SEI Smart Grid Maturity Model
Definition
v1.0

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http://www.sei.cmu.edu/smartgrid

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1 Executive Overview

The smart grid maturity model is a business tool developed by utilities for utilities and managed by the Software Engineering Institute at Carnegie Mellon University. The model is intended to provide a framework for understanding the current state of smart grid deployment and capability within an electric utility and provide a context for establishing future strategies and work plans. This document provides a detailed definition of the smart grid maturity model and key background information that will support its use. While this model is intended for use primarily by electric utilities, many aspects of it are applicable to water and gas utilities.

1.1 What is a Smart Grid?

A smart grid is an automated utility delivery and communication infrastructure that connects equipment, systems, customers, and employees. It enables ‘on-demand” access and control using current and event driven information on customers, assets, and the utility network systems to optimize operations, planning, system situational awareness, reliability, and efficiency.

A smart grid is responsive to customer, utility, and energy market needs through complete and dynamic integration of systems and processes. It provides the ability to adapt as needs evolve and opportunities arise. A smart grid also enables utilities to deliver, and customers to receive, reliable, cost effective, environmentally friendly energy and services. Figure 1 outlines the different components of a smart grid.

Figure 1. Smart Grid Defined
1.2 What is the Smart Grid Maturity Model?

The Smart Grid Maturity Model (SGMM) includes a framework and associated assessment tools that help utilities understand their position as they achieve smart grid capabilities. It is comprised of five levels of maturity across eight domains that characterize the holistic impact to be expected through smart grid initiatives (see SEI Smart Grid Maturity Model Overview). The Smart Grid Maturity Model has been used by over 50 utilities globally since its release in June 2007. The detailed history of the SGMM development is provided in Appendix B.

The SGMM includes the following suite of documents:

- SEI Smart Grid Maturity Model Definition
- SEI Smart Grid Maturity Model Overview
- Smart Grid Maturity Model Assessment Survey
- Smart Grid Maturity Model Results Survey

1.3 Smart Grid Maturity Model compared to the Modern Grid Initiative

Another view of smart grid characteristics is the modern grid strategy developed by the National Energy Technology Laboratory (NETL) for the US Department of Energy (http://www.netl.doe.gov/moderngrid/). This strategy includes seven characteristics of a modern grid that encompass their vision for the future. These characteristics are

1. Motivates and includes the customer
2. Accommodates all storage and generation options
3. Enables markets
4. Provides power quality for the 21st Century needs
5. Optimizes assets and operates efficiently
6. Self-heals
7. Resists attack
While developed in parallel with the above characteristics, the Smart Grid Maturity Model defined within this document has been shown to be highly complementary with them. A mapping of the SGMM maturity levels and domains to the seven characteristics of a modern grid is provided in Figure 2. In this chart, the label indicates the level of affinity between the characteristic and a given domain.

<table>
<thead>
<tr>
<th>DOE Principle Characteristics of Smart Grid</th>
<th>Smart Grid Model Maturity Domains</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivates and Includes the Consumer</td>
<td>Strategy, Management &amp; Regulatory</td>
</tr>
<tr>
<td>Accommodates All Generation and Storage Options</td>
<td>Organization &amp; Structure</td>
</tr>
<tr>
<td>Enables Markets</td>
<td>Grid Operations</td>
</tr>
<tr>
<td>Provides Power Quality for 21st Century Needs</td>
<td>Work &amp; Asset Management</td>
</tr>
<tr>
<td>Optimizes Assets and Operates Efficiently</td>
<td>Customer Management &amp; Experience</td>
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<tr>
<td>Self-Heals</td>
<td>Technology</td>
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<tr>
<td>Resists Attack</td>
<td>Value Chain Integration</td>
</tr>
<tr>
<td></td>
<td>Societal &amp; Environmental</td>
</tr>
</tbody>
</table>

Figure 2. Smart Grid Comparison with Modern Grid Characteristics
2 Document Scope and Purpose

The purpose of this document is to describe and provide background, clarity, and detail around the Smart Grid Maturity Model. The document describes the domains and levels that comprise the SGMM and offers details to help organizations achieve smart grid maturity. The document, and the smart grid itself, are designed for those with a certain level of knowledge about the utility industry.

The intended audience is as follows:

- Prospective utilities that are considering using the model or who simply want to know more about it
- Utility personnel who are preparing to take the SGMM surveys and who may have questions when completing the surveys
- Industry stakeholders
  - Utility industry organizations, associations, user groups and standards bodies
  - Regulators, public Service commissions, government bodies
  - Press and industry publications
  - The academic community and research institutions
  - Knowledgeable members of the public, including consumers
- Vendors, including utility equipment providers and service providers
3 The Smart Grid Maturity Model

The Smart Grid Maturity Model (SGMM) is a management tool that guides an organization toward a smart grid transformation by providing a process with clearly articulated steps that have defined smart grid stages and options and that allow organizations to quantifiably measure success and prioritize options. It creates a common framework and language for defining key elements of a smart grid transformation and helps to bridge gaps between strategy and execution.

The goal by all connected to the SGMM project is to help advance the adoption and deployment of smart grids and smart grid technology and benefits, across the industry and around the world.

3.1 Maturity Model Scope

The smart grid maturity model addresses all aspects of a utility’s network, structure, services, and supporting processes. The scope includes everything that an end-to-end intelligently linked network affects within the utility; connecting assets, end user devices, business processes, and customer interaction.

The model includes interaction with and enablement of retail, generation, supply chain services, and advanced features; but, it is not intended to cover characteristics of retail-only companies, generation (macro or point of use), or industry suppliers. Still it does include the flexibility for an intelligent utility network to adapt to achieve improved functions of a changing utility distribution network.

As shown in Figure 3, the primary intent of the SGMM is to address utility network assets, processes and services, and customer interface, interaction, and benefits. The other related businesses or communities represented by the surrounding boxes that fall partially inside of the dashed line are included only as they relate to running a smart grid. As an example, the model assumes that the smart grid utility provides all the necessary connectivity, function, services, and support to intelligently utilize distributed generation. But, the scope of model is not intended to define the maturity of any of the connected distributed generation entities attached to the grid.

In the diagram, centralized generation is generation that provides for the core needs of the community served and generally enters the grid through the transmission network. Distributed generation, in its current state, generally supplements the supply and often enters the grid through the outer points of the distribution grid. Distributed storage supplements the supply when needed and increases the flexibility of storage.
3.2 Smart Grid Levels

The next two sections (Sections 3.2 and 3.3) explore the structure of the Smart Grid Maturity Model. Levels of maturity within the model are introduced in this section. Section 3.3 introduces domains and the characteristics within each domain for each level.

Figure 4. Smart Grid Levels
The visual representation of the progress starts at Level 5 and displays a top down view. Organizations begin at the bottom with Level 1 and work their way up through the levels in each domain. Utilities begin at an assumed Level 0, where they are not engaged in any smart grid functions, and proceed through the model as follows:

- Level 1 - smart grid vision is being formed, but is not yet integrated into an enterprise strategy nor is it an accepted common vision
- Level 2 - smart grid has become integrated into the enterprise strategy and initial, focused efforts are underway
- Level 3 - significant portions of the smart grid infrastructure are in place and cross-functional flow of data and control is evident
- Level 4 - the majority of smart grid infrastructure is in place and process integration is prevalent, which enables optimization
- Level 5 - learning and adaptation is evident from the results through Level 4

### 3.2.1 Level 1 - Exploring and Initiating

Organizations at Level 1 have decided that they must do something to move toward a smart grid. They probably have a high-level vision of the future and they may have one or more evaluation projects, tests, or proof of concepts underway.

