GE Digital Energy

Real. Smart. Solutions.

End-to-end vision, technology and expertise to build a smarter grid. Today.

imagination at work

Building a grid that can do more with less: That's the power of GE.



GE smart grid solutions are redefining energy realities around the world. Our proven technology, focused innovation and unmatched expertise optimize end-to-end grid efficiency, reliability and flexibility. If there's an opportunity for improvement – from generation and transmission to distribution and consumption – chances are GE is already working on the solution.

The need for a smarter grid is critical. Growing worldwide energy needs demand viable solutions today – with the scalability to be ready for tomorrow. GE's smart grid initiatives integrate solutions for utilities, consumers and industrial sites. Our unparalleled experience and forward-looking invention touches every facet of the energy value chain.

GE can help overcome your power challenges and re-energize our planet's energy infrastructure to handle the demand of the next hundred years. Because we're building a reimagined grid with: ***Real. Smart. Solutions.***

Real. We've developed the technology, conducted the trials and proved the results. GE has smart grid products and services that can improve your performance today. They are real and running. Right now.

Smart. We've added intelligence, understanding and control improvements ranging from incidental through monumental. As a result, utilities, consumers and regulators all have better ways to manage energy usage and control costs.

Solutions. GE has a holistic smart grid vision. We're leveraging our unmatched resources and scope to design, build and integrate complete smart grid solutions. Our customers get a smarter grid, not merely smarter grid products.

Real. Smart. Solutions. GE is building them today.

A clear, compelling roadmap to success begins with GE.

What makes GE the smarter choice for smart grid solutions? Everything – GE has expertise across everything electrical. Nobody else even comes close to the breadth and depth of our real-world expertise. GE brings more than 110 years of experience building successful energy grid solutions to help you understand your status and plan your future.

It's not just the destination: GE can improve the journey. GE can help you set your direction for smart grid success. Our experience and thought leadership make it easy to follow this simple path.

Set goals. Considering regulations, your current equipment, economic factors and business issues, GE can help you create your roadmap with clear, measurable goals.

Know the available technology. Your GE smart grid team can help you understand what's real, what's vaporware and what's on the horizon, to help set your direction and fashion an overall improvement plan.

Execute to industry standards. GE is helping shape smart grid standards around the world, so we can help you choose solutions that are scalable and flexible.

Create a solid business case. Working to a clear value proposition with a stringent vetting process, we can help ensure your smart grid investment improves your operation in meaningful, important ways.

Your smart grid roadmap may run all the way from generation to consumption, with rich improvements every step of the way. Or you may need to focus on updating your distribution control. Or getting consumers on board to manage peak demand. Whatever shape your roadmap takes, GE's turbine-to-toaster experience can help get you where you need to be faster.

1. Understand generation needs
GE can help optimize your current generation capacity and assets, integrate centralized and distributed renewables, engineer microgrids and strengthen protection and control. So you can power more with less and be ready for tomorrow's ever-increasing demand.

2. Determine transmission and distribution requirements
GE has proven smart grid breakthroughs to monitor, control and optimize how you move power. Our industrial-strength communications and network management systems can help you understand and better manage loads. Diagnostics, visualization and control systems help prevent and minimize the effects of outages.

3. Architect a communications plan
Your grid can't be smart unless it communicates. GE can architect an end-to-end communications infrastructure, from generation through transmission and all the way into consumers' homes.

4. Monitor, optimize and analyze assets to extend their lives
GE's asset monitoring, diagnostics, energy management and control systems can maximize efficiency and help control costs across a facility. Sub metering and Time-of-Use reporting help you better understand operations and identify opportunities to improve.

5. Realize consumer benefits in individual homes and communities
Smart appliances, demand response control and dynamic pricing will help consumers optimize their energy spend. Energy portals and home automation will empower true consumer energy management. And smart meters will provide the functionality and communications to make it possible. GE can be your one resource to help do it all.

6. Integrate business systems
GE's systems integration and partner programs can develop intelligent business systems and processes for today, and for the needs of tomorrow.

7. Choose the right partners to deliver your Real. Smart. Solutions.
GE has the team, technologies and solution set to make your smart grid future proof. Our unmatched experience, talent, ongoing research and commitment to the future of the smart grid make us the right choice for your long-term success.

