ORACLE SOLUTIONS
FOR SMART GRID
Technology and Applications for Your Utility’s Future
Around the world, utilities are under pressure. Citizens demand energy and water that won’t undermine environmental quality. Regulators seek action on Smart Grid and Smart Metering initiatives that add intelligence to infrastructure. Customers seek choice and convenience – but without additional costs.

Oracle can help.

We offer utility experts, mission-critical software applications, a rock-solid operational software suite, and world-leading middleware and technology that can help address these challenges. We understand the complexity around Smart Grid initiatives, implementations, and the unknown. Oracle provides flexible, innovative technology and applications that increase efficiency, improve stakeholder satisfaction, future-proof your organization, and turn information into power.

Our solutions address challenges in the four key Smart Grid areas:

1. Customer Technology (CT)
2. Operational/Electrical Technology (OT)
3. Smart Metering
4. Information/Data Technology (IT)

Whether your utility is looking for a stand-alone application to solve a business problem or a portfolio of solutions to address your entire initiative, Oracle is ready to partner with you today on your Smart Grid journey.
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ORACLE SOLUTIONS FOR SMART GRID
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What is a Smart Grid?

A Smart Grid for electricity is an intelligent, auto-balancing, and self-monitoring power grid. It accepts power generated from any source (coal, sun, natural gas, or wind) by a facility of any size or location—centralized or distributed. It then uses advanced sensors, state-of-the-art applications, and distributed computing to transport that electricity efficiently and cost-effectively, with minimal human intervention, to customers for their consumption.

Oracle Smart Grid Vision

Smart Grid projects are one of the most important of Utilities’ initiatives. They help utilities design, implement, and optimize the vision of a delivery infrastructure that connects electricity to customers through an information-rich network.
Smart Grid is an electricity infrastructure that leverages advancements in four key areas:

1. **Customer Technology (CT)**—Solar, distributed generation, renewables, electricity storage, smart appliances, and PHEVs.

2. **Operational/Electrical Technology (OT)**—SCADA, telecommunication, sensor, and control technologies, wireless control networks, mesh networks, distribution and substation automation, metering.

3. **Smart Metering**—a type of advanced meter that enables a utility to remotely collect meter data (usage and events) from customers in frequent intervals. Also referred to as Advanced Metering Infrastructure (AMI).

4. **Information/Data Technology (IT)**—Consumer energy management, home area networks/displays, enterprise back office applications, network management and analytics.

To some extent, Smart Grid is a vision toward which all parts of the electricity industry are working. There is neither a single set of requirements nor a single technology path to a Smart Grid. There is, however, an emerging understanding that Smart Grids will:

- Rely to the greatest extent possible on digital information and control, rather than on analog technologies or constant human intervention.

- Increase the amount of generated electricity ultimately delivered to customers through new materials and a wide variety of grid optimization tools.

- Accommodate:
  - Distributed generation, including variable generation from renewables.
  - Demand side management.
  - Advanced building control technologies.
  - “Smart” consumer appliances.
  - Centralized and distributed storage.
  - New applications such as widespread charging of electric vehicles.

- Provide all customers with appropriate levels of information and control options.

- Rest on standards that accommodate both regulated and competitive entities to deliver a wide variety of products and services to all parts of the economy.

Smart Grids offer customers advanced energy management options.
Smart Grids Offer Customers Advanced Energy Management Options

By working with utilities to implement and optimize Smart Grid projects that incorporate these characteristics, Oracle is helping utilities, retailers, and third-party service providers leverage advancements in Customer, Operational/Electric, and Information/Data Technologies as well as Smart Metering to:

- Optimize grid use.
- Improve grid efficiency and security.
- Better align demand with supply constraints and grid congestion.
- Enable distributed generation (especially from renewable sources).
- Empower customers to manage their consumption and take advantage of pricing and supply options.

Ultimately, Smart Grids will significantly enhance utilities’ ability to address major business drivers such as:

- Environmental and climate-change concerns.
- Power delivery constraints and disturbances.
- Emerging customer demands.
- Energy security.

