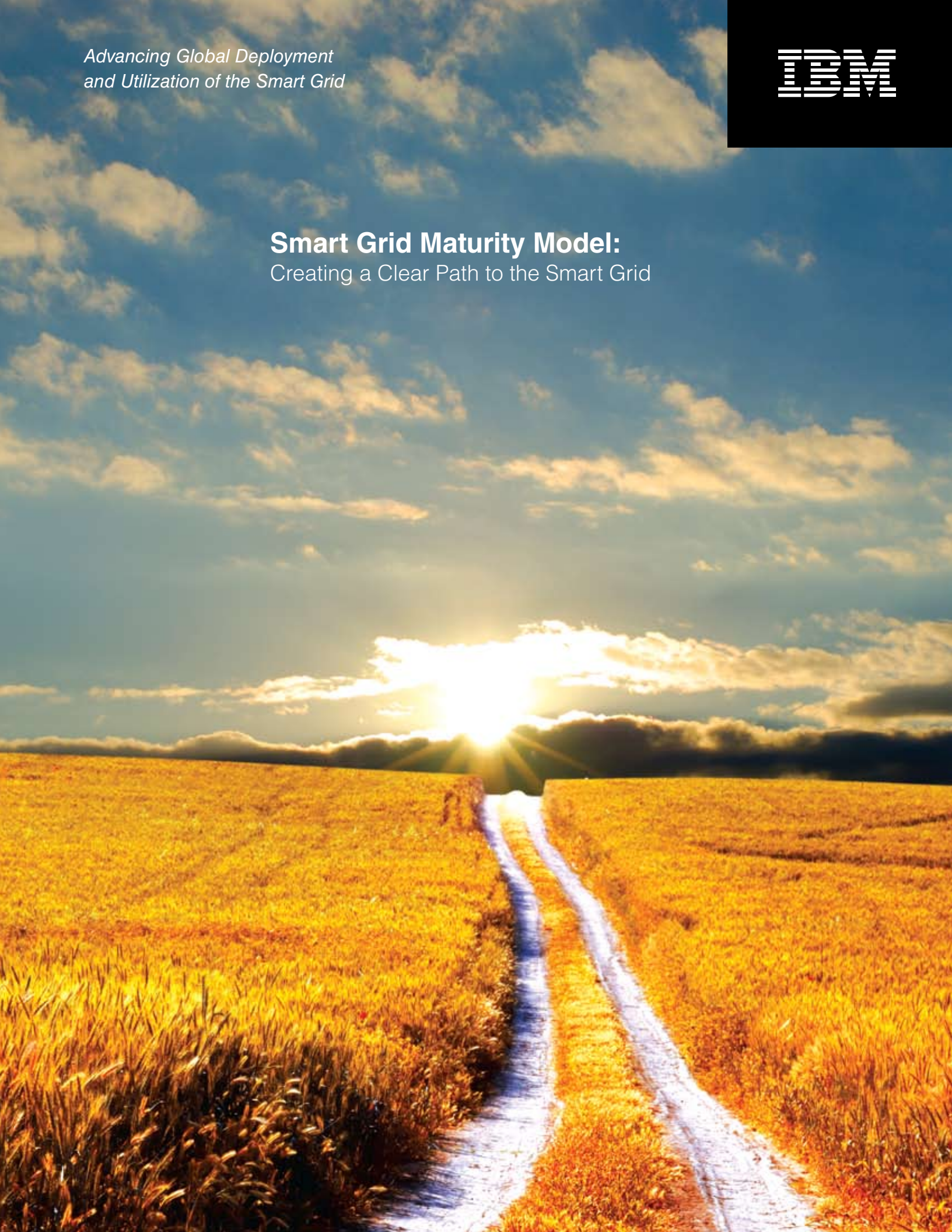
Advancing Global Deployment and Utilization of the Smart Grid

IBM

Smart Grid Maturity Model:
Creating a Clear Path to the Smart Grid



The Age Of Smarter Energy Is Here

Around the globe, progressive utilities see the inevitability of adopting a smart grid to modernize the power grid. More than meters and mobility, the smart grid represents a whole new framework for improved management of electric generation, transmission and distribution.

