioral patterns to emerge from seemingly unrelated events.**

captured according to predefined states in their lifecycle and of derive patterns of behavior. It is possible, therefore, to build up detailed models of consumption and to use these models not only to help predict demand more effectively but also to attune the tariff packages for consumers and to influence end user consumption in a positive and energy efficient manner.

By effectively exploiting the data at their disposal and by proactively improving service levels and product offerings for consumers, utility companies are in a position to improve customer care and retention levels in innovative and unprecedented ways.

It is, of course, possible to use these behavioral models of consumption to detect fraudulent consumption of energy and water or consumption of utilities for criminal purposes, such as manufacturing illegal substances (growing cannabis for example). TIBCO's complex event processing software is used in many industry sectors to detect abnormal patterns of events. For example, in trading environments it is used to analyze pre-trade and posttrade compliance requirements to prevent insider trading. In airline command centers it is used to enable decisions based on contextual information about flight schedules, meteorological conditions, crew availability, and baggage handling to minimize disruptions to the airline service.

**Figure 4. TIBCO's enterprise service bus and complex event processing software work together to derive patterns and behavioral models**



## 9. Improving Service Reliability

In addition to providing essential data about consumption, smart meters can also provide alerts of system outages and data about service reliability. A sudden drop in or absence of consumption in a particular sector can be detected by correlating data coming in from the meters and acts as an alert to the delivery infrastructure. Early warning alerts enable the utility provider to take corrective action and to communicate information to consumers about the duration of the outage and the Early Target Availability (ETA) of resumption of service. By providing timely information about outages or reduced service levels, providers are able to differentiate their services from other providers, improve customer satisfaction, and gain competitive advantage.

### **ELECTRIC SERVICE RELIABILITY ON THE SOON-TO-BE SMART GRID**

The competitive pressures building on the electric industry are particularly acute in the generation, transmission, and distribution areas of the business, where service reliability is the primary mission. We have seen in both Europe and North America major power outages and rolling blackouts indicating the stress of economic growth on an aging infrastructure.

**The smart grid allows generators and loads (consumers) to interact in real time, using modern information and communications technology.**

Today's power grid is more than 100 years old and has its control systems embedded in the generating plants, transmission lines, and substations. Information flows in one direction, from the consumers back to the utilities. Utilities attempt to predict demand and generation requirements through sophisticated forecasting techniques, but in order to be prepared for the "margin of error," it is typical to have as much as 10% of generating capacity on standby. This is inherently expensive and inefficient.

Moving the transmission and distribution of energy to a demand/response, two-way flow of information is what the industry now calls the smart grid. The full smart grid allows generators and loads (consumers) to interact in real time, using modern information and communications technology. Managing demand to eliminate the peak fraction of demand eliminates the cost of generators, cuts the wear and extends the life of equipment, and allows consumers to get more value from the system by prioritising their needs. Implementing a true smart grid is still some way off, but steps toward this vision are already being made today.

TIBCO is working with one of the world's major grid operators to implement solutions aimed at realizing the promise of the smart grid. Starting with

**TIBCO is working with leading energy generators to harness the power of CEP and analytics for better operational control of the grid and improved service reliability.**

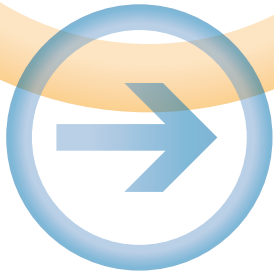
Generation Dispatch, we are working with our client to transform the process from a reactive to a proactive mode.

Our recognized leadership in high-throughput messaging makes TIBCO a natural fit for processing the large volume of real-time data produced by generation systems, market feeds, and advanced metering systems. Processing this data and turning it into real-time intelligence is where our complex event processing (CEP) technology is applied with rulebased, event-decision methods. Intelligence about events as they occur reduces operational errors which impact equipment performance and responsiveness to demand.

The primary benefits of the Generation Dispatch project are to increase efficiency in dispatch operations by reducing operational errors impacting performance or demand/ response scenarios. This leads to lower overall production costs. Other realized benefits include compliance with increasing government regulations geared towards threat detection and minimizing blackouts, brownouts, and equipment failures. An additional benefit is the reduction in training time and associated costs for new dispatch personnel, thanks to the capture of business rules and procedures in a rules engine.

TIBCO customers engaged in smart initiatives are already experiencing at first hand the benefits of improved control of meter roll-outs and protection of revenue by harnessing BPM. Improved customer satisfaction and retention rates can be directly attributed to customer switching mechanisms enabled by BPM and improved customer service and billing enabled by the seamless integration of consumption data with back-end applications. Powerful complex event processing technology is being applied by customers to analyze consumption patterns and service levels for sales and marketing purposes.

TIBCO is currently engaged in some groundbreaking projects with leading energy generators to harness the power of CEP and analytics for better operational control of the grid and improved service reliability. From being a key player in seamless integration of meter data with back-end systems across an enterprise service bus, TIBCO is helping utility customers today to implement core customer-facing processes essential to smart initiatives.



## 10. About TIBCO

**TIBCO Software Inc.** (NASDAQ: TIBX) is a provider of infrastructure software for companies to use on-premise or as part of cloud computing environments. Whether it's optimizing claims, processing trades, cross-selling products based on real-time customer behavior, or averting a crisis before it happens, TIBCO provides companies the two-second advantage™ – the ability to capture the right information at the right time and act on it preemptively for a competitive advantage. More than 4,000 customers worldwide rely on TIBCO to manage information, decisions, processes and applications in real time. Learn more at [www.tibco.com](http://www.tibco.com)



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