The Age of the Smart Grid is Here
Smart Grid Maturity Model Offers Best Practices for Utilities Worldwide

Software Engineering Institute
Carnegie Mellon University
IBM Corporation
World Energy Council
March 30, 2009
The Age of the Smart Grid is Here

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The Age of the Smart Grid is Here

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General Manager
IBM Global Energy & Utilities Industry Chairman, GridWise
IBM Addresses Smart Grid Transformation
Ray Jones, IBM
Our purpose

“*To Advance the Deployment and Utilization of Smart Grids Globally*”

How? -- Adopt the Maturity Model approach

... *A maturity model can move an entire industry forward*

The Maturity Model ...

1. Creates a roadmap of activities, investments and best practices that lead to a desired future state
2. Provides characteristics of maturity that you would expect to see at each stage along the journey
3. Identifies observable indicators of progress -- measurable outcomes that should improve with maturity

Best way to widest possible adoption and benefit ... Establish open, global stewardship and growth.

Stewarding selection criteria:

> Global, impartial and prestigious organizations
> Widely recognized with broad industry representation
> Speed and experience to implement and act
> Not a “Standards” body – this is a business tool
> Sustainable Business Model
> Ability to govern; ability to collect and analyze data
The Road to the Smart Grid Maturity Model

1H 2008 - Developed by Global Intelligent Utility Network Coalition
IBM and 7 utilities from 4 continents provide SMEs to over 6 months to develop, debate and validate the SGMM content

APQC creates two surveys with input from IUN Coalition
- SG/MM Level Assessment Survey
- Smart Grid Results Survey

Surveys piloted, refined with IUN Coalition

2H 2008 - SGMM opened to broad industry use
Over 40 Utilities have participated WW

March 2009
- SGMM donated to CMU/SEI for Stewardship & Growth
- World Energy Council will support global Advocacy & Participation

GOAL: Widespread industry adoption to help transform the industry
SGMM Participation To Date – *Uncovering a World of Data*

40+ Utilities, Representing **100 Million Consumers** and over **$100 Billion in Revenue**

... and counting!

*Approximate... numbers now being calculated*
The “Smart Grid” Maturity Model is a strategic management framework to identify opportunities for improvement or innovation.

**1. What is it?**

The SGMM is a management tool to guide, appraise and improve toward a Smart Grid transformation.

**2. How does it help?**

The SGMM creates a clearly articulated journey with defined Smart Grid stages and options.

- It creates a common framework and language for defining all the key elements of a Smart Grid transformation.
- It helps bridge gaps between strategy and execution.

**3. How is it used?**

The SGMM can be used in a variety of ways...

- To create and communicate a common vision
- To assess where you are, plan where you want to be, measure success
- A tool to prioritize options
The Heart of Smart Grid Maturity Model

www.sei.cmu.edu/smartgrid

is built on 3 concepts

8 Domains - logical groupings of functional components of a smart grid transformation implementation

**Strategy, Management & Regulatory**

- Cost strategy expanded due to SG capabilities
- Strategic case emerging enabling policy (more full benefits realization of regulatory treatment of investments made)
- New business model opportunities (different business models and/or new implementation strategies)

**Organization & Structure**

- Collaborative impact of investments in all aspects of the organization
- Organizational structure support new ventures and services that emerge (e.g. grid, customer experience)
- Culture of collaboration and integration across organizational boundaries

**Technology**

- Automation central computing, maintenance, and distribution functionalities
- New software infrastructure for advanced analytics
- Leading edge grid-visibility systems

**Societal & Environmental**

- Activities that facilitate and enable societal and environmental goals
- Examples of SG that drive critical societal and environmental outcomes
- New resources available as substitutes for market products to meet reliability objectives

**Grid Operations**

- Grid employee self-healing capabilities
- Automated grid restoration and automation
- End-to-end grid-visibility systems

**Work & Asset Management**

- Optimizing the use of assets between demand and supply
- New tools and process improvement scenarios
- Develop business case at functional level

**Customer Management & Experience**

- Customer management of demand and grid reliability enhancements
- Use grid investment opportunities to drive market-based services
- Process to leverage customer insights across business areas

**Value Chain Integration**

- Converged data management and support through a supply chain
- New business processes enabled by SG investments
- New data availability for improvements
- Process to leverage customer insights across business areas

5 Maturity Levels – defined sets of characteristics and outcomes

200 Characteristics – capabilities you would expect to see at each stage of the smart grid journey

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Smart Grid Maturity Model – Levels, Descriptions and Results