#### 3.2.1.1 People, Features, and Activities

At this level, the prophets and heroes in the organization are engaged in experiments to explore the vision of the smart grid. The individuals involved take on side projects to bring the smart grid mentality into the mainstream processes of the organization.

### 3.2.2 Level 2 - Functional Investing

What most differentiates a Level 2 organization from Level 1 is that the Level 2 organization has at least one smart grid project or deployment underway. The organization at this level should have an integrated strategy, but that strategy may not be implemented across the organization and the smart grid project may only be in one or two functional areas. If there are multiple towers of implementation, they are not necessarily tied together. One or more business cases are far enough along to release investment dollars, but the business cases may not be integrated end-to-end. Advanced Metering Infrastructure (AMI) is the most common first step for most utilities at this level.
3.2.2.1 People, Features, and Activities

At this level, the missionaries in the organization take the work that the prophets and heroes completed in Level 1 and develop strategies to promote it throughout the organization so that the smart grid movement can gain legitimacy. The experiments from Level 1 are developed into proof of concepts in Level 2.

3.2.3 Level 3 - Integrating

Level 3 organizations have taken significant steps toward a smart grid vision and have implemented their strategies beyond pilots into full scale deployments. Key infrastructure and process changes are place, thus enabling the flow of data and control across two or more functional areas. Decisions now reflect the increased data and automation for enhanced operation, products, and services.

3.2.3.1 People, Features, and Activities

At this level, individuals from various Lines of Business (LOB) have become champions for the smart grid adaption. The smart grid actions are becoming systemized across the organization and repeatable practices are created and shared.

3.2.4 Level 4 - Optimizing

Organizations that have achieved level 4 have achieved enterprise-wide smart grid transformation of their infrastructure and processes. Management and operational systems rely on and take full advantage of observability and integrated control across and between enterprise functions. Level 4 organizations may even reach out to the extended network, for example, to consumers, for the purposes of participating in and managing Demand Response and other sophisticated functionality.

3.2.4.1 People, Features and Activities

The personnel at this level can be considered victors, as they have achieved demonstrable results with the Smart Grid Maturity Model. The organization is undergoing a transformation with real-time connections and broad reuse of smart grid strategies.

3.2.5 Level 5 - Innovating

Level 5 organizations extend the capabilities and benefits of Level 4 through innovative programs and promotion of products and services that leverage the smart grid. They take state-of-the-art and state-of-
the industry to a new plateau of best practices. At this level, organizations implement new industry business models and may fundamentally reorganize supply and customer interaction around the smart grid.

3.2.5.1 People, Features, and Activities

At Level 5, the innovators in the organization are continuing to develop and expand the smart grid strategy and ensure that the SGMM is pervasive across the organization and across the value chain. The organization can take advantage of self-healing operations and autonomic business processes. The result could be a fundamental transformation of the utility business.

3.3 Smart Grid Domains

Domains are logical groupings of related capabilities and characteristics that provide focus areas for evaluating capability at each maturity level. They can cover a spectrum of factors that contribute to maturity, but these factors are usually related to one another when they are grouped within a domain. The Smart Grid Maturity Model consists of eight domains. Each domain includes a variety of characteristics that further describe the domain.

Domains are not mutually exclusive, but items are not duplicated across domains. When an element spans multiple domains, it is addressed in one domain, while needs and specifics of the other domains are taken into consideration. Each domain includes five levels of achievement: Initiating, Investing, Integrating, Optimizing, and Innovating.

The following descriptions elaborate on the SEI Smart Grid Maturity Model Overview document. In each description, required characteristics are those that the organization must meet to achieve that domain level. Most domain levels also include descriptive characteristics that may enhance an organization's achievement, but are not necessary to qualify for the domain level. Each characteristic is captured in a short phrase, and further elaboration is available for some of the descriptive phrases. The first four domains captured relate to people and technology (Strategy, Management and Regulatory; Organization and Structure; Technology and Society; and Environmental), the last four involve processes (Grid Operations; Work and Asset Management; Customer Experience; and Value Chain).
3.3.1 Strategy, Management, and Regulatory (SMR)

The Strategy, Management, and Regulatory (SMR) domain includes vision, strategic planning, decision making, strategy execution, and discipline, regulatory, and investment process. The management of the mission, vision, and strategy must be fully integrated to guide the way through a successful smart grid transformation.

SMR-1: Initiating

The organization develops a smart grid vision at this level.

**Required Characteristics**

- First smart grid vision developed: Must have a smart grid vision development plan in place with a goal of operational improvement
- Support for experimentation: Include proof of concepts
- Informal discussion with regulators

**Descriptive Characteristics**

- Funding out of existing budget
- Informal discussions with other utilities and vendors regarding smart grid experiences and lessons learned
- Business as usual in terms of planning

SMR-2: Investing

The organization works across internal boundaries to move toward smart grid with discrete investment and management decisions.

**Required Characteristics**

- Integrated vision and organizational acknowledgement: Budget process validates against smart grid vision
- Initial alignment of operational investment to vision
- Distinct smart grid funding and budget
- Collaboration with regulators and stakeholders: Communicating smart grid vision and strategy with regulators. Aligning current initiatives and proofs of concept and future initiatives to the strategy. Incorporating regulators perspectives and guidance.
- Commitment to proof of concepts: An evolution of proof of concepts from research and development into a deployment plan that flows from smart grid strategy and vision (e.g., successful proofs of concept links to regulatory coordination)
- Initial smart grid strategy and business plan approved: These will encompass aspects from all domains (customer management, grid operations, societal and environmental, etc.).

**Descriptive Characteristics**
• Collaboration with utility industry groups and suppliers: Industry groups provide a forum to share experience, pool knowledge, and accelerate the implementation schedule by standardizing key processes.
• Initial smart grid leader identified

SMR-3: Integrating

The smart grid is integrated into management processes across lines of business in this level.

Required Characteristics

• Completed smart grid strategy and business case incorporated into corporate strategy
• Smart grid governance model deployed: Smart grid governance integrates into management processes and decision-making (e.g., roles, processes and tools).
• Smart grid leaders ensure cross LOB application of smart grid: One or more leaders with explicit authority.
• Mandates and/or consensus with regulators to make and fund operational smart grid investments: Not only on visible aspects such as AMI, but also less visible supporting infrastructure investments

Descriptive Characteristics

• Corporate strategy expanded to leverage new smart grid-enabled cost recovery with elevated rate of return: This is funding beyond that to deploy smart grid according to initial vision and strategy
• Funding driven by new revenue opportunities or enhanced cost recovery with elevated rate of return: This is funding beyond that to deploy smart grid according to initial vision and strategy.

SMR-4: Optimizing

Smart grid is a core component of the business strategy and provides opportunities for enhanced external relationships.