Few question that traditional power grids are showing their age. Rising energy costs, aging network assets, an aging workforce and regulators are putting pressure on utilities to become even more operationally efficient. The convergence of environmental pressures, the demand for alternative energy sources and financial expectations requires a new level of enterprise information and integration.

In many developed and emerging economies, getting a smart grid up and running cannot come soon enough.

By 2010, nearly 60 "mega-cities" worldwide—most of these in emerging markets—will have populations of five million or more, up nearly 50 percent since 2001. Governments, regulators and utility companies need to ensure that these mega-cities will survive under the crush of demand for access to affordable power.

Smart Grid Maturity Model – Levels, Descriptions and Results

Level 5: Innovating – Next Wave of Improvements		New business, operational, environmental and societal opportunities present themselves, and the capability exists to take advantage of them.	***Perpetual Innovation*** *Self-healing operations* *Autonomic business* ***Innovators***
Level 4: Optimizing – Enterprise Wide		Smart Grid functionality and benefits realized. Management and operational systems rely on and take full advantage of observability and integrated control across and between enterprise functions.	***Transformation*** *Real time corrections* *Broad reuse* ***Victors***
Level 3: Integrating – Cross Functional		Smart Grid spreads. Operational linkages established between two or more functional areas. Management ensures decisions span functional interests, resulting in cross functional benefits.	***Systemization*** *Repeatable practices* *Shared information* ***Cross LOB Champions***
Level 2: Functional Investing		Making decisions, at least at functional level. Business cases in place, investments being made. One or more functional deployments under way with value being realized. Strategy in place.	***Strategy*** *Proof of Concepts* ***Missionaries***
Level 1: Exploring and Initiating		Contemplating Smart Grid transformation. May have vision, but no strategy yet. Exploring options. Evaluating business cases, technologies. Might have elements already deployed.	***Vision*** *Experiments* ***Prophets, Heroes***

Getting From Here To There

Building more traditional utility grids is not the answer. Most countries today are looking for new and more efficient ways to improve in their energy generation and distribution.

By contrast to traditional grids, smart grids add intelligence throughout the grid to improve system reliability and efficiency, improve management of supply and demand, optimize operations and streamline costs. The infusion of digital intelligence also enables integration of traditional and new sources of power and their applications — wind, solar, plug-in hybrid electric cars and so forth — providing end-to-end insight across all forms of energy. In the process, smart grids will make possible greater levels of repeatability, reliability and security.

Consumers will be able to interact with the smart grid in multiple, convenient ways as well. For instance, they may be able to select new services and pricing options, and gain near real-time visibility into their usage and costs. The smart grid helps consumers make "smart" homes and energy-conscious choices possible.

But how do we get from here to there — from today's conventional power grid to tomorrow's cleaner, more efficient smart grid? Increasingly, executives of utilities know that transformation to the smart grid is the right thing to do. But many remain unclear as to how to manage the transformation — and where to begin.

Enter the Smart Grid Maturity Model

The Smart Grid Maturity Model is a methodology that creates a road map of activities, investments and best practices that leads to creating a smart grid. The Maturity Model can be used to establish the smart grid journey, to communicate vision and strategy, and to assess current opportunities, choices and future goals.

The Smart Grid Maturity Model can be used as a strategic framework to develop business cases and explicit plans to move forward. It uses observable indicators to measure progress. Ultimately, the Maturity Model helps you move in an orderly fashion through the maze of challenges in a smart grid transformation—from technological to regulatory to organizational.

The Smart Grid Maturity model was developed by IBM in collaboration with the Global Intelligent Utility Network Coalition, which includes leading utilities from around the world, and with support from APQC (American Productivity & Quality Center). The intent for the model is to stimulate, guide and support a utility's own efforts and investments in smart grids. The more widely the Maturity Model is adopted and used as a tool for measuring and sharing best practices, the more benefit it will bring to all participants, the industry and the planet.