**Level 5: Innovating – Next wave of improvements**

- **Perpetual Innovation**
  - Self-healing operations
  - Autonomic business

- **Innovators**

**Level 4: Optimizing – Enterprise Wide**

- **Transformation**
  - Real time corrections
  - Broad reuse

- **Victors**

**Level 3: Integrating – Cross Functional**

- **Systemization**
  - Repeatable practices
  - Shared information

- **Cross LOB Champions**

**Level 2: Functional investing**

- **Strategy**
  - Proof of Concepts

- **Missionaries**

**Level 1: Exploring and Initiating**

- **Vision**
  - Experiments

- **Prophets, Heroes**

New business, operational, environmental and societal opportunities present themselves, and the capability exists to take advantage of them.

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.

Smart Grid spreads. Operational linkages established between two or more functional areas. Management ensures decisions span functional interests, resulting in cross functional benefits.

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.

Contemplating Smart Grid transformation. May have vision, but no strategy yet. Exploring options. Evaluating business cases, technologies. Might have elements already deployed.
A Few Words About Levels

What is your Smart Grid objective
...your ideal end-state

Not every utility will need, or want, to go to level 5

1 Exploring
2 Investing
3 Integrating
4 Optimizing
5 Innovating

Five Levels of Smart Grid Maturity

Level 1 Goal
Goal could be a single function (e.g., AMM)

Level 2 Goal
Cross functional integration could be goal

Level 3 Goal
Sometimes the cost, or risk, of moving to the next level may exceed the benefits

Level 4 Goal
Not every utility will need, or want, to go to level 5

One possible future state of Smart Grid maturity across the industry

Smart Grid maturity level curve across the industry that we might find today
# Eight Smart Grid domains and important elements

## People and Technology Domains

1. **Strategy, Management and Regulatory**
   - Vision, planning, decision making, strategy execution and discipline, regulatory, investment process

2. **Organization**
   - Communications, culture, structure

3. **Technology**
   - Information, engineering, integration of information and operational technology, standards, and business analytics tools

4. **Societal and Environmental**
   - Conservation and green initiatives, sustainability, economics and ability to integrate alternative and distributed energy

## Process Domains

5. **Grid Operations**
   - Advanced grid observability & advanced grid control, quality and reliability

6. **Work and Asset Management**
   - Optimizing the assets and resources (people and equipment)

7. **Customer Management and Experience**
   - Retail, customer care, pricing options and control, advanced services and visibility into utilization quality, and performance

8. **Value Chain Integration**
   - Enabling demand and supply management, distributed generation, load management, leveraging market opportunities
### The heart of the model - Sample smart grid characteristics

#### Strategy, Management & Regulatory
- **5 Innovating Next Wave Improvements**
  - Overall strategy expanded due to SG capabilities
  - Optimal rate design regulatory policy (most beneficial regulatory treatment for investments)
  - SG is a core competency
  - External stakeholders share in strategy

#### Organization & Structure
- **4 Ongoing Enterprise Wide**
  - SG driven strategy and influences corporate decision-making
  - SG is a core competency
  - SG drives strategy and influences corporate decision-making
  - SG drives strategy and influences corporate decision-making

#### Technology
- **3 Integrating Cross Functions**
  - SG initiatives across LOBs
  - SG is driver for org. change (addressing aging workforce, culture issues, etc.)
  - SG initiatives across LOBs
  - SG initiatives across LOBs

#### Societal & Environmental
- **2 Functional Innovations**
  - SG is driver for org. change (addressing aging workforce, culture issues, etc.)
  - SG initiatives across LOBs
  - SG initiatives across LOBs

#### Grid Operations
- **1 Exploring and Initiating**
  - SG is driver for org. change (addressing aging workforce, culture issues, etc.)
  - SG initiatives across LOBs
  - SG initiatives across LOBs

### Characteristics Examples: Work & Asset Management
- **Level 1**
  - Component performance analysis
  - Introducing support for home energy management systems
  - Risking AVAMS
  - Conducting value analysis for new systems

- **Level 2**
  - Customer participates in DR enabled new business productivity
  - Performing AVAMS
  - Feedback from customers on SG

### Cross Functional Characteristics Examples:

- **3 Integrating Cross Functions**
  - New vision influences change
  - Organizational change driven by new SG initiatives
  - Organizational change driven by new SG initiatives
  - Organizational change driven by new SG initiatives

- **2 Functional Innovations**
  - New vision influences change
  - Organizational change driven by new SG initiatives
  - Organizational change driven by new SG initiatives