GE enables the smart grid
Our advanced, holistic solutions apply the performance gains of new technologies while extending the capabilities and life cycles of older investments. That helps you reduce risk and optimize performance – as you build the grid of tomorrow, today.

Generation-to-consumption tools, integrated to optimize the right solution for you.

The GE smart grid: Better from beginning to end.

GE's smart grid is an integrated solution set that can combine technologies and expertise from thought leaders throughout the world. On a city-wide basis, GE's solutions holistically support a geography's entire infrastructure network – from transmission and distribution to consumption and distributed generation. We see solutions in the framework of a complete picture that includes all utilities, consumers, businesses and the planet. And our commitment to open systems and standards means GE's solutions can integrate with virtually any technology on the grid. We truly connect everything from the turbine to the toaster.

Making renewable doable

Wind, solar and biomass generation are welcome additions to the smart grid. GE's **Renewable Energy** technologies enable easy integration of renewable energy just about anywhere along the grid. You get clean energy without congestion or capacity worries. GE renewable technologies can also help forecast renewable potential and store excess renewable generation – flattening out the inherent ups and downs of generation that relies on nature.

Generating flexible energy alternatives

Distributed Generation Connection and Optimization tools increase reliability through safe interconnections of wind, solar and other generators. GE's Microgrid Control System uses generator information to select the most-effective option available, while also controlling and optimizing the generation, storage and delivery of clean renewable energy.

Keeping a digital eye on the ball

Intelligent GE **Protection and Control devices** protect critical electrical equipment and ensure safe reliable power up and down the line. They continuously monitor system health, employing both predictive and early-detection tools. Disturbances are detected, analyzed, and handled instantly through controlled actions, such as fault isolation, load shedding, power restoration and alarming.

Smart Grid Facts

69 utilities in 16 countries – including the top three global utilities – use GE DMS/OMS systems to improve reliability.

Substations connecting like never before

GE's **digitized substations** enable utilities to define the performance requirements for their substations and create a standardized, proven configuration of power-control and information technologies to streamline substation construction, management and maintenance. You get predictable performance and real-time information exchange with centralized network systems. And you can build substations faster, more cost-effectively and with reduced risk.

Trimming delivery losses

Innovative solutions, like GE's **Volt/VAR technology**, can reduce energy waste by adjusting voltage and reactive power on distribution lines in response to demand from users. So you deliver a more precise level of power with reduced losses to meet real-time needs. Better understanding the true reactive power status frees up line capacity and reduces the need to invest in additional generation and substations.

Knowing what's up and isolating what's down

Outage Management Systems (OMS) restore power faster when unforeseen problems cause outages. Automated solutions, like Fault Detection, Isolation and Restoration (FDIR), determine the location of an outage, isolate it and then route power to minimize the number of customers affected. Smart OMS solutions can also determine the cause of the outage and dispatch properly equipped repair crews more efficiently – to get the power back on faster.

Stability over the long haul

GE's **EMS solutions** keep the power flowing efficiently and reliably through transmission lines. Wide Area Monitoring Systems (WAMS) synchronize phase angles to maximize line capacity and maintain stability. With more accurate condition understanding and management, we help you stop potential problems before they occur and prevent catastrophic cascading outages. Smarter software uses capacity knowledge to flexibly integrate clean power from concentrated solar facilities and large wind plants.

Transforming efficiency and reliability

A smarter grid means more efficient **transformers** and a smarter way to track aging assets throughout your grid. New amorphous transformers use GE technology to slash no-load losses and increase the efficiency throughout your delivery system. GE's Asset Optimization technologies monitor the health of older transformers. Using physical performance characteristics to identify assets at risk, you can make repairs or replace transformers before they cause outages.

650,000 of the world's critical electrical assets – generators, transmission lines, motors – are protected by GE's Multilin devices.

GE's energy-saving amorphous technology is reducing waste in millions of transformers throughout the world.

A cityscape of capabilities and control

GE's smarter **Distribution Management System (DMS)** gives grid operators decision-support capabilities to maximize system efficiency, identify troubled assets and improve network performance and reliability.

Power to the people

GE's **Wide Area Protection** prevents and minimizes power outages. Our solutions detect outages and automatically reconfigure the system to restore power. Secure high-speed communications networks share real-time information and direct operations to either intelligently shed load or to identify and access additional generation. In the end, networks and people make the right decisions to keep the power on to more people more often.