Smart Grid Evolution

As the following illustration shows, not all of these technologies are new. In fact, Smart Grid evolution has been taking shape for the past 10 years. Smart Grids rely on information technology advancements across telecommunications and operations. Utilities apply these technologies both to grid operations—transmission and distribution wires and associated equipment—and to the customer site—meters, customer-owned energy technology equipment and appliances, and home area networks (HANs).
Overview: Oracle Smart Grid Solutions

Oracle offers the industry’s most complete set of solutions for handling Smart Grid business processes, including:

- A robust foundation of leading data handling and integration technologies—an enterprise information management (EIM) system—to handle the extraordinary increase in data processing/management that invariably accompanies every Smart Grid project.
- Business and utility-specific applications that address the many new business processes and programs that will emerge as Smart Grid reaches an increasing number of customers.
Building the Foundation: Oracle’s Data and Integration Solutions

Data Handling

Smart Grid brings with it an exponential growth in the amount of data that must be gathered, verified, stored, analyzed, and transformed in near-real-time for intelligent responses and decision support.

How Much Data?

- Moving from monthly to hourly consumption reads increases data-handling requirements more than 730 times.
- Using 15-minute intervals increases customer consumption data 2,920 times.
- Utilities will also want to collect Smart Meter data on amps, volts, watts, VARs, total-harmonic distortion, and momentary interruptions.
- Increase in intelligent sensors on the distribution network will further add to the increase in data about the state of the network.

Utilities must support Smart Grids with the additional processing power needed to:

- Continually assess power delivery and available feeder capacity.
- Analyze sensor data to mitigate feeder problems before they occur.
- Prepare bills that reflect and explain to customers the complex pricing models that encourage them to shift optional electricity use to off-peak hours.
- Manage rebates and incentive processes for customers purchasing and installing energy efficient equipment or feeding customer-owned distributed generation into the grid through net metering.
- Size the network to optimize available capacity and limit line losses.
- Provide near-real-time views of usage and costs that empower customers to make the best usage decisions for their situation.

1Smart Grid Basics, Turning Information into Power, An Oracle White Paper; May 2009
• Avoid data overload on downstream systems by managing information through distributed processing and report-by-exception messages to throttle events.
• Automate demand response programs—enrollment, event planning, notification, and analysis.

To meet these technology needs, Oracle offers:
• Oracle Database to capture increasing emphasis on network operational data.
• Oracle Fusion Middleware to:
  – Monitor activities.
  – Process events.
  – Provide security.
• Oracle Exadata for extraordinary speed in data processing.
• Oracle Spatial for mapping any application.
Integration

Smart Grids require integration among appropriate applications so that:

- Meters and intelligent sensors on the net distribution network act as grid nodes. This helps utilities identify outages, pinpoint outage locations, specify equipment causing the outage, and confirm power restoration.

- Customer-owned energy technology equipment and smart appliances respond individually to system disturbances and peak power conditions. This minimizes the potential negative effect of these conditions on customers.

- Transmission and distribution grids can use power from distributed generation and storage. Rooftop photovoltaics, advanced batteries, and plug-in hybrid electric vehicles (PHEVs) can contribute to supply. Related technologies like thermal storage for cooling or combined heat and power can also reduce peak and overall demand.

- Utilities can reduce dependence on more generation or power supply contracts. Smart Grids help limit the need for additional fossil fuel generation.

- Engineers involved in generation and transmission and distribution grid planning can leverage these technologies to improve utility planning.

To handle these requirements, Oracle has developed an integration structure that incorporates both enterprise information management and an advanced architecture, both of which rest on the principles of:

- Open standards.
- Pre-integration for critical applications.
- Flexible techniques that enable utilities to respond rapidly to changing situations.
Enterprise Information Management

To structure integration, Oracle uses Enterprise Information Management (EIM), an integrative discipline for structuring, describing, and governing information assets, regardless of organizational and technological boundaries, to improve operational efficiency, promote transparency, and enable business insight. EIM:

• Enables a business to take ownership, responsibility, and accountability for the improvement of data quality and information accuracy and consistency.
• Enables a business to establish a single version of truth for data over time.
• Improves business process and operational efficiency and effectiveness.
• Provides a strategy and technique to mitigate the risks as well as maximize the value of implementing commercial packaged applications.
• Reduces the number and effort of integration over time.
• Enables the control of unnecessary data duplication and proliferation.
• Enables a more flexible and scalable process integration.
• Improves the data quality, integrity, consistency, availability, and accessibility over time.
• Maximizes the return on investment of service-oriented architecture (SOA)-related technologies.
• Establishes a critical component of the Enterprise Architecture.