- **1 Exploring and Initiating**
  - New vision influences change
  - Organizational change driven by new SG initiatives
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### Work & Asset Management
- **Level 1**
  - Component performance analysis
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### Cross Functional Characteristics Examples:

- **3 Integrating Cross Functions**
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- **2 Functional Innovations**
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- **1 Exploring and Initiating**
  - New vision influences change
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  - Organizational change driven by new SG initiatives

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The heart of the model - smart grid characteristics

**Characteristics Examples:**

- **Organization & Structure**
  - Performance and compensation linked to SG success
  - Consistent SG leadership across LOBs
  - Org. is adopting a matrix or overlay structure
  - Culture of collaboration and integration
  - SG measures on balanced scorecard

- **& Asset management**
  - Use of assets between different areas of assets in abstract representation framework

- **Customer Management & Experience**
  - Customer management of SG and its impacts on energy usage and usage level
  - Customer engagement at decision-making levels

- **Value Chain Integration**
  - Overall strategy developed due to SG success
  - Optimal risk management strategy (most beneficial regulatory treatment for investments)
  - Strategic planning initiatives implemented in SG

---

**Strategy, Management & Regulatory**

- Overall strategy developed due to SG capabilities
- Optimal risk management strategy (most beneficial regulatory treatment for investments)
- Strategic planning initiatives implemented in SG

**Organization & Structure**

- Collaborative engagement across all aspects of transformed business
- Organizational change management through partnerships
- Culture of innovation and collaboration

**& Asset management**

- Use of assets between different areas of assets in abstract representation framework

**Customer Management & Experience**

- Customer management of SG and its impacts on energy usage and usage level
- Customer engagement at decision-making levels

**Value Chain Integration**

- Overall strategy developed due to SG capabilities
- Optimal risk management strategy (most beneficial regulatory treatment for investments)
- Strategic planning initiatives implemented in SG
Smart Grid Maturity Model

...helping determine strategic intent

Green dots = Current status based on survey
Yellow dots = Aspirations based on planning
Gaps in between = Opportunities for improvement

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**Strategy, Management & Regulatory**

- Overall strategy expanded due to SG capabilities
- Optimized SG visioning process & alignment
- Organizational changes support new initiatives and service models
- New business model opportunities present themselves and are implemented

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**Organization & Structure**

- Collaboratively engage all stakeholders in all aspects of transformational work
- Organizational change support new initiatives and service models

---

**Technology**

- Autonomous computing, machine learning
- Persistent use and leadership on standards
- Leadership influence in technology and industry groups
- Leading edge grid technology systems

---

**Societal & Environmental**

- Acquire the "Triple Bottom Line" (financial, environmental and societal)
- Customers enabled to manage their usage (e.g. tools and self-adaptive networks)
- Tailored analytics and advice to manage distributed generation

---

**Grid Operations**

- Grid employs self-healing capabilities
- Automated grid decision systems with displaying process analytics based control
- Optimal rate design/ regulatory policy
- Utilization system with dynamic controls

---

**Work & Asset Management**

- Optimizing the use of assets between and within supply chain participants
- Just in time retirement of assets
- Plug-in play customer based generation
- Near real-time status of customer usage
- Consumption linked to device available mobility and EDR programs

---

**Customer Management & Experience**

- Customer management of their end to end energy supply and usage level
- Usage analytics driven decision making
- Net billing programs in the home
- Automated response to pricing signals
- Enhanced customer experience integrated across all channels
- Recent customer usage data (e.g. daily)

---

**Value Chain Integration**

- Coordinated energy management and generation throughout the supply chain
- Coordinated control of entire energy assets
- Dispersible resources are available for energy storage
- Proprietary innovation is supplied (e.g. IAMS - Customer Multiplier Platform)

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**Innovating Next Wave Improvements**

- SG drive strategy and transformational programs
- SG is a core competency
- External stakeholders share in strategy and alignment
- SG visioning and alignment is engaging the stakeholders
- Innovation in applications and innovative funding schemes

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**Optimizing Enterprise-Wide**

- Completed SG strategy and business transformation vision
- SG governance with clear SG programs
- SG Lessons learned
- Integration of assets
- Ability to make and execute decisions
- Leadership being a primary ingredient

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**Integrating Cross Functional**

- 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

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**Functional Investing**

- New process being defined due to increased automation and observability
- Initial distribution to sub-station automation projects
- Implementing advanced outage restoration schemes
- Expanding and investing in extended communications networks