Required Characteristics

• Smart grid is a core competency that drives strategy and influences corporate direction: It is inherent in the way the organization does business. Method of governance is re-evaluated to address unique investment requirements of smart grid (strategic investments that will be significant in magnitude/impact, long-lived and subject to upgrade as technologies mature). Approach emphasizes need to consider design strategies that provide flexibility to adapt over time and reduce switching costs.
• Strategy shared with key external stakeholders: Demonstrates shared strategy with stakeholders. Examples are engagement with regulators and potential interveners in forums conducive to education and non-confrontational discussion of viewpoints. Working groups established to develop strategies for addressing key issues as a collaborative process.

Descriptive Characteristics

• Willing to invest and divest, and engage in joint ventures and IP sharing to execute strategy: Can access specialized skills that are not readily accessible or affordable by individual companies. Can provide a method of sharing information to mutually benefit stakeholders, accelerating the experience curve. Can help address the unique aspect of Transmissions and
Distributions (e.g., franchise territories incorporate heterogeneous assets or environments) by allowing utilities to specialize (e.g., urban/underground vs. rural/radial) and learn from others’ experiences.

- Enables opportunities for enhanced market driven funding and innovative regulatory funding schemes: May include knowledge sharing on investment priorities, regulatory strategies, and pooling of resources to support consultations that will benefit the larger group.
- New external business partnerships emerge to improve intra-company optimization
- More attractive mergers and acquisitions regulatory treatment and repeatable process: Repeatable processes for mergers and acquisitions. The benefits of scale to reduce the per capita cost of smart grid investments are recognized.
- Enables refined mission space for the organization: Mission space is the boundary of products, services and markets that an organization covers. A smart grid may enable transformation into new business boundaries and markets by creating a platform for a two-way customer experience.

SMR-5: Innovating

All stakeholders, internal and external, are involved in all aspects of business and have a goal of innovation at this level.

Required Characteristics

- Overall strategy expanded due to smart grid capabilities: Capitalize on smart grid as a platform for introduction of new services and product offerings.
- Optimized rate design and regulatory policy (most beneficial regulatory treatment for investments made): Optimized rate design involves how to ensure costs are recovered; if there are time differentiated prices, then price elasticity models are included so that the response to a price is included in the revenue estimates. This two-way platform provides path for a more granular understanding of customer behavior in reaction to new rates in the context of time, location, and service options. Optimized regulatory policy attains beneficial regulatory treatment for investments made and risks taken. Lots of variables exist regarding new investment types, including more technology, new types of products and services, etc.
- New business model opportunities present themselves and are implemented

3.3.2 Organization and Structure (OS)

The Organization and Structure domain includes communications, culture, structure, training and education, and knowledge management. For the smart grid to be successful, the organizational structure must promote and reward cross-functional planning and design and operations while allowing for empowered decision making.

OS-1 Initiating
At this level, the organization has made a formal commitment to change.

Required Characteristics

- Articulated need to change
• Executive commitment to change

Descriptive Characteristics

• Culture promotes individual initiatives and discoveries: Ideas are developed with minimal resource commitment and low-visibility activities to avoid project termination.
• Knowledge is growing, although it may be compartmentalized
• Prophets and heroes take the lead

OS -2 Investing

The organization works across internal boundaries to move toward smart grid at this level.

Required Characteristics

• New vision begins to influence change and incorporate related priorities like addressing the aging workforce issue: Vision has to look beyond a technological aspiration to address the benefits to each stakeholder group and it must be communicated beyond the project team to all potential stakeholders.
• Organized more around operational end-to-end processes (e.g., meter through distribution): Organization is overcoming natural barriers related to workforce impacts through active engagement. Long-term organizational impacts are recognized and pro-actively addressed.
• Matrix teams for planning and design of smart grid initiatives across LOBs begin collaborating (e.g., IT, engineering, operations, etc.): Organizational recognition of the need to invest balances the need to leverage creativity and initiative with a more controlled investment strategy and reporting structure. There is an emphasis on initiative working within the concept of a team and a chain of command.
• Performance and compensation plans for smart grid are considered: Plans are made to incent and reward smart grid efforts as part of cultural transformation.

Descriptive Characteristics

• Operational excellence is a top cultural priority: Recognize the impact of technology as a platform to rethink the service delivery model rather than working towards greater automation of processes that are currently both manual and automatic.
• Mission statement for smart grid articulates the need for change and the benefits to the stakeholders: The mission statement should be by business leaders to external and internal stakeholders and regulators.
• Operational leaders become missionaries of integration: This includes leveraging technology to create a platform that can change the service delivery model.

OS -3: Integrating

The organization is aligned to a smart grid along with individual’s performance and compensation at this level.

Required Characteristics

• Smart grid becomes a driver for organizational change: The smart grid affects culture, structure, role definition, compensation structure, etc. Focus is on the strategic priorities for the company. Emphasis should be placed on incorporating the concept of using the platform to rethink service delivery as a tool to address concerns such as aging workforce issues. Also should address organizational behavior through team building requirements. This
characteristic touches on the changes in skill sets and managerial approaches that occur as projects transition from concept to delivery to operations through a more organized, disciplined approach appropriate for the implementation phase.

- Incorporate smart grid measures on the balanced scorecard within the corporate measurement system
- Performance and compensation linked to smart grid success
- Consistent smart grid leadership across LOBs: Invest in redesign of processes to take advantage of the platform. Develop metrics that are aligned with operational goals. Re-evaluate the method and frequency of reporting on progress to operational priorities.
- Organization is adopting a matrix or overlay structure: Smart grid will introduce new cross-LOB interaction and interdependencies that take advantage of increased observability and control. The organizational structures will need to adapt to properly take advantage of the new capabilities.

**Descriptive Characteristics**

- Culture promotes collaboration and integration
- Collaborative successes are celebrated

**OS - 4: Optimizing**

Operational visibility extends across the organization, enabling cultural and organizational transformation.

**Required Characteristics**

- Integrated systems and control drive organizational transformation
- End-to-end grid observability allows organizational leverage by stakeholders: Increased observability between internal lines of business and external stakeholders open opportunities for organizational collaboration
- Organization flattens: With automation and control enhancements, decision-making will occur at the lowest empowered level; thus reducing the overall length of the command structure and allowing for greater efficiencies.

**Descriptive Characteristics**

- Significant restructuring likely occurs now: Since this is the point where business transformation will occur, this is also the point where organizational transformation will likely also occur. With overall smart grid infrastructure and processes in place, organizational structure can now be aligned and optimized to leverage smart grid capabilities.
- Culture of agility: Change management and communication have enabled the culture within the organization to quickly adopt and adapt to the innovation enabled by smart grid.
- Empowered and decisive work environment: Roles, responsibilities, and well-defined work processes are in place to guide daily activities across LOBs. The authority for decisions is clear and required interactions for coordination is documented and adhered to.
- Knowledge flows easily across the enterprise: The lines of communication, data and knowledge flow across the organization have been defined, refined, and are leveraged as part of cross-LOB business processes.
- Enterprise and cross-LOB accountability are more valued than LOB and unit performance
• Decentralized real-time decision making, real-time corrections: Leveraging the distributed observability of the smart grid to enable decision making at the closest point to the need.

**OS -5: Innovating**

Stakeholders are involved in all aspects of business and are concentrating on innovation.

**Required Characteristics**

• Stakeholders collaboratively engaged in key aspects of transformed business: Demonstrate how stakeholder’s participation is embedded into the key decision-making processes.

• Organizational changes support new ventures, products, and services that emerge: Build in organizational changes to enable evolution of the business, products and services offerings.