Managing man-hours

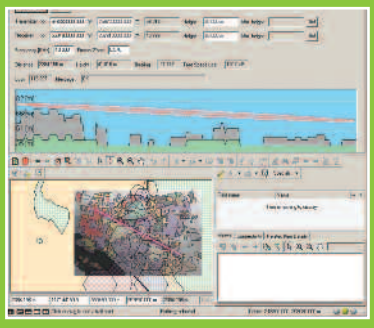
Field-force automation solutions help crews in the field and dispatchers at the control center maintain, repair and service the grid more efficiently – from routine service orders to outage restoration activities.

The power to control demand

Demand response solutions combine smart meters, smart appliances, traditional appliances, home automation and heating/cooling controls to dial down demand during peak times. GE demand response helps keep expensive peaking generation offline and reduces the need for new generation.

A true view from the top

Geospatial asset management systems give network operators a geographic inventory of assets and a detailed, accurate model of the T&D network. So you know the status of current equipment and you have a trusted basis for designing extensions to the network and planning grid upgrades.



Our engineers know how to communicate

Delivering the wireless or wired **primary communications networks** for utilities, GE's high-speed, high-bandwidth solutions are the enabling technologies that make a real-time, information-rich smart grid possible. From secure, long-distance wireless networks, including WiMAX solutions, to multi-service fiber optic multiplexors and rugged Ethernet switches, GE customers experience rich, reliable communications.

- Over 100 utilities, servicing over 1.3 billion consumers, trust GE EMS technologies for managing transmission networks.
- More than 1,000 companies in 40 countries rely on GE's geospatial technology and advanced engineering applications for network design.

The power to understand

Energy information and control can be vital elements in a smart home automation hub. PCs, home energy panels and mobile devices can deliver real-time information to guide and enable immediate household energy decisions. Utilities can even share real-time pricing information so consumers can understand the true, minute-to-minute cost of power. Automation hubs can also interact with lighting, appliances and heating/cooling systems to manage a household's total energy usage.

Meters that "read" customers

Smart meters with Advanced Metering Infrastructure (AMI), coupled with dynamic pricing, can teach consumers to modify their energy-use profiles, saving money and shifting high-energy-consuming activities to lower-demand times. Now a meter shifts from being a simple reporting device to becoming a powerful influencing device. GE's meters are communications-neutral, working with whatever protocol utilities choose.

Appliances that know better

Smart appliances receive signals from smart meters that determine how they operate. During peak periods, they can change modes or put off high-energy-consuming activities to times when more energy is readily available and costs are lower. Consumers can maintain their lifestyles with little or no disruption, while lowering energy costs. Utilities get lower peak-demand loads and increased consumption during low-demand periods – generating revenue from otherwise idle grid assets.

(PHEVs) Plug in, take off

Plug-in Hybrid Electric Vehicles will connect with smart-metered homes to make electric transportation practical and affordable. Dynamic pricing can encourage charging at night and give utilities a revenue stream for fixed assets that are otherwise lying idle.

From device to enterprise, GE has over 300,000 data management installations.