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**Exploring and Launching**

- Articulated need to change
- Executive commitment to change
- Funding likely out of existing budget
- SG is driver for org change (addressing aging workforce, culture issues, etc.)
- SG measures on balanced scorecard
- Compensation linked to SG success
- Consistent SG leadership cross LOBs
- Org. is adopting a matrix or overlay structure

---

**Sample Aspiration**

- Usage analytics driven decision making
- Net billing programs in the home
- Automated response to pricing signals
- Enhanced customer experience integrated across all channels
- Recent customer usage data (e.g. daily)

---

**Sample Current Score**

- Optimizing the use of assets between and within supply chain participants
- Just in time retirement of assets
- Plug-in play customer based generation
- Near real-time status of customer usage
- Consumption linked to device available mobility and EDR programs

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**Overall Level 0**

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Surveys Put the Maturity Model to Use
...assess, measure, and identify opportunities

- **Maturity Assessment**
  - Utility self-assessment
  - Describes current state
  - Scores are generated for each domain and each level
  - Assessment report compares to all participants
  - Enables roadmap for improvements

3. Level 3 Integrating – Cross Functional

3.1. Strategy and Management
A. Has your smart grid vision, strategy and business case been incorporated into your corporate vision and strategy?

<p>| | |</p>
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<thead>
<tr>
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<tbody>
<tr>
<td>a. no</td>
<td></td>
</tr>
<tr>
<td>b. limited</td>
<td></td>
</tr>
<tr>
<td>c. extensive</td>
<td></td>
</tr>
<tr>
<td>d. complete</td>
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B. Do you have a smart grid governance model in place (roles, processes, tools, etc.)

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<tbody>
<tr>
<td>a. not at all</td>
<td></td>
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<tr>
<td>b. partial</td>
<td></td>
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<tr>
<td>c. extensive</td>
<td></td>
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<tr>
<td>d. integrated into existing organization</td>
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C. Do you have one or more smart grid leaders with explicit authority across functions and lines of business to ensure application of smart grid?

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<tbody>
<tr>
<td>a. no</td>
<td></td>
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<tr>
<td>b. a single leader</td>
<td></td>
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<tr>
<td>c. multiple leaders</td>
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D. Have regulators authorized your smart grid investments (e.g. via mandate or other technique)?

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<tbody>
<tr>
<td>a. no</td>
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<td>b. indirectly</td>
<td></td>
</tr>
<tr>
<td>c. partially</td>
<td></td>
</tr>
<tr>
<td>d. explicit and complete</td>
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</table>
**Enhance Assessment with Performance Data**

**Opportunity & Results**

- Depicts resulting performance
- Identifies trends
- Enables business case and rate case development
- Report compares to all participants
  - Mean, quartiles, etc.
- Ability to report by demographics
  - By region
  - By total customers
  - Etc.

---

<table>
<thead>
<tr>
<th>Section 4: Operations</th>
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</table>
| 12. Please provide the following information regarding field visit operations (truck rolls):
| a. Total work orders initiated |
| b. Total field visits operations (truck rolls) avoided by smart grid |

<table>
<thead>
<tr>
<th>Section 5: Customer Benefit</th>
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</thead>
</table>
| 13. Please provide the following information regarding connects and disconnects:
| a. Total connects/disconnects |
| b. Remote connects/disconnects |

| 14. What is your organization’s ERT accuracy (estimate of restoration time)? |
| 15. How many of your customers have visibility to their price/consumption information on demand? |
| a. % at least monthly |
| b. % at least weekly |
| c. % at least daily |
| d. % Near real-time |
Sample of reports that survey participants receive
... this table shows actual composite of all participants as of March 13, 2009

- Scoring results: Numerical scores in every domain, by level
  - Green Level achieved… at least 70% of criteria met
  - Yellow Progress made… 40% to 70% of criteria met
  - Red Long way to go… less than 40% of criteria met