**Descriptive Characteristics**

• Entrepreneurial mind set: Business leaders and decision-makers take an aggressive approach to innovation with a balance of managed risk and reward. Business as usual may fit for current operations, but they the next set of innovations will move the industry to greater efficiency, capability, and social consciousness.

• Culture of innovation: Innovative thought extends beyond leaders and decision makers down to individuals across the enterprise. Channels are in place to harvest ideas, develop them, and reward those that help shape future advances in process, organization, technology, etc.

**3.3.3 Technology (TECH)**

The Technology domain includes information, engineering, integration of information and operational technology, standards, and business analytics tools. 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.

**TECH-1: Initiating**

During this phase, the organization is exploring standardized and flexible systems.

**Required Characteristics**

• The value of a strategic enterprise IT architecture for smart grid use is explored: Includes process transparency, process enhancement, interoperability, and reuse (e.g. SOA, ESB, etc.). Does not have to include smart grid, just the knowledge and potential experience that will be useful as the smart grid is designed and deployed.

• Change control process used for smart grid applications and IT infrastructure: The following three items must be underway to qualify as level one: a smart grid business case, a smart grid blueprint, and a smart grid component and processes evaluation. The qualifications for what constitutes compliance for these items will be defined as part of the measurement and survey definition process.

• Identifying opportunities to use technology to improve functional departmental performance: (e.g., reduce cost, improve workflow, simplify complex activities, automate repetitive tasks, etc.).
• Developing processes to evaluate and select technologies in alignment with smart grid vision and strategy

Descriptive Characteristics

• Compliance plan for industry standards: Related to smart grid technologies
• Engaged in the evaluation of off the shelf and near-term technologies: e.g., AMI meters
• Analytics in use (automation not required)
• Functions automated but not well linked (e.g., financial is not linked to operational, data is captured but not flowing or being used)
• Have point-to-point interfaces between systems

TECH-2: Investigating

In this phase, the organization has a defined technology strategy that realizes the interdependencies with limited deployments.

Required Characteristics

• Governance aligns tactical IT investments to strategic IT architecture within a LOB: Begin the organization of the application portfolio and determine the strategic directions that need to occur to gain the benefits of smart grid.
• Common architectural vision and commitment to standards across LOBs: At least internal standards must be defined and a plan to adopt and adapt industry standards where applicable within the architecture. Standards will include topics such as communications, software development, change management, safety and security, and installation and maintenance. Demonstrate application of standards within the tower.
• Common technology evaluation and selection process applied for all smart grid activities
• Conceptual data communications strategy for grid: A data communication strategy at the conceptual level has been defined to guide pilots and planning activities.
• Intelligent Electrical Devices (IED) connectivity and business unit pilots are developed
• Implementing opportunities to use technology to improve functional departmental performance and identifying cross LOB opportunities
• Information security built in to all smart grid initiatives: Initiatives does not imply deployments, but rather plans, pilots, etc.

Descriptive Characteristics

• Architecture implementation plan initiated
• Analytics deployed online
• Promoting the industry adoption of open standards
• Active in industry-specific conferences

TECH-3: Integrating

In this phase, the organization implements the technology strategy and integrates its organizational systems.
Required Characteristics

- Smart grid impacted business processes aligned with strategic IT architecture across LOBs: Robust concept of the portfolio, clear direction in implementing strategic applications capable of supporting the smart grid directions.
- Application of common architectural framework (e.g., standards, common data models - CIM is an example): Across functions and LOBs (e.g., uses IEC 61850 (a standard for substation automation)). Demonstrate use of standards across LOBs.
- Implementing smart grid technology to improve cross LOB performance and evaluating further enterprise opportunities
- Use of advanced intelligence and analytics: Advanced sensor plan (e.g. using PMUs): Effective assessment of the dynamic performance of the power system requires wide-area Information from properly distributed phasor measurement units (PMUs).
- Detailed data communication strategy and tactics

Descriptive Characteristics

- Application of open standards and evolving off the shelf technologies.

TECH-4: Optimizing

Organizational systems are interconnected through a realized IT architecture and visibility extends across lines of business and functions within the organization during this phase.

Required Characteristics

- Data flows end-to-end: e.g., from customer to generation (where permitted)
- Enterprise business processes are optimized with strategic IT architecture; efficiencies being realized: Performance improvement techniques (e.g., lean six sigma) are applied to cross LOB processes to tune efficiencies possible with increased observability and control across IT architecture; Continued direction of the development of the strategic application portfolio
- World-aware systems drive complex event processing, monitoring, and control
- Predictive modeling and near real-time simulation for support processes; Analytics drives optimization: The application of new analytics capabilities is folded into cross-LOB business processes to enable increased efficiencies based upon real data and business rules.
- Technology is deployed to improve enterprise business performance (e.g., business intelligence and knowledge management tools integrated into smart grid)

Descriptive Characteristics

- Work with vendors to encourage new and innovative technology solutions to meet smart grid needs across the industry
- Enterprise-wide network and data security implemented

TECH-5: Innovating

Organizational system and processes have the ability to adapt to internal and external influences in this phase.
Required Characteristics

- Autonomic computing and machine learning are implemented: In a self-managing system, the human operator takes on a new role by defining general policies and rules that serve as an input for the self-management process, which is managed real-time by the computational system.
- Monitoring and actively engaging in developing emerging standards: Able to engage in developing standards given experience in deployment of smart grid through level 4

Descriptive Characteristics

- Leader and strong influence in conferences, industry groups, etc.: Distributech, IEEE PES, Gridwise, Intelligrid, DOE, etc. A leader through experience up to and including Level 4 smart grid
- Leading edge grid stability systems
- Business processes automatically re-optimize as conditions dictate: Through AI and other advanced technology solutions
- Partnering with vendors to develop new and innovative technology solutions to meet smart grid needs across the industry

3.3.4 Societal and Environmental (SE)

The Societal and Environmental domain includes conservation and green initiatives, sustainability, economics, and the ability to integrate alternative and distributed energy. A smart grid can provide the ability for a utility, and society, to make choices and take advantage of energy alternatives and efficiencies, regarding both production and consumption.

SE-1: Initiating

The organizations in this phase are aware of the growing importance of societal and environmental issues for a utility business and consumers.

Required Characteristics

- Awareness of issues and utility's role addressing them: Cost increases, global warming, oil/water issues (pollution), hazardous materials, spill control, “not in my backyard”
- Environmental compliance

Descriptive Characteristics

- Renewables programs
- Initiating conservation programs, efficiency programs, and “green” programs internally and externally
- May be showcasing green efforts
• Emissions trading possible

SE-2: Investing

Organizations in this phase are engaging in societal and environmental issues through managing decisions, investments, and networks in such a way that facilitates sustainable energy utilization.

Required Characteristics

• Recognition of issues: Strategy and/or work plans incorporate activities to address cost increases, global warming, pollution, hazardous materials, spill control, and consumer backlash
• Established energy efficiency programs for customers
• Triple bottom line view (i.e., financial, environmental, and societal): Triple bottom line accounting means expanding the traditional reporting framework to take into account environmental and social performance in addition to financial performance. Agreement with internal stakeholders on these metrics as investment drivers is necessary.
• Environmental proof of concepts underway: This is not HAZMAT, but rather ties to the triple bottom line view and links to what smart grid can address
• Consumption information provided to customers: Includes actual consumption data through granularity and frequency that provides insight into usage and enables shifting behaviors

Descriptive Characteristics

• Monitoring carbon emissions
• Accommodates multiple energy sources including renewables
• Cross-industry efforts (e.g., utilities and homebuilders)

SE-3: Integrating

All systems throughout the organization are interconnected and focused on societal and environmental issues through organizational programs and reporting during this phase.