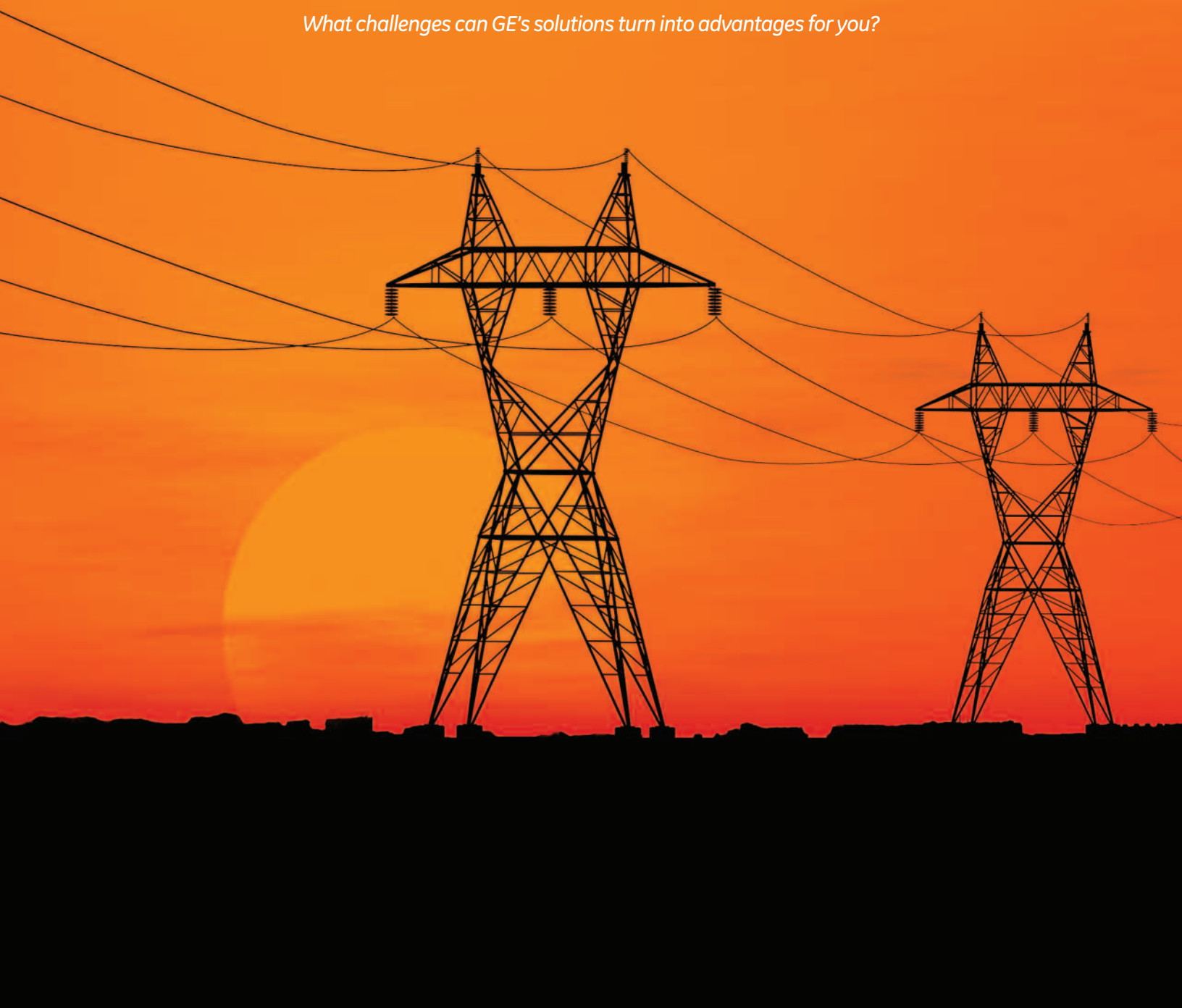
Millions and millions of GE smart meters are installed and preconfigured to accept new technology breakthroughs throughout the world.

Whether you're powering a city, a country or an industrial plant…
Moving power is about more than stringing cable.

GE solutions move energy around the globe.
Much of the planet's electricity is generated, delivered or consumed using GE solutions. With 110+ years in the energy industry, we're uniquely positioned to understand how the challenges of electrifying the world are different today, and changing for tomorrow. Whether it's transmission lines or smart-home technologies, GE's solutions, leadership and industry collaborations can help modernize your slice of our planet's electrical infrastructure – and turn challenges into advantages.

Real powerful solutions come from applying technologies, building synergies and redefining realities to improve the performance, reliability and efficiency of your electrical system. It's the smarter way to the smart grid – that's working with GE solutions around the world.

What challenges can GE's solutions turn into advantages for you?



More energy challenges from generation to consumption.
More energy solutions from GE.

Challenge: Power interruptions drag down the economy and disrupt our lives.

Real. Reliable. Solutions.

Power interruptions cost European Union businesses €150 billion each year.[1] Outages cost the U.S. economy an average of $1.5 billion each week – $80 billion, with a 'B' each year.[2] They cost utilities in penalties, repairs, overtime and customer service. GE's smart grid technologies deliver dramatic reliability gains.

With smarter networks, focused maintenance, better understanding and greater load control, you have what it takes to prevent outages. There are technologies to anticipate and prevent problems before they happen. And when unplanned outages do occur, smart grid outage management systems can reroute power to minimize the outage, analyze needed repairs and dispatch crews more effectively to get the job done faster and more efficiently.