Oracle is committed to participate in and use utility industry integration standards such as CIM and MultiSpeak, helping utilities integrate Oracle solutions with non-Oracle applications and business processes.

Security

Providing prudent security to your Smart Grid is essential. Oracle Security Technology is unsurpassed in the industry, providing:

• Secure meters and data by enhancing AMI security and comprehensive meter data security.
• The ability to help streamline customer and employee care by implementing user, role and password management as well as enabling next-generation consumer energy portals.
• An agile architecture for compliance which helps reduce time and cost and aids in rapid adjustment to new regulations and mandates.
Architecture
Oracle delivers application integration via its Applications Integration Architecture (AIA), based on:

- Best Practice Processes that optimize business performance.
- Process Integration Packs—pre-built, out-of-the-box, integrated Oracle Applications for quick implementation of business processes, without the risk.
- Foundation Packs that create custom business processes across any applications, using predefined, application-independent object and service definitions.

All of these are powered by Oracle Fusion Middleware, the industry-leading, open standards-based platform.
Oracle Maximizes Applications Integration Architecture Value Through:

- **Direct Integrations** to support data flows between systems. Direct integration acknowledges that not all integrations need to be process integrations. Sometimes utilities just need a nightly batch upload or pure data synchronization between systems. Direct integrations support this type of requirement.

- **Process Integration Packs** (PIPs) that optimize pre-built, composite business processes across enterprise applications. These are designed for utilities that want to implement end-to-end processes, PIPs allow utilities to get up and running with core processes without having to build the entire integration from scratch.

- **Foundation Packs** that standardize common object and shared service libraries with supporting SOA programming models and best practice implementation methods. Foundation Packs form the supporting framework for PIPs. Using Foundation Packs, utilities can build their own custom integrations with Oracle’s “do it yourself” solution, bypassing such tasks as defining a common object model, architecture framework, or creating a service library.
Building on the Foundation: Oracle’s Smart Grid Applications for Network and Customer Business Processes

Network Business Processes

Smart Grids bring with them a host of new equipment with unique data generation and communications profiles, including:

- New telecommunications and operational (sense and control) technologies. These improve delivery performance and resilience.
- New sensor and control technologies. These, when combined with distributed intelligence, make it possible to report and resolve grid issues in real time (self-healing).
- Intelligent electronic devices for transmission and distribution. These alert operators to automatically respond to problems and accommodate additional generation from non-dispatchable renewables.
Customer Benefits

Smart Grid network business processes are not, of course, entirely new. Many see them as the next-generation of distribution automation. They aim not only to increase efficiency, but also to deliver specific customer benefits like fewer power outages, faster repairs, and proactive information delivery regarding service issues.

To ensure these benefits, Oracle’s Smart Grid portfolio includes:

- **Oracle Utilities Distribution Management**, which leverages real-time field sensors and controls to optimize grid operations for reliability, efficiency, capacity constraints, losses, voltage profile, etc.

- **Oracle Utilities Meter Data Management**, which collects, stores, and interprets data from smart meters and becomes the gateway between customers and grid operations.

Customer Business Processes

Smart Metering

In Smart Metering, an Advanced Metering Infrastructure (AMI) of interval meters and two-way communications systems serves as a gateway for utility/customer interaction. Smart appliances and near-real-time usage displays or messaging enable customers to participate in a variety of utility programs for conservation, peak demand reduction, load shifting, and carbon footprint reduction.

Smart Metering has the potential to reduce both customer and utility costs. It helps customers reduce overall use and better respond to price incentives. It reduces such utility costs as meter reading, turn-on/turn-offs, and contact center responses to bill estimations.