Therefore, in 2009, IBM and the Global Intelligent Utility Network Coalition handed over the Smart Grid Maturity Model to Carnegie Mellon University's Software Engineering Institute (SEI). To stimulate, guide, and support efforts and investments in smart grids, the SEI will assume primary responsibility for the ongoing governance, growth and evolution of the model. In order to support widespread adoption and use, the SEI will ensure availability of the model and supporting materials and services for the user community; maintain consistency of its application, validity, and results; and analyze and provide feedback on its use, value and impact for stakeholders.

In addition, the World Energy Council (WEC) will be a channel for global dissemination, participation and adoption of the model using its worldwide network of member committees. Together, they will lead the Smart Grid Maturity Model activities globally to support the transformation of the utility industry.

> *Using the Smart Grid Maturity Model, IBM can help you implement top-to-bottom processes and technologies and guide you on your path to the smart grid.*

It All Begins With A Vision

The Smart Grid Maturity Model—essentially a matrix of almost 200 outcomes, capabilities and benefits, plotted and tracked in various work domains—progresses through five levels of maturity. Not every utility will need, or want, to go to the last level. Depending on their situation, a utility can select which level is optimal for their smart grid vision. Level 5 for example perpetuates innovation into new frontiers of the energy business. Before you go there, let's start at the beginning.

Level One: Vision
Having a vision of your smart utility, and how your business and customers ultimately benefit, is the critical first level of the Smart Grid Maturity Model. At this stage, you may not have a strategy to realize that vision, but it's a time to explore options, evaluate business cases and technology, and access which elements you have already deployed.

Level Two: Strategizing for Investing
Getting a strategy in place for investing is next. At this level, you make decisions, at least at a functional level, regarding the way forward. With business cases developed, investments are made on one or two functional deployments—with value being realized.

Level Three: Integrating Across Operations
Now your smart grid program starts to spread. Operational linkages are established between two or more functional areas. Management decisions span functional interests, resulting in benefits ranging from shared information to repeatable practices.

Level Four: Optimizing Enterprise Wide
Real-time corrections and broad reuse of systems and information are transformative when compared to the old analog grid. Smart grid functionality and benefits are being realized in powerful new ways—from end-to-end observability to real-world aware systems to environmental score keeping and reporting.

Level Five: Perpetual Innovation
New business as well as operational, environmental and societal opportunities present themselves, and the capability now exists to take advantage of them. Self-healing and autonomic, your utility is in a perpetual state of readiness to respond (and innovate) on a dime.

> *Tom Standish, group president of Regulated Operations, CenterPoint Energy, encourages every utility to participate in the Smart Grid Maturity Model survey. "It provides insights into where you are on your smart grid journey and what milestone objectives to set to achieve the benefits of smart grid—for both customers and business," Standish said.*

Utility Domains Impacted by Smart Grid

With this general progression of the "levels of maturity" in mind, let's take a look at the eight domains in your utility that are impacted by the changes brought about by the smart grid transformation.

People and Technology Domains:
The core business areas that are most affected in a smart grid transformation.

Strategy, Management and Regulatory
The mission, vision, strategy, and how it is managed must be fully integrated in order to guide the way to a smart grid. By the end of the process, you've created an open environment for new business opportunities. You've also optimized systems, resulting in likely favorable treatment for regulatory policy.

Organization
For a smart grid to be successful, the organizational structure must promote and reward cross-functional planning and operations, but still allow for empowered decision making. In doing so, the organization flattens, which helps to drive a culture of innovation and integration.

Technology
A cohesive technology strategy must connect and support the innumerable data sources and users that make up a smart grid, today and into the future. Eventually, the smart grid establishes a common architectural framework, which allows you to optimize processes across the board via near real-time simulation and analytics. Automated data flows—from the customer via automated metering and the power generation side, for example—streamline your entire business model.