Required Characteristics

• Active programs to address societal and environmental issues: Cost increases, global warming, pollution, hazardous materials, spill control, and consumer backlash
• Segmented and tailored information for customers that include environmental and social benefits
• Programs to encourage off-peak usage: Greater utilization of the energy network troughs by customers
• Integrated reporting of sustainability and impact

Descriptive Characteristics

• Synthesize triple bottom line view across LOBs
• Investment to reduce carbon dioxide: Focus on energy efficiency
• Commercial and industrial customers enabled to manage their own usage (e.g., through self-adaptive networks)
• Commercial and industrial customers have access to tailored analytics and advice
SE-4: Optimizing

During this phase, organizations have business processes that capture the wider industry interests and deliver a sustainable, economic, and environmentally friendly energy network.

**Required Characteristics**

- Collaboration with external stakeholders: At this level, collaboration with the diverse set of external stakeholders is part of the standard business processes (includes environmental groups, investment community, etc.)
- Environmental scorecard and reporting
- Programs to shave peak demand
- Available active management of end-user energy uses and devices

**Descriptive Characteristics**

- Load programs to reduce carbon footprint
- Ability to scale distributed generation units
- Environmentally driven investments aligned with smart grid strategy
- Taking leadership on issues (e.g., enlightened utility)

SE-5: Innovating

Organizations in this phase are evolving the technology, business processes, and assets to deliver greater societal value and environmental benefits.

**Required Characteristics**

- Meet or exceed the triple bottom line targets: Triple bottom line accounting means expanding the traditional reporting framework to take into account environmental, social and financial performance.
- Residential customers enabled to manage their own usage (e.g., through self-adaptive networks)
- Analytics and advice tailored to customers

**Descriptive Characteristics**

- Monetize carbon

3.3.5 Grid Operations (GO)

The Grid Operations domain is characterized by advanced grid observability, control, quality, and reliability. A solid foundation of intelligent grid components and operational design, that uses technology and automation fused with enterprise processes, contributes to a holistic smart grid.
GO-1: Initiating

During this phase, the evaluation of automation and process capabilities that a smart grid will enable for grid operations and contribute to the formulation of an overall smart grid blueprint occurs.

**Required Characteristics**

- Exploring new sensors, switches, and communications devices for grid monitoring and control: Including safety and security aspects. This may be research and dialog, not only test and pilots.
- Exploring outage and distribution management systems linked to sub-station automation: Including safety and security aspects. Applies to any use of the sub-station automation data, not just by distribution utility (e.g., to schedule or balance energy level and flow on transmission grid).
- Building a business case at functional level and conducting value analysis for new equipment and systems: The following three items must be underway to qualify as Level 1: a smart grid business case, a smart grid blueprint, and a smart grid component and processes evaluation. The qualifications for what constitutes compliance for these items will be defined as part of the measurement and survey definition process.
- Proof of concept and component testing
- Safety and physical security are factored in to all smart grid initiatives: The safety and physical security needs for smart grid capabilities should have been considered during exploration, evaluation, testing, and piloting. Cyber security is addressed at a higher maturity level.
- Evaluating communications technologies

**Descriptive Characteristics**

- Distribution and sub-station automation pilots

GO-2: Investing

This phase allows for the deployment of initial grid automation features as part of a smart grid vision and blueprint.

**Required Characteristics**

- Initial distribution and sub-station automation projects underway
- Implementing advanced outage restoration schemes: Must have one functional/operational tower using smart grid
- Piloting Remote Asset Monitoring (RAM) of key assets to support manual decision making: Data collection across LOBs drives integrated modeling and allows for more informed manual planning and maintenance decisions
- Expanding and investing in extended communications networks: Digital communications may be necessary to support the full capability of smart grid communications, but a blend of analog and digital will most likely be in place; rural areas may lag behind urban in moving to digital.

**Descriptive Characteristics**

- Emphasis on communications with respect to automation
• Increased observability

GO-3: Integrating

In this phase, cross-functional automation and control are realized.

Required Characteristics

• Sharing data across functions and systems
• Implementing control analytics to support manual decision-making: Critical mass of data, equipment, and technologies are integrated with analytics for inclusion into system based control
• Move from estimation to fact-based planning: Enabled by asset monitoring capabilities from Level 2 and data availability, the organization transitions from scheduled-based to condition-based maintenance.
• Customer meter becomes an essential grid management sensor: Visibility of meter data at grid control level with a plan to retrieve the data.

Descriptive Characteristics

• New processes being defined due to increased automation and observability
• Beginning to reduce information latency across functions and departments
• Integrated weather information enhances planning

GO-4: Optimizing

During this phase, grid operations are integrated into and drive enterprise processes.

Required Characteristics

• Integration into enterprise processes
• Dynamic grid management: Management is targeted and focused on high-priority tasks. Organization is transitioning from estimation to live data grid management. Practicing load balancing, Volt/VAR control, power factor management, circuit efficiency, peak management, etc.
• Tactical forecasts based on real data: Tactical and actionable forecasts rely on more frequent data being available
• Information available across enterprise through end-to-end observability
• Automated decision-making within protection schemes (i.e., leveraging increased analytic capabilities and context): Greater speed and capacity enables increased analytics to support.

Descriptive Characteristics

• More accurate planning and design
• Near real-time modeling and simulation
• Transitioning from people-based decision-making to automated decision-making: Analytics are eased into the decision-making processes and validated over time through use by dual person/machine interaction
GO-5: Innovating

Increased observability and control drives innovation in this phase.

Required Characteristics

- Grid employs self-healing capabilities: Self-healing operations are an expansion of the self-healing grid concept that encompasses people, processes communications, etc. A self-healing grid is capable of automatically anticipating and responding to power system disturbances, including the isolation of failed sections and components, while optimizing the performance and service of the grid to customers\(^1\).

- System-wide automated grid decision making (applying proven analytics-based control): Dependent on the full observability and trust that was established at Level 4.

- Optimized rate design/regulatory policy: Optimized regulatory policy is about getting the most beneficial regulatory treatment for investments made and risks taken. New investment types (e.g., more technology, new business models) move regulators to new territories. Optimized rate design ensures costs are recovered, and if there are time differentiated prices, that price elasticity models are included so that the response to a price is included in the revenue estimates.

Descriptive Characteristics

- Ubiquitous system-wide dynamic control: Decisions on whether centralized or distributed control is more appropriate will be addressed within the strategy and blueprinting efforts of each organization.

- Universal dynamic protection: Should demonstrate fulfillment of strategy of real-time sensing and dynamic adaption of settings

- New opportunities as a result of the integrated view of customers, assets, and operations

3.3.6 Work and Asset Management (WAM)

The Work and Asset Management domain includes optimizing the assets and resources (people and equipment), operating and maintaining assets based on up-to-date, fact-based performance data, enabling the evolution from preventative and reactive to predictive, and self-healing for more efficient use of resources.

WAM-1: Initiating

During this phase, the organization evaluates the possibilities and sets a vision for advanced asset and workforce management capabilities; this encompasses asset knowledge, inventory, and spatial relationships.