In a larger context, Smart Metering enables deferral of new electricity generation plants. It also helps utilities avoid building a new transmission and distribution infrastructure by reducing peak-demands and the related capacity constraints. That reduces not only the huge infrastructure costs but also such negative environmental effects of energy use such as greenhouse gas emissions and landscape-damaging transmissions.

In combination with technologies like in-home displays and smart thermostats, Oracle helps customers and approved third parties achieve energy savings using information from:

- **Oracle Utilities Meter Data Management**, for consumption updates and for delivering prices to devices.

- **Oracle Utilities Customer Care and Billing**, for information on the size of the bill and for services like prepayment and self-disconnect.
Oracle’s Smart Grid Applications for Network and Customer Business Processes

Conservation Programs
Oracle applications also address more advanced customer operations. For example, as utilities initiate programs that enable price-based demand response, they can turn to Oracle for help in managing all aspects of energy efficiency programs and enabling the back office functionality needed to forecast, manage, and settle electric vehicle load. Oracle provides this support through:

- **Oracle Utilities Customer Care and Billing**, which supports net metering and feed-in tariffs, marketing campaigns for recruitment and management of demand response and conservation programs, with unbundled billing capabilities. It also supports electric vehicles from component to track, measure, bill, and settle electric consumption versus supply, including “roaming charges.” Through the addition of **Oracle Utilities Meter Data Management**, Oracle supports interval-based tariffs, prepaid customers, to support prices to devices and to sell, lease, and service smart appliance and other energy efficiency equipment.

- **Oracle Utilities Load Analysis**, which supports the forecast demand and customer load modeling that help utilities eliminate excess or unneeded supply from their portfolios.

**And More**

- **Oracle Utilities Mobile Workforce Management**, Primavera, and Hyperion optimize resource use during the planning, scheduling, and installation of utility-controlled renewable devices like solar panels on homes and buildings.

- **Oracle Real-Time Analytics** control costs through accurate forecasts of the needed demand response volume and duration.

- **Oracle Complex Event Processing** ensures the smooth operation of demand response programs via support for two-way interaction with AMI and in-home devices for communication and control.

- **Oracle Utilities Outage Management** communicates maps and details of outages to customers. Working with **Oracle Business Intelligence** tools and Portals, Outage Management places real-time grid data onto interactive dashboards. With it, staff can undertake enterprise reporting, ad hoc queries, analysis, data mining, proactive notifications, predictive intelligence, and real-time decision-making. They can also disseminate appropriate extracts to customers and third parties like police and fire departments.
One large electricity distribution company in the American Midwest faced a series of common Smart Grid needs to:

- Aggregate and profile customer-level meter data quickly to obtain accurate consumption analyses and improved responses to changes in demand.
- Deploy a single, integrated system capable of forecasting, profiling, and aggregating meter reads within a short amount of time.
- Determine accurate and fair allocations of unaccounted-for energy within its territory.

A single application, Oracle Utilities Load Profiling and Settlement, enabled this utility to:

- Profile and aggregate data for more than 2.5 million meters in its service territory.
- Perform as many as 12 settlement runs in a 24-hour period, thus gaining the ability to balance an entire state territory (an approximately 10,000 Megawatt system) on an hourly basis.
- Eliminate unaccounted-for energy.
- Gain the flexibility required to adapt quickly to market changes.
Handling Large Data Volumes

One of the largest utilities in the U.S. has begun its march to Smart Grid with a Smart Metering program that will change once-a-month consumption reads to once-an-hour. Potentially, reads could occur once every 15 minutes.

To support the exponential data growth created by the Smart Meter program, this utility has worked with Oracle on creating a scalable, clustered configuration. The utility now depends on the Oracle technology stack—including Oracle Database, Oracle Real Application Clusters (Oracle RAC), and Oracle Grid Control—to run its data center.

With Oracle RAC, the utility can use smaller, more-efficient servers that offer excellent performance and scalability while handling 720 times the amount of data—and without forcing the utility to scale up to a massive mainframe.