Societal and Environment
A smart grid allows a utility, and society, to make choices and take advantage of energy alternatives and efficiencies, regarding both production and consumption. In this domain, the utility establishes a path to actualize the "triple bottom line"—addressing financial, environmental and societal issues at once.

Process Domains:
The four process areas most affected by a smart grid transformation.

Grid Operations

A holistic smart grid is based on a solid core foundation of intelligent grid components (such as sensors and actuators) and operational design. Use of technology and automation is fused with enterprise processes. One way in which the smart grid could impact the operation is by delivering ubiquitous and dynamic control system-wide.

Work and Asset Management

When operating and maintaining assets is based on up-to-date, fact-based performance data, the utility moves from a preventative maintenance model to a predictive and self-healing model. This is a huge leap forward in optimizing the use of equipment and people.

Customer Management and Experience

Through the smart grid, the customer becomes empowered to make their own choices regarding their use and cost of energy. Customer care, pricing options, advanced services, outage detection—the smart grid makes the utility more responsive to the customer.

Value Chain Integration

Extending automation beyond traditional boundaries and across the entire value chain opens opportunities for innovation and efficiencies. Ultimately, the smart grid helps coordinate energy management and generation across the supply chain, driving down costs.

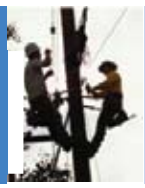
What is the Intelligent Utility Network?

The Intelligent Utility Network is IBM's solution for the smart grid. It encompasses a broad set of offerings that address the complete energy value chain, from power generation to consumer premise. The Intelligent Utility Network fundamentally is an information network which connects together the 'participants' in the energy value chain, at multiple levels, and enables the intelligent flow of information which can be used to transform and optimize their respective roles in the regulation, generation, supply and consumption of electricity. The Intelligent Utility Network is the information management component of the smart grid.

Putting the Smart Grid Maturity Model Into Action

DONG Energy is Denmark's largest energy company, formed in March 2006 by the merger of six diverse companies in the fields of electrical and gas distribution and sales, power generation, and oil and gas exploration. An energy company in the truest sense of the word, Dong is also an innovator, now running pilots in wind energy to power electric vehicles.

Like many electrical distribution companies around the world, Dong is moving through a transformation from a conventional energy model to one that takes advantage of alternative and traditional energy sources. These companies face similar challenges in integrating renewable energy into their business models, from managing innovation to the daily challenge of relieving stressed-out grids.