It's Working:

When Great Britain's Office of Gas and Electricity Markets introduced a Quality of Service Interruptions Incentive Scheme, EDF™ Energy leveraged its GE Distribution Management System (DMS) to cash in on the program's incentives and avoid paying penalties. EDF Energy, one of the UK's largest energy companies, worked with GE to create automatic fault isolation and rerouting schemes that utilized the DMS hardware and software already in place. As a result, fewer consumers are affected by outages and service is restored faster. The system resulted in a 20% reduction in customer interruptions and a 30% reduction in customer minutes lost in the first 18 months of operation. The cash payoff? EDF received a regulatory performance reward of over £1 million.

[1] Study conducted by Jonathan Mason for ECI.
[2] Study conducted by Lawrence Berkeley National Laboratory (Berkeley Lab) for the U.S. Department of Energy's Office of Electric Transmission and Distribution.

Challenge: Inefficiency and the need for overcapacity waste money and resources.

Real. Efficient. Solutions.

The grid is wasting energy at every point during every second of every day – lots of energy. And that costs lots of money. The cost of generating a kilowatt-hour of electricity is 70 to 170 times the cost of "saving" a kWh through efficiency. GE's smart grid technologies help reduce the flow of lost energy and wasted money. We have solutions that help lower delivery losses in transmission and distribution, and technologies that anticipate and monitor demand to help you minimize overcapacity. In the end, consumers and businesses actually use more of the power you bring into the system.

It's Working:

AEP™ (American Electric Power Co., Inc.) is addressing the waste and inefficiency factors designed into our power delivery model. Utilizing GE's Coordinated Volt/VAR-Control (CVVC) system, AEP is dynamically controlling voltage and power factors on feeders to minimize losses and reduce customer energy consumption. By maintaining power factors near unity, AEP is reducing reactive power loading. They're applying more real power and lowering reactive power waste – all while maintaining customer service voltage standards. The bottom line? AEP needs to generate less power to meet the same consumer demand.

Challenge: Our energy workforce and infrastructure are both fast approaching retirement age.

Real. Productive. Solutions.

More than 50% of grid assets are at or approaching the end of their usable life. In the next 10 years, 50% of the grid's skilled workforce will retire – with a critical shortage of replacement workers. GE's smart grid productivity solutions help on both fronts. Asset monitoring, management, maintenance and optimization solutions can keep capital-intensive grid assets on the job beyond their intended lifetimes. Workforce management and field force automation solutions use advanced analytics, communications and geospatial technology to apply human resources more efficiently and effectively.

It's Working:

Eneco,™ one of the Netherlands' leading utility companies, is using GE Energy's Field Force Automation (FFA) solutions to increase productivity in its Joulz division – including 500 field workers who provide construction, maintenance and operations services on distribution grids. Since the introduction of GE's FFA solutions, Eneco has reported outstanding results, including significant productivity improvements for office personnel and field workers. Yearly inspections are now completed by March instead of December and maintenance work previously completed around year-end is now completed around September. The initiative has delivered an additional benefit not originally anticipated: Significantly increased revenue from more accurate billing and invoicing.

Challenge: The current formula for powering our planet is also a formula for changing its climate.

Real. Clean. Solutions.

Climate change is going to lead to economic change. Because today 40% of the planet's CO_2 emissions come from power generation. By 2020, Europe has committed to cutting its greenhouse gas emissions by 20%, producing 20% of its energy from renewable sources and increasing energy efficiency by 20%. As carbon legislation becomes reality, GE smart grid customers will have an advantage. Our efficiency technologies reduce waste in the system. And we can help optimize renewables to add more clean wind, solar and biomass in the generation mix – enabling more domestic clean energy sources. That means less reliance on the volatility of imported fuels and greater energy independence and security. You get a world of advantages for a carbon-constrained world.