\(^1\) Energy Independence and Security Act 2007, Title XIII.
Required Characteristics

- Building a business case at the functional level: Smart grid business case, blueprint and component and processes evaluation underway
- Conducting value analysis for new equipment and systems: Related to asset management and planning
- Exploring Remote Asset Monitoring (RAM) beyond SCADA: Event driven, persistent, IP-based communications differentiates RAM from SCADA. Enables communication channels beyond costly point-to-point channels and enables intelligence.

Descriptive Characteristics

- Evaluating mobile workforce and crew communication systems integrated with monitored asset data: Enables optimization of work tasks and parts utilization based upon current information about assets
- Exploring proactive and predictive asset management
- Exploring opportunities from spatial view of assets

WAM-2: Investing

In this phase, the utility makes decisions and investments on first deployment steps toward efficient management of assets, while taking advantage of smart grid capabilities.

Required Characteristics

- Developing mobile workforce strategy: Not necessarily connected to the smart grid strategy.
- Approach for tracking, creating an inventory, and maintaining event history of assets under development: An example is using RFID tags linked to inventory database.
- Developing an integrated view of GIS and asset monitoring for observability based on location, status, and interconnectivity (nodal).

Descriptive Characteristics

- Pilots for enhancements to crew scheduling
- Developing track history of assets: Having asset trends and profiles that are based on real asset data.

WAM-3: Integrating

In this phase, all systems are interconnected to support work and asset management.

Required Characteristics

- Performance and trend analysis available for individual components of system
- Developing Condition Based Maintenance (CBM) programs on key components: CBM requires the use real data from devices to determine the need for maintenance or replacement.
- Integrating RAM to asset management
- Integrating RAM to mobile workforce systems, automating work order creation: Use of communications and automation to improve workforce productivity
- Integrated view of Geospatial Information Systems and asset monitoring for observability based on location, status and interconnectivity (nodal)
• Tracking inventory from sourcing to utilization: Includes location information for an asset (i.e., whether put into use, pulled from use, in staging or warehousing, etc.). Some level of automation must be in place, even if workers enter the data via keyboard, barcode reader, etc. Should touch most or all asset classes.
• Modeling asset investments for key components based upon smart grid data.

Descriptive Characteristics

• Beginning asset optimization: asset performance and management model is based on real data
• Skill-based routing
• Predictive retirement
• Nodal information is based on real data
• Developing proximity awareness capability for mobile assets and their interrelation to one another and to fixed assets

WAM-4: Optimizing

During this phase, work and asset management are integrated into enterprise business processes.

Required Characteristics

• Enterprise view of assets including location, and interrelationships based upon status, connectivity, and proximity: Systems do not have to be tightly integrated, but access and view of the data is enabled across the enterprise (e.g., federated model of assets)
• Asset models based on real data: These models should include financial analysis by asset
• Optimization across asset fleet: Service life managed for individual and among assets to: minimize outages, minimize maintenance, maximize productivity, useful life and financial return
• Condition based and predictive maintenance on key components

Descriptive Characteristics

• Efficient inventory management utilizing real asset status and modeling: Maintain the minimal inventory to support spares availability based upon current asset status for the most effective return on investment
• Optimizing crews and their equipment
• Optimizing use of assets by grid operations

WAM-5: Innovating

During this phase, the organization tunes the use of assets across the entire supply chain and drives strategic investment decisions based on the best asset ownership and utilization model.

Required Characteristics

• Optimizing the use of assets between and across supply chain participants: Processes defined and executing across partners
• Just-in-time retirement of assets: Leverage assets to peak utilization
Descriptive Characteristics

- Enterprise-wide abstract representation of assets for investment decision: Drives investment and asset utilization into strategic investment scheme

3.3.7 Customer Management and Experience (CME)

The Customer Management and Experience domain includes retail, customer care, pricing options and control, advanced services, advanced visibility into utilization quality, and performance. Through smart grid, the customers are empowered to make their own choices regarding their use and cost of energy.

CME-1: Initiating

The organization is exploring new ways to meet customer expectations and enhance customer experiences during this phase.

Required Characteristics

- Research on how to reshape the customer experience through smart grid (leveraging customer satisfaction surveys, focus groups and other techniques): Balancing customer (end use consumer) benefits versus utility operational benefits. Can be through public research via media, conferences.

Descriptive Characteristics

- Drive by or walk by Automated Meter Reading (AMR)
- Broad customer segmentation (e.g. geography, income)
- Limited remote load control, load management for commercial and industrial
- Reactive to customer experience (e.g., outage notifications, etc.): At this level, customers experience reactive through phone calls to the utility

CME-2: Investing

The organization is investing to better meet customer expectations and enhance business efficiency during this phase.

Required Characteristics

- Piloting remote Advanced Metering Infrastructure and Automated Meter Reading (AMI/AMR): This is specifically directed toward residential customers (non-commercial and industrial). One advantage is reduced need for access to customer premises and reduces estimated bills.
- More frequent (than monthly) knowledge of customer usage: This is within the utility as increased data gathering and analytics are initiated to better understand customers and their usage patterns. Will support analytics and planning by both T&D.
- Modeling of reliability issues to drive investments for improvements
- Piloted remote disconnect/connect
Assessing impact of new services and delivery processes (e.g., Home Automation Networks (HAN), meter installs, turning on/off power, etc.): This includes pricing schemes and other innovative offerings to residential, commercial and/or industrial customers.

Descriptive Characteristics

- Evaluating new customer relationship models: This involves consumer-based generation rather than utility-based distribution
- Ability for customer to specify and purchase green power

CME-3: Integrating

In this phase, integrated business systems and processes increase efficiency and interaction to improve customer satisfaction and provide new services.

Required Characteristics

- High degree of actionable customer segmentation: For residential customers, all defined segments must have associated action plans to leverage products and services to the segment
- Two-way meter communication: For residential, meter implies whatever manner consumption is measured and tracked (in cases where meters are not used)
- Remote disconnect and connect: For residential customers, does not imply utility owns the device just that the required integration and control is in place.
- Remote load control available: for discretionary control of customer high energy devices
- Automatic outage detection at substation
- Common customer experience
- Customer participation in demand/response: Modeling and tracking participation

Descriptive Characteristics

- New interactive products/services for pricing, control, conservation, customization, efficiency, etc.
- Predictive customer experience: Outage notifications (planned, back in service), usage, new services, etc.
- Piloting home/device control / home area network

CME-4: Optimizing

Organizations will enable management of individual customers based upon their usage histories and profiles during this phase.

Required Characteristics

- Analysis of usage within pricing programs
- Automatic outage detection and proactive notification at circuit level
- Automated response to pricing signals for major energy using devices within premise: At the customer premise
- Net billing programs enabled in the home (i.e., vehicle to grid)
- Recent customer usage data (e.g., daily)
- Common customer experience integrated across all channels
**Descriptive Characteristics**

- Behavior modeling augments customer segmentation
- New customer service models enabled: Customized and personalized contracts, billing, and customer service (e.g., SLAs, pricing, turn-ons, load control, etc.).
- Customer accounts managed through home device control and home area network
- Predictive customer needs: Includes peak power demands.

**CME-5: Innovating**

The organization has products and services tailored to individual customer profiles and desires.