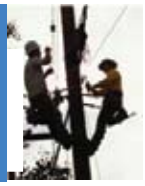
SG/MM *The Smart Grid Maturity Model*	**Strategy, Management & Regulatory** *Vision, planning, decision making, strategy execution and discipline, regulatory, investment* 	**Organization & Structure** *Communications, culture, knowledge management, training and education* 	**Technology** *Information, engineering, integration of information and operational technology, standards, and business analytics tools* 	**Societal & Environmental** *Conservation and green initiatives, sustainability, economics and ability to integrate alternative and distributed energy* 
Level 5: Innovating – Next Wave of Improvements 	• Overall strategy expanded due to SG capabilities • Optimized rate design/regulatory policy (most beneficial regulatory treatment for investments made) • New business model opportunities present themselves and are implemented	• Collaboratively engage all stakeholders in all aspects of transformed business • Organizational changes support new ventures and services that emerge • Entrepreneurial mind set, Culture of innovation	• Autonomic computing, machine learning • Pervasive use and leadership on standards • Leader and influence in conferences and industry groups, etc… • Leading edge grid stability systems	• Actualize the "triple bottom line" — (financial, environmental and societal) • Customers enabled to manage their own usage (e.g. tools and self-adaptive networks) • Tailored analytics and advice to customers • Managing distributed generation
Level 4: Optimizing – Enterprise Wide 	• SG drives strategy and influences corporate direction • SG is a core competency • External stakeholders share in strategy • Willing to invest and divest, or engage in JV and IP sharing to execute strategy • Now enabled for enhanced mkt driven or innovative regulatory funding schemes	• Integrated systems and control drive organizational transformation • End to end grid observability allows organizational leverage by stakeholders • Organization flattens • Significant restructuring likely occurs now (tuning to leverage new SG capabilities and processes)	• Data flows end to end (e.g. customer to generation) • Enterprise business processes optimized with strategic IT architecture • Real world aware systems — complex event processing, monitoring and control • Predictive modeling and near real-time simulation, analytics drives optimization • Enterprise-wide security implemented	• Collaboration with external stakeholders • Environmentally driven investments (aligned with SG strategy) • Environmental scorecard/reporting • Programs to shave peak demand • Ability to scale DG units • Available active mgmt. of end user energy uses and devices
Level 3: Integrating – Cross Functional 	• Completed SG strategy and business case incorporated into corp. strategy • SG governance model deployed • SG Leader(s) (with authority) ensure cross LOB application of SG • Mandate/consensus with regulators to make and fund SG investments • Corp. strategy expanded to leverage new SG enabled services or offerings	• SG is driver for org. change (addressing aging workforce, culture issues, etc.) • SG measures on balanced scorecard • Performance and compensation linked to SG success • Consistent SG leadership cross LOBs • Org. is adopting a matrix or overlay structure • Culture of collaboration and integration	• SG impacted business processes aligned with IT architecture across LOBs • Common architectural framework e.g. standards, common data models, etc. • Use of advanced intelligence/analytics • Advanced sensor plan (e.g. PMUs) • Implementing SG technology to improve cross LOB performance • Data comms. detailed strategy/tactics	• Active programs to address issue • Segmented & tailored information for customers — including environmental and social benefits • Programs to encourage off-peak usage • Integrated reporting of sustainability and impact • Synthesize triple bottom line view across LOBs
Level 2: Functional Investing 	• Integrated vision & acknowledgement • Initial strategy / business plan approved • Initial alignment of investments to vision • Distinct SG set-aside funding / budget • Collaboration with regulators and stakeholders • Commitment to proof of concepts • Identify initial SG leader	• New vision influences change • Organizing more around operational end-to-end processes (e.g. breaking silos) • Matrix teams for planning and design of SG initiatives across LOBs • Evaluating performance and compensation for Smart Grid	• Tactical IT investments aligned to strategic IT architecture within a LOB • Common selection process applied • Common architectural vision and commitment to standards across LOBs • Conceptual data comms. strategy • IED connectivity and business pilots • Implementing information security	• Established energy efficiency programs for customers • "Triple bottom line" view — (financial, environmental and societal) • Environmental proof of concepts underway • Consumption information provided to customers
Level 1: Exploring and Initiating 	• Developing first SG vision • Support for experimentation • Informal discussion with regulators • Funding likely out of existing budget	• Articulated need to change • Executive commitment to change • Culture of individual initiatives and discoveries • Knowledge growing; possibly compartmentalized (i.e. in silos)	• Exploring strategic IT arch. for SG • Change control process for IT for SG • Identifying uses of technology to improve functional performance • Developing processes to evaluate technologies for SG	• Awareness of issues and utility's role in addressing the issues • Environmental compliance • Initiating conservation, efficiency, "green" • Renewables program

Phase II – Highlights, People and Technology Domains (v3.1)

Black text = Requirements for this level *Blue text = Descriptive characteristics or desired traits*

The path forward is the Intelligent Utility Network (IUN), which uses information technology to improve the management and, therefore, the performance of electrical grids. DONG Energy used the Smart Grid Maturity Model to determine their overall aspirations and to identify where they were on their path to a smart grid and where they wanted to be.

Through its planning process, DONG Energy identified more than 80 projects that would advance its smart grid implementation. The company turned to the Maturity Model to prioritize its list of projects and focus on a core set of five projects that will provide the greatest benefit, giving DONG Energy a clear path forward on its smart grid journey.