And all of this technology wraps up to the utility’s use of Oracle Utilities Customer Care and Billing to ensure accurate billing amidst multiple rate changes and multiple programs to help customers get full value from the Smart Metering investment.

Solving Smart Grid Field Issues

A prominent Australian electricity delivery organization has solved a problem common to most utilities planning Smart Grid projects: how to provide a platform for designers and project teams to collaborate on engineering drawings. Oracle’s AutoVue enables staff in the company’s power transmission division to view 350,000 CAD-based engineering drawings that illustrate site plans and layouts of terminal stations and buildings exactly as they would appear in AutoCAD.

AutoVue provides users with the ability to access drawings from the company’s network or any location with Internet access. It enables design and project managers to digitally review and collaborate on thousands of engineering drawings. It also eliminates the need for contracted graphic designers to travel to the company’s office and download drawings, load them onto a CD, and publish them to the document management system.

The result: Reduced costs associated with mailing copies of drawings to internal staff and customers while improving efficiency—two important aspects of speeding the achievement of Smart Grid.
Implementing a Self-Healing Approach to Service Restoration

Another Australian utility is experiencing the advantages of a major step toward the self-healing aspect of Smart Grid: the Fault Location, Isolation, and Service Restoration (FLISR) capabilities of Oracle Utilities Network Management System. FLISR automatically:

- Senses trips (faults) in SCADA-controlled switches (i.e., feeder circuit breakers (CB) and downstream reclosers (ACR)).
- Identifies the faulted section using the telemetered Protection Trip and Fault Indication (FI) flags.
- Isolates the fault.
- Restores power to customers by automatically switching them to non-faulted sections of the line.

From the utility’s point of view, FLISR does not “fix” an outage. Outage Management predicts probable outage locations, and FLISR identifies the faulted feeder section. Crews must still verify the fault and make permanent repairs. FLISR helps minimize the scope of work and increases crew efficiency, but it does not eliminate human intervention.

From the customer point of view, however, there is only a brief, momentary outage. Customers in turn experience fast power restoration. They are unaware that it arrives through a different route, and its route is of no consequence to them. Customers see FLISR as a first step toward a self-healing grid – a grid in which coordinated automatic controls minimize outage durations and the number of affected customers.
**Microgrids**

Oracle is working with a major California utility to install one of the first working microgrids designed for use outside such major facilities as military bases or large industrial installations.

A microgrid is an autonomous electricity environment that operates within a larger electric utility. And this one will make far more efficient use of local, micro-site generation from renewables.

Microgrids are expected to be particularly useful in handling the demand that will be created by the growth of plug-in electric vehicles (PEVs), including plug-in hybrids (PHEVs). The expectation that such vehicles will remain parked at charging stations for longer than the time required to recharge them means that PEV load may better match the characteristics of intermittent generation from wind or solar. Managing intermittent supply and demand may be considerably easier if both are relatively isolated within a microgrid.
Oracle’s microgrid offering provides the intelligence needed to manage local, distributed generation and local demand via a Microgrid Controller that is in turn controlled by the Oracle Utilities Network Management System. The Controller links and controls all available sources of generation and storage within the microgrid.

Introducing storage into the microgrid may permit it to act relatively independently. Using electricity close to the source of generation has clear efficiency benefits; power is no longer subject to the 5 to 8 percent loss typical when it is transmitted more than 100 miles over 500 KV lines. Microgrids can also save capital costs by delaying or eliminating the need for additional transmission lines and corridors. They could also play a significant role in limiting the scope and duration of power outages by working within the grid context to reduce demand, add more generation, and undertake intelligent switching.
On the Horizon: Mitigating Grid Disturbances

As part of their Smart Grid initiatives, utilities will almost certainly develop programs to communicate with appliances on customer premises as a way to shorten power blackouts or avoid them altogether. Had such programs been in place in the eastern part of the U.S. in the summer of 2003, for instance, the region might have avoided a widespread blackout that cost the economy hundreds of millions of dollars.