**Required Characteristics**

- Capability for customer management of end-to-end energy supply and usage level
- Automatic outage detection at the residential level or at the device: Assumes capability for monitoring individual devices has been deployed (e.g., refrigerator is not powered even though house still has power).
- Plug and play customer-based generation supported
- Near real-time data on customer usage

**Descriptive Characteristics**

- Innovative customer products possible: For example, appliance repair programs
- Consumption level by device available (price based time of use recommendations): Assumes capability for monitoring individual devices has been deployed
- Mobility and CO2 programs: Buying and selling credits; trading credits
3.3.8 Value Chain Integration (VCI)

The Value Chain Integration domain includes enabling demand and supply management, and allowing for distributed generation and load management. By extending automation beyond traditional boundaries, and across the entire value chain, opportunities for innovation and efficiencies arise.

VCI-1: Initiating

The organization is evaluating possibilities, identifying assets, and setting a vision across the value chain during this phase.

Required Characteristics

- Assets and programs that facilitate load management programs are identified: These might not be owned or controlled by the organization, but are necessary to achieve load management.
- Distributed generation (DG) sources and existing capabilities to support them are identified: Identification is an ongoing process, not a one-time event. Must identify tasks required to enable DG even if it is not owned or controlled by the organization.
- Developing a strategy for diverse resource portfolio: Determine organization’s role to support and manage a diverse portfolio. Resource portfolio is the set of both energy sources (e.g., including DG, DR, renewables and storage) and ways to reduce or balance load in a holistic manner.

Descriptive Characteristics

- AMR or one-way AMI infrastructure
- Education for curtailing peak usage available to customers
- Implemented simple peak demand programs (e.g., a/c load shedding)
- Has contract vehicles to accommodate DG to large customers

VCI-2: Investing

In this phase, all decisions, systems, and investments are focused on a network capable of realizing alternate generation benefits.

Required Characteristics

- Introducing support for home energy management systems
- Piloting grid investments to utilize a diverse resource portfolio
- Redefining the value chain into a new ecosystem (e.g., RTOs, traditional resource providers, customers, suppliers, etc.): Begin discussion with customers and suppliers about new and innovative points for applying automation and integrating processes to enable efficiencies and introduce new products and services.
Descriptive Characteristics

- Programs to promote customer distributed generation (e.g., solar rebates, wind)
- Support for distributed generation systems
- Has contract vehicles to accommodate distributed generation to mid- and small-based customers

VCI-3: Integrating

In this phase, business systems are interconnected and promote network interaction.

Required Characteristics

- Integrated resource plan includes new resources (including Volt/Volt-Ampere Reactive (VAR), DR, DG): At the distribution level, there are several major system components that can affect the management of volts and VARs. These components are: tap changing (LTC) transformers, LTC line regulators, and capacitor bank controls (pole-top and substation step-bank), all of which can lend themselves to automation. In any good evaluation of a Volt/VAR management system, all of these components must be considered individually, as well as collectively, to ascertain the most efficient, viable method of control. Demand-side management (DSM) programs consist of the planning, implementing, and monitoring activities of electric utilities which are designed to encourage consumers to modify their level and pattern of electricity usage.
- Enabling market and usage information for use by customer energy management solutions: (e.g., integrated smart thermostats to AMI)
- New resources available as substitute for market products to meet reliability objectives: Smart grid enables new models for trading energy efficiently given new sourcing capacity from customer based and distributed generation, new T&D connectivity and control, and innovative rate and pricing options. Initial deployment of energy trading leveraging some of these features is underway at this level.

Descriptive Characteristics

- Programs to support value chain partners for load management and DG. (e.g., Rural Electric Associations and Retail Electric Providers)

VCI-4: Optimizing

During this phase, business processes enable the capture and utilization of distributed generation and related load management initiatives.

Required Characteristics

- New and existing energy resources can be dispatched and traded: Utilities realize opportunities for value shift from generators so that they can share the gains from ancillary services (e.g., power on demand)
- Portfolio optimization modeling expanded for new resources and real-time markets: Modeling entire generation and load management potential in real-time, including ability to scale DG
- Ability to communicate with Home Automation Networks (HAN)
- Visibility and control of customer large demand appliances: Remote control of large demand devices (air conditioning) to balance demand/supply.
**Descriptive Characteristics**

- Uses DG and load management to sell extra power off network

**VCI-5: Innovating**

In this phase, the organization is refining energy management and automation of assets to realize greater value and benefits.

**Required Characteristics**

- Dispatchable resource are available for increasingly granular market options (e.g., Locational Marginal Pricing (LMP))
- Coordinated energy management and generation throughout the supply chain
- Optimization of entire energy assets: Including new resource options throughout the value chain (consumer to operator).

The following is an excerpt from the Energy Independence and Security Act of 2007, Title XIII:

Section 1301 – Statement of Policy - National policy to support the modernization of the nation’s electricity T&D system ... that can ... achieve each of the following, which together characterize a smart grid:

- Digital information and controls
- Dynamic optimization with cyber-security
- Deployment and integration of distributed resources and generation, including renewables
- Use of demand response, demand-side resources and EE
- Smart technologies for metering, grid communications and distribution automation
- Integration of smart appliances and consumer devices
- Advanced storage and peak-shaving technologies, including PHEVs and thermal-storage A/C
- Give consumers timely information and control options
- Develop standards for communication and interoperability of appliances and eqpt connected to the grid, including grid infrastructure
- Identify and lower barriers to adoption of smart grid technologies, practices and services

This is the actual text of this section from the Act:

TITLE XIII—SMART GRID
SEC. 1301. STATEMENT OF POLICY ON MODERNIZATION OF ELECTRICITY GRID

It is the policy of the United States to support the modernization of the Nation's electricity transmission and distribution system H. R. 6—293 to maintain a reliable and secure electricity infrastructure that can meet future demand growth and to achieve each of the following, which together characterize a smart grid:

(1) Increased use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid.

(2) Dynamic optimization of grid operations and resources, with full cyber-security.

(3) Deployment and integration of distributed resources and generation, including renewable resources.

(4) Development and incorporation of demand response, demand-side resources, and energy-efficiency resources.

(5) Deployment of “smart” technologies (real-time, automated, interactive technologies that optimize the physical operation of appliances and consumer devices) for metering, communications concerning grid operations and status, and distribution automation.

(6) Integration of “smart” appliances and consumer devices.
(7) Deployment and integration of advanced electricity storage and peak-shaving technologies, including plug-in electric and hybrid electric vehicles, and thermal-storage air conditioning.

(8) Provision to consumers of timely information and control options.

(9) Development of standards for communication and interoperability of appliances and equipment connected to the electric grid, including the infrastructure serving the grid.

(10) Identification and lowering of unreasonable or unnecessary barriers to adoption of smart grid technologies, practices, and services.
Appendix B: History of the SGMM

In the fall of 2006, IBM approved a growth case based on the business case developed in IBM’s Energy and Utility global industry group to greatly expand IBM’s investment in the area of smart grid, which IBM refers to as the IUN (Intelligent Utility Network). IBM began forming the Global Intelligent Utility Network Coalition (GIUNC) in late 2006. The intent of the GIUNC was, and still is, to enlist a limited group of leading utilities from around the world where joint investments in new technology and techniques can be made and shared as new real-life smart grid projects are approved, tested, and deployed.