It's Working:

The Hawaiian Islands are aggressively moving from their 80%-fossil-fuel-dependent energy generation to more renewable, carbon-free solutions. GE is working with the U.S. Department of Energy, Hawaii Natural Energy Institute, Maui Electric Company and Hawaiian Electric Company to deliver smart grid solutions that will help see 40% of Hawaii's electricity coming from clean renewable energy sources by 2030. Hawaii's holistic solution deployment includes the demonstration of increased solar and wind integration features through GE's Distribution Management System. The deployment is also rolling out technology breakthroughs in energy storage and other renewables–integration features to maximize the usable energy from Hawaii's vast renewable resources. At the same time, GE will demonstrate peak load management with Demand Response systems and Volt/VAR technologies to reduce the need for peaking generation and help manage the integration of wind and solar power. The project is looking to reduce peak load in a substation by 15% and help enable higher penetrations of renewable energy in Maui.

GE engineers sound, dynamic, worry-free solutions.
Unmatched domain expertise delivers more than superior engineering.

Unmatched domain knowledge to assemble needs-based solutions.
GE's approach to the smart grid is simple: Find what works best and do it. We are continuously developing innovative products, cultivating new partnerships and seeking smart entrepreneurs to join the cause.

GE's global research centers employ industry authorities and proven research rigor in a concerted effort to continuously find better ways to deliver energy. With a commitment to open systems and enabling standards, GE people are bringing unparalleled experience, talent, tenacity and technology together to build complete smart grid solutions.

Challenge: Consumers are in the dark about the consequences of their energy usage.

Real. Consumer-Empowering. Solutions.

For the first time in the 100+ years of an electrified world, consumers can finally understand how their habits directly affect their energy consumption. And it makes a difference. A number of international studies have shown that real-time smart grid pricing information changed consumer behavior, helped reduce household electricity costs by up to 10% and lowered peak-time consumption by 15%. With information portals and in-home devices, GE's smart grid shows consumers how they can take control of their energy usage without sacrificing lifestyle.

It's Working:

Louisville, Kentucky consumers are improving their energy profiles without sacrificing lifestyles. GE smart appliances in homes equipped with GE smart meters are helping consumers understand their energy use and make decisions that save energy and money every day. Smart appliances are also lowering peak power demands by moving high-energy-consumption activities, such as freezer defrost cycles, to off-peak times.

Challenge: A roller coaster of load demand means huge investments in capacity that's hardly ever used.

Real. Load-Smoothing. Solutions.

As energy demand continues to grow, so will the need for investment in peaking resources that are rarely used, yet need to be available. That contributes to skyrocketing energy costs – between 2000 and 2007, electric rates increased an average of 42% in the U.S. and 105% in the UK. With worldwide energy demand forecasted to double by 2030, it's only going to get worse. GE is smoothing the demand peaks and valleys with demand response solutions, consumer empowerment tools and voltage-reducing Volt/VAR technologies to lower peak demand and better manage loads around the clock.

It's Working:

The world's largest Marine Corps base uses GE's smart microgrid to handle on-site power generation and energy storage, while simultaneously interacting with the local electric grid. Advanced network control and communications smooths load requirements by lowering peaking demand and integrating power from the grid and onsite storage as needed. The solution also enhances the base's ability to add renewable resources, shrinking its carbon footprint and increasing its energy independence.

Real. Smar

Challenge: Communications technologies that power the smart grid cannot be vulnerable.

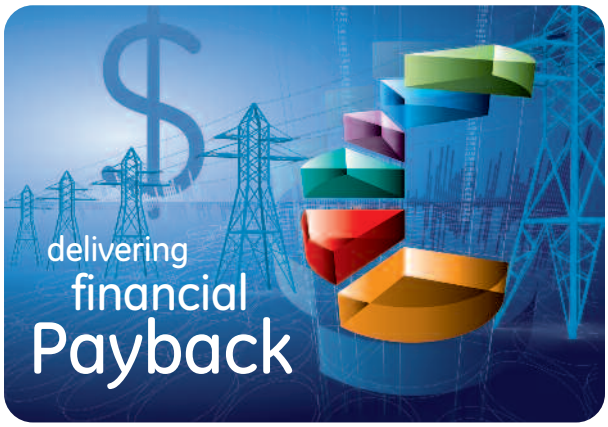
Real. Secure. Solutions.

Moving information is as important as moving power in the smart grid. GE has made the securing of private fiber optic, wireless and Ethernet communication networks a cornerstone strategy to aid in eliminating cyber risks. We're actively involved with the National Institute of Standards and Technology (NIST) initiatives to standardize and optimize smart grid security. We work with the world's leading IT security experts to design systems that resist outside influences, detect tampering and follow strict protocol – to keep information and energy flowing safely. And GE is employing technology and protocols to help ensure data transmitted across the smart grid remains private.