If intelligent appliances and two-way communications had been in place at that time, grid operators could have avoided this situation by negotiating with the appliances to reduce demand or even turn off for brief periods, on a rolling basis. In cases of prolonged crisis, grid operators might assign appliances a specific ration of power, which customers could then trade with others, giving them the option to determine the value of scarce electricity to them and buy or sell it as needed.

Utilities will also use communication with appliances to help shorten power outages. Such communication could force major loads from pumps and air conditioners, requiring them to remain off until the faulted feeder is repaired, while still providing customers the power needed for lights and food refrigeration.

To develop such programs, utilities will need advanced applications like Oracle Siebel Customer Relationship Management (CRM) to help develop, test, market, and monitor the results of appliance communication programs. Siebel CRM can, for instance, test the results of offering various incentives to customers if they sign up for such programs and help utilities ensure that they are correctly balancing costs and results. Once customers have signed on, Oracle Utilities Customer Care and Billing will ensure that customers receive the appropriate incentives and comply with the terms and conditions of the program.
On the Horizon: Supporting Electric Vehicles

Electric vehicle (EV) market momentum is increasing. Many major car manufacturers have introduced highway-ready EVs since 2009.\(^1\)

Analysts foresee EVs’ winning 5-8 percent of automobile sales worldwide by 2020 and 15-20 percent by 2030. Analysts also anticipate a sharp increase in the number of vehicles fueled completely or in part by electricity.\(^2\)

Meeting the Challenge

Electric utilities will have the opportunity—and the challenge—to fuel these vehicles. Meeting that challenge requires utilities to answer many questions. A list of the most important would likely include:

- Can we restrict EV charging to off-peak hours, when base load is rarely used to the maximum?
- Should EV owners be required to use a time-of-use rate to ensure they limit peak-time recharging?
- Should utilities plan to encourage the use of EVs as storage, permitting them to discharge electricity back into the grid during times of peak demand?
- How should EV owners pay for recharging when away from home?
- Will EV recharging require additional infrastructure?
- Should a utility exercise control over recharging to ensure that not all EVs “plug in” at the same time and cause a system overload?

Oracle’s Smart Grid solution as a whole provides the robust architecture and data handling capabilities readily able to handle the addition of a major new and data-heavy market opportunity. A number of the individual applications within that solution (Oracle Utilities Customer Care and Billing, Oracle Siebel Customer Relationship Management, Oracle Utilities Meter Data Management, Oracle Utilities Rate Management, Oracle Complex Event Processing, and Oracle Utilities Load Analysis, among others) handle tasks like program development, marketing, processing, and evaluation in addition to the rigorous complex billing and metering processes vital to success.

Of particular note is the ability of Oracle Utilities Network Management System (NMS) to provide diagnostic and predictive capabilities related to EV refueling. The NMS Feeder Load Management (FLM) function addresses anticipated electricity flows as the number of EVs increases. It also addresses scenarios in which EV batteries feed back electricity into the distribution network. Additionally, NMS provides optimization capabilities that determine the best mix of energy resources required to handle changing neighborhood voltage requirements and to manage different neighborhoods as unique microgrids.

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Oracle Addresses Key Challenges

Our solutions address challenges in the four key Smart Grid areas:

1. Customer Technology (CT)
2. Operational/Electrical Technology (OT)
3. Smart Metering
4. Information/Data Technology (IT)

Oracle provides utilities with:

- Safe and reliable operations with exponential growth of data.
- Consumer interaction.
- Device management:
  - Device registry.
  - Device asset management.
  - Distributed intelligence.
  - Configuration management.
  - Operations technology governance.
- Integration of beyond-the-meter consumer energy technologies with grid operations.

The Oracle solution is evolving, keeping pace with customers’ and utilities’ emerging needs while also incorporating new technologies and refining best business practices. We have the solutions you need today to address a single business process, or a portfolio of technology and applications to address your entire Smart Metering or Smart Grid initiative.

Oracle’s focus on keeping ahead of the pace of change in the industry—globally and locally—assures utilities of all sizes, worldwide that Oracle is truly the Smart Grid Choice for your utility’s Smart Grid future.