SG/MM *The Smart Grid Maturity Model*	**Grid Operations** *Advanced grid observability & advanced grid control, quality and reliability* 	**Work & Asset Management** *Optimize the assets and resources (people and equipment)* 	**Customer Management & Experience** *Retail, customer care, pricing options and control, advanced services, visibility into utilization, quality, and, performance* 	**Value Chain Integration** *Enabling demand and supply management, distributed generation and load management, leveraging market opportunities* 
Level 5: Innovating – Next Wave of Improvements 	• Grid employs self-healing capabilities • Automated grid decisions system wide (applying proven analytic based controls) • Optimized rate design/regulatory policy • Ubiquitous system wide dynamic control	• Optimizing the use of assets between and across supply chain participants • Just in time retirement of assets • Enterprise-wide abstract representation of assets for investment decisions	• Customer management of their end to end energy supply and usage level • Outage detection at residence/device • Plug-n-play customer based generation • Near real-time data on customer usage • Consumption level by device available • Mobility and CO2 programs	• Coordinated energy management and generation throughout the supply chain • Coordinated control of entire energy assets • Dispatchable recourses are available for increasingly granular market options (e.g. LMP – Locational Marginal Pricing)
Level 4: Optimizing – Enterprise Wide 	• Integration into enterprise processes • Dynamic grid management • Tactical forecasts based on real data • Information available across enterprise through end-to-end observability • Automated decision making within protection schemes (leveraging increased analytics capabilities and context)	• Enterprise view of assets: location, status, interrelationships, connectivity and proximity • Asset models reality based (real data) • Optimization across fleet of assets • CBM and predictive management on key components • Efficient inventory management utilizing real asset status and modeling	• Usage analysis within pricing programs • Circuit level outage detection/notification • Net billing programs in the home • Automated response to pricing signals • Common customer experience integrated across all channels • Recent customer usage data (e.g. daily) • Behavior modeling augments customer segmentation	• Energy resources dispatchable/tradable, utility realizes gain from ancillary services (e.g. power on demand) • Portfolio optimization modeling expanded for new resources and real time markets. • Ability to communicate with HAN (Home Area Network), incl. visibility and control of customer large demand appliances
Level 3: Integrating – Cross Functional 	• Sharing data across functions/systems • Implementing control analytics to support decisions & system calculations • Move from estimation to fact-based planning • The customer meter becomes an essential grid management "sensor" • New process being defined due to increased automation and observability	• Component performance and trend analysis • Developing CBM (Condition Based Mgmt.) on key components • Integrating RAM to asset mgmt, mobile work force and work order creation • Tracking inventory, source to utilization • Modeling asset investments for key components based on SG data	• High degree customer segmentation • Two-way meter, remote disconnect & connect, and remote load control • Outage detection at substation • Common customer experience • Customer participation in DR enabled • New interactive products/services • Predictive customer experience	• Integrated resource plan includes new targeted resources and technologies (e.g. DR, DG, volt/VAR) • Enabling market and consumption information for use by customer energy mgmt systems • New resources available as substitute for market products to meet reliability objectives
Level 2: Functional Investing 	• Initial distribution to sub-station automation projects • Implementing advanced outage restoration schemes • Piloting remote monitoring on key assets (RAM) for manual decision making • Expanding and investing in extended communications networks	• Developing mobile workforce strategy • Approach for tracking, inventory and event history of assets under development • Developing an integrated view of GIS and RAM with location, status and nodal interconnectivity	• Piloting AMI/AMR • Modeling of reliability issues to drive investments for improvements • Piloted remote disconnect/connect • More frequent customer usage data • Assessing impact of new services and delivery processes (e.g. HAN)	• Introducing support for home energy management systems • Redefine value chain to include entire eco-system (RTOs, customers, suppliers) • Pilot investments to support utilization of a diverse resource portfolio • Programs to promote customer DG
Level 1: Exploring and Initiating 	• Exploring new sensors, switches, comms. devices and technologies • Proof of concepts / component testing • Exploring outage & distribution mgmt. linked to sub-station automation • Building business case at functional level • Safety & physical security	• Conducting value analysis for new systems • Exploring RAM (Remote Asset Monitoring), beyond SCADA • Exploring proactive/predictive asset maintenance • Exploring using spatial view of assets	• Research on how to reshape the customer experience through SG • Broad customer segmentation (e.g. geography, income) • Load management in place for C&I • Reactive customer experience	• Identified assets and programs within value chain to facilitate load management programs • Identified distributed generation sources and existing capabilities to support • Develop strategy for diverse resource portfolio