It's Working:

CenterPoint® Energy in Houston, Texas, relies on GE's cyber-security-enabled WiMAX wireless radios, engineering services, and technical support for its Advanced Metering System communications network that connects meter collection devices to CenterPoint Energy's private network. This rugged, secure, two-way communications solution uses 128-bit encryption to protect data in transit and an array of authentication tools to secure data at points throughout the network. GE gets the right data to the right destinations without interception, misdirection or tampering.

Challenge: Before making an effective business change, you need an effective business case.



Real. Financial. Solutions.

A grid isn't really all that smart if it doesn't make financial sense. GE's smart grid solutions deliver payback in efficiency, reliability, capital-cost reduction and asset utilization. We also have the financial resources and financing solutions to help throughout your smart grid deployment. So you have smarter ways to pay for the solutions that help you:

- Maximize your assets' productive life cycles
- Lower labor costs
- Reduce the need for new equipment
- Even the peaks in demand for power, so you maximize the use of generation
- Solve problems with maintenance instead of repair

It's Working:

Financial benefits of smart grid technology are wide-ranging and significant. Here are a few of the gains smart grid communities can expect:

- Improved maintenance and asset management lengthens asset life and defers capital expenditures
- Efficiency gains result in more of the power generated being consumed by paying customers
- Load leveling reduces the need for new generation while shifting consumption to non-peak times – maximizing the profitable capacity of current assets
- Field Force Automation increases worker productivity, speeds repairs and reduces downtime

t. Solutions.

Communities with efficient, reliable energy resources will be the communities that thrive in the 21st century. They'll have the power to attract business and industry. They'll have better jobs for a higher-skilled, higher-paid workforce. They'll have more potential to fund the extras that make a society thrive.

GE's smart grid is an economic engine for communities and utilities. It helps you do more with less – from equipment repair and maintenance to dispatching workers in the field. And, as the utility workforce reaches retirement age and replacing workers becomes more challenging, you'll have systems in place to adjust to changing realities without jeopardizing performance.

The bottom line?
You get new ways to maximize the revenue from all your assets.

The smart grid is an economic engine. For everyone.

Technologies, People, Commitment, Proven Deployments, Worldwide Resources.

More energy solutions from GE.

GE is working to change the world

The worldwide community needs to change the way it regulates utilities and power distribution. GE is working to help.

Through education and outreach to regulators, governments and organizations worldwide, GE is advocating a re-examination and restructuring of how utilities are overseen and regulated. Current thinking was developed for the current grid – neither is up to the job at hand anymore.

Setting the standard – literally

The smart grid's new transmission and distribution technologies need new, uniform, performance-based standards. GE is taking an active role on standards committees and governing boards throughout the world. We're lending our experience to help make standards practical, attainable, safe and affordable.

As a major standards influencer, GE's smart grid solutions are designed to be in line with performance and compliance requirements being created worldwide.

There's never enough innovation to satisfy us

While everyone at GE is certainly proud of our invention and leadership, we're also smart enough to know that we don't have a lock on innovation. And, we don't want one. The best way for the smart grid to grow and thrive is with new ideas and better products being developed all the time.

GE advocates a smart grid built on open systems to encourage ongoing innovation from companies large and small, everywhere in the world. It's everybody's smart grid, and we believe open systems should keep it that way.

Open to collaboration

The name you trust for objective performance across the smart grid is GE. We're committed to bringing you the right solutions for your grid performance – even if they're not GE solutions. So, we openly collaborate with other technology companies to integrate products and streamline solutions. Because it's all about working smarter.

Building the grid for the next 100 years

GE has been in the power grid business since day one. We're proud of that accomplishment. And, we're proud of the advances our technology has brought to light in parts of three centuries. Today, we stand ready to build the smart grid foundation for the next century of power transmission and distribution. It's a commitment that helps complete the GE smart grid advantage.

Real. Smart. Solutions.

The smart grid is here. All you need to get started is a smart conversation with GE. We're building it today.

Ready to optimize the reliability, efficiency and performance of your grid? GE has the real smart solutions you need to do more with less today. Here's how to find out more:

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imagination at work

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