In 2007, after enlisting the support of APQC, IBM began developing, with the GIUNC and various subject matter experts, the Smart Grid Maturity Model to define a smart grid and its evolution. The committee first developed the levels and domains, and then defined the characteristics of each domain/level intersection.

By late April 2008, APQC began creating the surveys that utilities could use to assess their standing against the Smart Grid Maturity Model. By the end of 2009, more than 30 utilities had taken the surveys and seen the results.

At the GIUNC summit in June of 2008 in Washington DC, the new Smart Grid Maturity Model was presented to the larger group of member executives present. It was agreed that the model should be transferred to a global body or institution for totally impartial delivery, stewardship and growth. Industry standards bodies expressed interest in taking the model through their processes but this avenue was not pursued because it was determined that the SGMM was more of a business tool than a standard. The founding companies felt strongly that the use of the model should be a choice, not a mandate, and that it should be used for a utility to measure itself against its own goals and against the market as a whole. They did not want it to be used to compare one utility to another.

After numerous discussions with potential stewarding candidates and industry leaders about the best possible choice, it was clear that a combination of Carnegie Mellon University’s Software Engineering Institute (SEI) taking the lead stewardship role, with the support of the World Energy Council (WEC) for global advocacy and APQC for data collection and analysis, provided an excellent home for the ongoing management and growth of the model.

After receiving transfer of all rights to the model from each of the GIUNC members and APQC, IBM handed over the model to CMU/SEI on March 9, 2009 as a donation.

The goal for this project has always been to help advance the adoption and deployment of smart grids and smart grid technology and benefits across the industry and around the world.
Appendix C: Glossary

Automation, substation
Substation automation goes beyond traditional SCADA to provide added capability and information that can further improve operations and maintenance, increase system and staff efficiencies, and leverage and defer major capital investments. Applications and data of interest may include remote access to IED/relay configuration ports, waveforms, event data, diagnostic information, video for security or equipment status assessment, metering, switching, volt/VAR management, and others maintain uninterrupted power services to the end users.

Business enablement
Availability of new capabilities or opportunities through the discrete steps taken as part of smart grid realization.

Communications Infrastructure Security
Technology and techniques used to ensure the protection and survivability of networks essential to operations.

Connect/disconnect, Remote
The ability to connect or disconnect service to a customer without sending a technician to the physical location.

Customer Program Take Rate
The percentage of customers that sign up for a service made available through smart grid deployment.

Customer Visibility to Consumption
Service available through telephony, internet, etc. that enables customers to view their consumption information on demand.

Customer Visibility to Price
Service available through telephony, internet, etc. that enables customers to view the price of energy they consumed.

Dedicated R&D Budget
Research and development budget discretely targeted to smart grid initiatives within a company. Density spread of rural, suburban, and urban in service area.

Estimate of Restoration Time (ERT) accuracy
The percentage of actual restoration times (time from outage detection until service is restored to a customer, or actual clock time of restoration) that meet or exceed the initial ERT.
Fault
A fault condition occurs when one or more electrical conductors contact ground and/or each other. Types of faults include phase to ground, double-phase to ground, three-phase to ground, phase-to-phase, and three-phase. This includes momentary faults.

Feeder miles
The number of miles of feeder circuits in a grid.

Field visit
An event where utility personnel go to a physical location to operate, maintain, or inspect some aspect of their grid.

Industrial customers
Customers that have factories or are involved in manufacturing; they typically have the highest energy needs. Other customer types are residential and commercial.

Interruptions, planned
Customer interruptions necessary to perform any activity that is planned by the utility (e.g., routine maintenance, capital improvements, etc.).

Line losses
Energy waste resulting from the transmission of electrical energy across power lines.

Load, actual
The measured load on the grid.

Load, predicted
The estimated load expected on the grid.

Mean Time Between Failure (MTBF)
Represents a statistical approximation of how long a set of devices should last before failure. Time is the time a device is actually in use, not absolute clock time. A simple calculation is MTBF = (downtime-uptime)/number of failures.

Other cost
Other costs are costs associated with the specified process, but not specifically covered in personnel cost, systems cost, overhead cost, or outsourced cost. These other costs include costs for supplies and office equipment, travel, training, and seminars. It also includes the cost of telephones, except for that portion captured in systems cost.

Outage detection
Identification of which circuits are down and the location and potential cause.

Outage duration
The time from first indication of outage to restoration of service to all impacted customers.
Outage frequency
Total number of customer interruptions/total number of customers over a year; this is the same as SAIFI.

Outsourced cost
In determining outsourced cost, include the total cost of outsourcing all aspects of the specified process to a third-party supplier or third party logistics provider. Exclude one-time charges for any type of restructuring or reorganization. Outsourced costs should also include costs for intracompany outsourcing (i.e., reliance on a shared services center).

Personnel cost
Personnel cost is the cost associated with personnel compensation and fringe benefits of employees (i.e., those classified as FTEs, which includes both full-time and part-time salaried/hourly employees) contributing to each respective process. Personnel cost should include all of the following costs: Employee Compensation: includes salaries and wages, bonuses, overtime and benefits; Fringe: includes contributions made towards the employees’ government retirement fund, workers compensation, insurance plans, savings plans, pension funds/retirement plans, and stock purchase plans; Special allowances: includes relocation expenses and car allowances.

Planning, estimated
The use of empirical or expert judgment to drive work and asset planning.

Planning, fact-based
The use of real asset and operational data to drive work and asset planning rather than empirical or expert judgment.

Recover Strategy, cost or rate
A strategy for how a utility will manage reduced revenue and/or increased costs from the implementation of smart grid; this must be worked with regulators to ensure viability.

Regulated/Deregulated
Supervision over rates, terms and conditions of service, financing, and service areas by a governmental agency. Deregulation is the removal or relaxation of regulations or controls.

ROI, automation
The return on investment attributable to the deployment of automation on the grid and behind the grid to enable smart grid capabilities.

Self-healed
Where automation or other switching techniques are used to restore service without human intervention.

Sensors
Any device or technique that is used to monitor or detect on the grid.

Service area (in sq. miles)
The total land area within the scope of operations and control of the utility.
**Systems costs**

System costs include all expenses, paid or incurred, in conjunction with:

- computer hardware or computer software acquired by the organization or provided to the organization through service contracts
- costs required to process, service, and maintain computer hardware or computer software
- the cost of providing and maintaining services for each applicable process (e.g., computer system(s) processing (CPU) time, network/system communication charges, maintenance costs for applications and data storage). This includes the costs related to LANs, WANs, etc. This does not include one-time costs for major new systems developments/replacements. Consultant fees should not be included in depreciation of new system implementations. Include only those costs that occur more than six (6) months after implementation, as normal system maintenance costs.
- Any systems cost (e.g., maintenance) which is outsourced to a third party supplier should be captured in the separate cost category labeled outsourced cost.
- the salaries, overtime, employee benefits, bonuses or fees paid to full-time, part-time or temporary employees, or independent contractors who perform services relating to computer hardware, computer software, processing, or systems support

**Total customer count**

This is the total number of customers. Because some customers may have multiple meters this is not meter count.

**Truck rolls**

This applies to any activity that requires a vehicle to be dispatched or sent.

**Work Plan**

This refers to a time-phased plan of work activities that will be conducted to achieve strategic and business goals for the smart grid. This plan identifies the scope, duration and cost for each activity so that budgeting and resource planning can be aligned to enable execution.