Phase II – Highlights, People and Technology Domains (v3.1)

Black text = Requirements for this level *Blue text = Descriptive characteristics or desired traits*

Why Participate Now?

With the Smart Grid Maturity Model, best practice organizations stand out, as leaders and innovators among peers and customers alike. In the transition to a smart grid, participants who use the Maturity Model can benefit greatly from the sharing of best practices—including shared research, benchmarking data and custom reports.

These utilities can use it to collaborate with regulators, vendors and other utilities, network with peers, and share their experiences—all of which contribute to an evolving industry view of smart grid value.

By participating today rather than down the road, utilities can become a leader in a movement to advance the energy industry forward. At the same time, participating utilities will demonstrate efforts to improve customer service and the environment in association with other industry leaders.

Why IBM

Along with leading the global support for the Smart Grid Maturity Model, IBM has proven successful around the world in delivering smart grid solutions that provide improved reliability and end-to-end network data in near real-time. We bring to the table the integration skills, leading-edge technology, partner ecosystem, and business and regulatory expertise required to support every level of Smart Grid Maturity Model activities. We provide planning and business case development from pilot programs to full-scale execution.

Our extensive experience can deliver a comprehensive Intelligent Utility Network solution that is manageable and scalable in a secure environment. We can become smarter about energy by applying technology and accessing information to transform the way power is sourced, distributed and consumed. IBM scientists and industry experts

> *"The Smart Grid Maturity Model has been a key tool in Country Energy progressing along the path to our Intelligent Network. Through mapping and benchmarking, our current operations against the model has allowed us to identify the areas in which to focus our efforts to make the greatest gains and form our overall Intelligent Network strategy."*
>
> *– Col Ussher, Executive General Manager, Country Energy*

are working with clients to build smart energy solutions around the world. We are working with utility companies globally to accelerate the adoption of smart grids to help make them more reliable and give customers better usage information.

Proven, tested and validated solutions and methodologies. IBM's successful Energy & Utilities Solutions Framework has been validated with top energy and utilities companies, and is focused on transformative solutions found in the Maturity Model.

In addition, our global Centers of Excellence and solutions labs ensure proven solutions even before they are implemented—minimizing risk in scheduling, cost and performance.

IBM's Intelligent Utility Network addresses the challenges of rising energy costs, aging infrastructure and increased demand for reliability by leveraging all of the benefits of automation and digitization.

Relevant industry expertise, supported by an industry-leading partnership ecosystem. IBM alliances with best-of-breed Business Partners reduce customer project costs and minimize implementation and integration risks. We bring together the relevant tools, resources and people experienced in the Energy & Utilities industry.

Global reach with local service. We can send in local teams that understand your business, technical and regulatory environments. IBM's unique capabilities and presence in 160 countries mean utility companies around the globe have the resources and responsiveness they need to implement and support a mature Intelligent Utility Network solution of any scale.

Financing options. IBM Global Financing offerings are available. Flexible payment structures allow utilities to more effectively distribute initial costs and match payments to service benefits.

For more information

To learn more about the Smart Grid Maturity Model or to start using it today, please contact your local IBM representative or visit our Web site at:

ibm.com/energy

IBM Corporation
New Orchard Road
Armonk, NY 10504
U.S.A.

Printed in the United States of America
June 2009

EUB03005-USEN-00