Technology is a example of a domain that has reached Level 2

<table>
<thead>
<tr>
<th>All Participants Composite</th>
<th>SGMM Overall Score</th>
<th>Strategy and Management</th>
<th>Organization</th>
<th>Technology</th>
<th>Societal and Environmental</th>
<th>Grid Operations</th>
<th>Work and Asset Management</th>
<th>Customer Management and Experience</th>
<th>Value Chain Integration</th>
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<tr>
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<td>0.16</td>
<td>0.11</td>
<td>0.39</td>
<td>0.18</td>
<td>0.18</td>
<td>0.13</td>
<td>0.10</td>
<td>0.09</td>
<td>0.13</td>
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<tr>
<td>Level 4</td>
<td>0.24</td>
<td>0.25</td>
<td>0.16</td>
<td>0.19</td>
<td>0.31</td>
<td>0.24</td>
<td>0.34</td>
<td>0.25</td>
<td>0.19</td>
</tr>
<tr>
<td>Level 3</td>
<td>0.39</td>
<td>0.38</td>
<td>0.36</td>
<td>0.38</td>
<td>0.55</td>
<td>0.29</td>
<td>0.39</td>
<td>0.45</td>
<td>0.27</td>
</tr>
<tr>
<td>Level 2</td>
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<td>0.52</td>
<td>0.43</td>
<td>0.71</td>
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<td>0.69</td>
<td>0.54</td>
<td>0.58</td>
<td>0.37</td>
</tr>
<tr>
<td>Level 1</td>
<td>0.71</td>
<td>0.77</td>
<td>0.74</td>
<td>0.78</td>
<td>0.94</td>
<td>0.74</td>
<td>0.65</td>
<td>0.46</td>
<td>0.59</td>
</tr>
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</table>

Level 0 – Participants scores to date are split almost exactly 50/50 between Level 1 and Level 2

Work and Asset Mgmt. is an example where the composite is level zero
... e.g. an area that may may need more focus
Knowledge you may gain from your assessment results …

**A Management Tool**

- How your organization compares to other survey participants overall
- Do you have deficiencies in one area that may adversely effect others
- Perhaps you have been project oriented, rather than program driven (e.g. lots of peaks and valleys)
- Maybe you have the “cart before the horse” in some areas
- Confirm results where you have been putting focus
- Point out areas that might need more focus

Has a lack of a strategy led to uneven results overall?

Should the practices applied in this area be replicated in others?

Is step by step progression being followed?

Does this area need additional emphasis?
SEI’s Role in Smart Grid Maturity Model Framework

Bill Wilson

Mike Konrad
Serving Smart Grid Stakeholders

The U.S. Department of Energy’s support of the Smart Grid Maturity Model enables the model to be accessible to the electric power industry.

Building on the strong foundation developed by IBM, the SEI is committed to expanding and enhancing the model for the following stakeholders:

- Utilities
- Equipment manufacturers and systems integrators
- Consumers
- Regulators
- Governments
Why the SEI? Experience Matters

• The SEI is located at Carnegie Mellon University, a global research university recognized worldwide for its energy and environmental research initiatives.

• The SEI is a trusted, objective broker of best practices, methods, and tools to organizations worldwide.

• The SEI is a global leader in software and systems engineering, architecture, and security best practices—all critical elements of smart grid success.

• The SEI has a proven foundation of people and processes to support and evolve models into industry standards.
Why the SEI? Experience Matters

• The SEI is the developer and steward of global de facto process improvement standards such as CMMI.

• The SEI is the home of the world-renowned CERT, a leader in improving software, systems, and network security practices.

• The SEI is a collaborator with industry and government on important architectural and cybersecurity considerations of the smart grid, including ongoing efforts with U.S. Department of Energy and U.S. Department of Homeland Security in critical infrastructure protection.
The SEI’s Role - 1

- Provide governance of the Smart Grid Maturity Model
- Promote and advocate the widespread availability, adoption, and use of the model
- Grow and evolve the model based on stakeholder needs, market needs, and user feedback
- Utilize extensive transition activities – education, training, awareness, partnership – to support products and services of the model
The SEI’s Role - 2

Leverage 25 years of experience to

- Serve as advocates of smart grid technology initiatives for utilities worldwide
- Ensure consistency and quality of model adoption worldwide
- Promote and advocate adoption through case studies, education, training, partnerships, and conferences
- Expand and grow adoption of the Smart Grid Maturity Model through governance, community involvement, and much more
When Will the Smart Grid Maturity Model Be Available?

The Smart Grid Maturity Model has been used by utility organizations worldwide:

- The current model is available at www.sei.cmu.edu/smartgrid.
- The SEI will build on the strong foundation of the model through user feedback, experience in developing best practices, and training and development.
- Utilities can request a copy of the Smart Grid Maturity Model questionnaire to begin to establish their foundational process for Smart Grid transformation. Contact SEI Customer Relations at customer-relations@sei.cmu.edu.
Smart Grid Maturity Model – Future Activities

In the coming months, the SEI will transition the model and ramp up its stewardship activities.

Interested parties should join our mailing list to learn more about future activities, including user workshops and other opportunities to get involved. Contact SEI Customer Relations at +1-412-268-5800 or customer-relations@sei.cmu.edu.
The Age of the Smart Grid Is Here

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